

ELECTRONIC DESIGN

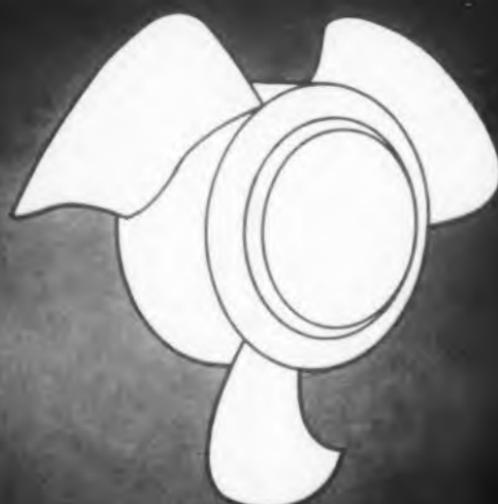
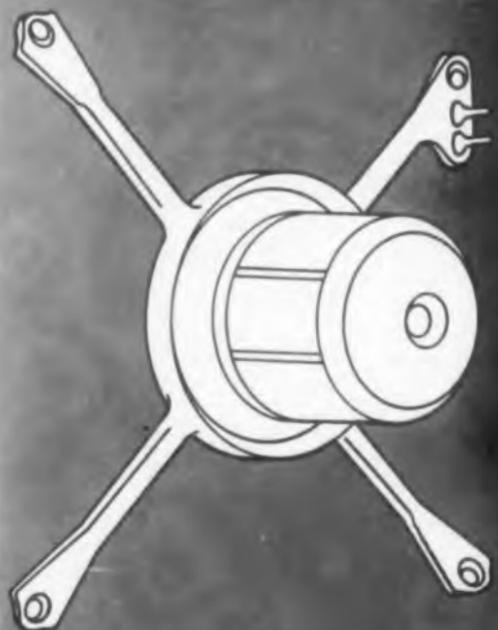
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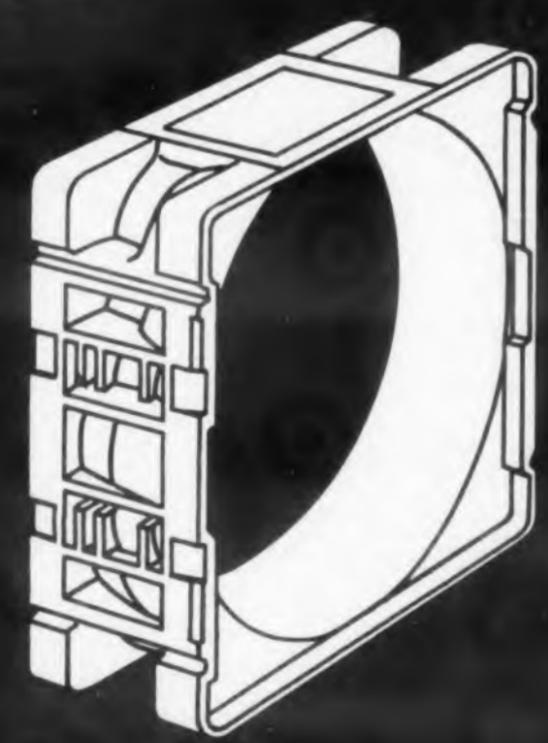
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Potting....



Casting....



Molding

Potting, Casting, Molding used to produce a low-cost quality fan p. 22

Precision Computing Resolvers

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ACCURACY

Highest accuracy in rotating components is a CPPC fundamental. Our Precision Computing Resolvers are no exception. Without compensation, a recent production run of resolvers showed functional errors of .06% or less. Perpendicularity of axes was $\pm 3'$ in 360° . Due to extreme symmetry of rotor and stator, nulls are excellent in these resolvers. Low phase shifts are also a feature.

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able in any or all units: resistive, feedback winding, thermistor. Types available for transistor circuitry. Pin or screw terminals or lead wires. BuOrd type shafts and BuOrd MK 4 Mod 0 brush block obtainable.

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ENGINEERS—For an interview during IRE Convention, telephone David D. Brown, personnel director at Circle 7-5576

cppc

CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS, PENNSYLVANIA

CIRCLE 7 ON READER-SERVICE CARD

HIGHLIGHTS OF ISSUE



Low-Cost Cooling Fan (Cover) 22

Cost barrier for a quality cooling fan has been broken by special tooling which eliminates machining and assembly operations. Stator is held together by epoxy resin, rotor is centrifugally cast and a molded frame requires no machining.

Impedance Matching 18

Matching an rf power amplifier to a load of any impedance can be accomplished simply without reference to cumbersome charts and graphs. The engineer will find these design insights equally adaptable to other matching problems.

Let's Do Something About Too Many Diodes

Read the Editorial on p. 17 to learn how you can help cut down on the number of types of diodes that are now being produced.

When we question diode manufacturers about the absurdity of producing thousands of different types they say that they are in business to please the customer. If he wants a special type, they'll make it.

There is a prevailing view on how to lick the problem. We all say "Why not make these thirty or forty types? They solve 95 per cent of our problems." But the trouble is one reader's recommended list is as good as another's and they are not alike. George Rostky's editorial suggests a method for getting the consolidated opinion of many readers. With your support, this opinion can be made strong enough to influence manufacturers. Let's work together.

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MAR 17 1959

March 18, 1959 Vol. 7

N U M B E R

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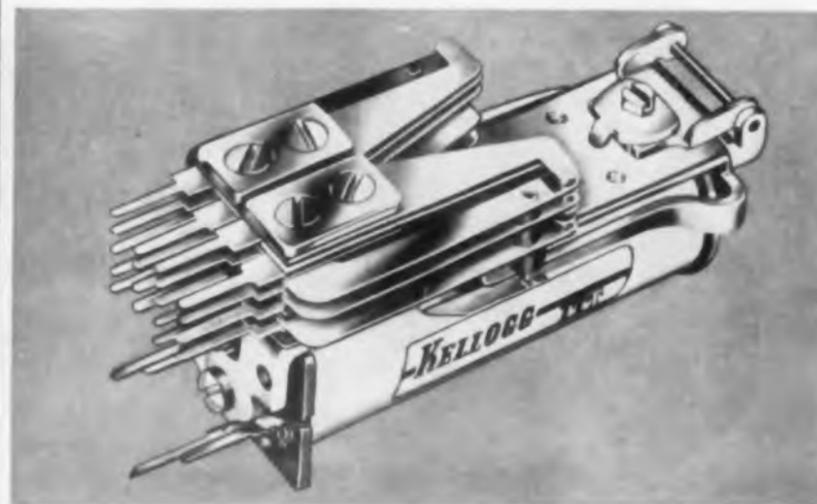
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ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer; and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation publication at Bristol, Conn. Additional entry, New York, N.Y. Copyright 1959 Hayden Publishing Company, Inc. 32,000 copies this issue.

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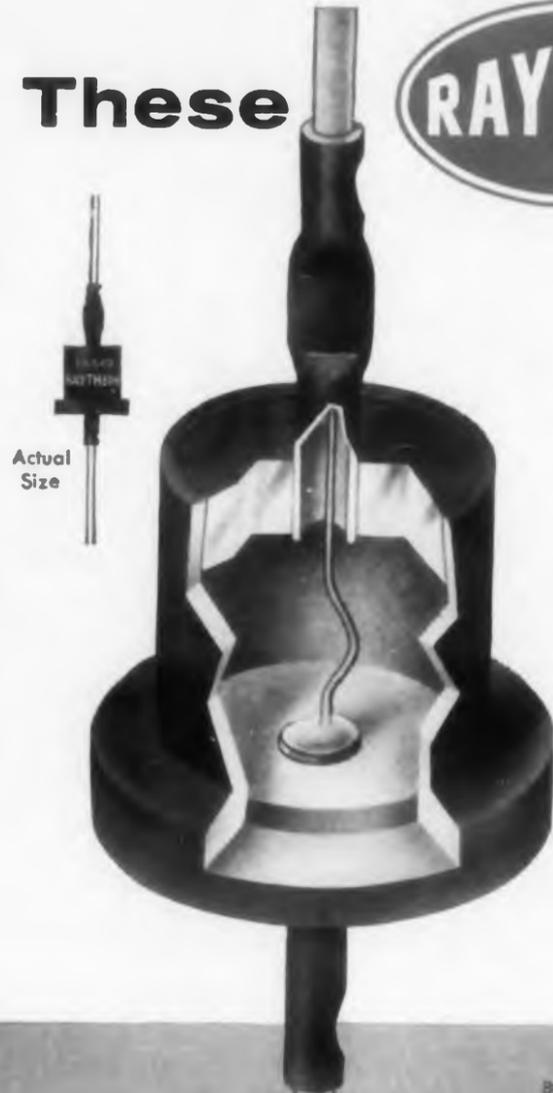
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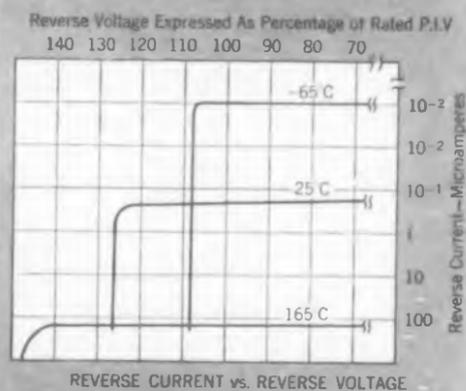
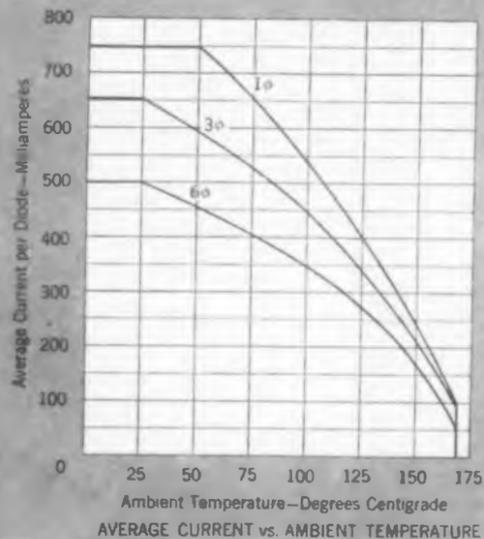
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Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV μ A
1N536	50	0.25	2
1N537	100	0.25	2
1N538	200	0.25	2
1N539	300	0.25	2
1N540	400	0.25	2
1N1095	500	0.25	2
1N547 (1N1096)	600	0.25	2

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500 hours at -65°C

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DESIGN

BEHIND
THE
NEWS

Transistorized Ignition Systems

for . . . Reliability . . . Cold Weather Starting . . . Increased Engine Efficiency

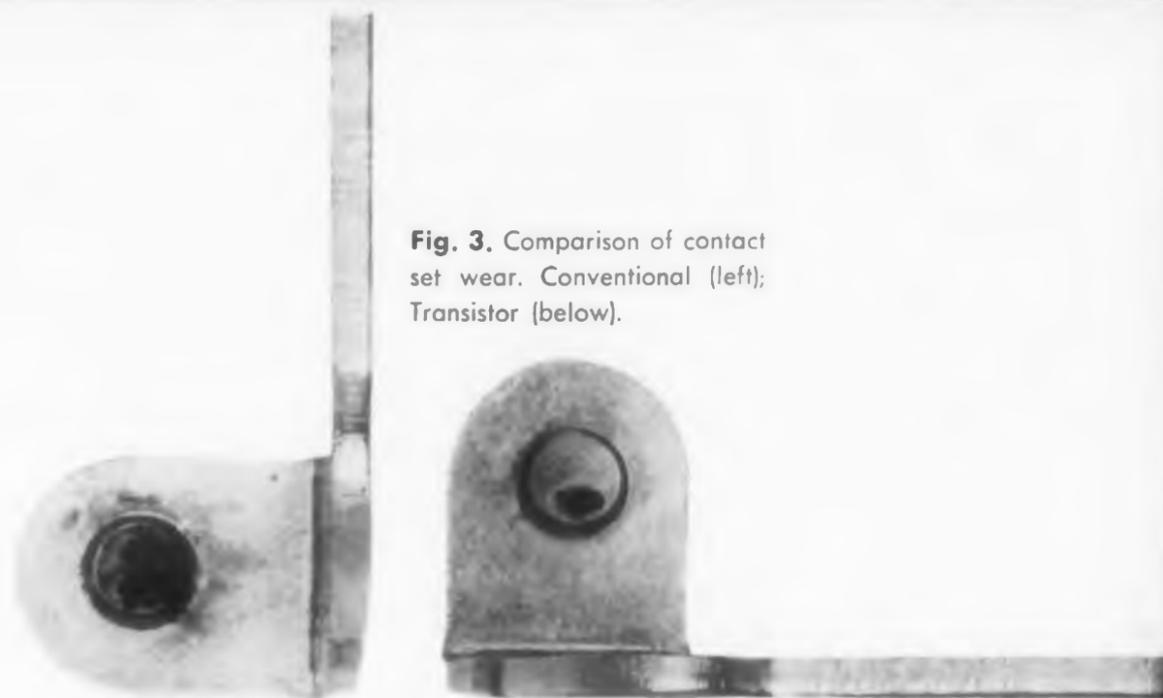
SLIGHTLY LARGER than a conventional ignition coil, a complete, self-contained transistorized ignition system promises lifetime distributor contact service, reliable starting in temperatures as low as -20°F , and constant voltage output for spark plug firing throughout the engine speed range.

Shortcomings in the conventional ignition system are eliminated in the new development announced by The Electric Auto-Lite Co., Toledo, Ohio.

Conventional Ignition System

The conventional ignition system for a simple four-cylinder engine is shown in Fig. 1. Current through the primary of the ignition coil, or transformer, is interrupted by the primary switch. This switch is mechanically operated by a cam, driven by the engine shaft through a gear train. Every time the switch opens, high voltage appears across the secondary of the coil and is applied to the rotating "finger" of the distributor. This finger is

Fig. 3. Comparison of contact set wear. Conventional (left); Transistor (below).



driven by the same shaft as the primary switch, and the distributor contains as many equally-spaced fixed contacts as there are cylinders.

No actual contact exists between the rotating finger and the fixed contacts—the spark jumps across the air gap every time the finger comes in front of a fixed contact and, simultaneously, the primary switch opens.

Each fixed contact is connected to a spark plug so that the high-voltage circuit comprises the sec-

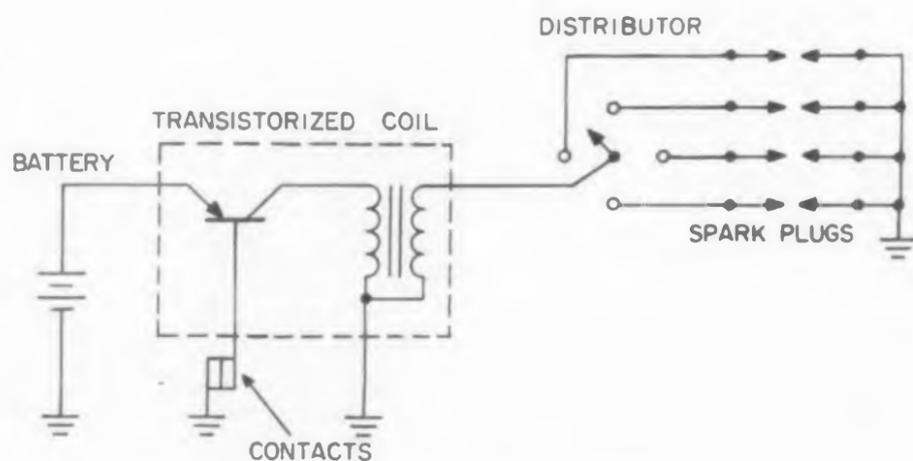


Fig. 1. Conventional ignition system for a 4-cylinder engine.

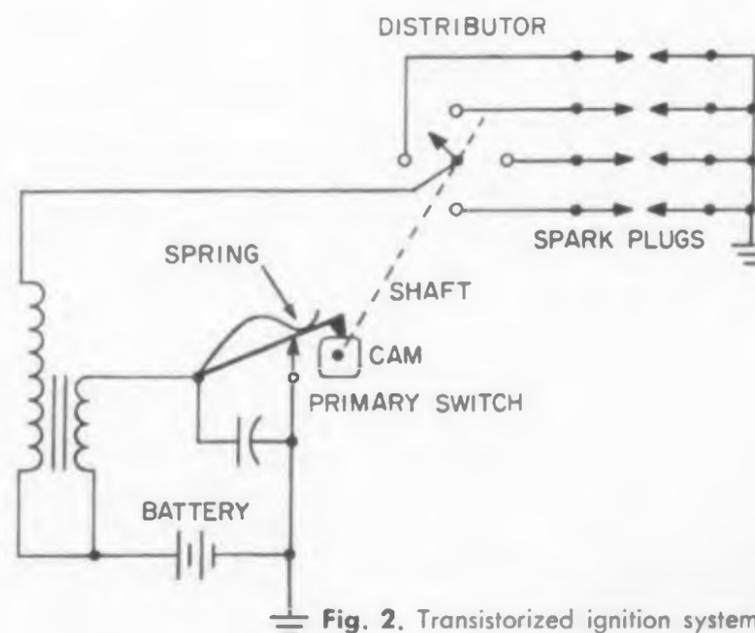


Fig. 2. Transistorized ignition system.

Creative Microwave Technology

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NEW ONE-WATT COMMUNICATION KLYSTRONS COVER GOVERNMENT AND COMMON CARRIER BANDS

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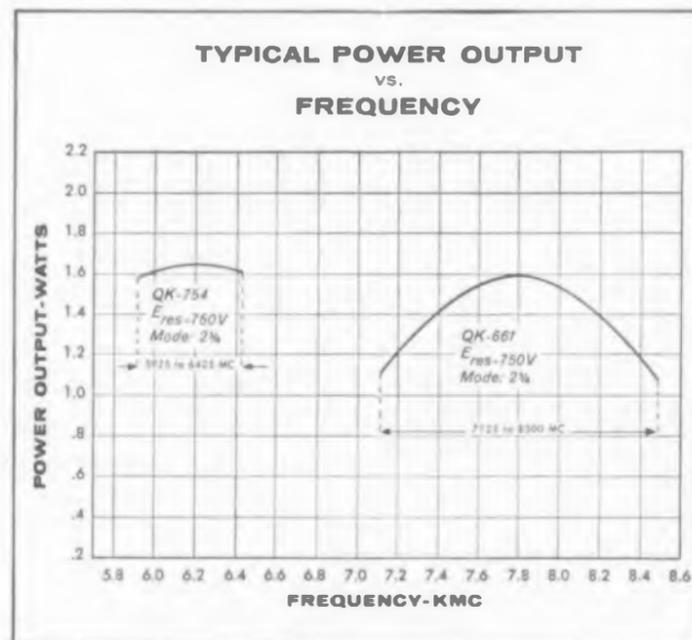
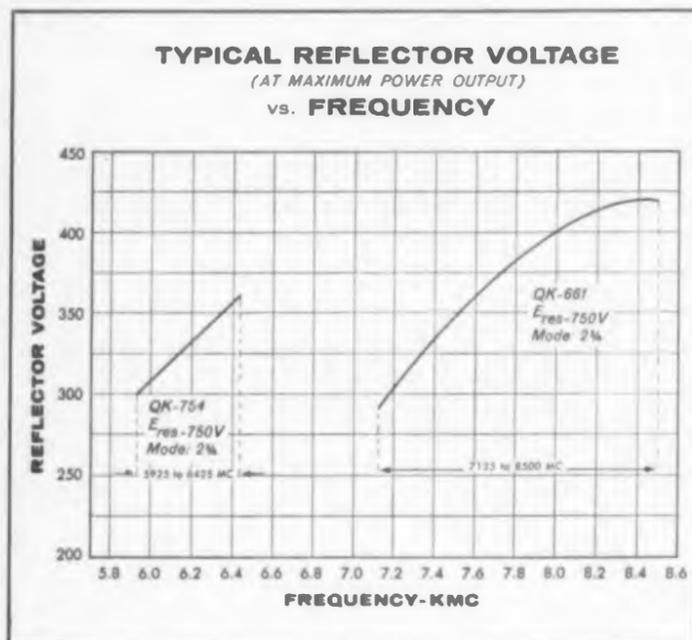
Both are mechanically tuned, integral-cavity, long-life, reflex-type tubes. The QK-754 uses a coaxial output; the QK-661, a waveguide output.

To insure efficient operation the tubes are available with integral cooling fins or with a heat-sink attachment suitable for connection to the chassis.



Typical operating characteristics

	QK-754	QK-661
Frequency Range	5925 to 6425 Mc	7125 to 8500 Mc
Power Output	1.5 watts	1.6 watts
Electronic Tuning (to half-power pts)	50 Mc	25 Mc
Modulation		
Sensitivity (10 V pk-to-pk mod volt)	1 Mc/V	600 Kc/V
Temp. Coefficient	± 0.1 Mc/°C	± 0.1 Mc/°C



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BEHIND THE NEWS

ondary of the coil, the distributor finger, an air gap, fixed contact, spark plug, and return to coil secondary. Most of the troubles due to the ignition system originate in the primary switch or in the coil.

Shortcomings

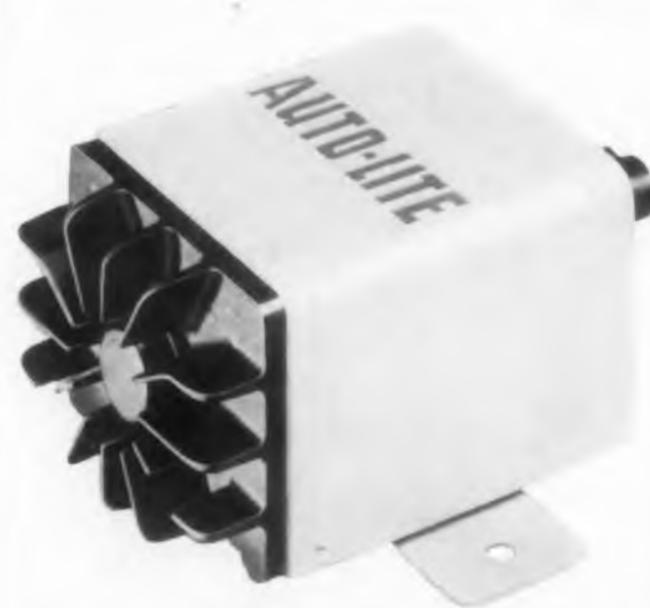
In a mile of average driving, the distributor contacts make and break at rates ranging from 12,000 to 24,000 times a minute, depending on engine speed. With primary currents as high as four amps, current densities exceed 1,000,000 amps in.² during "break." The resultant heat created erodes the contact surface until ignition failure requires contact replacement.

During average climate conditions, the engine turns over rapidly during starting so that the rate of contact operation does not permit the heat created to raise the contact surfaces to oxidizing temperature. In extremely cold weather, the engine turns over slowly, the contact surfaces remain together longer, and the excessive heat will bring the tungsten surface to red-heat, resulting in build-up of tungsten oxide. This bluish rust-like scale, "blue" points, accounts for poor cold weather starting and is responsible for a large majority of "down" time.

Finally, at high speeds the contacts open and close too rapidly to permit full build-up of input current. This results in reduced output when the engine speed is increased; up to 50 percent drop off in available ignition power may occur, for example, when a driver swings out to pass another car.

Transistor-Switched Transformer System

As shown in Fig. 2, a power transistor is placed



Auto-Lite "Transicoil" package with transistor and heat sink visible.

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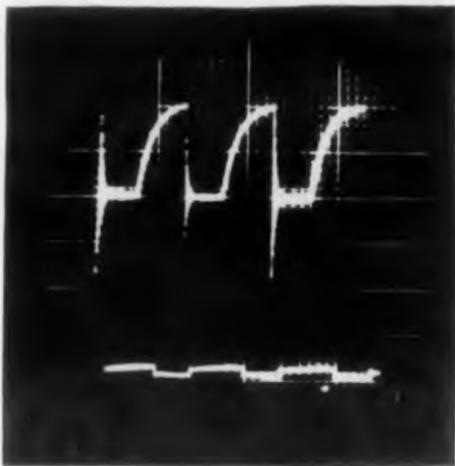


Fig. 4. Conventional system primary current rises relatively slowly (2.5 amps P-P). Transistor base current rises rapidly (250 ma P-P).

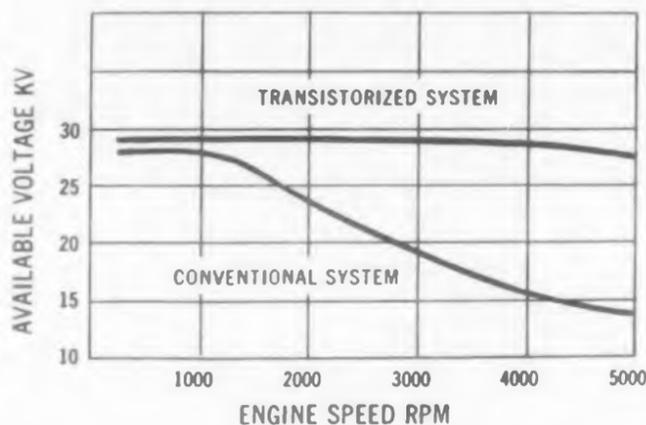


Fig. 5. Transistor system output voltage remains constant despite engine speed changes.

between the battery source and the primary coil; the distributor contacts, triggering the base circuit, handle less than 250 ma while controlling 7.5 amps flow through the primary coil. This results in greatly increased contact life. Prolonged endurance tests of over 3500 hours and 100,000 miles show practically no wear, see Fig. 3. Cold weather starting tests have shown oxidation to be completely eliminated.

The input current of the transistor system rises rapidly to maximum value while the conventional system rises slowly from the time the contacts close, shown in Fig. 4. This rapid rise of current, regardless of engine speed, is responsible for an almost constant output voltage throughout the speed range; comparison between output voltages for both systems is shown in Fig. 5.

A new development in contact set design, called "Power Points," further improve reliability by reducing high speed bounce approximately 15 percent over previous designs.

Applications

The new system can be installed, in a matter of

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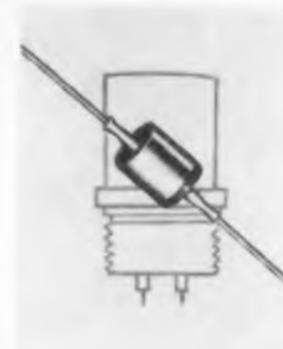
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STYLE 2	-.172" x .438"	6.8 mfd/35V to 56 mfd/6V
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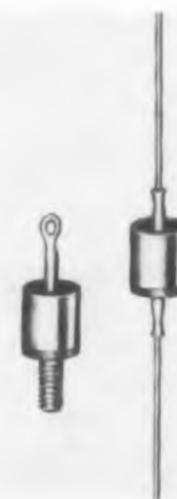
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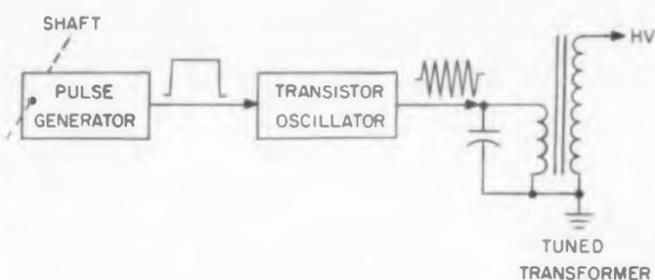


Fig. 6. Block diagram for a typical transistorized ignition system.

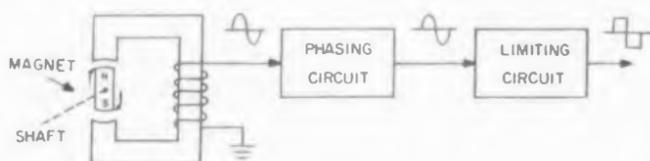


Fig. 7. A typical pulse generator for the new system uses a conventional alternator (driven by the engine), a phasing circuit (to provide spark advance), and a limiter (to clip the sine waves).

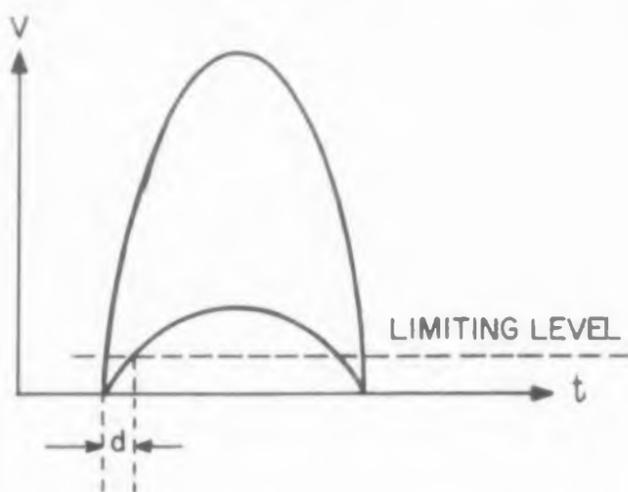


Fig. 8. The time difference d , corresponding to the automatic advance, is provided automatically by the difference in the sine wave amplitudes at different engine speeds.

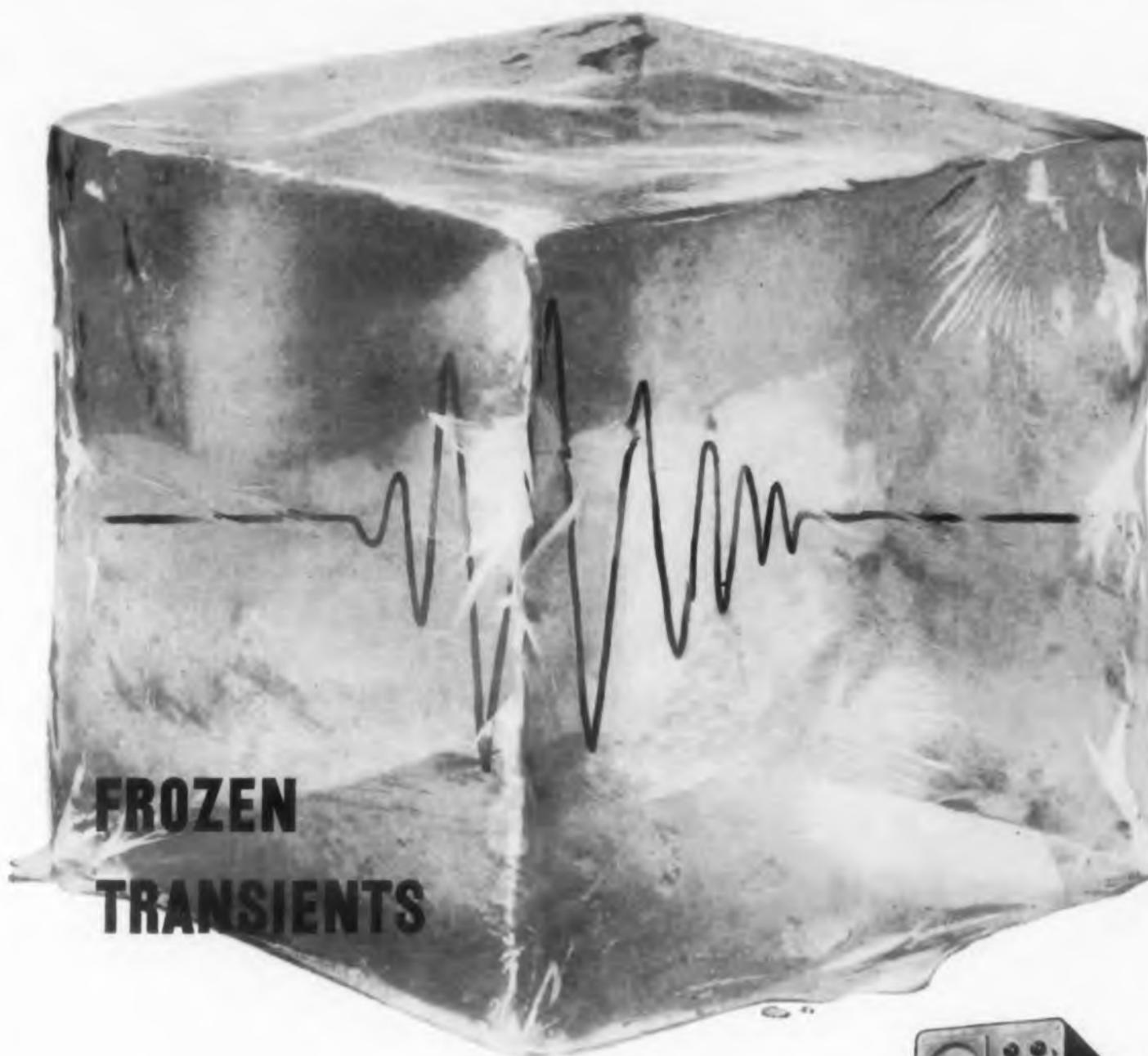
minutes, in any battery ignition system by removing the existing ignition coil and capacitor and mounting the new transistor assembly. Applications include passenger, commercial and military cars, trucks, boats, and tractors.

The complete package, consisting of the transistor, its heat sink, the transformer and associated circuitry, will be available as optional equipment for 1961 passenger cars. The initial cost is estimated to be in the range of power steering.

Foreign Design Approach

A leading French automobile manufacturer, according to A. V. J. Martin of the Carnegie Institute of Technology, is conducting tests on a transistorized oscillator supply for high voltage generation. The primary switch is replaced by an electromechanical pulse generator triggering

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WITH FAFNIR MINIATURE BALL BEARINGS YOU GET ALL FIVE IMPORTANT FEATURES



VACUUM MELT 440C. Balls and rings of Fafnir miniature bearings are made from vacuum melt 440C stainless steel.

ADVANTAGES. Since vacuum melt steel is extremely clean, balls and races are free from pits and inclusions providing better finishes which result in super sensitive bearings with low torque values.



BALANCED DESIGN. Each size bearing has its "tailormade" retainer of predetermined weight and dimensions.

ADVANTAGES. Pitch circle of the balls is centered between bore and O.D. and bearing is symmetrical in design.



HARDENED RETAINERS. All retainers are made of hardened 410 stainless steel.

ADVANTAGE. Precise hardening, insured against brittleness and easy breakage by quality control, provides springiness... eliminating bending or distortion.



SWAGED RETAINERS. In manufacture retainers are swaged so that ball pockets of retainers are ironed outwardly.

ADVANTAGE. Ball runs against a hardened, smooth surface not a rough edge.



HEAT STABILIZATION. All rings and balls are heat stabilized to 600 degrees.

ADVANTAGE. Standard Fafnir bearings may be used for high temperature applications as well as regular applications.

All Fafnir miniature bearing tolerances are to ABEC-7 standards except for the inner ring bores where tolerances are $+.0000 - .0002$ to provide greater flexibility in selective assembly. Bearing balls are lapped to 2.5 millionths for sphericity and 5 millionths for size variation. Fafnir Miniature Ball Bearings are available in the following types: open; flanged; two shields and flanged two shields. Complete details and dimensions in bulletin No. 469. Write for copy. The Fafnir Bearing Company, New Britain, Conn.



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CIRCLE 8 ON READER-SERVICE CARD

BEHIND THE NEWS

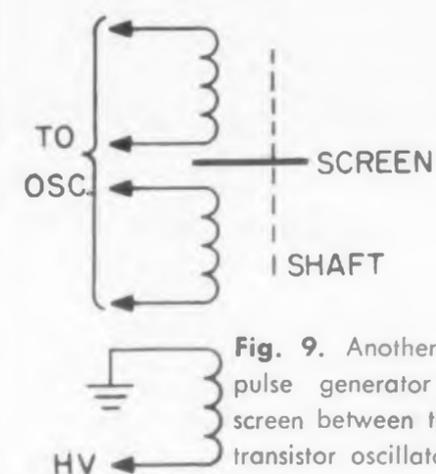


Fig. 9. Another electromechanical pulse generator uses a metallic screen between the two coils of the transistor oscillator.

Fig. 10. This screen, driven by the engine, pulses the oscillator when a slot allows coupling between the two oscillator coils.

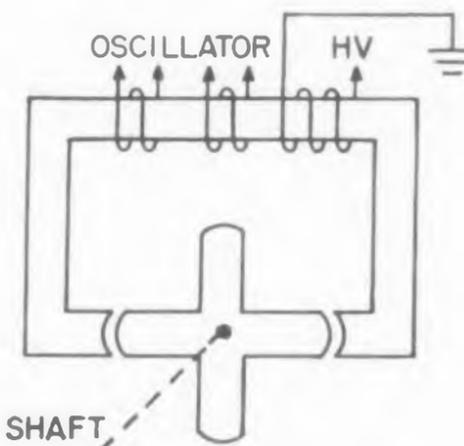
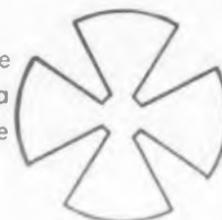
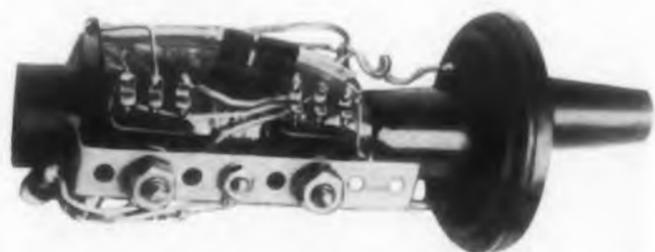


Fig. 11. In the magnetic circuit method, the spokes of magnetic material close the oscillator circuit.



Developmental ignition system built inside the usual high voltage coil can. The two transistors can be clearly seen in the foreground.

the transistor oscillator, as shown in Fig. 6.

The electromechanical pulse generator can take a number of forms. For example, in Fig. 7 a conventional alternator, driven by the engine, provides a sinusoidal voltage whose frequency is equal to a multiple of the rotation speed. A simple limiting circuit will then change the sinusoids into a square

waveform. The phase (and hence the advance) can be adjusted manually or automatically by a phasing circuit connected between the alternator and the limiter.

Moreover, the amplitude of the sinusoidal voltage varies with the speed of rotation. This makes for an automatic increase of the advance, since the same limiting level will cut a large amplitude sinusoid sooner than a small amplitude sinusoid (Fig. 8). The time difference "d" corresponds to the automatic advance. The transistor oscillator, using a ferrite core step-up transformer, operates between 50 to 80 kc.

Direct Pulsing of the Oscillator

The electromechanical pulse generator can be integral with the oscillator, with corresponding simplification and economy. An example is given Fig. 9. A metallic screen is placed between the two coils of the transistor oscillator and prevents oscillation. However, this screen is of the shape indicated in Fig. 10 and rotates with the engine. When the shaft position is such that no metallic part is placed between the coils, the oscillator functions and provides the high voltage. The circular screen has as many slots as there are cylinders.

Another possibility is indicated in Fig. 11. The rotating part is now a star of magnetic material, with as many spokes as there are cylinders. When the shaft position is as indicated on the figure, the magnetic circuit of the oscillator is closed, and the oscillator functions. When the rotation of the star opens the magnetic circuit, the oscillations cease.

In both Figs. 9 and 11, the shaft carrying the rotating screen or star also carries the finger of the distributor.

Practical Advantages

The system indicated in Fig. 11 can be of small dimensions, and has been constructed as a small unit which takes the place of the usual primary switch-distributor combination, and does away with the separate coil, see Fig. 12.

The new ignition system takes less current from the battery for better results at all speeds. It can be parasitic-suppressed to reduce radio interference by virtue of its fixed low frequency and undecaying oscillation during pulses.

The automobile industry has been concerned with the deficiencies of the classical circuit, and several ideas have been put forward embodying some electronic equipment. Before, however, systems using vacuum or gas tubes suffered from the limitations of the tubes themselves, especially as regards ruggedness, life expectancy, and supply voltages. In aircraft, where safety is at a premium, two complete and entirely distinct ignition circuits of the conventional type are now necessary. The solid state devices seem ideally suited to this kind of problem.

AN IMPORTANT NEW PRODUCT ANNOUNCEMENT FROM HUGHES!

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FOR LOW-NOISE MICROWAVE AMPLIFIERS

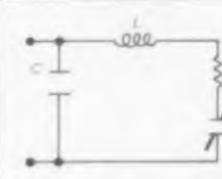
Now Hughes Products brings you high performance parametric amplifier diodes at a price in the same range as good microwave mixer crystals. These Hughes diodes have been designed to solve your problems associated with low-noise parametric amplifiers, modulators, frequency converters, harmonic generators, electronic tuners, switches, etc., at microwave as well as at lower frequencies.

Used in a 3000 Mc high gain parametric amplifier with both signal and idler channels as inputs, these diodes have produced at room temperature in

the laboratory a noise temperature of 100 K above absolute zero. Noise temperatures of 50 K above absolute zero were obtained when diode was cooled by liquid nitrogen.

The Hughes Parametric Amplifier Diodes are available in two rugged, hermetically sealed versions. One has a miniaturized glass package (type HPA 2800); the other has been adapted to a conventional microwave package (type HPA 2810). Both are hermetically sealed in glass and have the same cutoff frequency.

TECHNICAL SPECIFICATIONS AND DATA:

Package (actual size)	C	C @ zero bias (nominal)	cutoff frequency* (nominal)	L (nominal)	V _S ** Min.	V _S ** Nom.	Equivalent Circuit
HPA 2800 	0.1 μf						
HPA 2810 	0.2 μf	2.5 μf	70KMC	4mμh @ 1KMC	5V	7V	

*At breakdown voltage

**Breakdown voltage (10_μA point)

Address inquiries to:

Hughes Products, Semiconductor Marketing Dept.,
P. O. Box 278, Newport Beach, California.

CAPACITANCE vs. BIAS VOLTAGE	Reverse Bias Voltage	Capacitance C
	0 V	2.5 μf
	3 V	0.76 μf
	7 V	0.60 μf

Creating a new world with ELECTRONICS

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BEHIND THE NEWS

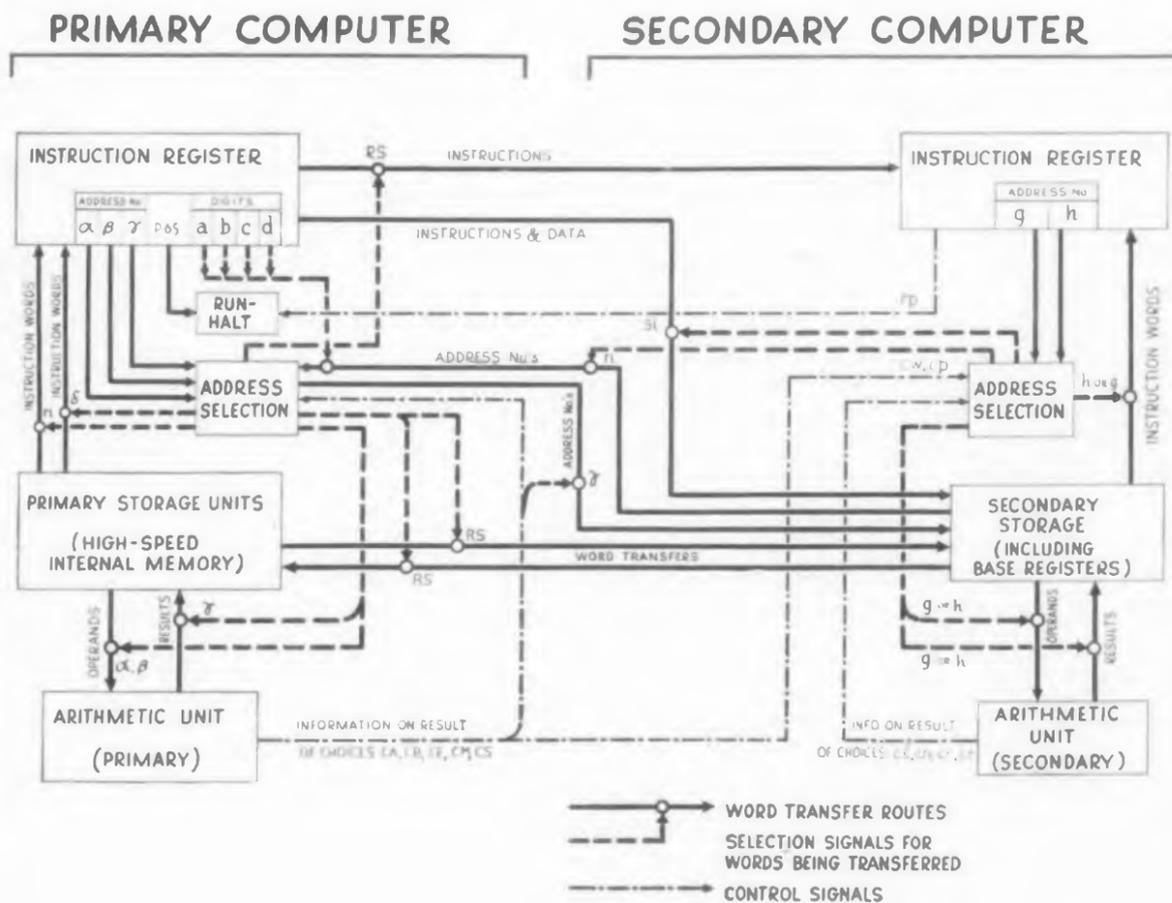
Co-ordinating Computer Networks for Increased Efficiency

ONE APPROACH to developing more useful computing systems is that of connecting together several computers into an integrated network. Techniques have been under study at the National Bureau of Standards for attacking and solving the logical problems encountered in organizing such a network. These problems include devising a scheme for making all the computers collaborate efficiently, and designing an instruction system for carrying out such collaborative operations effectively.

Problems

In organizing such a network, many

logical problems are encountered that do not ordinarily occur in the usual single-computer system. One problem is that of devising an efficient scheme for enabling all the computers to share among themselves, automatically, the total workload undertaken by the network. Another problem is that of designing a machine instruction system which can carry out these complex operations effectively and yet is simple enough to code easily. Investigations of the Bureau's data-processing systems laboratory has resulted in the design of the new NBS Pilot Data Processor, a multi-computer network with powerful data-processing capabilities.



Two-computer network

Initial Approach

One mode of approach for increased efficiency is to connect together several computers into an integrated network so that all of the machines in the network could be made to work together on large-scale problems. By dividing up the total task into different pieces, and by having all the different computers in the system work on different pieces of the task simultaneously, an increase in the speed of solution can be achieved.

Under ideal circumstances, the entire job could be split up into pieces that are completely independent, and each computer could carry out its assigned portion of the work without interacting on the other machines in the network. In actual practice, however, this ideal of complete independence cannot be attained because the results of one set of computations will, as a rule, be needed as input data for another set, and the starting of one phase of operations will have to wait for the ending of another phase. When these successive phases are carried out by several different computers, one machine may have to stop and wait idly for data from another if the different steps are not properly coordinated—thereby wasting time.

Multi-Computer System

The new NBS multi-computer system is made up of several independently operating units that run concurrently. From time to time, as the need arises, they can exchange data and instructions.

The primary computer of this system is a full-scale machine that performs a wide variety of arithmetical and other operations. The secondary computer, though an independent internally programmed machine, is more limited in scope and is intended mainly as an adjunct to the first machine. While the primary is performing the major arithmetical processing manipulations, the secondary concurrently carries out specialized procedures that assist the primary's program; these correspond to the "job requests" delegated by the primary.

Associated with the secondary computer is the secondary storage unit containing a certain number of short word-storage locations. Some of these locations are used as "base registers" by the primary computer. These base registers contain numbers used by the primary as automatic address modification constants, or as alternative addresses for its next instruction. Loading of the base registers and manipulation of the numbers stored in them are carried out by the secondary computer.

To make a "job request," the primary instruction program inserts a new instruction in the secondary's computer's instruction register. Alternatively, the primary program can also order data transferred between the primary storage unit and



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Both the 21" TONOTRON Tube and the 21" TYPOTRON tube are now available for delivery. For additional information please write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

See the new Hughes 21" TONOTRON tube in action at the I.R.E. show (Booths 2801-2807)

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meet and surpass rigid requirements of airborne analog-to-digital translation despite environmental extremes. Shock, vibration, and severe temperatures do not affect their continuous, noise-free operation.

THEY'RE DIRECT Librascope encoders provide a simple, one-step means of digitizing analog data.

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THEY'RE RELIABLE Multi-million turns at high speeds with constant contact resistance.

THEY'RE VERSATILE 14 basic models in a wide range of capacities with special function codes built-in to simplify computer requirements.



MODEL 740



MODEL 713



MODEL 758



MODEL 724



MODEL 708

OUTPUT CODE	MODEL NO. @	TOTAL CAPACITY	RESOLUTION PER TURN	DIMENSIONS DIA. x LENGTH
PARALLEL BINARY (LINEAR)	740	10 bits (1024)	1024	$4\frac{3}{8}'' \times 2\frac{1}{2}''$
	743	13 bits (8192)	128	$2'' \times 3\frac{1}{2}''$
SERIAL BINARY (LINEAR)	707	7 bits (128)	128	$2'' \times 2\frac{3}{4}''$
	713	13 bits (8192)	128	$2'' \times 3\frac{1}{2}''$
	717	17 bits (131,072)	128	$2'' \times 4\frac{1}{8}''$
	719	19 bits (524,288)	128	$2'' \times 4\frac{1}{8}''$
SERIAL BINARY (SIN-COS)	757†	7 bits per quadrant* (4 quadrants)	512	$2\frac{1}{4}'' \times 4\frac{1}{8}''$
	758†	8 bits per quadrant* (4 quadrants)	1024	$4\frac{1}{8}'' \times 3\frac{3}{8}''$
BINARY CODED DECIMAL (8-4-2-1)	723	2,000	200	$3\frac{1}{8}'' \times 4\frac{3}{32}''$
	724	20,000	200	$3\frac{1}{8}'' \times 4\frac{3}{32}''$
	733	3,600	200	$3\frac{1}{8}'' \times 4\frac{3}{32}''$
	734	36,000	200	$3\frac{1}{8}'' \times 6\frac{1}{8}''$
	735	360,000	200	$3\frac{1}{8}'' \times 6\frac{1}{8}''$
GRAY	708	8 bits (256)	256	$3\frac{1}{8}'' \times 1\frac{1}{8}''$

@All models available with internally mounted isolation diodes for sequential multiplexing applications.

†Available in hermetically sealed servo-driven package as Models 757-S and 758-S.

*Including limit 1 and polarity information. Sine and cosine functions generated simultaneously and independently. One turn of shaft generates 4 quadrants of information.

For full details on Librascope shaft-to-digital encoders write for catalog E 11-1.

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CIRCLE 12 ON READER-SERVICE CARD

BEHIND THE NEWS

the secondary storage unit.

To synchronize the actions of the two computers properly, the programming system earmarks certain selected instructions in the primary program. Instructions so marked are intended to be performed after certain key instructions have been carried out by the secondary computer. When an earmarked instruction is reached in the primary program, control of the relative time sequencing of primary and secondary operation passes to the secondary program. This program can then regulate the relative priority of execution of subsequent instructions in either program by special sequence-regulating instructions—called an rp (regulate primary program) instruction.

Operation

In operation, the primary computer, upon reaching an earmarked instruction, will check, before executing this instruction, to see whether the secondary computer is stopped and waiting with an rp instruction. If this is not the case, the primary waits until the secondary reaches an rp. As soon as both programs have reached a mutual waiting status (that is, with the primary waiting with an unexecuted earmarked instruction and the secondary waiting with an unexecuted rp instruction), the sequencing will take place according to an explicit code written in the secondary (rp) instruction word. Various alternatives are available, under which priority may be accorded to either computer depending on whatever order of sequencing is most appropriate to the logic of interchange. Possible sequences include repetition or skipping of the primary instructions.

When both computers are in a mutual waiting condition, the secondary computer can also refer to the various base registers and control counters that the primary computer has just referred to or is about to refer to. The secondary computer can make these references either directly, that is, as a result of explicit register numbers written in the secondary instruction or indirectly that is, according to the locations specified in the currently waiting primary instruction. In consequence, the secondary computer can be used to monitor or interpret the program of the primary in a highly flexible fashion.

The new NBS Pilot Data Processor contains not only a primary and secondary computer but also a third independent computer, which specializes in operations that control and interpret the data flowing between the system's internal memory and its external storage and display devices. In the future development of these network systems, it is expected that even larger numbers of independent machines will participate cooperatively in the performance of stringent tasks.

Circle 498 for Ohmite spread ►

ELECTRONIC DESIGN • March 18, 1959

CASE HISTORIES



Photos: Courtesy Ernst Norman Laboratories and Bodine Electric Co.



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opment and production. N/D equipped micro-clocks, selected by the Smithsonian Institute, are operating in a dozen locations around the world right now, keeping track of vital satellite movements . . . to accuracies of one milli-second and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department J-3.


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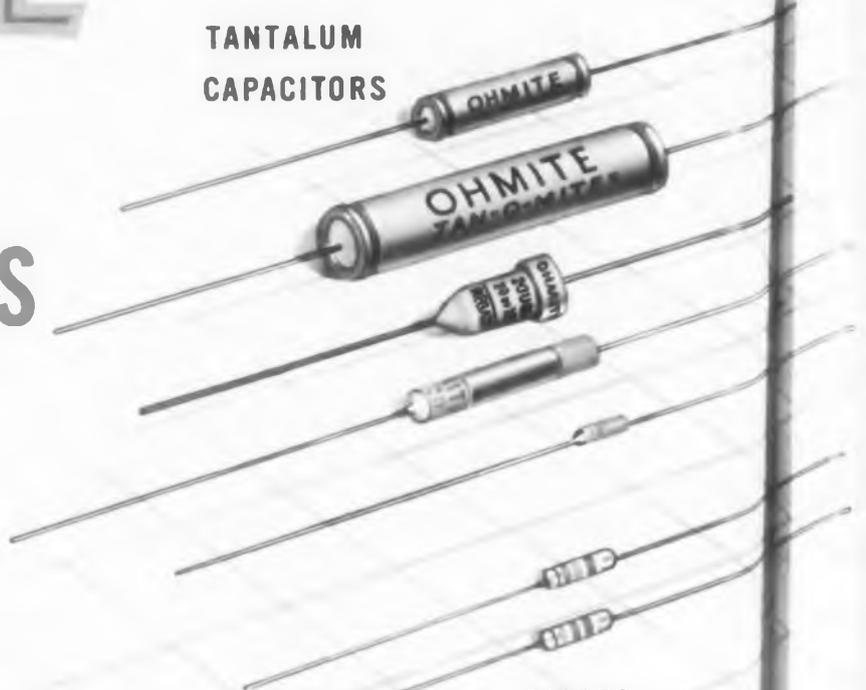
NOTHING ROLLS LIKE A BALL

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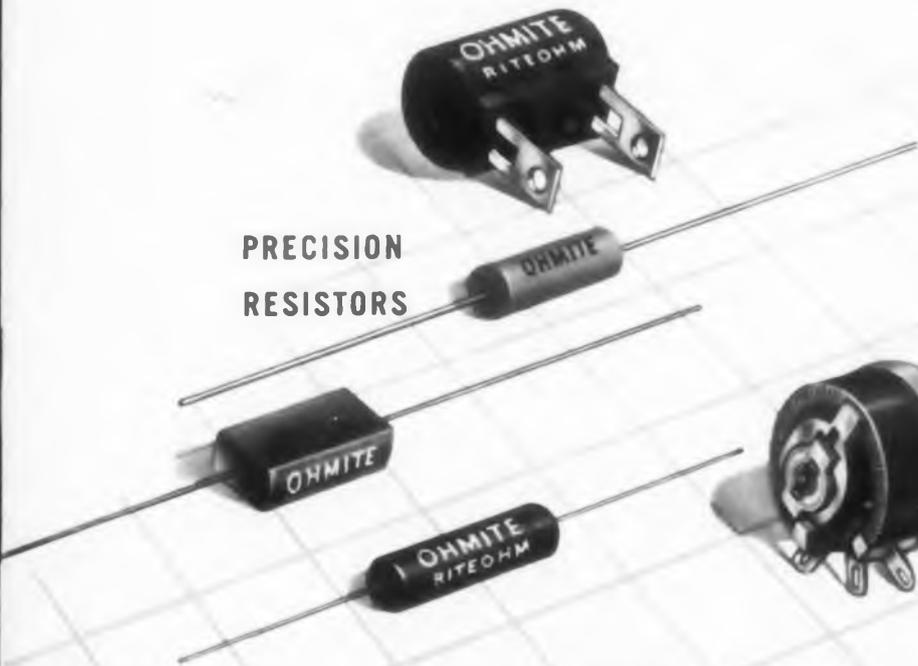
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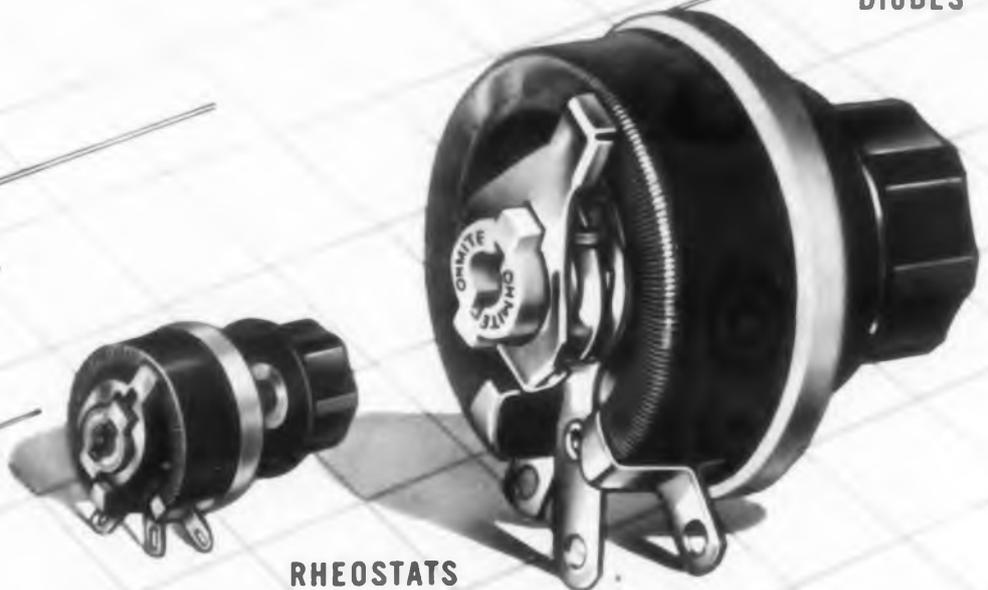


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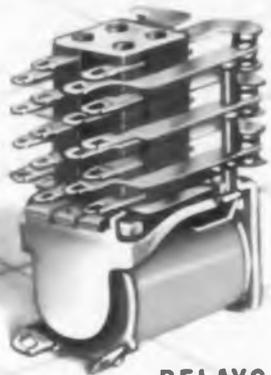
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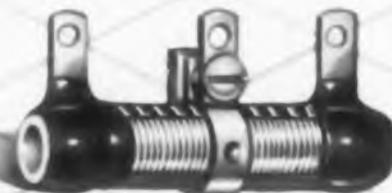
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For forward thinking . . . for new products to meet the needs of tomorrow . . . you can depend on Ohmite. Ohmite maintains a continuous program of research and development to explore new product ideas and to improve present products and processes. Furthermore, Ohmite's superb laboratory facilities permit in-plant testing of its products to meet rigid military specifications.

This unceasing research activity has kept Ohmite components truly "pacing the progress of industry."



Ohmite has complete laboratory facilities where difficult customer application problems are studied.

NEWS BRIEFS . . .

• • • **ELECTRONIC TOPICS**, ranging from computers to communication systems to semiconductor devices, comprised almost 40 per cent of the program offered at the Winter General Meeting of the AIEE, held in New York City during Feb. 1-6. Over 500 papers were presented to an estimated 6500 engineers. Consensus of opinion among members indicates the growing popularity of the informal presentation and panel discussion as contrasted with the stiff, formal reading of prepared papers encountered in the past. Discussions after paper presentations were particularly lively and pointed. In addition, there appeared to be a marked, and healthy, increase in participation by students from various universities throughout the country.

• • • **FOURTEEN NATIONS** are in active competition for positions on the program of the First International Conference on Information Processing to be held in Paris during June 15-20. So far, approximately one-third of the selected papers have been prepared by U. S. engineers and five of the thirteen planned symposia will be coordinated by American computer experts.

In conjunction with the five day technical session, a worldwide exhibition of information processing equipment will be on display from June 13-23. The exhibit, called Auto-Math 1959, will be limited to the latest in equipment and techniques in the field.

• • • **PLEASURE CRAFT**, yachts, and work boats can be outfitted with a new line of marine equipment ranging from low-cost Lorain to a portable, transistorized direction finder. Recently introduced by Sperry Piedmont Co., Charlottesville, Va. division of Sperry Rand, the navigational instruments feature a sleek nautical appearance as contrasted with the "black-box" look common to earlier styling. A ten inch radar unit, with range extending to 20 miles, a compact five inch radar with a one- and five-mile range, an automatic pilot, converters, and miniature gyro-compasses round out the full line.

• • • **WRITERS OF GHOST STORIES** and horror movies may soon lose a favorite device for setting an eerie atmosphere . . . the "squeaky hinge" is on its way out. An application for its successor—a silent, non-sticking all-nylon plastic hinge—is now in the U. S. Patent office. The new hinge, developed by American Plastics Corporation, will require no lubrication and is expected to outwear its conventional metal counterpart many times.

This is the time of our annual subscription renewal.

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ELECTRONIC DESIGN • March 18, 1959

after routing,
clip and save



a continuing series on technical topics of specific interest to engineers

What is the true value of high purity aluminum foil in electrolytic capacitors?

Since the word "purity" is relative, the term "high purity" in describing the foil used in electrolytic capacitors has been often misused. Twenty years ago, 99.80% aluminum was the highest purity commercially available. A few years later, 99.85% aluminum anodes became available and for a period of time were considered "high purity" foil.

Today, 99.99% aluminum is readily available for applications where the cost differential between 99.99% and standard purity anodes is justifiable. In some technical circles, purities of 99.85% to 99.87% aluminum are still referred to as "high purity". At Sangamo Electric Company high purity means 99.99% aluminum or better anode foil.

From the engineer's viewpoint, the advantage of 99.99% aluminum over 99.87% aluminum in electrolytic capacitors is both tangible and intangible. Most of the benefits are derived from the fact that there are fewer crystals of metal impurities on the surface of the higher purity foil. Crystal impurities such as iron do not form an insulating dielectric oxide and produce points of high electrical leakage. In a circuit, where capacitors of lower anode aluminum purity are used, voltages are set up between the dissimilar metals and deformation, or point corrosions, slowly takes place. This action decreases the shelf life of the capacitor.

Other benefits provided from the use of 99.99% aluminum foil include longer life, better high temperature operation and lower dissipation factor. When variable factors are equal, the summary advantages of 99.99% anodes versus 99.87% anodes can be shown as follows:

	99.87% Anodes	99.99% Anodes
DC leakage	Per Mil-C-62A or EIA-RS-154	EIA-TR-140 or about 1/2 leakage for 99.87% anodes
Shelf life	2 years	2 1/2—3 years
Estimated life expectancy	4—7 years	7—12 years

Where extremely low leakage is important, where temperature of operation is between 65°C and 85°C, or where exceptional long life is required and something better than standard electrolytic capacitors is desired, 99.99% aluminum anodes are well worth the additional cost.

Capacitor manufacturers, like Sangamo, pay a premium of approximately 60% more for 99.99% aluminum foil. To obtain this near-perfect purity, the aluminum ingots used to produce 99.99% anodes must be reprocessed from a good supply of bauxite and a well run electro-chemical process.



The use of 99.99% high purity aluminum anodes in Sangamo Type TR Twist-Tab Electrolytics, surgically clean papers, and a highly effective end seal gives these capacitors excellent operating life and superior electrical characteristics. They are designed to operate in a temperature range from -20°C to 85°C and are available in ratings from 3 to 450 volts D.C.

Engineering Catalog Number 2227 gives full information and is available upon request for your files.

5C59.1

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

--designing towards the promise of tomorrow

CIRCLE 13 ON READER-SERVICE CARD



SHRUNK BY EXPERTS

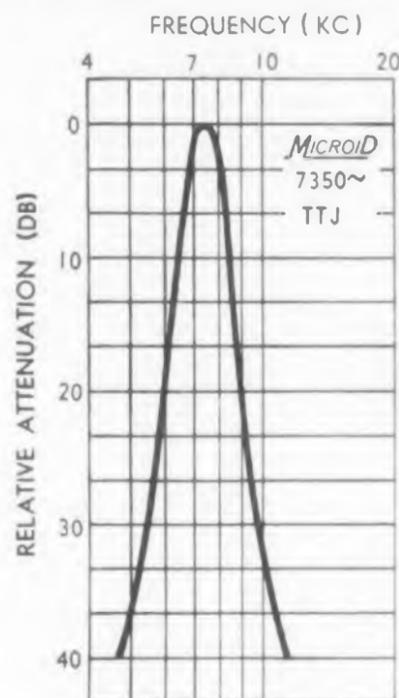
Burnell & Co. may not be experts in the art of head shrinking. But when it comes to toroids, filters and related networks, Burnell has the know-how to solve an infinite variety of small space problems. The new **MICROID**® filters by Burnell & Co. are a notable achievement in the shrinking of filters which can be designed for low pass or band pass applications.

For example, as a low pass filter, Type TCLJ starts at 400 cps. Physical size is 11/16" x 1-11/16" x 1/2" max. For higher frequencies from 7,500 cycles up to 100 kc, size is 3/4" x 1" x 1/2".

The band pass filter, Type TTJ pictured here, ranges from 7,350 cycles

up to 100 kc. Physical size is 1/2" x 19/32" x 15/16", weight .3 ounces, band width 15% at 3 db and + 60% - 40% at 40 db. Wherever space and performance are critical requirements, miniaturized **MICROID**® low pass and band pass filters provide utmost reliability as well as more unit surface economy on printed circuit boards. Completely encapsulated, they are ideally suited to withstand high acceleration, shock and vibration environments. Write for special filter bulletin to help solve your circuit problems.

See these and other subminiature components on display at Booth 2919-2921, IRE Exhibit.



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WASHINGTON REPORT



Ephraim Kahn

Loose U. S. Patent Policy to be Tightened

Government patent policies, inconsistent and "contradictory", are being examined by the Senate's Subcommittee on Patents, Trademarks and Copyrights. The group's chairman, Senator Joseph C. O'Mahoney (D., Wyo.) points out that the federal government is the "largest single investor in scientific research and development, and both the amount of money it spends and the number of agencies administering its research programs are steadily increasing."

Noting that this activity is presently "producing a large number of discoveries and inventions which may be patentable, and will produce an even greater number in the future," the Senator adds that "the public has a very substantial interest in what the government does with its patent rights."

New Legislation

Legislative action may be suggested "to bring order to this presently chaotic field of important government activity" after the subcommittee completes its study, states Senator O'Mahoney. Though the nature of such recommendations is not yet known, the group has cited, with apparent approval, a report made in 1947 by the Justice Department. This urged that the government take title to all patents produced under research contracts or grants, except in special cases. In the exceptional instances where the government did not take title to the patent, it was to receive an irrevocable, royalty-free non-exclusive license and if the contractor failed to place the invention in adequate commercial use within a designated period, he was to offer non-exclusive licenses at a reasonable royalty to all applicants.

The Government Patents Board, created in 1950, was not given power over the disposition of inventions made by contractors or grantees, according to the subcommittee, and practices with regard to inventions by employees vary. For example, the National Science Foundation (which is considering a change in its rules) has so far taken the view that in no case is it desirable for title to patents produced through government-financed research to rest in the government; it feels that a non-exclu-

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sive perpetual license to use an invention is all that it needs. On the other hand, the Tennessee Valley Authority retains all patents produced by government research but grants non-exclusive royalty-free licenses.

NASA Has Long Reach

In the meantime, business and government are trying to unsnarl some of the tangles that result from varying official patent policies. The situation seems particularly acute under contracts let by the National Aeronautics and Space Administration, which is in the business of developing new technology. Under the Space Act, any invention made in the course of work under a NASA contract normally becomes the exclusive property of the government. The NASA Administrator may find, however, that the public interest would be served by having the contractor keep the patent. Furthermore, NASA's reach is long—it covers inventions under subcontracts even though the inventor may be unaware that he is working on a space agency project.

The Space Act's patent provisions require the Commissioner of Patents to notify NASA of any application received—whether stemming from government- or privately-financed activity—which seems to have "significant utility" in the conquest of space. NASA then can take title to the patent for the government within 90 days, or waive this right in the "public interest."

A new federal patent policy seems to be implied in this—that the government has pre-emptive rights to inventions of importance to the national interest regardless of the fact that costs of development may have been borne by industry. It also raises the question of possible retroactive application of the NASA Administrator's ability to buy, condemn, lease, or otherwise obtain title to, or use of, patents that he needs or wants.

ASPR More Lenient

Industry by far prefers the Defense Department's patent rules. The Armed Services Procurement Regulation demands only that the government be given a non-exclusive royalty-free license to all patents on inventions made or reduced to practice in the course of performance of a contract with the military. Several industry associations are trying to have this ASPR rule substituted for the current Space Act provision.

NASA is aware that the law makes it difficult to write patent regulations which will stimulate broad business participation in the space research program. To do so, it will evidently have to take advantage of the latitude given to its Administrator by Congress. NASA is not required to take title to patents; it can settle for a license to use the patent. In addition, provision is being made for special awards to inventors whose patents are

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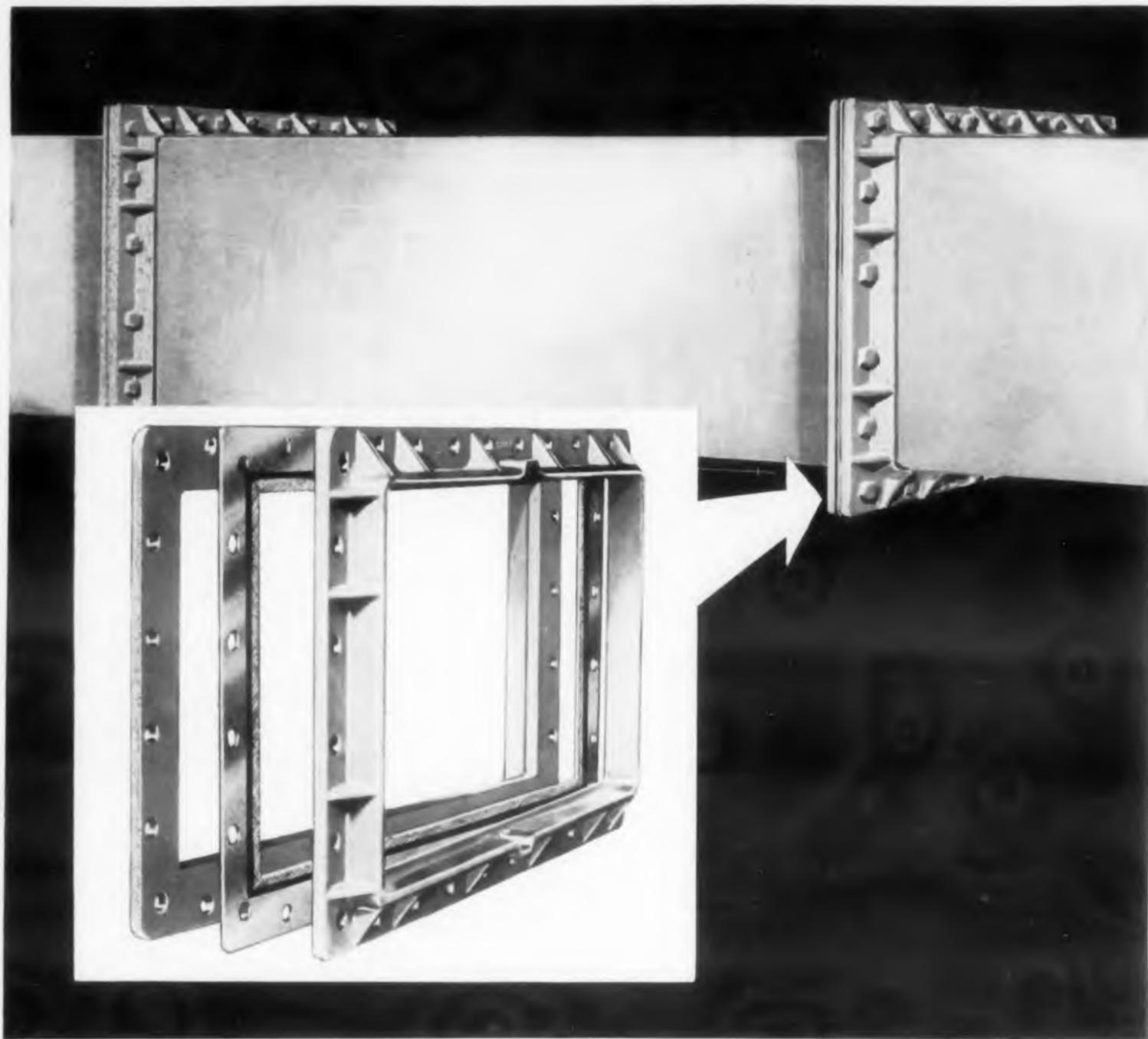
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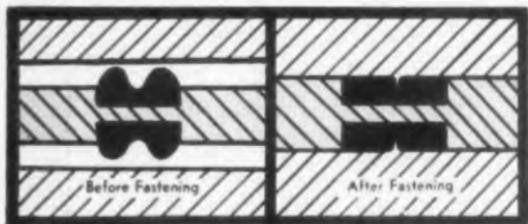
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CIRCLE 16 ON READER-SERVICE CARD

WASHINGTON REPORT

taken over by the agency.

NASA has already gotten ideas both from individuals and companies for projects that may be useful in space exploration. At the end of January, 365 ideas had been received, of which 145 came in during that month alone. The agency stamps each with a time and date, thereby setting priority of submission and authorship. None are to be published without the author's permission. The agency can give awards to authors (individual or corporate) of accepted ideas. They may, of course, also lead to development contracts, though this is by no means certain. In view of the scale of rewards for ideas that is probable, the money aspect is far more likely to be of interest to an individual than to a corporation. But companies might find value in the prestige of having had an idea accepted, particularly for institutional advertising purposes.

Transistor Supply Planning

Possible transistor shortages are being felt out by the Defense Department. Questionnaires are being sent to prime contractors for certain electronic devices because the military want to know which (if any) transistors and related items are likely to be in short supply. Contractors will be asked to state their needs for transistors by category and number. Response to the questionnaire will be mandatory.

New Security Bill

New Industrial Security Bill, endorsed by the Administration, has been introduced by Senator John M. Butler (R., Md.). Purpose of the bill is to protect vital defense facilities, including plants, against sabotage, espionage, and other acts of subversion.

The bill provides that any individual who is barred from access to a defense facility shall be notified in writing of the charges against him and given adequate opportunity to defend himself against such charges. It also provides that any such person summarily barred from access to any defense facility but in whose case the bar is removed as a result of the proceedings shall be compensated by the U. S. Government for his loss of earnings. The measure states, too, that it is not intended to deprive any individual of any right or benefits conferred by the federal labor laws. Penalties imposed for violation would be fines of up to \$10,000 or imprisonment up to five years. Chances of passage of the proposed law are considered slim.

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN*.

ELECTRONIC DESIGN • March 18, 1959

EDITORIAL

Let's Standardize Diodes Now!

You can spend many precious hours seeking the diode you need among the 3500 now available. And then, you miss one that does a better job, or an equal job at half the price.

In last year's July 23rd issue, *ELECTRONIC DESIGN* urged manufacturers to standardize more quickly. Manufacturers have been trying, through committees of IRE, AIEE, EIA, and the military, but progress has been painfully slow, and the number of available diodes grows steadily.

"Why," we asked, "can't manufacturers agree on how to define and measure recovery time, peak inverse voltage, reverse leakage current, and forward conduction? And why can't they get together and eliminate duplicate diode types?"

The reply, though it sounded like passing the buck, made sense: "It's up to the users."

ELECTRONIC DESIGN welcomes the challenge to start the ball rolling. Our readers are all electronic design engineers and, almost to a man, diode users.

Readers, we'd like your help. We'd like to know what are your favorite diodes for each general application (mixer, general purpose, rectifier, computer, photodiode, variable capacitor diode, etc.). Tell us who manufactures your favorite diode types, his price for one unit and for 100. Tell us what you like about the diodes you prefer and what you don't like. You may like the high back resistance and dislike the package or the price, for example.

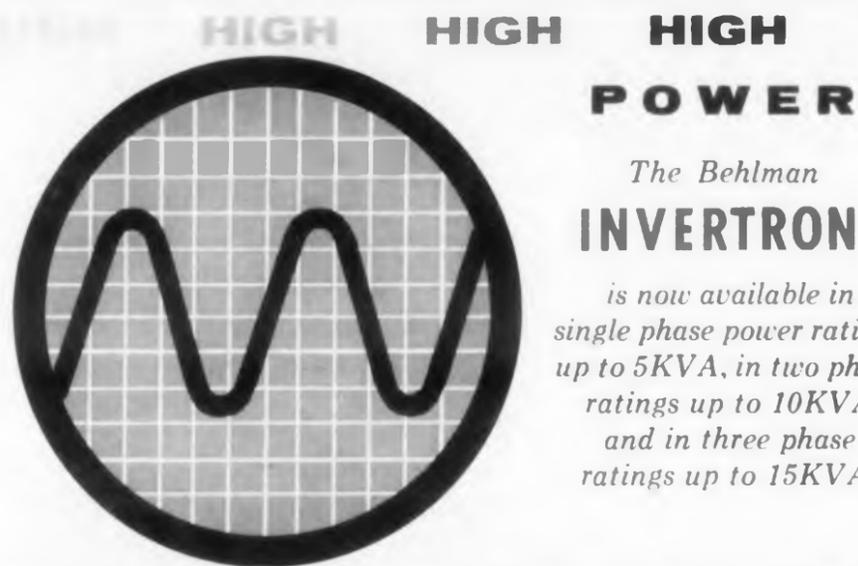
If you feel as strongly about diode standards as we do, if you spend too much time searching for the diode you need, if you'd like to see a "sensible" diode list, send us your own "Preferred List" right away. We'll publish the results of this "Diode Popularity Poll" in *ELECTRONIC DESIGN*.

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Impedance Matching

Having been intimately involved over the past ten years with the design of communication networks, Elmer W. Schwittek, currently head of the Communication Laboratories at Stromberg-Carlson, shows how to eliminate drudgery from impedance matching problems.



E. W. Schwittek

Electronics Engineer

Stromberg-Carlson, Div. General Dynamics Corp.,
Rochester, N. Y.

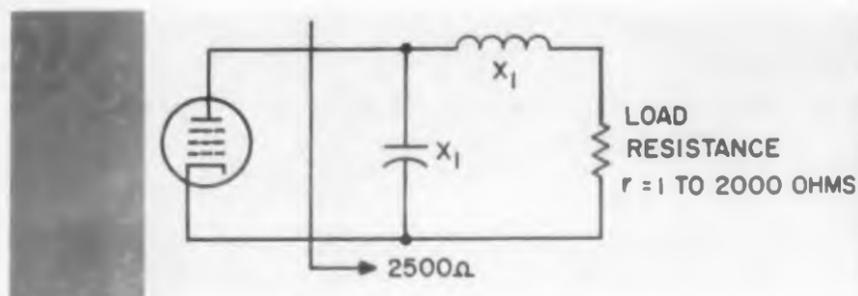


Fig. 1. Simple L network.

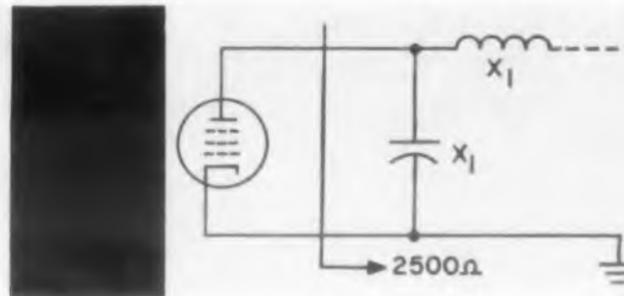


Fig. 2. Pi network.

MATCHING an rf power amplifier to a load can be considerably simplified with just several handy equations and a few design insights. It is not necessary for the engineer to refer to cumbersome reference charts. And, although the case of matching an rf power amplifier to a load is discussed, the procedure is equally adaptable to other impedance matching problems.

Impedance Matching Problem

To illustrate a more simplified approach to impedance matching, an output network will be designed to match a 4X150 class C rf power amplifier to a load which contains a resistance in series with a reactance. The resistance can assume any value between 1 and 2000 ohms and the reactance can assume any value between $+j$ 2000 to $-j$ 2000 ohms. Frequency range is from 2 to 8 mc.

The value of resistance into which the PA (power amplifier) tube delivers maximum power within its ratings has to be calculated. This value, of course, is the required input impedance of the output network. However, this calculation will not be discussed, since Eitel-McCullough (Eimac) has made this graphical procedure available in their tube catalog. The treatment is excellent and yields extremely accurate results. For the sake of this example assume that the proper load for the

4X150 is 2500 ohms.

The design of this network will be considered first on the basis of the load being a pure resistance having a value between 1 and 2000 ohms. This will avoid some confusion throughout the example. After all, the network must at least perform this function and in most cases including a reactance in the load will only effect component magnitude, not this configuration.

If in a PA output network design only the load resistance needs to be transformed to the desired input impedance (2500 ohms), a simple L network of the form shown in Fig. 1 would suffice.

However, since the value of r can vary between 1 and 2000 ohms, let us examine the Q of this circuit as determined by the following equation:

$$R = (Q^2 + 1)r \quad (1)$$

If various values of r are substituted in Eq (1), it will be found that $Q < 5$ for all values of r between 96 and 2000 ohms. With a Q less than 5 the harmonic attenuation of this circuit would be low; so low, in fact, that a sizable portion of the tube output would be present in the form of harmonic power in the load and poor tube efficiency would be apparent as far as the fundamental frequency is concerned. A Q of 7 should be considered to be the lower margin of good engineering practice. Higher values of minimum Q may be required if specific harmonic attenuation specifications exist.

Avoiding Low Q Condition

To insure against the above low operating Q condition it is necessary to consider a more complicated network—a pi network, for example. A convenient means of controlling operating Q is to select a fixed value of input capacitance such that Q will never be lower than 7. (See Fig. 2.)

$$Q = \frac{R}{X_1}$$

$$X_1 = \frac{R}{Q} = \frac{2500}{7} = 357$$

If this value of X_1 is what is required to assure a Q of 7 at 2 mc, and the value of input capacitance remains constant, the Q at the upper end of the frequency range (8 mc) will be:

$$Q = \frac{R}{x_1} = \frac{2500}{357} = 28$$

The efficiency of an L network (assuming lossless capacitors) is related to operating Q and coil Q as follows:

$$\text{Percent Eff.} = \frac{(Q_{\text{coil}} - Q) 100}{Q_{\text{coil}}}$$

Assuming a coil Q of 150, the efficiency of the L network (which will form the first half of the pi network) at 8 mc will be:

$$\text{Percent Eff.} = \frac{(150 - 28) 100}{150} = 81.3 \text{ per cent}$$

This degree of efficiency is not considered particularly high. For this reason a maximum Q limit of 20 is considered good engineering practice.

To eliminate the high Q condition at 8 mc without, at the same time, reducing the Q below 7 at 2 mc, it is desirable to employ band-switching of the network input capacitor. Two bands covering the range 2-4 mc and 4-8 mc would be

a reasonable choice. Under these new conditions the value of X should be reselected to provide a reasonable compromise between harmonic attenuation and network efficiency. If X were reselected to be 300 ohms at 2 mc (band 1) and 4 mc (band 2), then:

$$Q = \frac{2500}{300} = 8.33 \text{ at 2 mc (band 1) and 4 mc (band 2)}$$

$$Q = \frac{2500}{150} = 16.7 \text{ at 4 mc (band 1) and 8 mc (band 2)}$$

From this point on only the 2-4 band will be examined since the 4-8 mc band calculations would be identical.

The following calculations are only pertinent to the first half of the pi-network shown in Fig. 3.

2 mc (Band 1)

$$R = (Q^2 + 1)r_{f1}$$

$$r_{f1} = \frac{R}{1 + Q^2} = \frac{2500}{1 + 8.33^2} = 35.5$$

$$x_1 = Qr_{f1} = 8.33 \times 35.5 = 296$$

Assuming coil Q of 150

$$Eff = \frac{Q \text{ coil} - Q}{Q \text{ coil}} = \frac{150 - 8.33}{150} = 94.5 \text{ per cent}$$

4 mc (Band 1)

$$R \cong Q^2 r_{f1} \quad (Q > 10)$$

$$r_{f1} = \frac{2500}{16.7^2} = 9$$

$$x_1 = Qr_{f1} = 16.7 \times 9 = 150$$

Assuming coil Q of 150

$$Eff = \frac{Q \text{ coil} - Q}{Q \text{ coil}} = \frac{150 - 16.7}{150} = 88.7 \text{ per cent}$$

Summarizing:

- To prevent the possibility of a low Q condition a network more complex than a single L

network must be used.

- The value of X_1 was selected so that the limits of operating Q of the first L section are firmly established. Regardless of what network follows this L section or regardless of what load is present it is certain that an operating Q of less than 8.33 is not possible when the tube has been loaded to its proper plate current, i.e., presented with a 2500 ohm resistive load.

- The problem remaining is to determine what must follow the first L section in order to transform any of the possible load resistances to r_{f1} which is 35.5 ohms resistive at 2 mc, 9 ohms resistive at 4 mc, and has resistive values between 35.5 and 9 ohms at frequencies between 2 and 4 mc.

Matching Load Resistance $> r_{f1}$

To fulfill part of the above requirements another L section following the first will successfully transform all resistive loads greater than r_{f1} to the value of r_{f1} . (See Fig. 4.)

The matching capabilities of a pi-network are definitely limited to those load resistances greater than r_{f1} . The maximum value of x_2 may be found as follows:

$$x_2 = Qr_{f1}$$

but

$$Q = \frac{R}{x_2}$$

$$x_2 = \sqrt{Rr_{f1}}$$

The matching capabilities of a pi-network required when R and r_{f1} are at their largest values, i.e., 2000 ohms and 35.5 ohms, respectively:

$$x_2 \text{ max.} = 267 \text{ ohms}$$

Total value of maximum reactance required in the pi-network coil would be:

$$x_1 + x_2 = 267 = 563 ; 44.8 \mu\text{h at 2 mc.}$$

The value of x_2 will approach zero as the load resistance approaches r_{f1} .

Minimum value of X_2 will occur when the load resistance is equal to twice the minimum value of r_{f1} . This fact is obtained as follows:

$$R = (1 + Q^2)r_{f1}, \text{ but } Q = \frac{R}{X_2}$$

$$R = r_{f1} \left(1 + \frac{R^2}{X_2^2} \right), X_2^2 = \frac{R^2}{R - r_{f1}}$$

$$\frac{X_2^2}{R} = \frac{(R - r_{f1}) 2R - R^2}{(R - r_{f1})^2}$$

Setting this quantity to zero and solving for R in terms of r_{f1} :

$$X_2 \text{ is minimum when } R = 2r_{f1}.$$

Since minimum r_{f1} occurs at 4 mc and is equal to 9, X_2 is minimum when $R = 18$ and this minimum value of X_2 is,

$$R = (1 + Q^2)r_{f1}$$

$$18 = (1 + Q^2)9$$

$$Q = 1 = \frac{R}{X_2}, \text{ Since } R = 18,$$

$$X_2 \text{ min.} = \frac{R}{Q} = \frac{18}{1} = 18 = 2200 \text{ mmfd at 4 mc}$$

To determine if this is actually the largest capacity required, the minimum value of X_2 at 2 mc is determined.

$$R = 2r_{f1} = 2 \times 35.5 = 71.0$$

$$R = (1 + Q^2)r_{f1}$$

$$71.0 = (1 + Q^2)35.5; \quad Q = 1 = \frac{R}{X_2}$$

Since $R = 71.2$, $X_2 = \frac{R}{Q} = 71.2$; i.e., 1100 mmfd at 2 mc.

The maximum required value of X_2 will occur when the load resistance is equal to r_{f1} . At this condition $X_2 = \infty$. Since X_2 in a practical case cannot equal infinity some additional calculation

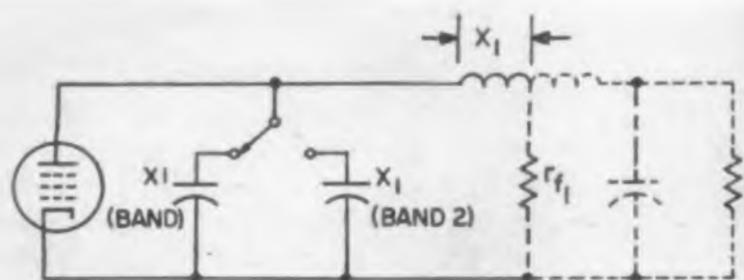


Fig. 3. A more complicated pi network employing bandswitching of the input capacitor.

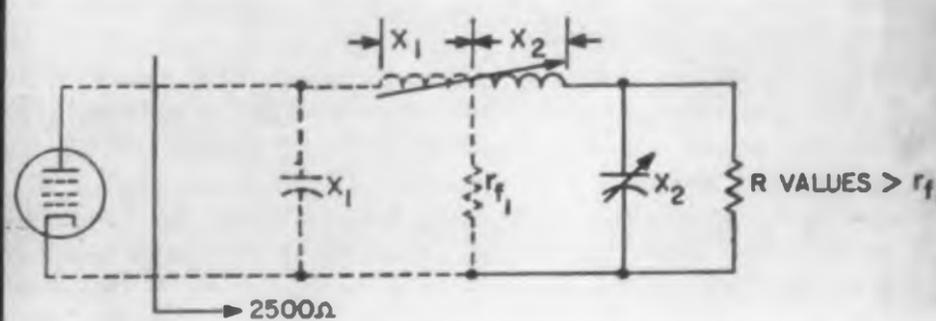


Fig. 4. The addition of another L section transforms all resistive loads greater than r_{f1} to the value of r_{f1} .

is required using the maximum value of X_2 that is possible to determine what the minimum value of resistive load actually can be. This can become important in the 10 to 30 mc frequency range. However, since this example is concerned with frequencies no higher than 8 mc, we will assume that X_2 can go to infinity.

Matching Load Resistances $< r_{f1}$

We have succeeded in determining the circuit required to match load resistances which have a value greater than r_{f1} . The problem remaining is to transform those load resistances below r_{f1} to the required value of 2500 ohms.

The most efficient means of matching to resistive loads less than r_{f1} is merely to use one L section. (See Fig. 5.)

$$R = Q^2 r \quad (Q > 10)$$

$$Q = 50$$

$$X_1 = 50$$

$$x_1 = 50$$

However, since the value of X_1 has been previously selected so that Q can be controlled when matching higher load values we no longer have the option of employing the above circuit to perform this matching function. Since the load resistance range is so great, since we have already arrived at a practical circuit to match resistive loads greater than r_{f1} , and since it is desirable to keep the number of tuned and switched elements to a minimum, it is advisable to maintain the original circuit configuration to as great a degree as possible and sacrifice some network efficiency.

An approach that is reasonable is to add an additional L section which has the function of stepping up the low load resistance values to values which can be matched by the pi-section. That is, the combination of x_3 and X_3 (the additional L section which has the function of resistance so that the value of r_{f2} is equal to or greater than r_{f1}). (See Fig. 6.)

This immediately means that the demands on the x_3 , X_3 section are quite flexible. There is a considerable choice as to just what value of r_{f2} we should demand. Since the pi-section was designed to transform any value of load from r_{f1} to 2000 ohms, obviously r_{f2} could fall anywhere between the value of r_{f1} and 2000 ohms and the x_2 , X_2 section could accomplish the matching function. Though any choice will function properly, one approach is to demand that r_{f2} always equals r_{f1} . This means that x_2 can be zero and that X_2 be infinity.

It should be noted, however, that unless the output network tuning procedure is adequately outlined, there is a definite possibility that the transmitter operator will unknowingly choose

the value of r_{f2} in spite of what the designer does. It should be the designer's responsibility so to outline tuning procedure and so to limit the value of x_3 and X_3 so that the value of r_{f2} is limited to those values which will yield reasonable efficiencies.

To illustrate this flexible matching situation, assume a load resistance of 1 ohm, an r_{f1} of 9 (4 mc, band 1) and an r_{f2} of 9. As previously mentioned if $r_{f2} = r_{f1}$, then $x_2 = 0$ and $X_2 = \infty$.

This would demand an X_1 capacitor of an impractically large value.

By similar calculations, if r_{f2} is chosen to be 2000 ohms, the value of X_2 is quite practical, but then network efficiency is at its least desirable point. A compromise value of r_{f2} is then determined based primarily upon network efficiency and the practicality of the value of capacity corresponding to X_2 , X_3 , $X_2 + X_3$.

If a value for r_{f2} equals 50 ohms is chosen it will mean at least a practical value for X_2 , X_3 .

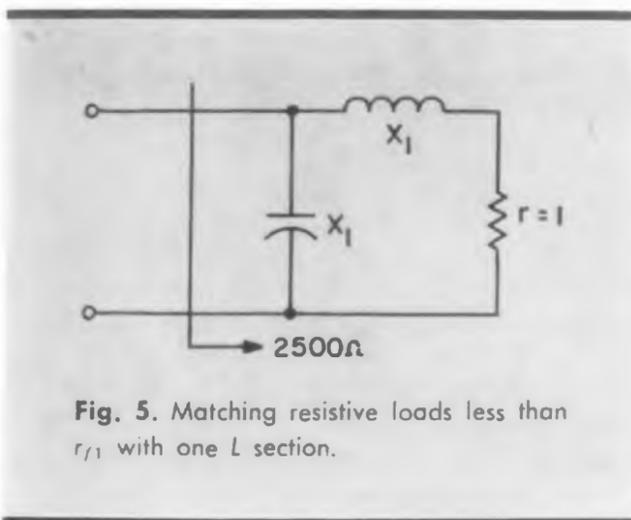


Fig. 5. Matching resistive loads less than r_{f1} with one L section.

$X_2 + X_3$. But this choice opens up new possibilities, since it is now possible to match load resistances in the range from 1 to 50 ohms with the pi- L matching circuit. This means that it is no longer essential that the original pi-network be required to match load resistance values down to the value of r_{f1} . This situation can further assist in making the value of output capacity more practical.

From the above example it has been shown that the network shown in Fig. 7 would suffice. Normally X_2 and X_3 will be combined into one capacitor and that x_3 is zero except when the complete pi- L circuit was required for matching. It also has been shown that pi- L network will transform all resistive loads between 1 and 2000 ohms to the desired input impedance of 2500 ohms. The pi- L network was chosen since it performs this function without change in network configuration while at the same time preserving control of minimum network Q .

Reactive Loads

Up to this point reactive loads have been ignored. This has been done primarily to simplify this example. Basically the method of approach for reactive loads is merely to separate the load into its resistive and reactive components, treat the resistive components as the load resistance, and treat the reactive component as a portion of the matching network. This sounds simple enough on the surface, but to illustrate the procedure let us investigate the following example. Assume the load to be $1 + j 4.9$, a load impedance which is included in the range of those impedances that this output network should be capable of matching. Fig. 8 indicates the series and shunt representation of this load impedance.

Assume that we are operating the pi- L network at 4 mc, band 1, where r_{f1} is 9 ohms. The question arises as to whether we should class the $1 + j 4.9$ load impedance as being in that category of resistive loads below r_{f1} (since in the series representation the value of resistance is 1 ohm), or above r_{f1} (since in the shunt representation of the value of resistance is 25 ohms) i.e., whether we can match it with the pi- L network only or whether it can be matched with the pi-network ($x_3 = 0$). As a matter of fact the reactive portion of the load allows this load to be matched with either network as shown in Figs. 9a and 9b. Load matched with pi- L network (r_{f2} chosen to be 50 ohm).

It may seem that the required output capacity is less when using the pi- L network to match this load while calculations will show that the efficiency is just slightly greater when the pi-network is used. If r_{f2} were chosen to be 100 ohms rather than 50 the value of required output capacity would be further reduced with a slight additional loss in efficiency.

The point of the above example is to indicate that reactive loads allow the network designer some additional choice in design. Utilizing the load reactance may present an opportunity to provide more practical values of network components. Some reactive loads may require additional range in some of the matching components.

Room for Ingenuity

Completely different approaches are possible to provide a solution for the design problem. The solution shown is practical, but there remains considerable room for ingenuity in providing an output network that is simple and easy to tune. Antennas are the usual load for the PA. If antenna impedance characteristics are well established it is quite possible to utilize this information to simplify the network and to further restrict component range. ■ ■

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- Transients attenuated at least 8:1 (18 db)
- Fast response—less than 1 cycle (0.02 sec) for 63% recovery
- Less than 0.35% distortion

The new Sorensen Model FRLD750 fast-response, low-distortion a-c regulator is ideal for critical applications like null testing, meter calibration, and the powering of pulse-type circuits, such as those used in computers, where false triggering is not permissible.

Since there is no phase shift between input and output, the FRLD750 can also be used in multiples for the regulation of multi-phase power. Line and load transients are reduced by at least

8:1, regardless of their magnitude. Both cabinet and 19" rack-mounting models available. Write for technical data or see your Sorensen representative.

And don't forget, Sorensen engineers will be glad to discuss your special power requirements with you. They can help you select the proper a-c or d-c power supply, regulator, or frequency-changer from the widest transistorized line on the market, or assist you in designing special power systems. 839



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CIRCLE 18 ON READER-SERVICE CARD

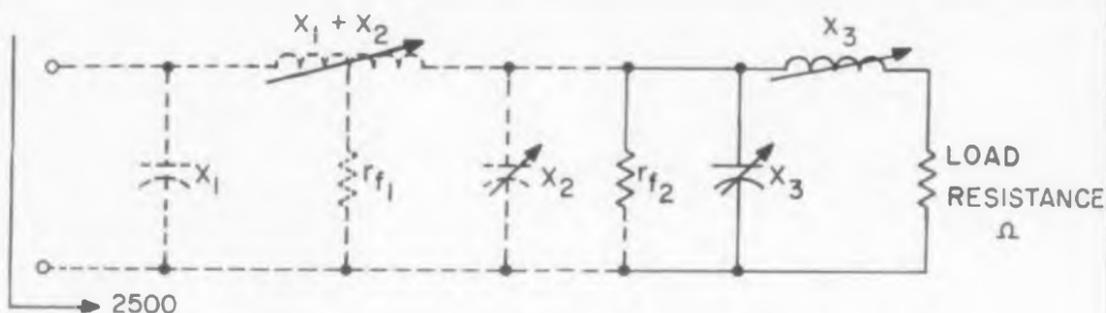


Fig. 6. The addition of an L section steps up the low load resistance values to values which can be matched by the pi section.

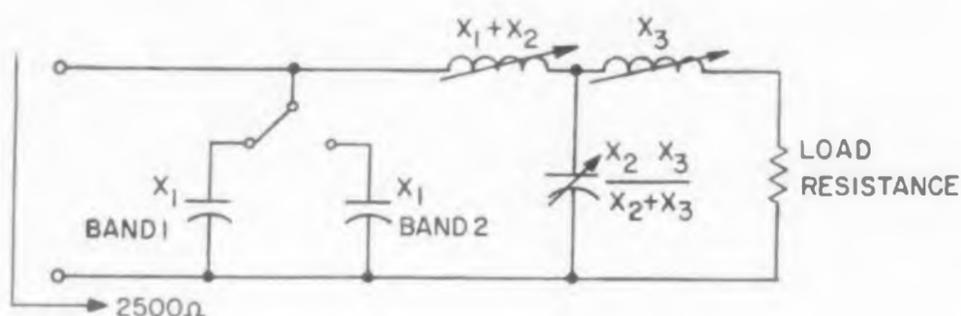


Fig. 7. A more practical pi-L matching circuit



Fig. 8. Series and shunt representation of a load impedance, $1 + j4.9$.

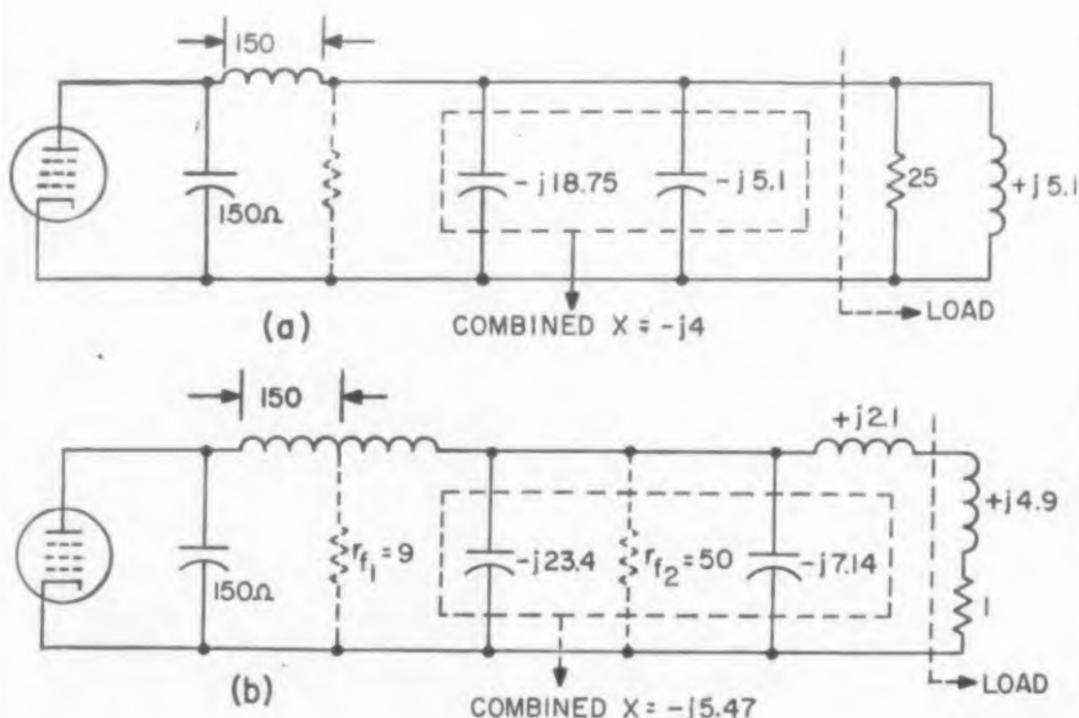
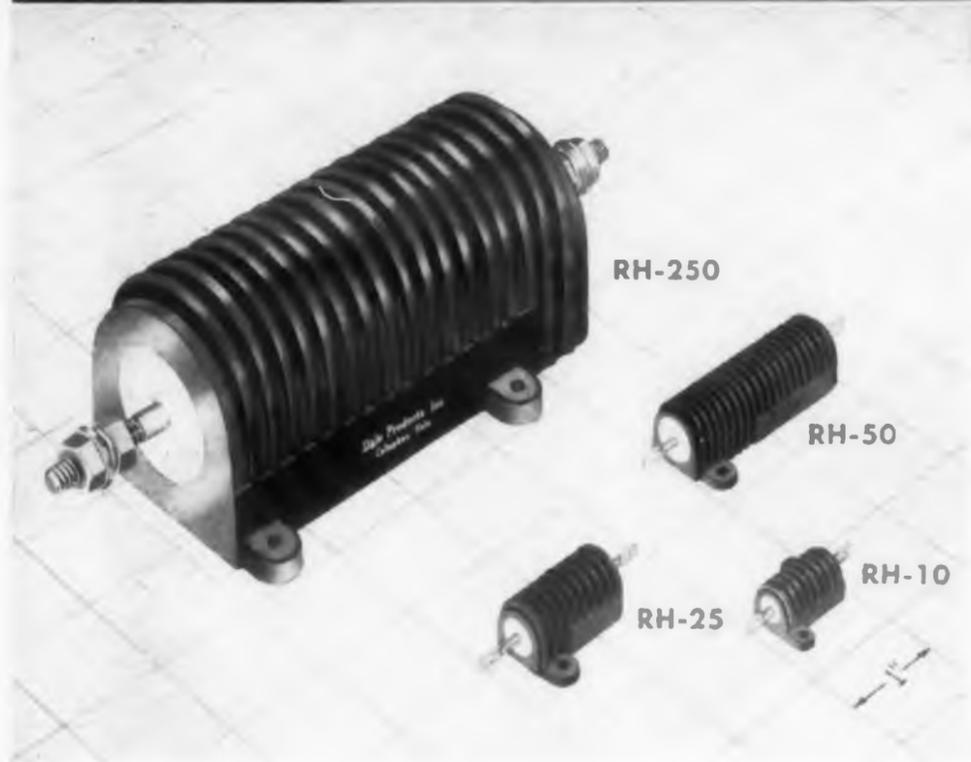


Fig. 9a and 9b. Reactive portion of the load allows the load to be matched with either network, 9a or 9b.



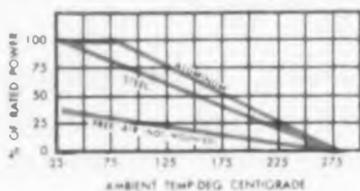
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CIRCLE 19 ON READER-SERVICE CARD

Designed for the specific application of high power requirements, coupled with precision tolerance. Mounts on chassis for maximum heat dissipation. Operates under severe environmental conditions as outlined in specifications below.

- Rated at 10, 25, 50 and 250 watts.
- Resistance range from 0.1 ohm to 175K ohms, depending on type.
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%.

TEMPERATURE COEFFICIENT: Within ± 0.00002 degree C.

COMPLETE PROTECTION: 100% impervious to moisture and salt spray.

WELDED CONSTRUCTION: Complete welded construction from terminal to terminal.

RUGGED HOUSING: Sealed in silicone, inserted in radiator finned aluminum housing.

SMALLEST IN SIZE: 7/16 x 3/4 to 3 x 4-1/2 inches.

MILITARY SPECIFICATIONS: Surpasses applicable paragraphs of MIL-R-18546B. Visit the Dalohm Booths 2742-44 at the I.R.E. Show

Windings, laminations, bracket held together by epoxy



Potting

Rotor includes stacks, and blades centrifugally cast



Casting

used to produce **Low-Cost**

THE MAIN portions of this fan—iron laminations, coil windings, bearings, lead wires and holding bracket—are one integral piece, held rigidly together by an encapsulating epoxy resin. Because of this cost saving design approach and others the electronic engineer can buy 100 CFM of cooling air for \$6.85°—about one tenth the usual price for quality blowers.

The 60 cycle-powered unit can fit almost anywhere as it is 5 in. sq and 1-1/2 in. deep. Because of a well-engineered propeller design the unit delivers high volume at high pressure at low noise (42 db on the A scale; about 10 db lower than average room air conditioners). Pressure is sufficient to drive air through a dust filter and tightly-packed electronic equipment (see graph).

Called the Muffin Fan by its producer, Rotron Mfg. Co., Inc., Woodstock, N. Y., the motor is the inside-out type with cantilevered bearings. The air-impeller is integral with the rotor. This patented de-

°Quantities of one thousand. Approximately 20 per cent higher for small orders.

sign, which was used successfully to produce miniature military blowers (Aximax,

and the Saucer. ELECTRONIC DESIGN, March 5, 1958, p 106), has been further perfected so that it can be made by automatic means. As a result there are only three pieces in the new fan, the molded stator, the centrifugally-cast rotor, and the molded phenolic venturi block. It takes but 15 minutes of labor to inspect



Three pieces of fan assemble without screws or bolts. Bezel with grill clamps onto molded venturi block.

Molded venturi block
Molded venturi block
needs no machining



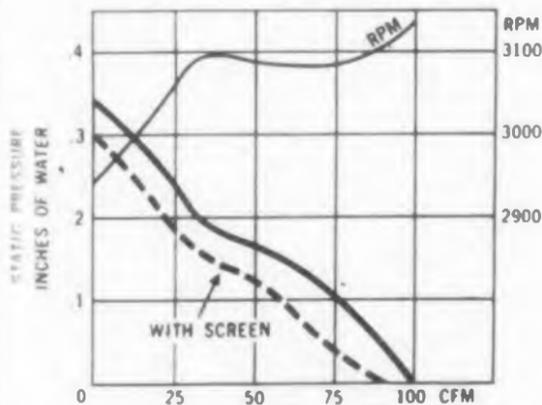
Molding

Cooling Fan

and assemble the pieces produced by automatic processes.

Unusual Product Design Cuts Cost

Molded stator. The entire stator assembly comprising motor laminations, stator stack, and wound stator is completely encapsulated. Development of the method to mold this assembly was the biggest tooling problem licked by the manufacturer. The spider arms, or mounting bracket, has embedded in it fiber glass rods for reinforcement. Molds were designed to dispense epoxy on a production schedule. Conveyors, and convection and



Performance curves of fan shows high volume and relatively high pressure.

infrared ovens are used to process the assembly at a fast rate. The epoxy encapsulant is a special mix which maintains its dimensional stability and withstands severe thermal shock.

Rotoprop assembly. This assembly is comprised of rotor laminations, cast propeller and a hardened-and-ground shaft.

The normal manufacturing method to produce this sub-assembly would be to stack the rotor laminations and centrifugally cast the rotor stack and then machine the piece for pressing into the propeller. The propeller would normally be purchased as a die casting and machined carefully to accept the rotor stack and shaft. To save machining cost, the shaft was changed to a hardened and ground part and a method devised to stack the rotor laminations into a mold with the hardened shaft in place for casting. The rotorprop assembly was then centrifugally cast complete in one operation. No additional machining operations were required.

Extreme accuracy as to concentricity between the shaft and the inside diameter of the motor can be maintained.

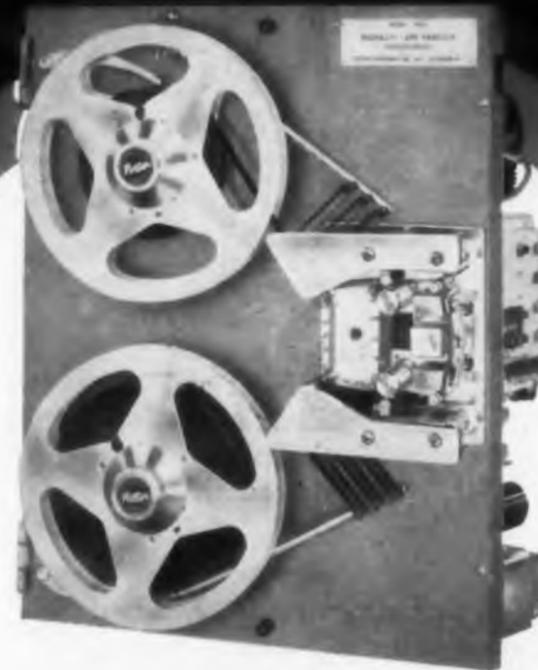
Venturi block. This part was originally designed to be an aluminum die casting but again to eliminate machining operations the part was changed to a plastic. A dimensionally-stable phenolic that can be molded to blueprint tolerances requiring no machining or finishing operations was used. The multi-cavity mold used to produce the venturi block was no more expensive than the die-casting die would have been.

Other Features

The bearings in this fan are unique and came about as the result of a careful re-evaluation of what the industry has been doing in the past ten years. Since only minute quantities of lubricant are actually needed, provided that the lubricant is there when wanted, and that it does not chemically deteriorate, a design using a Teflon seal is used which holds a small quantity of oil and seals air out. Because the quantity of oil is small compared to other motors, the most expensive lubricants can be used—the \$20 a gallon variety for example. This approach reverses the trend of other motor designers to produce oversize oil reservoirs.

For more information on this low noise and low cost fan turn to the Reader-Service number and circle 101.

New Speed...Versatility...Reliability...



TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

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- Completely transistorized for maximum reliability
- Trouble free brushless motors
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- Linear servo system
- Life expectancy of pinchroll mechanism: over 100,000,000 operations
- Skew $\pm 3 \mu\text{sec}$ $\frac{1}{2}$ " tape, center clock at 100 i.p.s.
- Vacuum loop buffer
- Continuous flutter free cycling 0 to 200 cps
- Normal speed up to 100 i.p.s.
- Rewind or search speed constant at 300 i.p.s.
- Six speed forward or reverse up to 150 i.p.s.
- Better than 3 milliseconds start, 1.5 millisecc stop
- Front panel accessibility
- In line threading
- End of tape and tape break sensing
- All functions remotely controllable
- Tape widths to $1\frac{1}{4}$ "

The 906 is usually supplied with the Potter 921 transistorized Record-Playback Amplifier; a unit that features:

- | | |
|------------------------|-------------------------------------------------|
| Pulse or level outputs | Manual, relay, or electronic function switching |
| Output gating | Dual read-write operation |
| 1 i.p.s. to 150 i.p.s. | |

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Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

CIRCLE 20 ON READER-SERVICE CARD

Microwave Test Instruments

Part 7

The microwave engineer should bear in mind that a number of manufacturers produce test equipment and accessories on a custom basis, fulfilling special needs, and that the companies in the field are not restricted to those mentioned in this series. ■ ■

Miscellaneous

MICROWAVE measurements are made with a wide array of test equipment. Some are of very specialized nature. In this concluding part, echo boxes, standard horns along with a number of other specialized microwave test instruments are covered.

Standard Gain Horns and Echo Boxes

Echo boxes are high-Q resonant cavities which give, in a single reading, an indication of the overall performance of a radar system. Signal generators and power meters are widely used in measurements on radar systems where detailed knowledge is required, but the echo box is convenient for a single overall performance measurement.

The echo box consists of a high-Q resonant cavity which is coupled to the radar by means of either a directional coupler or a pickup antenna. The cavity stores energy during the transmitted pulse, and continues to oscillate after the end of the pulse period, with an exponential rate of decay. This exponentially decaying signal is returned to the radar receiver. It initially saturates the receiver, and eventually decays into the noise level. The total elapsed time between the transmitted pulse and the time the noise level is reached is called the "ring time," and is a measure of overall radar performance. Typical loaded Q's of echo boxes are of the order of 50,000 to 90,000.

Standard horns are used in measurements concerned with antenna design and development. They may be used as standards for calibrating other antennas, as feed horns for reflectors and lenses, as pickup horns for sampling power, and as receiving and transmitting antennas for point-to-point communications. The method by which standard-gain horns are used to calibrate other antennas is essentially one of substitution. The

gain standard and the unknown antenna are alternately connected to a well-matched receiver and the difference in level between them is measured—for example, by using a precision attenuator. Horns are available in gains of 10 to 25 db, and the gain at any frequency in a band can readily be computed when it is known at a given frequency. Standard horns along with echo boxes are listed in Table 1 according to manufacturers.

Receivers and Field Intensity Meters

Receivers have many applications in microwave work, including radio noise measurement, field intensity measurements, antenna pattern measurements, and numerous others. General-purpose laboratory receivers feature wide tuning range, accurate frequency and signal level calibration. Receivers intended for antenna pattern measurements are designed for wide frequency range, and maximum sensitivity and linearity.

Field intensity meters are receivers designed for accurate frequency and power calibration and high sensitivity. An internal signal calibrator permits accurate voltage and power measurements. Calibrated antennas are included so that signal level readings can be accurately related to field intensity. Receivers and field intensity meters are listed in Table 2 according to manufacturers.

Miscellaneous Instruments

Microwave test bench is an integrated system for performing laboratory and production tests. It can include such subunits as attenuators, frequency meters, detectors, slotted lines, and directional couplers. Such setups can, also be made by using standard units and assembling them into a complete system by means of mounting stands, supports. Microwave test benches along with a

number of other microwave equipment are listed in Table 3.

Traveling-wave tube amplifiers have a number of uses in design and testing of microwave systems. They can be used wherever there is a requirement for broad-band gain, pre-amplification, high-speed pulse generation, or signal amplitude or phase modulation. Microwave amplifiers making use of traveling-wave tubes provide high gain and moderate power outputs, and can modulate the amplitude or shift the phase of the input signal. The units are completely self-contained units incorporating all the power supplies and controls necessary for their operation.

Radar moving target simulator is another type of unit for calibrating radar system performance.

Table 1. Standard Horns and Echo Boxes

Manufacturer	Standard Horns	Echo Boxes
Airtron, Inc.	X, KU, K, V	--
Amerac, Inc.	--	2.7-2.9 KMC
De Mornay-Bonardi	S, C, XN, XB, X, KU, K, V, Q, M, E	--
Diamond Antenna & Microwave Corp.	L, S, C, XN, SB, X, KU, K, V	--
Douglas Microwave Co.	L to Z	--
F-R Machine Works, Inc.	L, S, C, XN, XB, X, KU, K, V, A, M, E	--
Microwave Associates, Inc.	X, KU, K, V, M	34-36 KMC
Narda Microwave Corp.	L, S, C, XN, XB, X, KU, K, V, A, M, E	5.35-5.45 KMC, 9.20-9.45 KMC
Polarad Electronics Corp.	4.19-7.74 KMC, 7.36-10.0 KMC	--
Polytechnic Research and Development Co., Inc.	--	15.8-16.2 KMC
Radar Design Corp.	S, C, XN, XB, X, KU, K	--
Sperry Gyroscope Co.	8.5-9.6 KMC	--
Waveline, Inc.	S, C, XN, XB, X, KU, K, V	--

Whereas the echo box may be used for checking transmitter and receiver performance, the moving target simulator tests the radar range tracking circuits. It provides a microwave return signal with the same pulse characteristics as the transmitted radar signal, which may be adjusted so that it has a continuously varying range and then used to check the radar range tracking circuits. It also provides a series of accurate fixed range echo pulses that may be used to calibrate the radar range markers. The simulator may be connected to the radar set directly through a directional coupler, or it may be used with a pickup horn antenna.

Antenna-pattern transmitter is a convenient X band source, particularly designed for antenna measurements. It consists of an antenna assembly, a modulator, and a remote control unit. A motor-tuned magnetron is mounted on the antenna assembly. The unit has variable antenna polarization through 360 deg, two azimuth positions 10 deg apart for dual-range use, and manually adjustable elevation.

Peak power test set provides direct reading of peak power by comparison between the unknown signal and a known reference on a synchroscope. The test set consists of a signal generator and a crystal video receiver, and can also be used as either one. In making power measurements using this unit, the comparison is made by means of an external synchroscope, and the power read-out of the reference source is made by means of an external wattmeter bridge. The signal generator pulses are first matched with the height of the unknown pulse, then the test set is switched to cw operation and the power measured with the power bridge.

Microwave stability tester measures drift and frequency modulation of a microwave signal. It uses a digital type of discriminator, so that very small frequency variations can be quantized and measured as a dc voltage. Any frequency change causes a change in the number of pulses quantized and a change in the voltage level of the integrator, whose amplified output is calibrated

in cycles per second on a frequency deviation meter. The amplified output of the quantizer, after filtering and demodulation, also drives a drift meter calibrated in kilocycles per minute.

Microwave Q-meter is useful in measuring the Q of echo boxes and other forms of cavity resonators. Its operation is based on an accurate comparison of the rate of decay of oscillations in the cavity under test with a rate of discharge of precision capacitors into a highly stable known resistor. It therefore does not require highly stable oscillators, accurate tuning of the cavity, nor precise setting of the output signal to a particular level.

In addition to the measurement of Q, this unit can also be used for a number of other types of measurements, such as measurements of conductivity of metals and dielectric losses of materials at high frequencies.

Precision attenuator calibrator may be regarded as a reference standard for signal levels, and is used for the accurate calibration of signal generators. Signals through the attenuator under test and through a precision reference piston attenuator in the instrument are each modulated by alternate halves of a square wave generator. By adjusting the standard piston, equality of the signals is obtained. The difference is displayed on a cathode ray tube and also operates a phase sensitive rectifier which shows this difference on a meter.

Noise figure indicator, when used with an auxiliary noise generator, continuously and directly indicates the noise figure of a receiver under test. A square wave modulates the noise generator, causing it to go on and off alternately for equal periods. The bursts of noise from the generator are fed into the receiver under test, and the i-f output of the receiver is taken to the noise figure indicator. The signal is detected, and amplified by a video amplifier. From the relative signal levels during the on and off periods of the square wave, the unit computes the noise level of the receiver under test. ■ ■

(Tables continued on following pages.)

Table 2. Receivers and Field Intensity Meters

Type of Instrument	Manufacturer	Model No.	Frequency Range	Sensitivity	Price	Accessory Equipment	General Comments
	Engineering Associates	AN/APR-4	38-4,000 MC in 5 tuning units	--	Approx. \$3000	--	Accuracy of frequency calibration $\pm 1\%$; I-F bandwidths 0.6 and 4.0 MC; panoramic, video and audio outputs; automatic motor-operated sector sweep tuning at variable speed on all tuning units; originally radar search receiver being sold for use as general purpose laboratory receiver.
Receivers	Polarad Electronics Corp.	R	400-46,700 MC using 8 plug-in tuning units	-85 dbm (at 400 MC) to -55 dbm (at 46.7 KMC)	Basic unit and power supply \$1500 Tuning units \$2500-\$4410 each	--	Accuracy of frequency calibration $\pm 1\%$; I-F bandwidth 3 MC, video bandwidth 2 MC; linear dynamic range 60 db with AGC; receiver AM, FM, CW, MCW, pulsed signals; 60 db image rejection 400-11,260 μ , bandpass and high-pass filter used in higher-frequency tuning units.



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Westrex Corporation

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Table 2. Receivers and Field Intensity Meters (continued)

Type of Instrument	Manufacturer	Model No.	Frequency Range	Sensitivity	Price	Accessory Equipment	General Comments	
Field Intensity meters	Scientific-Atlanta, Inc.	402	2-75 KMC	-90 dbm (at 30 MC) to -70 dbm (at 65 KMC)	\$7500	--	Designed primarily as wide-range receiver for antenna pattern measurements where maximum sensitivity and linearity are required, linear 40 db dynamic range (may be extended by use of P-F attenuator); models 402A and 402C have AGC, others do not; crystal video detector output for oscilloscope, bolometer detector for recorder operation, no direct-reading frequency calibration, tuning chart for approximate settings, no R-F pre-selection or image rejection.	
		402A			\$6000			
		402B	30 MC-75 KMC		\$8500			
		402C			\$9000			
	Empire Devices Products Corp.	NF-112	1.0-10.0 KMC using 4 plug-in tuning units	--	\$14,500 complete with all accessories	Standard gain horn antennas, tripods, etc.		Equipped with impulse noise generator for calibrating CW and broadband measurements, includes double tuned cavities preceding the first mixer, maximum peak amplitude 79 db above 1 microvolt per MC.
	Polarad Electronics Corp.	FIM	1.0-10.0 KMC using 4 tuning units	--	\$20,488.50 complete with all accessories	Calibrated antennas, antenna reflector, tripod		Frequency calibration accuracy ±2%, image rejection 60 db; input R-F voltage range 20 microvolts to 3 volts; 60 db R-F attenuation, 20 db R-F attenuation, includes CW calibration signal 0.2 volts to 5 microvolts RMS.

Table 3. Miscellaneous Instruments

Type of Instrument	Manufacturer	Model No.	Frequency Range	Special Features	Accuracy	Price	General Comments
Microwave Test benches	Ferranti Electric, Inc.	Integrated microwave test bench	9.0-10.0 KMC	Includes: 1. Three klystron input 2. Wavemeter 3. Attenuator 4. Crystal power monitor 5. Slotted line	--	--	Single unit formed from two halves of a light alloy block, attenuation range 30 db, accuracy ±0.1 db, wavemeter in absorption type with micrometer tuning; slotted line has engraved centimeter scale.
		Microwave Associates, Inc.	MA-1019 MA-1018 MA-1018	26.5-40.0 KMC 50.0-75.0 KMC	Includes: 1. Attenuator 2. Wavemeter 3. Standing wave detector 4. MA-1019 has directional coupler	--	\$1390 \$1725
Traveling-wave Tube Amplifiers	Alfred Electronics	505; 501 503; 504	1-2 KMC, 2.4 KMC, 4-8 KMC, 8-12.4 KMC	30 db gain, 10 MW output power, 24 db noise figure	--	\$1390 to \$1550 each	Consists of general purpose, medium power, high power and low noise groups as indicated; spurious modulation 35 db-40 db below signal; include provision for modulation.
		5-6752, 512; 502; 5-686B; 506, 510, 509, 5-6996	1-2 KMC to 8-12.4 KMC	20 db-30 db gain, 100 MW-10W output power, 25 db-40 db noise figure	--	\$1390 to \$3390 each	
		5-6826	2-4 KMC	30 db gain, 1 KW peak output power	--	\$4850	
		511A, 515A 523	2-4 KMC to 8-12.4 KMC	25 db gain, 1 MW-5MW output power, 11 db-15 db noise figure	--	\$1990 to \$3290 each	
	Hewlett-Packard Co.	490B	2-4 KMC	30 db gain, 10 MW output power	--	\$1100	Noise figures 25 db to 30 db; modulation provisions on all except 491A; hum and spurious modulation at least 30 db below signal level; prices include traveling-wave tube.
		491A		30 db gain, 1 W output power	--	\$1100	
		492A	4-8 KMC	30 db gain, 10 MW output power	--	\$1500	
494A	7-12.4 KMC	25 db gain, 5 MW output power	--	\$1500			
Menlo Park Engineering	TA-1 to TA-44 (26 different units)	L, S, C, X, KU bands	25 db-30 db gain; 1 dbm to 30 dbm output power, 10 db-30 db noise figure	--	\$1450 to \$3250 each	Complete series of units to cover the frequency and power ranges listed; provision for modulation.	

Table 3. Miscellaneous Instruments (continued)

Type of Instrument	Manufacturer	Model No.	Frequency Range	Special Features	Accuracy	Price	General Comments
Microwave Leveler	Alfred Electronics	702 to 708 (6 units)	1-2 KMC to 12.4-18 KMC	100 MW max power (mod 708 has 1 W max); RF control range ± 2 to -30 db relative to max level	± 1 db	\$ 750 to \$ 950 each	Maintains constant output from microwave signal sources; 0 db indication may be set at 1 MW to 100 MW level; less than 1.5 db insertion loss; DC to 100 KC frequency response; CW or square-wave internal modulation.
	Roger White, Inc.	TWA-P1W	0.8-1.2 KMC	1 MW output power	--	--	Noise figures 25 db for W series (1 watt), 20 db for M series (1 MW); minimum gain 25 db (except TWA-S1M has 30 db gain); includes provision for modulating output of the traveling-wave tube.
		TWA-L1W	1.0-2.0 KMC	1 W output power			
		TWA-L1M		1 MW output power			
		TWA-S1W	2.0-4.0 KMC	1 W output power			
		TWA-S1M		1 MW output power			
		TWA-C1W	4.0-6.0 KMC	0.8 W output power			
		TWA-C1M		1 MW output power			
Moving Target Simulator	Aircraft Armaments, Inc.	668	X or KU bands (interchangeable R-F heads)	Power output -25 dbm; maintained constant by automatic gain control; manually adjustable over a 70 db range	Variable delay accuracy ± 10 ft; range marker accuracy ± 5 yards	--	Designed to test radar range tracking circuits and perform other tests on X and KU band radars; provides microwave return signal with the same characteristics as the transmitted signal; provides fixed or varying range echo pulses; AFC maintains output frequency within ± 200 KC of input frequency.
Antenna Pattern Transmitter	Californio Technical Industries	119	8.5-9.6 KMC	Peak power output 20 KW	--	\$7950 (excluding antenna); Antenna \$4400	Consists of antenna assembly, modulator, and remote control unit; motor-tuned magnetron is located on the antenna assembly; variable antenna polarization; pulse width 1 microsecond, pulse rate 1000 pps.
Peak Power Test Set	Cubic Corp.	100X	As peak power meter and signal generator 8.5-9.6 KMC As crystal video receiver 10 MC 12 KMC	Peak power range: 0.01 to 3 MW Power output as signal generator: 0.01 to 3 MW Sensitivity as crystal video receiver: 1.6 volts per MW	As peak power meter: ± 0.2 db	\$1150	Can be used as peak power test set, signal generator, or crystal videoreceiver; generates CW signals having same peak amplitude as the unknown, and comparison is made with an external synchroscope and wattmeter bridge.
Microwave Stability Tester	Laboratory For Electronics, Inc.	5004	1120-3000 MC, 5200-6100 MC, 7000-10,000 MC, 9600-10,500 MC (four R-F heads)	Minimum measurable F-M peak deviation: 2 cps for S band to 10 cps for X band Max measurable FM deviation: 1000 cps (using internal meter); 5000 cps (using external oscilloscope)	2 cps at S band 10 cps at X band	Basic unit \$6500 R-F heads \$3030 to \$3500 each	Indicators peak F-M deviation on one meter, drift on another; also measures at 30 MC, and 30-230 KC; outputs may be viewed on an oscilloscope or spectrum analyzer; K-band head (23.0-25.0 KMC) available on special order.
Microwave Q-Meter	Wayne Kerr Labs.	--	S band, X band	Q range: 10,000-60,000 for S band; 30,000-150,000 for X band	$\pm 1\%$	--	Compares rate of decay of free oscillations in cavity under test with rate of discharge of precision RC circuit; frequency accuracy $\pm 0.05\%$; maximum range of transmission loss of cavities with which instrument will operate is 26 db.
Precision Attenuator Calibrator	Wayne Kerr Labs.	--	2.7-3.8 KMC	Range of measurement 10^{-4} to 10^{-12} watts	0.015 db to 0.02 db	--	Intended as reference standard for measurement of levels in the power and frequency range indicated; may be used to 10^{-15} watts for leakage measurements; wavemeter accuracy $\pm 0.1\%$.
Automatic Noise-Figure Indicator	Airborne Instruments Laboratory, Inc.	72	--	Measurable range of noise figure 0 to 20 db	± 0.5 db	\$1490	Used with type 70 Noise Generator; minimum acceptable noise input (source off) 50 microvolts into 50 ohms; I-F input 30 MC or 60 MC (specify which); I-F amplifier bandwidth 1.0 MC.



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Diode Logic 0.7 μ sec max

Transistor Logic 1.5 μ sec max

Signal Voltage Levels

± 18 volts, ± 6 volts

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-55°C to $+75^{\circ}\text{C}$

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COMPONENTS

CIRCLE 23 ON READER-SERVICE CARD



Solid State Relay

Operates in the Microsecond

WITH no moving parts, this solid state relay closes in five μ sec, drops out in 30. The coil circuit is completely isolated from the switching circuit and can switch several independent circuits within the same unit. Contact bounce, arcing, chatter and contamination are, of course, totally eliminated.

Life expectancy of the relay, if properly applied, is hoped by Pendar, Inc., 14744 Arminta St., Van Nuys, Calif., to be indefinite—meaning millions of cycles and unlimited shelf life. It should find application in sweep tube switching, gating; wherever fast switching and resistance to high vibration is required; and where shelf and operating life are at a premium.

Production units are rated to switch ac or dc from 10 mils to 10 amp in the spst category, and 10 mils to 0.5 amp in the dpst category. Operating on 28 v dc, the coil circuit pulls in at 18 v and drops out at 11 v or less, 14 ma and 6 ma, respectively. Transfer time is better than 50 μ sec.

The block diagram of Fig. 1 demonstrates the operation of the new relay. A zener reference element is used to set the pull-in and drop-out

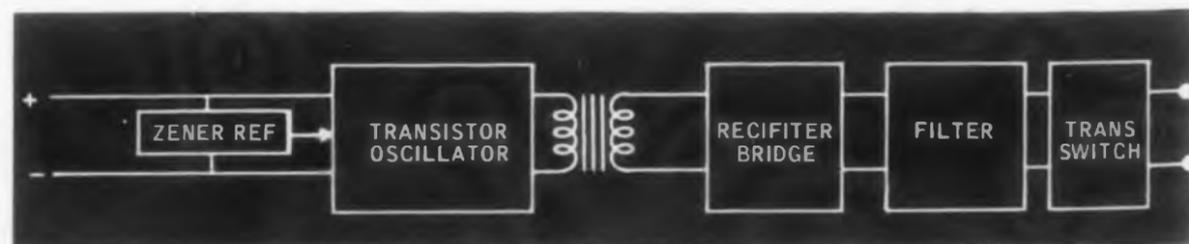


Fig. 1. Block diagram of solid state relay. Rectifier and filter changes ac square waves from the oscillator drive circuit to smooth dc for transistor switch operation. Adjustment of zener diode reference controls pull-in and drop-out voltage.

Solid state relay has coil circuit isolated from transistor switch, can handle from 10 ma to 10 amperes, spst, 10 ma to 0.5 amperes, dpst. Transfer speed is less than 50 μ sec.

nd Range

voltage, while an inductively coupled multivibrator feeds a square wave ac voltage to the isolation transformer. This set-up provides a choice of pick-up and drop-out voltages not easily accomplished by electromechanical relays—the spread can be extended over 7 v by adjusting the driver current to remove the possibility of a transient switching the relay.

A rectifier converts the transformed voltage back to dc and a filter element removes ac components; smooth dc is delivered to the transistor switch. At room temperature noise level on the contacts at 22.5 v, 10 ma, is only 80 mv peak to peak.

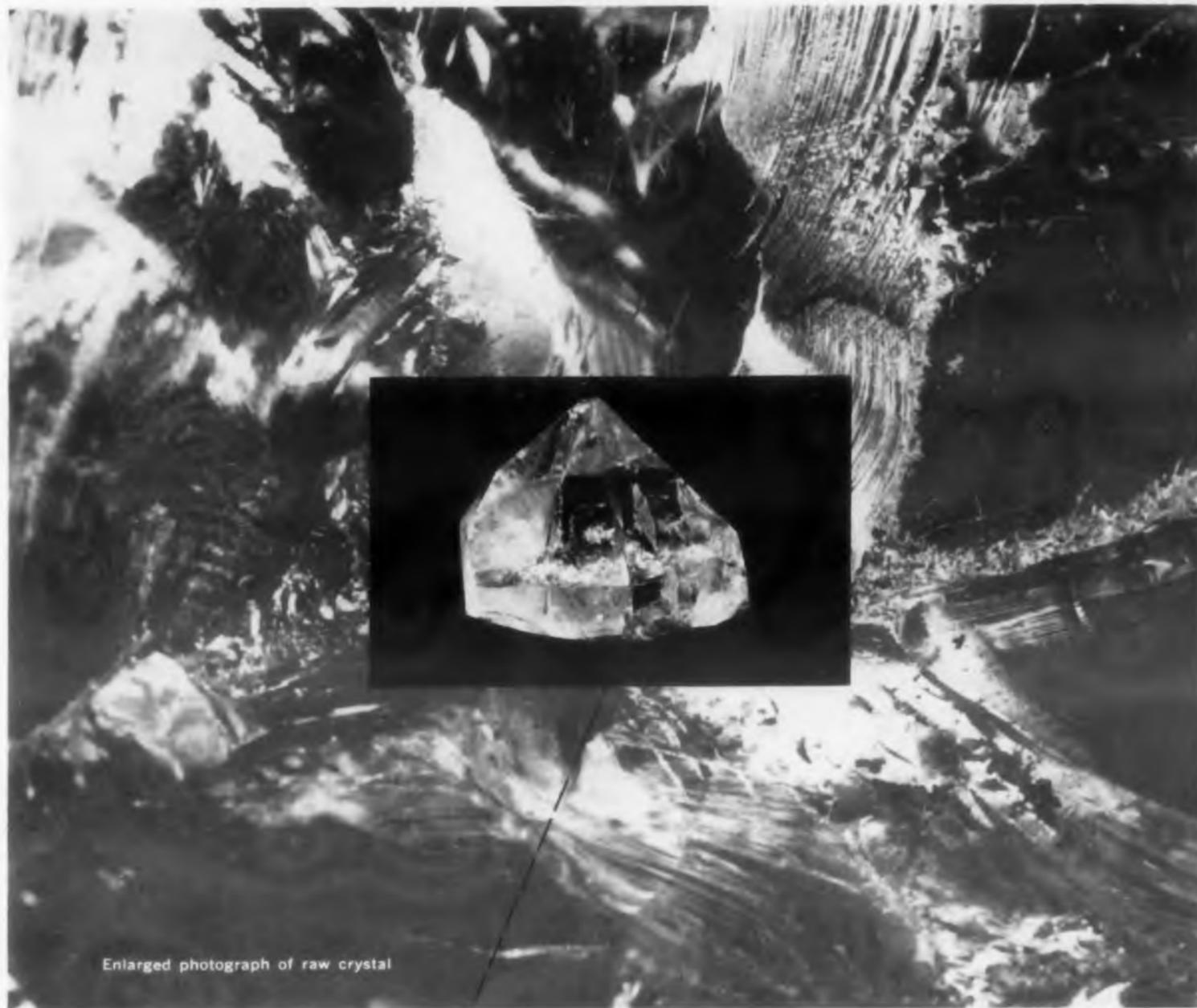
The switch consists of one or more transistors or diodes with rating and circuit arrangement compatible with the desired contact voltage, current, switching speed and whether it is to be used ac or dc. Voltage drop at the contacts is 19 mv at 22.5 v, 10 ma.

There is some contact leakage when the "contacts" are open: with 30 v and 10 mils on the contacts there is 11 μ a leakage (25 C). For 30 v dc with 1 a on the contacts there is 25 ma leakage.

The relay will handle its rated load at 0.5 v above the drop-out voltage and will continue to carry this rated load up to 30 v. At the 24 v normal level it has an overload factor of four on current and a factor of two on voltage. Entirely potted, temperature range is from -55 C to 125 C.

Six basic units are available: switching 10-100 ma spst NO; 10-11 ma dpst NO; 100 ma-0.5 amp spst NO; 100 ma-0.5 amp dpst NO; 1-5 amp spst NO; 5-10 amp spst NO.

For further information on this solid state relay, turn to the Readers Service Card and circle 102.



Enlarged photograph of raw crystal

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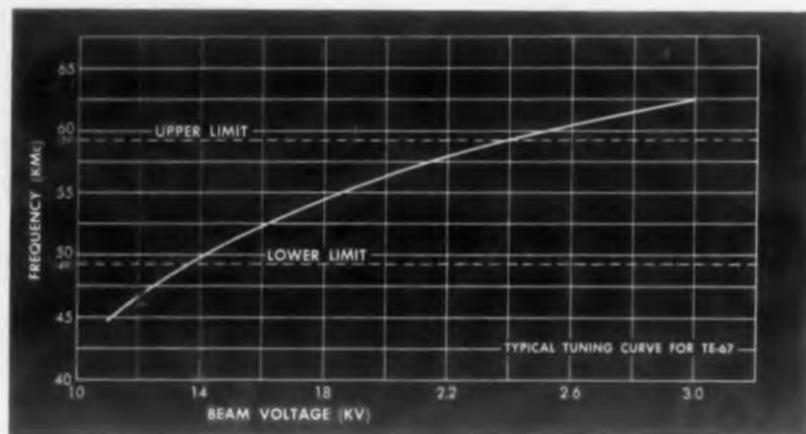
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This new tube provides a wide range of usable frequencies for applications in: advanced types of multichannel telephone and television systems, high definition short-range radar, highly directive communications, microwave spectroscopy and other fields where low power, voltage-tuned millimeter wavelength radio frequency energy is required. As the backward-wave tube is voltage tuned, frequency is automatically changed by varying the voltage input. No mechanical tuning adjustment is required.

For more detailed information on the tubes described here, write to: RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

ELECTRICAL DATA

Frequency Range	49kmc—59kmc
Anode Voltage	1000—3000 volts
Power Output	5mw average
Beam Current	5ma
Magnetic Field	1300 gauss (minimum)
Heater Voltage	6.3±10%

MECHANICAL DATA

Output Flange	Special adapter to RG-98/U
Maximum Diameter	0.625"
Length	8"
Mounting Position	Any
Weight	5 oz.*

*Without magnet (tube only). Magnets are available. Additional tubes are under development to extend the frequency range to 75 kmc.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif. • Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
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Red Bank Division



CIRCLE 25 ON READER-SERVICE CARD

KEEP JUNCTION TEMPERATURES DOWN— Mount Diodes on Fins

Diodes can be effectively cooled when mounted on fins—if the fins are efficient. Here, Werner Luft outlines steps to be taken to achieve good performance, and provides the design engineer with a graph to enable him to determine the efficiency of a fin. As a result, diode current capacity is increased.

Werner Luft
Product Analyst Engineer
International Rectifier Corp.
El Segundo, Calif.



TO KEEP THE junction temperature of a silicon or germanium diode below its upper limit, the diode often is mounted on fins and cooled by free or forced convection of air or liquid.

Factors influencing the cooling efficiency of a fin are varied. Fin efficiency is defined as the ratio of the heat *actually* dissipated by a fin to that which *would be* dissipated by an identical fin of infinitely conductive material. In practice, it is the ratio of the average fin temperature to the fin temperature at the hottest point.

As the maximum temperature of a fin is generally known, the total heat dissipation from the fin can be calculated if the fin efficiency is obtained.

Temperature Distribution

Heat dissipated from a fin is approximately proportional to the temperature difference between the average fin temperature and the temperature of the environment. Fig. 1 qualitatively illustrates the temperature distribution in a square fin of constant thickness. The temperature is shown along the ordinate and the fin is extended in a plane perpendicular to the ordinate.

In the center of the fin, where the diode is placed, there is a temperature rise above the environment of T_0 degrees. At the edges of the fin, the temperature difference above the ambient has dropped to T_L degrees. The average temperature difference will be somewhere between these two points.

Magnitude of the temperature drop from the

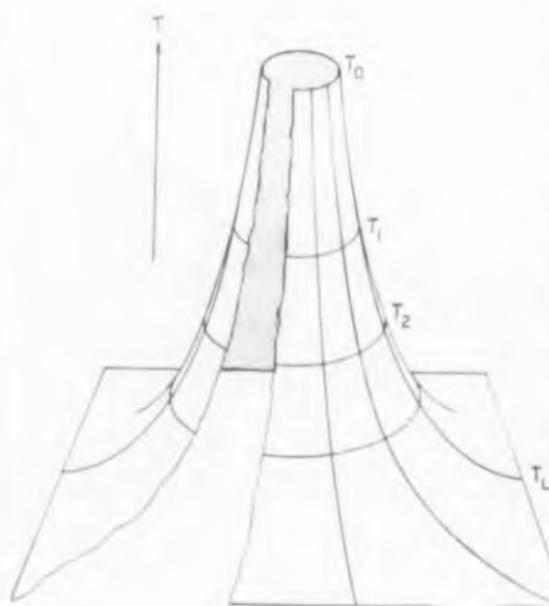


Fig. 1. Three-dimensional surface illustrating temperature distribution in square fin of constant thickness, with highest temperature near center. (Equation of curve is complex—shape shown is qualitative.)

center or base of the fin to the edges, per unit of heat dissipated by the fin, depends on

- the material of the fin, i.e. the thermal conductivity of the fin material—a material of higher thermal conductivity will decrease the temperature difference;
- thickness of the fin—a thicker fin will decrease the temperature drop;
- size of the fin—a larger fin will increase the temperature drop; and
- heat transfer coefficient between the fin and environment—better cooling methods will increase the temperature difference.

Keep Drop Small

Good design requires a fin with high efficiency—a fin where the temperature drop from center to edge is small. To have the same efficiency as a small fin, a large fin either must be thicker, made of a material with higher thermal conductivity, or both.

Two fins of the same size therefore must be of different thicknesses to have the same efficiency, if one has better cooling—a higher heat transfer coefficient—than the other. A fin cooled by forced convection of air, for instance, must be thicker than a fin of the same size and material cooled by free convection, if the same efficiency is expected.

To avoid confusion, it must be remembered that the fin efficiency does not give an actual measurement of the dissipated heat for different sizes of fin or for different cooling methods. A larger fin will dissipate more heat than a smaller

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is a resistor that opens up a whole host of new possibilities in your design and engineering work. Unfortunately, space does not permit us to tell the whole story here. But your request will bring complete details by return mail . . . including prices.

CHECK THESE OUTSTANDING TEST RESULTS*

TEMPERATURE CYCLE		
Initial	Final	% Change
235.6	235.8	.08
236.6	236.7	.04
236.1	236.2	.04
235.7	235.8	.04
235.4	235.5	.04
235.2	235.4	.08
237.7	237.8	.04
236.3	236.4	.04
236.5	236.6	.04
237.0	237.2	.08

MOISTURE		
Before	After	% Change
235.5	236.0	.21
237.4	237.5	.04
235.3	235.6	.13
236.2	236.6	.17
235.9	236.2	.13
236.9	237.4	.21
235.6	236.0	.17
235.4	235.6	.08
236.5	237.1	.25
236.1	236.6	.21

LOAD-LIFE 125° C		
Initial	After	% Change
233.5	233.9	.27
233.1	233.5	.27
233.0	233.4	.27
233.7	233.9	.18
234.8	235.1	.23
233.5	233.6	.14
233.9	234.1	.18
233.1	233.5	.27
232.8	233.0	.18
233.8	234.0	.18

TOTAL IMMERSION IN SOLDER AT 550° F. FOR 5 SECONDS		
Initial	Final	% Change
140.5	140.6	.07
139.5	139.5	0
140.0	140.0	0
139.3	139.4	.07
140.3	140.3	0
139.9	139.9	0
139.6	139.6	0
139.4	139.4	0
139.7	139.7	0
139.6	139.6	0

* Typical Data CF 1/2 When Tested to Mil R10509B

Electra Part No.	Mil Style	Wattage	Mil Resistance Range	Manufactured Resistance Range	Maximum Rated Voltage
CF 1/8	RN60B	1/8	10 ohms 1 meg	10 ohms 1 meg	250
CF 1/4	RN65B	1/4	10 ohms 2 meg	10 ohms 2 meg	300
CF 1/2	RN70B	1/2	10 ohms 2.5 meg	10 ohms 5 meg	350

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CIRCLE 26 ON READER-SERVICE CARD

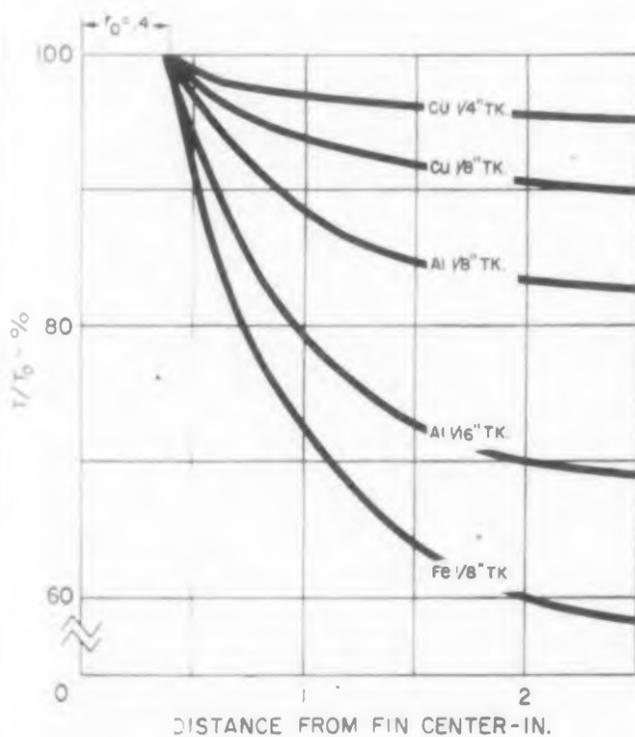
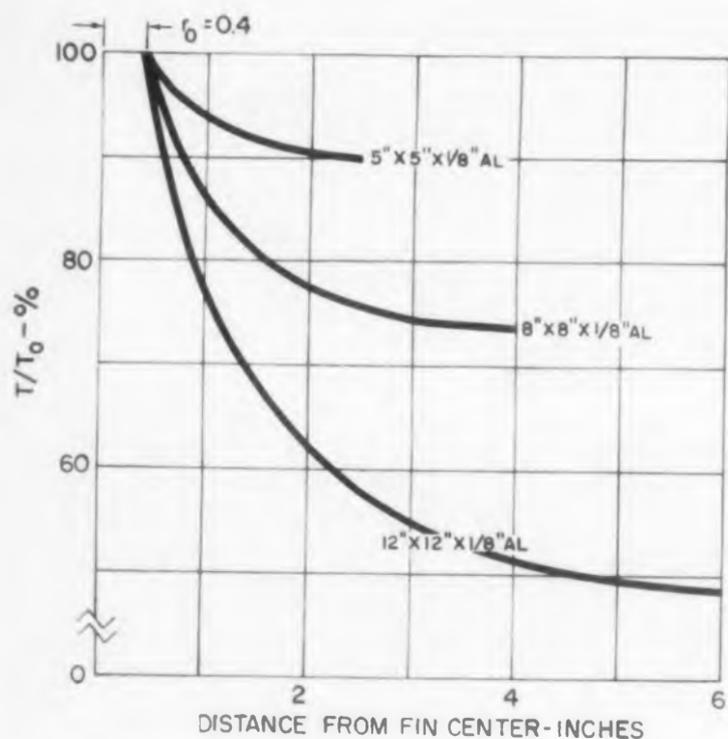


Fig. 2. Temperature distribution in 5 x 5 in. fins of different materials and thicknesses. Heat transfer coefficient: 0.016 w per sq. in. per deg C. Quarter-inch copper is most efficient fin shown here.



one of the same thickness and material, with the same cooling method. A fin cooled by forced convection will dissipate more heat than the same fin cooled by free convection.

Fin efficiency gives only the ratio of the heat a fin *actually* dissipates to that which the same fin under identical conditions *would* dissipate if

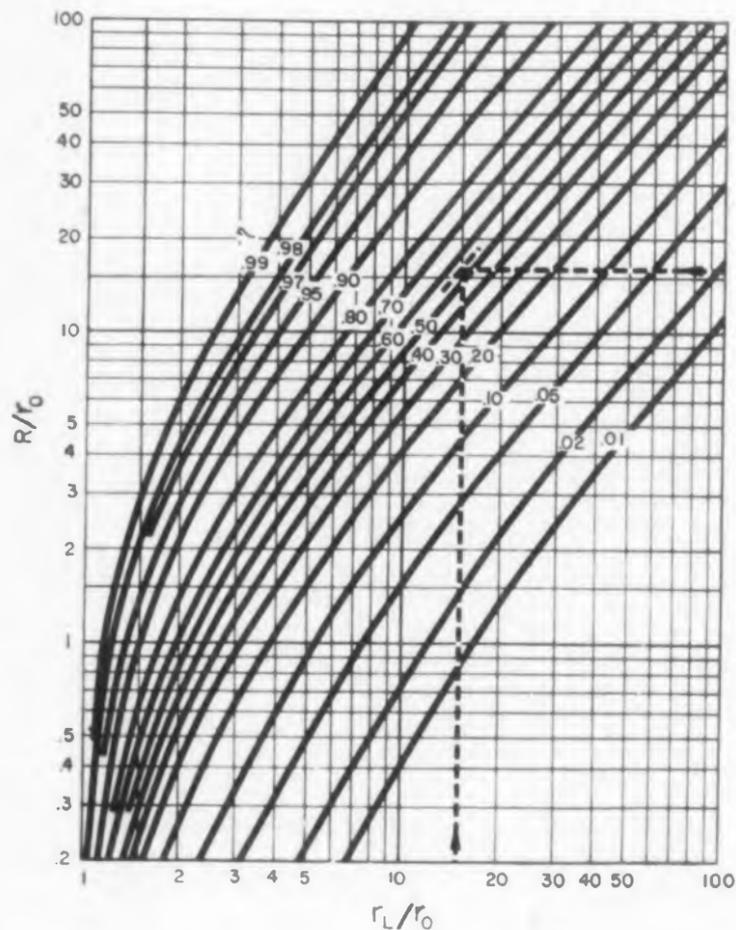


Fig. 4. Efficiency graph for annular fins of constant thickness.

Fig. 3. Temperature distribution in 1/8 in. thick aluminum fins of different areas, cooled by free convection and radiation.

there were no temperature drop from the center of the fin—where the heat source is mounted—to the edges of the fin.

Influence of Material, Dimensions

Influence of fin material and fin thickness on the temperature drop within the fin is shown in Fig. 2. All curves in the figure refer to fins 5 x 5 in., cooled by forced air of such velocity that a heat transfer coefficient of 0.016 w per sq in. per deg C is obtained. The heat comes from a silicon diode International Rectifier type 45L30, mounted in the center of these fins.

On the ordinate is plotted the ratio of the temperature difference above the ambient at each point of the fin to the corresponding temperature difference at the center. The abscissa gives the distance from fin center.

Temperature distribution within the fin from center to edge thus is pictured. The temperature drop from center to edge for the 1/4 in. thick copper fin is only five per cent of the temperature difference between fin center and environment.

Table 1 Approximate Thermal Conductivity for Some Materials in W/in. °C

Material	k
Copper	9.6
Aluminum	5.2
Brass (70% Cu, 30% Zn)	2.6
Steel, sheet carbon	1.1
Steel, stainless	0.4

Table 2 Approximate Heat Transfer Coefficient* on Vertical Fins for Different Cooling Methods in W/sq. in. °C

Cooling Method	h
Free convection of air with impeded radiation	0.004
Free convection of air and radiation	0.008
Forced convection of air 1000 LFM	0.023
Free convection of transformer oil	0.08

*Average values of those encountered for rectifier cooling. The heat transfer coefficient varies greatly with temperature, temperature difference from fin to environment, fin size, altitude, etc. The given values will therefore only indicate the magnitude of expected heat transfer.

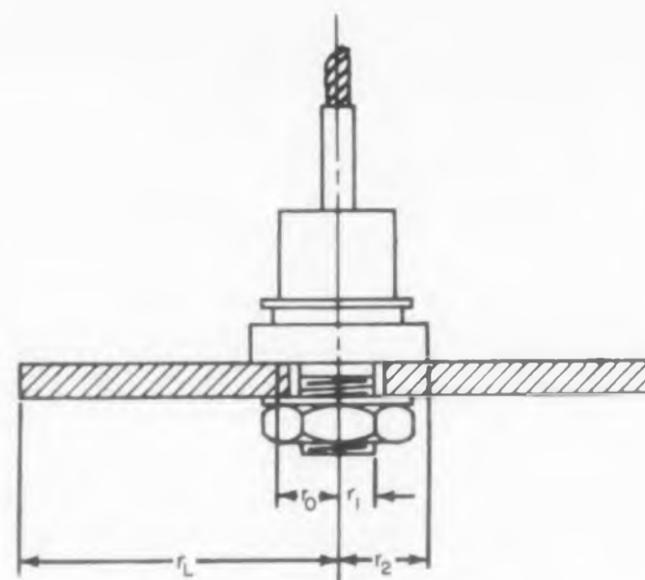


Fig. 5. Cross-section of silicon diode mounted on fin (symbols as used in text).

This, therefore, is a very efficient fin.

The corresponding temperature drop for the 1/8 in. thick aluminum fin is a less efficient 17 per cent; and for the 1/8 in. thick steel fin, an inefficient 42 per cent.

Comparing Three Fins

Influence of fin size is illustrated in Fig. 3. The curves refer to 1/8 in. thick square aluminum fins cooled by free convection of air and radiation, giving an approximate heat transfer coefficient of 0.008 w per sq in. per deg C. Mounted in the centers of the fins are the same silicon diodes shown in Fig. 2.

Inspecting the temperature distribution for the three fin sizes—5 x 5 in., 8 x 8 in., and 12 x 12 in.—we see that the temperature drop from center to edge for the 5 x 5 in. fin is 10 per cent of the temperature difference between center and environment. For the 8 x 8 in. fin, the corresponding drop is 26 per cent, and for the 12 x 12 in. fin, 52 per cent. Thus, while the 1/8 in. fin thickness gives an efficient 5 x 5 in. fin under the stated conditions, this thickness results in a low efficiency for a 12 x 12 in. fin.

Efficiency Graph

The graph (Fig. 4) is calculated for circular fins of uniform thickness with the heat source—the diode—placed at the center of the fin. For practical engineering purposes, it can be used equally well for square fins. For rectangular fins the graph is not especially valid. It will, however, give at least an estimate of the relative fin efficiency of families of rectangular fins having the same dimensional ratio of long side to short side. Rectangular fins with the long side not more than twice the short side can be treated, for practical

purposes, as square fins of equivalent area. But actual efficiency will be somewhat lower than the graph indicates.

In the graph,

• r_L designates distance in inches from the center to the edge for circular fins, and the shortest distance from center to edge for square fins. For rectangular fins, r_L is equal to half the geometric mean of one long and one short side.

• r_o designates the distance in inches from the geometric center of the heat source to the point where the heat enters the fin. For diodes with tapered threads, r_o is equal to half the pitch diameter of the thread. For diodes like the one shown in Fig. 5, r_o is $(r_1 + r_2)/2$ (dimensions are designated in the Figure).

$$R = \sqrt{ks/2h},$$

where k is the thermal conductivity of the material in w per in. per deg C; s is fin thickness in inches and h is the heat transfer coefficient between fin and environment in w per sq in. per deg C.

The graph (Fig. 4) is dimensionless. The abscissa of the chart is the ratio r_L/r_o and the ordinate is the ratio R/r_o . The curves represent the efficiency, η .

Example

Assume a 12 x 12 x 1/8 in. aluminum fin, to be cooled by free convection and radiation. The diode to be cooled by the fin is an International Rectifier Corp. silicon diode type 45L30.

• What is the efficiency of the fin?

$$r_L = 6 \text{ in.}$$

$$r_o = (0.55 + 0.25)/2 = 0.4 \text{ in.}$$

$$s = 0.125 \text{ in.}$$

$$h = 0.008 \text{ w/sq in. C (cf. Table II)}$$

$$R = \sqrt{(5.18 \times 0.125)/2 \times 0.008} = 6.36 \text{ in.}$$

(cf. Tables I and II)

$$r_L/r_o = 15, \text{ and}$$

$$R/r_o = 15.9.$$

Entering the graph for these values, we find the point of intersection at $\eta = 54$ per cent.

• How many watts can the fin dissipate if the diode case temperature must not exceed 100 C and the fin is placed in an ambient of 40 C? (The diode is soldered to the fin so the case temperature of the diode will be the same as the temperature of the fin center.)

T_o , the temperature difference—fin center to ambient is 60 deg C and A , the total fin area, is 288 sq in.

Total heat dissipated by the fin is

$$Q = \eta T_o h A = 75 \text{ w.}$$

Reference

Thermal Impedance of Cooling Fins, E. J. Diebold and V. Luft, *AIEE Transactions*, Vol. 77, Part 1, November 1958, pp. 739-745.

UPCC-M2K
UPCC-F2SL

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on male card connector-dip
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UPCC-M & -F units available with wire solder, turret type, solderless AMP 37, or dip solder terminals (1/16", 1/8", 1/4" boards).

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Max. Wire Size #18 AWG
Voltage Breakdown (Min.) 2500v, AC, RMS
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Current Ratings 7.5 amps

Also custom configurations to meet your specific application requirements.

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CIRCLE 27 ON READER-SERVICE CARD

DESIGN PREVIEW

Automatic Focusing System



This strange looking device is an automatic focusing mechanism. In this design the lens is moved back and forth by a servo-motor. Setup shown is capable of two per cent accuracy in ranging—7 in. at 60 ft. It focuses on any object at which it is aimed.

Sometimes, in our efforts to get news and design information to you *first*, we find ourselves in possession of data about products that are still in the laboratory or design stages—and which you can't buy! When this happens we're frankly baffled. What shall we do with it? Suppress it? Tell you about it? In this case we resolve our dilemma by giving you a *Design Preview*.

You can't buy the OAR . . . yet. It will take numerous forms, we are sure—its applications are limited only by the imagination of the user.

DESIGNED direct from the equations, the Optical Automatic Ranging system will focus a lens on any object it is pointed at, and will tell its range with two per cent accuracy.

Prospective applications include automatic focusing for TV, motion picture or still cameras, microscopes, automatic proximity warning devices, precision inspection for mass-produced items which need to be held to dimensional tolerances of 10^{-3} in., continuous automatic control of color processes, detection, measurement and con-

trol of temperature, and many others.

Mell Greene, research director for Comapeo, Inc., 17071 Ventura Blvd., Encino, Calif., explains that the laboratory device shown in the photo is a "straightforward mechanical formulation of the equations." He derived the mathematics and turned them directly into a mechanical process without wasting time for frills.

Design

A special case of the OAR system is shown in

Fig. 2 to demonstrate the principle. Where R_0 is the radius of the unstopped lens, R the radius of the lens stopped by an aperture, r the radius of the aperture, f the focal distance, a the offset of the focal surface and the centroid of a vibratile aperture, x_0 the excursion of the vibratile aperture along the optical axis and $x_0 \sin \omega t$ is the excursion with respect to time (simple harmonic motion), then

$$E_{sig} = E_{max} f^2 r^2 / R_0^2 [a^2 + 2ax_0 \sin \omega t + \frac{x_0^2}{2} (1 - \cos 2\omega t)]$$

E_{sig} is the energy on the surface of the photoresponsive element, and E_{max} is the maximum energy through the lens system.

In the pilot model a photocell is oscillated back and forth along the optical axis, instead of vibrating the aperture. It has the same effect and there is less inertia to contend with. When



Fig. 1. Mell Greene, coinventor of the device, claims that the transducer used in the prototype is responsive to broad areas of color.

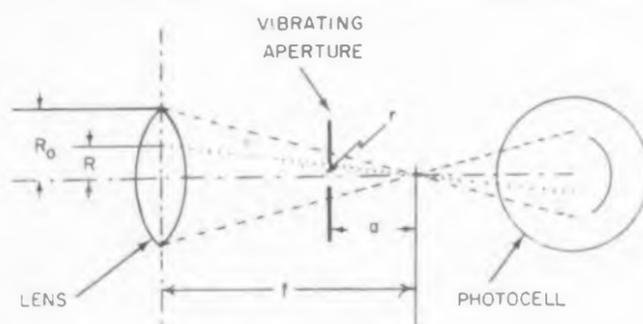


Fig. 2. Principle of automatic focusing. In this derivation, aperture is considered to vibrate; in practice the photocell is oscillated.

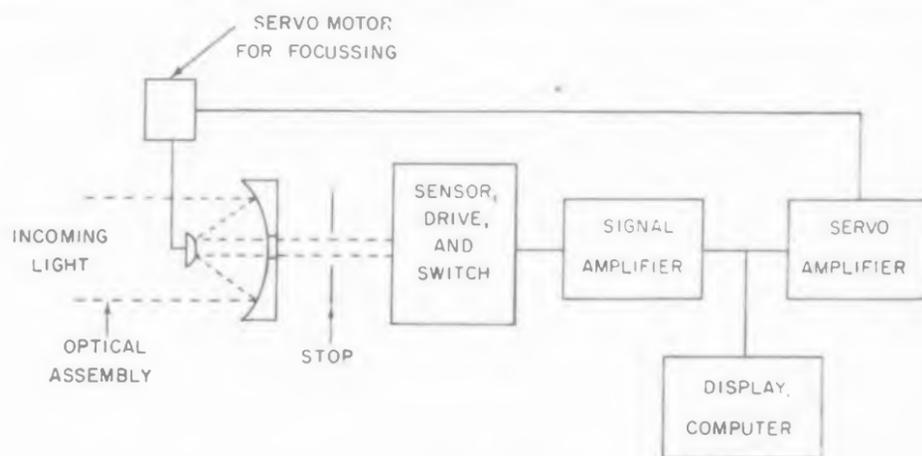


Fig. 3. The OAR system, adapted to ranging devices. Lens assembly shown is the reflecting type. The "stop" is a static aperture, behind which a vibrating photoresponsive element is driven along the optical axis. When the midpoint of the sensor's motion coincides with the image focal surface, the signal emitted has twice the frequency of vibration; shifting of the focal surface decreases the frequency and shows a phase shift indicative of the direction of movement.

The midpoint of the sensor's motion coincides with the image focal plane, the sensor's signal varies at 120 cps—twice the 60 cps vibration. If the focal conditions alter and the plane of image focus moves, the signal frequency diminishes toward 60 cps. This shift of frequency, which is out of phase with respect to the displacement of the centroid of the sensor element, yields an ideal signal for servo command.

A servo motor focuses the lens. Part of the signal can be used to activate a computer or display to give range directly. Setup for ranging and direction finding is blocked out in Fig. 3.

Operation

We went down to see the OAR system in operation. The prototype shown in the photo is bulky and not very beautiful; it's not meant to be. It was built just to demonstrate the automatic focusing principle. Greene says the whole device could be packaged in around 100 cu in.—4 x 5 x 5 in., for example—exclusive of the lens system, with a suitable choice of components.

In operation, the device was aimed at some cars in the parking lot. It gave a preliminary mutter and sat humming quietly to itself. The range indicator showed that it was focused on an automobile a hundred feet away.

A car drove past, the OAR system growled and the lens moved to focus on the new object. Range: 24 ft. When the car had gone by, the OAR unit moved back to focus on the original car. It did this several times, looking very impressive.

The OAR system's accuracy, claim the inventors, is limited only by the focal length and aperture of the lens, the wavelength-shortness of the radiation it is required to detect and the optical quality of the lens system. At 30 miles it should be able to detect and range an object the size of an airliner with two per cent accuracy.

Greene estimates that it should resolve dimensional differences as small as 40×10^{-6} cm. This means that precision parts could be monitored during grinding and controlled with a tolerance smaller than anything we know of.

If a PbS detector or other heat-sensitive element is used instead of a photocell and a quartz or sapphire lens instead of glass, the OAR system is suited to detecting, locating and measuring heat sources.

Comapeco, Inc., is not a manufacturing concern; it is set up to do research. The applications listed above are not at present in process—they are so far speculation. Comapeco plans to license the manufacture of the OAR system for a variety of applications.

For further information on this automatic focusing system turn to the Readers-Service Card and circle 103.

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SPECIFICATIONS

TEMPERATURE RANGE—Full rating to 85°C; to 125°C with 50% de-rating.

LIFE TEST—250 hours at 85°C and 125% of rated voltage.

VOLTAGE RANGES—100, 200, 400 and 600V DC.

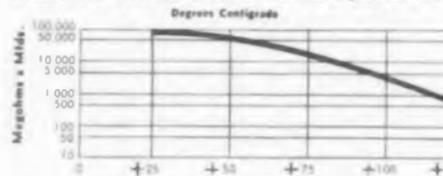
CLOSE TOLERANCES—Available in tolerances to $\pm 5\%$.

INSULATION RESISTANCE—See I.R. versus temperature curve below.

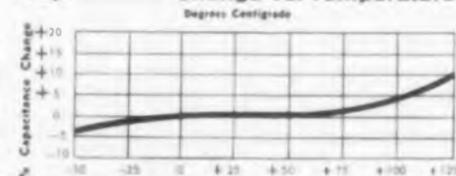
DIELECTRIC STRENGTH—Twice rated voltage for 1 minute.

CAPACITANCE IN MFDS.	100 VOLTS			200 VOLTS			400 VOLTS			600 VOLTS			1,000 VOLTS		
	T	W	L	T	W	L	T	W	L	T	W	L	T	W	L
.001	062	$\frac{1}{8}$	$\frac{1}{8}$	125	$\frac{1}{4}$	$\frac{1}{4}$									
.0047	062	$\frac{1}{8}$	$\frac{1}{8}$	062	$\frac{1}{8}$	$\frac{1}{8}$	093	$\frac{1}{4}$	$\frac{1}{8}$	125	$\frac{1}{4}$	$\frac{1}{4}$	156	$\frac{3}{8}$	$\frac{1}{4}$
.01	062	$\frac{1}{8}$	$\frac{1}{8}$	062	$\frac{1}{8}$	$\frac{1}{8}$	140	$\frac{1}{4}$	$\frac{1}{8}$	203	$\frac{1}{4}$	$\frac{1}{4}$	234	$\frac{3}{8}$	$\frac{1}{4}$
.022	093	$\frac{1}{4}$	$\frac{1}{8}$	140	$\frac{1}{4}$	$\frac{1}{8}$	203	$\frac{1}{4}$	$\frac{1}{8}$	234	$\frac{1}{4}$	$\frac{1}{4}$	218	$\frac{1}{2}$	$\frac{1}{4}$
.047	125	$\frac{1}{4}$	$\frac{1}{8}$	156	$\frac{1}{4}$	$\frac{1}{8}$	218	$\frac{1}{4}$	$\frac{1}{8}$	281	$\frac{1}{4}$	1	343	$\frac{1}{2}$	$\frac{1}{4}$
.1	156	$\frac{3}{8}$	$\frac{1}{8}$	234	$\frac{1}{4}$	$\frac{1}{8}$	250	$\frac{1}{4}$	1	312	$\frac{1}{2}$	$\frac{1}{4}$	359	$\frac{1}{2}$	$\frac{1}{4}$
.22	187	$\frac{1}{2}$	1	250	$\frac{1}{4}$	$\frac{1}{8}$	343	$\frac{1}{4}$	$\frac{1}{8}$	468	$\frac{1}{2}$	$\frac{1}{4}$	500	$\frac{1}{2}$	$\frac{1}{4}$
.47	281	$\frac{1}{2}$	$\frac{1}{4}$	340	$\frac{3}{8}$	$\frac{1}{8}$	437	$\frac{1}{2}$	$\frac{1}{8}$	531	$\frac{1}{2}$	2	765	$\frac{1}{2}$	2
1.00	359	$\frac{3}{4}$	$\frac{1}{4}$	437	$\frac{3}{8}$	$\frac{1}{8}$	500	$\frac{1}{2}$	2	796	$\frac{1}{2}$	$\frac{1}{4}$	859	$\frac{1}{2}$	$\frac{1}{4}$

Insulation Resistance vs. Temperature



Capacitance Change vs. Temperature



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This article presents the key to tube type symbols used by most European tube manufacturers. Using these tables, the filament characteristics, structure and other pertinent data can be quickly determined.

Interpreting European Tube Symbols

Gerardo Gerardi

Boston, Mass.



TABLE 1 Receiving and Amplifier Tube Symbols

First Letter (Filament)	Subsequent Letters (Structure)	Figures (Socket)
A — 4v C — 200 ma	A — rf single diode B — rf double diode	30-39—Octal 40-49—Rimlock, special European
D — 1.4 v dc	C — triode, except output and gas filled	
E — 6.3 v G — 5 v	D — triode, output E — tetrode, except output	80-89—9 pin min. 90-99—7 pin min.
H — 150 ma	F — pentode, except output	All other numbers in- dicate special sockets
K — 2 v dc M — 2.5 v O — no fil.	H — hexode or heptode K — octode or heptode L — output tetrode or pentode	
P — 300 ma U — 100 ma	M — tuning indicator P — tube with secondary emission system Q — enneode X — full-wave gas-filled rectifier Y — half-wave vacuum rectifier Z — full-wave vacuum rectifier	

Receiving and amplifier tubes are keyed as shown in Table 1. Special tubes (ruggedized, high reliability, long life) are keyed according to the same table, but the figures are placed between the letters.

For example, an EF 80 is a 6.3 v filament pentode, 9 pin miniature. An E80F would be ruggedized, long life, or other special version of that type. An ECC-83 is a 6.3 v, dual triode, 9 pin miniature. Equivalent U.S. tube type for an ECC-83 is a 12AX7.

TABLE 2 Cathode Ray Tube Symbols

First Letter (Focusing)	Second Letter (Screen)
D — Electrostatic focussing and deflection in two directions	B — Bluish, short persistence, 1% max brightness after 0.01 sec.
M — Electromagnetic focussing and deflection	F — Orange, long persistence, 0.1% max brightness after 75 sec.
	G — Green, medium persistence, 1% max brightness after 0.05 sec.
	N — Green, long persistence, 0.1% max brightness after 6.4 sec.
	P — Double layer screen, short persistence blue followed by very long persistence green-yellow, 0.1% max brightness after 80 sec.
	R — Green-yellow long persistence, 0.1% max brightness after 20 sec.
	W — White, medium persistence; direct view; 8000 k color temp; projection: 5500 k color temp.

First group of figures—screen diameter in cm
Second group of figures—serial number

Cathode ray tube symbols indicate focussing method, type of screen, screen diameter and serial number (Table 2). A type DG13-2 is an electrostatic type, green, medium persistence, with a screen diameter of 13 cm.

TABLE 3 Transmitting and Rectifier Tube Symbols

First Letter (Classification)	Second Letter (Filament)	Third Letter (Cooling)
D — Rectifier (including grid-controlled)	A — direct, tungsten	G — Mercury filled
M — Triode, amplifier or modulator	B — direct, thoriated tungsten	L — Forced air
P — Pentode	C — direct, oxide coated	W — Water cooled
Q — Tetrode	E — heater-cathode	X — Zenon filled
T — Triode, rf, af or oscillator		

First Group of Figures	Added Letters (Socket)
Rectifiers — dc output power, watts or kw, for tube in 3-phase half-wave circuit	E — Medium 7 pin
RF Tubes — Approx. power output, watts or kw, in Class C telegraphy	ED — Edison
Modulators — Approx. dissipation, watts or kw.	EG — Goliath
	G — Medium & pin
	GB — Jumbo 4 pin
	N — Medium 5 pin
	P — P base

Transmitting and rectifier tube types are designated by two or three letters followed by two sets of figures. Tube classification is indicated by the first letter, or first two letters in the case of a dual type. In Table 3, the second letter becomes the third letter in a dual tube designation. Likewise, the third letter (cooling) becomes the fourth letter for dual tubes. Where no third (or fourth) letter is given, the tube is radiation cooled.

Transmitting type QQE 04/20 is a dual tetrode, indirectly heated cathode. Maximum anode voltage is 4 kv; output power is 20 watts. It is important to note that these characteristics must be interpreted in the light of the tube application.

TABLE 4 Phototube Symbols

First Figure (Base)	First Letter (Cathode)	Second Letter (Type)
2 — Octal, 8 pin	A — Cesium antimony, blue sensitive	G — Gas filled
3 — Octal, 8 pin	C — Cesium on oxidized silver red sensitive	V — Vacuum
5 — Special		
8 — 9 pin miniature		
9 — 7 pin miniature		

Phototube type numbers consist of two figures followed by two letters. Tube base is indicated by the first figure; second figure is the serial number.

Type of cathode is indicated by the first letter, while the second letter gives the class of tube (Table 4). A 90AV is a miniature 7 pin, blue sensitive, high vacuum type.

TABLE 5 Voltage Regulator Symbols

Number (Voltage)	First Letter (Max current)	Figure	Second Letter (Base)
Average operating voltage	A — 8 ma	Serial number	K — Octal
	B — 20 ma		P — P base
	C — 40 ma		
	D — 100 ma		
	E — 200 ma		

Voltage regulators are coded by a number followed by a capital letter, a second figure, and often by another letter. Operating voltage is given by the first number. Current range is indicated by the first letter. The second figure indicates the serial number, and the last letter, if given, is the base type.

For example, according to Table 5, a type 85A2 operates at 85 v and 8 ma max current. Type 150C1K is a 150 v tube, 40 ma max current, with an octal base.



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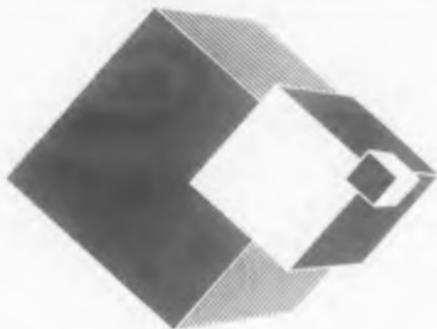
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This is one of a series of papers presented at the Symposium on Microminiaturization of Electronic Assemblies sponsored by Diamond Ordnance Fuze Laboratories late last year. Because symposium attendance was limited to government personnel only, ELECTRONIC DESIGN is publishing these papers as a special service to our readers. In addition, all of the symposium papers will be published in their entirety in bound form available only from ELECTRONIC DESIGN. For further information on these Proceedings, turn to Reader-Service Card and circle 100.

Three levels of design are suggested by the author. Each level is aimed for circuit operation under different conditions and the author discusses the various factors important to this operation.

DESIGN of a binary counter of the Eccles-Jordan flip-flop type can be regarded as a three stage problem. First is the design of the basic circuit for laboratory breadboard operation. Second stage involves design of the circuit in field equipment where checking and replacement are possible. The third level of design is that of a circuit to go into a piece of field equipment where unit replacement is not possible due to inaccessibility or microminiaturization.

A typical saturated two-transistor flip-flop equipped with set and reset networks is shown in Fig. 1 (a).

If the "set" and "reset" inputs of the circuit of Fig. 1 (a) are tied together, Fig. 1 (b), the circuit will operate as a binary counter. In this case the positive input pulse goes to both transistor bases, but can only cut "off" the conducting transistor. This circuit is sensitive to the relation of the size of the cross-coupling capacitors, C_c , and the shape and duration of the trigger pulse. Wider variations in this pulse may be tolerated, and

cross-coupling capacitors may be omitted, if the input pulse is steered to the proper transistor. The input circuit may be converted to a steering circuit by connecting the diode biasing resistors R_{K1} and R_{K2} to the collectors of T_1 and T_2 respectively. In addition, the resistors R_s may be returned to a positive voltage source, V_{BB} , to insure cut-off of the transistors.

In many applications the input to the binary counter is a square wave from a previous stage as shown in Fig. 1 (b). In this case the time constants $R_T C_s$ and $R_T C_R$ also play a part in deter-

mining the recovery time of the counter. Waveforms during operation (Fig. 2) illustrate what happens at various points in the circuit for a square-wave input.

First Level Design

In the first level of design of a binary counter, one needs to consider only:

- Output signal power required
- Input signal power available
- Speed at which the stage must count

The maximum speed at which a binary counter

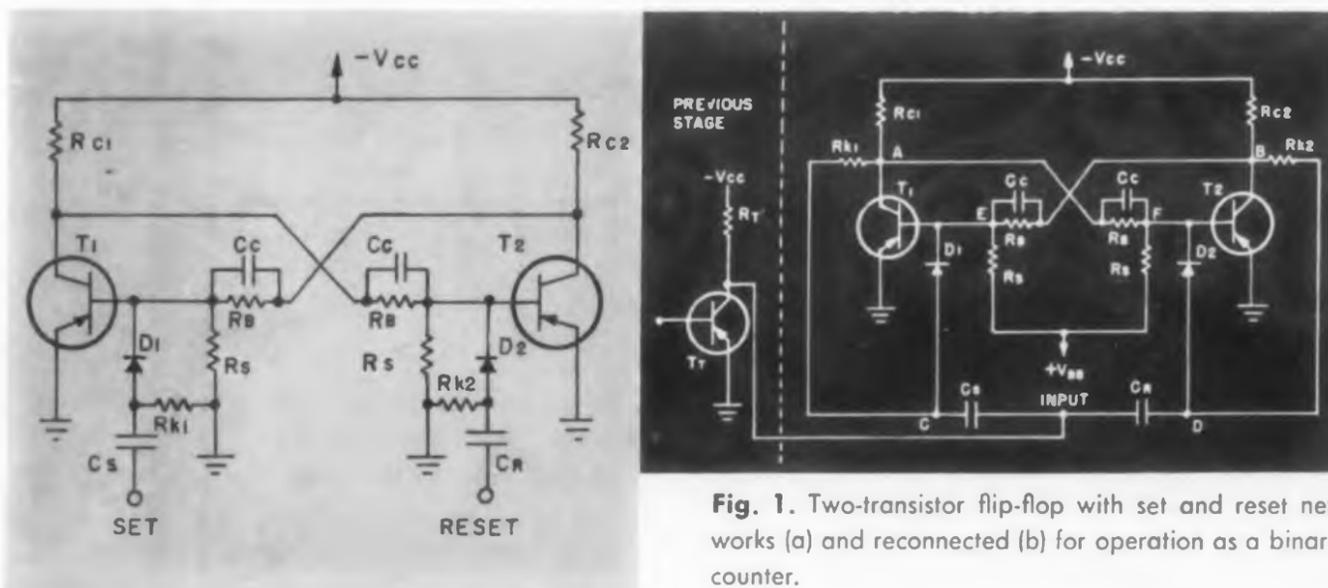


Fig. 1. Two-transistor flip-flop with set and reset networks (a) and reconnected (b) for operation as a binary counter.

Design of a

Two-Transistor Binary Counter

P. Emile, Jr.

Diamond Ordnance Fuze Laboratories
Washington 25, D. C.

will operate depends on the alpha cutoff frequency of the transistors used, in addition to other factors to be discussed. In this type of circuit, a good "rule of thumb" is that the maximum speed at which a counter will run reliably is approximately 1/10 the alpha cutoff frequency of the transistor.

To realize this speed, cross-coupling capacitors must be used. For instance, in the case of the surface barrier transistor, the maximum speed of operation is about 300 kc without capacitors and about 2 mc with cross-coupling capacitors of the proper value.

By employing emitter-follower coupling and faster gating this factor of 1/10 can be increased to about 1/5. If complementary-symmetry circuits and high-speed gates are used, this factor can be increased to about 1/3 or 1/2.5.^{1,2} If one chooses the maximum frequency of operation of the binary counter to be 1/10 alpha cutoff, the minimum alpha cutoff of the transistor to be used is specified. To decide exactly what transistor to use one may also wish to consider size, β , and material (germanium or silicon).

Another good "rule of thumb" is that the output voltage obtained from a circuit of this type is from 0.7 V_{CC} to 0.8 V_{CC} , where V_{CC} is the collector supply voltage. Therefore when the desired output voltage is specified the supply voltage can also be immediately specified.

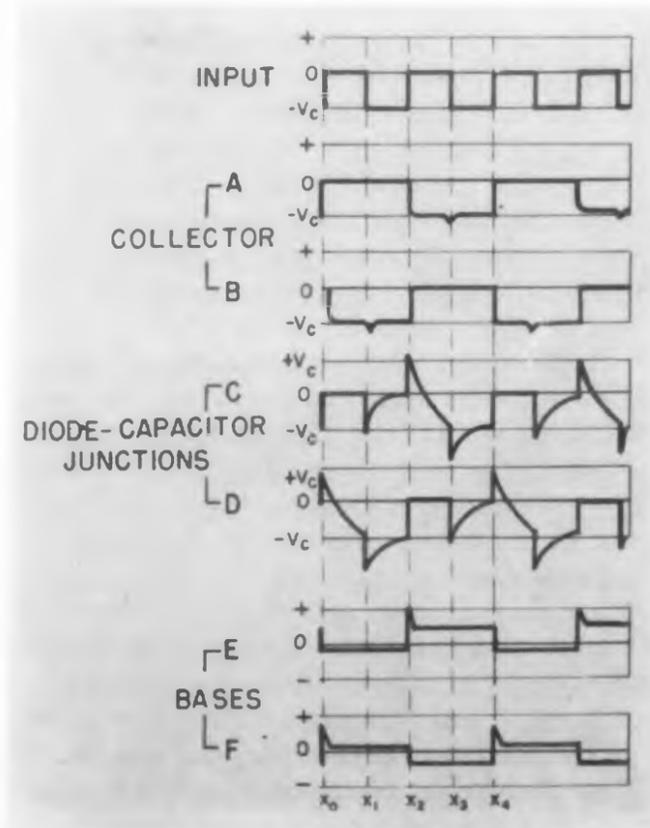


Fig. 2. Waveforms in the two-transistor binary counter shown in Fig. 1(b). Letters refer to points on the circuit of Fig. 1(b).

It may be shown that the relationship

$$R_B \cong \frac{\beta}{4} R_C$$

gives a safety factor ($S = 4$) to allow for decrease in β and still insure saturated operation for a grounded emitter switch as used in the basic flip-flop.³ In the basic flip-flop the size of the collector resistor, R_C , is limited by several factors. The minimum R_C is limited by the maximum current rating of the transistor and/or the allowable power dissipation by the flip-flop. The maximum R_C is limited by the load R_L which must be driven from the collector.

$$R_L = \frac{R_B R_{EXT}}{R_B + R_{EXT}}$$

where R_B is a base biasing resistor and R_{EXT} is the external load resistance. Assuming that the maximum R_C is desired, one can compute R_C to be:

$$R_C = \frac{\beta - 3S}{3\beta} R_{EXT}$$

The value of R_C is thus specified in terms of the β of the transistor to be used, the safety factor S and the external load to be driven. If the load is capacitive it is well to specify R_C such that

$$R_C C_L \leq \frac{1}{10f}$$

where C_L is the loading capacitance and f is the maximum frequency at which the circuit is to operate. This will insure reasonably square output waveforms.

Results of sample calculations indicate that if all other factors are equal, the use of a transistor with the higher β will result in a larger R_C (and therefore lower power dissipation for the counter). An expression for R_B in terms of the external load, the β of the transistor and the safety factor is:

$$R_B = R_{EXT} (\beta/3S - 1)$$

Resistor R_S is chosen to limit the effect of I_{CBO} in the "off" transistor. It should be five or more times larger than R_B ($R_S \cong 5R_B$) to prevent loading of the "on" transistor. Often R_S is returned to a positive voltage $+V_{BB}$ rather than to ground.

For shortest recovery time of the binary, R_K should be small. However, a lower limit for R_K of about $5R_C$ ($R_K \cong 5R_C$) is necessary to limit feed-through and loading. A value often used is $R_K = 10R_C$.

The cross-coupling capacitors C_C should be large enough to transfer enough charge to switch the transistor from "off" to "on." They should not be so large as to transfer appreciable charge to

the collector, of say, T_1 , when T_2 is "on" and the reset diode, D_2 , is pulsed. Theory predicts that for the highest speed of operation $V_C C_C$ should be greater than Q_A , the charge stored in the base region of the "on" transistor, excluding charge due to saturation.

If highest speed of operation is not of importance the cross-coupling capacitors are unnecessary with the type of steering described in this article. In the event that the cross-coupling capacitors are omitted the transition time of the flip-flop is approximately equal to the time for the "off" transistor to turn on with current drive through R_B only. This switching time may be computed from Ebers' and Moll's equations.

It is difficult to calculate the transition time if the cross-coupling capacitors are included. However, experimental results show that the transition time for a circuit with cross-coupling capacitors can be less than 1/3 the transition time for the same circuit without cross coupling capacitors.

The input capacitors C_S and C_R should be as small as possible to allow shortest recovery time of the binary counter. However, for good operation of the binary counter described herein, the input pulse must completely switch the "on" transistor to "off." This requires that

$$V_I C_S = V_I C_R \cong Q_T$$

where V_I is the minimum input voltage to the binary counter and Q_T is the charge required to turn "off" the "on" transistor. In cases where the turn-off charge and minimum input signal are known the values of C_S and C_R may be computed directly. If Q_T is not known then

$$C_S = C_R \geq \frac{3Q_A}{V_I}$$

will give usable values of C_S and C_R . In circuits which use cross-coupling capacitors it is well to specify $C_S = C_R = 3C_C$. Much larger values of C_S and C_R are sometimes used but one must insure that the time constants $R_{K1} C_S$ and $R_{K2} C_R$ are small compared to the time between input pulses.

For room temperature operation and at collector current levels high compared to I_{CBO} , e.g. I_C° 1 ma for 2N77 type transistors, practically any diodes will suffice, e.g. 1N99, 1N34, 1N56. For operation at high temperature or at collector current I_C° comparable to βI_{CBO} the back impedance of the diodes must be high (greater than 10 megohms). Otherwise voltage leakage to the transistor bases from points C and D will offset the effect of the positive bias voltage and cause the circuit to fail. Silicon diodes have performed satisfactorily in some low current circuits.

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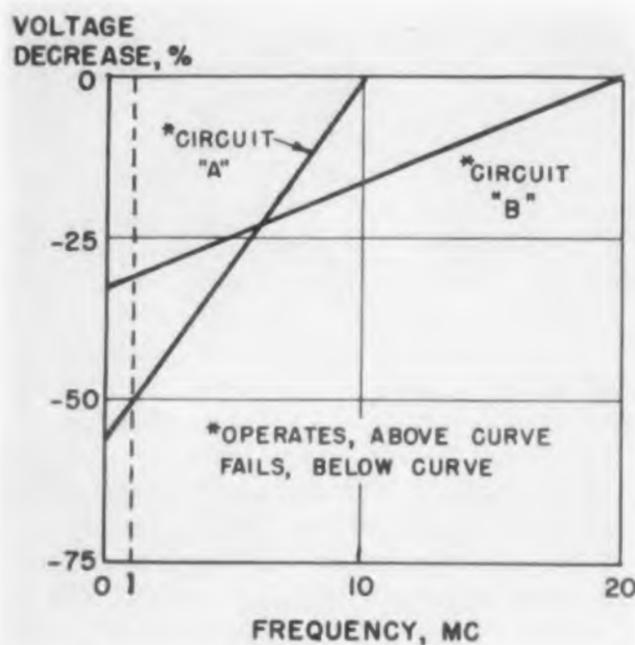


Fig. 3. Lower limit of input voltage before failure versus counting frequency.

Second Level Design

The second level of design is that of a circuit to work in a field system, such as a computer in which marginal checking and unit replacement are allowed. At the second level of design additional factors enter, such as:

- Total power consumption
- Circuit tolerances
- Temperature considerations
- Total number of components
- Cost per unit

Often in large systems, although impedance levels may be fixed, the supply voltages and current levels may be flexible. In such cases a generalized common-emitter NOR circuit may be considered. This circuit may then be designed for minimum power dissipation.⁴

Circuit tolerances of a binary counter must be known if the circuit is to be used in a large system. For example, will the circuit fail to operate (1) if the input voltage decreases 20 per cent, (2) if the supply voltage drops 10 per cent, (3) if the collector resistors are different by 30 per cent?

The curves in Fig. 3 show one concept of margins. The plots are allowed percentage decreases of input voltage before failure occurs vs. counting frequency. The curve labelled "A" is for a type of direct-coupled binary counter. The curve labelled "B" is for an optimized emitter-follower-coupled binary counter. Either of the circuits will operate if the input voltage is above the lines.

Consider the case of operation at 10 mc. This is practically the upper frequency limit of circuit A. A 1 per cent decrease in the input signal from

the nominal 100 per cent input level would cause this circuit to fail. Circuit B, on the other hand, will operate if the signal decreases 15 per cent from its nominal input value at 10 mc. However, at 1 mc the situation has changed. At this point the circuit A will operate if the input voltage is decreased 50 per cent from the nominal value while circuit B must receive a signal within 30 per cent of its nominal value to operate properly. For 10 mc operation it is clear which circuit would be used for reliable operation. For 1 mc operation there is a choice.

In marginal checking, the problem is to find a so-called "handle" to vary which will cause circuits which are near failure, or "marginal," to fail. In the case of the binary counter a good "handle" in many cases proves to be the positive voltage supply, $+V_{BB}$. If a circuit is near failure because of high I_{CBO} due to temperature or age, lowering the positive voltage will cause the circuit to fail. If the circuit is near failure due to a decrease in β , increasing the positive voltage above the design value will cause the circuit to fail. Upper and lower limits before failure may be set in both cases.

The design value of the positive voltage, in particular, must be determined by the highest expected temperature of operation and the expected I_{CBO} at that temperature. However, if low temperature operation is also anticipated the safety factor (S) must be chosen high enough that the decrease in β with lower temperature will not cause circuit failure. Silicon transistors must almost certainly be used if high temperature operation is desired, e.g. 150 C.

The number of component parts used in a binary counter circuit is a compromise between a conservative design using 8-10 transistors per stage with each transistor performing a simple separate function (e.g. logical binary counter and a design using only 2 transistors. Reliability may be higher for the more conservative design, but, on the other hand, it may not be because long-term reliability varies inversely with the number of active components. Local experience has shown that the binary counter design (without the cross-coupling capacitors) performs very well for low frequency operation (less than 10 kc) with the 2N207 audio transistor. With cross-coupling capacitors and using surface barrier transistors the circuit performs with greater than 10 per cent margins up to 2 mc.

If emitter-followers are added and higher speed steering gates used, the circuit will operate up to 20 mc. This last is a maximum frequency and 10 mc or 16 mc is thought to be a more practical limit, i.e., 10 per cent or greater margins on input voltage and other design values. The binary counter presented here represents a good compromise among the various

factors mentioned. There are circuits which operate faster and there are circuits which theoretically would be more reliable for random counting in that RC time constants would not be used, e.g. the logical binary counter.^{5,6}

The average cost of assembly of several breadboard systems at DOFL has been 10 per transistor and associated components. Considering the cost of the transistors, diodes, resistors, and capacitors, the type of binary counter described herein has cost about \$30 per stage in a breadboard version. If the cost per transistor remained unchanged the logical binary counter would cost approximately \$100 per stage in a breadboard version. Microminiaturized binary counter modules now under investigation may eventually cost in the range of \$1 to \$3.

Third Level Design

The third level of design is that of a circuit to be used in a system where unit replacement is impossible. This situation occurs in microminiaturization.

The design requirements for a circuit to go in a sealed system are more rigorous than for a circuit which can be replaced if defective. After the circuit has been designed and thoroughly tested in a breadboard model, it is necessary to specify a rigorous acceptance or rejection test for the field models. Analysis of the circuit may be so complete that off-value, weak, or defective components can be identified merely by observing a single-output waveform. This should be possible even if the circuit is not malfunctioning at the time of the observation. The circuit may then be rejected before potting or final sealing, or at least restricted to uses in which its weaknesses will not endanger future operation of the system. For instance, if it were discovered that the I_{CBO} of the transistors was higher than the design value, the circuit might still be used in low temperature applications if all its other characteristics were acceptable.

If the circuit uses standard size components, the waveforms at several points may be monitored. In the case of this binary counter, the waveforms at points C and D, Figs. 1 (b) and 2, give much information about the circuit. For instance, the decay times of the step waveforms indicate the time constants $R_K C_B$ and $R_K C_R$. These time constants compared to the input frequency show how close the circuit is to its maximum frequency of operation. The voltage levels at points C and D indicate the collector voltage of the off transistor and thereby indicate the I_{CBO} . The height of the positive spike can be used as a measure of the charge required to turn off the "on" transistor if the input signal and diode characteristics are known. This height indirectly measures the alpha cutoff frequency of

the transistors in the binary counter. The points *C* and *D* in a binary counter would then be good points to monitor for an acceptance test.

In the microminiaturized DOFL-2D binary counter wafers now being studied only one output terminal is available.⁷ This point is the output of one collector which would normally drive the following stage. The resistors in this wafer are carbon deposited strips, the capacitors are silver fired areas, the diodes are germanium dots and the transistors are bits of germanium mounted in holes in the 1/2 inch by 1/2 inch by 1/50 inch ceramic plate. Checking the internal connections with a probe and an oscilloscope is difficult unless the probe is very small. If the wafers are potted or stacked, this becomes impossible.

Three different approaches have been made to check the individual circuits through the use of the external connections only.

First, resistance measurements have been made between all terminals taken two at a time. This method can identify some catastrophic failures and is good to detect "leakage paths." However, the test is a dc test and somewhat limited.

Secondly, a series of so-called "standard tests" was set up as follows:

- (1) Output voltage was measured; waveshape noted
- (2) Positive voltage decreased to zero or until circuit fails to operate correctly. Output voltage at $V_{in} = 0$ or plus bias voltage when failure occurs was measured.
- (3) Upper and lower limits on input voltage before failure was measured.
- (4) The collector voltage was lowered until the circuit failed. Operation at -3 volts was also checked.
- (5) Maximum resistive load and maximum capacitive load before failure was measured.
- (6) Upper frequency limit was determined. Also resistor R_T was varied from 100 to 10 K and the upper frequency limit was noted at each value of R_T .
- (7) Circuits were labelled and any anomalies noted.

The expected results of the standard tests can be computed from the circuit design. These results are then compared with the results obtained from a breadboard model. Any differences are corrected by improved theory and redesign. Next, the results from the 2D wafers are compared with the breadboard circuit results. Any differences will be due to off-value, weak or defective components. In some cases the values of the components in the 2D circuit can be determined and if they are too far off, the information can be fed back to the makers of the 2D wafers.

A third method of analysis has also been tried. Resistors, capacitors and diodes in a breadboard model of the binary counter were systematically

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bridged, shorted or opened. Also, transistors with very high β and very low β were substituted in the unit. The effect of these mutations was observed on the accessible waveforms, in the case of the 2D binary counter, the output waveform. Knowing these casual relationships a first order analysis of the circuit condition can be made by carefully observing pips, slopes and amplitudes of the output waveform.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information

on the Proceedings, turn to Reader Service Card and circle 100.

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Acknowledgments

The author wishes to acknowledge the helpful discussions with T. A. Prugh during the preparation of this paper. The author also wishes to thank N. J. Doctor, Amiel I. Goodman and E. L. Cox for help in devising test procedures described in this paper.

Designing a Transistor NOR Circuit for Minimum Power Dissipation

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Computers make extensive use of NOR circuits because they perform all of the logic functions. In this article, the author describes a method of designing a transistor version of a NOR circuit.

BECAUSE the transistor NOR circuit is capable of performing all of the English logic functions AND, OR, and NOT, it is extremely useful in computer systems. The NOT function is performed by a NOR with one input. The AND function is performed by three NOR circuits and the OR function is performed by two NOR circuits as shown in Fig. 1.

The basic building block, the transistor NOR circuit as shown in Fig. 2, employs a junction transistor in the common emitter configuration. The transistor is used as a two-position switch rather than as a linear device.

As shown in Fig. 2, the circuit consists of M input lines with input resistors R_i , a base bias resistor R_b , and a collector resistor R_c . The positive bias V_{bb} supplied through R_b causes the transistor to be turned off if all of the inputs (A , B , and C) are near zero voltage. The transistor is on if one or more of the inputs (A , B , C) are at a negative voltage V_c . V_c must be sufficiently large such that the current I_b through R_i is equal to or greater than I_c/B , where B is the base to collector short circuited current gain, and I_c is the maximum current in the collector resistor R_c .

When the transistor is cut-off, the output voltage is approximately the same as the supply voltage V_{cc} . When the transistor is in the saturated state most of the collector supply voltage V_{cc} appears across R_c and the output is near ground potential. A voltage signal is present on the output if voltage signals are not present on any of the inputs. Conversely, a voltage signal is not present on the output if voltage signals are present on any or all of the inputs.

A basic question encountered in using the NOR circuit is "will the circuit operate properly when a single collector is required to drive a certain desired number of output circuits?" An expression for this number of outputs, N , in terms of

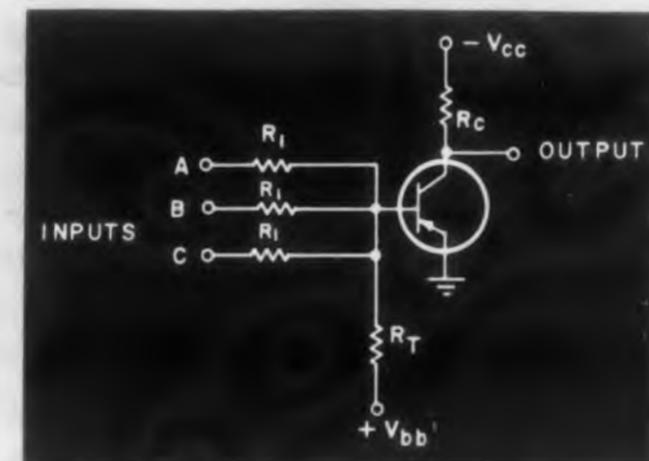
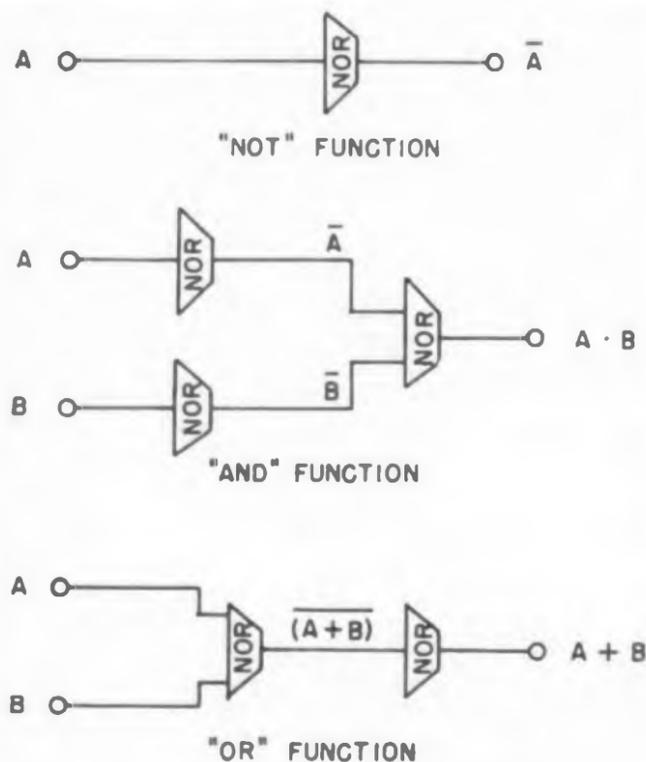


Fig. 2. (above) Basic transistor NOR Circuit.

Fig. 1. (left) English logic functions performed by NOR circuits.

the circuit components, was derived by W. D. Rowe.¹

$$N = I_c \left[\frac{1}{S I_c + I_{cbo} + \frac{0.25(M-1)}{R_1}} + \frac{R_1}{V_{ce}} \right] \quad (1)$$

Where I_{cbo} is the maximum expected base to collector leakage current with the emitter open circuited. 0.25 is the base to emitter voltage for germanium transistors, and S is the safety factor employed to compensate for a decrease in gain of the transistor and other circuit parameter tolerances.

It was assumed that V_{be} , the base to emitter voltage when the transistor is in the "on" state, was very much smaller than V_{ce} , the collector supply voltage and that the leakage current I_{cbo} was very much smaller than I_c , the maximum current flowing in the collector resistor. It was also assumed that the transistor acts as a perfect switch when the transistor is in the saturated state. Consequently, under saturated conditions $-V_{ce} = I_c R_c$. All results will be based on these assumptions.

Given a certain number of inputs to a NOR circuit which is to drive a certain number of output circuits, it is desired to minimize the power dissipation $I_c^2 R_c$ in the collector resistor R_c , subject to the restriction that eq (1) be satisfied. The objective here is to minimize $I_c^2 R_c$ with respect to base resistor, R_1 , and collector current I_c .

Input Current Limiting Resistor

From eq (1) the expression for R_1^* may be derived.

$$R_1^* = \frac{0.25(M-1)}{I_c} = \frac{1}{N} \left(\frac{I_{cbo} + S}{I_c + B} \right) - \left[\frac{I_{cbo} + S}{I_c + B} \right] \quad (2)$$

This expression gives the value of the input-current limiting resistor for a minimum R_c and also minimum power dissipation ($I_c^2 R_c$), if such a minimum exists. The expression for power dissipation is:

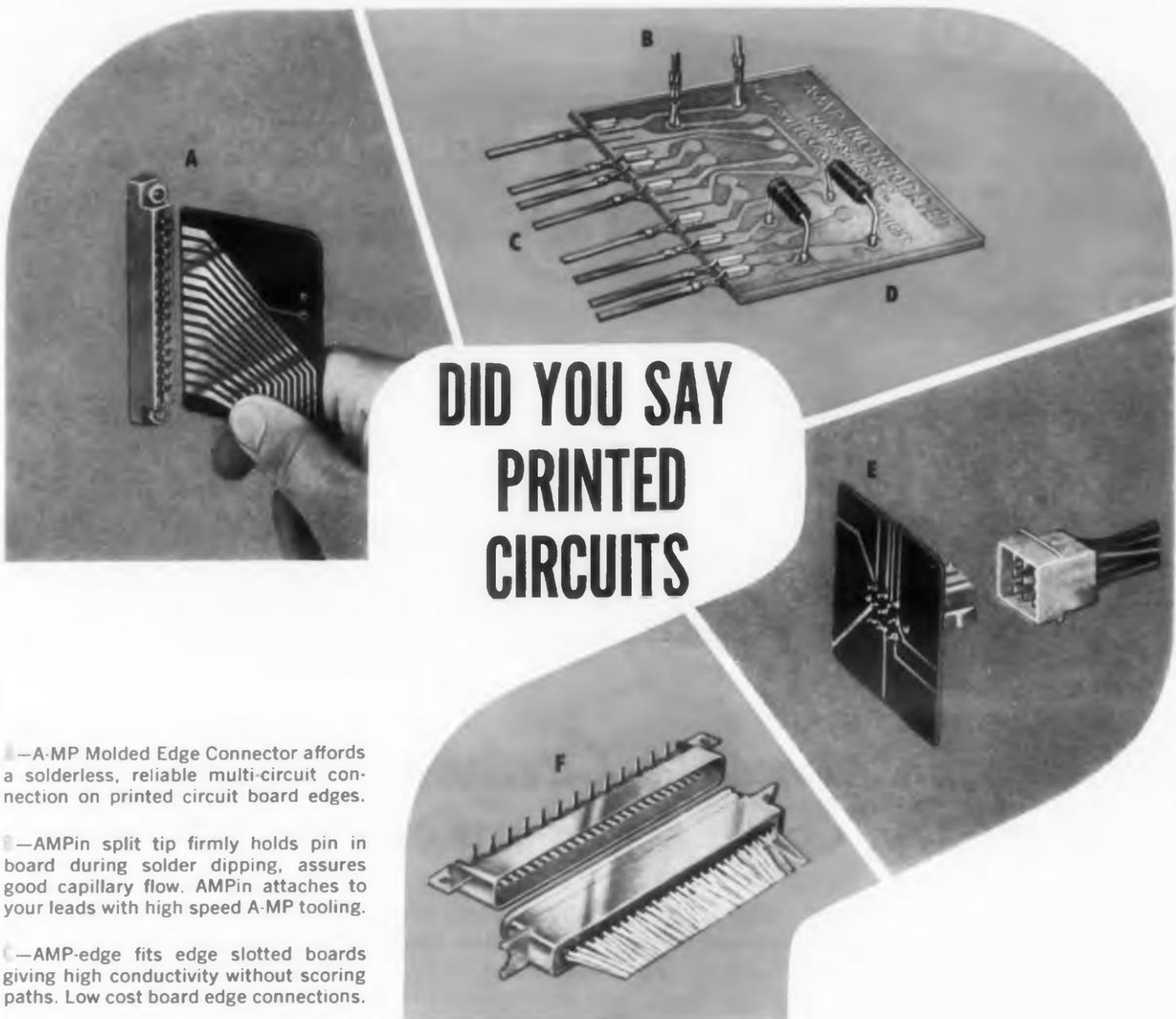
$$I_c^2 R_c = \frac{I_c^2 R_1}{\frac{S}{B} + \frac{I_{cbo}}{I_c} + \frac{0.25(M-1)}{R_1 I_c}} - N \quad (3)$$

Collector Current

Collector current for minimum power dissipation (I_c^*) is:

$$I_c^* = \frac{I_{cbo} \left(-1 + 4N \frac{S}{B} + \sqrt{1 + 8N \frac{S}{B}} \right)}{2 \left[\frac{S}{B} - N \left(\frac{S}{B} \right)^2 \right]} \quad (4)$$

Minimum power dissipation will be designated as $(I_c^2 R_c)^*$.



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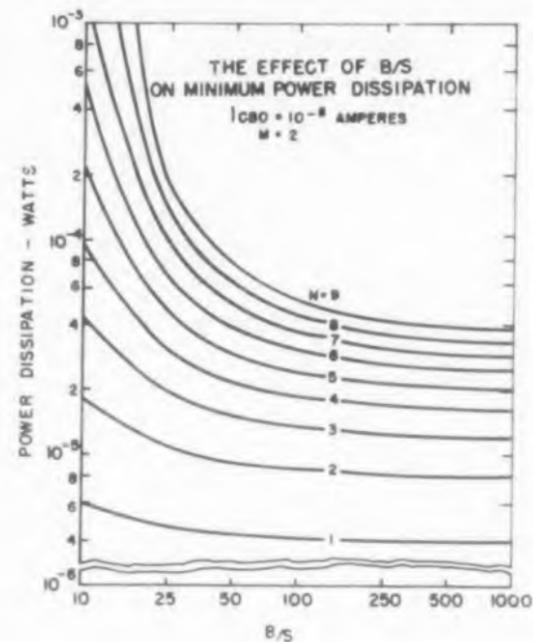


Fig. 3. Effect of B/S on minimum power dissipation.

When (4) is substituted into (2) R_1 reduces to

$$R_1^* = \frac{0.25(M-1)}{I_{CBO}} \quad (5)$$

The expressions (4) and (5) for the collector current (I_C^*) and the input-current limiting resistor (R_1^*) when substituted in eq (3) (power dissipation) give a minimum in power dissipation ($I_C^2 R_C$).

Using the expressions for R_1^* and I_C^* a program of moderate complexity was devised for an IBM 704 Computer to calculate minimum power dissipation as a function of I_{CBO} (base to collector leakage current), B/S (base to collector current gain with safety factor), M (number of input circuits), and N (number of output circuits). The computed values provided sufficient data for the creation of informative graphical results.

Referring to Fig. 3, minimum power dissipation decreases with a decrease in the number of output circuits. The minimum power dissipation decreases with an increase in B/S , and as B/S becomes infinite, this decrease approaches the limit

$$4N(M-1)I_{CBO}$$

It is also interesting to note that as N decreases to 1, B/S becomes decreasingly significant in the determination of minimum power dissipation.

Referring to Fig. 4, I_C^* also decreases with a decrease in the number of output circuits. I_C^* decreases with an increase in B/S and this decrease approaches a limit as B/S becomes infinite. This limit is $4NI_{CBO}$. Note that as N decreases to 1, B/S becomes decreasingly significant in the determination of the collector current which gives a minimum in power dissipation. It can also be determined that minimum power dissipation

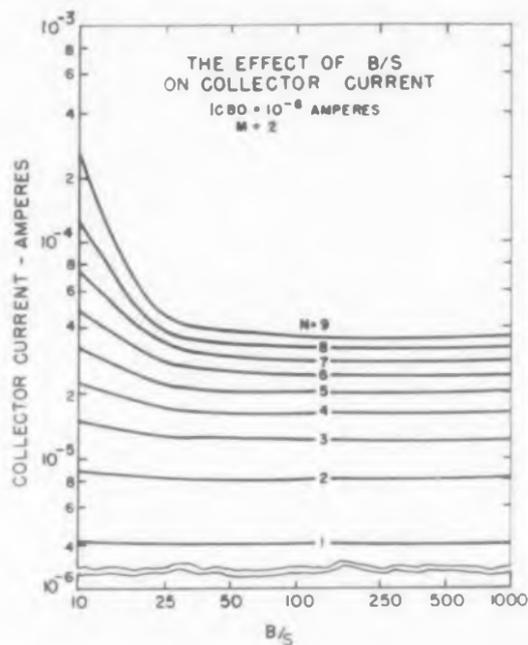


Fig. 4. Effect of B/S on collector current.

tion is linearly related to I_{CBO} and $0.25(M-1)$:

Specifically if a transistor NOR circuit is to have two inputs ($M = 2$), drive nine circuits ($N = 9$), employ transistors with Betas of 50 ($B = 50$), and I_{CBO} 's of 10^{-6} amperes, correct values of V_{CC} , R_C , I_C and R_1 can be ascertained to effect minimum power dissipation. For this particular design situation a safety factor of 2 is employed. The B/S factor is therefore 25. Values of I_{CBO} , B , and M used in this typical example were chosen because of their practicability to current design situations.

If the above values for I_{CBO} , B/S , M and N are substituted in expressions (4) and (5) the calculations yield

$$R_1^* = 250 \text{ K and } I_C^* = 47 \mu\text{a.}$$

Therefore minimum power dissipation using eq. (3) is 177 μ watts. The collector supply V_{CC} is then calculated to be 3.75 v. Consequently $R_C = 79 \text{ K}$.

If V_{BE} is not very much less than V_{CC} and I_{CBO} is not very much less than I_C , the NOR circuit may be capable of driving but, say, eight outputs rather than nine. In this case, design for one more output than actually needed.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings; turn to Reader Service Card and circle 100.

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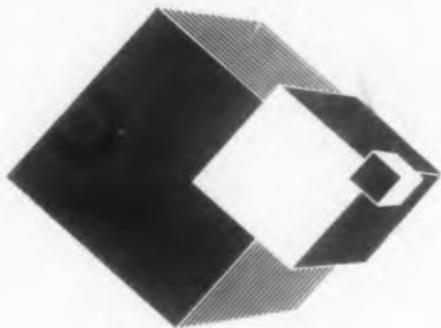
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CIRCLE 33 ON READER-SERVICE CARD



Thomas A. Prugh

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Circuits described in this article were designed as compatible building blocks to be interconnected to perform complex functions. This is a preliminary effort to solve the standard-circuit problem for circuits to be used at frequencies up to 15 kc and temperatures below 45 C. Future effort will be aimed at adding new and more efficient circuits.



STANDARD circuits and modules are being increasingly considered by the electronics industry because they avoid repetitious design. Also from the standpoint of mass production a few widely applicable standard circuits would permit low unit cost and high reliability. And as the circuits get smaller and are manufactured by printing or vacuum-deposition methods, the system designer will become primarily interested in the functioning of logical blocks rather than the individual component part values. In order to achieve reliable building blocks, the circuit design can and should be considered in detail only during the overall design of the particular wafers or modules. These modules then are stocked as the smallest component to be handled in development and production activities.

Work at the Diamond Ordnance Fuze Laboratories has resulted in circuits useful for rapid assembly of working systems. The circuits are primarily of the low power level, information handling type. Typical applications include digital computing and timing operations. The circuits

are restricted to those using the transistor as an off-on or relay-type device.

Specific Circuits

Standard circuits that have been designed are:

- Inverter
- Inverter less load
- NOR
- Flip-flop
- Binary counter
- Monostable multivibrator
- Free-running multivibrator
- Lamp control
- Power switch

These particular circuit types were chosen, in part, because they have been studied extensively. As a result, detailed information is available or calculable on the design, performance, and limitations of the circuits. Specific component part values are shown in the schematics. From the standpoint of presently used techniques of making microminiature assemblies, the resistor elements are the easiest to handle. Accordingly the circuits are designed to use no inductors and as few capacitors as possible.

Inverter (IN). The inverter circuit¹ shown in Fig. 1, as its name implies, inverts the input signal. For -1.5 volts in, the output is 0; for 0 in, -1.5 volts out. One inverter stage can drive several other inverter stages or similar type loads.

Inverter (INLL). A degenerate form of the inverter is shown in Fig. 2. The load resistor of 1 K ohm, normally found in the collector circuit, is omitted. This circuit is used to couple a signal to a common load resistor fed by several circuits.

NOR. The NOR circuit^{2,3} is similar to the inverter except for the number of inputs. The NOR

Standard

Transistor Switching Circuits

shown in Fig. 3 has two inputs. In principle, any number could be used. In practice, the two-input version is a compromise between versatility and noncriticalness. The two-input version is a compromise between versatility and noncriticalness. The two-input NOR has many similar logical properties to the two-grid pentode gating circuit. The logical function performed by the NOR is shown beside the schematic of Fig. 3. When neither A nor B is present an output exists. The NOR is an elemental building block. With one or more NOR circuits all the logical functions including NOT, AND, OR can be performed.

Flip-Flop (FF). A bistable circuit can be formed by connecting two inverter circuits together to form a toggle or flip-flop.⁴ The schematic is shown in Fig. 4. Information can be coupled into the flip-flop by connecting the collector of an INLL circuit to one of the collectors of the FF. **Binary Counters (BC and BCR).** The flip-flop can be modified by the addition of input pulse steering circuits to obtain a binary counter^{5,6} as shown in Fig. 5. The added capacitors, diodes and resistors provide alternate feeding of the input pulses to one transistor, then to the other.

When initial conditions need to be set into the binary counter, diodes coupled to the base of each transistor can be added as shown in Fig. 6. **Monostable Multivibrator (MMV).** The monostable multivibrator⁷ is used to generate a gate or time delay following an initiating trigger pulse. The design shown in Fig. 7 has the delay time adjusted by choice of the coupling capacitor between the two transistors. The start pulse is coupled into the "normally-on" transistor by means of a capacitor, resistor, and diode network. **Free Running Multivibrator (FRMV).** The free running multivibrator⁸ of Fig. 8 is a source of two

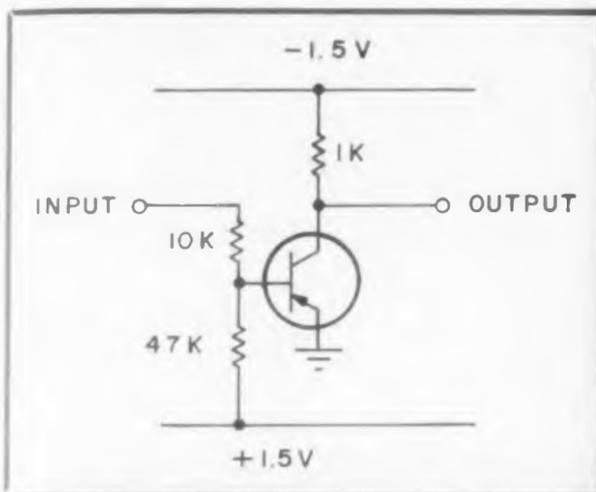


Fig. 1. (above) Inverter (IN)

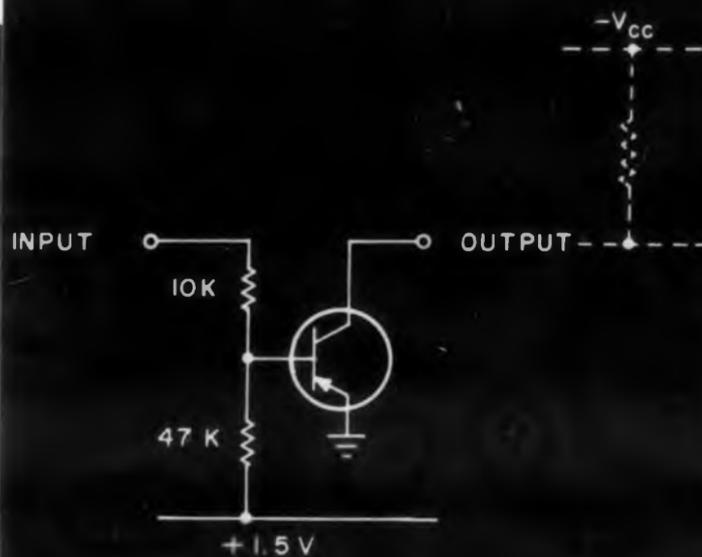


Fig. 2. (right) Inverter less load (INLL)

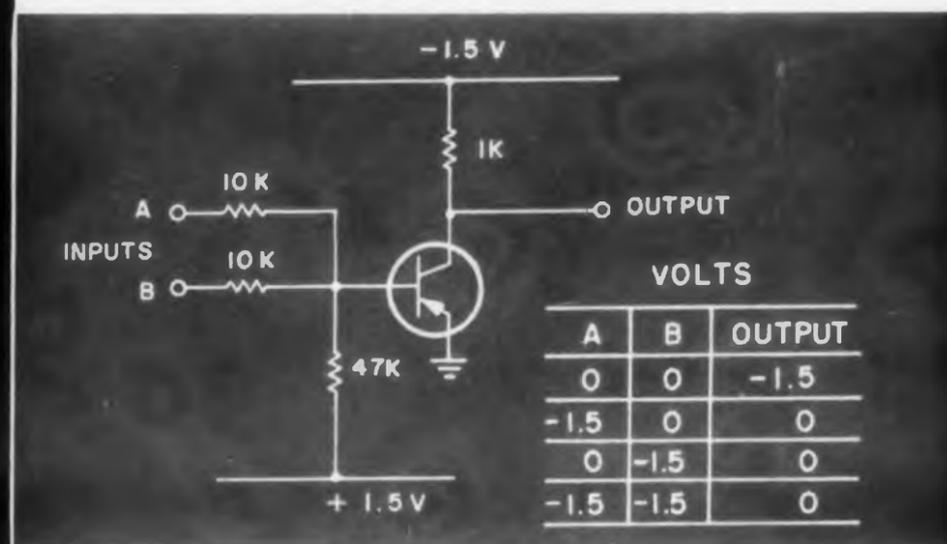


Fig. 3. NOR Circuit

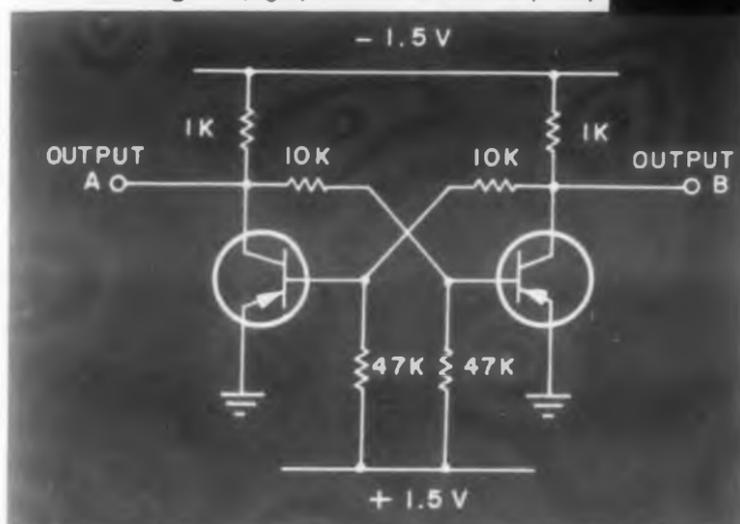


Fig. 4. (left) Flip-flop (FF)

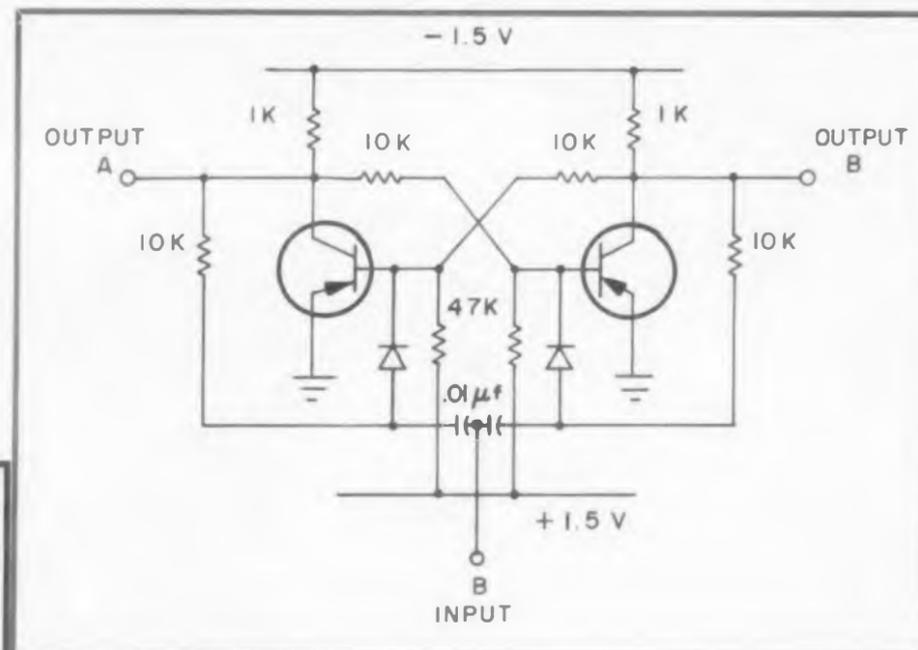


Fig. 5. (right) Binary counter (BC)

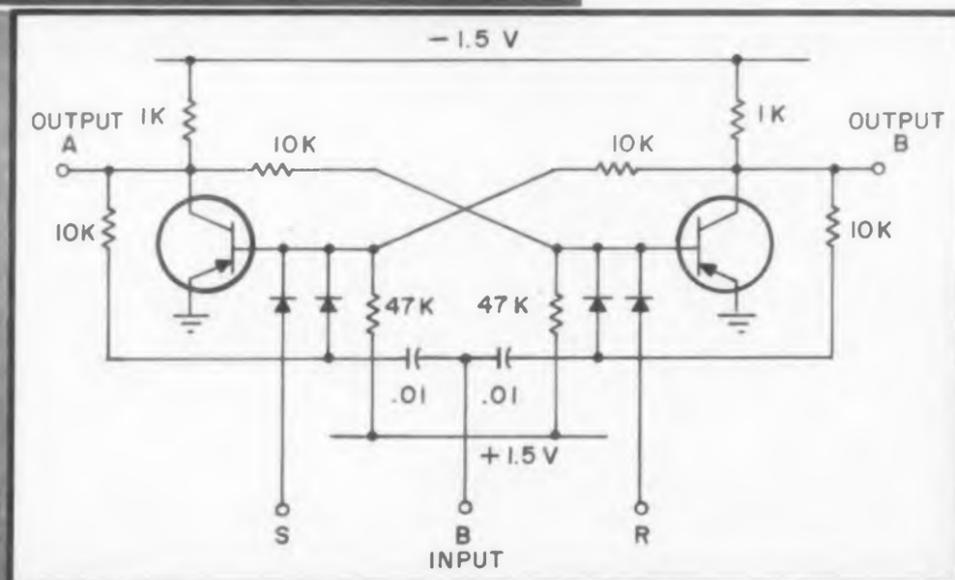


Fig. 6. Binary counter resettable (BCR)

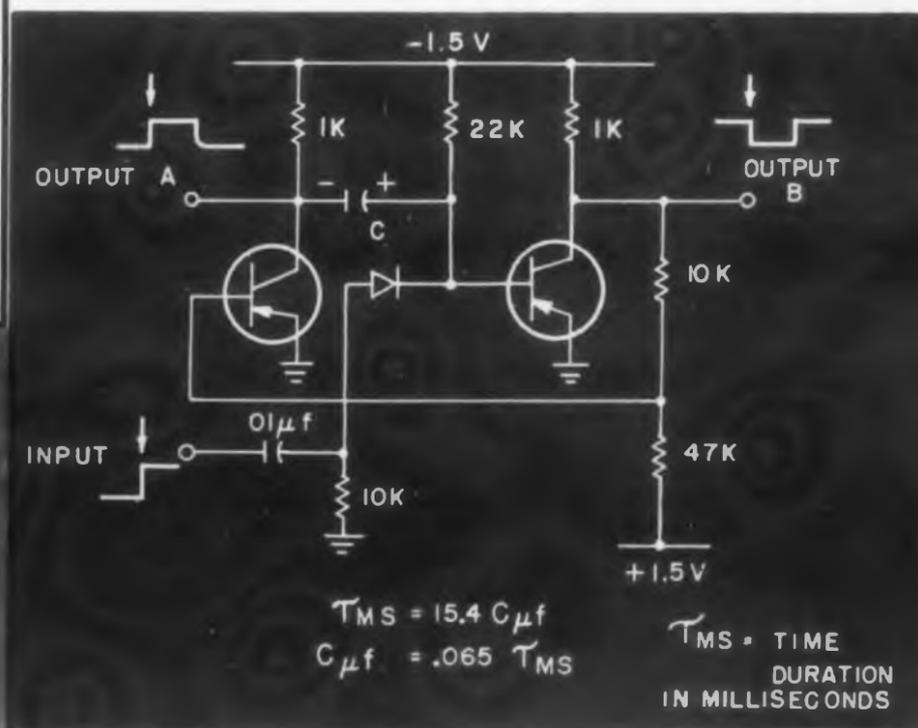
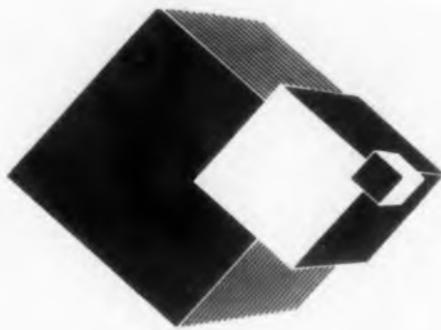


Fig. 7. (right) Monostable multivibrator (MMV)



symmetrical square waves of opposite polarities. The frequency is set by the cross-coupling capacitors.

Lamp Control (LC). The lamp control circuit of Fig. 9 is used when visual indication is required of the binary state of flip-flops or binary counters. A two-stage circuit is used because the lamps have a drain of about 50 ma. A single transistor could not reliably give enough current gain. Both this circuit and the following power switch circuit are designed to be driven by an output signal from one of the previously described circuits.

Power Switch (PS). The power switch circuit of Fig. 10 is similar to the lamp control circuit except for the output load. The power switch circuit will provide a heavy duty positive step in voltage at its output. One use of the circuit is to set or reset a number of binary counter stages simultaneously.

Design and Performance

Choice of Transistor Type. The specific circuits shown are designed for pnp transistors. Simple changes in the polarities of capacitors, diodes, and power supplies would permit the use of npn types. The pnp alloy germanium types are the most common transistors manufactured and are well suited to the circuits. Typical transistors are the 2N77, 2N105, and 2N207. The latter transistor has been used extensively in making small etched board modules. Higher frequency types include the 2N139 and those of the series 2N112-2N114. The microalloy 2N393 is a type of even higher frequency. For high-temperature operation, a silicon alloy type would be necessary.

Transistor Specifications. Two parameters are of major importance to the proper operation of the circuits: common emitter current gain (β) and collector cut-off current (I_{cno}). The drop in β with decreasing temperature sets the lower temperature limit of circuit operation. The increase in I_{cno} with increasing temperature sets the upper temperature limit for the circuits. Beta values of 50 or greater are required for all transistors except the output transistor in the lamp control circuit. This latter transistor was chosen to have a β greater than 100.

The β of the 2N207 drops to about 50 per cent

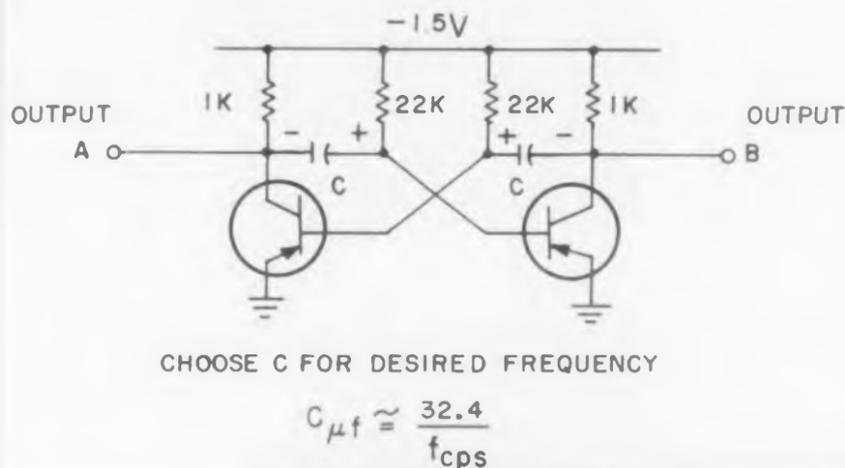


Fig. 8. Free running multivibrator (FRMV)

Fig. 9. (right) Lamp control (LC)

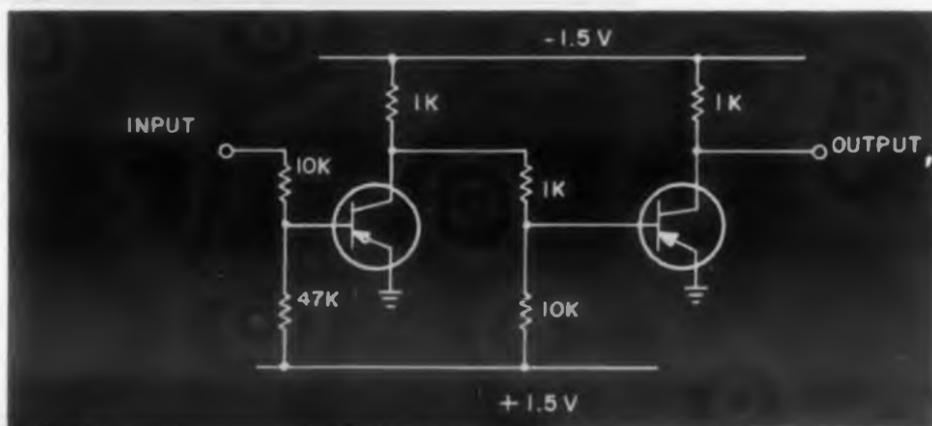


Fig. 10. (below) Power switch (PS)

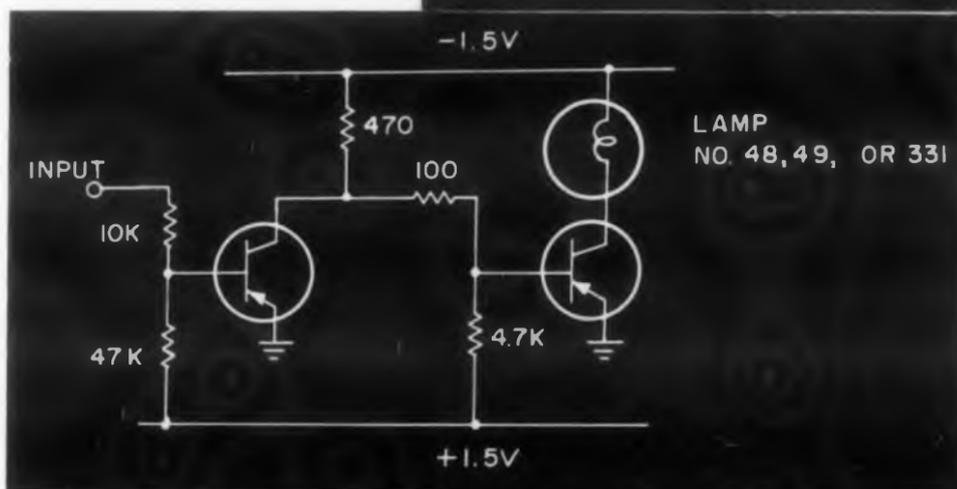
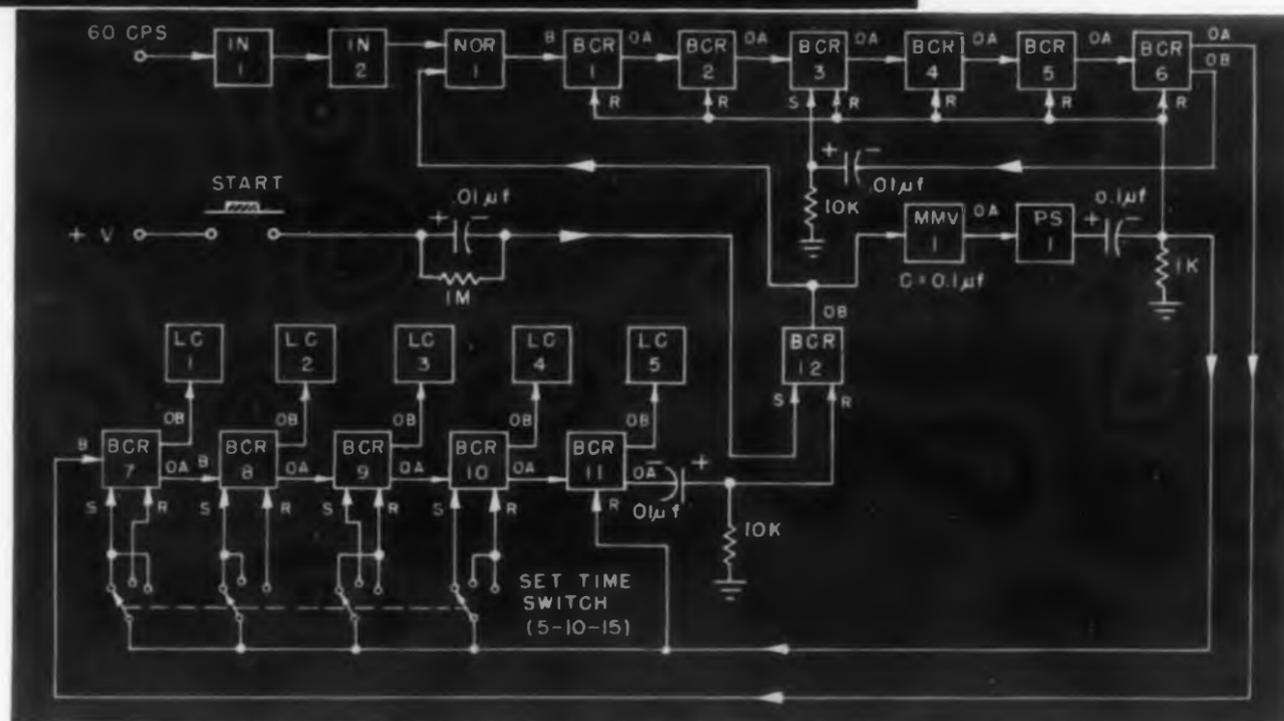


Fig. 11. (below) Block diagram of electronic timer. Code letters refer to the circuits previously described.



of its room-temperature value of -40 C. The circuits should perform properly down to this temperature although this has not been verified experimentally. The circuits are designed to operate with transistors having an I_{CBO} value up to $30\mu\text{a}$. For the 2N207 type, this value is reached at approximately 60 C.

Choice of Diodes. The diodes used in the binary counter are noncritical in terms of the characteristics of presently available diodes. Point contact germanium diodes of minimum quality have been used. The 1N90 is typical. It has a minimum forward current of 5 ma at 1 v and a maximum reverse current of $500\mu\text{a}$ at 50 v.

Junction diodes of equivalent characteristics should operate as well as point contact types in the low-frequency circuits considered so far. If the maximum upper operating temperature is desired for the circuits, the diode should be chosen for minimum reverse current at the upper temperature point.

Choice of Supply Voltages. The circuits are designed to operate from two single cells, one for the negative source and one for the positive source. Either 1.3 v mercury cells or 1.5 v dry cells are satisfactory. Two volt lead-acid cells can be used if the lamp control circuit has a 2-volt lamp (No. 48 or 49).

Upper Frequency Limit. The circuits have not been designed for optimum frequency response. Circuit simplicity and reliable low-frequency operation were stressed in these designs. The Binary Counter, using transistors such as the 2N77 or 2N207, has an upper input counting rate of approximately 15 kc. The input capacitors were chosen for these transistors and would need to be reduced in value to permit higher counting rates with higher frequency transistors. The lamp control circuit is limited in speed by the thermal response-time of the lamp. Observation of several switching cycles per second is possible. The other switching circuits have a transient response-time of about 20 microseconds.

Upper Temperature Limit. If 2N207 transistors and 1N90 diodes are employed in the circuits with other component parts as shown, the upper temperature limit is approximately 45 C. It is stressed that the particular design-values are not chosen to give high-temperature performance.

Techniques For Improving Performance

The circuits presented in the schematics have upper limits in frequency of tens of kilocycles and in temperature of approximately 45 C. The natural question is how to improve these limits, if necessary, for a particular application.

The upper frequency limit can be raised by two approaches. The first is to keep the previously described circuit topology and use higher frequency transistors and correspondingly lower

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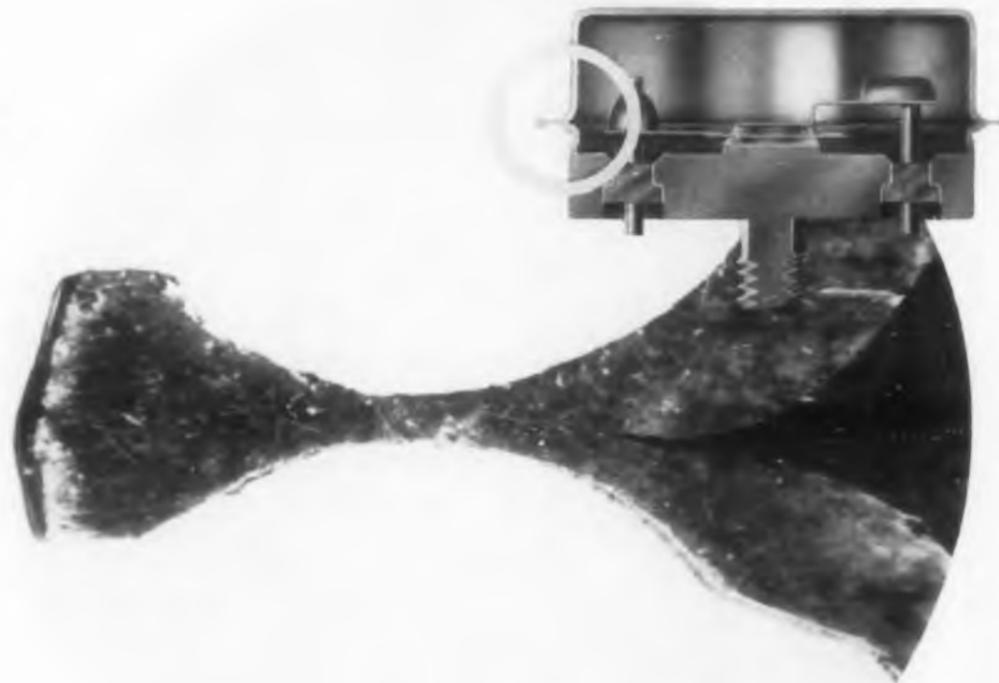


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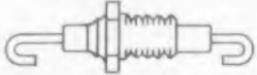
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Step type DA-729		10-1500	500	1000	
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Ring type DA-741*		10-1000	500	900-1300	
Eyelet type DA-784		25-1000	500	1000	For high frequency filtering and bypass, where size is important
Eyelet type DA-785		25-1000	500	1000	
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capacitors⁶ in the binary counter stages. Most of the circuit speeds are limited by the transistor and not by wiring capacitances. The upper speed is roughly proportional to the alpha cutoff frequency of the transistors.

The second approach is to use a more complex circuit² and more efficiently utilize a particular transistor-type. Speed-up or commutating capacitors can be used to provide better coupling between stages. The transistor can be operated in a non-saturating mode, thus reducing switching time appreciably. Complementary-symmetry operation can be used to obtain positive drive in the rise and fall times of a waveform.

In an analogous manner, the upper temperature limit can be improved. Keeping the same circuits, transistors with lower I_{C100} currents can be used (if available). The silicon alloy types will prove attractive as they become more readily available at modest prices. The base bias resistors and/or positive supply voltage can be modified for higher temperature operation. More involved circuitry can be used to boost the upper temperature limit.

Application Example

An example of the use of the standard circuits to construct a more involved system is shown in Fig. 11. The system is an electronic timer for generating 5, 10 or 15 second intervals following the activation of a push button.

One-second pulses are generated by dividing down the 60 cps line voltage through a six-stage binary divider (BCR-1 through BCR-6) with feedback to reduce the division ratio from 64 to 60. The input power line voltage is shaped to drive the binary counter by feeding through the two inverter stages (IN-1, IN-2). The NOR block is a gate described later on.

The basic counting register is another set of binary counter stages (BCR-7 through BCR-10). Three time-periods are provided, i.e., 5, 10 and 15 seconds. Using the one-second pulses as an input, the 4-stage binary counter has sufficient capacity (16 counts) to count the maximum time. The four stage counter is preset to the proper count to permit reaching its maximum count at the desired time. The "SET TIME" switch sets up the proper path for preset pulses at the start of the time interval.

The time interval is initiated by pressing the "START" push button. This flips BCR-12, used as a flip-flop, to a position which causes the NOR-1 circuit to pass 60 cps pulses to the 60 divider chain. This change in state of BCR-2 also triggers a monostable multivibrator (MM¹) of approximately 1 ms duration. This 1 ms pulse is amplified in the power switch (PS) and used to preset all the BCR stages to their proper positions. The preset pulse is fed through the "SET

"TIME" switch to the proper terminals of the BCR stages in the counting register to give the desired time interval. For example, to generate a 10-second interval, BCR-8 and BCR-9 are preset to their non-zero positions. Since BCR-8 has a value of 2 counts, and BCR-9 has a value of 4, a total of 6 counts is subtracted from the total capacity of the 4 stages. Thus, 16 less 6, or 10 one-second pulses are required to cycle the counter to a point where BCR-11 is flipped.

The fifth stage (BCR-11) of the counting register is used as a temporary memory to show that the time interval is over. This stage flips at the end of the time interval and flips back again 16 seconds later. This second change is used to reset BCR-12 and thus stop pulses from passing through the NOR-1 circuit. This completes the cycle of the timer. Pressing the START button initiates a new cycle.

Visual indication of the counter operation is provided by the lamp control circuits (LC-1 through LC-5). One is connected to each of the binary counter stages in the counting register (BCR-7 through BCR-11). The stages LC-1 through LC-4 indicate the instantaneous binary count in the register. LC-5 operated by BCR-11 indicates the end of the time interval.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle 100.

Acknowledgments

The circuits described are the result of the contributions of many people. Helpful discussions were held with Philip Emile, Jr. and E. L. Cox. Specific thanks are due Amiel Goodman and Jack Nimitz for conducting temperature studies on the circuits.

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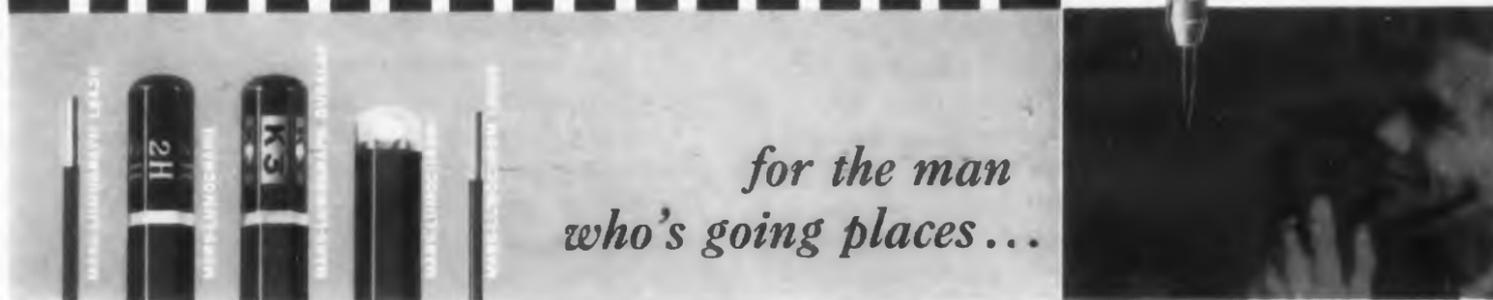


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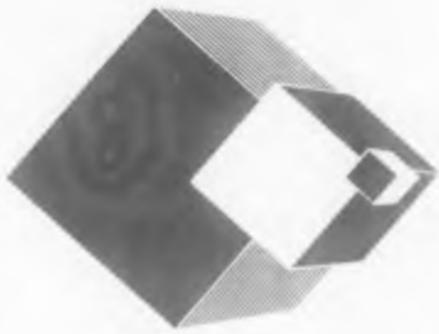
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Results of a literature survey indicate that it is possible to eliminate large-volume components by employing various circuit techniques. In this article, the authors disclose some of these techniques as related to amplifiers, simulated reactances, and filters and oscillators.

Circuit Techniques to Eliminate Large Volume Components—A Literature Survey

Jerome I. Cooperman and Philip J. Franklin
Diamond Ordnance Fuze Laboratories
Washington 25, D. C.

ENGINEERS have attempted to eliminate large component parts by employing various circuit techniques. While most of these techniques were initially developed for use with vacuum tubes, the extension of these principles to transistor circuits is logical. This paper is a result of a literature survey conducted to uncover and collect in one body some of these techniques; it will disclose their basic operating principles and how they might be applied in the field of micro-miniaturization. The presentation is given in three main groups: amplifiers, simulated reactances, and filters and oscillators.

Amplifiers

Positive feedback techniques. In designing amplifiers for miniature circuits, it is generally desirable to get maximum amplification per stage, using a minimum number of components, and yet have the system relatively free from instability or oscillation. A controlled amount of positive feedback incorporated in the amplifier design can achieve these ends in vacuum tube circuits, and to some extent in transistor circuits.

In a typical two-stage resistance capacitance coupled amplifier, to establish the proper dc operating conditions for the tubes, cathode bias is generally employed. The cathode by-pass capacitors are the most bulky of the components employed since values of the order of 10 μ f and larger are required for audio-frequency applications. If these capacitors are omitted, a great reduction in gain results from negative current feedback in the cathode bias resistor. Sulzer¹ de-

scribes a method of applying controlled positive feedback between the stages to offset this reduction in gain, Fig. 1. Positive feedback is applied by a resistor R_f connected between the cathodes. A similar method of applying positive feedback between the screen grids of two pentode stages to eliminate the screen by-pass capacitors is also described.

Anspacher² gives an analysis of a two-stage pentode amplifier circuit without by-pass capacitors, the resulting degeneration being nullified by means of positive feedback between the two screen grids.

Unlike vacuum tubes, transistors require a forward bias to establish the proper dc operating conditions. This may be supplied in several different ways. In order to stabilize the transistor against thermal runaway, dc feedback which tends to bias the transistor toward cutoff as the collector current rises, is commonly used. A resistor is connected in the emitter circuit to stabilize emitter current. The emitter resistor is generally by-passed to prevent loss in gain due to degeneration, as in vacuum tube circuits.

Alexander³ describes a transistor audio amplifier, (Fig. 2), similar to the previous vacuum tube circuits, where positive feedback between the emitters is used to obviate the requirement for large by-pass capacitors across the emitter resistors.

An additional economy involves the elimination of the two-resistor forward biasing network in each base circuit. This function is accomplished by the voltage drop that appears across

the base-emitter junction as a result of the leakage current of the transistor. This biasing method is not recommended, since it is sensitive not only to temperature variations, but also to differences between transistors.

Direct-coupled amplifiers. A somewhat different technique for eliminating large-volume components and improving the low-frequency response of an amplifier is to employ direct-coupling. Much of this information is summarized by Landee et al.⁴

"The use of PNP transistors made by fusion techniques and surface-barrier transistors permits a direct connection of the collector of one stage to the base of the following stage without the use of interstage biasing arrangements. This is possible since the collector resistance is high and the current gain is close to its nominal value when the collector-to-base voltage is zero or slightly positive. At low level stages, the use of this technique results in very simple circuitry. However, the collector-voltage swing of any stage directly coupled to the base of a following stage is restricted to a very small voltage (0.2 to 0.6 v). Since the transistors are operated as current amplifiers, the small allowable collector-voltage swing does not adversely affect the operation of low-level stages. In many practical amplifiers this technique may be employed for coupling the first two or three stages of a high-gain amplifier . . ." Hurtig.⁵ An amplifier circuit of this type is shown in Fig. 3. It has a power gain of 70 db and incorporates dc feedback for stabilization.⁶

As in the case of the vacuum tube, dc drift cannot be ignored. It is unfortunate that the temperature sensitivity of transistors increases the drift. However, if this circuit is employed as a low-level, high gain pre-amplifier, capacitive coupling at the output will remove the dc component without affecting its properties as an ac amplifier. The economy of component parts and the high gain cannot be overlooked for application in microminiature subassemblies.

Another type of direct-coupling scheme used with transistors is called complementary symmetry, and is discussed by Sziklai.⁷ This method is shown in Fig. 4 and can deliver a voltage gain of the order of 25 per stage.

Perhaps the most popular use of the principle of complementary symmetry is in Class B power amplifier applications. The advantage of Class B operation is that the circuit draws negligible current until signal is applied. In the usual configuration, both an input and output transformer are required. Sziklai describes a circuit of a Class B power amplifier with a direct-coupled complementary-symmetry driver (Fig. 5). This amplifier does not contain any parts other than the transistors themselves and operates from a high impedance signal source directly into a 16-ohm loudspeaker voice coil. The low output impedance and the stable operation are made possible by the over-all feedback which extends down to dc. Incidentally, this is a zero-center dc amplifier. Its economy of component parts recommends it for microminiature power amplifier applications.

Simulated Reactances

With certain circuit configurations, an active element such as a vacuum tube or transistor may behave as a reactance. Some well known applications of this phenomenon are the reactance modulator used in frequency modulation, and the Miller integrator and operational amplifiers used in analog computer work. Very often, however, the reactance effects are not pure, but also introduce resistive effects. For purposes of power supply filtering, the resistive effects are not considered to be as important as the reactive properties of the device. Linvill⁸ gives theory on RC active filters using transistors.

Inductance. Towner¹⁰ describes a circuit which is composed of resistive and capacitive elements, and three tubes as amplifiers. The device behaves as a true inductance in that it differentiates square waves, integrates triangular waves, and resonates with capacitance across its terminals. Some of the applications described are for a low frequency sine wave oscillator and as a filter circuit for tone control purposes in audio amplifiers.

Tomer¹¹ describes a circuit wherein a pentode tube may be used in place of a high in-

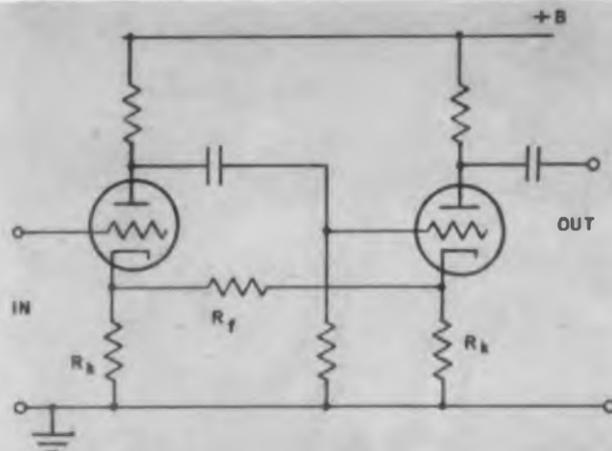


Fig. 1. Two-stage resistance-capacitance coupled amplifier with positive feedback.

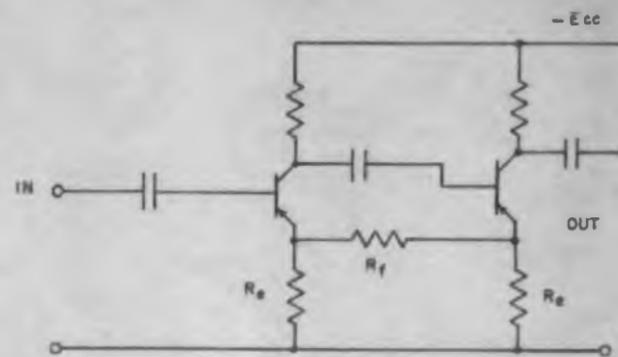


Fig. 2. Two-stage resistance-capacitance coupled transistor amplifier with positive feedback.

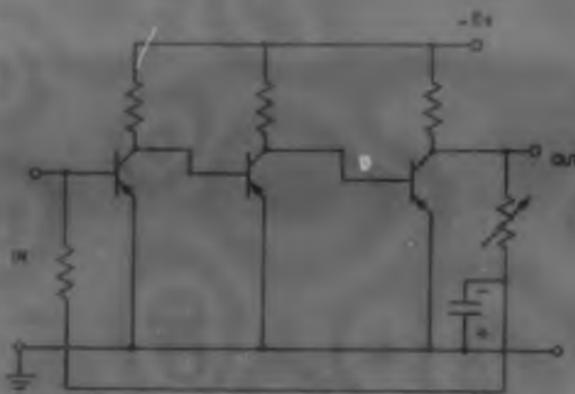


Fig. 3. Direct-coupled transistor amplifier.

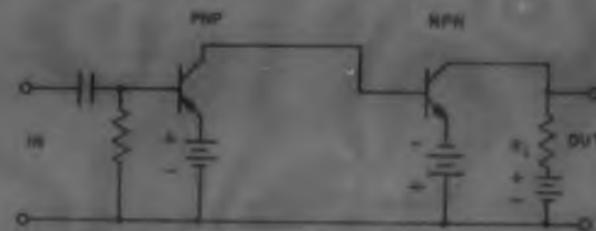


Fig. 4. Complementary symmetry direct-coupled transistor amplifier.

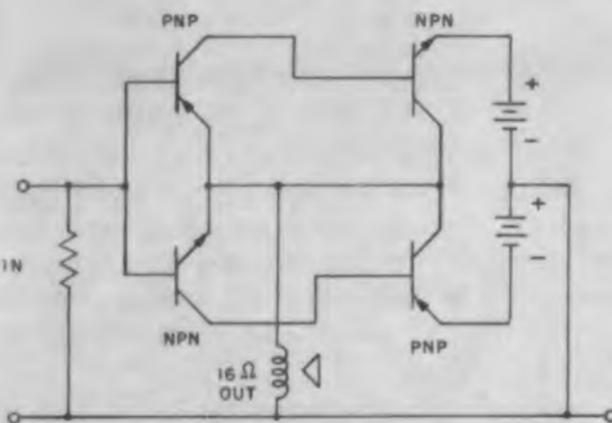


Fig. 5. Complementary symmetry Class B power amplifier with direct-coupled driver.

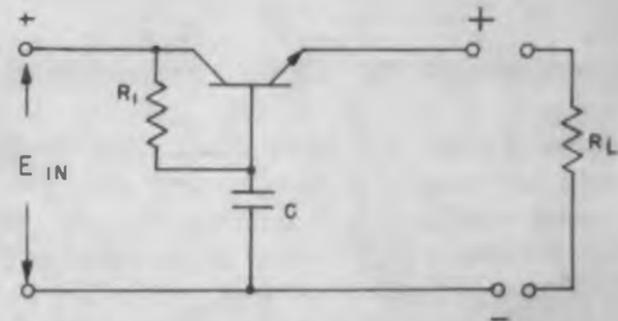


Fig. 6. Transistor-simulated series inductance.

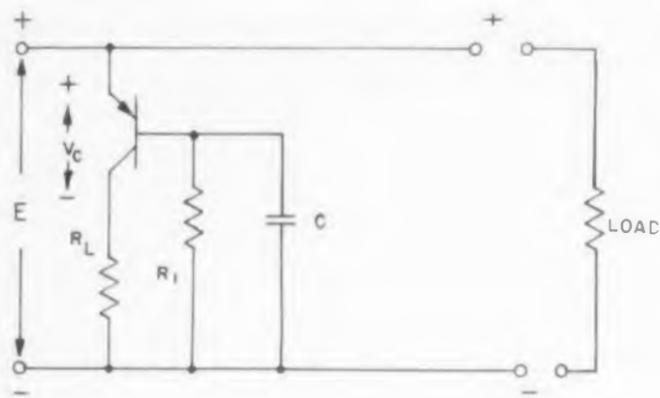


Fig. 7. Transistor-simulated shunt capacitance.

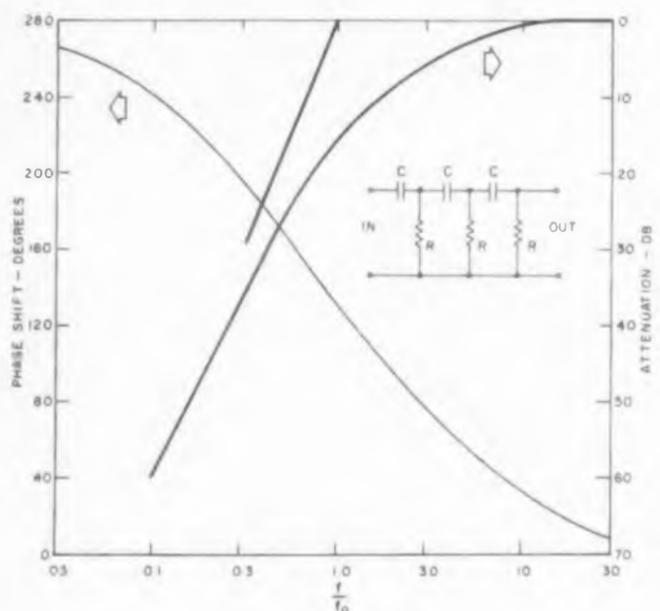


Fig. 9. Three-section high-pass ladder network with attenuation and phase characteristics.

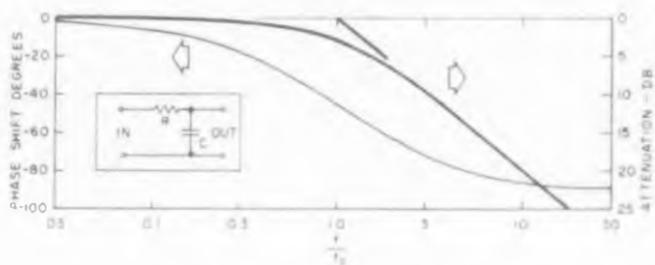
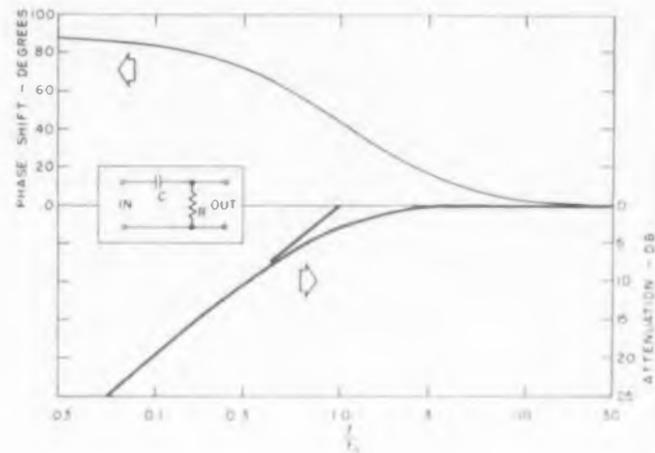


Fig. 8. Single-section high-pass filter with attenuation and phase characteristics (a) and Single-section low-pass filter with attenuation and phase characteristics (b).

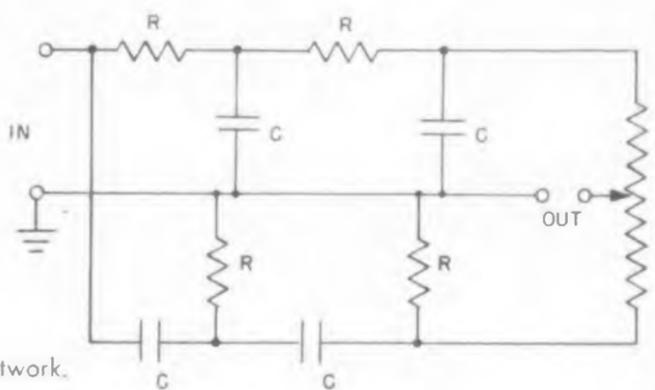


Fig. 10. Hadfield's null network.

ductance choke in a power supply filter. While not a pure inductance element, the high ac plate resistance and low dc drop through the tube permit the circuit to fulfill the requirements ordinarily imposed on a filter choke.

Stern¹² describes a transistor simulated inductance using only capacitance as the reactive parameter. A series simulated inductance is shown in Fig. 6.

Capacitance. The Miller integrator is a particular kind of operational amplifier. It is basically an amplifier stage with a capacitive feedback path from plate to grid. The apparent capacitance be-

tween grid and cathode terminals is a function of the size of the feedback capacitor and the gain of the stage. In effect, the plate-to-grid capacitance is amplified by the tube. Thus, it is possible to use a relatively small capacitance with a high gain stage to obtain a large circuit capacitance of low volume.

Stern¹² shows a circuit for a transistor simulated shunt capacitance, Fig. 7. The value of the capacitance used in the base path is multiplied by the transistor gain. As in the simulated inductance case, these circuits are inoperable above the transistor cut-off frequency. Oakes and Lawson¹³

use a similar capacitance multiplier circuit in a transistor power supply filter.

Filters and Oscillators

The usual inductance-capacitance filters and oscillators assume very large physical proportions when designed for low frequency operation. In addition, at sub-audio frequencies, the circuit Q of the inductors is so low that inductance-capacitance filters and oscillators are not practical. Both these factors have spurred circuit designers to develop alternative approaches.

When resistance-capacitance networks are used in the feedback loop of an amplifier, it is possible to achieve steeper curves of amplitude vs. frequency (higher Q) than the passive case, or even to invert the transmission characteristics of the network.

Resistance-capacitance oscillators are similar in theory. Sufficient in-phase feedback is employed to overcome the attenuation in the coupling network, and the amplifier then supplies its own input. The frequency stability, of course, is determined by the rate of change of phase with frequency at the resonant frequency of the network.

Ladder networks (cascaded L sections). The simplest network to be considered here is the single L section, shown along with its transmission and phase characteristic in Fig. 8.

It has an attenuation asymptotic to 6 db per octave beyond the "corner" frequency of $\omega = 1/RC$, and a maximum phase shift of 90 deg. Depending on the configuration, either low or high frequency attenuation may be obtained.

The attenuation rate of these networks may be made steeper by cascading two or more sections. For each section, an additional 6 db per octave slope, and 90 deg phase shift are obtained. Thus, for example, a three-section ladder has an attenuation of 18 db per octave beyond its corner frequency, and a maximum shift of 270 deg. One such network is shown with its characteristics in Fig. 9.

It can be seen that there is a phase shift of 180 deg at a frequency $f = 1/2\pi RC \sqrt{6}$ for this high pass filter. Although the three-section ladder network has no "resonant" frequency, it has been used in a tuned amplifier circuit by Hansel,¹⁴ and is commonly employed in resistance-capacitance (phase-shift) oscillators as described by Ginzton and Hollingsworth.¹⁵ The network is connected in a negative feedback path between the input and output of an amplifier stage. At some frequency there is an additional 180 phase shift contributed by the network. Thus, positive feedback is obtained, and the amplifier response will show a peak at this frequency.

If the amplifier gain is made sufficiently large

to overcome the attenuation in the network, the circuit will oscillate. For a network composed of equal resistances and equal capacitances, there is an attenuation of 29 at a phase shift of 180 deg, requiring a loop gain of at least this amount for the circuit to oscillate. Sulzer¹⁶ suggests a modification of the ladder network by "tapering" the sections so that the succeeding sections do not load the input sections. The attenuation in this network is only about 8 for a phase shift of 180 deg and so low mu tubes may be used in the oscillator.

Hooper and Jackets¹⁷ have reported on a transistorized RC phase shift oscillator.

Epstein¹⁸ describes a variation of this ladder network which has a gain greater than unity with 180 deg phase shift. Thus it is possible to construct an oscillator with only a cathode follower as the active element. Waidehlich¹⁹ gives a practical design procedure for oscillators of this type.

Smiley²⁰ describes another variation of the phase shift oscillator in which the ladder sections separated by active vacuum tube stages. Use is made of the Miller effect to increase the effective value of the capacitances in the network, permitting ultra-low-frequency operation with relatively small components. A further advantage of this oscillator is that three-phase output is available.

Sturm and Cottrell²¹ developed a transistorized three-phase, phase shift oscillator in which the ladder sections are separated by active transistor stages.

Hadfield²² describes a null network composed of two ladder networks connected to a common source (Fig. 10). The null frequency is controlled by means of a very high resistance potentiometer connected across the output terminals of the individual networks. One of these networks is a phase lead network; the other is a phase lag network. The voltages at the respective outputs of these networks are opposite in phase at all frequencies and a zero output or cancellation can be obtained at any frequency by a suitable setting of the potentiometer. A more detailed analysis is presented by Clothier²³ and a variation called the variable-T is discussed by Reid.²⁴

Zero phase shift network. A simple selective network, sometimes referred to as a zero phase shift or twin RC network, and discussed in detail by Punnett,²⁵ is shown in Fig. 11 along with its phase and transmission characteristics. Superficially, it appears to be a Wien bridge, and it has been referred to as such many times in the literature. Actually it is not, since the true Wien bridge is a four-terminal network having no common connection between the input and output. The network is a three-terminal network and it has a common connection between the input and output. It has a peak in transmission and



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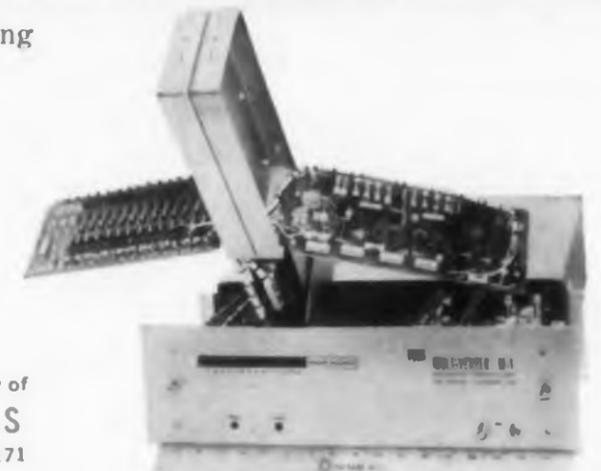
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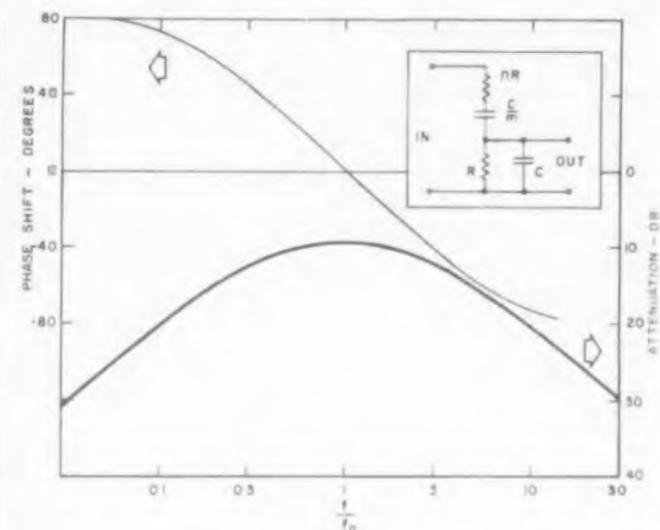


Fig. 11. The zero phase shift network with attenuation and phase characteristics.

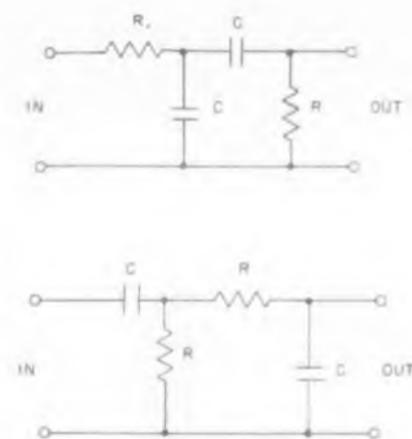


Fig. 12. Two variations of the zero phase shift network.

zero deg phase shift at its "resonant" frequency. Its attenuation is asymptotic to 6 db per octave each side of this frequency. If the general case for this network is considered, it is found that the highest selectivity occurs when $m = n = 2$. The resonant frequency obeys the relation $f = 1/2\pi RC$.

Two other networks composed of the same basic elements in different configurations, but having the same transmission characteristics are shown in Fig. 12.

Whitmer²⁶ describes a three-stage, broadly tuned bandpass amplifier employing two of these networks for interstage coupling. While not as selective as other circuits, the simplicity of the network and the absence of critical tuning requirements are advantageous.

Beatie and Conn.²⁷ and Punnett²⁸ employ this network as the interstage coupling in a two stage amplifier with a positive feedback loop, thereby obtaining a tuned amplifier system with Q's up to 20. Transistorized versions, while feasible, have not yet been described in the literature.

If the loop gain of the amplifier system is made

greater than 3, the circuit will oscillate at a frequency determined by the network and the amplifier phase shifts. Such a vacuum tube oscillator has been described by Terman.²⁸ Transistor oscillators of this type have been described and analyzed by Achuthan²⁹ and Hooper and Jack-ets.¹⁷

Another variation of this network is also described by Punnett²⁵ and consists of connecting the network to the output of a phase splitter. The operation approaches that of the Wien bridge by being more sharply tuned than the simple selective network and having zero output at its resonant frequency.

Wien bridge. A popular tuned RC network, the Wien bridge, is shown in Fig. 13 along with its transmission characteristics. It is more sharply tuned than the previous network, with a theoretical infinite attenuation and a discontinuous phase shift at its resonant frequency. It has been employed in tuned amplifiers by Shaw³⁰ and in oscillators by Clarke.³¹ It has a rather serious disadvantage in that it is a four-terminal network having no common connection between input and output, thus requiring an isolating transformer in many oscillator and amplifier circuits. However, it is possible to employ this network without a transformer. The network may be tuned by varying either the two capacitors or the two resistors in the right-hand branches simultaneously. The resonant frequency obeys the relation $F = 1/2\pi RC$.

Parallel-T network. Probably the most widely used RC selective network is the parallel-T or twin-T network. It has a higher Q than the previously discussed simple networks, less than the Wien bridge, and has a theoretical infinite attenuation and a discontinuous phase shift at its resonant frequency. A carefully constructed unit can have an attenuation of 120 db at this frequency. This network, invented by Augustadt,³²

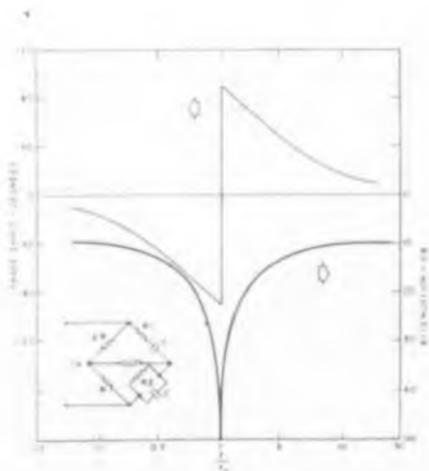


Fig. 13. The Wien bridge network with attenuation and phase characteristics.

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R _{CS}	Collector saturation resistance		6Ω typical 10Ω max	I _C —150ma I _B —15ma
h _{fe}	Small signal current gain at f—20Mc		2.5 typical	I _C —50ma V _{CE} —10v

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P _C	Total dissipation at 25° C. Case temp	2 watts		
h _{FE}	D.C. current gain		2N696—20 to 60 2N697—40 to 120	I _C —150ma V _{CE} —10v
R _{CS}	Collector saturation resistance		3.5Ω typical 10Ω max	I _C —150ma I _B —15ma
h _{fe}	Small signal current gain at f—20Mc		5 typical	I _C —50ma V _{CE} —10v

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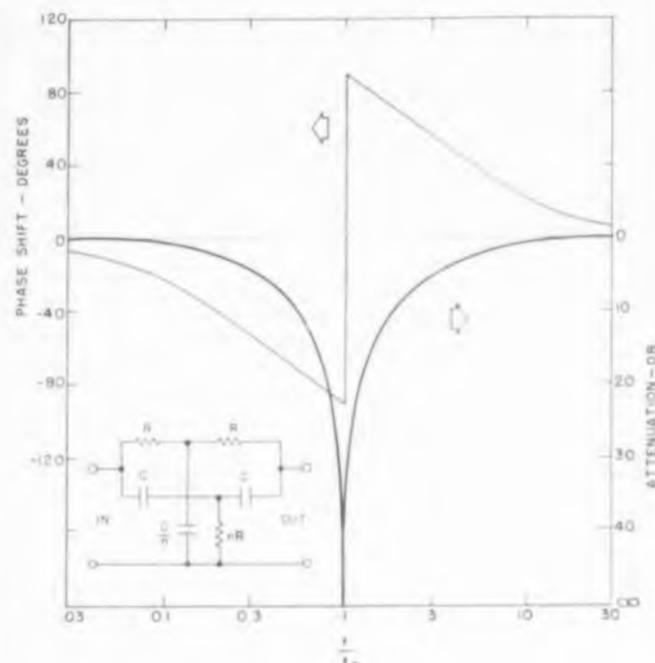


Fig. 14. The parallel-T network with attenuation and phase characteristics.

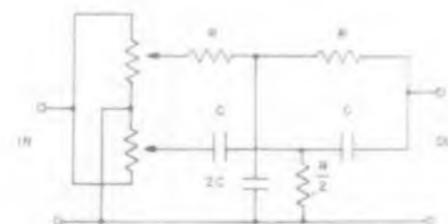


Fig. 15. The dual-input parallel-T network.

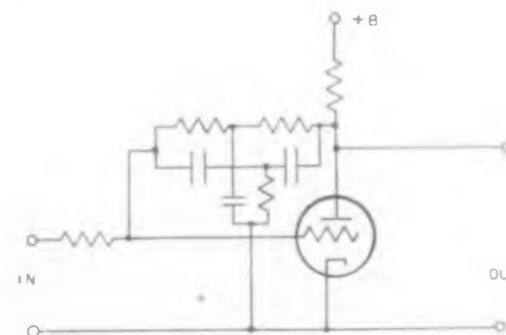


Fig. 16. A simple tuned amplifier employing a parallel-T network in the negative feedback loop.

is shown in Fig. 14 along with its transmission characteristics. The resonant frequency is given by $f = 1/2 \pi RC \sqrt{2n}$ where, for the highest Q , $n = 1/2$.

The parallel-T is a three-terminal network; there is a common connection between input and output. This feature makes the applications rather straightforward since no isolation transformer or special circuitry is required. Analysis of the parallel-T network and suggested applications have been made by Hastings³⁵ and Stanton.³⁴

One of the sharpest criticisms directed toward the parallel-T network is the fact that in order to vary the tuning frequency, three circuit param-

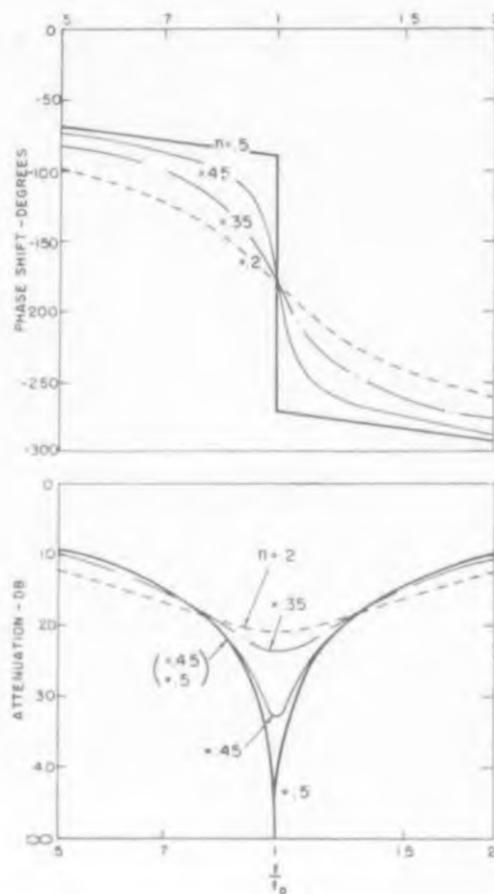
Fig. 17. Attenuation and phase characteristics of a parallel-T network with various values of n .

ters must be adjusted simultaneously and with perfect tracking to maintain the sharpness of rejection. White and Morgan³⁵ have made an ingenious modification that permits adjustment of the null frequency over a two-decade range without changing any of the circuit parameters. They split the input to the parallel-T, and in the case illustrated in Fig. 15, each T is fed from one section of a dual potentiometer. The null frequency is then only a function of the ratio of the voltages applied to the two T's and the null frequency of the basic network.

The use of the parallel-T network in vacuum tube tuned amplifiers was first described by Scott,³⁰ but subsequent articles by Fleisher,³⁷ Punnett,²⁵ Stanton,³⁴ and Hyde,³⁸ are more detailed. The tuned amplifier consists basically of a stage of gain with the parallel-T network in the negative feedback loop and is shown in Fig. 16. There is degeneration at all frequencies except at the resonant frequency of the network which is a transmission null. At this frequency, the amplifier gain is a maximum, resulting in a peak in the amplifier response. Among the articles showing practical circuits of tuned amplifiers employing this network are those by Dixon and Phillips,³⁹ Gitzendanner,⁴⁰ Rayner,⁴¹ and Roualt.⁴²

Bowers⁴³ calls attention to an interesting variation of the parallel-T network. If the multiplying factor, n , of the shunt arms of the network is less than 0.5, there is only a partial null and the network phase shift attains a value of 180 deg at the resonant frequency. The phase vs. frequency characteristic is degraded from the discontinuous function of the infinite attenuation network to a less rapid change, the slope becoming smaller as n is decreased. Attenuation and phase shift for various values of n are shown in Fig. 17. In the previously described amplifier, this phenomenon results in positive feedback or regeneration at the resonant frequency of the filter, thus increasing the amplifier gain at that frequency. Bowers,⁴³ McLaughan,⁴⁴ and Smith⁴⁵ have shown practical tuned amplifiers based on these principles. A similar circuit, but using transistors, is described by Sohrabj.⁴⁶

If the loop gain of the amplifier is made large enough to overcome the transmission losses of the network, the system will oscillate at a frequency determined by the network and the phase



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shift in the amplifier. The choice of n of the network is dictated by the open loop gain of the oscillator and the frequency stability that is desired. Vacuum tube oscillators of this type have been described by Smith⁴⁵ and Tucker.⁴⁷ A complete design procedure for parallel-T oscillators is given by Lynch and Robertson.⁴⁸ A transistor version is shown by Sohrabji.⁴⁶

Frequency discriminators utilizing parallel-T RC networks are advantageous for low frequency applications. There are two basic methods: two networks may be used directly, or in the inverse loops of feedback amplifiers. Tillman⁴⁹ and Stine⁵⁰ describe practical circuits and design techniques for these discriminators.

Bridged-T network. Still another frequency selective RC network is the bridged-T, described by Sulzer⁵¹ and others. The network and its transmission and phase characteristics are shown in Fig. 18. It has a minimum of transmission and zero deg phase shift at its resonant frequency, $f = 1/2\pi RC$. The unsymmetrical networks are characterized by a higher Q than is available from other networks containing only four components. Its relative simplicity and ease of frequency adjustment also make this network attractive for use in a tuned amplifier or oscillator.

Tisdale⁵² used the bridged-T network in conjunction with RC ladder sections to obtain a continuously adjustable low-pass filter. Sulzer has used this network in a vacuum tube⁵³ and a transistor⁵⁴ audio oscillator which feature low harmonic distortion.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle 100.

Acknowledgement

Net work response curves shown in this paper were computed from the network formulas, and with one exception appear on identical scales. The authors wish to thank Louis Nardizzi for his untiring efforts in computing data for the preparation of these curves.

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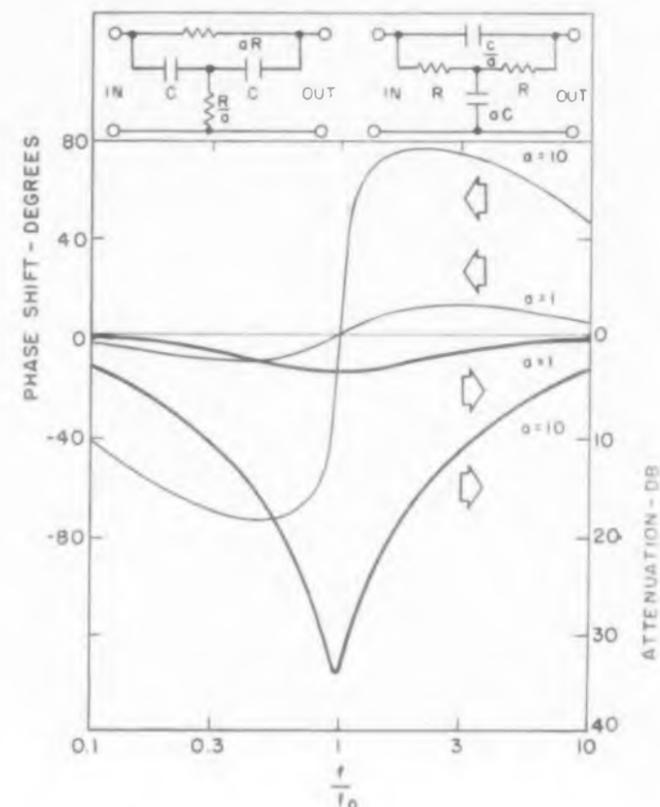


Fig. 18. The bridged-T network with attenuation and phase characteristics

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Teflon® is Du Pont's registered trademark for its fluorocarbon resins, including TFE (tetrafluoroethylene) resins.

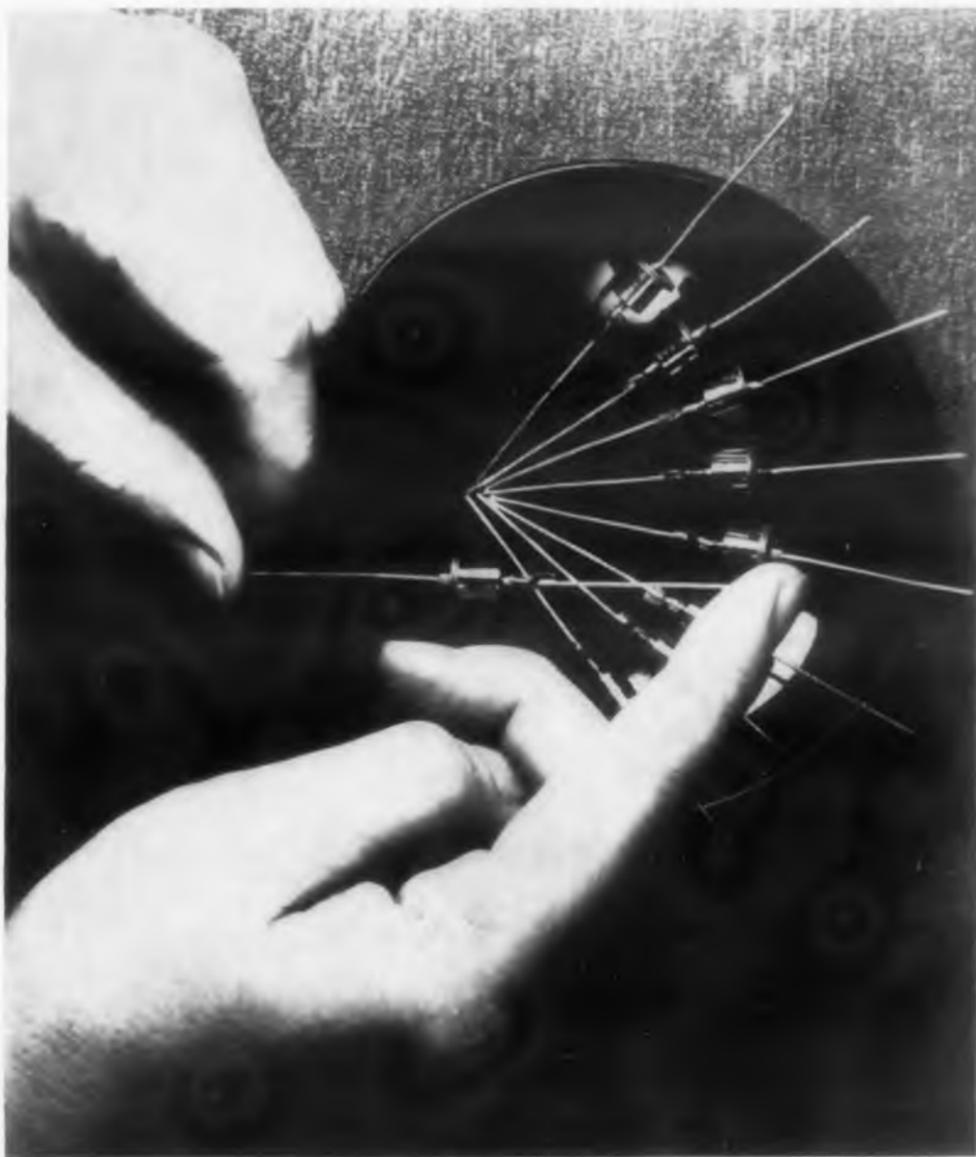
**continental
wire corporation**

WALLINGFORD, CONN. / YORK, PENNA.

CIRCLE 43 ON READER-SERVICE CARD

NEW PRODUCTS

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

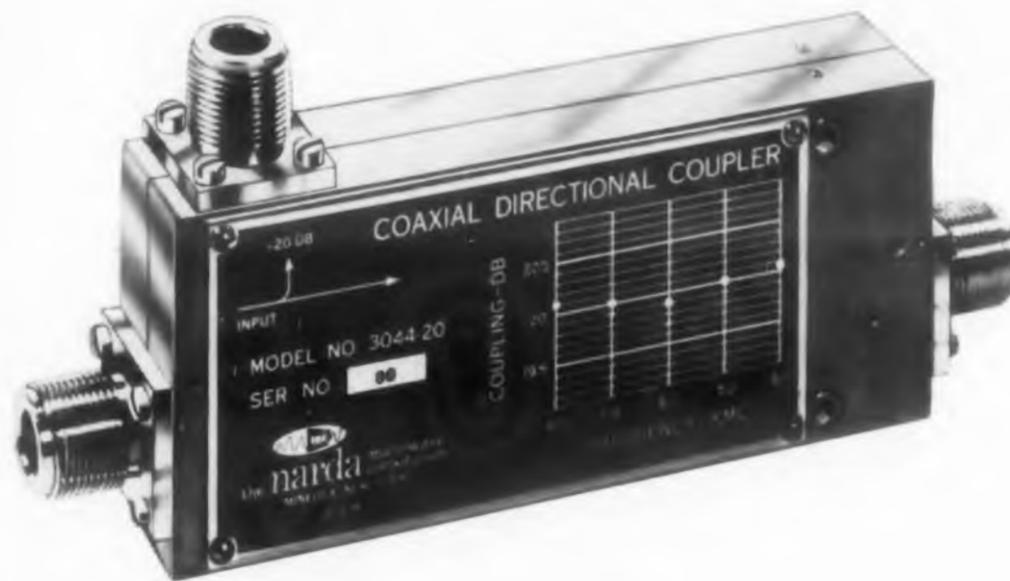


SILICON RECTIFIER

An operating life of 10,000 hr is expected for this silicon rectifier. For general purpose use in power supplies, magnetic amplifiers and variable speed motor controls, the unit's all welded hermetic package can function in temperatures that range from -55 to $+150$ C. Labeled the S-16, the rectifier provides an output of 500 μ amp. In the back direction it can stand 400 v and a maximum reverse current of 100 μ amp.

Semicon, Inc., Dept. ED, 258 East St., Lexington 73, Mass.

CIRCLE 44 ON READER-SERVICE CARD



FLAT COAX COUPLER

Limiting frequency response variation to only 0.2 db over a full octave, this series of flat coaxial couplers also present a deviation of mean value from nominal of only ± 0.3 db. Six models, designated 3040 through 3045, cover frequency bands from 240 to 11,000 mc with a nominal coupling value of 20 db. Four models are available with 10 db values,* covering 500 to 8000 mc. Primary vswr is 1.1 to 1.25, and secondary vswr is 1.2 to 1.3, depending on model.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N.Y.

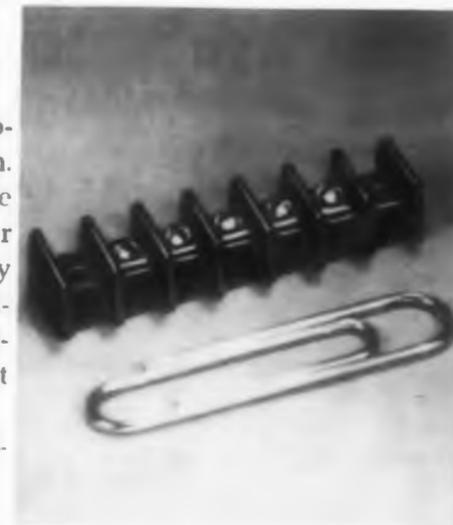
CIRCLE 45 ON READER-SERVICE CARD

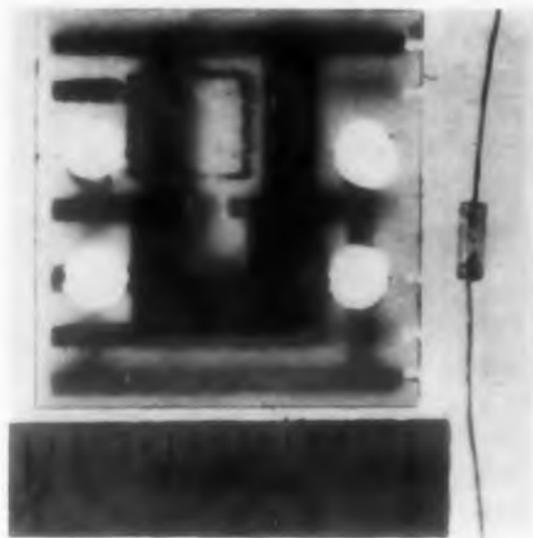
SUBMINIATURE TERMINAL BLOCKS

Made with 1 to 21 terminals, these subminiature terminal blocks are only 5/16 in. wide. Called the Series 409, they are molded of high tensile strength bakelite for commercial use. To meet Mil-M-14 they are made from other materials which includes CFG, MFE, MME, MDG and MAI-60, a special reinforced Alkyd for great tensile and impact strength.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N. Y.

CIRCLE 46 ON READER-SERVICE CARD



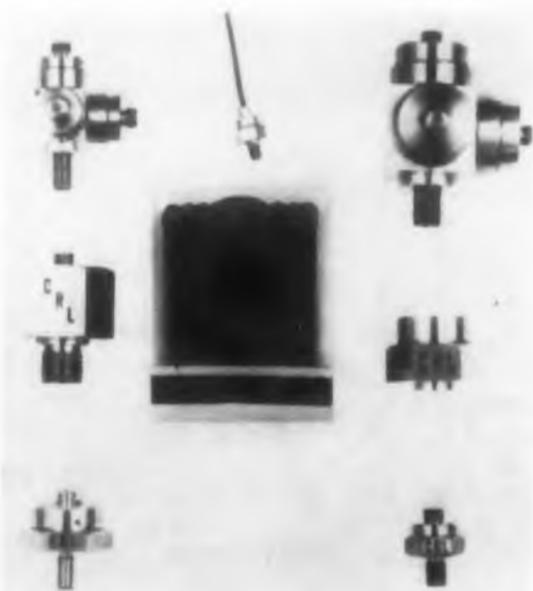


MICROMINIATURE LAMP

This microminiature incandescent indicator lamp operates directly from the output of a transistor. Developed by the Diamond Ordnance Fuze Laboratories (see *ED*, Mar 4 p 78), the lamp operates on less than 1.5 v and has a steady-state current drain of about 30 ma. It measures 0.035 in. in diameter and is 0.1 in. long.

Minitron Components Corp., Dept. ED, 187 Washington Place, Passaic, N. J.

CIRCLE 47 ON READER-SERVICE CARD



HIGH TEMPERATURE ACCELEROMETERS

Without cooling or correction, this line of crystal accelerometers operate in an ambient temperature range of -65 to $+540$ F. Using a new piezoelectric crystal in a true compression type seismic system, they have an accuracy of $\pm 5\%$ over broad acceleration and frequency range. The line consists of 16 units with sensitivities ranging from 30 mv/g to 1 mv/g.

Columbia Research Laboratories, Dept. ED, McDade Blvd. and Bullens Lane, Woodlyn, Pa.

CIRCLE 48 ON READER-SERVICE CARD

**RELIABILITY
IN THE PALM
OF YOUR HAND...**

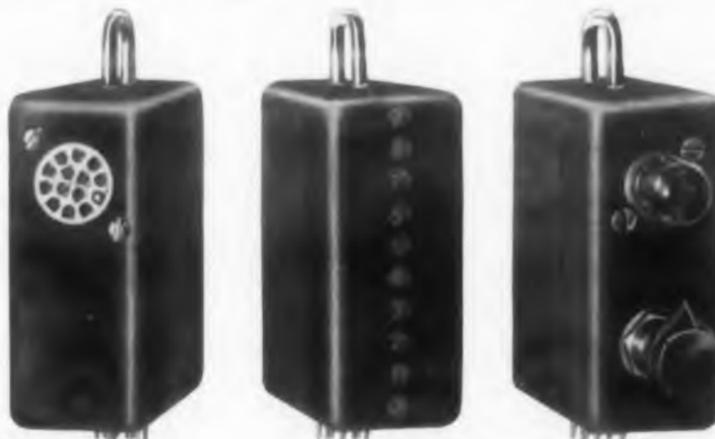
NEW EECO N-Series Transistorized DECADES

*for extremely reliable pulse-counting and frequency-division applications
in the frequency range of 0 to 250,000 pulses per second.*

FEATURES

The new EECO N-Series miniaturized and transistorized plug-in decimal counters feature simple power-supply requirements, low power consumption, small size, and extreme reliability. Saturation techniques, along with consistent derating of component tolerances result in a group of Transistorized Decades that will work dependably from 0 - 250 kcs even under adverse conditions of environment and power supply variations. All units are completely compatible with EECO T-Series Germanium plug-in circuits. In addition, an auxiliary 9-step staircase output is available. Most units are designed to plug into a special 13-pin miniature tube socket; other units plug into a standard 29-pin socket (Continental No. MM-29-22S). Mating socket is furnished with each decade.

ONE-HALF
ACTUAL SIZE

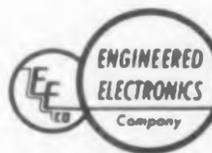


WIDE SELECTION

EECO N-Series plug-in Transistorized Decades are available in a wide range of models. The counting circuitry is standardized for the various models. Provisions for visual readout and/or preset controls are as follows:

MODEL	DESCRIPTION
N-101	No readout.
N-102	Incandescent readout.
N-104	Incandescent readout (remote). Typically a projection readout module.
N-105	Nixie readout. (Can be cabled to remote Nixie.)
N-106	Nixie readout with preset control switch. (Can be cabled to remote Nixie.)
N-107	Incandescent readout with inputs for external preset control.
N-108	Incandescent readout (remote) with inputs for external preset control.
N-111	No readout, but with 1-2-4-2 code.

*Additional information on N-Series Transistorized
Decades and other EECO products available on request.*



ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)

506 East First Street • Santa Ana, California

CIRCLE 49 ON READER-SERVICE CARD



TYPICAL SPECIFICATIONS

The N-102 Transistorized Decade (with internal incandescent readout) employs four binary stages operating in a 1-2-4-2 code. Visual readout consists of the numerals 0 through 9 displayed vertically and illuminated by incandescent lamps. Total power consumption is approximately one watt. Outputs include (N/10), (N/10)', and a 9-step staircase, which may be adapted for a visual display by means of an emitter follower and DC voltmeter.

ELECTRICAL SPECIFICATIONS

INPUT

Minimum Trigger Input: (0-100 kcs): 7 volts positive pulse or step at 0.5 μ sec. rise time; (100 kcs to 250 kcs): 7 volts positive pulse or step at 0.2 μ sec. rise time.
Maximum Operating Frequency: 250 kcs.
Input Impedance: 470 μ mf. capacitance, max.
DC Reset Input is provided (normally supplied by T-129 DC Reset Generator).

OUTPUT (No Load)

Amplitude: 8 volts, peak to peak.
Output Levels: (N/10) and (N/10)': -11 volts DC and -3 volts DC, nom. Staircase: -11 volts DC to -3 volts DC in 9 steps.
Rise Time: (N/10): 0.5 μ sec.; (N/10)': 0.5 μ sec.
Type: (N/10), (N/10)', and 9-step staircase.
Load: Typical, two N-Series decades or two T-Series flip-flops. (Load information available on request.)

PHYSICAL SPECIFICATIONS

Dimensions: 1-5/16" wide x 3" deep x 3-7/8" seated height (including handle). Dimensions are exclusive of external addenda found in external preset and Nixie models.

Mounting: Plugs into standard 9-pin miniature socket. (Some other models require a special 13-pin miniature socket, which is furnished with each such unit.)

Pin Connections: Arranged for in-line wiring of power and grounds.

Operating Temperature Range: -54° C to $+71^{\circ}$ C.

NOTE: 0 to 5 megacycle models available soon.

Introducing a NEW FAMILY OF MICROWAVE DIODES

PHILCO sets the pace with outstanding crystal performance

Announcing a new family of low-noise microwave diodes. Here is a major step forward in the development and control of germanium and silicon crystal diode performance. Philco microwave diodes are designed to meet the most stringent military environmental and electrical requirements for shock, vibration, torque and strain. Each of these new diodes is unsurpassed for performance. When only the best will do . . . the experts choose Philco.

- Exceptionally Low Noise Figure
- Outstanding Performance at 150° C
- High Resistance to Burn-Out
- Absolute Hermetic Seal

 <p>1N1838</p> <p>The first and only Germanium Mixer Diode specifically designed for ultra-low noise performance in Doppler receivers. A noise temperature ratio specification of 24db max at 20kc guarantees this performance. Through Philco's exclusive anchor whisker construction the practical elimination of microphonics is assured. The 1N1838 is hermetically sealed and has been uniquely engineered for Doppler equipments operating at 8,800 and 13,500mc.</p>	 <p>1N263</p> <p>Here's a Hermetically Sealed Germanium Crystal Diode designed for exceptionally low noise mixer performance at X-band. It has been engineered to such a degree that its tightly controlled characteristics assure that <i>any two</i> 1N263's will be a matched pair; its symmetrical construction allows easy polarity reversal in balanced mixers. The crystal may be used fixed-tuned over the range 8600 to 9600mc. IF impedance (Z_{if}) . . . 140 to 210 ohms; RF impedance (VSWR) . . . 1.3 max; Overall noise figure (N_{Frec}) . . . 7.5db max.</p>
 <p>1N26 1N26A 1N26B</p> <p>These Silicon Mixer Diodes bring tremendously improved performance to this family designed for high reliability operation in the 24,000mc region. As a result of Philco's unparalleled engineering activity in this area, existing performance limits in the 1N26 series have been greatly extended; by addition of the 1N26B . . . maximum operating temperature more than doubled (to 150° C.); VSWR reduced to 1.5; IF impedance range narrowed (400 to 600 ohms). All members of this family have a metal-to-ceramic hermetic seal guaranteeing reliable performance under extreme environmental conditions.</p>	 <p>1N78 1N78A 1N78B 1N78C</p> <p>These Silicon Mixer Diodes offer new and unsurpassed performance characteristics to this established family designed for maximum sensitivity operation in the 16,000mc region. The new member of this family is unilaterally interchangeable with existing types while incorporating strikingly superior features: conversion loss (L_c) reduced to 6.0db max; IF impedance (Z_{if}) range tightened (400 to 550 ohms); RF impedance (VSWR) reduced to 1.5; temperature range extended (150° C.). Engineered to meet the most demanding military applications, all the members of this series are packaged in a hermetically sealed case.</p>

Write Special Components Dept., ED 359 Lansdale Tube Company Division, Philco Corporation, Lansdale, Pa.

PHILCO
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNA.

NEW PRODUCTS

VTVM

Has 6-in. meter



The VT-10 VTVM has an edge-lighted 6-in. meter for accurate reading. Sensitivity of the unit's movement is 400 μ a, with 2% accuracy. For measurement stability 1% precision resistors are throughout the range switch. The unit has 7 ac (rms) and dc ranges, 0 to 1500 v. Also 7 ac peak-to-peak ranges, 0 to 2000 v. Other ranges include resistance, 0 to 1000 megohms, and db.

Arkay, Inc., Dept. ED, 88-06 Van Wyck Expressway, Richmond Hill 18, N.Y.

CIRCLE 51 ON READER-SERVICE CARD

Connectors

MS-E type



MS-E pin or socket types, Seal-E electrical connectors are supplied in sizes through O. Constructed with partitive hermetic glass seals they also have interfacial seals for internal moisture-proofing.

Connector Seals Corp., Dept. ED, Rosemead, Calif.

CIRCLE 52 ON READER-SERVICE CARD
CIRCLE 50 ON READER-SERVICE CARD

Gyros

For various uses



Flexible design of the series 1080 gyros allows the unit to be made into a directional gyro or a free gyro as well as a vertical gyro. Weighing a maximum of 4.75 lb, the unit's maximum dimensions are 3-7/8 x 3-7/8 x 6 in. Standard excitation of the gyro motor is 115 v, 400 cps, 3 phase. Optional excitation: 26 v, 400 cps, 3 phase; 115 v or 208 v, 400 cps, 3 phase, 4 wire. Standard pickoff is 115 v, 400 cps, 1 phase, with optional rated at 26 v, 400 cps, 1 phase.

Lear, Inc., Dept. ED, 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

CIRCLE 53 ON READER-SERVICE CARD

Double Plug Accessories

For multiple stacking

These three molded 3/4 in. double plug accessories are built for multiple stacking. Model MDP is designed for cable attachment and features a built-in cable guide to act as a strain relief. Internal set screws provide a rapid means of connection. The plug is rated at 15 amp continuous duty and 5 kv working voltage. Capacity is 0.8 μ f. Model MDPS has an internal shorting bar, and model MDPR has precision 1% resistors molded in. In all models the molded plug body is unbreakable plastic and the banana plug springs are one piece nickel plated beryllium copper.

Pomona Electronics Co., Inc., Dept. ED, 1126 W. Fifth Ave., Pomona, Calif.

CIRCLE 54 ON READER-SERVICE CARD

CIRCLE 55 ON READER-SERVICE CARD

Coors high strength ceramic-to-metal assemblies



COORS CAN FURNISH COMPLETE CERAMIC-TO-METAL ASSEMBLIES TO YOUR SPECIFICATIONS

The finest in manufacturing facilities and technical know-how are available to you at Coors—whether your requirement calls for a simple terminal bushing or a complex assembly of ceramic and metal parts. Coors high strength ceramic parts, metalized using high temperature techniques, are brazed to metal parts to provide the combination of physical, electrical and heat resisting characteristics needed for so many appli-

cations today.

Ceramic-to-metal bond strengths range normally from 9,000 to 12,000 p.s.i.—or higher depending on design. Brazes can be made at temperatures as high as 1083°C (1981°F.) using copper.

Extremely close dimensional tolerances can be maintained where Coors manufactures the ceramic components, does the metalizing and makes the final assembly of the

ceramic and metal parts. Also, this places responsibility in one place.

However, for those who do their own assembly work, Coors will supply the ceramic parts only—either plain or metalized.

Coors engineers will help you work out the mechanical design details of your metalized ceramic parts or ceramic-to-metal assemblies. Contact us at the earliest possible stage of design in order to save time.

COORS PORCELAIN COMPANY

GOLDEN, COLORADO

Manufacturers of

COORS SPACE AGE CERAMICS

COORS PORCELAIN CO., 600 9th St., Golden, Colo.

Please have your sales engineer see me to discuss ceramic-to-metal assemblies.

Name.....Title.....

Company.....

Address.....

City.....State.....



20760

true hermetically sealed solenoids

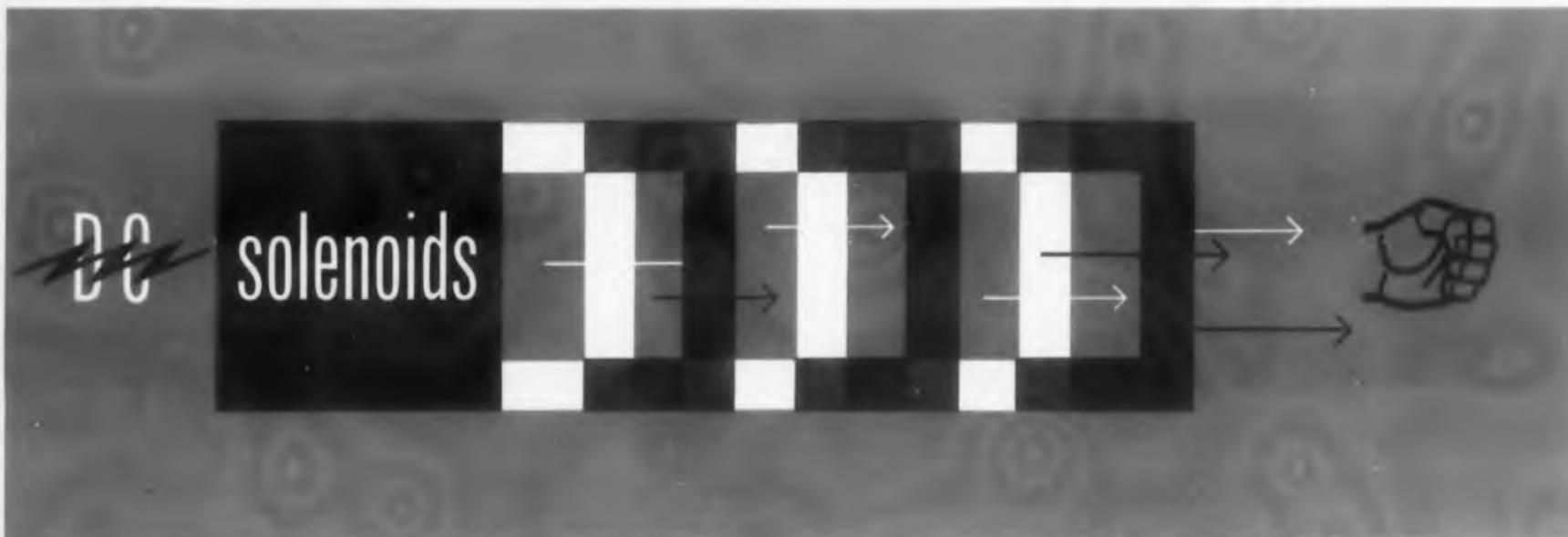
Just like a sealed vacuum tube! True hermetic sealing around a solenoid... glass seal terminals, lugs, and connectors. All welded and brazed construction. Completely plated after assembly. Exceed most requirements of military specification MIL-S-4040 (USAF). Priced at approximately the same level as conventional types.



20479

high-temperature solenoids

These modern new solenoids give you a reasonable life expectancy at temperatures as high as 350° C. A by-product of hermetic sealing. Class H insulation combined with inert gas filling add those necessary extra few degrees needed in your temperature limits... make these solenoids exceptional high-quality, high-temperature units.



MINIATURE

...and those unusual specialties you look for!

Having trouble finding solenoid specialties? Here at Cannon, we'd like to help you. Standard production now includes multiple-strip solenoids for keyboard operation, locking types requiring no holding current, and miniatures and sub-miniatures 1/2" diameter. In addition, our expanded solenoid engineering department is ready to serve you at any time.



16928 1700-10 19621
conventional d. c. solenoids
in many designs give you
positive action and
absolute reliability

CANNON PLUGS



CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif.
Please refer to Dept. 438

Factories in Los Angeles, Salem, Mass., Toronto, London, Melbourne. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities. See your Telephone Yellow Book.

Please ask for latest SR-S releases and/or Solenoid Bulletin.
CIRCLE 58 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Termination

Dc to 10 kmc



These terminations are miniaturized low power loads designed to operate from dc to 10 kmc. They are for use with airborne and other applications requiring compact, lightweight components. The units consist of a resistive film center conductor terminated within a matched housing. Their nominal power rating is 2 w, which can be increased by providing an external heat sink or forced air cooling. Known as the TA series, they are provided with either male or female connectors of type N, BNC or TNC. Impedance is 50 ohms and the input vswr over the entire frequency range is 1.1, maximum.

Microlab, Dept. ED, Livingston, N.J.

CIRCLE 56 ON READER-SERVICE CARD

Infrared Detector

Sensitive to six microns

The InSb infrared detector uses the photoconductive effect of indium antimonide. Operating at dry ice temperature, it is sensitive to six microns and has a time constant of less than one usec. Used with the company's auxiliary low noise transformers and preamplifiers, the noise equivalent power of the detector is 5×10^{-11} w. Low microphonic noise and circuit simplicity make the unit suitable for high speed scanning systems as well as infrared detection devices and remote temperature measurement units.

Radiation Electronics Corp., Dept. ED, 8241 N. Kimball Ave., Skokie, Ill.

CIRCLE 57 ON READER-SERVICE CARD

LCR Comparison Bridge

Direct reading



Parameter deviations of 1 part in 10,000 may be detected between electronic components with the model 544 LCR comparison bridge. The unit compares and measures resistances, capacitances, and inductances at a frequency of 60 cps. Percentage deviation is read directly. Resistance measurement limits are 3 ohms to 5 meg; capacitance, 500 μ f to 1000 μ f; and inductance, 3 mh to 10,000 h. The instrument has five meter ranges, indicating full scale differences of 1, 2.5, 5, 10, and 25%. Accuracy on range 1 is $\pm 0.1\%$. This instrument can serve as an electronic go-no-go gage; determine absolute electrical parameter values when used with a decade standard; and indicate or adjust the tracking characteristics of two or more variable resistors or capacitors mechanically coupled by a common shaft. It can also match components that must be duplicated. Either a level or foot operated switch protects the meter circuit from overload while components are being inserted or removed.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 59 ON READER-SERVICE CARD



Counting Modules

Plug-in

This decimal counting unit has a single-digit display 1-1/4 in. high that is packaged as an integral part of a plug-in counting module. The modules are used in a series of electronic counters, timers, and frequency meters. Digits are formed by illuminating from 5 to 11 character segments, and maximum counting rates of 100 kc and 1 mc are available.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

CIRCLE 60 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Inside ESC: Number Three



ESC ENGINEER-REPS know their business... and yours!

The men who represent ESC in the field are all top-flight technical people in their own right. Each is thoroughly conversant with the very latest developments in the fast-moving delay line field and each stands ready to apply the combined knowledge of the entire ESC organization to your particular problems.

Whether you want advice on a standard delay line application,

or something special from ESC's modern research laboratory, you can be sure of receiving top engineering talent, prompt delivery, and expert, local service. There's an ESC engineer-rep very close to you, wherever you are. Why not discuss your current delay line problem with him now.

<p>COMPONENTS SALES CORPORATION 218 East Hartsdale Avenue Hartsdale, New York SCarsdale 5-1050 New York State, New Jersey except Camden and Moorestown, Westchester County 44 Brattle Street Cambridge 38, Massachusetts UNiversity 4-1727 New England</p>	<p>KAY SALES COMPANY 2600 Grand Avenue Kansas City 8, Missouri BAaltimore 1-3800 7603 Forsyth, Suite 206 Clayton 5, Missouri PARKview 7-3414 Kansas, Nebraska, Missouri, Oklahoma, Arkansas, Albuquerque, N. M. and the following counties in Illinois: Monroe, Calhoun, Jersey, Madison and St. Clair</p>	<p>MAGNUSON ASSOCIATES 3347 West Irving Park Road Chicago 18, Illinois KEystone 9-7555 Teletype CG 913 Illinois (except Monroe, Calhoun, Jersey, Madison and St. Clair counties), Indiana, Iowa and S. Wisconsin 1359 West Maynard Drive St. Paul 16, Minnesota Minnesota and N. Wisconsin</p>	<p>HARRY J. WHITE COMPANY 121 Covered Bridge Road Haddonfield, New Jersey HAzel 8-2304 Camden and Moorestown, New Jersey; Eastern Pennsylvania and Delaware Mr. Richard Trainor 115 Greenbrier Road Towson 4, Maryland VALley 3-6184 Maryland, Virginia as far south as Alexandria, and Washington, D.C.</p>
<p>ELECTRODESIGN 736 Notre Dame Street West Montreal, Canada UNiversity 6-7367 Canada</p>	<p>A. L. LIVERA AND ASSOC., INC. 144-15 Hillside Avenue Jamaica 35, New York OLympia 8-1828 New York City, Long Island</p>	<p>WEIGHTMAN AND ASSOCIATES 4029 Burbank Boulevard Burbank, California VICTORIA 9-2435 1436 El Camino Real, Suite #5 Menlo Park, California DAvenport 6-3797 Arizona, California, Nevada and New Mexico except Albuquerque</p>	<p>TEX-O-KOMA SALES COMPANY 235 S. E. 14th Street Grand Prairie, Texas DALLAS: ANDrew 2-0866 FT. WORTH: CRestview 4-4530 Texas</p>



ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

exceptional employment opportunities for engineers experienced
in computer components... excellent profit-sharing plan.

CORPORATION 534 Bergen Boulevard, Palisades Park, New Jersey

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

See you at the I.R.E. Show, Booth #2409

CIRCLE 61 ON READER-SERVICE CARD

Very Compact....



NEW RCA "VC" 110° PICTURE TUBES!

Here's a compact honey! The new RCA "VC" (*Very Compact*) Picture Tubes—now 2 inches shorter than their prototypes!

Now commercially available in the new "VC" 110° designs are the RCA-17DKP4 and RCA-21EQP4, all-new premium types. They utilize conventional 110° components and circuitry. And, with only slight changes in focusing-voltage control, they are unilaterally interchangeable with previous 110° types. RCA "VC" 110° types employ the same heater cathode assembly that has been used and proven for reliability over the past decade in RCA Picture tubes.

So, when the need arises for a slim, *very compact* TV-set design, contact your RCA Field Representative. Your pass words are RCA "VC" 110° Picture Tubes. For technical data, write RCA Commercial Engineering, Sec. C-18-DE-2, Harrison, N. J.



RADIO CORPORATION OF AMERICA

Electron Tube Division

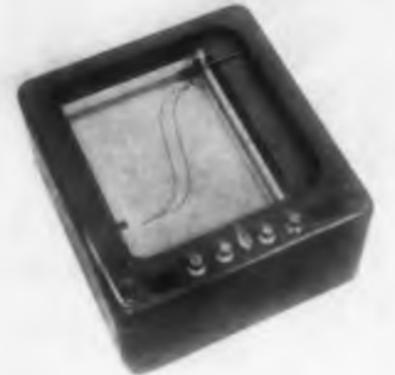
Harrison, N. J.

Visit the RCA exhibition at the N. Y. I.R.E. Show, Booths 1602-4-6, 1701-3-5-7

NEW PRODUCTS

X-Y Recorder

Accurate to 0.05%



The HR-92 X-Y recorder is used for computer readout and for plotting stress vs strain; magnetic material, tube, and semiconductor characteristics; pressure vs temperature; speed vs torque; or any other two related variables. It is designed for use with standard 8-1/2 x 11 in. graph paper. The unit is ruggedly built and uses self-balancing potentiometer servos to assure 0.05% accuracy and drift-free performance at available sensitivities of up to 1 mv per in. Three turn rebalance slide wires are lubricated to provide years of operation. The pen speed is 1 sec full scale without overshoot.

Houston Instrument Corp., Dept. ED, 1717 Clay Ave., Houston 3, Tex.

CIRCLE 62 ON READER-SERVICE CARD

Miniature Signal Lamp

For production control boards

The Perlite miniature signal lamp is designed for use in production control or power dispatcher boards. It is particularly adapted for metal boards where perforations are made on 1/4 in. centers on a square pattern, or 3/16 in. on a staggered pattern. It operates on 20 v, and a resistor, mounted on the socket, permits the use of a 110 v power supply. At low voltage, maximum lamp life is 2 years to indefinite.

Power Dispatchers Equipment Co., Dept. ED, P. O. Box 1947, Milwaukee 1, Wis.

CIRCLE 63 ON READER-SERVICE CARD

RCA FIELD OFFICES

EAST: 744 Broad Street
Newark 2, N. J.
HUmboldt 5-3900

MIDWEST: Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.
WHitehall 4-2900

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

Power Supply

30 kv output



Designated Model PS-30T, this 30 kv, full-wave voltage-doubler power supply operates on 117 v, 60 or 400 cps. The unit delivers 1 ma continuous and 1.75 ma peak current. Ripple is 1.5% at 1 ma and regulation is approximately 7% from no load to full load. It has replaceable 1B3 rectifier tubes and plastic dielectric capacitors. Dimensions of the case are 5-1/4 x 11-3/8 x 9-1/2 in., and the unit has oil-tight solder-seal terminals.

Film Capacitors, Inc., Dept. ED,
5400 Park Ave., New York 56, N. Y.

CIRCLE 64 ON READER-SERVICE CARD

AC VTVM

Covers 0.001 to 300 v in 12 ranges

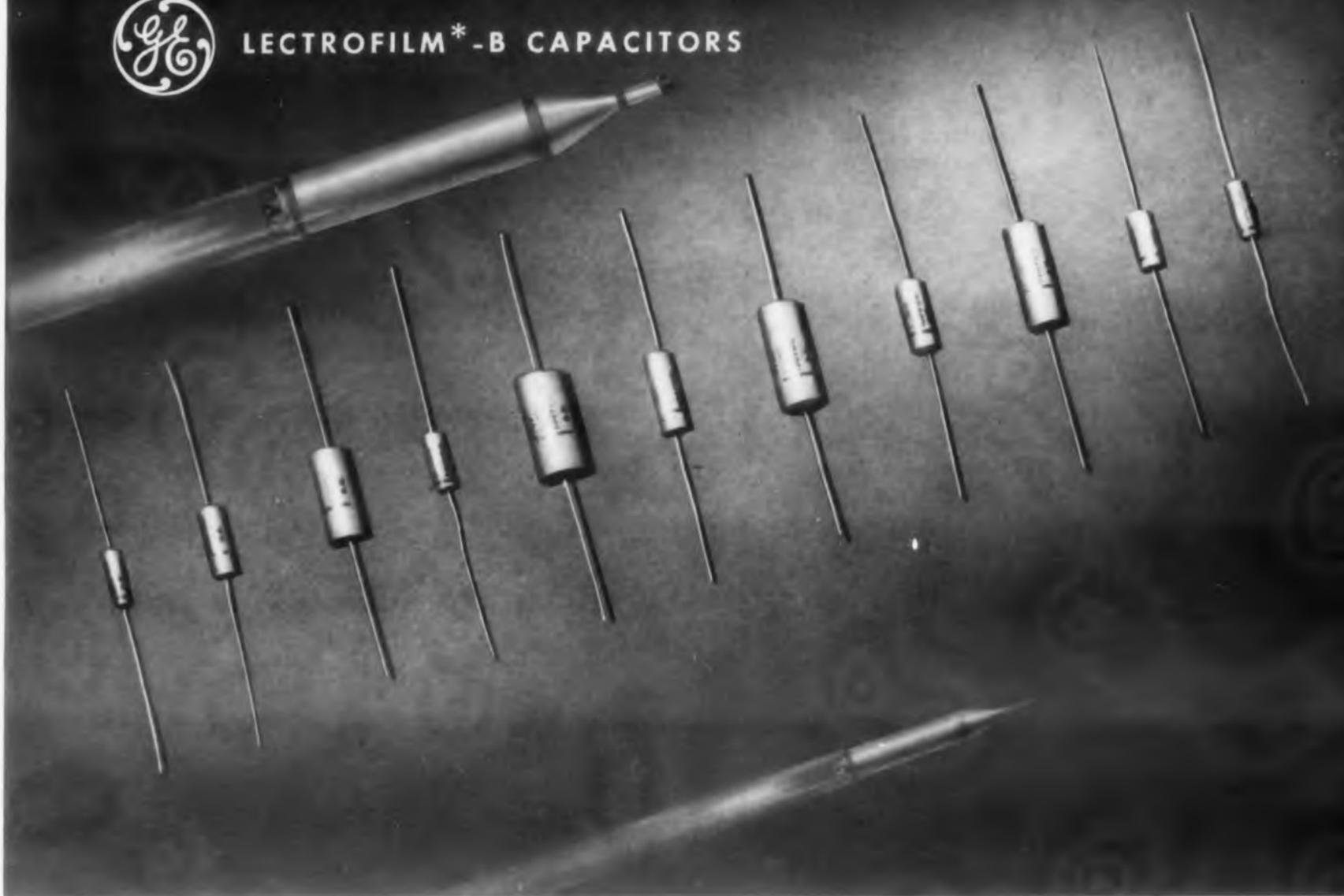
Model VA-104 ac vacuum tube voltmeter has a 10 cps to 4 mc frequency range and 12 voltage ranges from 0.001 to 300 v. Calibrated to read the rms value of a sine wave, it has an overall accuracy of $\pm 2\%$. It consumes 70 w and can be used on lines of 115 or 230 v, $\pm 10\%$, at 50 or 1000 cps. The unit incorporates long life electrolytic capacitors and output jacks which permit its use as a high gain, 4 mc wideband amplifier with a maximum gain of 50 db. A portable instrument, it is 7-3/8 in. wide, 11-3/16 in. high, and 11-5/8 in. deep.

Republic Electronic Industries Corp., Dept. ED, 111 Gazza Blvd., Farmingdale, N.Y.

CIRCLE 65 ON READER-SERVICE CARD



LECTROFILM*-B CAPACITORS



General Electric Announces for Missile Use . . .

New Lectrofilm*-B Capacitors for 44,000 Hours of Reliable Life

New G-E Lectrofilm-B capacitors offer you maximum reliability at lowest possible cost . . . results of over 3,000,000 unit-hours of life test data (per G-E Spec. MTC-3) indicate a probability of survival in excess of 0.99 for 44,000 hour life under rated voltage at 85C. Under rated voltage at 125C, the indicated probability of survival is in excess of 0.98 for 44,000 hour life.

LOW FAILURE RATE AND LONG LIFE of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are tightly wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

SMALL, LIGHTWEIGHT ENCLOSURE consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volts. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 447-4, General Electric Co., Schenectady, N. Y.

*Trade-mark of General Electric Co.

†Reg. trade-mark of DuPont Co.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 66 ON READER-SERVICE CARD

NEW PRODUCTS

Miniature Crystal Diodes

All glass

These all-glass miniature crystal diodes are designed for radio, television, data processing, and other military and commercial electronic applications. They have a maximum body length of 0.265 in. and a maximum diam of 0.105 in. The line includes: computer types 1N191, 1N192, and 1N198 which offer rapid recovery, good stability, and high conductance; gold bonded types 1N270, 1N276, 1N279, 1N281, and 1N283 which combine high temperature capabilities with high forward conduction; point-contact types 1N126A, 1N127A, and 1N128 which have a wide reverse resistance and voltage range; and silicon junction types 1N251, 1N252, 1N456, 1N464, 1N625, and 1N629 which operate with rapid recovery and high reverse resistance at temperatures up to 150 C.

Sylvania Electric Products Inc., Semiconductor Div., Dept. ED, Woburn, Mass.

CIRCLE 67 ON READER-SERVICE CARD

Portable Calibration Unit

Accurate to 0.01%



A portable, all semiconductor calibrator, model TC-10 is designed for precision alignment and calibration of electronic equipment such as fm record-reproduce systems. With a voltage standard accurate to 0.01%, it provides working calibration voltages in nine steps, each adjustable over a range of 10%. Nine precision oscillators and seven binary dividers provide 63 accurate calibration frequencies ranging from 1012 cps to 151.2 kc. These can be introduced into a system for discriminator alignment or for comparison with the output of a voltage-controlled oscillator. Supplied in a figerglass case, the unit weighs 25 lbs.

Ampex Corp., Instrument Div., Dept. ED, 934 Charter St., Redwood City, Calif.

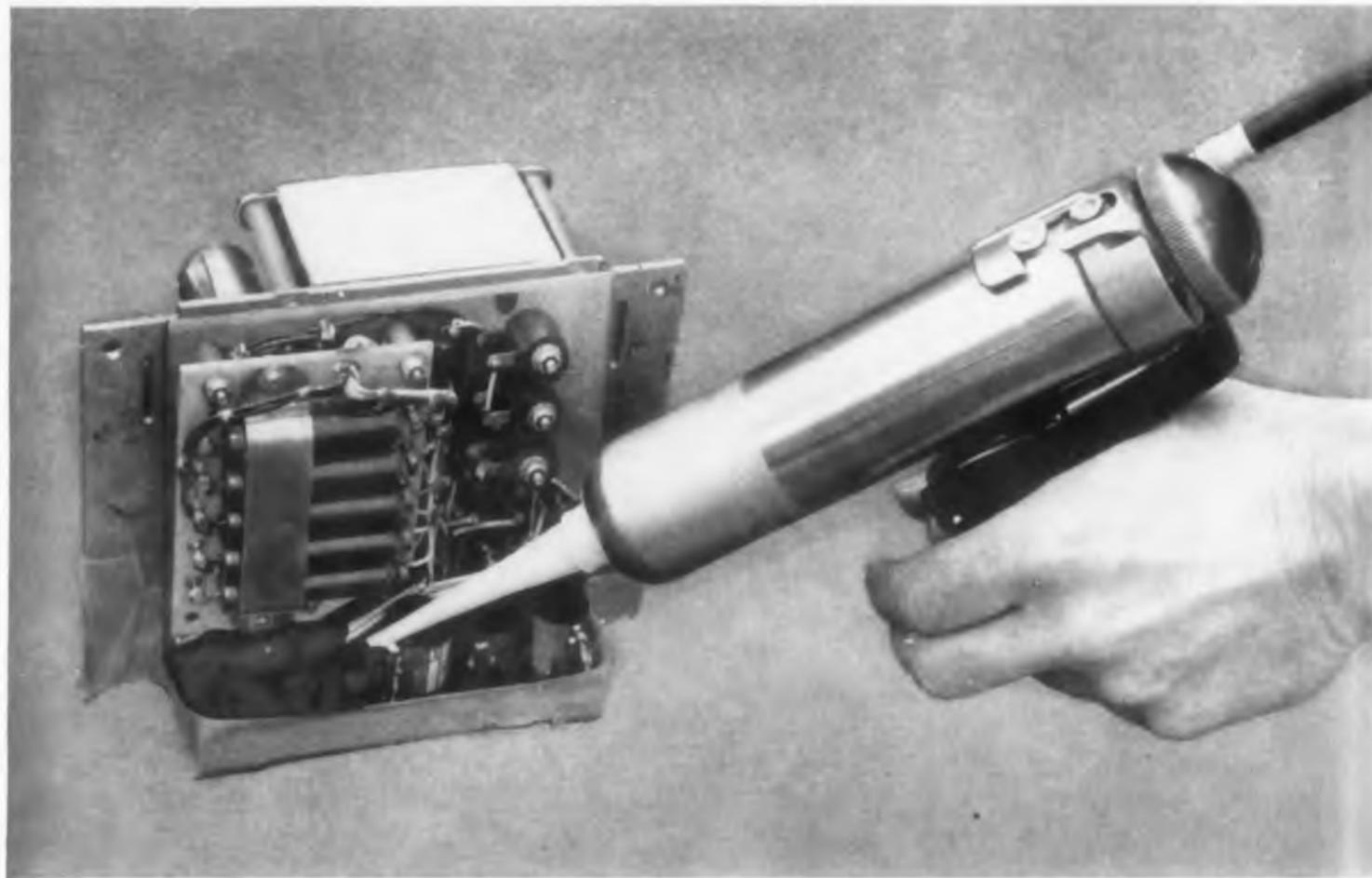
CIRCLE 68 ON READER-SERVICE CARD

Design better products with

SILASTIC RTV

SILICONE RUBBER

... seals and cushions delicate circuits



High impedance circuits in Northrop's Snark missile are coated with Silastic RTV for protection against moisture and vibration at temperature extremes. Silastic RTV is easy to apply . . . vulcanizes at room temperature.

TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range, °C . . .	-70 to 260C
Dielectric strength, volts/mil . .	300 to 500
Surface resistivity at 50% Relative humidity, ohms . . .	2.8×10^{13}
Dielectric constant, 10^5 cycles per second	2.5
Dissipation factor, 10^5 cycles per second	0.003

Sensitive electronic components are sealed against moisture and cushioned against vibration with a coating of Silastic* RTV, the Dow Corning silicone rubber. Silastic RTV forms a rubbery silicone solid in 24 hours at room temperature. Stays resilient from -70 to 260 C. This "do-it-yourself" material is used for a wide range of encapsulating, potting and caulking applications. Write for free sample and complete information.

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

*T.M. REG. U.S. PAT. OFF.

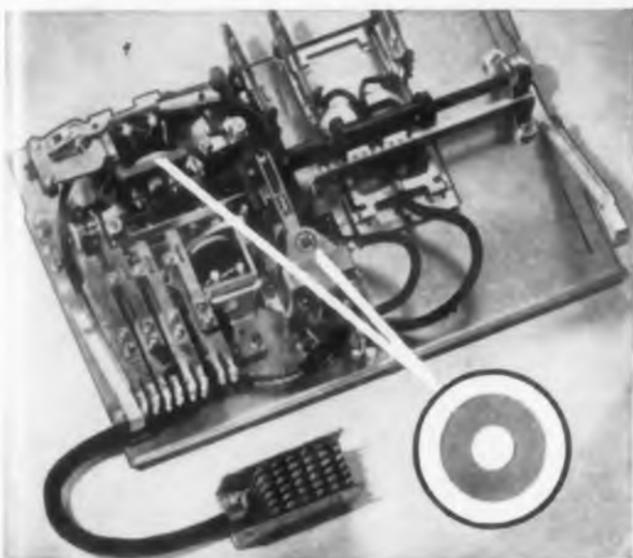
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MIDLAND, MICHIGAN

th Dow Corning Silicone Dielectrics



Stromberg-Carlson telephone switch insulator

SILICONE-GLASS LAMINATES INCREASE LIFE AND DEPENDABILITY

Laminates made by bonding glass cloth with Dow Corning silicone resins have high arc resistance, low loss factor, low moisture absorption, excellent retention of dielectric properties at high temperatures. Strong, lightweight—produced by leading laminators.

CIRCLE 501 ON READER-SERVICE CARD

SILICONE FLUIDS PROTECT ASSEMBLIES FROM MOISTURE



Southwestern Industrial Electronics seismographs

A protective film of Dow Corning 200 Fluid spray coated on electronic assemblies protects terminals, clips, switches and other exposed connections from the harmful effects of condensation. Glass and ceramic insulators coated with silicone fluid have low current leakage and a high degree of surface resistivity, even under very humid conditions.

CIRCLE 502 ON READER-SERVICE CARD

SILICONE COMPOUND PREVENTS ARCS, GROUNDS, SHORTS

Nonmelting, nongumming Dow Corning 3 Compound stays in place . . . provides an effective, moisture-proof dielectric seal for all types of electronic equipment. As a potting or filling material for electronic components and assemblies, silicone compounds flow into place with gentle pressure . . . have a serviceable temperature range of -40 to 205 C. Free sample available.

CIRCLE 503 ON READER-SERVICE CARD



AN Connector Terminals, Navy Helicopter

Resolver Function Error Bridge

0.01% full scale sensitivity



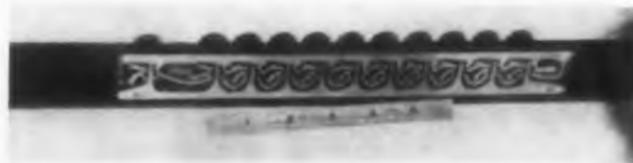
Resolver function bridge model RF-1 tests computing resolvers for deviation from an ideal sine or cosine function. The result, expressed directly in percentage error, is shown on a 4-1/2 in. zero-center meter. The output voltage from each resolver winding is measured by comparison to a standard voltage. Taps from the standard voltage circuit represent the cosine function at 5 deg intervals. High balance sensitivity is achieved since the carrier phase of the standard is precisely matched to that of the resolver output. The detector blocks all harmonic and quadrature voltages. In a cabinet 19 x 7 x 8 in., the unit accommodates any range of resolver inputs and outputs. Accurate to 0.002%, it has a full scale sensitivity of 0.01%.

Theta Instrument Corp., Dept. ED, 48 Pine St., East Paterson, N.J.

CIRCLE 69 ON READER-SERVICE CARD

Shift Register Package

1-1/4 x 11 x 1-1/8 in.



Model TRA-25-10 register assembly consists of ten core-transistor shift register elements driven by one core-transistor shaper-driver element. Test points are provided for observation of all pertinent waveforms. The unit measures 1-1/4 x 11 x 1-1/8 in. and requires pulse signals from 0 to 25 kc and a 12 v power supply. Custom registers of any size or configuration are also available. These are designed around the TRA-25-10 with packaging densities up to 2000 bits per cu ft at 55 C.

DI-AN Controls, Inc., Dept. ED, 40 Leon St., Boston, Mass.

CIRCLE 70 ON READER-SERVICE CARD

For further information on these products write Dept. 1615

NEW PRODUCTS

Amplifier

1/4 million voltage gain



Model 4300 amplifier provides a voltage gain of 1/4 million, a noise level of less than $0.025 \mu\text{v}$, and an 8-hr drift of less than $0.1 \mu\text{v rms}$ referred to input with a 5 cps galvanometer installed. It employs an optical beam-splitter, twin mutual-load photocells, a cathode-follower output and a galvanometer. Galvanometers are available in natural frequency ranges from 2 to 50 cps. Maximum output voltage is 30 v, peak to peak into an open circuit and 16 v peak to peak into 10 K. Dynamic range is 70 db, noise level to clipping level, and linearity is $\pm 2\%$, noise level to 50% clipping level, based on best straight line.

The Geotechnical Corp., Dept. ED, P. O. Box 28277, Dallas 28, Tex.

CIRCLE 71 ON READER-SERVICE CARD

Feed-Through Connector

One-piece

The type 3006 ConheX connector is a grounded-shield, feed-through, one-piece unit which serves as a cable lock. It holds coaxial cable while grounding the braided conductor to the chassis and passing the insulated center conductor through to the other side. This miniature connector is available in 50, 75, and 95 ohm sizes.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 72 ON READER-SERVICE CARD



SEMICONDUCTOR PROGRESS . . . THROUGH RESEARCH



An artist's conception entitled "Semiconductor Progress . . . through Research" depicts the flow of solid state devices from the raw state to products, to applications of the future. A reproduction of **this painting, suitable for framing, is available on request.**

Literature describing the progress of General Transistor's products, also developed through research, is available, in the form of **technical engineering bulletins, on request.**

See us at IRE Booth #2205 & 2207

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HIGH SPEED
COMPUTER SWITCHING
TRANSISTORS

BULLETIN
G-140A



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TRANSISTORS

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G-150A



GERMANIUM
GENERAL PURPOSE
TRANSISTORS

BULLETIN
G-160



GERMANIUM
BIPOLAR
TRANSISTORS

BULLETIN
G-170





Readout-Recorder

Monitors servo systems

For monitoring any servo system, this two channel readout-recorder provides permanent chart records of servo transmitter angular or displacement data. It can be used for dc to 2 cps recording, servo recording, production testing, inspection, or as a readout for analog computers. Fully automatic, it features zero time flyback. Chart speeds are 5, 10, 20, 40, and 80 in. per hr. Offering infinite scale expansion, the unit has rotating styluses coupled with a four-digit counter which adds and subtracts. It is ruggedly built and meets MIL-E-16400 specifications. Fully transistorized, it weighs 76.5 lb and measures 21.5 x 15.5 x 12.25 in. including shock mounted base.

Brush Instruments, Div. of Clevite Corp., Dept. ED, 37th and Perkins Ave., Cleveland 14, Ohio.

CIRCLE 73 ON READER-SERVICE CARD

Shock Tester

For electronic components

Built to JAN-S-44 and MIL-STD-202A specifications, this tester reproduces the moderate shock that electronic components and instruments receive in mobile and field equipment. The unit has a 0 to 4 lb capacity and handles instruments with diameters to 3.5 in.

Gaynes Engineering Co., Dept. ED, 1642-52 W. Fulton St., Chicago 12, Ill.

CIRCLE 74 ON READER-SERVICE CARD

Shaft Position Encoder

Operates from -65 to +162 F

Shaft position encoder model C-701 provides up to 1024 positions per shaft turn. A sealed unit, it operates at ± 8 g to 1000 cps and under a steady 100 g in the longitudinal axis. It may be used from -65 to +162 F.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 75 ON READER-SERVICE CARD

CIRCLE 76 ON READER-SERVICE CARD

GERMANIUM
BILATERAL
TRANSISTORS

BULLETIN
G-170



GERMANIUM
DRIFT TRANSISTORS

BULLETIN
G-180



GERMANIUM
PHOTOTRANSISTORS

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2N469



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Creative Imagination enabled Benjamin Franklin to orient all the observed electrical phenomena to his own "one fluid" theory—the basis of all our comprehension of electricity today.

At National Co. creative imagination is continuing to broaden our comprehension of the physical universe and apply it to the realization of such new means of communication as Ionospheric scatter systems.

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wave transmission, and missile check-out equipment using microwave and digital techniques.

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National Company, Inc., Malden, Mass.

NEW PRODUCTS

Multiplexer

For 7 analog data channels



Model 3515 standard multiplexer will transmit 7 analog data channels, 1 reference frequency channel, and a full-duplex communications channel. Additional channels are possible. System accuracy is $\pm 1\%$. Output impedance is nominally 600 ohms, and output level is adjustable from 0 to 5 v, peak to peak. From 1 to 8 adjustable and serviceable voltage-controlled fm sub-carrier oscillators may be plugged into the unit. Dimensions of the unit are 8-3/4 x 19 x 15 in., it weighs 30 lb.

The Geotechnical Corp., Dept. ED, P. O. Box 28277, Dallas, Tex.

CIRCLE 78 ON READER-SERVICE CARD

Insulated Terminals

For diversified uses

These molded insulated electronic terminals are available in three types. The first is a series of melamine-insulated feed-through terminals with molded outer threadings which mount directly in a tapped hole without additional hardware. The second is a series of diallyl phthalate insulated terminals with tapped inserts and metal flanges. This type is designed for spot welding or soldering onto a metal shell. The third is a series of printed circuit board receptacles designed for plug-in mounting of transformers, relays, switches, and other assemblies. These units are made of half-hard brass and accommodate standard pin sizes up to 0.125 in.

Lerco Electronics, Inc., Dept. ED, 501 Varney St., Burbank, Calif.

CIRCLE 79 ON READER-SERVICE CARD
← CIRCLE 77 ON READER-SERVICE CARD

Soldering Iron

Pencil size

This low wattage, miniature pencil soldering iron operates from 110 to 120 v without a transformer and has tips which slide on over the heating element so that all the power converted to heat is radiated through the tip rather than wasted in space. The heating element maintains a constant temperature at around 626 F. With 50 meg of insulation between element and tip and the element grounded through a third terminal, this device is especially suited for use around semiconductors. The whole tool weighs less than 1 oz.

M. M. Newman Corp., Dept. ED,
79 Clifton Ave., Marblehead, Mass.

CIRCLE 80 ON READER-SERVICE CARD

Precision Calibrator

For thermocouples

Precision model TC-2 thermocouple calibrator incorporates a platinum and platinum-rhodium thermocouple calibrated by the Bureau of Standards on 12 points for temperatures to 2200 F. For cold junction compensation it uses a constant-temperature thermocouple reference junction. The unit is 40 x 30 x 70 in., and is equipped with a 24 point rotary switch for error free switching from couple to couple. It also has an F-4 furnace 20 x 20 x 36 in.

Arcweld Mfg. Co., Dept. ED,
Grove City, Pa.

CIRCLE 81 ON READER-SERVICE CARD

Nylon Bobbin

Has insulated lead slot

A slot for insulating starting leads is an integral part of this nylon bobbin. This slot eliminates the need for washers or lead taping and makes the bobbin particularly suitable for automatic coil winding.

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

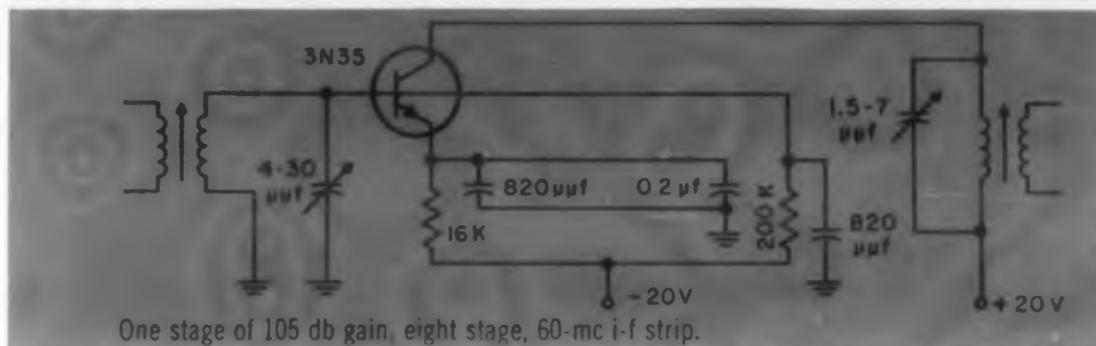
CIRCLE 82 ON READER-SERVICE CARD

CIRCLE 83 ON READER-SERVICE CARD

105 db gain in 60 mc I-F strip



Six-stage, 90 db gain, silicon i-f amplifier designed and built by TI's Apparatus division.



One stage of 105 db gain, eight stage, 60-mc i-f strip.



Write on your company letterhead for 105 db gain, eight stage, 60-mc i-f amplifier applications brochure.

...with TI 3N35 silicon transistors



105 db I-F STRIP CHARACTERISTICS

Bandwidth: 20 mc at 3-db down

Center Frequency: 60 mc

No neutralization required

The high gain of TI 3N35 transistors at high frequencies permits mismatch in the interstage coupling networks to eliminate complicated neutralizing circuitry. You save extra component costs, design with ease and gain added reliability . . . because the mismatch in this application sacrifices only 2.55 db gain per stage!

Designed for your high frequency oscillators, i-f, r-f, and video amplifier circuits, the TI 3N35 features . . . 20-db power gain at 70 mc . . . typical 150-mc alpha cutoff . . . operation to 150°C. These characteristics make transistorization feasible for radar, communications, missile, and other high reliability military applications.

In commercial production at TI for two years, the 3N35 has a product-proved record of high performance and high reliability. These units are in stock now! For immediate delivery, contact your nearby TI distributor for 1-249 quantities at factory prices . . . or call on your nearest TI sales office for production quantities.



FROM THE WORLD'S LARGEST SEMICONDUCTOR PLANT



TEXAS INSTRUMENTS INCORPORATED

SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 • 13500 N. CENTRAL EXPRESSWAY
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LAMBDA'S ALL-TRANSISTOR LINE

Delivered now • Guaranteed for five years

FOUR NEW POWER SUPPLIES



1-AMP and 2-AMP • CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC

0-1 AMP

0-2 AMP

Model LT 1095	\$285
Model LT 1095M (metered)	\$315
Model LT 2095	\$365
Model LT 2095M (metered)	\$395

- Ambient 50° C at full rating.
- High efficiency radiator heat sinks.
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.

- Compact. Only 3½" panel height.
- Short-circuit proof.
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.

- All transistor. No tubes.
- Fast transient response.
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote sensing and DC vernier.

CONDENSED DATA

Voltage Bands ... 0-8, 8-16, 16-24, 24-32 VDC

Line Regulation ... Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.

Load Regulation ... Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input 105-125 VAC, 50-400 CPS

Electrical Overload Protection ... Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

Thermal Overload Protection ... Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.

Size 3½" H x 19" W x 14⅞" D.



New! 1959 CATALOG
NOW AVAILABLE

New 36-page edition contains information and specifications on Lambda's full line of transistor-regulated and tube-regulated power supplies.



LAMBDA ELECTRONICS CORP.

11-11 131 Street, College Point 56, N. Y.

Send for your copy.

NEW PRODUCTS

28 V DC Motor

For aircraft and missile use

Operating at 28 v dc and 69 amp, model D-1000 motor delivers 1.6 hp at 2000 rpm. Output speeds to 25,000 rpm are available in units without a reduction gear box. Of explosion proof construction, the unit incorporates flame quench rings per MIL-E-5272 and a radio noise suppression filter per MIL-E-6181. AND-20000 mounting flanges are standard, but others are available. The motor has a life of over 1500 hr and withstands continuous starting at rated load at 2 sec intervals under severe inrush conditions. Actuator operation is at 260 F ambient at 60,000 ft altitude. Motors for ambient temperatures to 500 F and altitudes of over 200,000 ft are available for missile applications.

Hoover Electric Co., Dept. ED, 2100 S. Stoner Ave., Los Angeles 25, Calif.

CIRCLE 85 ON READER-SERVICE CARD

Polarized Relays

No contact bounce



Bistable type 51A and center stable type 51M polarized relays have 0.7 msec response and no contact bounce. They withstand 4000 shocks at 40 g, and operate from -40 to +70 C. Sensitivity is 1 to 3 amp-turns for the 51M; 2 to 5 amp-turns for the 51A. The units are 2.4 x 1.5 x 0.8 in. and come with 12-pin plug or solder lug bases.

C. P. Clare & Co., Dept. ED, 3101 Pratt Blvd., Chicago 45, Ill.

CIRCLE 86 ON READER-SERVICE CARD

← CIRCLE 84 ON READER-SERVICE CARD

Step-Servo Motors

Size 8



Available with impedances of 50 to 150 ohms, these 3/4 in. diameter size 8 step-servo motors contain two center-tapped stator windings and a permanent magnet rotor. They may be operated through voltage ranges of 20 to 40 v dc and have a holding torque range of from 0.5 to 1 oz-in. Stepping rates of up to 120 pulses per sec are achieved through shaft increments of 45 deg. No mechanical detents are used, assuring a long life limited only by the bearings. The units operate over a temperature range of -55 to +125 C and meet the environmental requirements of MIL-E-5272B and MIL-E-5400.

Induction Motors of California, Dept. ED, 6058 Walker Ave., Maywood, Calif.

CIRCLE 87 ON READER-SERVICE CARD

Coaxial Attenuators

For use with Type N connectors

For applications using Type N connectors, type HFA/N-50 fixed pad coaxial attenuators have a nominal impedance of 52.5 ohms and are usable in a frequency range from dc to 2500 mc. Maximum vswr through this range is 1.2. With an average power rating of 1/2 w, the units are available in standard models for attenuation values of 1, 2, 3, 4, 6, 10, 12, 15, and 20 db.

Applied Research Inc., Dept. ED, 76 S. Bayles Ave., Port Washington, N.Y.

CIRCLE 88 ON READER-SERVICE CARD



Forte! Fortissimo!

...yet how
sweet
the sound!



Generate the full excitement of High-Fidelity!

Specify the new RCA-7027 for your amplifier designs

Stronger and stronger grow the chords, the fervent expression of the artist—yet the sound is sweet, most pleasing to the listener's ear. The Concert Grand makes stringent demands upon high-fidelity amplifiers for *high power and low distortion*. Can your designs meet these demands? They can if you "design around" the RCA-7027!

RCA-7027 is a glass-octal type beam power tube. Two 7027's in Class AB₁, push-pull service with 450 volts on the plate can handle up to 50 watts of audio power with only 1.5 percent distortion. Structural features contributing to the exceptionally high plate dissipation (25 watts) of this compact tube are: button-stem construction, heavy stem leads having high heat conductivity, heavy plate material, radiating fins on control grid, and double base-pin connections for both control grid and screen grid.

Achieve for your hi-fi designs the advantages of high dissipation, exceptionally low distortion, and high power amplification offered by the new RCA-7027. Ask your RCA Field Representative for further details. For technical data, write RCA Commercial Engineering, Section C-18-DE-3, Sommerville, N.J.

RCA Field Offices

EAST: 744 Broad Street
Newark 2, N. J.
HUmboldt 5-3900

MIDWEST: Suite 1154,
Merchandise Mart Plaza
Chicago 54, Illinois
WHitehall 4-2900

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



RADIO CORPORATION OF AMERICA
Electron Tube Division
Harrison, N. J.

Visit the RCA exhibition at the I.R.E. Show, Booths 1602-4-6, 1701-3-5-7.

NEW PRODUCTS

Silicon Rectifier Test Set

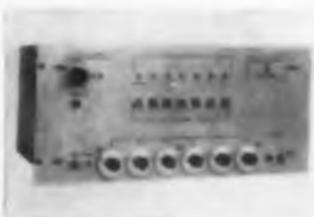
For 1 to 500 amp units



Model 128A silicon rectifier test set is a laboratory and production unit designed specifically to evaluate the dynamic characteristics of silicon rectifiers in accordance with ASESAs recommendations. It employs a simulator circuit which permits selection of any forward current or reverse voltage within its range. The set tests rectifiers with forward current ratings between 1 and 500 amp half-wave, and reverse voltage ratings to 2 kv peak. It is equipped with multi-scale instruments to measure all rectifier parameters and includes plug-in provisions for oscilloscope observation of wave shapes.

Wallson Associates, Inc., Dept. ED, 35 E. Runyon St., Newark 8, N.J.

CIRCLE 89 ON READER-SERVICE CARD



Counter Scanner

Transfers multiple data to one recorder

Operating from staircase voltages produced by up to six counters, the DY-2513 counter scanner automatically transfers the information displayed on each counter to one Hewlett-Packard model 560A digital recorder. It also automatically records preset decimal information manually selected by six decimal dials on the front panel. Readings from the scanned counters are recorded sequentially on adding machine tape with an identifying digit for each source. The unit may be used with the company's counters or with Hewlett-Packard models.

Dymec, Inc., Dept. ED, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE 90 ON READER-SERVICE CARD

The HOTTEST thing in COOLING...



MUFFIN® FAN

Now you can cool economically — less

Unlike conventional or phonograph-motor-assemblies, the MUFFIN® FAN boasts a high air performance of 100 CFM free delivery from a basic package only 4-11/16" square and only 1-1/2" deep while the weight is but 1-1/2 pounds. The completely original aerodynamic design permits operation through a dust filter and tightly packed electronic equipment.

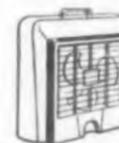
Unbelievably thin . . . entire fan assembly is only 1-1/2" thick! Protrusion into cabinet is 1-1/2" MINUS the panel thickness. The MUFFIN® FAN will mount into wall of cabinet imposing practically no space requirement inside the enclosure.

The MUFFIN® FAN is a completely integrated cooling unit. The propellor and stator assemblies, venturi block, grille

assembly and ingenious all-purpose mounting clips combine to form a *complete* package. The MUFFIN® FAN can be installed in a rectangular cutout in a panel in just seconds. When installed it represents the ultimate in cooling efficiency and a distinct asset to equipment appearance.

In addition, the MUFFIN® FAN provides the following distinct features . . . extremely quiet operation . . . will fit any panel thickness from 1/32" up . . . no capacitor, commutator or slip-ring . . . exclusive no-maintenance motor . . . flow direction quickly and easily changed by turning fan end-for-end . . . all electrical parts including terminal lugs are molded into water-tight shell.

The high performance level of the MUFFIN® FAN together



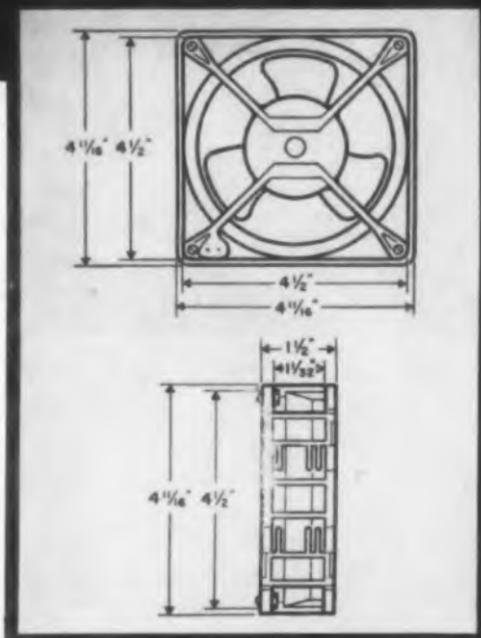
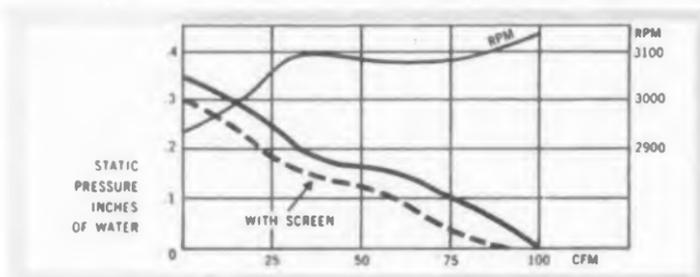
JUST A FEW OF THE MANY APPLICATIONS FOR THE ROTRON MUFFIN® FAN



ACTUAL SIZE

than \$8 in Quantity!

with its extremely compact size and economical cost provides for the first time efficient forced-air cooling in equipments where space or cost limitations previously made cooling prohibitive.



WRITE TODAY FOR COMPLETE TECHNICAL DETAILS TO . . .

ROTRON mfg. co., inc. WOODSTOCK, NEW YORK • ORiole 9-2401

CIRCLE 91 ON READER-SERVICE CARD

Rotary Switch

Has spring locked into switch



A steel alloy spring is built into the index mechanism of the PA-070 switch and it controls the spring return action. Switches with this feature can be supplied as single or double section units, or as single section units with line switch. Up to six positions per section, including the spring return position are available. Spring return can be placed in either the first or last position, and sections are laminated phenolic type PBE per Mil-P-3115, voltage breakdown 1000 v rms.

Centralab, Div. of Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 92 ON READER-SERVICE CARD

Phase Generator

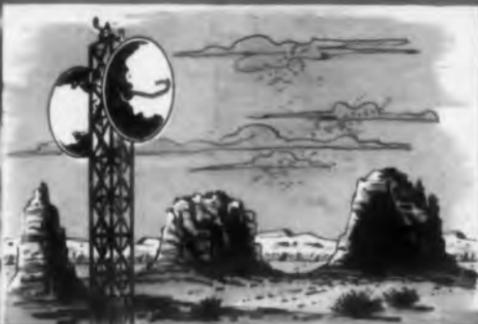
Covers 5 cps to 200 kc



Phase generator model 410 is a combination phase shifter and phase difference generator that covers 5 cps to 200 kc. The addition of an external capacitor extends this range down to 0.1 cps. Accuracy is 0.1 deg over the audio frequency spectrum, decreasing above and below. The unit can be used for the calibration of phase measuring devices, or, with an external phase detector, as a precision phase measuring device.

Dytronics Co., Dept. ED, 78 Sunnyside Lane, Columbus 14, Ohio.

CIRCLE 93 ON READER-SERVICE CARD



Proved
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for
Cross Country
Microwave



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ANTENNAS

This busy metropolitan area is the termination of over 1000 miles of microwave systems, providing reliable communications across town and country for the Western Union Telegraph Company. ANDREW's experience in research, development and manufacturing is the reason why the dependable performance of an ANDREW PS8-37, eight-foot Parabolic antenna was selected for this installation.

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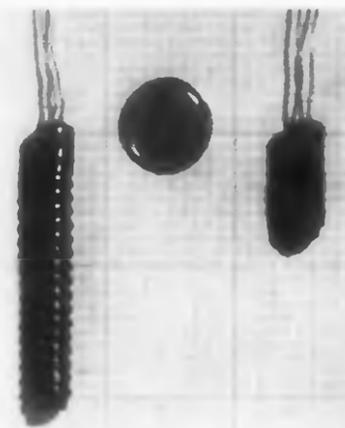
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ANTENNAS • ANTENNA SYSTEMS
TRANSMISSION LINES

NEW PRODUCTS

Miniature Bellows Motor

Works around curves



This miniature, squib-actuated bellows motor is designed for missiles, weapons, and weapons systems. Actuated by as little as 100 ergs at 1.5 v, or 0.3 amp, the motor is capable of providing 10 lb of thrust over a 1 in. minimum stroke within an elapsed time of 1 msec. In addition, the bellows can be guided around a 90 deg curve. The 0.32 in. diameter motor is 1 in. long, functions properly from -65 to +165 F, and withstands 20,000 g shock and acceleration. Shelf life is measurable in years.

Atlas Powder Co., Ordnance Materiel Dept., Dept. ED, Wilmington 99, Del.

CIRCLE 95 ON READER-SERVICE CARD

Transformer

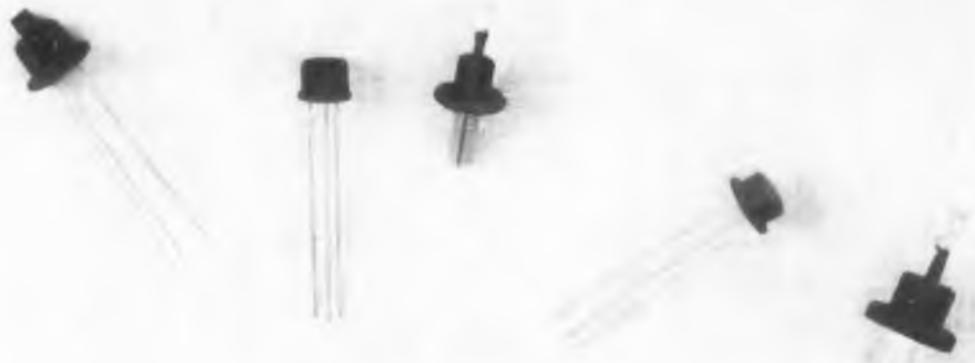
Shell type

The shell type Donut transformer is used for isolating high voltages on filaments and cascaded high voltage power units. The cost of the unit is reduced by the elimination of ceramic bushings, oil, and tank. In comparison with conventional oil tank units, its size and weight are reduced about 40 per cent.

Nothelfer Winding Labs, Inc., Dept. ED, P.O. Box 455 Trenton, N.J.

CIRCLE 96 ON READER-SERVICE CARD
CIRCLE 495 ON READER-SERVICE CARD

◀ CIRCLE 94 ON READER-SERVICE CARD

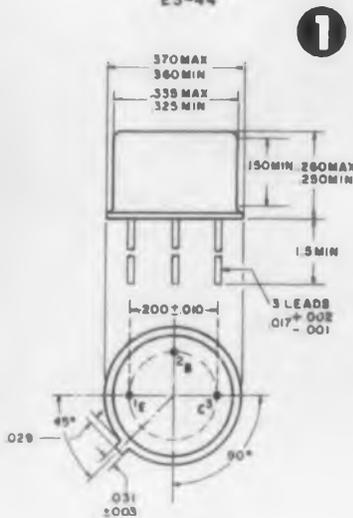


SEMICONDUCTORS

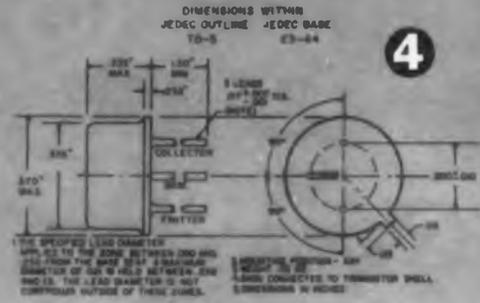
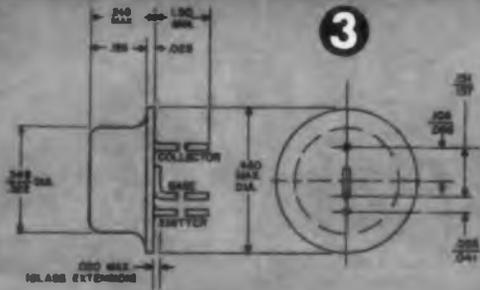
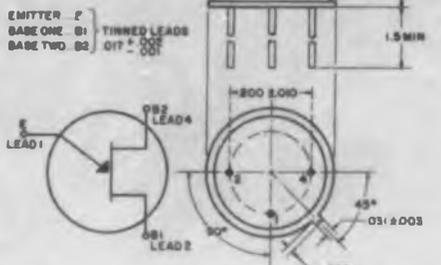
Transistors ● Rectifiers ● Germanium
● Silicon ● Selenium ● Copper Oxide
● Unijunctions ● Controlled Rectifiers
● Fixed-bed Mounting ● USAF ● JAN
● USN ● Low Frequency Audio
and Switching ● High Frequency
Switching ● Low-Medium-High
Current ● High and Low Temperature



DIMENSIONS WITHIN
JEDEC OUTLINE
TO-5
JEDEC BASE
E3-44



DIMENSIONS WITHIN
JEDEC OUTLINE TO-5
JEDEC BASE E3-53



TRANSISTORS Germanium • Silicon • Fixed-Bed Mounting • Unijunctions • Tetrodes • High Frequency Switching • Low Frequency Audio and Switching • USAF

NEW TECHNOLOGY

As a result of recent technology advancements in such areas as product engineering, manufacturing-line processing, and quality-control systeming, General Electric Company again offers you the *avant garde* in present-day transistor quality.

EXAMPLES

PNP low-frequency survival records have been shattered by the accomplishment of one-million unit-hours of life survival with the G-E 2N43A transistor.

Higher gain and improved saturation characteristics have been created for high-frequency switching. This was brought about by G.E. through recent improvements in d-c beta at higher collector currents, made with Types 2N123 and 2N450 transistors.

With a collector current of $1\frac{1}{2}$ μ a max. at 15 volts, G.E.'s germanium NPN high-frequency 2N167 gives an ultimate in I_{CO} . It also has a low collector capacitance of 3 μ mf.

The mechanically rugged golf-club/shotgun-tested ceramic fixed-bed transistor mounting has been expanded, product-wise, beyond the Series 2N489-494 unijunction line, and is now also offered in the NPN high-frequency transistor series (2N332-338).

MILITARY TYPES

G-E quality advances are also exhibited by General Electric's over-all success in supplying to an increasing number of military specifications covering semiconductor products. G-E MIL transistors include the USAF-types 2N43A, 2N44A, and 2N167. The G-E Types 2N123A and 2N396A are certified to meet military specs. (See adjacent rating chart.) For G-E military rectifiers, see next two fold-out pages.

ADDITIONAL INFORMATION

For more-detailed information, please contact your nearest G-E Semiconductor Products District Representative. (See back page.)

	USE	OUTLINE DWG. NO.	TYPE NO.
SILICON	AMPLIFIER AND COMPUTER NPN (Ceramic Fixed-bed Construction)	1	2N332
		1	2N333
		1	2N334
		1	2N335
		1	2N336
		1	2N337
		1	2N338
	UNIUNCTION NPN (Ceramic Fixed-bed Construction)	2	2N489*
		2	2N490*
		2	2N491*
2		2N492*	
2		2N493*	
2		2N494*	
			*A PN Device
GERMANIUM	AUDIO PNP	3	2N43
		3	(USAF) 2N43A Per MIL-T-19500/18
		3	2N44
		3	(USAF) 2N44A Per MIL-T-19500/6
		4	2N524
		4	2N525
		4	2N526*
		4	2N527
			*Also supplied as certified to meet MIL-T-19500/60
GERMANIUM	COMPUTER PNP	5	2N123
		5	2N123A Certified to meet MIL-T-19500/30
		4	2N395
		4	2N396
		4	2N396A Certified to meet MIL-T-19500/64
		4	2N397
		4	2N404
		5	2N450
		5	2N518
		3	2N1056
3	2N1057		
HIGH FREQ. AMPLIFIER NPN	6	2N78	
	6	2N169A	
COMPUTER NPN	6	2N167	
	6	(USAF) 2N167 Per MIL-T-19500/11	
	4	2N634	
	4	2N635	
TETRODE NPN	7	3N36	
	7	3N37	

RECTIFIERS! Fold out next page

RECTIFIERS Germanium • Silicon • High and Low Temperature • Controlled Rectifiers Low-Medium-High Current • JAN • USN • USAF

BASIC RATING CHART

Choose the performance range required for your particular needs from one of the most comprehensive line of rectifiers in the industry. Complete specifications are available through your distributor or G-E Semiconductor Products District Sales Office. Order by JEDEC or G-E Type No.

RECTIFIER CELLS											
JEDEC or G-E Type No.	PIV	Max. I _{DC} at T°C	Max. 1 Cycle (60 cps) Surge	Max. Oper. Temp. °C	Max. Storage Temp. °C	JEDEC or G-E Type No.	PIV	Max. I _{DC} at T°C	Max. 1 Cycle (60 cps) Surge	Max. Oper. Temp. °C	Max. Storage Temp. °C
1N91	100	150ma at 55° amb	25A	95°	85°	1N606A	600	400ma at 100° amb	10A	150°	175°
1N92	200	100ma at 55° amb	25A	95°	85°	1N607	50	800ma at 135° stud	15A	150°	170°
1N93	300	75ma at 55° amb	25A	95°	85°	1N607A	50	800ma at 135° stud	15A	150°	170°
USN1N93	300	75ma at 55° amb	25A	55°	85°	1N608	100	800ma at 135° stud	15A	150°	170°
1N151	100	500ma at 55° amb	25A	95°	85°	1N608A	100	800ma at 135° stud	15A	150°	170°
1N152	200	500ma at 55° amb	25A	95°	85°	1N609	150	800ma at 135° stud	15A	150°	170°
1N153	300	500ma at 55° amb	25A	95°	85°	1N609A	150	800ma at 135° stud	14A	150°	170°
1N158	380	500ma at 55° amb	25A	95°	85°	1N610	200	800ma at 135° stud	15A	150°	170°
1N253	95	1000ma at 135° stud	1A	150°	150°	1N610A	200	800ma at 135° stud	15A	150°	170°
1N254	190	400ma at 135° stud	1.5A	150°	150°	1N611	300	800ma at 135° stud	15A	150°	170°
1N255	380	400ma at 135° stud	1.5A	150°	150°	1N611A	300	800ma at 135° stud	15A	150°	170°
1N256	570	200ma at 135° stud	1.5A	150°	150°	1N612	400	800ma at 135° stud	15A	150°	170°
1N315	100	100ma at 85° amb	5A	85°	95°	1N612A	400	800ma at 135° stud	15A	150°	170°
USAF1N315	100	100ma at 85° amb	5A	85°	100°	1N613	500	600ma at 135° stud	15A	150°	170°
1N332	400	400ma at 150° stud	15A	170°	170°	1N613A	500	600ma at 135° stud	15A	150°	170°
1N333	400	200ma at 150° stud	10A	170°	170°	1N614	600	600ma at 135° stud	15A	150°	170°
1N334	300	400ma at 150° stud	15A	170°	170°	1N614A	600	600ma at 135° stud	15A	150°	170°
1N335	300	200ma at 150° stud	10A	170°	170°	1N1095	500	425ma at 100° amb	15A	150°	175°
1N336	200	400ma at 150° stud	15A	170°	170°	1N1096	600	350ma at 100° amb	15A	150°	175°
1N337	200	200ma at 150° stud	10A	170°	170°	1N1100	100	500ma at 100° amb	15A	165°	175°
1N339	100	400ma at 150° stud	15A	170°	170°	1N1101	200	500ma at 100° amb	15A	165°	175°
1N340	100	200ma at 150° stud	10A	170°	170°	1N1102	300	500ma at 100° amb	15A	165°	175°
1N341	400	400ma at 150° stud	15A	170°	170°	1N1103	400	500ma at 100° amb	15A	165°	175°
1N342	400	200ma at 150° stud	10A	170°	170°	1N1115	100	1.5A at 85° stud	15A	170°	175°
1N343	300	400ma at 150° stud	15A	170°	170°	1N1116	200	1.5A at 85° stud	15A	170°	175°
1N344	300	200ma at 150° stud	10A	170°	170°	1N1117	300	1.5A at 85° stud	15A	170°	175°
1N345	200	400ma at 150° stud	15A	170°	170°	1N1118	400	1.5A at 85° stud	15A	170°	175°
1N346	200	200ma at 150° stud	10A	170°	170°	1N1119	500	1.5A at 85° stud	15A	170°	175°
1N348	100	400ma at 150° stud	15A	170°	170°	1N1120	600	1.5A at 85° stud	15A	170°	175°
1N349	100	200ma at 150° stud	10A	170°	170°	1N1487	100	250ma at 125° amb	15A	140°	175°
1N368	200	100ma at 85° amb	10A	65°	85°	1N1488	200	250ma at 125° amb	15A	140°	175°
1N440	100	300ma at 100° amb	15A	150°	175°	1N1489	300	250ma at 125° amb	15A	140°	175°
1N440B	100	500ma at 100° amb	15A	165°	175°	1N1490	400	250ma at 125° amb	15A	140°	175°
1N441	200	300ma at 100° amb	15A	150°	175°	1N1491	500	250ma at 110° amb	15A	125°	175°
1N441B	200	500ma at 100° amb	15A	165°	175°	1N1492	600	250ma at 95° amb	15A	120°	175°
1N442	300	300ma at 100° amb	15A	150°	175°	1N1692	100	600ma at 100° amb	20A	115°	125°
1N442B	300	500ma at 100° amb	15A	165°	175°	1N1693	200	600ma at 100° amb	20A	115°	125°
1N443	400	300ma at 100° amb	15A	150°	175°	1N1694	300	600ma at 100° amb	20A	115°	125°
1N443B	400	500ma at 100° amb	15A	165°	175°	1N1695	400	600ma at 100° amb	20A	115°	125°
1N444	500	300ma at 100° amb	15A	150°	175°	1N2151	50	25A at 145° stud	300A	200°	200°
1N444B	500	425ma at 100° amb	15A	150°	175°	1N2155	100	25A at 145° stud	300A	200°	200°
1N445	600	300ma at 100° amb	15A	150°	175°	1N2156	200	25A at 145° stud	300A	200°	200°
1N445B	600	350ma at 100° amb	15A	150°	175°	1N2157	300	25A at 145° stud	300A	200°	200°
1N536	50	500ma at 100° amb	15A	165°	175°	1N2158	400	25A at 145° stud	300A	200°	200°
1N537	100	500ma at 100° amb	15A	165°	175°	1N2159	500	25A at 145° stud	300A	200°	200°
1N538	200	500ma at 100° amb	15A	165°	175°	1N2160	600	25A at 145° stud	300A	200°	200°
USAF1N538	200	500ma at 100° amb	15A	150°	175°	4JA60A*	100	70A at 120° stud	900A	200°	200°
1N539	300	500ma at 100° amb	15A	165°	175°	4JA60B*	200	70A at 120° stud	900A	200°	200°
1N540	400	500ma at 100° amb	15A	165°	175°	4JA60C*	300	70A at 120° stud	900A	200°	200°
USAF1N540	400	500ma at 100° amb	15A	150°	175°	4JA60D*	400	70A at 120° stud	900A	200°	200°
1N547	600	500ma at 100° amb	15A	165°	175°	4JA60E*	50	70A at 120° stud	900A	200°	200°
1N550	100	800ma at 135° stud	15A	150°	175°	4JA60F*	150	70A at 120° stud	900A	200°	200°
1N551	200	800ma at 135° stud	15A	150°	175°	4JA60G*	250	70A at 120° stud	900A	200°	200°
1N552	300	800ma at 135° stud	15A	150°	175°	4JA60H*	350	70A at 120° stud	900A	200°	200°
1N553	400	800ma at 135° stud	15A	150°	175°	4JA62A*	100	40A at 120° stud	900A	150°	200°
1N554	500	600ma at 135° stud	15A	150°	175°	4JA62B*	200	40A at 120° stud	900A	150°	200°
1N555	600	600ma at 135° stud	15A	150°	175°	4JA62C*	300	40A at 120° stud	900A	150°	200°
1N560	800	250ma at 100° amb	15A	150°	175°	4JA62D*	400	40A at 120° stud	900A	150°	200°
1N561	1000	250ma at 100° amb	15A	150°	175°	4JA62E*	50	40A at 120° stud	900A	150°	200°
1N562	800	400ma at 100° stud	15A	150°	175°	4JA62F*	150	40A at 120° stud	900A	150°	200°
1N563	1000	400ma at 100° stud	15A	150°	175°	4JA62G*	250	40A at 120° stud	900A	150°	200°
1N599	50	400ma at 100° amb	10A	150°	175°	4JA62H*	350	40A at 120° stud	900A	150°	200°
1N599A	50	400ma at 100° amb	10A	150°	175°	4JA62J*	350	40A at 120° stud	900A	150°	200°
1N600	100	400ma at 100° amb	10A	150°	175°						
1N600A	100	400ma at 100° amb	10A	150°	175°						
1N601	150	400ma at 100° amb	10A	150°	175°						
1N601A	150	400ma at 100° amb	10A	150°	175°						
1N602	200	400ma at 100° amb	10A	150°	175°						
1N602A	200	400ma at 100° amb	10A	150°	175°						
1N603	300	400ma at 100° amb	10A	150°	175°						
1N603A	300	400ma at 100° amb	10A	150°	175°						
1N604	400	400ma at 100° amb	10A	150°	175°						
1N604A	400	400ma at 100° amb	10A	150°	175°						
1N605	500	400ma at 100° amb	10A	150°	175°						
1N605A	500	400ma at 100° amb	10A	150°	175°						
1N606	600	400ma at 100° amb	10A	150°	175°						

*Also available with reversed polarity.

RECTIFIER STACKS

G-E Type	PIV (up to)	Max. I _{DC} at T°C (up to)
4JA211	630 V	6 amps. at 55° amb
4JA411	3360 V	18 amps. at 25° amb
4JA3011	630 V	48 amps. at 55° amb
4JA3611	1800 V	65 amps. at 55° amb
4JA6011	840 V	573 amps. at 35° amb
4JA6211	849 V	430 amps. at 35° amb

SILICON LOW CURRENT



Series: 1N536-540, 1N547, 1N560-561, 1N1095-1096, 1N440 B-445 B, 1N1100-1103, 1N1487-1492, 1N599 A-606 A, 1N1992-1995

Series: 1N536-540, 1N547, 1N1095-96—Provide maximum forward conduction at high operating temperatures (165° C.). **1N440-445, 1N440B-445B**—Similar to 1N536-540 series, but with extremely low reverse current. Ideal for magnetic-amplifier applications. **1N1100-1103**—Similar to 1N440B-445B series. **1N1487-1492**—Essentially the same as 1N536-540 series, except provides lower-cost units for lower-temperature requirements (140° C.). **1N599-600, 1N599A-606A**—Similar to 1N536-540 and 1N440B-445B series, respectively, except for somewhat lower forward-current ratings. **1N1992-1995**—Provides lower current and temperature operation (115° C.) than any of above series—very economical.

Series: 1N1115-1120, 1N253-256, 1N550-555, 1N332-349, 1N607 A-614 A, 1N562-563



Series: 1N1115-1120—Available for stud mounting direct to chassis, or finned. Similar, in characteristics, to 1N536-540 lead-mounted series. Provide maximum forward conduction at high operating temperatures. **1N253-256**—High power-handling ability. Primarily for power supply and magnetic-amplifier applications. Type 1N256 meets JAN spec. **1N550-555**—Similar to 1N440B series, except for stud mounting. Extremely low reverse current, particularly suited for magnetic-amplifier applications. **1N332-349**—Industry-popular series. For applications requiring high reliability at moderate currents operating up to 170° C. **1N607-614, 1N607A-614A**—Another widely-used industrial line. Ideal for applications requiring high currents at up to 150° C.



4JA411 Series

4JA411 Stacks: Combine high temperature operation (up to 150° C.) with increased ratings (up to 18 amps d-c). Hundreds of stack combinations to meet a variety of circuit conditions. High efficiency plus excellent regulation.

POTTED RECTIFIER CIRCUITS



Series: 4JA221 germanium, 4JA421 silicon

4JA220-221, 4JA420-421 Series: Mounted in standard eight-pin tube base (4JA220-420 Series) or in rectangular design with solder lug connections (4JA221-421 Series). Available in a large number of circuit configurations. One to 20 cells may be potted in a single circuit. Individual cell specifications determine ratings. 4JA220-221 Series utilize germanium 1N91-93 cells. 4JA420-421 Series utilize silicon 1N536-540, 1N1095-1096 and 1N1487-1492 cells. (See BASIC RECTIFIER-CELL LISTING at left.)

SILICON MEDIUM CURRENT

Series: 1N2184-2186



1N2184-2186 Series: First series of silicon medium current rectifiers to be made free from thermal fatigue. Designed for individual cell applications in the 2-to-25 amp range. High junction-temperature ratings. Extremely low forward voltage drop and thermal impedance. May be mounted directly, or electrically insulated from heat sink with mica-washer mounting kit provided with each unit.



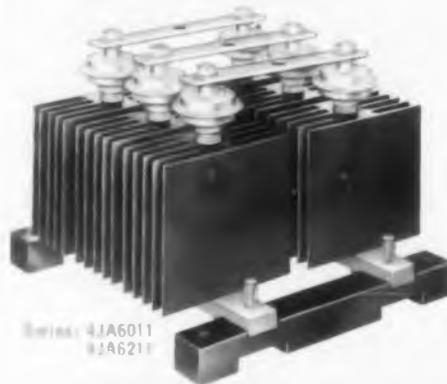
4JA3611 Series

4JA3611 Stacks: Provide a wide-range of power applications with d-c outputs up to 65 amps.

SILICON HIGH CURRENT



Series: 4JA60, 4JA61, 4JA62, 4JA63



Series: 4JA6011, 4JA6211

4JA60, 4JA61, 4JA62, 4JA63 Series: Large-area junction stud-mounted rectifiers. Operating temperatures to 200° C. D-c outputs as high as 85 amps per rectifying element. Lower-cost 4JA62, 4JA63 units are for applications which do not require the full-current ratings of 4JA60 line. Reverse polarities provided in 4JA61 and 4JA63 units. **4JA6011, 4JA6211 Stacks:** Hundreds of combinations available in various circuit configurations. D-c outputs up to 573 amps. The 4JA6211 series for lower-current, lower-cost operation.

SILICON CONTROLLED RECTIFIER

CONTROLLED RECTIFIER RATING CHART

G-E Type No.	PIV* and V _{BO}	Max. I _{DC} at Temp. °C.	Max. Temp. °C.		Max. Reg'd Gate Signal
			Oper.	Storage	
C35U	25	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35F	50	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35A	100	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35G	150	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35B	200	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35H	250	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35C	300	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.
C35D	400	Up to 16A @ 87° C. stud	125	150	3V, 40ma @ 25° C.

*Max. PIV and Min. V_{BO}

GERMANIUM LOW CURRENT



Series: 1N91-93 USN, 1N151-152, 1N158, 1N315 USAF, 1N388

Series 1N91-93, USN193—Alloyed-junction types combining very low forward resistance with high back resistance to give almost 100% efficiency. 1N93 is commercial version of U.S. Navy MIL spec. rectifier—the G-E USN193. **1N151-153, 1N158**—Single- and two-fin versions of 1N91-93 series cells. **1N316, USAF1N316**—Designed for high operating temp. (to 85° C.) and low reverse current. **USAF1N315** meets A.F. spec, MIL-E-1/1088. **1N388**—Features a very low reverse current at a high d-c reverse voltage. For magnetic-amplifier applications.



4JA211 Series

4JA211 Stacks: The industry's most widely-used semiconductor rectifier series. Hundreds of thousands in use. May be arranged in stacks up to 12 fins to produce more than 160 various circuit configurations. Small, lightweight, excellent regulation.

GERMANIUM MEDIUM CURRENT



Single-Fin Mounting
4JA3011 Series

4JA3011 Series: For general-purpose power supplies, control devices, blocking circuits, and many other applications. Extremely low power dissipation and forward voltage drop provide excellent regulation and efficiency. Available in stacks up to 12 fins, providing ratings in thousands of watts, depending upon the circuit design, with operation to 85° C. Also, available in single-fin mounting. Transient PIV's up to 600 volts per cell.



RECTIFIERS Selenium Copper Oxide • Miniature- Intermediate-Large Stacks Vac-u-Sel • High Efficiency Low Voltage

*Registered Trademark of General Electric Co.

General Electric Company's *Vac-u-Sel* rectifiers are produced through the unique *spherical vacuum-evaporation process*—the quality-advancement pioneered in this country by G.E. Briefly, the vacuum-evaporation process makes it possible to closely control the thickness of the selenium layers to satisfy varying requirements, and to obtain a pure, more even deposition of selenium over the entire cell surface.

VOLTAGES AND CELL SIZES

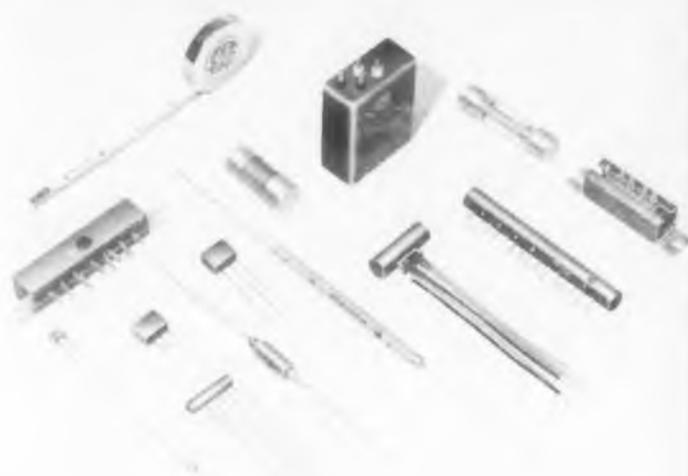
G-E *Vac-u-Sel* rectifiers are available in cells of 26, 36 and 45 volts (rms), and in cell sizes up to two inches square. Larger sized cells are available in the 26- and 36-volt ranges. Eighteen-volt cells are available as off-standard units in all cell sizes.

FINISHES AND MOUNTINGS

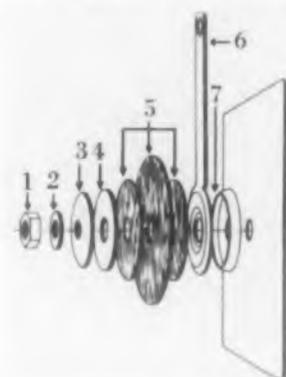
Vac-u-Sel rectifier stacks are supplied with 3 basic finishes: *standard commercial, heavy duty, and military*. Selected cells are stud mounted, eyelet and tube mounted, oil immersed or embedded.

MINIATURE CELLS

Minatures (cells up to $1\frac{1}{2}$ " diameter) have no center mounting hole and are mounted without spacer washers, assuring compact assemblies.



TYPICAL MINIATURE *Vac-u-Sel* RECTIFIERS



FEWER PARTS—improved G-E Cup-Washer Assembly consists of (1) Nut, (2) Metal Washer, (3) Spring Washer, (4) Pressure Washer, (5) Insulating Washers, (6) Terminal, (7) Cup Washer.

COPPER OXIDE RECTIFIERS

General Electric copper-oxide rectifier stacks operate as efficient, economical devices for converting a-c to d-c. They are particularly ideal for such applications as:

- | | |
|------------------------|-----------------------------------|
| Blocking | Circuit breakers |
| Magnetizing | High-speed relays |
| Electrolytic reduction | Electroplating |
| Polarizing relays | Telephone and telegraph equipment |
| Metering | |

Headquarters
General Electric Company
Electronics Park
Syracuse, N.Y.
GRanite 6-4411

For more information, contact your nearest G-E Semiconductor Products District Sales Representative

TRANSISTORS

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DEcatur 2-7120

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General Electric Co.
3800 N. Milwaukee Ave.
Chicago, Ill.
SPring 7-1600

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A. B. DALL
General Electric Co.
200 Main Ave.
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GRegory 3-6387

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Harrison 2-2649
GRanite 6-4411 Ext. 2305

RECTIFIERS

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Washington 5, D.C.
EExecutive 3-3600

R. E. BERRY | General Electric Co.
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R. W. OLSEN | General Electric Co.
442 Peninsular Ave.
San Mateo, Calif.
DIamond 2-7201

E. W. HOOKWAY, JR. | General Electric Co.
2111 So. Green Road
Cleveland 21, Ohio
EVergreen 2-0680

H. W. GEBHARDT | General Electric Co.
11840 W. Olympic Blvd.
Los Angeles, Calif.
GRanite 9-7765

G. R. CURTISS | General Electric Co.
Electronics Park
Syracuse, N.Y.
GRanite 6-4411
Ext. 2174

GENERAL  ELECTRIC

SEMICONDUCTOR PRODUCTS DEPARTMENT

FLIGHT CONTROLS

Expanding the Frontiers of Space Technology



Transistorizing missile flight control systems by Lockheed scientists has meant significant reductions in weight and space requirements.

Flight Controls offers one of the most challenging areas of work at Lockheed's Missiles and Space Division.

From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems. Rapid progress is being made in this field to advance the state of the art in important missile and spacecraft projects under development at Lockheed.

Flight controls programs include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment, and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

In the flight controls simulation laboratory, mathematical representations of elements in a control system are replaced one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems designs.

Lockheed Missiles and Space Division is weapons systems manager for such major, long-term projects as the Navy Polaris FBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7; and other important research and development programs.

Scientists and engineers desiring rewarding work with a company whose programs reach far into the future are invited to write: Research and Development Staff, Dept. C2-21, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in East or Midwest, offices are maintained at Suite 745, 405 Lexington Avenue, New York 17, N.Y. and at Suite 300, 840 N. Michigan Avenue, Chicago 11, Ill.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."

NATIONAL MISSILE INDUSTRY
CONFERENCE AWARD

Pre-flight check-out on final assembly on X-7 missile. The X-7 holds free-world's speed and altitude records for air breathing missiles.



One of Lockheed's test stands with dynamic thrust mount to simulate flight environment.

Lockheed / MISSILES AND SPACE DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA - ALAMOGORDO, NEW MEXICO

NEW PRODUCTS

Strain Gage Plotters

High speed



High speed strain gage plotters 220 and 221, designed for plotting structural, engine load, and other tests, can scan and record up to 20 channels per sec and plot up to 96 channels. They automatically plot individual graphs for each channel while a test is in progress. There are three zero positions per channel, separate range selectors, and separate gage factor selectors. Switching is accomplished by heavy duty, large contact, low noise, rotary type multideck switches. Positive gearing to the chart drive insures synchronization between the chart graphs and their particular input channels. The units can be modified for millivolt inputs, such as thermocouples, for use on temperature period tests.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 97 ON READER-SERVICE CARD



Reversible Motors

1/125 hp

Series M-105 reversible motors are rated at 1/75 hp for intermittent duty or 1/125 hp for continuous duty. The various models have ac or 6 to 48 v dc inputs. They are 1-3/4 in. in diameter and 3 in. long.

Carter Motor Co., Dept. ED, 2764A W. George St., Chicago 18, Ill.

CIRCLE 98 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.

Mach = 5.0 Run no. 58
P₀ = 60 psia

5 in./sec

Deflection 1 in./sec

Trace Interruption

Atten. = 150

TIME

Trace Interruption

60 ~ Time Mark

TORQUE

Atten. = 70

This is a record of leadership

Honeywell 906.1 Visicorder record, actual size. Note longitudinal grid lines and trace identification interruptions.



These studies of aerodynamic damping coefficients on an airframe were made by engineers at ARO, Inc. They were conducted in the Gas Dynamics Facility at the U.S.A.F.'s Arnold Engineering Development Center, Tullahoma, Tennessee, wind tunnel center of the Air Research and Development Command. The studies were directly recorded on a Honeywell 906-A Visicorder.

The problem: To measure damping-in-pitch derivatives for a clipped-delta-wing-body configuration over a Mach number range of 2.0 to 5.0 so that these measurements could be compared with the Mach number trend predicted by theory.

The set-up: A model of the delta-wing body, mounted

on its cross-flexure pivot support, was forced to oscillate through a linkage by an electro-magnetic shaker. Resistance strain gauges were bonded to the input torque member and to one of the pivot supports. These gauges supplied torque and displacement signals through a carrier amplifier to two galvanometers in the Visicorder. An oscillator, driving a third galvanometer, established a time base for the oscillogram.

The values discovered through this forced-oscillation balance system experiment showed some discrepancies from values predicted by theory, because the theory pertained to simpler bodies than that used in the tests. The experiments provided a new set of data which will result in more accurate predictions for future design.

in aerodynamic research



Z. A. Woodard, Jr., ARO, Incorporated, instrument technician, operates the Visicorder in the measurement of aerodynamic damping coefficients.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

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

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

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell

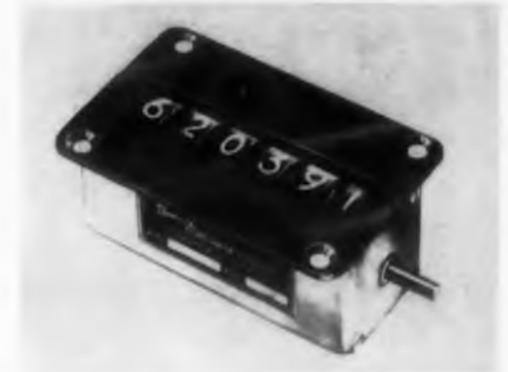


Industrial Products Group

CIRCLE 106 ON READER-SERVICE CARD

Mechanical Counter

Uses planetary gear



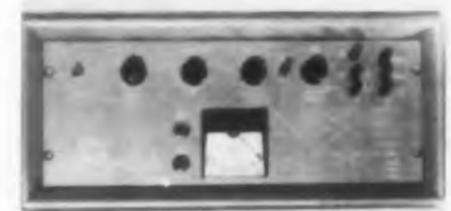
Using a planetary gear drive to rotate the numerals, the PlanetGear mechanical counter can make 10,000 counts per min. The quick transfer of numbers is accomplished by means of a nylon cam and a roller compensating device, which moves the planetary gear. There is no possibility of skips or misses since the gears are always in mesh. The torque required to turn the drums is uniformly low, and any device capable of turning the first numeral drum is capable of driving the entire counter reliably, as there are no peak load points in the counter operation. The planetary gears make it possible to drive the counting wheels at continuous speeds of 1000 rpm, and life tests have been run in excess of 100 million counts. The bearings, gears, cams, and rollers are nylon, and the main shaft is centerless ground, polished stainless steel. The 5/16 in. numbers conform to military specification MIL-S-33558.

Haydon Instrument Co., Dept. ED, 165 W. Liberty St., Waterbury 20, Conn.

CIRCLE 107 ON READER-SERVICE CARD

Magnetic Core Tester

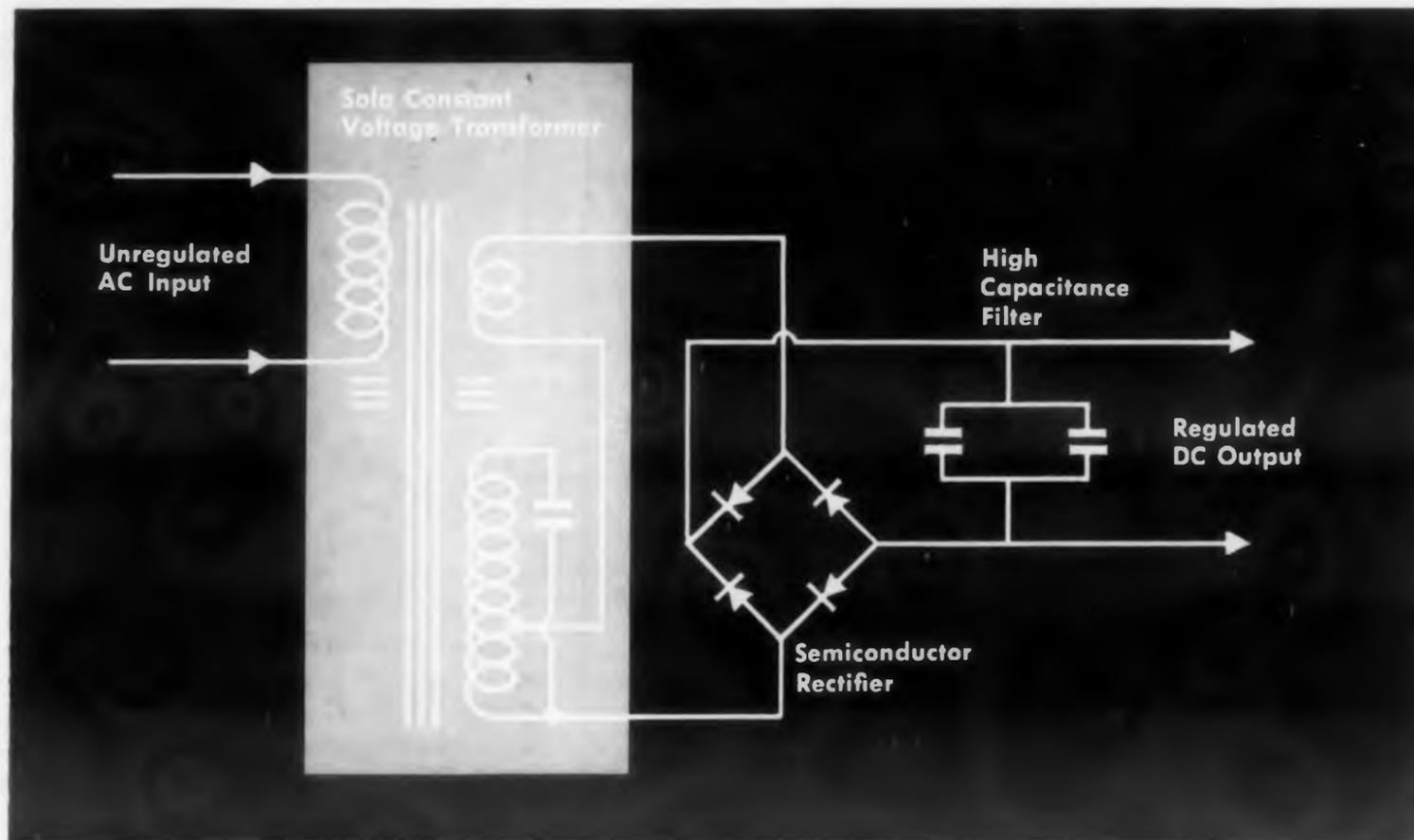
Handles switching time to 35 msec



With model RK-100, an instrument for testing tape wound cores, ferrite cores, and relays, two units may be operated synchronously for core plane and coincident current testing. The unit monitors tolerances on core parameters and determines drive requirements, switching times, and voltage and disturbance output. It provides 0.1 ma to 1 amp current pulses with 0.1 μ sec to 1 msec rise time and handles switching times to 35 msec.

Arkay Engineering, Inc., Dept. ED, 225 Santa Monica Blvd., Santa Monica, Calif.

CIRCLE 108 ON READER-SERVICE CARD



Inherently simple design of the Sola Constant Voltage DC Power Supply is shown by this general schematic diagram. Its basic simplicity of design and its reliable components make this regulated power supply rugged and dependable, both electrically and mechanically.

Just three reliable components make Sola's regulated dc power supply simple and rugged

Sola Electric Co. (an outfit where complexity-for-its-own sake wins no promotions) has combined three simple, reliable components — a special type of Sola Constant Voltage Transformer, a semiconductor rectifier, and a high-capacitance filter — to make a regulated dc power supply that is rugged and dependable.

Electrical characteristics of the special CV transformer maximize most of the advantages of the semiconductor rectifier and the capacitive filter, while virtually eliminating their disadvantages. This particularly happy combination of components gives output in the ampere range, regulation within $\pm 1\%$ even under $\pm 10\%$ line voltage variation, and ripple less than 1% rms. It handles variable, pulse, or high-amperage loads without a second thought . . . it even puts up with dead shorts.

Size? Maintenance? Cost? Sola's simplicity drive permits the units to occupy minimum space, to do without movable or expendable parts, and to sell at a reasonable price.

Simple construction, reliability and compactness are benefits common to the entire line of regulated dc power supplies. Sola designs and produces hundreds of ratings to meet widely varying electrical and mechanical requirements of equipment manufacturers; and also produces complete power supply systems to specification. It is set up to handle specific needs in production quantities. Your nearby sales engineer can supply all the facts.

In addition to custom service, Sola currently stocks six fixed-output models ranging from 24 volts at six amps to 250 volts at one amp. Six adjustable models are stocked, too.

For complete data write for Bulletin 31C-CV-235

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.



CIRCLE 109 ON READER-SERVICE CARD

NEW PRODUCTS

Panel Switch Light

1-3/8 in. long



This dpdt double break switch-light combination has an independent 28 v lamp circuit for panel mounting. It is supplied in momentary snap action or push-on push-off snap action with contacts rated at 28 v dc, 5 amp, inductive. Operating pressure is approximately 4 lb with 5/32 in. overall travel. The unit has a 5/8 in. mounting thread, a 7/8 in. case diameter, and a 1-3/8 in. length from mounting surface to and including terminals.

Pendar, Inc., Switch Div., Dept. ED, P.O. Box 3355, Van Nuys, Calif.

CIRCLE 110 ON READER-SERVICE CARD

Servo Motors

Size 10 and 11



These size 10 and 11 servo motors are available for 26, 55, or 115 v ac, 400 cps operation. They are 6 pole units with a stall torque of 0.6 oz-in. minimum and a no load speed of 6500 rpm. Rotor inertia is 1 g cm^2 , and acceleration at stall is $42,000 \text{ radians per sec}^2$. The units are 1-11/32 in. long and designed to operate in ambient temperatures from -65 to $+125 \text{ C}$. Special voltage requirements are available on order.

Western Gear Corp., Electro Products Div. Dept. ED, 132 W. Colorado St., Pasadena, Calif.

CIRCLE 111 ON READER-SERVICE CARD

FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS

A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS

Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) DESIGN ANALYSIS Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) DEVELOPMENT Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

4. PROPOSAL AND QUALTEST ENGINEER For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:
Mr. G. D. Bradley

THE GARRETT CORPORATION

9851 S. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS:

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AiResearch Manufacturing—Phoenix
AiResearch Industrial
Air Cruisers • Airsupply
Aero Engineering
AiResearch Aviation Service

CIRCLE 870 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Advanced electro-mechanical systems

AiResearch Spoiler Servo Control System for Canadair's CL-28 and CL-44



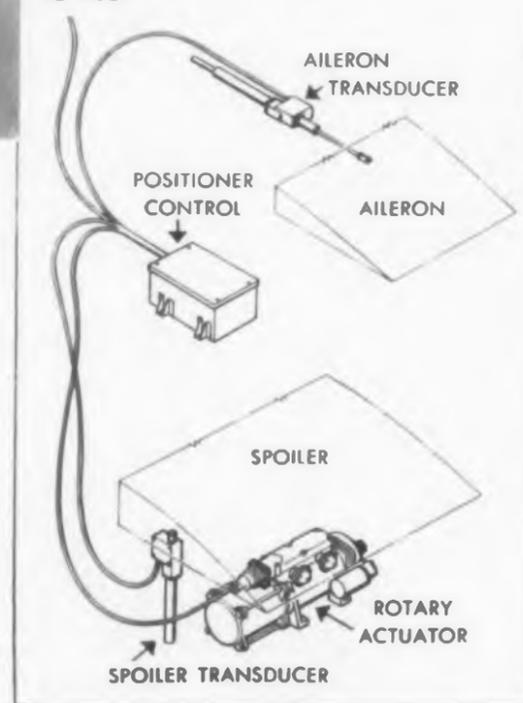
A substantial increase in aileron effectiveness is achieved by the AiResearch Spoiler Servo Control System which augments the function of the aileron by increasing the rate of roll of the aircraft. Full spoiler surface travel is achieved in 0.5 seconds by electromagnetic clutching of the 4 H.P. power servo.

The added control surface of the Spoiler Control Servo System operates on the inboard side of each aileron. This AiResearch electro-mechanical system automatically synchronizes the spoiler control surface to move simultaneously with the aileron by utilizing a magnetic amplifier and position transducers in the closed loop servo system.

This new Spoiler Control System is but one of the many types of electro-mechanical systems developed and manufactured by AiResearch. Other recent examples include radar antenna positioning equipment, magnetron and Klystron tuning devices, and safe-arm mechanisms for missile igniting.

The company's more than 20 years of experience in the development and manufacture of electro-mechanical equipment extends into aircraft, ground handling, ordnance and missile systems of all types. AiResearch capability and system responsibility can meet your specific electro-mechanical requirements. Your inquiries are invited.

TO PILOT



THE GARRETT CORPORATION
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 268 ON READER-SERVICE CARD

Are you a victim of SPECIPHOBIA?*



* That martyred, hands-tied feeling you get when your specification is loaded.

Did your contract specify that you use unproved devices instead of tubes? For a reason? Or just because something "new" was available? (Which meant derating your whole circuit just to get the performance you *know* tubes will give!) Well, mister designer, you are a victim of speciphobia!

Don't feel bad. Lots of circuit designers are in the same quandary. But why not do something about it? Summon your manly courage, and go ask this specifier whether he wants novelty (at an awful price), or:

... known performance, known reliability, safe design, good logistics, systems flexibility, and economy (all of which you can prove). In short... a design that doesn't apologize!

Then, when he innocently asks "... Why of course. How can you get this?", just tell him to get out of orbit and specify tubes. As a matter of fact, *General Electric 5-Star Receiving Tubes*. And tell him that you'll apply them with all your up-to-date know how on how to care for an electronic circuit.

If he's still skeptical, just ask him to come see us. We've got some data we'd be glad to show, and match with anything he's got. And while we're at it, don't forget to have us show him the tubes we're working on for the circuits you'll be designing next. Want *small size*? Well, you ain't seen nothin' yet! Receiving Tube Dept., Owensboro, Ky.

P. S. Come on over to Booth 2908 at the IRE Show, and we'll show you tubes doing things that make other devices blush. Look for the 7-foot tube!

Progress Is Our Most Important Product

GENERAL  ELECTRIC

2-411-102

NEW PRODUCTS

Altitude Test Chamber

Has low loading level



This self-contained altitude test chamber has a low loading level to simplify the testing of heavy units or components. The bottom of the 64 cu ft test space is less than desk height, or 29 in. from the floor. The low test area also enables the operator to reach the back of the test space more readily. The chamber provides temperatures from -100 to $+300$ F, simulated altitudes to 150,000 ft, and relative humidity from 20 to 95%. It has all necessary instrumentation for completely automatic operation and recording.

The American Research Corp., Dept. ED, Farmington, Conn.

CIRCLE 113 ON READER-SERVICE CARD

Miniature Lowpass Filters

Have 50 db attenuation

These small filters have 50 db minimum attenuation at the critical frequency. Attenuation of 25 db or more is maintained up to ten times this specified frequency. The pass-band insertion loss falls to 3 db at 0.01 times the maximum attenuation frequency. Encapsulated in epoxy resin for stability in environmental extremes, the units are 13/16 in. in diameter and 1-1/2 in. high. Mounting is accomplished with three no. 18 solid copper tinned leads. Rejection frequencies down to 20 cps may be specified.

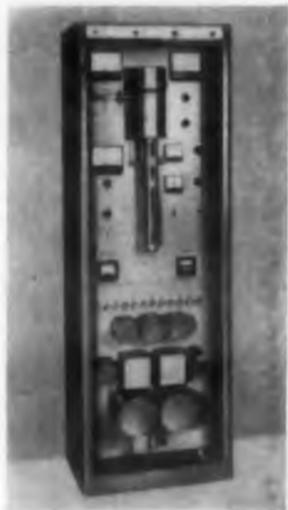
T T Electronics, Inc., Dept. ED P.O. Box 180, Culver City, Calif.

CIRCLE 114 ON READER-SERVICE CARD

◀ CIRCLE 112 ON READER-SERVICE CARD

UHF Broadband Amplifier

Provides 100 w output



When driven by a suitable signal, type RA-7 broadband amplifier is capable of providing an output power of 100 w or more in the 470 to 890 mc frequency range. The unit has a variable bandwidth, full metering, and a self-contained power supply and provides a method for adjusting the position of the feed point along the cathode line to insure proper drive impedance and low vswr. Operating as a translator amplifier, the RA-7 makes television services possible for communities shielded from originating TV stations and beyond the range of 10 w translators.

Adler Electronics, Inc., Dept. ED, 1 LeFevre Lane, New Rochelle, N.Y.

CIRCLE 115 ON READER-SERVICE CARD

Underwater TV Camera Cable

Has 0.99 in. diameter

This underwater TV camera cable is composed of two RG-59/U coaxial cables, two insulated and jacketed 7-wire control cable groups, and two 4-wire shielded control cables. A polyvinylchloride belt over the assembly is extruded to fill all voids, and the whole is wrapped in cadmium bronze shielding braid which is in turn covered by a lead cured neoprene sheath. The cable diameter is 0.99 in.

Rome Cable Corp., Dept. ED, Rome, N.Y.

CIRCLE 116 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD

this is Cable Systematics

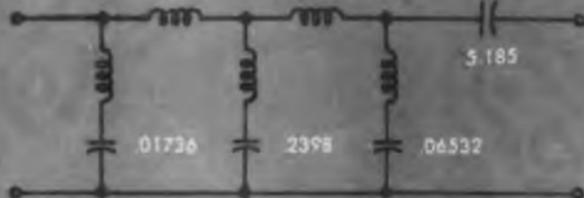


Advanced cabling techniques developed by Robertshaw provide the reliability demanded by today's complex missile site requirements. Whether your needs involve short lengths of custom multi-conductor cable or elaborate electronic cable assemblies, Robertshaw's progressive approach to cable design and fabrication mean *faster delivery* and *less cost*. Success of these concepts is being evidenced daily on the launching pads at Canaveral and Vandenberg. They can be adapted to help solve your cable assignment. Write for Cable Facility Brochure . . . **Aeronautical & Instrument Division, Robertshaw-Fulton Controls Company, Santa Ana Freeway at Euclid Ave., Anaheim, Calif.**



Would precise capacitance values at vital circuit points provide you with savings in

- Design Time
- Trimmer Costs
- Assembly Costs
- Space Consumption



Would 1% or closer tolerances at the same points heighten circuit reliability? Assure optimum slope of response curve? Eliminate trimmers?

Would an unusual case size or case configuration ease your "black box" packaging? Would it minimize components?

EFCON's prime stock-in-trade lies in providing precise capacitance values for precise circuit applications . . . offering the closest tolerances in the industry . . . the highest reliability.

Now you no longer need compromise circuit design because of unusual requirements in capacitance value, tolerance, case size or configuration. EFCON specializes in filling your "oddball" design needs in single units or by the thousand . . . nonstandard units costing no more than standard units . . . all with the extreme environmental capabilities of polystyrene or mylar.[®]



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WRITE FOR SPECIFICATION BULLETIN AT101 SHOWING STOCK CASE STYLES, DIMENSIONS, NOMENCLATURE DESIGNATIONS AND LISTING THE ELECTRICAL CHARACTERISTICS OF EFCON POLYSTYRENE AND MYLAR[®] CAPACITORS

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EFCON

682 BROADWAY NEW YORK 12, N. Y.

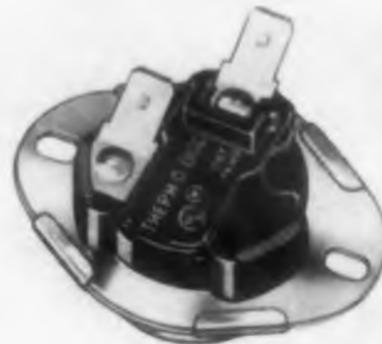
INDUSTRY'S PRIME SOURCE OF CLOSE TOLERANCE AND/OR NONSTANDARD VALUE CAPACITORS

CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Thermostats

For limit protection



For operating temperatures up to 350 F., series H-T thermostats have a high electrical rating and occupy a minimum of space. For limit protection, temperature control, or fan control, they can be used in central heating furnaces, air conditioning and ventilating equipment, aircraft equipment, and miscellaneous devices. The snap action units are designed for both spst and spdt operation and are available with normally open or normally closed contacts. They have surface or watertight mountings and enclosed or exposed bimetal discs and come in a choice of terminals that include inclined blades, vertical blades, or screw types. Temperature calibration is factory preset and nonadjustable.

Therm-O-Disc, Inc., Dept. ED, Mansfield, Ohio.

CIRCLE 119 ON READER-SERVICE CARD



Flat Cable

Voltage ratings from 300 to 3000 v rms

Designed to customer specifications, Turbo Ribbon Cable may be assembled from single conductors, twisted and jacketed pairs, triples, coaxial cables, shielded and jacketed wires, or any combination of these. Conductor sizes are 28 to 8 AWG, stranded or solid, and voltage ratings are 300 to 3000 v, rms. Widths up to 2 in. are available.

The William Brand & Co., Inc., Dept. ED, Willimantic, Conn.

CIRCLE 120 ON READER-SERVICE CARD

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Instructions
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Sets forth the basic principles and techniques of technical writing for handy reference or serious study

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NAME _____

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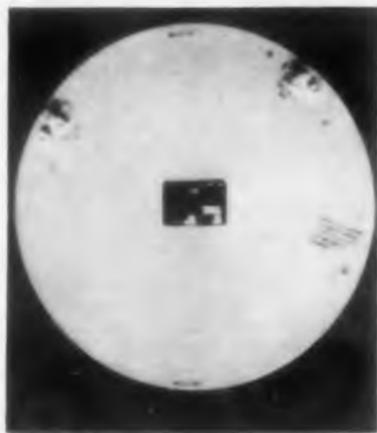
CITY _____

STATE _____

CIRCLE 121 ON READER-SERVICE CARD

Ultrasonic Delay Line

Has 10 mc bandwidth



This ultrasonic delay line has: a delay of 900 μ sec; an average maximum secondary level of over 70 db below the main delay; triple travel signals of 60 db; and direct feed through over 80 db. It has a 10 mc bandwidth centered at 40 mc. The bandwidth to the 3 db points is 22 mc. Insertion loss into 50 ohms is 55 db with a capacity of 60 μ f at input and output. The unit is designed with a mid-transducer tap for optimizing matching network problems. It weighs under 7 lb and is supplied in a 14-1/2 in. diameter evacuated aluminum case 1 in. deep.

Arenberg Ultrasonic Lab, Inc., Dept. ED, 94 Green St., Jamaica Plain 30, Mass.

CIRCLE 122 ON READER-SERVICE CARD

Phenolic Laminate

Shock-resistant

A glass-reinforced XXXP laminate, NELCO 230-R equals or exceeds the requirements of MIL P-3115-B, Type PBE-P grade. Capable of being cold-punched in thicknesses to 3/32 in., it has low moisture absorption, good electrical characteristics, and an impact strength eight times the standard NEMA requirement. It is furnished plain or copper-clad in thicknesses from 0.032 to 1 in. Standard sheet sizes are from 36 x 42 in. to 36 x 72 in.

New England Laminates Co., Inc., Dept. ED, 481 Canal St., Stamford, Conn.

CIRCLE 123 ON READER-SERVICE CARD

CIRCLE 124 ON READER-SERVICE CARD >

THE ONLY ULTRASONIC CLEANERS WITH A CHOICE OF TRANSDUCER POWERS!

ACOUSTICA ULTRASONIC GENERAL PURPOSE CLEANERS



ACOUSTICA ULTRASONIC HEAVY DUTY CLEANERS



The transducer is the heart of the ultrasonic cleaner!



An ultrasonic cleaner is no better than its transducer. Acoustica transducers have proved their superiority. The new low-frequency Multipower transducer used in the Acoustica heavy duty industrial line produces the most effective cleaning field known today. It represents a major break-through in ultrasonic technology.

All prices include tank and matching generator

Choose the correct cleaner for your purpose!

In determining which ultrasonic cleaning unit to buy, remember that all ultrasonic cleaning systems are not alike. The principle is the same, but the results are not. *The power and frequency of the transducer* are the key factors in determining the success or failure of applying ultrasonic energy for solving industry's cleaning problems. Acoustica research has developed *two* types of transducers for its ultrasonic cleaning units—the *General Purpose* 40kc barium titanate transducer and the *Multipower* heavy duty 20kc transducer. Expert Acoustica engineers are ready to advise you which type will better suit your needs. Mail the coupon below for information—there is no obligation.

Immediate Delivery From Stock

acoustica
LEADER IN RESEARCH AND DEVELOPMENT OF ULTRASONIC SYSTEMS

Acoustica Associates, Inc., 26 Windsor Ave., Mineola, N. Y., Pioneer 7-7900
10400 Aviation Blvd., Los Angeles, Calif., ORchard 0-3393, SPring 6-0511

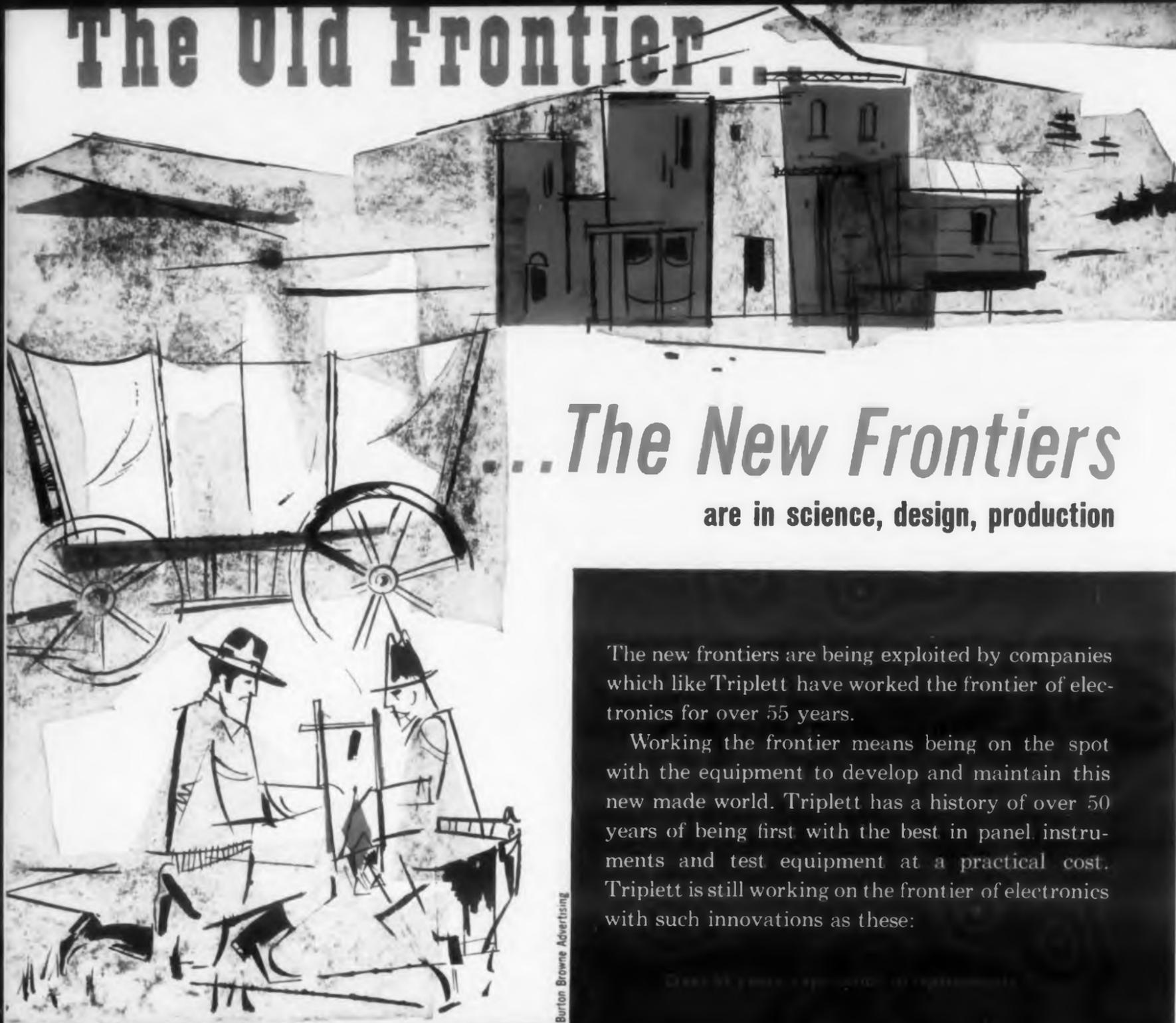
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Acoustica Associates, Inc.
26 Windsor Ave., Mineola, N. Y., Dept. ED

Send information to help us determine the correct ultrasonic cleaner for our purpose.

NAME _____
TITLE & COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

The Old Frontier...



...The New Frontiers

are in science, design, production

The new frontiers are being exploited by companies which like Triplet have worked the frontier of electronics for over 55 years.

Working the frontier means being on the spot with the equipment to develop and maintain this new made world. Triplet has a history of over 50 years of being first with the best in panel instruments and test equipment at a practical cost. Triplet is still working on the frontier of electronics with such innovations as these:

Burton Browne Advertising



Model 310 a complete miniature V-O-M with single switch selection and the ranges and accuracy of units several times its size. Used with Model 10 clamp-on ammeter plugged in it becomes one of the world's most versatile pieces of test equipment—even measuring current flow without stripping wires.



Model 630-PL V-O-M with such advanced features as an unbreakable clear plastic front for wide range, shadowless, instant vision, polarity reversing switch, single king size knob for selecting both range and circuit, continuous resistance readings from 0.1 ohm to 100 megohms.



Model 690-A, a new Transistor Tester with more Triplet "plus" in accuracy and simplicity, for testing leakage and gain of all low and medium power PNP and NPN transistors. Small, rugged, battery-operated, it measures DC Beta from 5 to infinity. Affords exact tests for shorts, checks forward & reverse leakage of diodes. Features single switch selection of transistor types, positive "off" to prevent accidental battery drain, separate "calibrate" and "gain" buttons eliminate errors, transistor socket and external leads for any basing arrangement.



New Unimeters—a great step forward in increasing meter inventory flexibility while cutting inventory cost. These Select-Your-Range unimeters consist of only two basic meter movements, which can be combined with any one of a number of separate dial-component units for a wide variety of meter ranges. Movements quickly and simply slide onto dial-components and lock together—no soldering, no wiring. Exclusive Triplet Bar-Ring construction for self-shielding, greater accuracy and sensitivity.

Triplet Electrical
Instrument Company
Bluffton, Ohio

Throughout the world Triplet first... to last.

NEW PRODUCTS

RF Coaxial Lobing Switch

Has 1.2 to 1 vswr



Type SP2T is a 0.7 lb rf coaxial lobing switch with a range of 100 to 10,000 mc, a maximum vswr of 1.2 to 1, and an isolation rating of 50 db down. Make before break or break before make switching is available. The unit is hermetically sealed, glass to metal, and has a minimum life of 1000 hr. Several models are available with a choice of type N, HN, or SC rf connectors.

Don-Lan Electronics Co., Dept. ED, 1101 Olympic Blvd., Santa Monica, Calif.

CIRCLE 126 ON READER-SERVICE CARD

Precision Dial Comparator

Direct reading in 0.00005 in.

This precision dial comparator is direct reading in 0.00005 in. and has a range of 0.004 in. Fully jeweled and shock resistant, it provides dual gaging contact pressure and fine adjustment on both stand and gage.

Hamilton Watch Company, Industrial Div., Dept. ED, Lancaster, Pa.

CIRCLE 127 ON READER-SERVICE CARD

Catadioptric Light Screen

Sensitive to hypervelocity projectile

Using the catadioptric technique of reflection and refraction this light screen is sensitive to hypervelocity projectiles as small

CIRCLE 125 ON READER-SERVICE CARD

as 0.22 caliber. Designed for ballistic range instrumentation, the device sets up a screen of light consisting of a collimated light beam which is reflected many times between parallel mirrors before passing into a photoelectric detector. The effective width of the beam interrupted by a projectile is 3/4 in. in any part of a 6 x 6 in. field. This gives a maximum phototube output signal over a wide range of projectile sizes. A current change is caused in the detector when a hypervelocity projectile breaks the light screen at any point. The current change is amplified and is used to trigger a shadowgraph system. These systems can produce photographic records of missile models in flight.

Avco Mfg. Corp., Research and Advanced Development Div., Dept. ED, 201 Lowell St., Wilmington, Mass.

CIRCLE 128 ON READER-SERVICE CARD

RF Choke Coil

Occupies 0.0066 cu in.



Occupying a volume of less than 0.0066 cu in., the Wee-Ductor rf choke coil covers a full range of inductances from 0.1 to 1000 μ h and has a high current rating at 125 C. It consists of a high permeability ferrite sleeve and core sealed in epoxy resin for moisture resistance per MIL-C-15305A. The unit is 0.15 in. in diameter and 0.375 in. long.

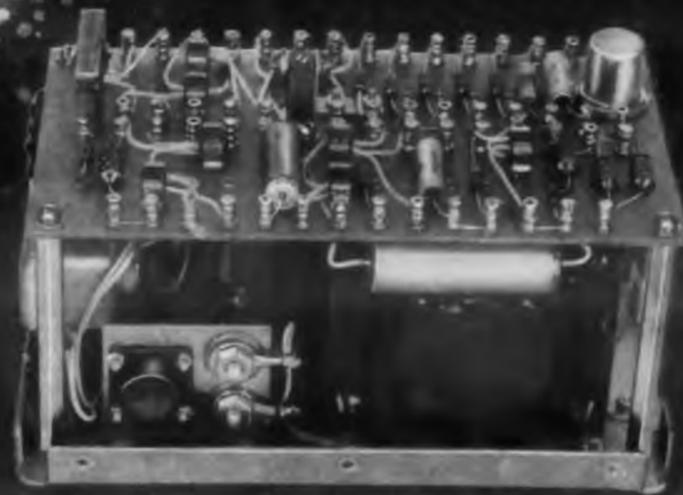
Essex Electronics, Dept. ED, Berkeley Heights, N.J.

CIRCLE 129 ON READER-SERVICE CARD
CIRCLE 130 ON READER-SERVICE CARD

ULTRA-STABLE

Transistorized power supply

62 A



AC to DC—regulated $\pm 0.1\%$ for 6 months

Characteristics

Input: 115 V AC 60 cps or 400 cps or
115/208 V AC 3 phase 60 cps or 400 cps

Output: Available in discrete steps of 0.5 volt from
either a. 12.0 volts DC to 28.0 V DC at 1.0 ampere
or b. 28.0 volts DC to 50.0 V DC at 0.5 ampere

Output is floating and can be used either as a positive or negative supply.

Load Regulation: Output voltage is regulated within $\pm 0.1\%$ from 0.5 to 1.0 ampere.

Line Regulation: Output voltage is regulated within $\pm 0.1\%$ for line variations of $\pm 10\%$ in voltage and frequency.

Temperature: Output voltage is regulated within $\pm 0.1\%$, under full or minimum load, over the temperature range of -55°C to $+85^{\circ}\text{C}$.

Ripple: Less than 1 milli-volt RMS or 3 milli-volts peak to peak.

Stability: 0.1% for a period of 6 months under a fixed load and line.

Reliability: Better than .95 for a period of 365 days, at 8 hours a day with a life expectancy of 10 years.

Output Impedance: Less than 20 micro-ohms at DC.

This unit can be supplied as a DC to DC Power Supply.

Applications

- Voltage reference in computers and complex networks.
- Laboratory voltage standard.
- Cascaded to provide higher voltages without degradation of performance.



Read about this unit and many other missile and airborne types in the new Daven Catalog of Transistorized Power Supplies!

THE **DAVEN** CO.  **LIVINGSTON, NEW JERSEY**

TODAY, MORE THAN EVER, THE DAVEN  STANDS FOR DEPENDABILITY





Why it pays you to specify

Bendix QWL Electrical Connectors for use with Multi-conductor Cable

For use with multi-conductor cable on missile launching, ground radar, and other equipment, the Bendix* QWL Electrical Connector meets the highest standards of design and performance.

A heavy-duty waterproof power and control connector, the QWL Series provides outstanding features: • The strength of machined bar stock aluminum with shock resistance and pressurization of resilient inserts. • The fast mating and disconnecting of a modified double stub thread. • The resistance to loosening under vibration provided by special tapered cross-section thread design. (Easily hand cleaned when contaminated with mud or sand.) • The outstanding resistance to corrosion and abrasion of an aluminum surface with the case hardening effect of Alumilite 225 anodic finish. • The firm anchoring of cable and effective waterproofing provided by the cable-compressing gland used within the cable accessory. • The watertight connector assembly assured by neoprene sealing gaskets. • The addi-

tional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip. • Prevention of inadvertent loosening insured by a left-hand accessory thread. • The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time. *TRADEMARK

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Scintilla Division

Sidney, New York



CIRCLE 131 ON READER-SERVICE CARD



A PHASE SENSITIVE NULL METER WHEREIN NOISE AND HARMONIC VOLTAGES ARE EFFECTIVELY ELIMINATED



MODEL 100A

PRICE
\$259⁰⁰
F.O.B.
NEW YORK

- Allows separate balance of in-phase or quadrature in null circuits.
- Eliminates the necessity for filters.
- High sensitivity.
- Direction of null clearly shown on zero centered meter.
- Synchro zeroing without recourse to coarse and fine switching.

For further information contact your nearest representative or write for brochure

INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th ST. • NEW YORK 3 • GR. 3-4684

Visit Booth 3206 IRE Show—New York Coliseum
CIRCLE 132 ON READER-SERVICE CARD

NEW VARIGRIP... ESNA® quick-release FASTENER



Consider these unique advantages:

1. Two-piece unit consisting of a self-locking Elastic Stop nut as the latch-lock and a retainer basket.
2. Stop nut fits any standard 1/4"-20 bolt. User supplies bolt in head style to suit job needs.
3. When bolt is installed, the nut is held in basket and tightened to the exact setting required by structure thickness. Infinite adjustment possible for full threaded length of the bolt.
4. Eliminates inventory of multiple length studs.
5. Bolt-nut latch-lock can be tightened or reset at any time.
6. One quarter-turn lock and unlock action; high re-usability.

Available in 1/4"-20 size only. For complete design information write to Dept. 533-357



ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey
CIRCLE 133 ON READER-SERVICE CARD

NEW PRODUCTS

Slip Ring and Brush Assembly

Has 2 mv noise level



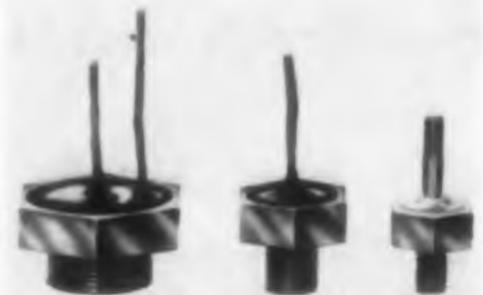
With all 40 circuits tied in series and with 50 ma of current flowing through this slip ring and brush assembly, the total combined noise level of the 40 slip rings and 80 brushes is under 2 mv. This noise level can be maintained through 1000 hr of operation at 500 rpm with 10 cps vibration and temperature extremes of -65 to +300 F. The breakaway friction level of the 40 circuit assembly, including ball bearings, is under 75 g cm. Capacitance is less than 20 µf and insulation resistance is greater than 5000 meg circuit to circuit and circuit to ground. The assembly meets all MIL-5400A requirements.

Slip Ring Company of America, Dept. ED, 5456 W. Washington Blvd., Los Angeles 16, Calif.

CIRCLE 134 ON READER-SERVICE CARD

Solid State Relays

Withstand heavy surges



Included in this line of solid state relays are current, voltage, temperature, time delay, and many other types for both automatic and remote control and for ac and dc operation. These units have no moving parts or magnetic circuits, and do not depreciate with time. Unlike transistors they are uninjured by heavy peaks and surges.

Clark Electronic Labs, Dept. ED, Box 165 Palm Springs, Calif.

CIRCLE 135 ON READER-SERVICE CARD

CIRCLE 136 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959



2½-inch size

ACTUAL SIZE



3½-inch size

THE BIG LOOK

IN SMALL PANEL INSTRUMENTS

Truly distinctive appearance, plus excellent readability and reliable operation in a modern new design; BIG numerals, BIG scale, BIG look, yet they will fit into the same usable panel space as ordinary instruments.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

THE BIG LOOK



IN GENERAL ELECTRIC'S SMALL PANEL INSTRUMENTS

Now, you can improve the appearance of your finest switchboards and panels with General Electric's dramatic **BIG LOOK** in small panel instruments. Backed by more than twenty-seven years of leadership and experience in creative panel instrument design, they give you these outstanding advantages:

DISTINCTIVE APPEARANCE

Functional new beauty in a graceful, clean-line design results from a modern blend of round and square elements. Although this attractive design makes the new instruments look much bigger, they will actually fit into the same usable panel space as ordinary instruments. Big border-to-border scale is "framed" in aluminum for better color blending and less reflectance. The color area of the window helps to channel the eye for quick reading. This dis-

tinctive color area is available in standard colors or the color of your choice in quantity orders.

EXCELLENT READABILITY

New design makes possible up to 28% increase in scale length over types replaced. Shadows are eliminated by cover design which admits natural light from all sides. Big, clear, upper-case numerals are positioned above the scale graduations (except three-digit end points) and cannot be obscured by the tapered pointer. The absence of arc-lines contributes to the pleasing appearance and facilitates quick, accurate readings.

RELIABLE OPERATION

Built-in General Electric quality assures extra long, trouble-free life with these outstanding features:

Shielded Mechanisms—Self-shielding of

all d-c movements allows mounting on magnetic or non-magnetic panels without special calibration—cluster mounting bezel-to-bezel without interaction—and the effects of stray magnetic fields are minimized.

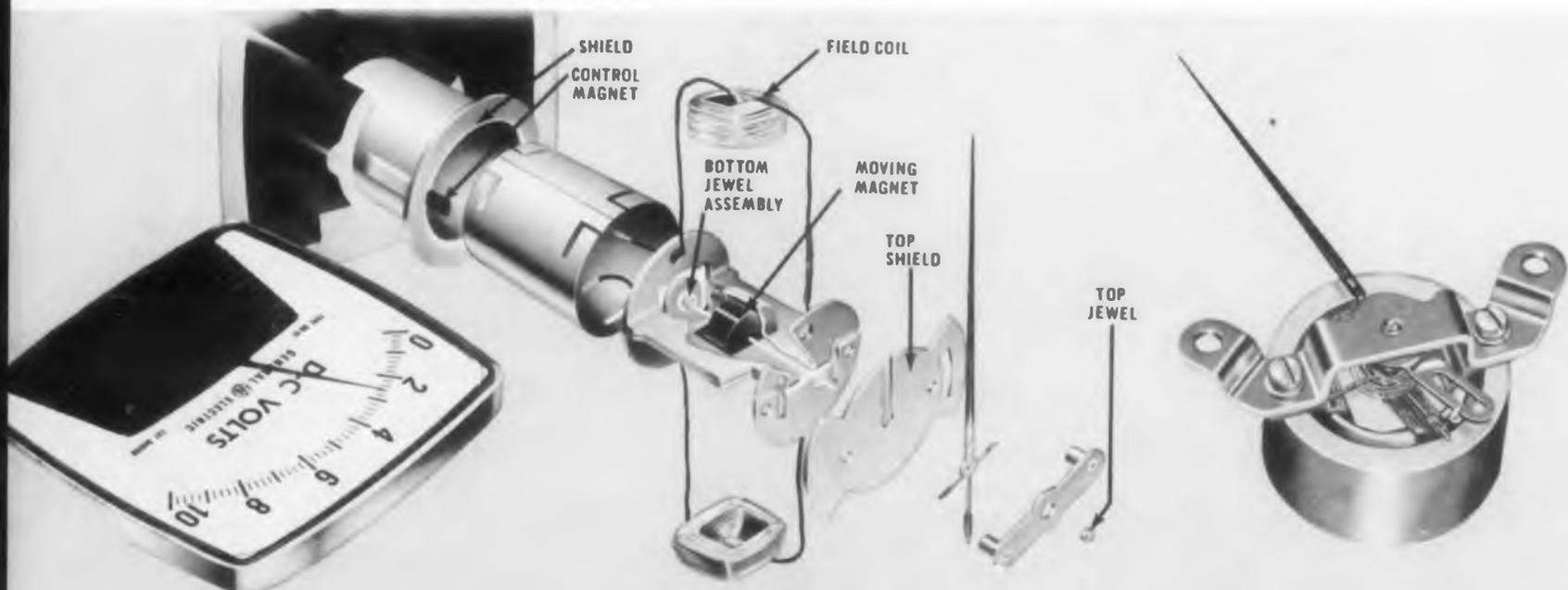
Completely Sealed—Internal parts and movements are protected from dirt, dust and water. Cases are sealed with neoprene gaskets in air-conditioned assembly areas.

Pivots and Jewels—Moving parts are supported on rugged steel pivots which rotate in low-friction, highly-polished glass jewels.

NEW LOW PRICE

Improved manufacturing techniques and facilities enable General Electric to offer you these new instruments at a new low price. See pages 3 and 4 for list prices.

ALL D-C MECHANISMS ARE SELF-SHIELDED



Exclusive moving-magnet mechanism, used in all d-c ratings except ammeters below 5 MA, eliminates need for zero-set because conventional control springs are replaced by a control magnet. When de-energized, moving magnet aligns with control magnet, bringing pointer to zero.

Core-magnet, used in d-c milliameters below 5 MA and all microammeters, has conventional control springs and requires a zero-set.

See General Electric's **BIG LOOK** in Small Panel Instruments

PRICING INFORMATION — Direct-current Types

Rating	Scale	Approx Terminal Resistance	DW-91, 2½-inch		DO-91, 3½-inch		Rating
			Cat. No.	List Price, GO-87A	Cat. No.	List Price, GO-87A	
D-C VOLTMETERS							
Volts	Volts						Volts
1.5	0-1.5		810X84	\$17	640X84	\$18	1.5
3	0-3		810X86	17	640X86	18	3
5	0-5		810X87	17	640X87	18	5
10	0-10		810X89	17	640X89	18	10
15	0-15	1000 ohms per volt	810X90	17	640X90	18	15
30	0-30		810X93	17	640X93	18	30
50	0-50		810X94	17	640X94	18	50
80	0-80		810X95	17	640X95	18	80
100	0-100		810X96	18	640X96	19	100
150	0-150		810X97	18	640X97	19	150
300	0-300		811X1	19	643X1	20	300
500*	0-500				643X2	21	500*
D-C AMMETERS (Self-contained)							
Amperes	Amperes						Amperes
1	0-1	0.0500	810X29	\$15	640X70	\$16	1
2	0-2	0.0250	810X31	15	640X72	16	2
5	0-5	0.0100	810X33	15	640X74	16	5
10	0-10	0.0050	810X35	15	640X76	16	10
15	0-15	0.0033	810X36	15	640X77	16	15
20	0-20	0.0025	810X37	15	640X78	16	20
30	0-30	0.00167	810X38	15	640X79	16	30
50	0-50	0.00100		15	640X80	16	50
D-C AMMETERS (For use with external shunts—prices do not include shunt or shunt leads.)							
Millivolts	Amperes						Millivolts
50	0-50	2.5	818X34	\$15		\$16	50
50	0-75	2.5	818X39	15	813X52	16	50
50	0-100	2.5	818X44	15	813X58	16	50
50	0-150	2.5	818X45	15	813X58	16	50
50	0-200	2.5	818X46	15	813X59	16	50
50	0-250	2.5	818X47	15	813X60	16	50
50	0-300	2.5	818X48	15	813X61	16	50
50	0-400	2.5	818X50	15	813X63	16	50
50	0-500	2.5	818X52	15	813X65	16	50
50	0-600	2.5	818X54	15	813X67	16	50
50	0-800	2.5	818X58	15	813X71	16	50
50	0-1 KA	2.5	818X62	15	813X75	16	50
50	0-1.2 KA	2.5	818X96	15	813X77	16	50
50	0-1.5 KA	2.5	818X99	15	814X13	16	50
50	0-2 KA	2.5	819X5	15	814X14	16	50
φ100		5.0	φ	15	φ	16	φ100
D-C MICROAMMETERS							
Microamperes							Microamperes
†20	0-20	3400	810X1	\$35	698X1	\$36	†20
†50	0-50	1600	810X3	27	698X3	28	†50
†100	0-100	1525	810X5	23	698X5	24	†100
†200	0-200	225	810X7	20	698X7	21	†200
†500	0-500	30	810X9	18	698X9	19	†500
D-C MILLIAMMETERS							
Milliamperes							Milliamperes
†1	0-1	7.8	810X11	\$17	698X11	\$18	†1
†1.5	0-1.5	7.6	810X12	17	698X12	18	†1.5
†3	0-3	2.6	810X14	17	698X14	18	†3
5	0-5	13.6	810X15	15	640X56	16	5
10	0-10	3.0	810X16	15	640X57	16	10
20	0-20	.52	810X17	15	640X58	16	20
30	0-30	1.7	810X19	15	640X60	16	30
50	0-50	1.0	810X20	15	640X61	16	50
80	0-80	.9	810X21	15	640X62	16	80
100	0-100	.5	810X22	15	640X63	16	100
150	0-150	.4	810X23	15	640X64	16	150
200	0-200	.3	810X24	15	640X65	16	200
250	0-250	.25	810X25	15	640X66	16	250
300	0-300	.2	810X26	15	640X67	16	300
500	0-500	.1	810X27	15	640X68	16	500

* External resistors are used on DW-91 above 300 volts and DO-91 above 600 volts.
 φ When instruments are required for 100 MV external shunt, order 100 MV rating and give scale range desired.

† These ratings have core-magnet movements (see Mechanisms).
 NOTE: To establish your quantity discount, contact your nearest G-E Apparatus Sales Office or Distributor.

at Booth 2928, I.R.E. Show, New York Coliseum, March 23-26

PRICING INFORMATION— Alternating-current Types

Rating	Scale	Approx Terminal Resistance Ohms	AW-91, 2½-inch		AO-91, 3½-inch		Rating
			Cat. No.	List Price, GO-87A	Cat. No.	List Price, GO-87A	
A-C VOLTMETERS— Self-contained							
Volts	Volts						Volts
1.5	0-1.5	3.0	823X54	\$17	824X54	\$18	1.5
3	0-3	11.1	823X57	17	824X57	18	3
5	0-5	29	823X58	17	824X58	18	5
10	0-10	110	823X61	17	824X61	18	10
15	0-15	251	823X62	17	824X62	18	15
30	0-30	779	823X65	17	824X65	18	30
50	0-50	2500	823X66	18	824X66	19	50
150	0-150	15000	823X70	19	824X70	20	150
300	0-300	54000	823X74	21	824X74	22	300
500	0-500	118000			824X76	29	500
A-C VOLTMETERS— Transformer-rated (Scale marked in terms of transformer ratio) *							
Volts	Volts						Volts
150	0-300	15000	823X81	\$19	824X81	\$20	150
150	0-600	15000	823X82	19	824X82	20	150
150	0-750	15000	823X83	19	824X83	20	150
A-C AMMETERS— Self-contained							
Amperes	Amperes						Amperes
1	0-1	0.16	823X20	\$17	824X20	\$18	1
3	0-3	0.015	823X24	17	824X24	18	3
5	0-5	0.007	823X25	17	824X25	18	5
8	0-8	0.003	823X28	17	824X28	18	8
10	0-10	0.0024	823X29	17	824X29	18	10
15	0-15	0.0016	823X31	17	824X31	18	15
20	0-20	0.001	823X32	17	824X32	18	20
30	0-30	0.0006	823X34	17	824X34	18	30
50	0-50	0.0004			824X35	20	50
A-C AMMETERS— Transformer-rated (Scale marked in terms of transformer ratio) *							
Amperes	Amperes						Amperes
5	0-50	0.007	823X39	\$17	824X39	\$18	5
5	0-75	0.007	823X40	17	824X40	18	5
5	0-100	0.007	823X41	17	824X41	18	5
5	0-150	0.007	823X42	17	824X42	18	5
5	0-200	0.007	823X43	17	824X43	18	5
5	0-300	0.007	823X44	17	824X44	18	5
5	0-400	0.007	823X45	17	824X45	18	5
5	0-500	0.007	823X46	17	824X46	18	5
5	0-600	0.007	823X47	17	824X47	18	5
5	0-800	0.007	823X48	17	824X48	18	5
5	0-1 KA	0.007	823X49	17	824X49	18	5
5	0-1.5 KA	0.007	823X50	17	824X50	18	5
5	0-2 KA	0.007	823X51	17	824X51	18	5
5	0-3 KA	0.007	823X52	17	824X52	18	5
A-C MILLIAMMETERS							
Milliamperes							Milliamperes
10	0-10	2158	823X4	\$17	824X4	\$18	10
25	0-25	341	823X7	17	824X7	18	25
50	0-50	84	823X9	17	824X9	18	50
100	0-100	21	823X12	17	824X12	18	100
200	0-200	4.1	823X14	17	824X14	18	200
500	0-500	0.70	823X17	17	824X17	18	500

* Cat. No. and prices are only for instruments and do not include external accessories such as potential and current transformers.
For AW-91 above 30 amperes and AO-91 above 50 amperes order 5-amp transformer-rated instrument for use with external current transformer.

For AW-91 above 300 volts and AO-91 above 500 volts order 150-volt transformer-rated instrument for use with external potential transformer.
NOTE: To establish your quantity discount, contact your nearest G-E Apparatus Sales Office or Distributor.

GENERAL SPECIFICATIONS FOR PANEL INSTRUMENTS

Dimensions (in Inches)	DO-91	DW-91	AO-91	AW-91	
Flange dimensions	3.5 X 3.5	2.69 X 2.69	3.5 X 3.5	2.69 X 2.69	Accuracy: All instruments are accurate to within $\pm 2\%$ of full-scale value. (Moving-magnet-types are calibrated for mounting within 45° of vertical and can be calibrated for other positions on request.)
Barrel diameter	2.80	2.21	2.80	2.21	
Barrel depth	1.31	1.30	1.31	1.30	
Scale lengths					
Moving magnet	3.0	2.25			Mounting: Interchangeable with JAN, MIL, and ASA 2½- and 3½-inch round sizes.
Core magnet	2.9	2.1			
Iron vane			2.9	2.0	Burden: AO-91 and AW-91—5 amp, 60 cycle: 0.5 VA at 0.5 p.f. lag. AO-91 and AW-91 voltmeters have approximately unity power factor at 60 cycles.
Weight	Net	Shipping			
All types (maximum)	8 oz.	12 oz.			



Old round design with 3 1/2-inch diameter has relatively small scale and numbers.



New BIG LOOK design fits into same usable panel space as older style instruments.

INCLUDING BOTH A-C AND D-C TYPES

An iron-vane repulsion-type mechanism is used for all a-c ratings. Two vanes are employed: one is attached to the moving shaft and the other is fixed to the field-coil frame. As current flows through the coil, both vanes are magnetized in the same polarity and the repelling force causes the moving vane to rotate. The pointer attached to the movable vane indicates deflection on the scale.

A substantially uniform scale distribution is obtained because the repelling force varies both as a square of

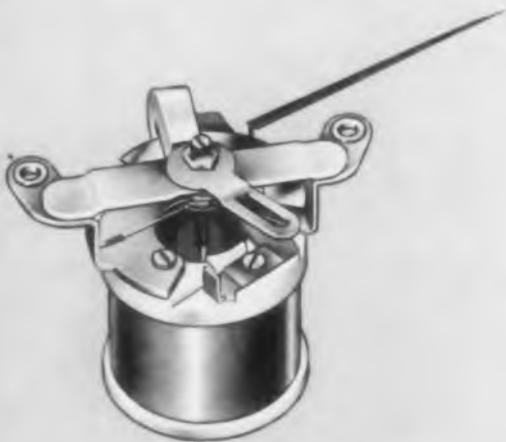
the current and inversely as the square of the distance between vanes.

MAGNETIC DAMPING

All a-c movements utilize magnetic damping to bring the moving mechanism quickly to rest. Alternating-current instruments are accurate to within 2% of full-scale value.

As with any iron-vane instrument, optimum accuracy is obtained when leads are brought down vertically to terminals.

Order General Electric small panel instruments by catalog number from your nearest G-E Apparatus Sales Office or Distributor. For catalog numbers, ratings, and pricing information, see inside fold.



Moving-iron mechanism, used in all a-c ratings, consists of field coil, fixed and movable vanes, and control spring.

Neoprene-sealed zero-set (a-c and d-c core magnet)

Neoprene gasket

Neoprene gasket

Aluminum bezel

Completely sealed cases protect internal parts of instrument from dirt, dust and water. Even zero-set is sealed with a neoprene O-ring.

at Booth 2928, I.R.E. Show, New York Coliseum, March 23-26

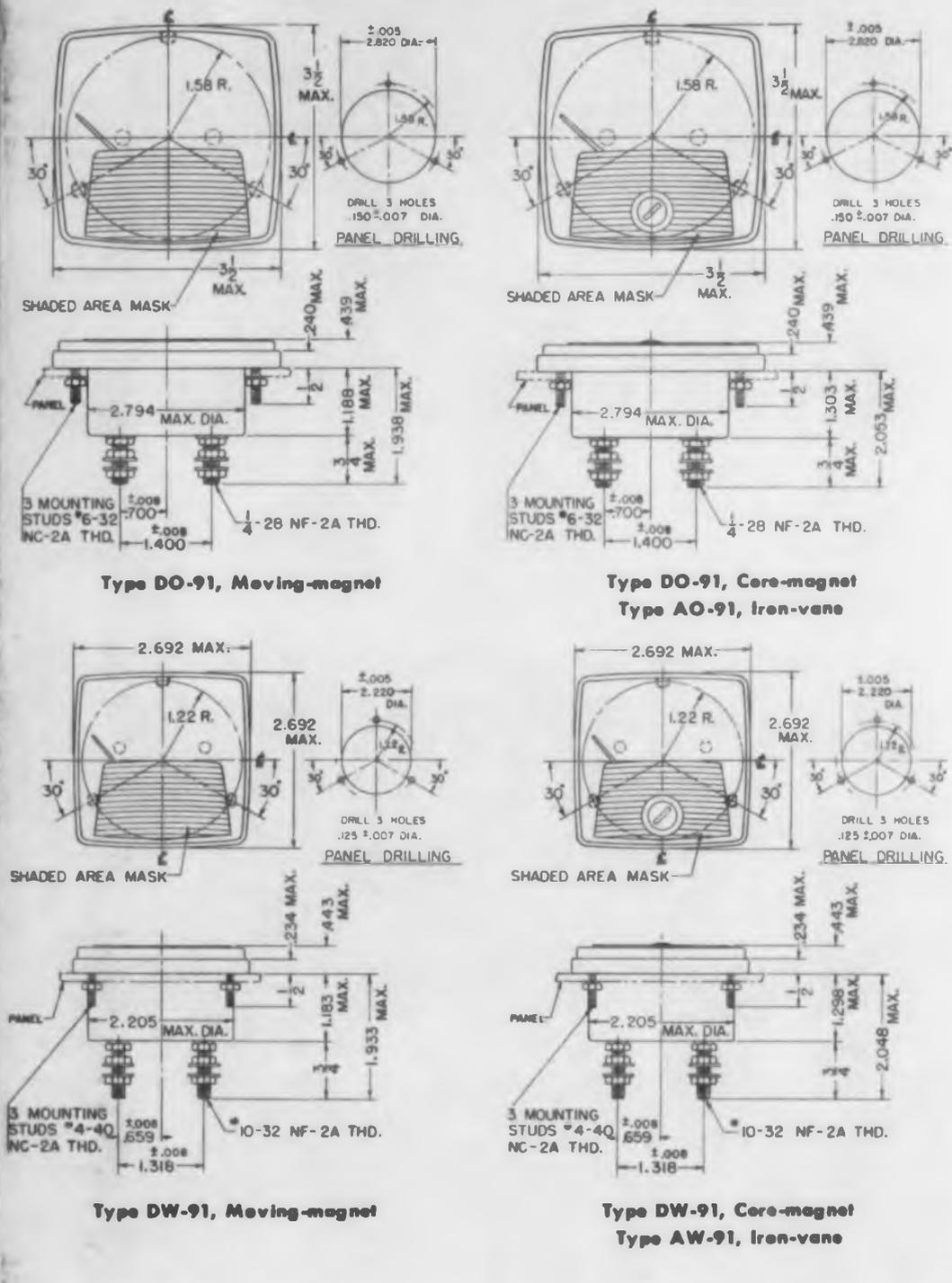
WRITE NOW FOR A QUOTATION

Your nearest G-E Apparatus Sales Office or Distributor can give you all the facts on BIG LOOK small panel instruments, including those with custom-marked scales. Most ratings are available for immediate delivery. Or, write direct to General Electric Co., Section 593-302, Schenectady, New York

Use these dimensions and panel-drilling specifications to plan your panel instrument needs

to meet all your measurement needs—

General Electric offers this complete line of precision instruments



ELECTRIC-QUANTITY INSTRUMENTS—voltage, current watts, vars, frequency and power factor.

Indicators
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 Switchboard Indicators can be furnished with contacts or "control initiation" to operate alarms or control circuits

Recorders
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 Portables
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Auxiliaries
 Current transformers
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 Gauss meters
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 Instrument standardization console
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PROCESS INSTRUMENTS

Indicators
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 Precision, A-c bridge type
 Pyrometer
 Resistance thermometer

Recorders (potentiometer and A-c bridge types)

Strip-chart

Recorder—Controllers

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 Pyrometer, seven control forms
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Halogen-types
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Time Switches
 General-purpose types
 Process types

Time Meters

GENERAL  ELECTRIC



Servo Motor Generator

Size 10

This 2.75 oz motor generator is designed for operation directly from transistor servo amplifiers and will develop a stall torque of 0.3 oz-in. The size 10,400 cps unit has a free speed of 6500 rpm and viscous damping of 31.1 dyne-cm per radian per sec. Generator output is 0.16 v per 1000 rpm at 10 v input, and 0.41 v per 1000 rpm at 26 v input.

Daystrom Transicoil, Dept. ED, Worcester, Montgomery Co., Pa.

CIRCLE 137 ON READER-SERVICE CARD

Light Image Intensifier Tube

Brightens 10^{-7} ft-c 1000 times

Light images at levels of 10^{-7} ft-c can be intensified over 1000 times with the WL-7257 intensifier tube. The unit produces an image of reduced size having a brightness increase of 1000 times minimum for input color temperature of 2870 K, and 2500 times minimum for actinic blue input. The light quantum gain is approximately 50 for input color temperature of 2870 K tungsten and 100 for actinic blue input.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 138 ON READER-SERVICE CARD



Rotary Relay

Rated at 5 amp, 30 v dc

Type 4C rotary relay is a hermetically sealed 4pdt dc unit with a contact rating of 5 amp, 30 v dc. It weighs 3.2 oz, operates at 125 C, and withstands 2000 cps vibration at 20 g acceleration.

Couch Ordnance, Inc., Dept. ED, 3 Arlington St., North Quincy, Mass.

CIRCLE 139 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.

CIRCLE 136 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

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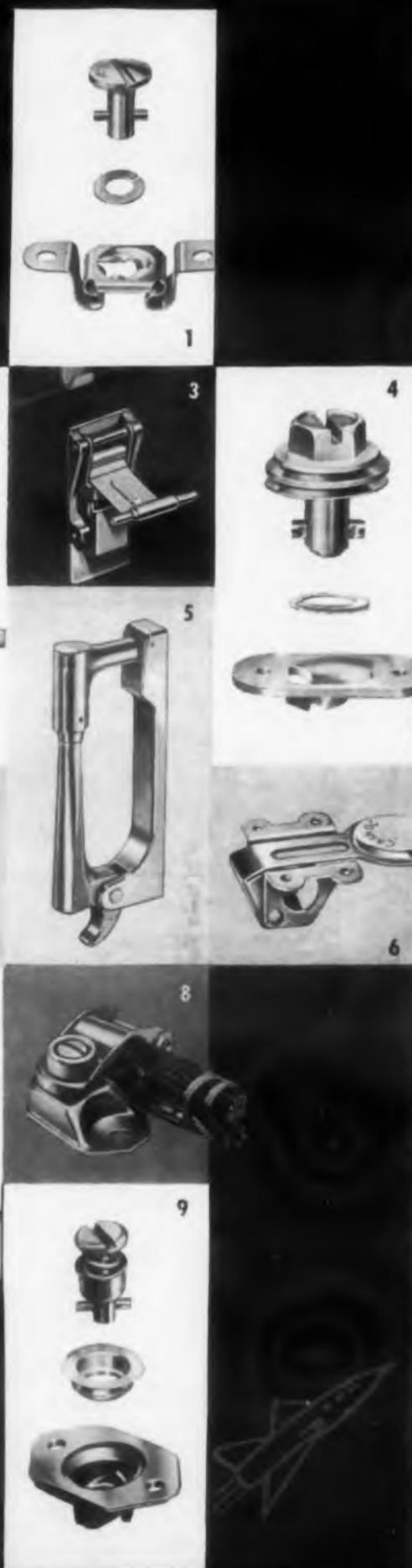
speed · versatility · positive performance

Outstanding creative engineering at Camloc has produced a variety of fastening devices. For access panels, doors, other closures, for simplified replacement of components and sub-assemblies. There are other fastening devices, designed for a variety of specialized applications, all of them retaining the three important features that characterize all Camloc products... speed, versatility and positive performance.



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IN-LINE READOUT

MINIMIZES OPERATOR ERROR and FATIGUE

MEGACYCLE - MICROSECOND - COUNTER - TIMER
MODEL 1031

Industrial Reliability - Laboratory Versatility - get them both in Systron's Model 1031 Counter-Timer. In just *one* glance you have the answer - and you get the answer in just *one* unit. 50,000 hour rated life Beam Switching Decades aid reduction of tube complement by 50% - increase reliability, decrease failure rate. This is just half of the story - 7 digit readout - 3 DC amplifiers - and increased crystal oscillator stability assures true versatility. Counting decades can drive 2 sets of NIXIE indicators and the Model 1401 Digital records without buffer tubes, relays or diodes - thus simplifying components for use in complete measuring and recording systems.

Systron manufactures In-Line Counters for laboratory, military and industrial applications, as well as complete Data Processing and Control Systems tailored to meet individual specifications.

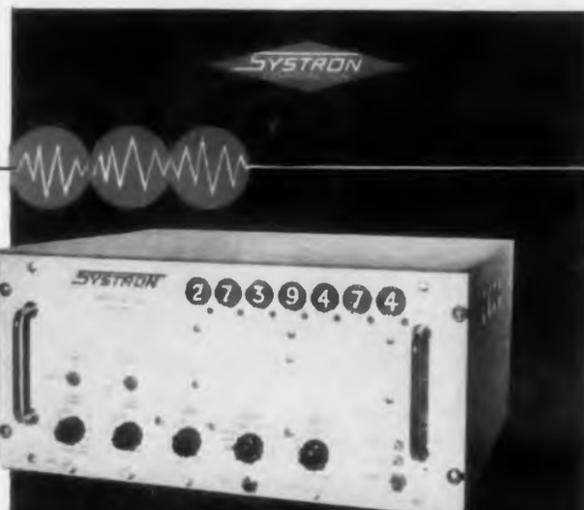
Write today for complete specifications of Model 1031 and your free copy of our new Short Form Catalog.

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CIRCLE 141 ON READER-SERVICE CARD



S Y S T R O N

S P E C I F I C A T I O N S

Range:
Frequency—0 cps to 1 MC
Time Interval—1 microsec. to 10⁷ secs.
Period—0 cps to 1 MC
Accuracy—±1 count, ±3 parts in 10⁷ per week
Readout—NIXIE IN-LINE, 0 to 10⁷

Time Base:
Frequency—1 microsec. to 10 sec. decade steps
Time Interval—1 cps to 1 MC. decade steps
Sensitivity—0.1 V rms.
3 DC Amplifiers

Input Impedance—
10 Megohms, Direct or AC coupled Step Attenuators with ± Trigger Level Adjustment

Outputs:
Oscilloscope Trigger Level Marker Signals
Secondary Frequency Standard
Digital Recorder socket
Display Time—0.1 to 15 secs and Manual Power—117 volts, ±10%, 60 cps

Price: \$1375.00
F. O. B. Concord, California

NEW PRODUCTS

Pressure to Voltage System

Provides signal output of 0 to 5 or ±2.5 v dc

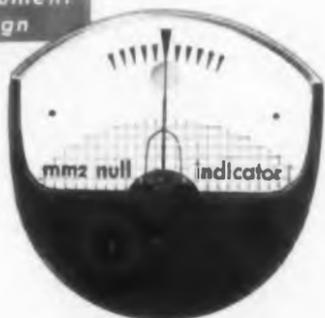
The unregulated model DCS-2 pressure to voltage system is a single package that operates from standard unregulated 28 v dc aircraft and missile power supplies. It combines the company's model S-30 variable-reluctance transducer with stable transistorized electronic circuitry and has a signal output of 0 to 5 or ±2.5 v dc over the rated pressure range. Because the stiff metal diaphragm is the only moving part, the instrument is resistant to shock and vibration. With no dc or ac amplifiers in the circuitry, drift problems are eliminated. In operation, a transistorized multivibrator works into a completely passive circuit which includes a temperature-stable, phase-sensitive demodulator with matched silicon diodes. This circuitry confines the necessary ac to within the shielded package, making it unnecessary to run ac lines elsewhere in the system. The resultant dc signal may be used as the input to voltage-controlled oscillators and dc computers as well as to other dc input systems.

Ultradyn, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N. Mex.

CIRCLE 146 ON READER-SERVICE CARD

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Modern MEDALIST design provides for greater readability and modern styling in minimum space. Unique core and magnet structure provides 1/2 ua/mm sensitivity at null point with sharp square law attenuation to 100 ua at end of scale in Type A. Internal resistance is 2000 ohms. Other sensitivities available. ASA/MIL 2 1/2" mounting. Standard and special colors. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Company, Manchester, N. H., U. S. A.

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meters



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stock motors!



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295 standard types of Bodine reducer and non-reducer motors are available at once... from stock. Reducer torque ratings up to 219 in. lbs.

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MOTORS

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CIRCLE 145 ON READER-SERVICE CARD

Rotary Switch

Has 1 in. diameter



Series 1900 Rotary selector switch is totally enclosed and built to exceed MIL-S-6807A requirements. It will carry 10 amp continuously and 5 amp, 115 v ac or 3 amp 28 v dc intermittently. Dielectric strength is 1800 v. The unit is available with a single wafer or up to 16 wafers and with continuous rotation or 2 to 10 positions with stops.

Janco Corp., Dept. ED, 3111 Winona Ave Burbank, Calif.

CIRCLE 147 ON READER-SERVICE CARD

DC Governor Motor

Holds uniform speed within 1%



Rated at 1/100 hp at 4500 to 9000 rpm, this dc motor is equipped with a governor that controls shaft speed variation within 1%. Rotor torque is rated at 3.5 oz in. for intermittent duty. Overall dimensions are approximately 1-1/2 x 3 in., including the shaft which protrudes about 1/2 in. beyond the frame. Weight of the unit is about 7 oz. Body of the M-120 unit is solid aluminum with anodized finishes available in 6 colors.

Carter Motor Co., Dept. ED, 2761 A W. George St., Chicago 18, Ill.

CIRCLE 148 ON READER-SERVICE CARD

Vernier Variable Resistor

Has 13.5 to 1 reduction



Designed for fine tuning applications, this vernier variable resistor's contact arm rotates 1 deg for each 13.5 deg of shaft rotation. Total contact arm rotation is 300 ± 5 deg, and total shaft rotation is approximately 4000 deg. Designated VA-45, it has a 0.25 to 0.5 w dissipation. Resistance range is 250 ohms through 10 megohms, linear taper, with standard tolerance $\pm 30\%$ for 250 ohms through 5 megohms, and $\pm 40\%$ for 5 to 10 megohms. Voltage rating across and terminals is 500 v dc. Available in many papers and shaft specifications.

Chicago Telephone Supply Corp., Dept. ED, Elkhart, Ind.

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Every Electronic Wire you need
in easy-to-use packages.

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Electrical and Electronic

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WIREMAKER FOR INDUSTRY
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Cord Sets and Portable Cord • Aircraft Wires
Electrical Household Cords • Electronic Wires
Welding Cable • Automotive Wire and Cable

CIRCLE 150 ON READER-SERVICE CARD

A
VOLT
IS
A VOLT
IS A
VOLT

Or is it? Monitoring mag-amp regulated ground power-supplies with a conventional voltmeter is like trying to measure micro-inches with a yardstick.

Take this preflight checkout system for example: 115-volt, 400-cycle power is regulated to $\pm 1\%$, equal to ± 1.15 volts. But ordinary 2% meter error is ± 3 volts...less than half the accuracy you need.

Now, wire a standard 110-120 volt Beckman expanded scale voltmeter into the circuit. Result: $\pm 0.3\%$ accuracy equal to ± 0.345 volt...better than twice the precision of regulated voltage. And one-tenth volt resolution makes reading easy...lets you take full advantage of the meter's drift-free accuracy.

What's more, there's no average-reading "fudge-factor" to contend with. Feed a Beckman AC meter anything from pure sine to square waves...it always reads true rms.

Helipot builds self-contained, panel-mounting Beckman expanded scale meters...AC or DC...in hundreds of models...commercial or ruggedized...in a wide variety of shapes, sizes and ranges. Color coding, special ranges and assemblies are yours for the asking.

Trade in your yardstick! Send for Data File C34.



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CIRCLE 163 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Transistor

Operates at 200 C



The ARA-46P silicon composite pnp transistor is thermally compensated to operate at temperatures up to 200 C. It has the general characteristics of a small signal transistor at the input and that of a power transistor at the output. Operating specifications are: collector voltage, 40 v; collector current, 3 amp; power dissipation at 25 C, 35 to 50 w; power dissipation at 150 C, 2 to 5 w; current gain, 10,000; input impedance, 2000 ohms; output impedance, 500 ohms.

Advanced Research Associates, Inc., Dept. ED, Semiconductor Div., P. O. Box 68, Kensington, Md.

CIRCLE 164 ON READER-SERVICE CARD

Pegboard Kit

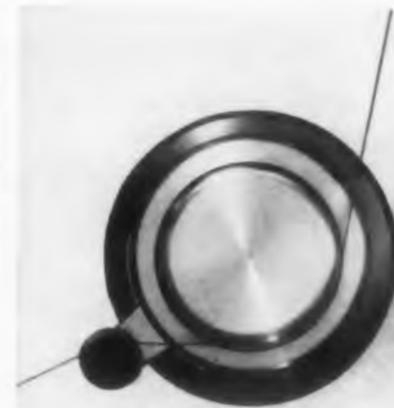
For circuit development



Available on an individual parts basis or in development sets with over 850 components, Erect-Tronic systems consist of precision drilled Duron pegboards, electrical and electronic components mounted on high-impact polystyrene bases with dual plug-in pins, and phosphor bronze Jiffy connectors. They are designed to permit quick check out of circuitry ideas without soldering or wire preparation. The sets can be used to build transistor and tube circuitry for audio, servo, pulse, video, computer, and radio frequency applications up to 20 mc.

Science-Electronics, Inc., Dept. ED, 195 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 165 ON READER-SERVICE CARD



AMPEX:
turning point
for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium-alloy Precision Reels. Widths of $\frac{1}{4}$ ", $\frac{1}{2}$ " and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters, and base thicknesses:

AMPEX STANDARD TAPE LENGTHS (feet)

REEL DIAMETER	BASE THICKNESS (mils)	
	1.0	1.5
7"	1800	1250
10 $\frac{1}{2}$ "	3600	2500
14"	7200	5000

*DU PONT TRADEMARK

For complete specifications or additional tape literature, write

AMPEX
MAGNETIC TAPE

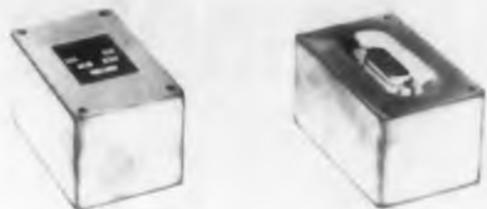
934 CHARTER STREET, REDWOOD CITY, CALIF.

CIRCLE 166 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Voltage Controlled Oscillator

For airborne use



Airborne voltage controlled oscillator model VOV-4S is a rugged, transistorized unit compatible with many existing airborne packages. It incorporates silicon junction diode networks and silicon transistors which permit operation in ambient temperatures to 125 C. The unit has $\pm 0.5\%$ linearity, low power drain, and high stability in cases of supply voltage variations. Dimensions are 3 x 1.62 x 1.87 in.

Data-Control Systems, Inc., Dept. ED, 39 Rose St., Danbury, Conn.

CIRCLE 154 ON READER-SERVICE CARD

Thermistors

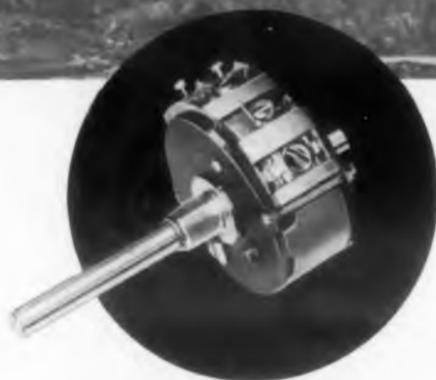
Interchangeable and matched



This line of interchangeable and close tolerance matched thermistors come in five major groups. More than 30 units are available. Resistance matched units are available such that at 25 C all units are within 1% of the R_0 of the highest resistance unit. Voltage matched units are such that the R_0 of the lower resistance unit is within a specified percentage of the higher unit. Other types of matched units include: series-parallel matched; resistance temperature matched; resistance ratio-temperature matched.

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

CIRCLE 155 ON READER-SERVICE CARD



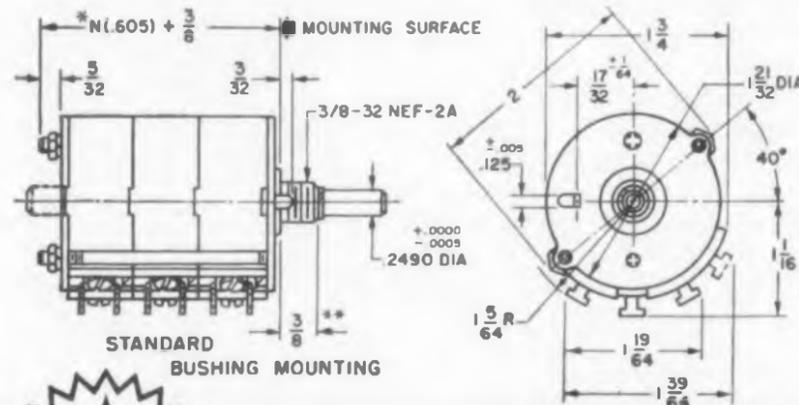
Demonstrated Precision and Reliability

"Workhorse" of the world's airlines, the famed Douglas DC-7 employs Clarostat Series 42 Precision Potentiometers for flap-position indication. This is one more example of Clarostat precision, proved under day-in-day-out working conditions.

CLAROSTAT PRECISION POTENTIOMETERS Series 42



Series 42 potentiometers are wire-wound and offer resistance tolerance of $\pm 5\%$, linear or tapered. Closer tolerances on special request. They are available in a wide variety of electrical and mechanical characteristics to meet application and environmental conditions. Standard units are rated at 3 watts @ 40° C., while special high-temperature units are available for operation up to 230° C., with a rating of 0.25 watt. Units may be ganged by means of threaded rods and end plates. Switches for limited or continuous rotation models are available.



SPECIFICATIONS

Power Rating: 3 watts @ 40° C.
.25 watt @ 230° C. (high-temperature type)

Typical Weight: 0.196 lb.

Insulation Breakdown Tests:
Between terminals and ground for 1 minute,
1000 v.a.c. @ 3.4 Hg.

Resistance Range: Linear, 1 to 100,000
ohms Tapered, 350 ohms per degree of rotation.

Resistance Tolerance: $\pm 5\%$.

Taps: To requirements.

Rotation: Mechanical and electrical,
291°, $\pm 3\%$. Effective, 280° to $\pm 3\%$.

Torque: 1 to 6 oz./in.



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Clarostat Means Precision You Can Count On

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MINIATURE AND SUB-MINIATURE PULSE TRANSFORMERS



These transformers are designed to become an inherent part of the circuitry in which they are used. Designs developed feature good, low-frequency response with minimum droop of the output pulse amplitude during pulse period as well as having good high-frequency response to minimize rise and decay times. Write for Bulletin PT 315 outlining mounting types, general specifications and outstanding features. Our facilities assure exceptional deliveries.

ACME ELECTRIC CORPORATION

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West Coast Plant: 12822 YUKON AVE., HAWTHORNE, CALIF. PO 3254



CIRCLE 157 ON READER-SERVICE CARD

NEW PRODUCTS

Vibrating Reed Electrometer

Measures 10^{-17} amp



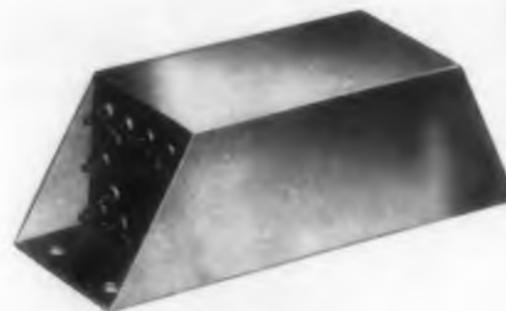
Current as low as 10^{-17} amp, and voltages as low as 0.02 mv can be measured with the Cary Model 32 electrometer. It also measures C^{14} activity to 5×10^{-10} curies per mg $BaCO_3$, and H^3 activity as low as 10^{-10} curies per mg H^3 . The unit accommodates ionization chambers from 50 to 1500 ml, as well as solid and liquid sample accessories. Ranges: 10, 100, 1000 mv, 10 v. Accuracy of the unit is $\pm 0.25\%$. It consumes 50 w at 115 v, 60 cps.

Applied Physics Corp., Dept. ED, 2724 South Peck Road, Monrovia, Calif.

CIRCLE 158 ON READER-SERVICE CARD

Servo Amplifier

Weighs 10 oz



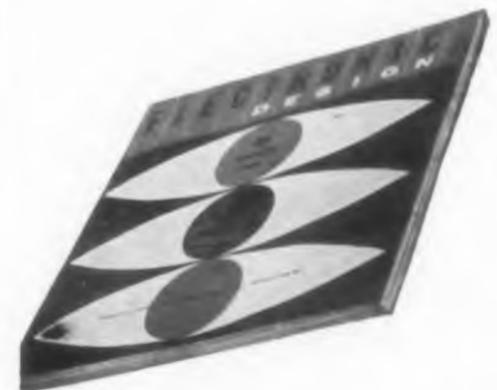
This magnetic amplifier, 4.5 in. long and weighing 10 oz, is a wide band pass servo unit designed to drive standard servo valves. It has a low emissivity finish for operation at high radiant energy levels and meets Mil-E-5272A. Input range for the two control inputs (one may be feedback), is -1 to $+1$ v. Maximum output is $+15$ ma and $+15$ v. Gain may be adjusted externally; supply of 115 v, 2400 cps.

Vickers Inc., Electric Products Div., Dept., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

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Tape Wound Cores

Epoxy encapsulated

Packaged, ready-to-wind, and epoxy encapsulated, these aluminum based tape wound toroidal cores are for use in magnetic amplifiers, saturable reactors, and special transformers. No taping or supplementary insulation of the core case is necessary, and breakdown rating between the winding and the case is above 1500 v, 60 cps, rms.

G-L Electronics, Inc., Dept. ED,
921 Admiral Wilson Blvd., Camden 5, N.J.

CIRCLE 160 ON READER-SERVICE CARD

Volt-Ammeter

Measures 0.03 μ v



Model 150 micro volt-ammeter measures down to 0.03 μ v and 2×10^{-12} amp, dc. It may be used as an amplifier, micro-microammeter, and with an external voltage supply as a meg-megohmmeter. As a dc voltmeter it measures from 1 μ v to 1 v full scale. As an ammeter it measures from 10^{-11} to 10^{-10} amp full scale. Gains of 10 to 10^7 are possible when used as an amplifier. The unit has zero stability as a voltmeter within 0.1 μ v per day, within 2×10^{-11} amp as an ammeter. The zero center scale indicates polarity and amplitude as well as null point, with 0.5 to 2 sec period.

Keithley Instruments, Inc., Dept. D, 12415 Euclid Ave., Cleveland, Ohio.

Booth 3414

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Engineers/Designers! Ask for this G-C

MICROWAVE FERRITE APPLICATION CHART

MICROWAVE FERRITE APPLICATION CHART

MATERIAL	BAND	LOWEST OPERATING FREQUENCY**	TYPICAL APPLICATION	TYPICAL POWER LEVEL
R-1	X	8,500 megacycles	Phase Shifter	Low Power
R-4	X	7,000 megacycles	Phase Shifter	Can be used above resonance at peak power > 1 Megawatt (2)
R-4	S	2,500 megacycles	Resonance Isolator (1)	Low Power
R-5*	C	5,000 megacycles	Phase Shifter	Can be used above or below resonance at peak power > 1 Megawatt (2)
R-5*	S	2,500 megacycles	Phase Shifter	Can be used above resonance at peak power > 1 Megawatt (2)
R-5*	L	1,000 megacycles	Resonance Isolator	Low Power
R-6*	S	2,500 megacycles	Phase Shifter	Similar to R-5
R-6*	L	1,000 megacycles	Resonance Isolator	Low Power

*NEW PRODUCT

REMARKS:

- (1) R-4 saturates more rapidly than R-1 resulting in faster reduction at low field losses. See hysteresis loop data.
- (2) Operating power levels reported by customers. It has also been reported that R-5 and R-6 can be used as low as 500 Mc/s in certain phase shifter applications.
R-1 and R-4 are Mg-Mn ferrites. R-5 and R-6 are Mg-Mn-Al ferrites.

**Lowest Recommended Frequency—can be used at frequencies above published value.



— it's included in the new General Ceramics Data Bulletin on Microwave Ferrites

This new comprehensive bulletin contains technical data on the most complete cross-section of materials in the industry, including two grades introduced for the first time. Included are hysteresis loops, magnetic and dielectric properties vs. frequency, and magnetic induction vs. temperature curves on ferrite materials R1, R4

and newly-developed R5 and R6. Application data, magnetic properties tables, and drawings and dimensions of available stock parts are also contained in new Bulletin 259. Request your copy of this informative literature, today; please address inquiries to General Ceramics Corporation, Keasbey, New Jersey—Dept. E.

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*Booth 1727:
60th Street Side, 1st Floor rear of Coliseum under mezzanine.

NEW PRODUCTS

Trimmer Potentiometer

For high temperature use

Miniature model W-10 trimmer potentiometer has a variable micrometer adjustment which gives a precise selection of resistance from 10 ohms to 150 K. For high temperature use, the unit has an epoxy encapsulated winding and an epoxy sealed case that withstands 500 F.

Atohm Electronics, Dept. ED, 7648 San Fernando Rd., Sun Valley, Calif.

CIRCLE 151 ON READER-SERVICE CARD

Commutator-Gating Units

In standard IRIG sampling rates



Available in all standard IRIG sampling rates and channel configurations, series CAG commutator gating units accommodate high level inputs ranging from 0 to +5 v full scale. Typical signal sources which may be used with the unit are potentiometers, cathode followers, and voltage references. The output may be fed directly to a standard subcarrier oscillator or to an rf transmitter.

General Devices, Inc., Dept. ED, P.O. Box 253, Princeton, N.J.

CIRCLE 152 ON READER-SERVICE CARD

Aluminum Clad Copper Wire

For high temperature use

Composed of an aluminum alloy cladding over a high conductivity copper core, this wire has applications both as magnet wire and as high temperature lead-in wire. Suited for use in aircraft, missiles, and high speed industrial equipment, it has about 70 per cent the conductivity of copper at room temperature.

Sylvania Electric Products Inc., Dept. ED, Warren, Pa.

CIRCLE 153 ON READER-SERVICE CARD

Telemetry Wave Dropout Analyzer

For magnetic tape



Designed primarily for telemetering instrumentation, this instrument measures: the dropout characteristics in a magnetic tape recording over a range of operating frequencies from 7.5 to 80 kc; a dropout amplitude range from 15 to 85%; and a dropout width range from 38 to 360 usec. For each dropout detected with respect to a predetermined amplitude and width, a 70 v positive going, rectangular pulse is emitted. It measures dropouts in accordance with Mil-T-21029 (Ships).

Acoustronics, Inc., Dept. ED, 156 Olive St., Huntington Station, N. Y.

CIRCLE 167 ON READER-SERVICE CARD

Differential Transformers

Linear stroke

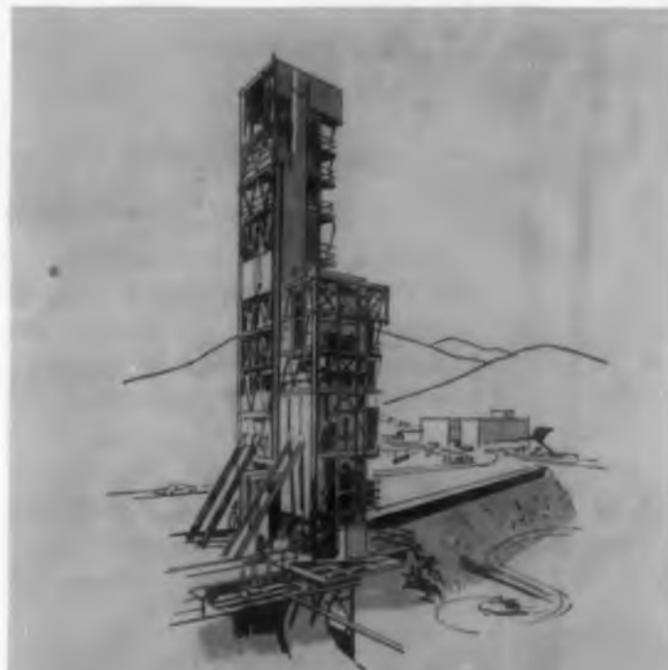


These differential transformers have a linear stroke of 70% of coil length, and high output and low impedance secondary windings. Linear displacement is from ± 0.5 to ± 8 in. Ratio of output voltage, at range limit, to null voltage is 1000:1. Linearity of $\pm 0.5\%$ over a temperature range of -60 to 250 F is attainable. The units are magnetically shielded, potted and furnished with Teflon insulated leads.

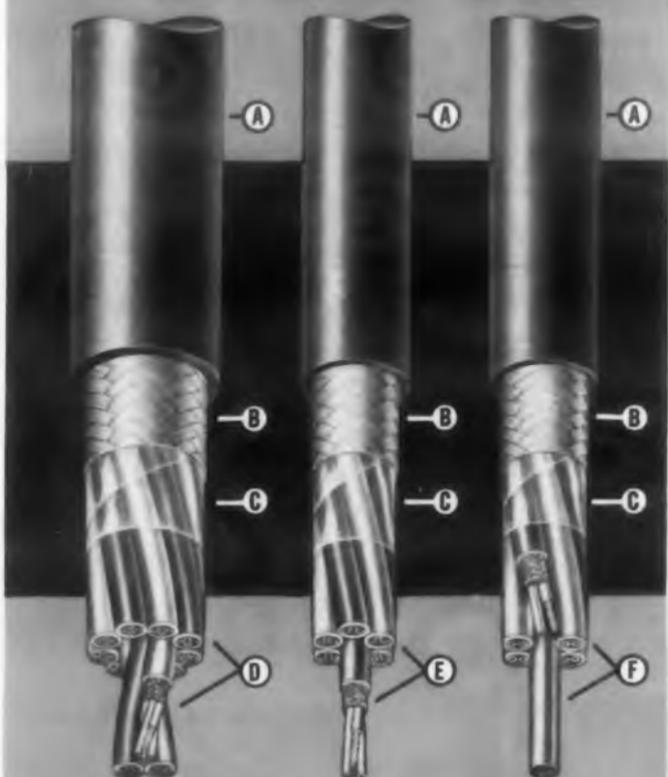
Automatic Timing & Controls, Inc., Dept. ED, Dept. 213, King of Prussia, Pa.

CIRCLE 168 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.



Series 1 Cables Series 2 Cables Series 3 Cables



Ⓐ Vinyl jacket Ⓑ Tinned copper shield Ⓒ Mylar tape wrap Ⓓ 12 color coded groups. Each group: 2, 3, or 4 color coded conductors, shielded, jacketed
Ⓔ color coded groups. Each group: 2, 3, or 4 color coded conductors, shielded, jacketed
Ⓕ 6 color coded pairs cabled around vinyl filler. Each pair coded thermocouple wire, shielded, jacketed.

THE WILLIAM BRAND & CO., INCORPORATED

WILLIMANTIC 2 TURBO BRAND CONNECTICUT

electrical and electronic wires and cables • harnesses and cable assemblies • plastic and coated insulating tubings • identification markers

BRAND TEAMS WITH MARTIN TO MEET TOUGH CABLE SPECS FOR TITAN TEST FIRING

Absolute reliability! A must for the control and telemetering cables used for transmitting high fidelity signals during missile development static test firings. The data collected must be absolutely accurate if it is to establish the validity of the missile design or become the basis for necessary changes. The Martin Company found the solution to these tough signal transmission problems with three special multi-conductor cables produced by Brand. Here's how Brand teamed with Martin to meet these new and difficult cable specifications:

Series 1 Instrumentation Cables: — Problem: Cables to have approximately the same uniform diameter with varying numbers of conductors, to fit into standard connectors. To meet critical electrical requirements, especially low loss characteristics. **Solution:** Use color coded Turbolene (polyethylene type) insulation to meet electrical and physical requirements. Give twisted pairs a uniform circular cross section by using specially developed extruded Turbolene fillers.

Series 2 Instrumentation Cables: — Problem: Cables to operate up to 100°C and to have approximately the same finished diameter with varying numbers of conductors. **Solution:** Use insulated wires meeting MIL-W-16878, manufactured with Turbo 540 vinyl compound and nylon jacketed. Carefully control lay lengths during cabling, and outer jacket wall thicknesses.

Series 3 Thermocouple Cables: — Problem: Non-hygroscopic, funginert cables, each six thermocouple pairs. **Solution:** Develop extrusion and cabling techniques to economically process hard and springy chromel, alumel, iron, constantan and copper conductors. Use Turbo 540 vinyl compound as primary insulation and as filler.

There were additional problems common to all series. (1) A vinyl jacketing material for the shielded groups to operate at both high and low temperatures, and to have an IR value comparable to those found in vinyl primary insulation. Turbo 570, a new custom formulation, was developed to meet these requirements. (2) All groups of conductors laid in a predetermined pattern to facilitate termination. The cables were manufactured on large two-bay planetary cablers to control positioning. (3) Long, unbroken, uniform lengths — all control and instrumentation circuitry is carried in steel reinforced concrete tunnels between test stands and blockhouse as shown in the above drawing.

Whether in missiles, aircraft, business machines or electronics — Turbo cables are custom engineered for specific operating conditions; manufactured by quality-conscious technicians; tested foot by foot for specification compliance. We invite you to call on our extensive engineering experience to solve your cable problems. No obligation, of course. Send your specifications or requirements.

Visit us at Booth M-19 at the IRE Show

CIRCLE 169 ON READER-SERVICE CARD



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selenium rectifiers

HIGH EFFICIENCY
LONG LIFE
RELIABILITY

Backed by the research, development, manufacturing and technical experience of the worldwide International Telephone and Telegraph Corporation



ITT SELENIUM CONTACT PROTECTORS

To extend the life of contacts in inductive circuits; To reduce radio interference resulting when opening inductive circuits.

Applicable to AC or DC circuits . . . Negligible effect on speed of relay operation . . . Performance surpassing RC networks Available in hermetically sealed cases . . . Rugged construction . . . Simple installation.



ITT HIGH DENSITY SELENIUM RECTIFIERS FOR HOME ENTERTAINMENT EQUIPMENT

Long life . . . Full range of current ratings . . . Smaller size . . . High output voltage . . . Low temperature rise . . . Proved mechanical construction . . . Available with mountings and terminals to meet all requirements . . . 85°C UL acceptance.

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IRE SHOW



ITT TUBULAR SELENIUM RECTIFIERS

Current ratings from 5 to 40 milliamperes and output voltages to 5000 volts dc . . . Adaptable to voltage multiplying circuits . . . Voltage immediately available (no warm-up time) . . . Low shunt capacity . . . Glass and metal hermetically sealed enclosures . . . Phenolic and paper enclosures . . . Polarized fuse-clip mounting or pigtail leads . . . Rugged construction.



ITT INDUSTRIAL SELENIUM RECTIFIERS

Custom designed for the application . . . Many cell sizes and voltages make possible a wide line of rectifiers supplying milliwatts to kilowatts of power . . . Stable operation over wide temperature range . . . Available for high temperature operation to 125°C . . . Long life . . . Good voltage regulation . . . Withstand temporary overloads.

ITT

Components Division

P. O. BOX 412, CLIFTON, NEW JERSEY

CIRCLE 170 ON READER-SERVICE CARD

NEW PRODUCTS

Scintillation Counter

For X-ray diffraction studies

Model 10-7 is a low noise, high speed counter for X-ray diffraction studies. Mounting flanges are available to match the counter to standard commercial X-ray diffraction systems. The unit includes a gain of 10 preamplifier, a selected photomultiplier tube, and a thin $NaI(Tl)$ crystal. It measures 1-5/16 x 6 x 4-1/2 in. and weighs 4 lb.

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

CIRCLE 171 ON READER-SERVICE CARD

Wirewound Resistors

Highly stable



Hermetically sealed type RSH-2B precision wirewound resistors have resistances from 1 to 4200 ohms and stability levels of 1, 0.5, 0.25, and 0.1%. Depending on the stability level, power ratings are 0.75 to 1.5 w at 25 C, derating to 0 between 100 and 130 C. Temperature coefficient is 0.00002 per deg C, and tolerances are between ± 0.05 and $\pm 3\%$.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

CIRCLE 172 ON READER-SERVICE CARD

Dual Recorder

Plots two quantities on one chart

The CH-37 Duplex Recorder plots two related electrical quantities side by side on one chart. Its two separate recording mechanisms are housed in a 15 x 16 in. case designed for semiflush panel mounting. The unit is provided with either a single speed synchronous motor giving 11 chart speeds from 1/4 to 30 in. per hr or a double speed motor offering 28 speeds from 1/4 in. per hr to 120 in. per min.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 173 ON READER-SERVICE CARD

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Electronic Design, Development and Production

We design and produce both simple and complex components and assemblies. Electronic, Electro-Mechanical and Mechanical for commercial and military applications in Radio, Television, Telecommunications, Computers, Radar, Guided Missiles and allied fields; also, Pulse Amplifiers, Triggered Circuits, Wide Band Circuits, Toroidal Windings and Transformers. Write for brochure giving complete information.

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SILVER CREEK, N. Y. • TELEPHONE 680

CIRCLE 174 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1969

Skived Teflon Tapes

For high temperature insulation

Made by skiving Teflon billets, these unsupported fused tapes have good electrical properties, resistance to all common chemicals, a low coefficient of friction, and a surface to which nothing will stick. Mainly for high temperature and high frequency wire and cable insulation, they also serve as stock for gaskets, seals, and other small parts. They are available in four grades designated ST-X, ST-C, ST-1, and ST-2; in widths from 1/4 to 12 in.; and in thicknesses from 0.002 to 0.1 in.

Continental-Diamond Fibre Corp., Dept. ED, Newark, Del.

CIRCLE 175 ON READER-SERVICE CARD

Data Processing Equipment

Punched tape

An integrated processing device, the Data Punch consists of a 20 digit per sec tape punch and a full-keyboard adding machine which activates the punch. It produces two records simultaneously: a detailed strip for immediate accounting data; and a punched tape which can be directed to digital computers and processors. Information on the punched tape can be converted to punched cards or magnetic tape for further processing.

Victor Adding Machine Co., Dept. ED, 3900 N. Rockwell St., Chicago 18, Ill.

CIRCLE 176 ON READER-SERVICE CARD

Antenna Pattern Analyzer

Uses rf crystals

Using rf crystals in a video detector system, the BA-7 antenna pattern analyzer requires a maximum of 1 μ w rf power to achieve a maximum measurement range of 45 db in one step. A dc biasing circuit is included to permit the use of conventional barretters, requiring a dc bias between 0 and 10 ma. The unit can be used to measure high power ratios; to determine the rejection coefficients of rf filters; and to calibrate attenuators. It has a wide dynamic linear range, a low noise level, and a wide rf frequency range where video crystal mounts are available.

Weinschel Engineering, Dept. ED, 10503 Metropolitan Ave., Kensington, Md.

CIRCLE 177 ON READER-SERVICE CARD

ITT

GOLD CROWN

S I L I C O N D I F F U S E D J U N C T I O N

POWER RECTIFIERS

ITT Gold Crown Diffused Junction Silicon Power Rectifiers utilize new concepts in diffused junction semiconductor device fabrication to achieve highest efficiency and maximum reliability. Gold plated for maximum thermal transfer . . . Dual positive hermetic seals . . . Conservatively rated . . . Trustworthy in the most demanding commercial and military applications.

SERIES F

Up to 70 amperes at 150° C case temperature

Peak inverse voltages to 600 volts

3/8" — 24 stud; 1-1/16" hex



SERIES D

Up to 30 amperes at 150° C case temperature

Peak inverse voltages to 800 volts

1/4" — 28 stud; 11/16" hex



SERIES C

Rated to 1.5 amperes with axial or printed circuit parallel leads; 10-32 stud mount available for higher output currents.

Peak inverse voltages to 600 volts



ZENER REGULATORS

ITT Gold Crown silicon zener regulators are designed for maximum stability of characteristics over the entire operating range of -65° C to +165° C. Hermetic sealing insures complete environmental protection and utmost reliability.

Gold Crown zener regulators feature:

- Four power ratings
- Eleven voltage ratings (3.9 — 27 volts)
- $\pm 10\%$ and $\pm 5\%$ tolerances
- Axial lead and stud mounting



SERIES B
750 milliwatts



SERIES T
1 watt



SERIES G
3.5 watts



SERIES K
10 watts

Write for complete technical information.

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Components Division

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

P. O. BOX 412 CLIFTON, N. J.

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All are of the consistent quality that has made—and kept—Handy & Harman first in the manufacture and development of silver and silver alloys for industry.

At the right are some of the general forms of silver made by Handy & Harman (what you don't see, ask for):

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- Silver Contact Alloys
- Silver Powders
- Silver Flake and Paint
- Silver Brazing Alloys
- Silver Electronic Solders
- Silver Sintered Metals
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CIRCLE 179 ON READER-SERVICE CARD

NEW PRODUCTS

Packaging Material

Low density



A low density, moldable packaging material made from polyurethane, K-Foam is a light weight material which protects all types of light-weight aircraft instruments, missile parts, electronic parts, and tubes. At the same time, it reduces tare and cubage. It can be molded in any density and meets MIL-P-6064A and MIL-C-7769 packaging specifications. Nonabrasive, nonhygroscopic, nontoxic, and flame proof, it has a neutral PH factor.

Henry B. Katz Industries, Inc., Dept. ED, 859-879 Summer Ave., Newark 4, N.J.

CIRCLE 180 ON READER-SERVICE CARD

Miniature Shift Register

One core per bit



Model SR-104 is a one-core-per-binary-bit unit with a 5 kc information rate and a 10 to 1 signal to noise ratio. Its operating temperature range is -55 to +125 C. A 14 μ sec, 22 v output pulse is obtained by applying a 10 μ sec, 7 ma input pulse and subsequently an 8 μ sec, 300 ma shift pulse. Encapsulated in an epoxy compound, the unit occupies a total volume of 0.2 cu in.

ESC Corp., Dept. ED, 534 Bergen Blvd., Palisades, N.J.

CIRCLE 181 ON READER-SERVICE CARD

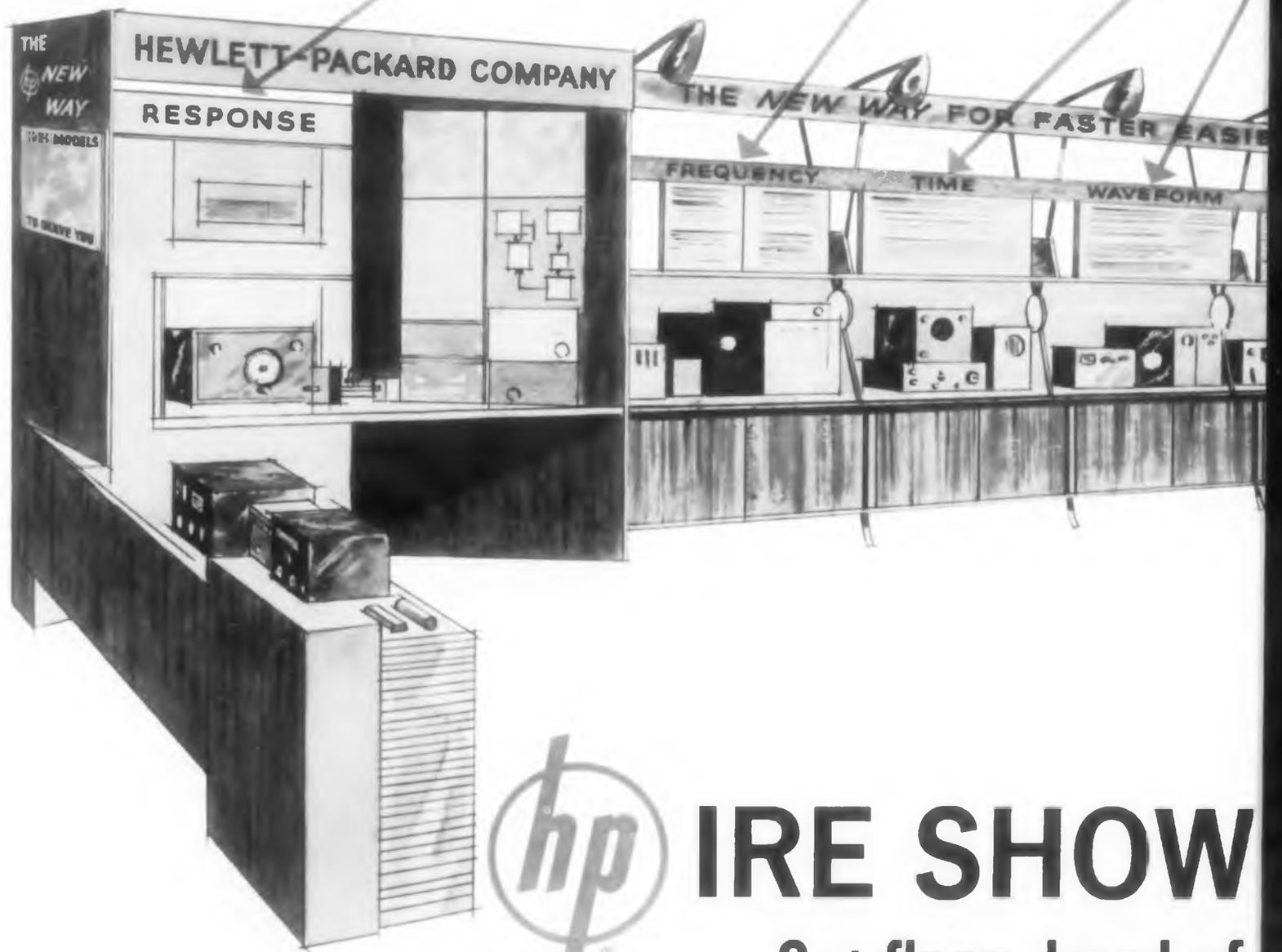
CIRCLE 499 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

A new way...

new cost-cutting measuring techniques
made possible by new-concept

 instruments



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59



RESPONSE

New electronic sweep oscillators (left). 5 units cover 2 to 18 KMC. Quick, accurate, convenient response measurements of all types of circuits such as masers, parametric amplifiers, TWT's, couplers, attenuators. Also new microwave wavemeters (right), including K and R bands, provide complete coverage 8.2 to 40.0 KMC.

FREQUENCY

Direct, instant, in-line readings; bright, steady numerals on new counters. New reading ease, wide range, improved sensitivity and accuracy.



TIME

New clock and divider circuit for control of extremely accurate frequency standards and comparison with station WWV within 10 microseconds accuracy ($1/10^{10}$ accuracy).

WAVEFORM

All-new, transistorized wave analyzer—20 cps to 50 KC, compact, versatile, featuring new control simplicity, new tuning ease, automatic features never before in any wave analyzer. Operating at -hp- display with new low cost, dual trace oscilloscope.



VOLTAGE

New, moderately-priced digital voltmeter providing true "touch-and-read" convenience, automatic range and polarity selection; permits readings to be recorded automatically. Also: new, portable transistorized ac voltmeter.

CURRENT

Revolutionary design approach provides new "clip-and-read" dc current measurement ease—no soldering, no circuit loading, no direct connection. Also new plug-in for -hp- 150A series oscilloscopes permits viewing ac current and voltage simultaneously—ideal combination for transistor circuit testing.



escalators

there

IS

a new way!
see it...test it at



IRE SHOW

2nd floor—head of escalators

other **NEW WAY** instruments you can see and operate at the  I.R.E. exhibit



NEW IN-LINE 220 MC COUNTER

New model 524C with plug-ins measures frequency to 220 MC, time interval 1 μ sec to 100 days, period dc to 10 KC. New in-line readout, brightly visible under any lighting conditions. Resolution 0.1 μ sec, stability $3/10^8$ short term, no calculation or complex setup, highest quality, regarded by many as premium commercial counter offered. \$2,300.00.



NEW IN-LINE 1.2 MC COUNTER

Model 523C Electronic Counter provides all-purpose versatility plus the time-saving convenience of bright, steady in-line readout. Measures frequency 10 cps to 1.2 MC, time interval 1 μ sec to 27.8 hours, period 0.00001 cps to 10 KC. Stability $2/1,000,000$ per week. Results displayed in sec, msec, μ sec or KC, automatic decimal. Display time variable, accuracy ± 1 count \cdot stability. Price on request.



NEW TRANSFER OSCILLATOR FOR COUNTERS

Together with hp 524 series counter, measures frequency to 12 KMC quickly, easily, with counter accuracy. Guesswork, trial and error experimentation, expensive setups are eliminated. Measure on pulsed, AM, FM, CW or noisy circuits. Overall accuracy better than 10 times that of best microwave wavemeters; accuracy on clean CW signals is about $1/1,000,000$. Stability better than 0.002%/minute. \$750.00.



NEW PRECISION VTVM

Model 412A is a precision vacuum tube voltmeter providing measurements from 1 mv to 1,000 v full scale, with accuracy of 1%. This remarkable new high-accuracy instrument also measures currents from 1 microampere to 1 ampere full scale with 2% accuracy, and measures resistances 0.2 ohms to more than 5,000 megohms. \$350.00.



PRECISION FIXED ATTENUATOR

-hp- 372A series provide fixed standards of attenuation for waveguide measurements for all bands and waveguide sizes from 2 to 40 KMC. Their precise accuracy is not affected by temperature, humidity or other external factors. \$100.00 to \$375.00.



at **IRE** \cdot head of escalators \cdot 2nd floor

If you aren't attending this year, please call your -hp- representative or write direct for information on any new -hp- equipment.

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26 ISSUES IN **59**

NEW PRODUCTS

Pancake Synchros and Resolvers

Accuracies to 5 min



Available in size 20 and 27, these pancake synchros and resolvers feature accuracies down to 5 min and are made for instruments such as inertial guidance systems. Their electrical properties are designed to meet specific applications or to match standard components for accuracy, voltage gradient, and impedances. They may be obtained with integral flanges and hubs.

Luther Mfg. Co., Dept. ED, 7312 Varna St., North Hollywood, Calif.

CIRCLE 182 ON READER-SERVICE CARD

AC Voltage Calibrator

Has 0.1% accuracy



Absolute voltages accurate to 0.1% may be obtained by setting the digital controls of this precision ac voltage source. This accuracy is maintained at all frequencies from 35 cps to 10 kc. The unit will provide up to 30 w of power. Output wave form is sinusoidal with less than 0.15% distortion.

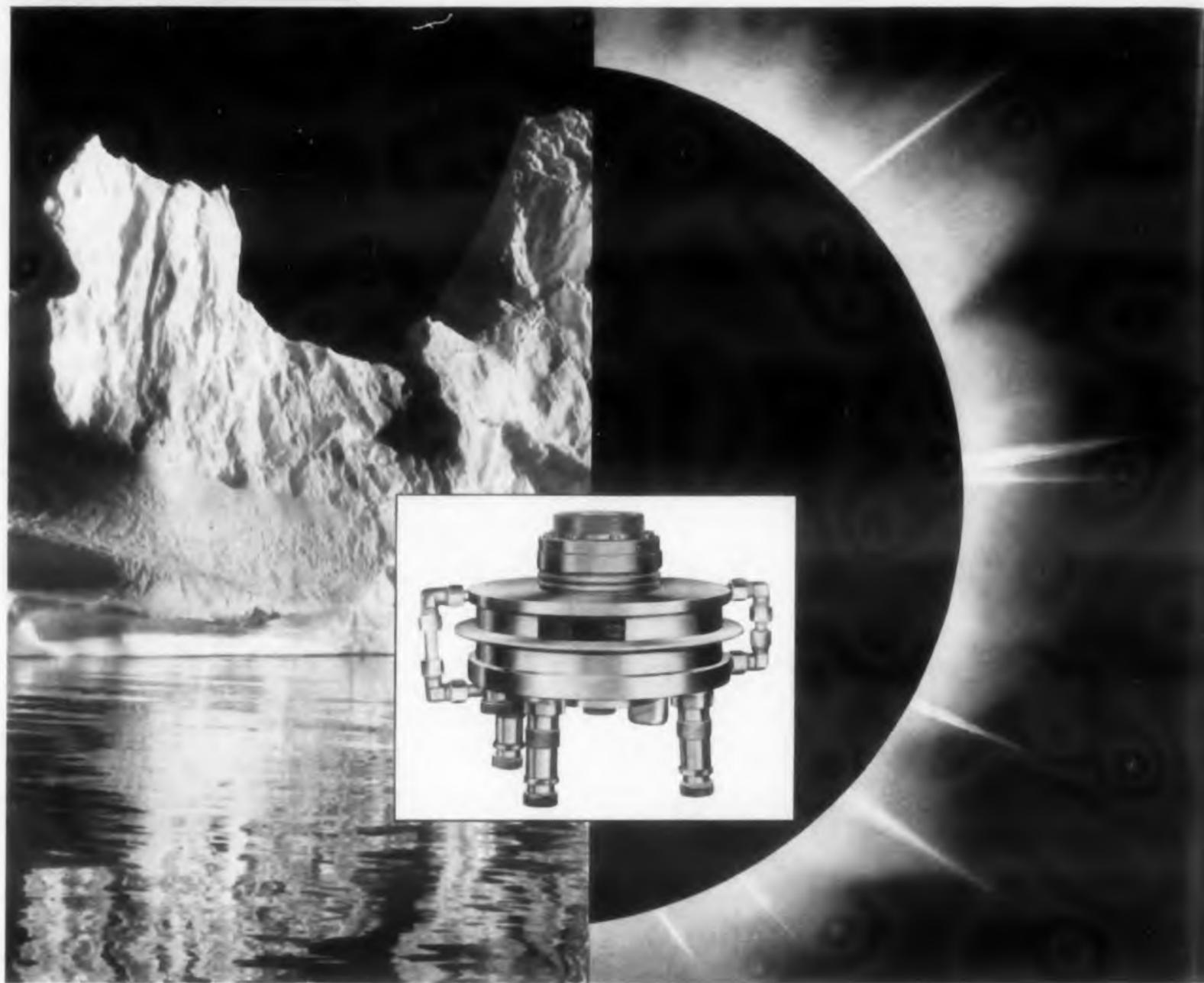
Holt Instrument Labs., Dept. ED, Oconto, Wis.

CIRCLE 183 ON READER-SERVICE CARD

This is the time of our annual subscription renewal.



THE RAW MATERIALS OF PROGRESS



FLUOROCHEMICALS, STABLE BELOW 0°

Polar cold! "Hot Spot" heat! To meet environmental and operational extremes like these, the RCA high-output transmitting tube shown above, needed a coolant superior to water. That coolant is FC 75, an inert fluid, one of the 3M Fluorochemicals. RCA found that FC 75 safely cooled tubes with plate dissipations in the order of 1,000 watts per sq. cm., and permitted essentially the same power output to be obtained at temperatures below 32° F. as that obtained with water cooling at temperatures above 32° F. The most stable fluid ever offered to electronics, FC 75 properties make it excel as a coolant and insulating fluid.

It has high dielectric strength, high heat transfer capability, is self-healing. It has wide liquid range with a pour point of -148°F. and low viscosity. It is thermally stable in excess of 800°F. As an evaporative coolant it is all these: nonexplosive, nonflammable, nontoxic, odorless, non-corrosive. Check the other properties at the right—then investigate FC 75, as well as other 3M Chemicals for the electronics industry: KEL-F® Molding Powders, KEL-F® Dispersions, KEL-F® Elastomers, Cardolite® NC 513, KEL-F® Oils, Waxes and Greases, Acids and Alkanes.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 184 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959



3M FLUORO-CHEMICAL FC 75 pours at -148°F . It has a wide liquid range of -148°F . to 212°F . at atmospheric pressure, with low viscosity. In addition, it offers these useful properties: high dielectric strength of 37KV; self-healing, maintaining dielectric strength after repeated high voltage arcing. Compatible with most materials used in high temperature equipment. Thermally stable in excess of 800°F ., it prevents development of hot spots in equipment. Prevents sludge formation due to hydrolysis or oxidation.

or at 800°F .

For free literature, write on your company letterhead, specifying product interest to 3M Chemical Division, Dept. WD-39, St. Paul 6, Minn.



3M CHEMICAL DIVISION, MANUFACTURERS OF:
Acids • Resins • Elastomers • Plastics •
Oils, Waxes and Greases • Dispersion
Coatings • Functional Fluorochem-
icals • Inert Liquids and Surfactants

Range and Balance Instrument

For bridge arm resistances



The BR 111 range and balance unit is a full scale, adjustable instrument that balances out small inequalities in bridge arm resistances. It is equipped with gold contact relays that minimize dry circuit problems; a front panel switch for changing to auxiliary power supplies; pushbuttons for controlling both range and balance; and a remote switch for setting all channels into two standardization modes. Built to withstand adverse environments, it contains six independently adjustable, identical channels, constructed on a single chassis for mounting in standard 19 in. racks. It is engineered to permit adjusting bridge current to the proper value by precision calibrating resistors. The unit is designed as a control center for use in coupling strain gages or resistive-bridge-type pickups to direct writing oscillographs, standard meters, chart recorders, and analog-to-digital converters. When coupled with high sensitivity galvanometers in a multichannel photographic recording oscillograph, it permits direct recording without amplifiers.

Computer Engineering Associates, Inc., Dept. ED, 350 N. Halstead, Pasadena, Calif.

CIRCLE 186 ON READER-SERVICE CARD

Alarm System

For industrial processes

Designed with no moving parts, the Fault-Finder alarm system monitors electric sub-stations, industrial plant operations, and unattended microwave repeater stations. The basic system contains a transistorized ring counter scanner that monitors up to 20 separate items at a scanning rate of 10 points per second. Each monitored item is represented by a switch which sounds an alarm for abnormal conditions at the receiving-annunciator unit. The system requires only one communications channel, ranging from a pair of wires to a subcarrier radio or microwave channel. It has plug-in circuit boards and operates from 115 v, 60 cps current or a 125 or 48 v dc source.

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

CIRCLE 187 ON READER-SERVICE CARD



When WEIGHT and SIZE are Critical...

... consider
ARNOUX's new,
transistorized, high-
sensitivity, miniature
temperature-measure-
ment subsystems for
missile and aircraft
flight testing.



This newest series — TME-1SD and TME-2SD — are for use with fast-response, 100-ohm resistance temperature transducers to produce a full 5-volt output for a span of only 75 F. TME-1SD is a single-channel model; TME-2SD, a dual-channel model.

The unit contains a regulated power supply, transistor amplifier, and gain and zero controls. No additional power source or controls are needed.

Nominal, overall accuracy is ± 2.5 percent throughout MIL-E-5272A environmental conditions. Power consumption is 26 watts (TME-1SD) or 27 watts (TME-2SD), at 28 vdc. Output impedance is approximately 10,000 ohms. The bridge can be balanced for zero output setting at any temperature from -320 F to $+250$ F. Gain adjustment allows full-scale span to be varied. Maximum drift over the environmental temperature range is ± 2 percent of full scale.

designers and manufacturers of precision instrumentation

For further
information
write for
Bulletin 503

ARNOUX

ARNOUX CORPORATION

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CIRCLE 188 ON READER-SERVICE CARD

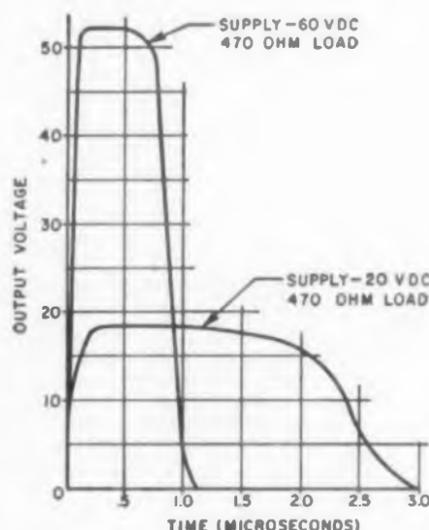


MICRO SWITCH Precision Switches

"1PB600" Series pushbutton switch,
one of many in the "One-Shot" line.



New "One-Shot" switches produce one square wave pulse per operation



These are typical output curves
for the "1PB600" Series "One-Shot"
switch, illustrated above.

This new series of snap-action switches incorporates a special circuit which produces a single square wave pulse regardless of the speed of switch operation. Variations can be furnished with pulse widths from 0.1 to 10.0 microseconds. The basic "One-Shot" circuit can be provided with a variety of switch types. No standby power is required. The circuit is potted for physical and environmental protection.

These "One-Shot" assemblies provide a pre-engineered, compact package to accomplish a shaped wave output, thus eliminating costly, time-consuming custom development of circuits.

"One-Shot" switches are available for operation in temperatures from -65° to $+185^{\circ}$ F.

Applications include computer and radar consoles, keyboards, electronic test equipment, fusing, arming and firing circuits, checking ring counters, setting and re-setting flip-flops, and reflected pulse systems. Ask for data sheet 150.

Engineering assistance on switch application is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILL.

A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario

See working models of the "One-Shot" switch in Booth No. 2202 at the IRE Show



Honeywell

MICRO SWITCH PRECISION SWITCHES

CIRCLE 189 ON READER-SERVICE CARD

NEW PRODUCTS

Differential Transformer Indicator

Has 1% accuracy



Accurate, large scale indication and recording of linear motion, size, weight, force, pressure, and other quantities measurable by differential transformer transducers is achieved with the model 300A differential transformer indicator. Completely self-contained, the instrument has a 10 in. Weston panel meter, a constant current excitation supply, self-checking features to eliminate drift errors, and five calibrated sensitivity ranges which cover all usual scientific and industrial requirements. Accuracy is 1% with maximum resolution of 0.000005 in. of core displacement. Special dial marking are available as required, and a suitable electrical output is provided for direct operation of standard potentiometer recorders.

Daytronic Corp., Dept. ED, 216 S. Main St., Dayton 2, Ohio.

CIRCLE 190 ON READER-SERVICE CARD

Cable Cutter

Nonshorting

Individual conductors in the cable bundle are not short-circuited when the cutting action of this propellant-actuated guillotine takes place. The unit uses a ceramic cutter blade that is driven through the cable bundle onto a ceramic anvil. Driving power comes from a standard screw-in explosive cell. Designed to eliminate all switches, plugs, relays, contactors, or receptacles, this cutter permits the solidly permanent wiring of all circuit elements to an unactivated battery. Activating the battery energizes the circuit and firing the cutter de-energizes it. Potential applications exist where electrical circuits should be severed with no electrical contact between separate circuits.

Beckman & Whitley, Inc., Dept. ED, 985 E. San Carlos Ave., San Carlos, Calif.

CIRCLE 191 ON READER-SERVICE CARD

Permanent Magnets

Have continuously variable field strengths

With the Variflux magnet, field strengths continuously variable over a 20 to 1 ratio of maximum to minimum are obtained at any chosen gap by means of adjustable magnetic shunt rings. Variability of the gap is 0 to 4-1/2 in. Stock pole faces, readily interchangeable, are: 10 cm diameter flat field shimmed pole faces suitable for nuclear magnetic resonance and beta spectrometers; 5 cm diameter high intensity field poles; and 10 cm radius 60 deg sector poles suitable for mass spectrometers. Typical unshunted fields are 3000 gauss at 1 cm separation of the 5 cm diameter pole faces; and 1200 gauss at 2 cm separation of the 10 cm diameter pole faces. The units have negligible hysteresis.

Laboratory for Science, Dept. ED, 5431 College Ave., P. O. Box 2925, Oakland 18, Calif.

CIRCLE 192 ON READER-SERVICE CARD

Precision Multiplier-Divider

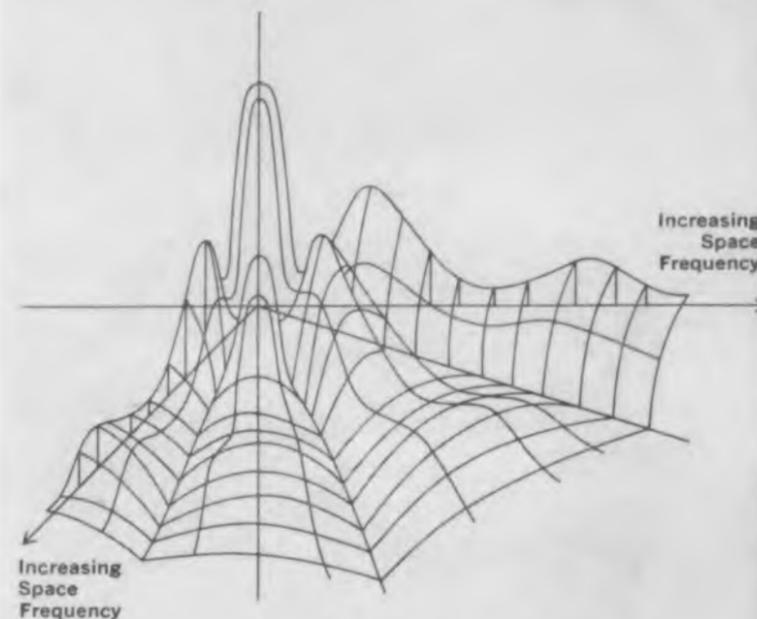
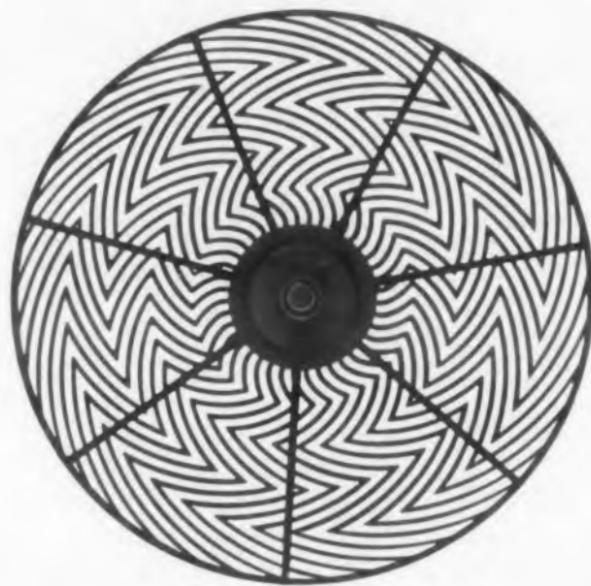
Analog computing component



Model K5-M multiplier-divider is a precision analog computing component with long term stability. Based on an all-electronic semiconductor network, it accepts three variable inputs, e_1 , e_2 , e_3 , and provides as output $e_1 e_2 / e_3$. Its accuracy as a multiplier, including drift, is better than 0.1 v in all four quadrants. A three-digit decade provides an adjustable voltage which may be added to numerator, denominator, or output. This voltage also serves as an adjustable scale factor for operations involving only two variables. Dynamic response is determined by an adjustable switch setting. The unit is mounted on a standard 7 in. rack panel. In addition to filament power at 115 v ac, it requires 100 ma at plus and minus 300 v dc. The standard range of inputs and outputs is plus and minus 50 v. Typical applications include analog computation, correlation, precision modulation, and control. No external equipment is necessary to obtain products, ratios, squares, square roots, or absolute values.

George A. Philbrick Researches, Inc., Dept. ED, 285 Columbus Ave., Boston 16, Mass.

CIRCLE 193 ON READER-SERVICE CARD



Phosphor bronze reticle (actual size) and space frequency transfer characteristics of circular aperture reticle.

TARGET DISCRIMINATION IN INFRARED DETECTION SYSTEMS

The pioneering field of infrared detection offers many challenging opportunities to scientists and engineers at Ramo-Wooldridge for advanced studies in the solution of target discrimination problems. Research is continually under way at Ramo-Wooldridge in the integrating of infrared detection devices with the latest electronic systems techniques for enhanced target detection on the ground and in the air.

The phosphor bronze reticle, or image chopper, illustrated above was developed by Ramo-Wooldridge. It indicates a marked stride in space filtering discrimination concepts, and is used for target signal enhancement in guided missiles, anti-aircraft fire control and air collision warning applications.

The reticle is used in the focal plane of an infrared optical system and is rotated to chop the target image for the desired space filtering. It is also employed in time filtering, such as pulse length discrimination, or pulse bandwidth filtering.

Space filtering is critical to infrared systems, because of its ability to improve the detection of

objects located in the midst of background interference. In a manner similar to that used in the modification of electronic waveforms by electrical filtering, space filtering enhances the two-dimensional space characteristics of a target. The size and features of the target are highlighted and the undesired background eliminated.

Scientists and engineers with backgrounds in infrared systems—or any of the other important areas of research and development listed below—are invited to inquire about current opportunities at Ramo-Wooldridge.

- Electronic reconnaissance and countermeasures systems
- Analog and digital computers
- Air navigation and traffic control
- Antisubmarine warfare
- Basic research
- Electronic language translation
- Information processing systems
- Advanced radio and wireline communications
- Missile electronics systems



RAMO-WOOLDRIDGE

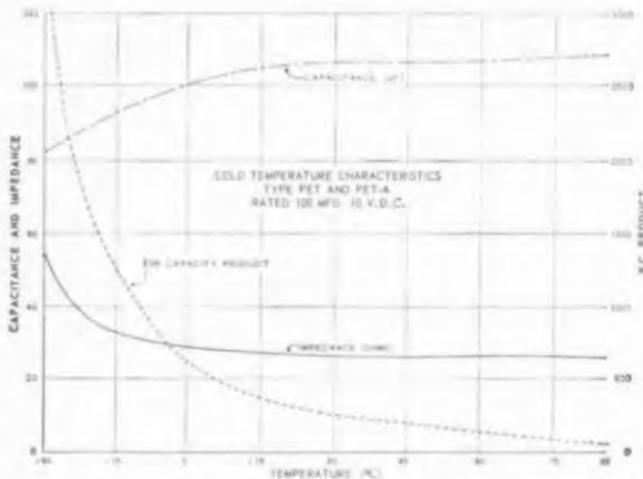
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a division of *Thompson Ramo Wooldridge Inc.*



New High-Performance Electrolytics for Printed Circuits and Miniaturized Equipment

A new line of Mallory electrolytic capacitors . . . latest refinement of the industry—standard FP, WP, and TC models . . . now brings extra performance and compactness to designers of printed circuits and miniaturized products. High temperature shelf life, operating life, and capacitance stability have been substantially increased, by the use of new Mallory low-impedance electrolyte.



Typical temperature characteristics of Type PET and PET-A capacitors.

The new design gives more capacity per unit size than previously possible with comparable aluminum electrolytics. Leakage current, power factor and impedance are exceptionally low. Models are rated for temperatures from -30 to $+85^{\circ}\text{C}$.

Two designs are available. The PET series, specifically for printed circuits, has all leads coming from one end of the case, and is available in single, dual and triple ratings. The PET-A series has axial leads suitable for printed circuit or conventional wiring . . . comes in single and dual ratings.

Excellent performance and protection against humidity are obtained by a plastic case with epoxy end seal.

Case sizes range from $\frac{3}{4}'' \times \frac{5}{8}''$ to $\frac{5}{8}'' \times 1\frac{7}{8}''$. Maximum capacity is 23 mfd/3 VDC to 3 mfd/50 VDC for the smallest size; 1500 mfd/3 VDC to 238 mfd/50 VDC for the largest size. A complete range of ratings is available. Get full details and a consultation on your circuit applications, by writing to Mallory today.



CIRCLE 195 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Terminations

50 to 300 w ratings



These high power coaxial terminations cover the dc to 10 kmc range with a maximum vswr of 1.2. Models RDL-30N and RDL-31N have a dc to 4 kmc range and are rated at 200 and 50 w, respectively, without forced cooling. Model RDL-6N(H) covers 2 to 10 kmc and has a 300 w rating. All units are designed for use with type N connectors.

Radar Design Corp., Dept. ED, P.O. Box 38, Pickard Dr., Syracuse, N.Y.

CIRCLE 196 ON READER-SERVICE CARD

Miniature Indicator

For edge-lighted panels

For all edge-lighting applications, type 855S-E Color-Lite has a 1/2 in. opaque cap, designed for flush mounting, which prevents any light from showing in front of the panel. It uses a standard GE 327 or 328 incandescent bulb, and is available with or without a red filter. The front is removable for easy replacement of bulbs. In both screw body and flange types, the units are 3/8 in. in diameter and have nylon coding collars in standard RETMA colors to simplify wiring behind the panel.

The Sloan Co., Dept. ED, 4029 Burbank Blvd., Burbank, Calif.

CIRCLE 197 ON READER-SERVICE CARD

Automatic Circuit Evaluator

Self-programming

The SPACE Mark Ia. self-programming automatic circuit evaluator is designed for rapid checking of production line electrical equipment. No patchboard arrangement or tape punching is required to place the system in operation.

When a verified wiring harness is connected to the instrument, a punched tape program is generated in the analysis mode of operation. This tape is then used to verify harnesses of similar circuit configuration in the verification mode. Errors are printed out as leakage, resistance, open, or short, together with the appropriate coordinates. The primary function of the instrument is testing for leakage and continuity between two test points which are automatically selected from all combinations of 420 inputs by a scanning unit. The system operates at seven tests per sec and is housed in a cabinet 52 x 44 x 22 in.

Brooks Research, Inc., Dept. ED, P.O. Box 67, Rochester 10, N.Y.

CIRCLE 198 ON READER-SERVICE CARD

Stereophonic Cartridges

Have dual tips

Type 8T ceramic stereophonic cartridges have a response that is smooth from 20 to 20,000 cps and flat to 12,000 cps with gradual rolloff beyond. Output voltage is 0.3 v; compliance, 2×10^{-6} cm/dyne; recommended load, 1 to 5 meg. Tracking pressure is 5 to 7 g; cartridge weight is 7.5 g; and channel isolation is 20 db. The cartridges have two jewel tips, a 0.7 mil for microgroove and a 3 mil for 78 rpm. They mount on standard 7/16 and 1/2 in. centers.

Sonotone Corp., Dept. ED, Elmsford, N.Y.

CIRCLE 199 ON READER-SERVICE CARD

Deposited Carbon Resistors

Rated at 5 w



In values from 100 ohms to 150 meg, DCH-5 deposited carbon resistors are rated at 5 w to 70 C, and derate to 0 at 160 C. Hermetically sealed, the units have a standard tolerance of $\pm 1\%$ and measure 4-1/4 x 9/16 in.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

CIRCLE 200 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

custom-designed Lord mounting systems for:



inertial guidance systems
analog and digital computers
primary navigational systems
integrated electronic systems
radio receivers, transmitters, transponders
magnetrons
airborne radar
pressure transducers
airborne controls and instrumentation
integrating accelerometers

assure:

positive protection for sensitive equipment

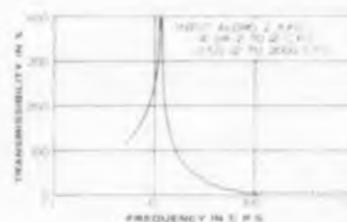
The mounting system shown here was designed, developed and produced by LORD for the inertial guidance platform of an ICBM. It clearly demonstrates LORD's capability to meet the most sophisticated requirements for shock and vibration protection.

You can assure optimum reliability for your missile or advanced jet project by utilizing LORD skills and experience. Integration of LORD abilities with those of your staff will result in an economical system design providing maximum protection for given weight and size.

Complete research, engineering, test and production facilities—staffed with personnel of outstanding capabilities—can provide vital assistance for your program. Full information is available from your nearest LORD Field Engineer or the Home Office, Erie, Pennsylvania.



High-performance mounting system protects 180-lb. guidance platform against ICBM environment. Highly original design weighs only 18 lbs., uses Lord BTR elastomer for broad temperature operation.



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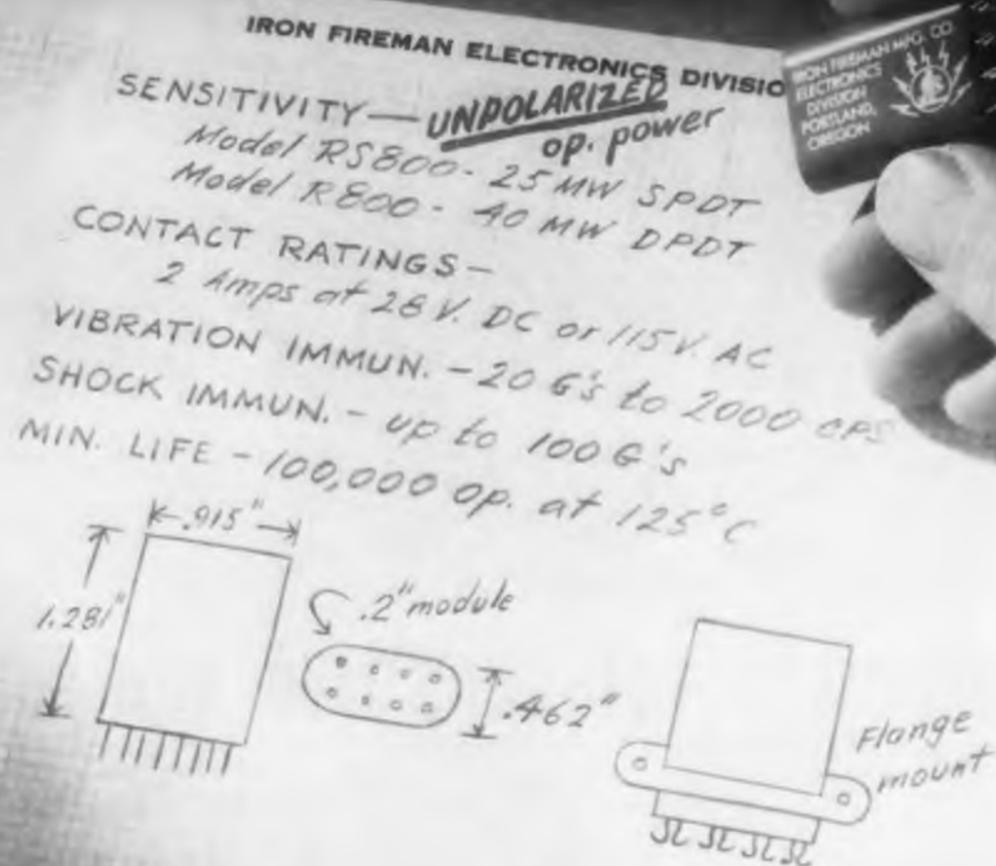
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LORD MANUFACTURING COMPANY • ERIE, PA.

CIRCLE 201 ON READER-SERVICE CARD

Now MICRO-MINIATURE SENSITIVE RELAYS

by Iron Fireman



Sensitivity down to 25 mw.

The sensitivity ratings, vibration and shock immunities shown above are achieved for the first time in a micro-miniature package.

Where only limited power is available, the Iron Fireman R800 offers sensitivities as low as 25 MW of unpolarized exciting power and a high degree of reliability and environmental immunities.

Conforming to and exceeding the test requirements of MIL-R5757C, the performance and reliability of this relay is further enhanced by separately sealing the coils within the outer shell.

Complete performance data available on request. Write to the address below.

When space, weight and sensitivity are a problem specify the Iron Fireman R800 Relay



MICRO. MIN. RELAYS



HIGH SPEED RELAYS



SLIP RINGS & BRUSHES



FREE AND VERTICAL GYROS



IRON FIREMAN *Electronics* **DIVISION**

2838 S. E. NINTH AVENUE, PORTLAND 2, OREGON

CIRCLE 202 ON READER-SERVICE CARD

NEW PRODUCTS

Dummy Load Device

For off-air transmitter tests



The Matchmaster is an instrument which tests transmitters without signals on the air. It consists of a dummy load with a direct reading rf wattmeter and a standing wave ratio bridge. It is useful for measuring the swr in antenna feed lines, the adjustment of radio transmitter power output before going on the air, and many other applications. All components are contained in a cabinet 6 x 8 x 8 in.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

CIRCLE 203 ON READER-SERVICE CARD

Slide Rule

For frequency response calculations

Model 1490 control engineering slide rule gives magnitude ratio and phase response angle in one setting. It has scales for direct conversion from decibels to actual magnitude, and from angular frequency to frequency (cps) or period time (time per cycle). Given the various constants, the rule produces the magnitude ratio in db and phase angles in deg for any angular frequency between 0.001 and 1000 radians per unit time.

Frederick Post Co., Dept. ED, 3650 Avondale, Chicago 18, Ill.

CIRCLE 204 ON READER-SERVICE CARD

Miniature Speed Changer

Adjustable over 25 to 1 range

The miniature series 2 speed changer provides ratios continuously variable from 1 to 5 up to 5 to 1 down. It has a maximum horsepower output of 0.025; a maximum speed of 10,000 rpm; and a torque output of 5 to 40 oz-in. depending on the ratio setting. It is encased in a black anodized aluminum housing with a long easy-to-read scale and is supplied with either servo

er foot mounts. The foot mounts may be rotated 90 deg in either direction. The stainless steel input and output shafts are 3/16 in. in diameter and the housing is 2-5/8 in. long.

Metron Instrument Co., Dept. ED, 432 Lincoln St., Denver 3, Colo.

CIRCLE 205 ON READER-SERVICE CARD

Thyratron Tube

Has 6.4 amp anode current rating

Type VTP 7386 thyratron has a peak anode current rating of 100 amp and is adaptable to any circuit employing a C6J, C6JA, 5685, or 5C21 tube. It can control current pulses to the welding transformer in spot and seam welding machines, and convert ac current to dc for running variable speed motors. It can also serve in adjustable dc power supplies and replace lower-rated types in grid controlled rectifier service. The unit triggers when the potential on the control grid falls between -3 and -7.5 v dc, assuming a maximum forward voltage on the plate of 1000 v. It will also pass current with less than $+75$ v on the plate if the grid carries a positive voltage of at least 3 v. Continuous anode current rating is 6.4 amp. The tube operates over a broad range with a maximum recommended frequency of 440 cps and withstands ambient temperatures from -55 to $+75$ deg C.

Vacuum Tube Products Co., Inc., Dept. ED, 2020 Short St., Oceanside, Calif.

CIRCLE 206 ON READER-SERVICE CARD



Computer Power Supply

Has multiple outputs

This computer power supply system provides six different dc output voltages that are electrically isolated from one another and two ac outputs, one regulated and one unregulated. It is free from transients and provides a total of 4.75 kw dc from six individual rectifier supplies.

Bogue Electric Mfg. Co., Dept. ED, 52 Iowa Ave., Paterson 3, N.J.

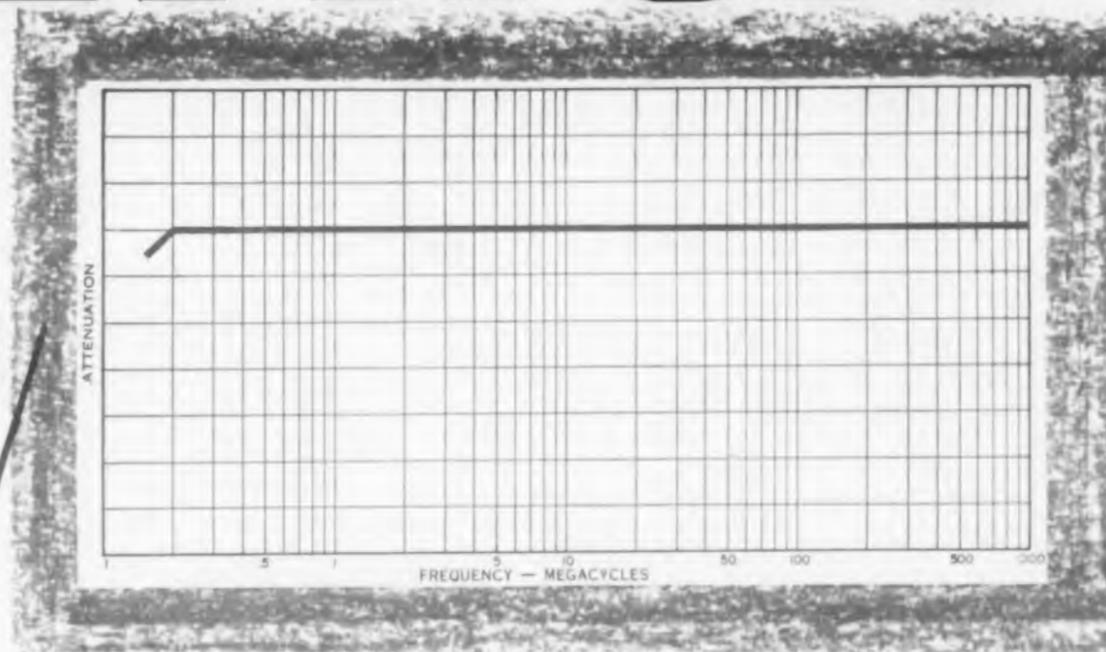
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ELECTRONIC DESIGN • March 18, 1959

how to meet/exceed MIL-SPECS..

FILTRON[®]



RF INTERFERENCE SUPPRESSION

FILTERS

Filtron's prime objective has always been the suppression of radio frequency interference. This objective has been fulfilled thousands of times in making customer's equipment conform to specified performance levels, whether Military, F.C.C. or Industrial.

Filtron first determines what form and magnitude of suppression is necessary to meet specifications. This is accomplished in our modern fully-equipped screen rooms and engineering laboratories, situ-

ated in Flushing, N. Y., and Culver City, Calif. Next, each phase of design and production is company controlled, as our capacitor manufacturing division, coil winding division, metal fabrication shop and metal stamping departments are exclusively producing the highest quality components for Filtron's RF Interference Filters.

If you have a RF Interference Filter problem, consult Filtron—the most reliable name in RF Interference Filters.

Send for your copy of our **NEW CATALOG**.

FILTRON CO., INC. FLUSHING, NEW YORK • CULVER CITY, CALIFORNIA

Visit our Booths 2841-43 at the IRE Show

CIRCLE 208 ON READER-SERVICE CARD



NEW FUSION-SEALED glass capacitors defy environmental stresses

Corning's new CYF-10 capacitors are guaranteed to be four times better than MIL specs require on moisture resistance.

All the data we've gathered to date indicates that with the new CYF-10 you have a capacitor that is *practically indestructible* under severe environmental stresses.

For example, these CYF-10's will withstand MIL-STD 202A moisture conditions for over 1000 hours with no signs of deterioration.

To make the CYF-10 impervious to environmental stresses we've completely encapsulated the glass dielectric capacitor element in a glass casing. This encapsulation is completely fusion-sealed against moisture, salt, corrosion and weathering.

If you need both high reliability and miniaturization, the new CYF-10's—the only FUSION-SEALED capacitors available—are worthy of your investigation. For complete details, write to Corning Glass Works, Bradford, Pennsylvania.

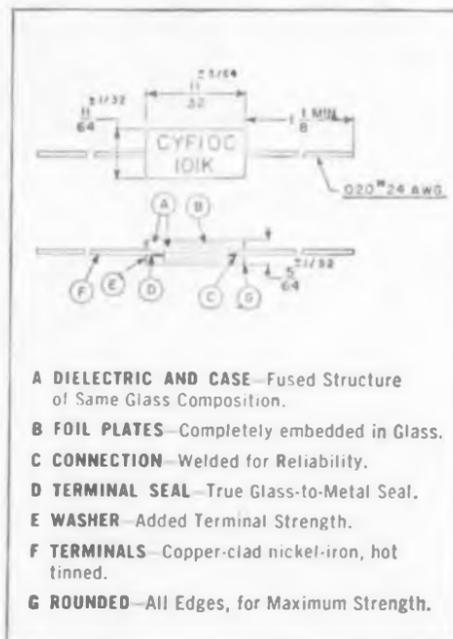


CORNING GLASS WORKS

Electronic Components Department

CORNING MEANS RESEARCH IN GLASS

CIRCLE 209 ON READER-SERVICE CARD



- A DIELECTRIC AND CASE—Fused Structure of Same Glass Composition.
- B FOIL PLATES—Completely embedded in Glass.
- C CONNECTION—Welded for Reliability.
- D TERMINAL SEAL—True Glass-to-Metal Seal.
- E WASHER—Added Terminal Strength.
- F TERMINALS—Copper-clad nickel-iron, hot tinned.
- G ROUNDED—All Edges, for Maximum Strength.

NEW PRODUCTS

Preamplifiers

Low noise



Of weatherproof construction, these low noise preamplifiers measure 3-5/8 x 12 x 5 in. Model PRU-L is available for any frequency from 400 to 1000 mc and has a 3 db bandwidth of 10 mc. Noise figure is 6 db \pm 1 from 400 to 600 mc, 7 db \pm 1 from 700 to 1000 mc. It provides 10 db gain and has a self-contained power supply rated at 117 v, 50 to 60 cps, 10 w. Model PR is available for use from 50 to 250 mc in 6 mc bandwidths. It has a noise figure of 3 db from 50 to 150 mc and 4 db from 150 to 250 mc.

Community Engineering Corp., Dept. ED, Box 824, State College, Pa.

CIRCLE 210 ON READER-SERVICE CARD

Heat Exchanger

Dissipates up to 7000 w

Model CR-2, CR-5, and CR-7 heat exchangers dissipate 2000, 5000, and 7000 w, respectively, but they can be adapted to any intermediate rating. Designed for airborne, shipboard, and ground support electronic equipment, the largest exchanger measures 10-11/16 x 19-9/16 x 15-1/2 in.

The Hallicrafters Co., Dept. ED, 4401 W. Fifth Ave., Chicago 24, Ill.

CIRCLE 211 ON READER-SERVICE CARD

Plastic Capacitor

Has 0 temperature coefficient from -55 to $+55^{\circ}\text{C}$

Type KYA plastic film dielectric capacitor is a rugged hermetic bathtub enclosure with a temperature coefficient of 0 \pm 10 ppm per deg C uniform from -55 to $+85^{\circ}\text{C}$. Capacitance range is 0.01 to 1 μf ; voltage, to 1000 wvdc. The unit has a long term stability of $\pm 0.05\%$ and a power factor of under 0.1% at 25 C.

Diamond Electronic Corp., Dept. ED, 6 White St., New York 3, N.Y.

CIRCLE 212 ON READER-SERVICE CARD

Movie Cameras

Incorporate digital recording devices

These cameras incorporate a Magnavox digital recording device which provides a 96-bit matrix image on each frame of film and correlates coded data with pictorial records in real time. The cameras can be operated at any rate up to 80 frames per sec and are useful in engineering tests, missile tracking, reconnaissance, flight tests, and microfilm document recording. They can record time, temperature, pressure, vibration, stress, deflection, shaft position, elevation, azimuth, altitude, range, and similar coded digital data. The Magnavox recorders are offered with the 35mm 75 Fototracker and the Bell & Howell model 71 Eyemo cameras. Cameras of this type now in use can also be provided with the recorders.

Traid Corp., Dept. ED, 17136 Ventura Blvd., Encino, Calif.

CIRCLE 213 ON READER-SERVICE CARD

Right Angle Adapter

Has maximum insertion loss of 0.1 db

Built to USAF specifications, this right angle adapter has a maximum vswr of 1.15 to 1, a maximum insertion loss of 0.1 db, and a power handling capacity of 500 w. Its frequency range is 350 to 5000 mc. The 2000-UG-1264/U adapter features a captivated continuous center conductor covered with a continuous Teflon dielectric. It is qualified according to MIL-E-5272, fits LT male and female connectors, measures 3-3/4 x 3 in.; weighs 7 oz.

Tamar Electronics, Inc., Dept. ED, 2339 Cotner Ave., Los Angeles 64, Calif.

CIRCLE 214 ON READER-SERVICE CARD

Portable Communication Test Set

For audio and carrier frequencies

Model JK audio and carrier frequency test set consists of a transistor oscillator and a meter. The oscillator supplies a stable 1000 cps constant voltage and provides outputs of 0, -13, and -16 db into a 600 ohm line. Output impedance is 600 ohms. The db meter is designed for testing at frequencies from 60 cps to 600 kc and is readable from -20 to +43 dbm. It has a rotary switch for range changing and voltage ranges of 1, 5, 25, and 125. Self-contained loads of 150 and 600 ohms can be selected by switch. Both units fit into one leather case with space for leads.

Stewart Bros., Div. of Instrument Labs, Dept. ED, 315 W. Walton Place, Chicago 10, Ill.

CIRCLE 215 ON READER-SERVICE CARD

How to make
a Magnetic Core
that's really
SMALL?

use **AL**

PERMENDUR



Write for
your copy
"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. ED-15

When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With it you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this

alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

Let us supply your requirements. Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

CIRCLE 216 ON READER-SERVICE CARD



U.S. Army Signal
Laboratory
designs computer
to measure wind effects
on missile launchings...

...and Vernistat* is there!



Since different types of pilot balloons have different rates of rise, and wind effects vary with each type of missile, signal inputs to the computer must be easily and quickly adjusted. That's one reason why USASRD engineers chose two Vernistat Adjustable Function Generators. Only seconds are required to change from one function to another.

Near-surface winds at a launching can easily force a missile off course, with the result that the missile lands outside the target area. To counter the effect of such surface winds, the missile launcher is tilted to a corrective angle. Calculating the wind effect and the proper angle of tilt of the launcher, however, can be mathematically quite complex and a time-consuming operation. The United States Army Signal Research and Development Laboratory at Ft. Monmouth, New Jersey has developed a compact computer for this job. Quickly and accurately, from pilot balloon data, the computer calculates both wind displacement on the missile and the proper tilt of the launching stand.



Doesn't Vernistat thinking belong in your system design too?

Nonlinear servo system and computer inputs are easily adjusted with the Vernistat Adjustable Function Generator. In addition, the Function Generator enables nonlinear system characteristics to be corrected with a minimum of time and effort. The Function Generator, a variation of the unique Vernistat a. c. potentiometer, can generate mathematical or empirical functions, even those with multiple slope reversals. The function is displayed graphically on a 6 x 8 inch

panel which allows for instant visualization and adjustment.

Connected to a 34-pole printed circuit switch are 101 voltage levels. Any of the 34 poles can be connected to any desired voltage level to within 0.5%. The Generator's X-axis represents shaft position of an interpolating Vernistat potentiometer, and the Y-axis represents percentage of input voltage.

Linear interpolation between each adjacent pair of the 34 selected volt-

age levels is provided by a Vernistat interpolating potentiometer. Minimum slope of voltage output curve is zero, with a 20-volt maximum between adjacent poles. Maximum output impedance is 130 or 470 ohms. Units are designed for operation over a wide range of frequencies.

Write now for full details on Vernistat Adjustable Function Generators, a. c. potentiometers, and variable ratio transformers.

***vernistat**® — a new design concept that unites in one compact device the best features of both the precision autotransformer and the multiturn potentiometer.

Perkin-Elmer Corporation



765 Main Avenue, Norwalk, Conn.

CIRCLE 217 ON READER-SERVICE CARD

NEW PRODUCTS

HIGH TEMPERATURE SURFACE COATING.—

Clear epoxide Eccocoat C 26 can be used continuously at 500 F and for short periods up to 600 F. Surface resistivity is above 10^{15} ohms at room temperature and about 10^{14} ohms at 500 F. Moisture and chemical resistant, the material is used for coating printed circuit boards, electronic circuits and components, metals, and ceramics. It can also be used in place of varnish for dipping or impregnation of coils or motor windings. It is applied by dip, brush, or spray and adheres to a wide variety of materials.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 218 ON READER-SERVICE CARD

OSCILLOSCOPE TUBE.—For visual or photographic observation, crt type 5WP11 has magnetic deflection and electrostatic focus.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Seneca Falls, N.Y.

CIRCLE 219 ON READER-SERVICE CARD

GALVANIZED STEEL TOWER.—For two-way, broadcast, and microwave use, model 1810 has a triangular cross-section with an 18 in. face. It is produced in standard 10-ft sections for heights up to 290 ft and meets RETMA specifications for a 100 mph wind load.

All Products Co., Dept. ED, Mineral Wells, Tex.

CIRCLE 220 ON READER-SERVICE CARD

MOLDED NYLON HEX NUTS.—In ten sizes from no. 2 through 5/16 in., these nuts have washer faces and are double countersunk. They are made with a single chamfer and, except for the 5/16 in. sizes which are jam nuts, are standard thickness with unified series Class 2B threads.

Gries Reproducer Corp., Dept. ED, 168 Beechwood Ave., New Rochelle, N.Y.

CIRCLE 221 ON READER-SERVICE CARD

COMPONENT HOLDER.—This spring loaded device is used to hold the leads of resistors, condensers, and dials for test purposes. It is gold plated for low contact resistance and maximum corrosion resistance and will handle wires from 0.005 to 0.09 in. in diameter.

General Components Inc., Dept. ED, 225 East 144th St., New York 51, N.Y.

CIRCLE 222 ON READER-SERVICE CARD

FLYING SPOT SCANNER.—Flat face type 5ZP15 has high resolution, electrostatic focus, and magnetic deflection. It uses a P15 phosphor with blue-green fluorescence and short persistence.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Seneca Falls, N.Y.

CIRCLE 223 ON READER-SERVICE CARD

Have you sent us your subscription renewal form?

ELECTRONIC DESIGN • March 18, 1959

GAS FLOWMETER.—Accommodating flow rates up to Mach 8, this unit can measure contaminated gases with a low pressure drop. It has an accuracy of $\pm 0.5\%$ of reading and good repeatability over a 10 to 1 linear range. Temperature range extends to -425 F.

Pottermeter Co., Dept. ED, Union, N.J.

CIRCLE 224 ON READER-SERVICE CARD

MEDICAL PREAMPLIFIER.—This EEG preamplifier makes it possible to display electroencephalograph signals on standard medical cardiographs and electrocardiographs by increasing their sensitivity by a factor of 30. It is designed so that the EEG and ECG signals may be delivered simultaneously to an oscilloscope through a single cable. Noise level is $1 \mu\text{v}$ peak and 60 cps rejection is 1 million to 1.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 225 ON READER-SERVICE CARD

ALTERNATE PULSE RELAY.—Designed for easy installation on long production runs, the PA relay mounts with a single bolt in a tapped 8-32 core. It transfers contacts when pulsed for about 30 msec. Contacts are rated at 7.5 amp, 115 v, 60 cps, resistive. Length is 2 in.; height, 1-3/4 in.; weight, 3-1/2 oz.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 226 ON READER-SERVICE CARD

THERMAL TIME DELAY.—Series TH fixed time delays have snap action load contacts in many arrangements and switch up to 20 amp. They are easily adjustable and provide automatic ambient temperature compensation. Available either hermetically sealed or in explosion proof housings, they are suited for air conditioning, refrigeration heater controls, computers, and recycling applications.

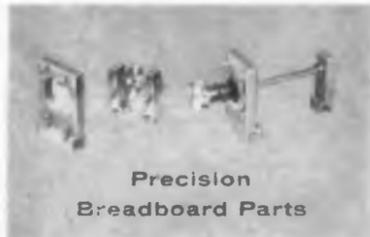
Industrial Timer Corp., Dept. ED, 1407 McCarter Highway, Newark 4, N.J.

CIRCLE 227 ON READER-SERVICE CARD

TEMPLATES.—Four lettering aids and one electronic drawing aid have been added to the Leroy line: Spartan Medium forms solid or outline capital letters and numbers; Shadow forms shadow type capitals and numerals; Isometric forms caps and numbers sloped for isometric drawings; the Standard Lettering Template forms 0.05 in. capitals in vertical or slanting style; and the Electronic Tube Symbol forms practically all the symbols used for various types of electronic tubes and semiconductor devices.

Keuffel & Esser Co., Dept. ED., Adams and Third Sts., Hoboken, N.J.

CIRCLE 228 ON READER-SERVICE CARD



They all arrived the SAME DAY!

All the necessary precision components for a closed-loop control system arrived the same day, in one shipment, just 3 days after being ordered from Servomechanisms' Mechatrol Division. There was no waiting on the part of the engineer—he started his breadboarding within a few days after ordering.

Our new MDA^o program—the result of eleven years of design and production experience—enables engineers to order, from a single catalog, the precision mechanical and electronic components they need for the development of control systems. Immediate, off-the-

shelf delivery is assured. Most of these components were developed for SMI's own subsystems and have been proven by years of service in the field. To supplement the SMI line, the quality products of other leading manufacturers have been selected.

It will pay you to take advantage of this new, exclusive service. A single source means only one purchase order, one invoice—and, no waiting. Get started by writing for your copy of the New Mechatronic Development Apparatus Catalog, MDA 59, today.

^oMechatronic Development Apparatus



CIRCLE 229 ON READER-SERVICE CARD

MECHATROL DIVISION
1200 Prospect Avenue, Westbury, L. I., New York
WESTERN OFFICE
1000 West El Segundo Blvd., Hawthorne, Cal.

Electronic Products **NEWS**

by **CARBORUNDUM**
Registered Trade Mark

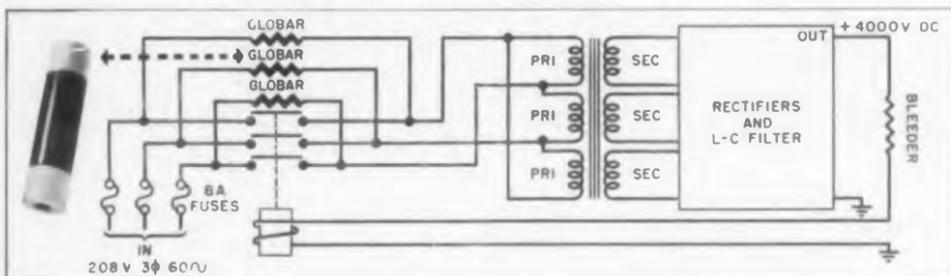
High Energy Resistor Delays Fuse Opening— Collins Radio uses GLOBAR® resistor to handle short-time overload

A unique application of a GLOBAR high energy resistor is made in a radio power supply unit manufactured by Collins Radio, Cedar Rapids, Iowa. The resistor is used for delaying the opening of a fuse under a short-time overload current condition.

Requirements are rigorous. The resistor has to be capable of handling 21 amps for 3 seconds (140 times rated load) and 10 amps for 5 seconds and must not arc, burn, char or change in resistance by more than $\pm 5\%$ when subjected to 5 seconds of the specified overload currents for 5 cycles on with 5 minutes off. It must operate con-

tinuously under 35 watts loading for 1,000 hours in a room temperature ambient, the resistance change being not more than 10%.

A GLOBAR Type SP resistor, $3\frac{1}{4}$ " long, $\frac{3}{4}$ " O.D. and $\frac{5}{8}$ " I.D. is used. This resistor will operate continuously in ambients up to 1,000° F. It is supplied with metalized ferrule type ends for fuse clip mounting. For information on GLOBAR resistors for similar high temperature, high energy applications, write to GLOBAR Plant, Refractories Division, Dept. EDR 39, The Carborundum Company, Niagara Falls, N. Y.



4000 VOLT SUPPLY FOR AN/FRW-2 SHOWING STEP-START CIRCUITRY

CERAMIC IGNITER for oil and gas burners A development of high temperature resistors

The versatility of silicon carbide for high temperature resistors is further demonstrated by its application as a ceramic igniter for fuel oil and gas furnaces.

Conventional igniters utilize either a hot wire, which has a relatively short life, or a spark discharge system, necessitating a high potential transformer.

Requirements for the ceramic igniter were that it should operate directly from 12, 24 and 115 volt



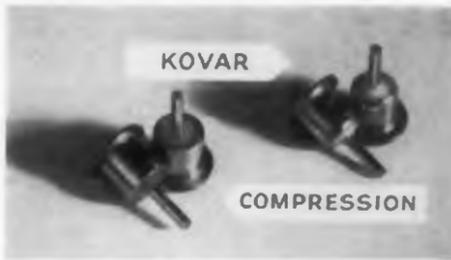
sources, have high stability, be inexpensive and effective for up to 25,000 cycles of operation. A composition similar to that of the GLOBAR Type SP resistor proved to be the answer. By varying resistivity, operation is possible on any of the desired voltages.

To alert electronics engineers, the success of this application may suggest the many possibilities of utilizing similar resistors in high temperature circuits with ambients up to 1,000° F. Terminals which can be spot-welded or brazed into circuits have been developed. Prototypes of such resistors are now actually being evaluated by several customers as potential components for missiles and other critical applications.

Technical assistance and information can be secured by writing to GLOBAR Plant, Refractories Division, Dept. EDIR 39, The Carborundum Company, Niagara Falls, N. Y.

Matched or Compression Seals?

Which metal-to-glass combination should you choose for packaging rectifiers and other housings?



Two types are available. The first type is represented by KOVAR® matched seals in which the identical thermal expansion characteristics of KOVAR Alloy and borosilicate hard glasses result in a fused hermetic bond. Since KOVAR has about the same expansivity as silicon and germanium, stability in operation is assured. The second type is represented by the compression seal which relies on differences in contraction between glass and metals, like mild steel, to provide a tight joint.

Both types give excellent service depending upon the design and application of the unit. Compression seal applications are often those where the use of heavier metal parts is advantageous.

Among other advantages, KOVAR "top hats" have special value as high voltage seals. The insulating glass does not need to be contained within a compression band and thus can be extended for higher flash-over voltage ratings.

For help in your choice of seals, write Latrobe Plant, Refractories Division, Dept. EDK 39, The Carborundum Company, Latrobe, Pa.

NEW BULLETIN DESCRIBES FIXED NON-INDUCTIVE CERAMIC RESISTORS



Gives data on Types A, B, and CX resistors recommended for general-purpose applications in electronic and electric power circuits. A wide range of sizes, shapes and compositions provide desired resistivities and watt ratings. For a copy, write: GLOBAR Plant, Refractories Division, Dept. ED 39, The Carborundum Company, Niagara Falls, N. Y.

NEW PRODUCTS

LIQUID LEVEL GAGE.—Model 0358-1 makes continuous level measurements of a wide range of electrically conductive liquids and granular solids with accuracies of up to 1/10 in. over a 10 ft. range. All electronic, it uses a capacitance circuit which requires no moving mechanism in the material being measured. Readout may be in dial or counter form, or it may be built into a standard 11 in. strip chart recorder.

Magnetic Instruments Co., Inc., Dept. ED, 546 Commerce St., Thornwood, N.Y.

CIRCLE 231 ON READER-SERVICE CARD

ELECTRONIC TEST SET.—The Checkmate automatically tests electronic systems for overall performance. Each test set is designed for a specific system and automatically tests it when the press-to-test button is pushed.

CGS Labs., Dept. ED, Route 7 at 35, Ridgefield, Conn.

CIRCLE 232 ON READER-SERVICE CARD

VINYL INSULATION REPAIR KIT.—Contains Vyna-Kote, a liquid vinyl that repairs all kinds of damage to vinyl insulated wires. Consists of twelve 2 oz bottles, one each of ten colors, one clear, and one thinner.

Spectra-Strip Wire & Cable Corp., Dept. ED, P.O. Box 415, Garden Grove, Calif.

CIRCLE 233 ON READER-SERVICE CARD

MINIATURE TRIODE-PENTODE.—Model 6EAS combination medium- μ triode and sharp-cutoff pentode is a 9-pin miniature type utilizing a 450 ma heater with controlled warm-up time. Each unit has its own separate cathode with individual base-pin terminal. The tube is intended for use as a combined oscillator and mixer tube in TV receivers with 40 mc i-f circuits.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 234 ON READER-SERVICE CARD

COMPRESSOR AND VACUUM PUMP.—A compact, two-stage, motor driven air pump for airborne radar systems, ground support, and electronic test equipment. Operation is entirely oil-free, and requires no lubrication. Operating temperature range is -65 to $+200$ F; and compressor capacity is 0.025 ppm at 30 psi absolute outlet with 7 in. Hg absolute inlet pressure.

Great Lakes Mfg. Corp., Dept. ED., 4223 Monticello Blvd., Cleveland 21, Ohio.

CIRCLE 235 ON READER-SERVICE CARD



CERAMIC PARTS AND METALLIZED ASSEMBLIES GLASS-TO-METAL SEALS KOVAR ALLOY CERAMIC RESISTORS VARISTORS THERMISTORS

CIRCLE 230 ON READER-SERVICE CARD

BONDED CONTACTS.—Dense, nonporous, stress-free contacts permanently bonded to rivet or backing. Bonding holds up to the melting temperature of the metal, provides maximum strength and corrosion resistance, and improves electrical and thermal conductivity. Contacts are more economical than brazed contacts of medium to large size silver or silver alloy.

Contacts, Inc., Dept. ED, 1500 Silas Deane Highway, Wethersfield, Conn.

CIRCLE 236 ON READER-SERVICE CARD

REUSABLE SHIPPING CONTAINERS.—Interiors of CDF instrument cases are padded with polyurethane foam 1-1/2 to 2 in. thick. Inside dimensions are 7-3/4 x 2-3/8 x 14-1/8 in.; 7-3/4 x 3-5/8 x 14-1/8 in.; and 7-3/4 x 5 x 24-1/2 in.

Continental-Diamond Fibre Corp., Dept. ED., Newark, Del.

CIRCLE 237 ON READER-SERVICE CARD

ROLLING RULER.—Pocket drafting tool for small drawings. Roller construction carries the rule in a straight line, keeping the edge parallel. Incorporates a protractor, a template for small circles, and inch scales divided into tenths and sixteenths; draws parallel and perpendicular lines, angles, and circles with up to 6 in. radii. Overall size is 6 x 2 x 1/2 in.

Fullerton Engineering Sales Co., Dept. ED., 4623 York Blvd., Los Angeles 41, Calif.

CIRCLE 238 ON READER-SERVICE CARD

POPPET VALVE.—A miniature precision safety pressure relief mechanism designed to protect electronic containers from ambient pressure variations due to altitude and temperature changes. It weighs 7.4 g and is pre-set to customer requirements between 1 and 20 psi.

Glaeser Engineering, Dept. ED., 5642 Bankfield Ave., Culver City, Calif.

CIRCLE 239 ON READER-SERVICE CARD

PRESSURE SCANNING VALVE.—High pressure, high speed 48J Scanivalve is designed for measuring turbo-engine pressures. It makes one 1/2 in. diameter flush diaphragm transducer scan 48 pressures in one second. Various motor speeds are available. Diameter is 2 in.; length, 6.5 in.

General Design, Dept. ED., 631 30th St., San Diego 2, Calif.

CIRCLE 240 ON READER-SERVICE CARD

COLOR FLYING SPOT SCANNER.—Type 5ZP24 has a clear, nonbrowning faceplate, an aluminized screen, and a P24 phosphor of blue-green fluorescence and short persistence.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Seneca Falls, N.Y.

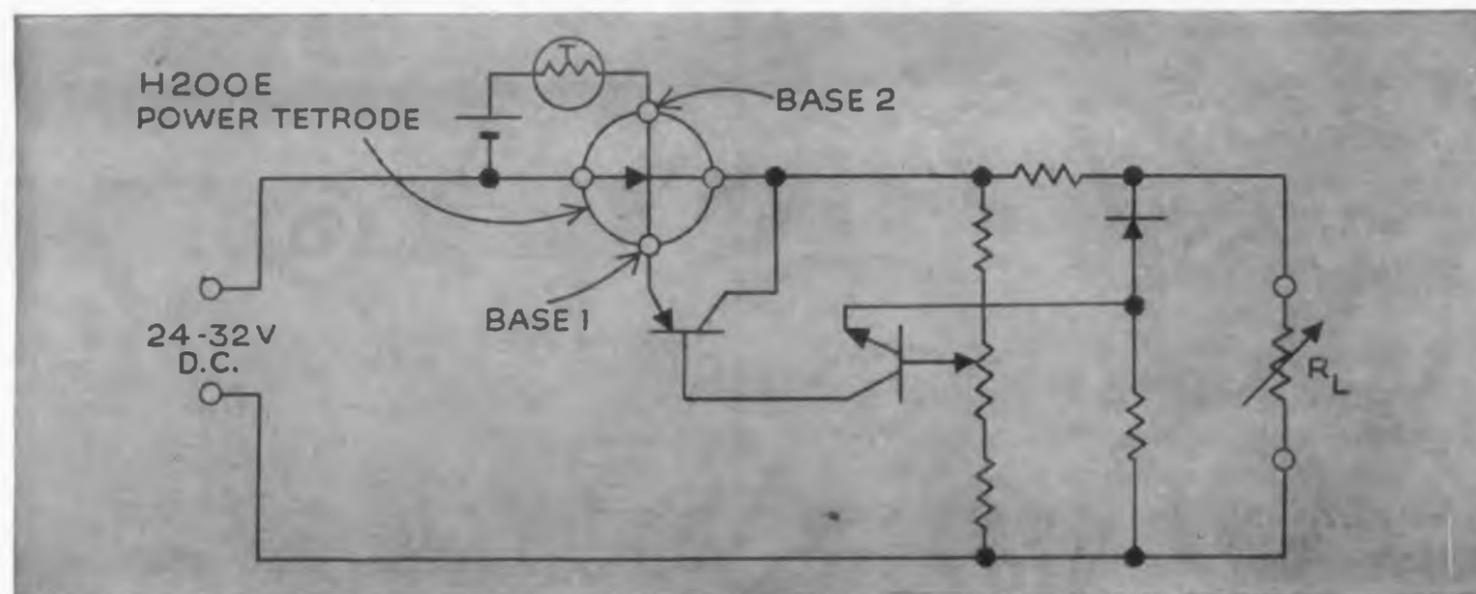
CIRCLE 241 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Open Circuit Regulation Maintained at 71°C.



—with Honeywell's Power Tetrode



Shown above is a voltage regulator circuit using Honeywell's H200E Power Tetrode. This circuit is designed to supply 22 volts output with 1% regulation, with inputs of 24 to 32 volts and load currents of zero to 3 amperes. The system has short circuit protection.

Circuit values can easily be adjusted to maintain regulation at other voltages and through other current ranges. The base 2 circuitry can be modified to give varying degrees of leakage current stability.

The Tetrode makes possible an improved series

voltage regulator for systems where current requirements are apt to vary widely. It offers overload protection, improved high temperature operation, and controlled regulation characteristics. Its second base connection provides control of the total system leakage.

For complete voltage regulator circuit description along with component values, write Honeywell, Dept.

ED-3-58, Minneapolis 8, Minnesota. Regional representatives may be reached in Union, New Jersey, (MURdock 8-9000), Boston (ALgonquin 4-8730), Chicago (IRving 8-9266), and Los Angeles (RAYmond 3-6611 or PARKview 8-7311).

Honeywell

 *First in Control*

CIRCLE 242 ON READER-SERVICE CARD

PACE TRANSDUCERS CAN TAKE IT!



PACE Model P1 transducers were used by a missile component manufacturer to measure pressure during a centrifuge test. The transducer shown above broke loose, and was repeatedly battered against a concrete wall until the centrifuge stopped.

Upon being returned to the factory, the transducer was tested and found to be still holding its original calibration. With a new cover and electrical connector, it was as good as new.

PACE builds a complete line of rugged, reliable magnetic reluctance transducers, designed to withstand extreme pressure overloads and the abuse encountered in normal and abnormal applications.

For detailed information on these transducers and related equipment, phone or write to the factory or contact your local PACE Engineering Company representative.

PACE engineering company
13035 Saticoy Street — North Hollywood, California
Stanley 7-7139

CIRCLE 243 ON READER-SERVICE CARD

NEW PRODUCTS

SSB RADIO TELEPHONE RECEIVER.—High frequency type 52 is compatible with existing transoceanic ssb systems and has two independent sidebands that deliver up to four simultaneous 3 kc telephone and teletype channels. Up to ten crystal-controlled frequencies may be pretuned in the 3.7 to 30 mc range. These can be manually or remotely controlled.

Westrex Corp., Dept. ED, 111 Eighth Ave., New York 11, N.Y.

CIRCLE 244 ON READER-SERVICE CARD

LUBRICANT.—Supplied in a spray can, Paralese mold release and lubricant eliminates sticky and marked molds. Applications result in no build-up.

Foundry Rubber Inc., Para Products Div., Dept. ED, 5200 River Rd., Washington 16, D.C.

CIRCLE 245 ON READER-SERVICE CARD

NUT DRIVERS.—Line of nut drivers with hex shaped heads and color coded handles. Designed to get into tight places inaccessible to standard nut drivers. Available individually or in kits in 3/16 through 1 2 in. sizes.

Hunter Tools, Dept. ED, P. O. Box 564, Whittier, Calif.

CIRCLE 246 ON READER-SERVICE CARD

COAXIAL TERMINATION.—For Type N connector application, type HFT/N-50 has an impedance of 52.5 ohms and a maximum vswr of 1.2 from dc to 2500 mc.

Applied Research Inc., Dept. ED, 76 S. Bayles Ave., Port Washington, N.Y.

CIRCLE 247 ON READER-SERVICE CARD

SYNCHRONOUS WELD-TIMER.—Transistorized model T3, called the Tweezer-Weld Trans-Sync Timer, has a 1 kva capacity and is especially suited for precision welding where contact resistance varies widely. A rotary switch adjusts the welding time from 0.5 cps to 10 cps of line frequency. Models T-6 and T-25 are larger versions.

Federal Tool Engineering Co., Dept. ED, Cedar Grove, N.J.

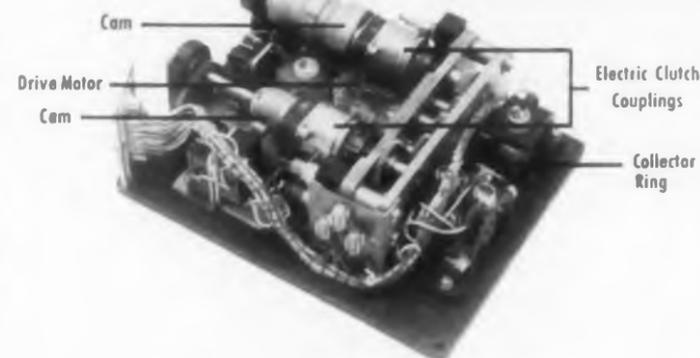
CIRCLE 248 ON READER-SERVICE CARD

AIR-TO-LIQUID HEAT EXCHANGER.—Designed to provide cooling for Klystron anodes, model LC-5 dissipates 2000 w of heat from Monsanto type OS-45 oil at a circulation rate of 3 gal per min. Normally mounted within an electronic rack, it uses room air of up to 125 F at altitudes of up to 10,000 ft as the cooling medium. It is built to MIL-E-4158, MIL-T-4807, and MIL-STD-170 specifications.

Ellis & Watts Products, Inc., Dept. ED, Cincinnati 36, Ohio.

CIRCLE 249 ON READER-SERVICE CARD

electric clutches actuate missile firing timer



Three miniature stationary field clutches function as automatic power links between the timing cams and drive shafts in this compact, wing-mounted firing sequencer for all-weather fighters. Less than 1" in dia., clutches operate at temperatures from -67° to $+275^{\circ}$ F. Withstand repeated shocks during landings. Stationary field design, low current actuation facilitate remote control. Self-adjusting, they put all wear on low-cost, replaceable elements—simplify maintenance. Write for Catalog No. 6292.



Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

CIRCLE 250 ON READER-SERVICE CARD



SMALLEST IN THE INDUSTRY!
(patent applied for)
TRANS-ELEC

MINI-LITE

New Miniature transistorized control panel light that mounts in just 30 seconds!

Simply insert this indicator light in a $\frac{3}{8}$ " panel-hole, tighten the collar nut and plug in the taper pins. It's completely mounted and hooked up in 30 seconds... no soldering needed! Enclosed transistor and 3 resistors can control the NE-2E neon lamp with a 3.0 volt signal. This brand new self-contained display light unit is available in a variety of circuits for computers, data processors, signal systems and transistorized automatic control devices. Body only $\frac{1}{2}$ " in diameter and $1\frac{1}{4}$ " long. For complete data on the Mini-Lite and other control panel components, write us or phone WE 9-6754.



TRANSISTOR ELECTRONICS CORPORATION
3359 Republic Ave. Minneapolis 26, Minn

CIRCLE 251 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

NYLON CABLE CLIPS.—These Nylon molded-type clips have a ribbed reinforcing edge that holds indefinitely against the strains of vibration, weather, moisture, and chemical corrosion. They are electrically nonconductive and have no sharp edges to damage insulation or tubing.

Commercial Plastics Co., Dept. ED, 945 George St., Chicago 14, Ill.

CIRCLE 252 ON READER-SERVICE CARD

DUAL HEAT SOLDERING GUN.—Model 8200K has a Triggermatic control which provides 90 and 125 w. A prefocused spotlight illuminates the work while the gun is in use.

Weller Electric Corp., Dept. ED, 601 Stone's Crossing Rd., Easton, Pa.

CIRCLE 253 ON READER-SERVICE CARD

PHOTOELECTRIC CONTROLS.—These units provide automatic control of lights regardless of time of day, weather, or season. Lights are automatically switched on at the same darkness value of each night and off again when daylight returns. Model A200 turns on at 35 ft-c, off at 55 ft-c; model B200 turns on at 0.5 ft-c, off at 1 ft-c.

White Engineering Co., Dept. ED, 238 Grand Ave., Rutherford, N.J.

CIRCLE 254 ON READER-SERVICE CARD

PEG BOARDS.—These two additions to the SeeZak electronic component line measure 4 x 7 and 4 x 12 in. They are designed for electronic systems planning and development.

U. M. & F. Mfg. Co., Dept. ED, 10929 Vanowen St., North Hollywood, Calif.

CIRCLE 255 ON READER-SERVICE CARD

POWER SILICON RECTIFIERS.—This unit features diffused silicon junction, a solid copper base, a hot tin dipped terminal, a hermetic seal for the silicon chamber, and tough epoxy protective coating.

Vickers Inc., Electric Products Div., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

CIRCLE 256 ON READER-SERVICE CARD

GLASS PROBE THERMISTOR KIT.—Designed for circuit planning, the KP50 kit contains thermistors in decade steps from 100 ohms to 10 meg. Complete technical characteristics and resistance vs temperature curves are furnished for all six units.

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

CIRCLE 257 ON READER-SERVICE CARD

CUT COSTS OF TEST EQUIPMENT BY 20% WITH Technical Information Service

Case histories have shown that companies waste up to 20% of their annual expenditures for test equipment.

A prime cause is the failure to make the best buy obtainable because each company did not know the full range of available equipment. Collecting and maintaining complete, timely, and accurate product information is difficult—could cost as much as \$25,000 a year to service—and yet could be incomplete and inaccurate.

A prodigious number of crucial engineering and purchasing man-hours are squandered in test equipment procurement. Tracking down sources of supply takes days and, often, weeks. Key personnel are trapped by protracted correspondence and sales interviews while obtaining full specifications and prices. When modifications are involved, workloads increase geometrically. This costly routine must be repeated every time new purchases are made.

Now, for the first time, you can plug these hidden profit leaks through the use of a completely new concept in instrument evaluation for procurement.

Technical Information Service (TIS) provides you with complete, timely product information about all available electronic test equipment. In a matter of minutes you can possess detailed descriptions of equipment produced by every manufacturer in the business, from the largest to the smallest, without bias in favor of either. What's more, the descriptions include the full specifications, price, and the names and addresses of local sales representatives—all you need to initiate procurement.

Consider the benefits enjoyed by clients of Technical Information Service.

SINGLE SOURCE OF SUPPLY INFORMATION

Clients have the only central source of supply information designed specifically for their electronic test equipment requirements. Completely categorized, up-to-the-minute information makes the user a technical expert capable of quickly evaluating complete spec-by-spec comparisons of competitive equipment. Since TIS maintains accurate files by constant check of all sources for additions and changes in specifications and prices, clients may make inquiry by phone or letter on any test instrument problem at any time.

With such information at their fingertips, clients can make their purchases with total awareness of what the market has to offer. Procurement is made with minimal demands on key personnel and their time. Many clients find that this accelerated purchasing procedure has earned an extra bonus in expediting tight-schedule projects for which the test equipment is needed.

COMPLETE, ACCURATE INFORMATION

Clients receive detailed data on more than 4,500 separate instruments manufactured by some 400 different companies. Constant review of the entire instrument field by graduate engineers keeps data on specifications, prices, and models up to date at all times.

Suppliers are queried on incomplete or dubious information, if necessary, before their products are included in any TIS release.

Since all products are described without charge and without advertising claims, small and large manufacturers are on equal footing. Their instruments speak for themselves with bald facts, free of slanted claims or persuasive case histories. Clients make their own evaluations from complete, factual information.

SUPPLIER RESEARCH SERVICE LOCATES "CUSTOM" INSTRUMENTS

Often, seemingly built-to-order requirements can be satisfied by minor modification to standard instruments. The complete listing of all large and small manufacturers of stock items provides a ready reference for such inquiry, either directly by the client or through the efforts of TIS.

In those cases where unique equipment is a necessity, TIS Supplier Research surveys the market for the client, collecting all the pertinent information he requires to initiate serious negotiations with suppliers.

COMPLETE PRIVACY

Whether TIS is locating sources for unique requirements or providing information on standard equipment, clients maintain a cloaked identity during all stages of inquiry. The Client conducts negotiations with the suppliers in whom he is interested.

FOUR-VOLUME DIRECTORY

Clients of the tax-deductible Technical Information Service receive a free, four-volume, handsomely bound encyclopedia of standard equipment and sources published twice a year and supplemented constantly. Three volumes are devoted to descriptions of equipment. The fourth volume is an extensive cross-index of manufacturers and their representatives. Completely free of advertising, the directories give clients a complete, factual picture of all standard electronic test instruments. Clients of Technical Information Service receive both the Directories and Supplier Research Service.

PROVEN IN USE

For the past two years TIS has served such clients as General Electric, M.I.T., Lincoln Labs., General Motors, NASA, Litton Industries, Naval Ordnance Lab., Hewlett-Packard, Lockheed Aircraft, Western Electric, RCA, Marconi Instruments, Eglin AFB, American Bosch Arma, and hundreds of others. The merit of TIS is proven by the fact that many clients have contracted additional service for other departments and projects.

SAMPLE TIS AT THE IRE SHOW—FREE!

Judge the value of TIS by personal experience. See TIS in operation at the IRE Show. Stop at Booth 4431 to check a product requirement. See how TIS can save as much as 20% of your annual expenditure on test equipment. See how TIS can reduce the hidden costs of instrument procurement. If you are unable to attend the IRE Show, fill in the coupon below.



VOL. I—Sources • VOL. II—Modifiers • VOL. III—Scalers
VOL. IV—Index of Manufacturers and Representatives



Technical Information Corporation

41 Union Square, New York 3, New York, WAtkins 4-2111

I cannot stop at your booth at the IRE Show, but I am interested in Technical Information Service. Please send me complete information about it.

NAME _____ TITLE _____

DEPARTMENT _____ COMPANY _____

ADDRESS _____

CIRCLE 258 ON READER-SERVICE CARD

NOW...VTVM's for all applications

... panel-mounted ...
small-size
**ELECTRONIC
VOLTMETERS**

SEND FOR CATALOG 10A which gives complete specifications and prices on panel-mounting, relay-rack and plug-in models.



Build accuracy into all your equipment, test and production alike, with Metronix DC and AC Electronic Voltmeters.

These Metronix instruments are no larger than conventional voltmeters, cost little more. They offer higher accuracy because they don't load the circuit. In AC applica-

tions, they respond accurately over a frequency range of 20 CPS to 100 KC.

Selective, step-ranges run from 0-10MV, to 0-300V AC, and 0-1 to 0-1000V DC. Metronix Electronic Voltmeters can be furnished in MIL-spec, rack-mounting and plug-in models.

Metronix INC

A SUBSIDIARY OF

ASSEMBLY PRODUCTS, INC.

Chesterland 17, Ohio



S.A. 1875

CIRCLE 259 ON READER-SERVICE CARD

MINIATURE AND SUB-MINIATURE

relays by **Hi-G**



HG-25M

Rugged and reliable relays are manufactured at Hi-G in a wide range of standard units... and to customer order with special designs to meet your particular requirements.

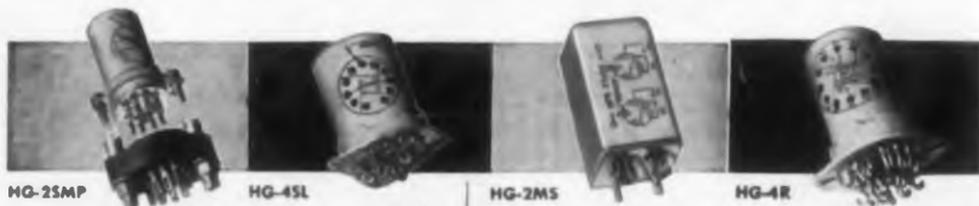
Complete experimental and prototype facilities permit Hi-G engineering personnel to study and evaluate your relay needs.

New, complete illustrated specification sheet available. Write for your free copy today.

And for information on special relay units, send your specifications to Hi-G for study and recommendations at no obligation.

rugged / reliable / shock and vibration resistant

A FEW OF THE WIDE RANGE OF HI-G STANDARD RELAYS



HG-25MP

HG-45L

HG-2MS

HG-4R

Hi-G inc.

BRADLEY FIELD

WINDSOR LOCKS, CONN.

Visit Hi-G booth #2106 at I.R.E. show
CIRCLE 260 ON READER-SERVICE CARD

NEW PRODUCTS

SURFACE TEMPERATURE PROBE.—Model 116D measures skin and gas temperatures and is useful for flight testing manned aircraft, rockets, and missiles. The sensor is platinum wire and has 500 ohms resistance at 0 C. The unit's upper limit is 760 C.

Rosemount Engineering Co., Dept. ED, 4900 W. 78th St., Minneapolis 24, Minn.

CIRCLE 261 ON READER-SERVICE CARD

WIRE TIES.—Rubber "Mouse Tails" are available in two forms. One type, in 1 to 4 in. lengths, is tapered at both ends. It is installed by passing one end through a hole in the chassis, looping the shank over the wire bundle, and inserting the other tapered end through an adjacent hole. When clinched up tight, expansion of the rubber holds the "tail" firmly in place. The other type are for intermediate bundle ties between tie down points and are designed to eliminate wax string ties.

Rubber Teck, Inc., Dept. ED, 19115 S. Hamilton Ave., Gardena, Calif.

CIRCLE 262 ON READER-SERVICE CARD

CATHODE RAY TUBES.—Types 5AHP14, 5AHP-14A, 5AHP19, and 5AHP19A are round glass, high resolution tubes with electrostatic focusing and magnetic deflection. They use various screen phosphors.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Seneca Falls, N.Y.

CIRCLE 263 ON READER-SERVICE CARD

LIGHTWEIGHT NUT.—In 1/4 through 1/2 in. sizes, type FN-22 has 220,000 psi tensile strength, good fatigue characteristics, and high reusability. It is cadmium plated either with or without molybdenum disulfide coating.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

CIRCLE 264 ON READER-SERVICE CARD

FLAT FACE OSCILLOSCOPE TUBE.—Type 3RP1A cathode ray tube has electrostatic focus and deflection, uses a P1 phosphor with green fluorescence and medium persistence.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Seneca Falls, N.Y.

CIRCLE 265 ON READER-SERVICE CARD

RADAR INDICATOR TUBE.—Type 7MP14 is a clear face, round glass, non-ion trap tube with magnetic focus and deflection.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Seneca Falls, N.Y.

CIRCLE 266 ON READER-SERVICE CARD

**Acid
Bright**
LIKE THE
SUN



OROSENE★
999
24K ACID BRIGHT GOLD

OROSENE

999 is an entirely new gold complex. It produces mirror bright, hard electroplates in either rack or barrel plating.

OROSENE

999 produces a bright, hard 24 Karat (99.8%) gold plate. It is the ONLY 24 Karat bright gold.

OROSENE

999 24 Karat Gold electroplates are twice as hard as ordinary 24 Karat gold plates—this is produced by a preferred orientation of the gold micro crystals. It is as hard as ordinary bright alloy golds. (125 Knoop).

OROSENE

999 24 Karat plates are ductile, as ductile as ordinary 24 Karat plates. This is achieved by the preferred orientation of crystal lattice.

OROSENE

999 contains NO silver, NO sulfur compounds and NO antimony. It has exceptional tarnish and sulfide resistance.

OROSENE

999 barrel solutions have the best throwing power and leveling of ANY bright gold or ordinary gold for barrel plating.

OROSENE

999 bright gold has only ONE addition agent. It is self-regulating and simple to control.

OROSENE

999 24 Karat Hard Bright Gold offers the electroplating metallurgist a new dimension in gold plating. It solves many plating problems where ordinary bright, hard or 24 Karat golds have failed.

★ Patent Pending

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INC

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Providence, R. I.

JACKSON 1-4200

Chicago Office
7001 North Clark Street

CIRCLE 267 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

NEW LITERATURE

Transducers 269

A new four page two color brochure is available on request to furnish useful information for users of strain gages, load cells, resistance thermometers, pressure transducers, or other resistance bridge transducers. This brochure describes in detail how the resistance bridge indicator (RBI) is set up to provide a visual digital display with readout in any desired units such as micro-in. per in. for strain gages, pounds, tons or ounces for load cells, etc. The brochure also contains schematic diagrams and information on typical applications with complete specifications of the RBI. Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.

Limit Switches 270

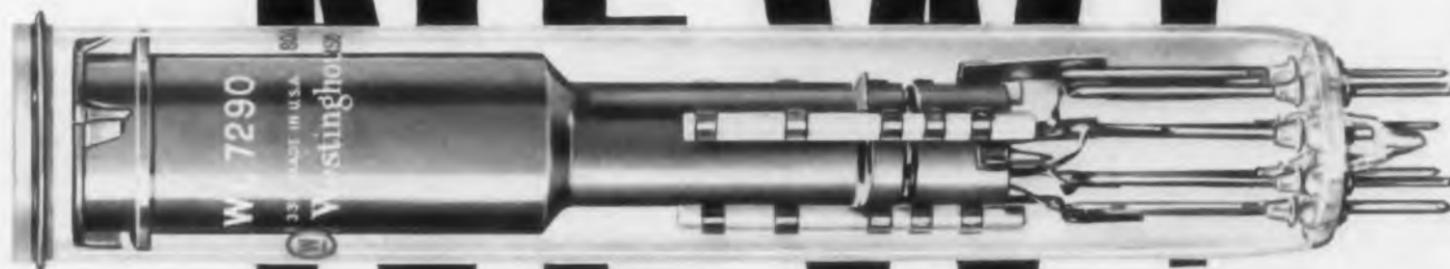
An all new 16-page catalog number 84, covering a complete line of Heavy Duty Limit Switches Catalog 84, a 16-page illustrated booklet covers a complete line of heavy duty limit switches and gives complete details of three types of Micro Switch heavy-duty limit switches for industrial uses—the plug-in "200LS" series, featuring quick replaceability; the compact "LS" series; and the rugged "ML" switches, available in regular or explosion-proof types. Switches with a variety of contact arrangements for either direct or alternating-current applications are listed and several actuator designs in each switch type are shown. The new catalog is published as an aid to the plant engineer and maintenance man, as well as the designer of original equipment. MicroSwitch, Div. of Minneapolis-Honeywell Regulator Corp., Freeport, Ill.

Magnetic Amplifier Design Manual 271

Engineering Bulletin #403-A is a 16-page Magnetic Amplifier Design Manual. The new design manual has 45 schematic diagrams and graphs describing magnetic amplifier design and application techniques. Some of the topics covered in the new manual are: Signal Mixing, Voltage and Current Comparators, Automatic Polor Systems, Electrohydraulic Valve Drives, Gyro and Position Pickoffs, Insulation & Cable Barriers Checker, Integrators, Limiters, Sweep Generator Potentiometric Amplifier Circuit, Relay Tester, LaPlace Transforms, Transform Generation, Velocity Servos, etc. The new 403-A Design Manual is available without charge to qualified design engineers. Requests should be made on company letterhead to Aeromag, Inc., 22519 Telegraph Road, Detroit 41, Mich.



Westinghouse tube engineering...
serving the nation through imagination



WESTINGHOUSE- DEVELOPED

special vidicon for slow scan

This new Westinghouse vidicon WL-7290 has been designed with extremely high dark resistance, permitting picture retention for both slow- and delayed-scan transmission.

THE WL-7290 FEATURES:

- Standard vidicon quality with normal scan
- Dark current 1/100 of standard vidicon
- Retention of 450 TV line resolution for minimum of 45 seconds with scan off
- Will operate in a standard vidicon camera

The WL-7290 is ideally suited to Narrow Band Transmission such as telemetering or telephone line transmission.

YOU CAN BE SURE...IF IT'S

Westinghouse

Electronic Tube Division Elmira, N.Y.

WL-7290 slow scan is in production. Sample quantities immediately available. Requests for technical data are invited.



CIRCLE 272 ON READER-SERVICE CARD

Engineers! Designers!
**THERE IS NO SUBSTITUTE
 FOR RELIABILITY!**

Specify—
**PERFORMANCE
 PROVEN "MAG MOD"**

MAGNETIC MODULATORS



For complete specifications and application data on "Mag Mod" Miniature and Standard Components, call or write.

Miniaturized design permits engineers to employ these new components in transistorized printed circuit assemblies and wafer type structures. All models offer maximum reliability, fully ruggedized construction and conform to MIL-T-27A specifications.

- COMPLETE RELIABILITY
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Typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

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CIRCLE 353 ON READER-SERVICE CARD

for maximum reliability

PREVENT THERMAL RUNAWAY

Prevent excessive heat from causing "thermal runaway" in power diodes by maintaining collector junction temperatures at, or below, levels recommended by manufacturers, through the use of new Birtcher Diode Radiators. Cooling by conduction, convection and radiation. Birtcher Diode Radiators are inexpensive and easy to install in new or existing equipment. To fit all popularly used power diodes.



with NEW BIRTCHER DIODE RADIATORS

B

Birtcher Cooling and retention devices are not sold through distributors. They are available only from The Birtcher Corporation and their sales representatives.

THE BIRTCHER CORPORATION industrial division

4371 Valley Blvd. Los Angeles 32, California

Sales engineering representatives in principal cities.

FOR CATALOG
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 test data write:



CIRCLE 274 ON READER-SERVICE CARD

NEW LITERATURE

Miniature Transformers 275

A new short form catalog listing complete specifications on the company's products include miniature, subminiature, transistor, MIL-T-27A and industrial transformers that are available from distributor stock. The short form catalog serves as a ready reference for a quick run-down on the transformers offered by company, showing the wide range of models at a glance. Harold Edelstein, Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N.Y.

Precious Metals Plating

The cost of precious metals plating per unit area to specified thicknesses may be seen at a glance with this Metals Data Chart. The slide chart also tells at a glance: cathode efficiency data; milligrams per sq in. and grams per sq ft of particular precious metals for 0.0001 in. deposits; recommended current densities and actual plating time required for nine different precious metals plating formulations; and corresponding thicknesses. The chart is available for \$1.00 (shipped post-paid) from Sel-Rex Corp., 75 River Road, Nutley 10, N. J.

Plastics Catalog

This 64-page plastics catalog is designed to supply plastics buyers with the best and latest information in a detailed manner. The catalog's 12 sections include: Plexiglas, Vinyls, Acetates, Phenolic Laminates, Nylon, Teflon, Kel-F, Polyethylene, Polystyrene, Rexolite, Fiberglass and "Supplies." The latter section includes all necessary data on coatings and accessories. Write on company letterhead to Mr. Morton French, General Sales Manager, Commercial Plastics & Supply Corp., New York City, N. Y.

Germanium Diodes 276

Bulletin 158 describes company's line of gold-bonded germanium diodes. It lists many types for general purpose and computer use, where from one to four operating characteristics are specified. Special computer types with ten specified characteristics are also shown. These incorporate many superlative features for computer applications. The bulletin features a new system devised by company to classify diodes for ease in selection by number and value of characteristics. It should arouse considerable interest among diode users frequently confronted with the complex listings that sometimes make selection, on the basis of operating characteristics, quite a chore. Ohmite Mfg. Co., 3683 Howard St., Skokie, Ill.

when
 every
 second
 counts...
 ... count on
**THERMAL
 time delay
 RELAYS**

by **DIALCO**

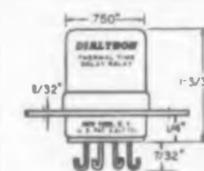


Hermetically Sealed

Rugged—built to meet conditions of
**high altitude
 high vibration
 high temperature**

DIALCO RELAYS exhibit no resonance from 5 to 1,000 CPS at 10 G's; are not damaged by 50 G's shock; are fully compensated for temperatures from -65° C to $+125^{\circ}$ C.

Available in delays from 1 to 300 seconds; heater voltages up to 150 V, interchangeable on DC or AC of any frequency with a power drain of 4 watts. SPST normally open or normally closed contacts are rated at 6 amps at 115 V. AC or 3 amps at 28 V. DC resistive.



SUB-MINIATURE

Lightweight
 (3/4 oz.)
 Standard 7-pin
 plug-in or solder
 terminals with
 mounting flange

Dialtron Corp., 203 Harrison Pl., Brooklyn 37, N. Y.

Send data on Thermal Time Delay Relays to:
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 Position _____
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DIALTRON
 CORP

203 Harrison Pl., Brooklyn 37, N. Y.
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CIRCLE 277 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Tube Standards

Two international standards recommendations affecting electronic tubes are now available. The third supplement to International Electrochemical Commission (IEC) Publication 67, Dimensions of Electronic Tubes and Valves, provides the basis for the interchangeability of electronic equipment among the 33 participating nations. IEC Publication 100 lists recommended methods for the measurement of direct interelectrode capacitances of electronic tubes. The methods apply to receiving, cathode-ray, gas and photo tubes, photocells and multiplier types, and high-power vacuum tubes. Copies of IEC Publication 67 (Third supplement) at \$2.40 each and of IEC Publication 100 at \$4.00 each are available from American Standards Association, Dept. PR 37, 70 East 45th St., New York 17, N. Y.

Magnetic Amplifier Systems 279

An 8-page color brochure entitled, "Magnetic Amplifier Systems For Nuclear Reactor Installations" describes the rod programmer amplifiers designed for the nuclear electric power plant at Shippingport, Pa. A functional diagram outlines an integrated static control system for a nuclear reactor power installation. Illustrated with photographs and charts, bulletin S-963 gives the details of magnetic amplifier servo drives and applications in nuclear drive systems, covering control rod drives, hydraulic valve control and remote handling control, as well as engineering specifications and transfer characteristics of the units are included. Also described are the manufacturer's STAT-PACK static magnetic switching systems used in reactor control circuits, programming and simulators; magnetic amplifier voltage/current regulators and regulated dc power supplies; and low level linear magnetic amplifiers, which have applications in control system instrumentation, console measurements and laboratory experimentation. Magnetic Amplifiers, Inc., 163 Tinton Ave., New York 55, N.Y.

Logic Unit Board 280

An 8-page illustrated booklet describing the versatile new logic unit board discusses many applications, and pointedly illustrates the fact that the logic unit board actually represents an improved technique for development of digital computers and data handling systems. This transistorized digital component is a highly versatile array of basic computer elements which can be connected simply and rapidly to serve whole logic and control functions of complex digital computers. Mechanical Division of General Mills, Inc., 1620 Central Ave., Minneapolis 3, Minn.



NIKE HERCULES

With deadly accuracy the U.S. Army's new Nike Hercules ground-to-air guided missile streaks out to meet an approaching enemy air force. Its nuclear warhead can wipe out an entire formation.

Western Electric selected Teflon* insulated wire for use in building the alert guidance and control systems of this faster, higher climbing Nike.

As leading specialists in high temperature insulated wires and cables, the men and women at Hitemp are proud of this choice, and the role Teflon wiring plays in giving America a strong new perimeter of defense.

HITEMP WIRES, INC.

1200 SHAMES DRIVE, WESTBURY, NEW YORK

*Du Pont's trade name for Tetrafluoroethylene

CIRCLE 281 ON READER-SERVICE CARD



CHART-PAK precision tapes and die-cut symbols made these conductor paths and terminal pads for a printed circuit layout in 9 minutes 40 seconds!

HOW LONG WOULD IT TAKE YOU TO DRAW THEM?

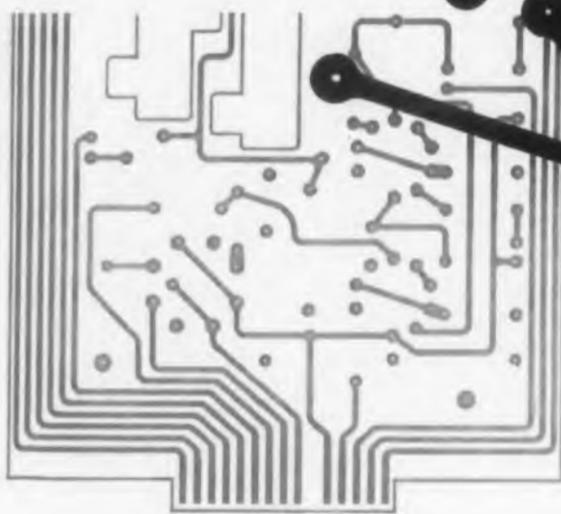


Chart-Pak tapes and symbols are precision manufactured to .002". High dimensional stability. Flat black surface is opaque, non-reflective. Pressure-sensitive adhesive backing holds firmly, will not melt under heat of reproduction; yet can be easily lifted and reapplied for corrections. Available in tape widths of 1/32" and up, and in lands, fillets, corners, tear drops, etc. Ideal for use on any surface, especially Chart-Pak "Mylar" precision grids. Write for full details.

CHART-PAK
Saves time...
Saves money!



CHART-PAK, INC.

ORIGINATOR OF THE TAPE METHOD OF DRAFTING

143 River Road, Leeds, Mass.

CIRCLE 282 ON READER-SERVICE CARD

Soldering is **EASIER FASTER BETTER**
with **American Beauty Soldering Tools**

American Beauty electric soldering irons are the highest quality made. The finest engineering, best materials and on-the-job experience since 1894 is yours with every American Beauty. There is a right model, correct tip size and proper watt input to do any soldering job easier, faster and better.

TEMPERATURE REGULATING STANDS

Automatic devices for controlling tip temperatures while iron is at rest—prevents overheating of iron, eliminates frequent retinning of tip, while maintaining any desired temperature. Available with perforated steel guard to protect user's hand.

NO. 3125
3/8" TIP
60 WATTS

NO. 3136
3/8" TIP
100 WATTS

NO. 3150
3/8" TIP
200 WATTS

NO. 3178
3/8" TIP
300 WATTS

NO. 3198
1 1/8" TIP
550 WATTS



WRITE FOR 26-PAGE ILLUSTRATED CATALOG CONTAINING FULL INFORMATION ON OUR COMPLETE LINE OF ELECTRIC SOLDERING IRONS—INCLUDING THEIR USE AND CARE.

AMERICAN ELECTRICAL HEATER COMPANY

DETROIT 2, MICHIGAN

CIRCLE 283 ON READER-SERVICE CARD

NEW LITERATURE

Ceramic Capacitors

284

A new 16-page Ceramic Capacitor Cross-Reference Guide is now being made available to engineers and purchasing agents in the electronics industry. This guide lists all units that are stocked and available for immediate delivery from Company distributors. "Special" or specification capacitors are not covered by the guide. The Guide lists over 600 ceramic capacitors by type and rating. These units are stocked in production quantities at factory prices, by industrial distributors. Equivalent units of other manufacturers, where available, are listed next to the company's capacitors, providing an easy method of determining sources for any given capacitor. The Guide contains separate sections devoted to general purpose discs and tubulars, temperature compensating discs and tubulars, high voltage discs, dual capacitors, buffer capacitors, low voltage capacitors, stand-off and feed-thru, transmitting, high accuracy and trimmer capacitors. Centralab, A Division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Vibration Meter

285

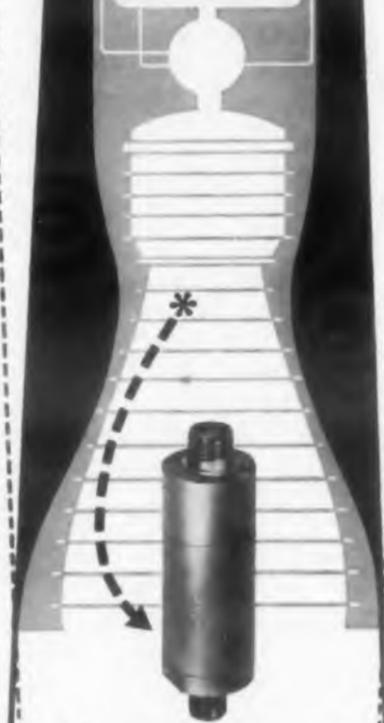
A new illustrated technical bulletin, No. WK-B-731A, describes Company's new Type B-731A vibration meter, an instrument with wide electronic, industrial and aircraft application that offers a new method of measuring distance and vibration. The new technical bulletin lists features, brief specifications, and design features, and illustrates the vibration meter. This latest instrument development may be used for vibration tests to meet JAN-MIL specifications in electronic components; to measure vibration in rotating shafts or bearings, on a production line for determining sizes and grades of parts for tolerance; and for testing airframes, either in wind tunnels or on actual airframes. The technical bulletin points out that the new Type B-731A vibration meter avoids hazards and makes remote testing possible. The instrument is particularly suited to the measurement of vibration where direct physical contact is not possible, and for measuring the dilation and eccentricity of rotating parts. Wayne Kerr Corp., P.O. Box 801, Philadelphia 5, Pa.

Cables

286

A six-page folder on plastic insulated and jacketed control cable (rated 600 v) lists the specifications of small diam—station—flexible and supervisory control cables with 2 to 19 conductors. Also IMSA municipal signal cables Specifications 19 and 20—1956 with 3 to 12 conductors. Chester Cable Corp., 159 Oakland Ave., Chester, N. Y.

THRUST SENSING FOR LIQUID ROCKET ENGINES



***STATHAM PA324 Pressure Transducer**

Because of its outstanding performance in severe missile environments, the Statham Model PA324

Absolute Pressure Transducer has been chosen to play the key role in important new thrust control systems based on accurate measurement of thrust chamber pressure.

For further information write for Data File ED-600-1.

STATHAM INSTRUMENTS, INC.
12401 West Olympic Boulevard
Los Angeles 64, California



CIRCLE 287 ON READER-SERVICE CARD

Thermostat Metals

289

"Graphical Determination of Element Size and Performance" Technical Data Bulletin TRU-... saves engineering time in determining the correct thermostat-metal element size and properties for new applications. This 4-page technical data bulletin provides graphical solutions, accurate enough for first sample determinations. A table gives Truflex thermostat metal types, their thermal deflections, mechanical and restrained forces. By using this table, the size and performance of simple beams, cantilever beams, special and helix coils and U-shapes can be determined for any of 40 different Truflex thermostat metals. Metals and Controls Corp., General Plate Division, Attleboro, Mass.

RFI Shielding

290

Comprehensive technical data and product information on RFI gasketing are now available in a handy, new RFI Designers Data File. Prepared to help designers solve specific shielding problems, this fully illustrated reference file offers both technical data and practical information about RFI gasketing materials. Also included are RFI problem outline sheets which may be used by designers to indicate specific problems, and forwarded to the company headquarter's staff of design service engineers for immediate recommendations. Copies from Technical Wire Products, Inc., 48 Brown Ave., Springfield, N. J.

Power Supplies Folder

291

A 4-page folder covers the uses and specifications of Electro Model PS-2 dual purpose filtered dc power supply. The new power supply powers transistor circuits, hybrid sets, 12/6 v auto radios without hum. The illustrated folder features tabulated information on percentage of ripple, continuous maximum current rating, and special features for transistor circuit servicing provided by Model PS-2 as well as other power supplies. According to the manufacturer, the information in this table demonstrates that Model PS-2 outperforms all units in its price class. Two output ranges are provided—0 to 20 v at a rating of 75 ma for operating transistor circuits, and 0 to 16 v with a rating of 5 amps for operating 12/6 v radios and hybrid sets. A special pi-type input filter holds ripple down to 0.15 per cent up to 75 ma (well below the critical requirement for low current loads in servicing transistor radios) and 0.5 per cent up to 5 amps.

A separate milliammeter for each range detects minute variations in transistor current. Each range has its own output terminals. Write R. C. Crossley, Electro Products Lab., 4500 N. Ravenswood Ave., Chicago 40, Ill.

Got a problem that calls for thread-cutting screws?

PARKER-KALON offers three new, improved thread-cutting screws for every application in every material



1 New, Improved P-K Type F*

... hardened thread-cutting screws developed for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steels, plastics and resin-impregnated plywood.



2 "Pentap"... the new, Improved P-K Type B-F*

(formerly F-Z) combining the five thread-cutting flutes of the Type F screw with the coarse-pitch, widely-spaced threads of the P-K Type B. The thread-cutting "Pentap" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, and prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.



3 P-K® Type L†

... is a completely new and improved thread-cutting screw developed by Parker-Kalon especially for use in Nylon. The Type L functions as a combination thread-cutting and thread-forming screw in that it cuts a small amount of the Nylon to allow the full diameter threads to form. Type L offers a particular advantage in Nylon assemblies which must be disassembled for service, because the P-K Type L can be removed and replaced without stripping or galling.

The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving, and avoid the possibility of stripping or galling.



FOR SEMS... and Neoprene or Nylon washer STAPS® in thread-cutting and thread-forming tapping screws, or machine screws in any kind of pre-assembled fastener-washer combination, P-K can supply them, too!

KEEP AMERICAN INDUSTRY AT WORK... BUY P-K... MADE IN U.S.A.

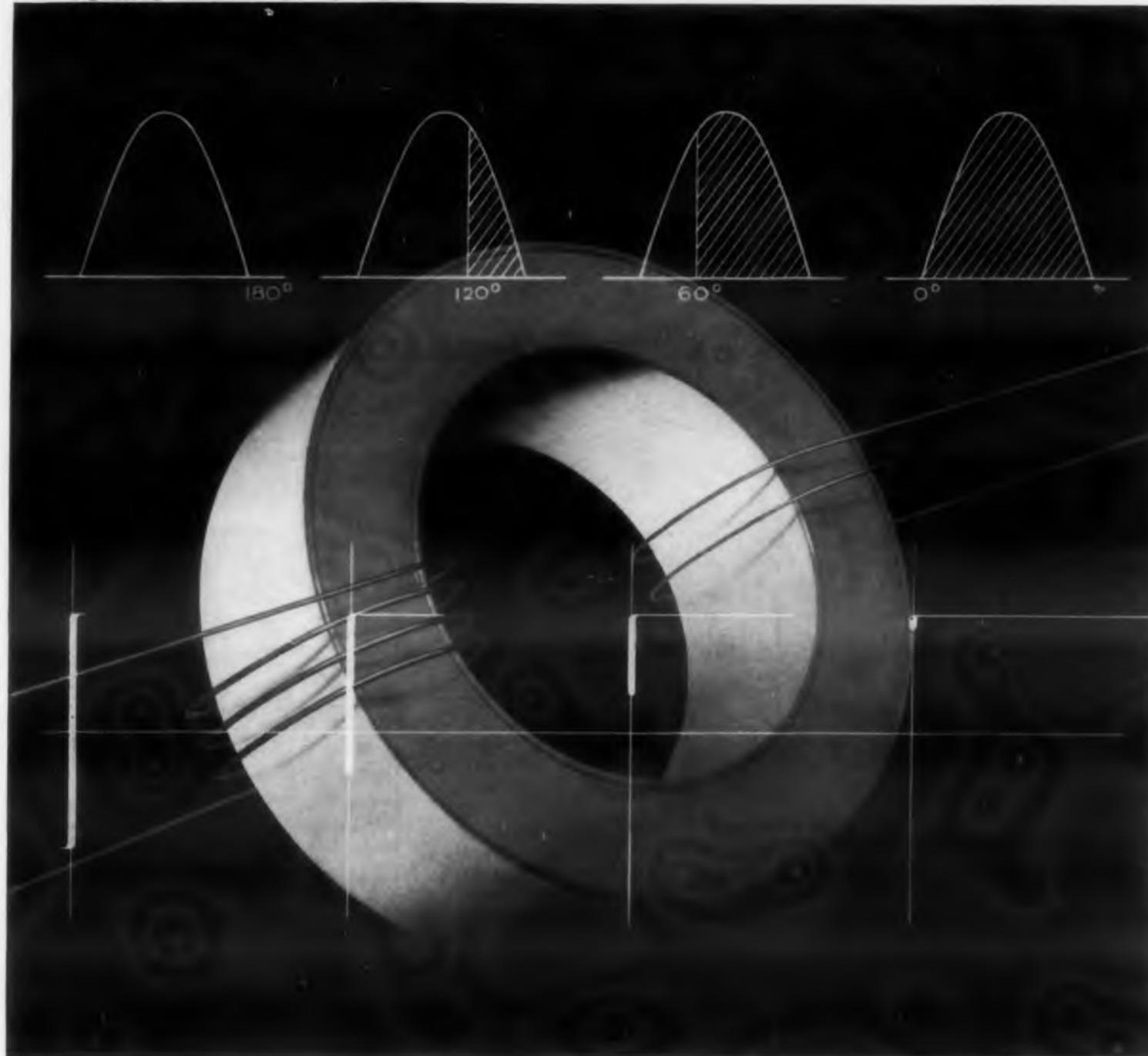
*Patent Pending †U. S. Patent 2,350,346

FOR SAMPLES OF P-K THREAD-CUTTING SCREWS AND SEMS, CALL YOUR LOCAL P-K "BULK-STOCKING" DISTRIBUTOR

PARKER-KALON® fasteners

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey • Offices and Warehouses in Chicago and Los Angeles

CIRCLE 292 ON READER-SERVICE CARD



Want a billion-position switch?

Magnetic amplifier manufacturers turn to Orthonol[®] tape cores for precise proportioning control or switching action

Orthonol is a switching material that can be turned all the way on—or part way on—with vast precision.

The rectangular B-H loop of the 50% nickel, grain-oriented alloy provides an amplifier output which is linear and directly proportional to control (reset) current. This response is so linear that the amplifier acts as a valve with an infinite (at least a billion) number of steps from full off to full on.

Full off and full on can be achieved with snap action, because the horizontal saturation characteristic of the B-H curve means a very low saturated impedance. Thus, when the amplifier is on, it is *on*; when it is off, it is *off*. On-to-off impedance ratios of at least 1000 to 1 provide complete assurance of this absolute characteristic.

Should your manufacturing facilities prevent the use of

Orthonol in tape wound core form, you can still take advantage of this excellent material in laminations. An Orthonol laminated core has characteristics almost identical to those in toroidal form.

Like all Magnetics, Inc. products, Orthonol tape wound cores and laminations are Performance-Guaranteed. Full details await your inquiry. *Magnetics, Inc., Dept. ED-60, Butler, Pennsylvania.*

MAGNETICS inc.

Visit our booth 2533 at the IRE Show
CIRCLE 293 ON READER-SERVICE CARD

NEW LITERATURE

Ultrasonic Cleaners

294

A new data sheet is now available on the giant size Series 5000 Narda SonBlaster ultrasonic cleaner, which consists of 23 systems for applications to mass-production cleaning or degreasing of mechanical, electronic, optical, horological, aircraft or missile parts or assemblies; to rapid cleaning of radioactive elements, "hot" lab apparatus, medical instruments, ceramic materials, electrical components and technical glassware; and to expediting metal finishing and chemical processing of many kinds. The data sheet describes Model G-5001, a 40-kc, 500-w average output SonBlaster generator designed for energizing a wide range of cleaning tanks, and the G-5002, a 20-kc 500-w average output generator which will operate magnetostrictive transducers for such functions as drilling, dip soldering and other high-intensity or high-temperature applications. Owing to Narda's mass-production techniques this equipment is available at the lowest prices in the history of the ultrasonic industry, starting from \$1140. Most items of the series can be shipped from stock. In addition to complete data on the 23 systems of the Series 5000, detailed information is given on applications and processes for which this equipment can be used. Tanks of different sizes, submersible transducer arrangements and metal-working tools are illustrated. Bulletin on Series 5000 Narda SonBlaster ultrasonic cleaner from the Narda Ultrasonics Corp., 625 Main St., Westbury, N.Y.

High Temperature Wire

295

The 1959 Super-Temp catalog on Teflon insulated wires and cables is now available. This elaborate, 64-page publication is completely new and contains 8 sections of the latest engineering information and prices on high-temperature magnet wire, lead wire, cables, tubing, and Teflon tape. Each section is preceded by detailed general information on the products cataloged. This information is consistent from section to section facilitating quick, easy reference on military specifications, temperature ranges, wire and cable constructions, colors, tests, etc. The catalog also contains technical bulletins and other information that provide engineers with design criteria for high temperature wiring. American Super-Temperature Wires, Inc., Winooski, Vt.

Don't forget to mail your renewal form to continue receiving **ELECTRONIC DESIGN**.

Recording and Plotting Systems 296

Two basic systems with time-tested features for recording and processing the multitude of strains required to evaluate complex structural systems in laboratory and industrial applications and tabulate strains on a typewriter, IBM cards or punched tape are illustrated and described in a new two-color, four page folder. The two basic systems available are: the "B" system, described as printing strain values in sequence together with channel number while the "C" system, is described as plotting strain vs. load for each channel on an exclusively designed continuous loop of paper reeved over powered sprocketed rollers with flanged floating idlers. The folder describes the many advantages of this new paper loop system and also describes the unique features common to both. Systems can be assembled in multiples of 24 channels utilizing the 24-451 scanning module which is described as the building block of B & F systems. It is designed to balance, calibrate, control and scan the output of 24 strain gage channels containing 1, 2 or 4 active arms and convert these variable resistances to variable voltages. General specifications are described in the folder as well as specifications under the headings: Power Supply, Programmer, Accuracy and Housing. B & F Instruments, Inc., 3644 North Lawrence St., Philadelphia 40, Pa.

Contactors and Relays 482

New line of special purpose contactors and relays, engineered and designed for the computer, power supply and electronic industries, are covered in 16-page booklet. Also, there are designs for the air conditioning and heating and refrigeration fields. Type F, R, B and BR relays are described. This folder contains engineering and cataloging data which will be of interest and help to electrical engineers. The Rowan Controller Co., 2313-2315 Homewood Avenue, Baltimore 18, Md.

Test Equipment 483

New Test Equipment Catalog No. 38-T describes latest electronic, electrical, radio, television and industrial testers. Triplett Electrical Instrument Co., Bluffton, Ohio.

Electronics Catalog 299

Detailed product listings on a wide variety of electronic parts and equipment are included in a 108-page catalog. Items for industrial, service, high fidelity, sound, and amateur radio use are described. Curle Radio Supply Co., 439 Broad Street, Chattanooga, Tenn.

HIGH HIGH efficiency at HIGH operating temperatures



SILICON POWER TRANSISTORS

Available Now in production quantities!

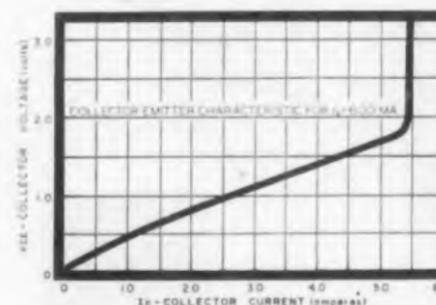
The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the "true power range." Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

Additionally, and unlike germanium units which are limited to approximately 85°C, these transistors can operate in ambient temperatures up to 150°C. Thus, even where the higher power rating is not required, these units may be used for their high temperature capabilities.

There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

Westinghouse Silicon Power Transistors are available

in 2 and 5 ampere collector ratings. Both of these are available in 30, 60, 100, and 150 volt ratings in production quantities for your immediate applications. Sample quantities are available in higher voltage ratings. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.



LOW SATURATION RESISTANCE

Important improvements in silicon purification and transistor fabrication have produced a new series of Westinghouse Power Transistors of exceptionally low saturation resistance.

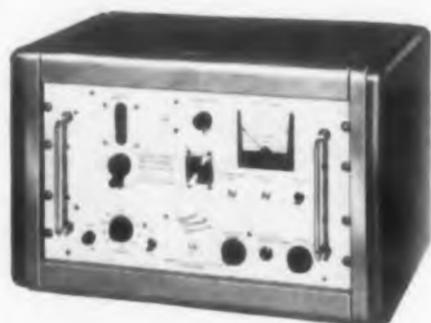
YOU CAN BE SURE... IF IT'S

Westinghouse

MICROWAVE INSTRUMENTS



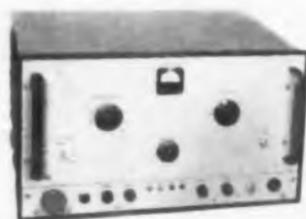
*... to improve
your
products*



... generation

... ultra-stable oscillator 814

Ultra-stable, high-power, tunable . . . short-term stability is 5 parts in 10^8 , long-term, 5 parts in 10^6 . Twenty-one models are available to cover complete spectrum from 2500 to 25,000 mc/s. Special units to 60,000 mc/s. Power output ranges from 20 milliwatts to 1.5 watts. Tunable, directly calibrated dials read frequency to 0.1 percent.



... measurement

... stability tester 5009

Exceptional, highly-advanced instrument for precision measurement of change, rate of change and stability from change. Four models measure drift and fm in frequency bands from 1120 to 14,500 mc/s. Meters calibrated to read peak fm deviation in cps and drift in kc. Accurate . . . at S-band measures deviation to less than 1 cps — at X-band to 10 cps. Instantaneous readings and continuous monitoring.

These instruments and others on display at IRE Show Booth 3207-3209



LABORATORY FOR ELECTRONICS, INC.

1079 COMMONWEALTH AVE. BOSTON 15, MASS.

CIRCLE 301 ON READER-SERVICE CARD

NEW LITERATURE

Relays

302

A unique series of relays designated Model TT and TS is described in Bulletin No. 160. These advanced units incorporated "Molded Module" contact springs, that is, spring combinations which are molded into a single compact assembly for permanent alignment and unsurpassed operating stability. Very high sensitivity for their size and high ambient operating capability are other features of these units discussed in the bulletin. For a free copy of Bulletin 160, write to Ohmite Manufacturing Company, 3679 Howard Street, Skokie, Ill.

Right Angle Connectors

303

Illustrated 6-page brochure gives specifications, outline dimensions and general information on right angle pin and socket connectors for printed circuit applications. These miniature right angle connectors are available in various contact sizes and molding compounds. Right angle pins dip solder to printed circuit board. Solder cups on receptacle accept #20 AWG wire. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Boulevard, Long Island City 1, N.Y.

Resistance Thermometer Wire

304

To aid in better resistance thermometer design, a new brochure has been prepared on resistance thermometer wire, showing graphically resistance versus temperature from 0 deg to 500 deg C with various pure metals and alloys used in thermometry. Also included in this brochure are the various types of enamel that can be applied to the wire best suited for your particular wiring requirements, whether it be the standard oleoresinous which is rated for continuous use at 105 deg C, or the Secon Ceramic Insulation which is rated for continuous use at 500 deg C. Secon Metals Corp., 7 Intervale Street, White Plains, N.Y.

Soldering Iron Tips

305

Data sheet catalogs Long-Life Soldering Iron Tips (No. 601, superseding #600), showing 81 new shapes and sizes—a total of 124. Included are plug tips, from 1/16 in. to 1-1/8 in. diameter and screw tips from 7/16 in. to 1-3/4 in. diameter. Various tip shapes are illustrated, complete dimensions given, as well as advice on use and care; includes list prices. Gives detailed specifications on the new Extradur Tips which give up to 20 times longer life than copper tips. Heacon Electric Co., 161 W. Clay Ave., Roselee Park, N.J.

Molded Cable Assemblies

306

A new, twelve-page catalog, covering standard molded-type cable assemblies as well as field, special and coaxial types, illustrates 34 standard types utilizing common connector ends and standard molded terminal ends. Cable assemblies are supplied in lengths as required. There are three pages of tabular reference data giving types, cable numbers, corona levels and special remarks. Corona levels range from 2 kv ac to 15 kv ac and 15 kv dc to 40 kv dc. These cable assemblies are used for missile, aircraft and general applications. H. H. Buggie, Inc., Box 817, Toledo 1, Ohio.

Pressure Transducers

307

Three new instrumentation bulletins technically describe a series of rugged, high performance pressure transducers: Model DP-7 pressure transducer, (Bulletin 58-131), Model GP-15D high range pressure transducer (Bulletin 58-135) and Model DP-15D high range differential pressure transducer (Bulletin 58-140). Each data sheet contains instrument descriptions, application information and performance specifications. BJ Electronics, Borg-Warner Corporation, 3300 Newport Blvd., Santa Ana, Calif.

Rectifier Kits

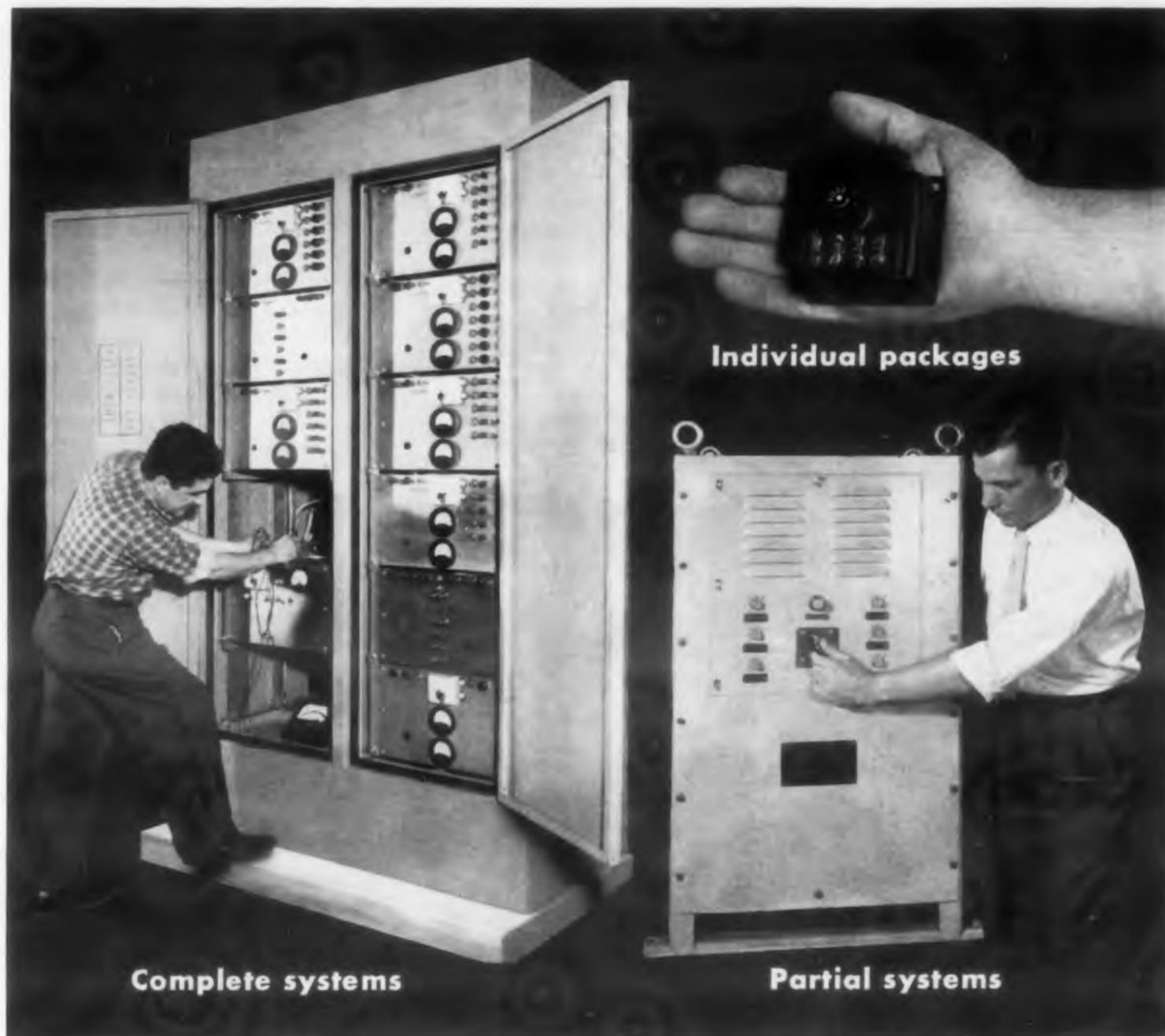
308

A four-page folder, illustrates and describes a new kit for on-the-spot conversion of Leece-Neville alternator systems with selenium rectifiers to utilize newly developed, more economical silicon rectifiers. According to the literature, the new silicon rectifiers, which consist of six tiny cells in lieu of the previous separate unit, provide greatly improved alternator performance and higher rating; and require only minimum maintenance. The folder pictorially presents the details of the silicon rectifier, what it is, and very importantly, how it is easily installed. Detailed information on its design and construction, plus application data is likewise included. Copies may be obtained from the Leece-Neville Co., 1374 East 51st St., Cleveland 3, Ohio.

Digital Systems

309

A new 4-page short-form catalog on the complete digital systems line, as well as a two-page flyer on the digital voltmeter lists product features, brief specifications, and ordering information on the company voltmeter, control unit, pre-amplifier, ac/dc converter, ohmmeter, scanners, printer control units and ratiometer. The dc measurement instrumentation flyer is the beginning of a series of publications on individual units in the Cubic digital line. Cubic Corp., San Diego, Calif.



Complete systems

Partial systems

Save design time, avoid assembly headaches with General Electric custom-designed DC power supplies

General Electric can meet your power-supply requirements—your requirements from individual packages to complete systems. These can be supplied from (1) completely engineered equipment in stock, (2) by custom packaging of components, or (3) with completely new designs. Whatever your prob-

lems, General Electric can handle your power supply system responsibility and save you design time and assembly problems.

FOR MORE INFORMATION contact your nearest General Electric Apparatus Sales Office or write to General Electric Company, Section A535-1, Schenectady, New York.

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GENERAL  ELECTRIC

CIRCLE 310 ON READER-SERVICE CARD

Microwave Component News



from SYLVANIA



NEW Subminiature Microwave Diodes

Sylvania opens the way to advanced miniaturization concepts in microwave and radar design with new smaller Silicon Microwave Diodes



Major step in the trend to ever smaller radar and microwave equipment to meet today's military and commercial demands is represented by Sylvania's new line of subminiature microwave diodes. The new diodes meet the electrical performance of their larger counterparts and are equivalent in ruggedness and reliability. They combine in one unit Sylvania's unmatched experience in diode packaging and proven technical excellence in microwave diode design.

The subminiature metal-to-glass package opens the way to new possibilities in strip-line and slab-line transmission designs. Included among the new types are Detector Diodes ranging in frequencies from 100 mc to 9,000 mc and Mixer Diodes in frequencies from 3,000 mc to 9,000 mc. Contact your Sylvania representative for full information on the new subminiature microwave diodes—or write Sylvania directly.

NEW SYLVANIA MICROWAVE DIODES

D 4050—UHF Detector
D 4063—X Band Video Detector

D 4064—S Band Mixer
D 4065—X Band Mixer



SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
Semiconductor Division
100 Sylvan Road, Woburn, Mass.
CIRCLE 311 ON READER-SERVICE CARD

NEW LITERATURE

Potentiometers

312

A 4-page brochure summarizes key information on Trimpot® and Trimit® lead screw actuated potentiometers. Designed for quick reference, this brochure features a specification table listing available resistances, terminal types, and settings, power ratings, operating temperatures, and dimensions of the more popular models. Cut-away drawing illustrates the internal construction and design features of Trimpot. Bourns Specification Summary #4 from: Bourns Laboratories, Inc., P.O. Box 2112, Riverside, Calif.

Molded Fiber Glass

A 2-color, 32-page brochure illustrates and describes in detail the mechanical, electrical and chemical properties of molded fiber glass. Fabricating and finishing operations which can be performed on this material are also described. Write directly to: Molded Fiber Glass Companies, Dept. ED, 4826 Benefit Ave., Ashtabula, Ohio.

Switches

313

Revised 24-page catalog covers the representative line of precision snap-action and mercury switches manufactured by this company. Data on high-temperature, maintained-contact, explosion-proof, high capacity, proximity, oil-tight, environment-free and multicircuit types are included. Has photos, dimensions, electrical ratings, characteristics and application information. Micro Switch, Freeport, Ill.

Plastics

314

Folder gives information on Kel-F, a fluorocarbon plastic with a combination of interesting physical, chemical, electrical and mechanical properties, which is now processed in all forms by this company. The versatile material has improved performance of electronic, aircraft, missile, chemical handling and processing equipment. Development and properties of Kel-F are covered in this booklet. Fluro-Plastics, Inc., Division of Flexrock Co., Philadelphia 1, Pa.

Precision in miniature

Waveforms Portable

520A Voltmeter

510B Oscillator



NOW! COMPACT RACK & PANEL MOUNTINGS IN ANY SHAPE OR FORM YOU NEED!

Waveforms precision voltmeters and oscillators give you top performance and uniform quality. Save space, too. So compact they mount on a 5"x7" panel, these instruments are now available in any shape, form or mounting—rack or panel—you require.

Waveforms integrated operation permits fast deliveries and low cost, even on custom specifications. Mass production techniques applied to special order work.



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Send today for complete technical information. If you prefer, phone:

Waveforms INC.

"Precision in miniature" ELECTRONIC INSTRUMENTS
335 Sixth Avenue, New York 14, N.Y.

WAtkins 9-2795

CIRCLE 315 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Data Processing System 316

Illustrated folder U1395 describes the features of the new, large-scale Univac II data-processing system. The computer offers a new, high-speed memory system—the magnetic-core memory, which provides instantaneous access to 24,000 alphabetic or numeric characters. It is the only system to provide direct recording of information on magnetic tape and records information at a pulse density of 250 characters per recording inch. Remington Rand Div. of Sperry Rand Corp., 315 Fourth Ave., New York 10, N.Y.

Bearings and Bushings

Fully illustrated, 70-page catalog covers graphex, coprex and woodex oil-less and self-lubricating bearings, bushings and machine parts manufactured by this company. A reference guide for sintered metal parts, this comprehensive catalog details Wakefield alloys and their recommended usage; a complete section is devoted to properties of powdered metal compositions determined by test; tables illustrating the standard sizes of bearings available from tools on hand;

and plant facilities. Metal structures in various stages of development, which helps buyers compare good and bad sintering, is graphically illustrated with a group of microphotographs. *Copy available by writing on company letterhead to: Wakefield Bearing Corp., Dept. ED, 29 Foundry St., Wakefield, Mass.*

Pulse Control Instruments 317

This 8-page condensed catalog provides capsule technical descriptions of more than 25 pulse control instruments, including pulse generators, flip-flops, coincidence detectors, delays, mixers, counters and power supplies. Burroughs Corp., Electronic Tube Div., P.O. Box 1226, Plainfield, N.J.

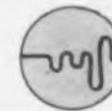
DC Measurements 318

This 9-page brochure, "Low Level DC Measurements," details instrumentation and circuit design applications. Low dc potentials in the microvolt ranges can now be read easily by means of a new precision chopper inverter. Microdyne, 300 West Washington, Chicago 6, Ill.

Microwave Component News



from SYLVANIA



NEW Space Saving Ferrite Devices



Three-port Circulator,
Model FD-TC 522



Coaxial Ferrite Isolator,
Model FD-155

Sylvania introduces new ferrite devices covering UHF through K band

Sylvania scientists and engineers have developed advanced ferrite devices with new utility and reliability. They are the results of pure research and product development by the Microwave Physics Laboratory, now a part of Special Tube Operations.

Now, new Tee circulators are available that perform the same electrical function as standard phase shift circulators, yet occupy only 25% of the space and cost much less. The devices can also be used as isolators and as fast-acting switches.

New isolators, available in coaxial and standard design, incorporate exclusive space-saving features in addition to outstanding electrical performance. The 8½-inch FD-151, for example, provides 15-db isolation across the band from 2-4 kmc. Whatever the degree of isolation required, you'll get a smaller package and top reliability from Sylvania.

Data on Sylvania ferrite devices available from stock may be obtained from your Sylvania representative or by writing to the address below. Devices can also be custom designed to meet your specific requirements.



SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
Special Tube Operations

500 Evelyn Avenue, Mountain View, California

CIRCLE 320 ON READER-SERVICE CARD

Announcing! FALSTROM STANDARDIZED* LINE

The Falstrom Company, long known as a producer of custom metal fabrications now offers the STANDARDIZED* line of cabinets, consoles, and racks.

*Falstrom STANDARDIZED enclosures are produced to basic Falstrom designs from standard tools and dies by tested Falstrom procedures to fit the specific equipment they will house. Delivery is prompt but not from stock.

WRITE TODAY for folder, "How to get a quotation on a Falstrom STANDARDIZED enclosure"

 **FALSTROM
COMPANY**

115 Falstrom Court, Passaic, New Jersey



Consoles



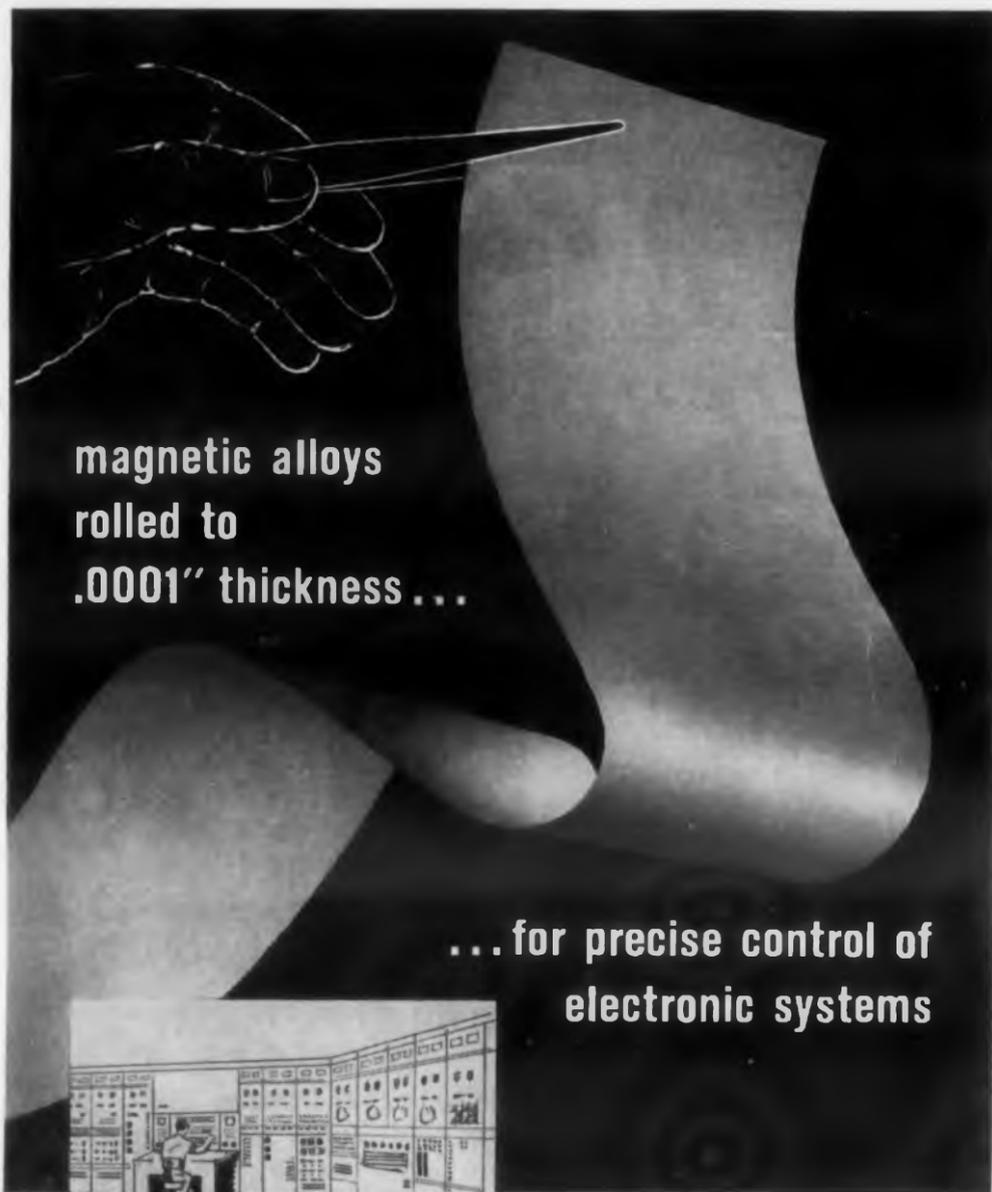
Cabinets



Rack
Cabinets

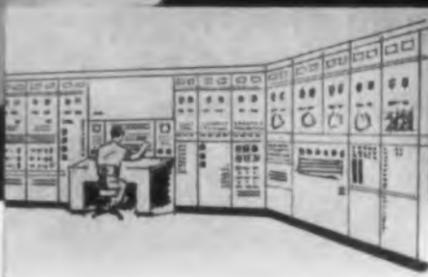
See us at the I.R.E. Show in New York—booth #1327.

CIRCLE 319 ON READER-SERVICE CARD



magnetic alloys
rolled to
.0001" thickness...

...for precise control of
electronic systems



Now you can obtain high magnetic permeability alloys such as 4-79 Moly Permalloy, Alfenol, and HyMu "80" in cold rolled strip and foil in production quantities! The unique and newly expanded facilities of Precision Metals Division are geared to produce ultra-thin metal strip and foil in any quantity and in virtually any alloy.

Precision Metals strip and foil for development and production offer these special advantages:

uniform magnetic properties
thicknesses from .010" to .0001"
dimensional uniformity

extremely close tolerances
excellent surface characteristics

For specific requirements, Precision Metals can also furnish custom alloys to your own specification in the form you need. Write today for fully illustrated facilities booklet, ED-3.



HAMILTON

WATCH COMPANY / Precision Metals Division

Lancaster, Pennsylvania

CIRCLE 321 ON READER-SERVICE CARD

NEW LITERATURE

Glass, Asbestos Woven Tapes 322

"Atlas Asbestos and Gaspun Woven Tapes" describes and contains samples of untreated continuous filament Fiberglas all-purpose electrical insulating tapes. "Atlas Asbestos and Fiber Glass Textiles for Electrical Insulation, Thermal Insulation, Plastic Reinforcement, Pipe Lagging, Filter Fabric and Packing and Gasketing" describes the performance characteristics, uses and sizes of the entire Atlas line of Gaspun and asbestos textiles. Brochures and samples of the products described available from: Atlas Asbestos Co., North Wales, Pa.

Electronic Catalog 323

This comprehensive 1959 catalog contains complete listings on the wide variety of electronic parts and equipment for industrial use carried by Federated Purchaser, Inc., as well as sections devoted to replacement, audio, high fidelity and ham parts and equipment. Federated Purchaser, Inc., 1021 U.S. Hwy. 22, Mountainside, N.J.

Microwave Measurements 324

This 36-page application booklet describes the latest techniques and instrumentation for making various microwave standards measurements. It presents a detailed description of the techniques used in the general areas of standards measurement, including frequency, attenuation, impedance and power. Mr. R. Whitburn, Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.

Service Offered 325

This is a 20-page, three color, illustrated booklet, which describes the services of the St. Louis Car Company. Resources, capacity, location, diversified facilities, technical staff, and past achievement are factors described and pictured. Company produces transportation equipment, military vehicles, and materiel, and industrial and commercial items ranging from major assemblies to special fabrication. St. Louis Car Co., 8000 North Broadway, St. Louis 15, Mo.



OK Boss, you tell 'em how we're gonna revolutionize the party line telephone system with transistor oscillators controlled by . . .

NEW REEVES-HOFFMAN LOW FREQUENCY CRYSTALS

New Reeves-Hoffman low frequency crystals, type RH8-DP, offer excellent frequency stability over a temperature range of -55° to $+105^{\circ}\text{C}$. Available from 4 to 15 kc, they are designed for use not only in telephone carrier and communications systems, but in aircraft navigation, guided missile, sonar, telemetering and test equipment as well. These crystals meet MIL C-3098B specifications for shock, vibration, aging and moisture resistance.

WRITE FOR BULLETIN RH8-DP

SEE US IN BOOTH 1809 AT THE
IRE NATIONAL CONVENTION



DIVISION OF
DYNAMICS
CORPORATION
OF AMERICA
CARLISLE,
PENNSYLVANIA

REEVES-HOFFMAN SPECIALIZES IN VOLUME PRODUCTION OF CRYSTALS FROM 1 MC DOWN

CIRCLE 326 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Precision Components

327

A 4-page, 2-color brochure describes and illustrates this firm's standard line of precision components for computers, instruments and control systems. Engineered to high military and commercial standards, these components are available for early delivery. The brochure provides detailed specifications and performance data on cams, synchros, mechanical differentials, oldham couplings and 10-w low-inertia servo motors. Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N.Y.

Transformers

328

More than half of this 24-page catalog is devoted to a description of the many types of transformers that can be produced as "custom" units. The catalog also gives a comprehensive idea of the mounting types and electrical ratings possible in custom units. New transistor transformers are described in detail. Harold Edelstein Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N.Y.

Winding Machines

329

Six-page Condensed Catalog 58A is a shortened, convenient, quickly-read form of the 16-page Catalog 58. Specifications, features and full descriptions of the company's automatic, semi-automatic and subminiature toroidal winders, the tape winding machine, the high speed hobbin winder and the new permeameter are present in this condensed catalog—much of this information in the form of comprehensive, wee-at-a-glance tables. Boesch Mfg. Co. Inc., 45 River St., Danbury, Conn.

Bobbin Cores

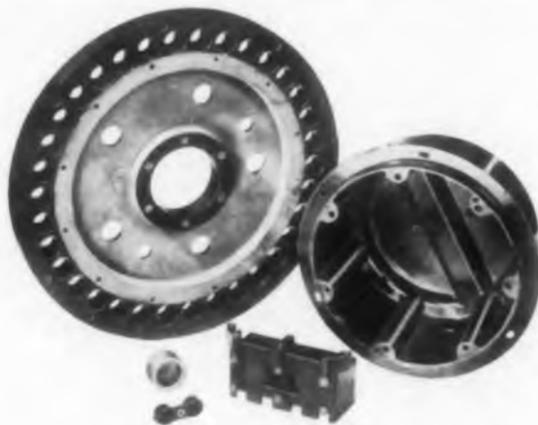
330

Bulletin BC-203, illustrated and containing 16 pages, provides preliminary information which designers may use to tentatively complete circuit designs without the need for expensive experimentation. Included are the first published guaranteed maximum-minimum limits for tape wound cores, measured according to industry accepted pulse techniques which are detailed in the test. Magnetics, Inc., Butler, Pa.

DIALL

50-51

plastic
molding
compound



—for absolute reliability in plastic molded parts

Here is the toughest plastic that money can buy — a *Dacron**-filled, diallyl phthalate compound. Diall 50-51 does not crack around inserts even under thermal shock. It has high impact and structural strength, and exceptional dimensional stability. It is completely unaffected by moisture.

Now in granular form, Diall 50-51 is easily molded into the most intricate shapes. Used in thousands of rocket and missile parts. Certificates of military and other approvals furnished on request. Write for Bulletin 50-51.

*Du Pont Trade Name

MESA PLASTICS COMPANY

11751 Mississippi Ave., Los Angeles 25, Calif.

CIRCLE 331 ON READER-SERVICE CARD



CURTISS WRIGHT



ADVANCED DESIGN COMPONENTS



New ULTRASONIC DELAY LINES

Low cost — Small size

Development engineers can now employ new concepts in existing and proposed applications. These Curtiss-Wright delay lines are extremely small, hermetically sealed and vibration proof. They are ideally suited for use in computers, coders and decoders, telemetering and navigational systems.

SPECIFICATIONS

Delay range... 5 to 6000 microseconds
Tolerance... ±0.1 microsecond
Signal to noise ratio... Greater than 10:1

Input & output impedance... 50-2000 ohms
Carrier frequency... 100 kc-1 mc
Delay to pulse rise time... Up to 800:1

DIGITAL MOTORS For high reliability applications



These stepping motors meet the requirements of assured reliability and long life for aircraft, missile and automation systems.

FEATURES

Dynamically balanced
Bi-directional • Positive lock
Simplicity of design
High pulsing rate

TIME DELAY RELAYS For high vibration applications



"H" Series thermal time delay relays are designed to meet the high shock and vibration conditions of today's military applications.

FEATURES

Time delays from 3 to 180 seconds
Temperature compensated
Hermetically sealed • Miniature
Meets rigid environmental specifications

WRITE FOR COMPLETE COMPONENTS CATALOG 159

ELECTRONICS DIVISION

CURTISS-WRIGHT

CORPORATION • WEST CALDWELL, N. J.

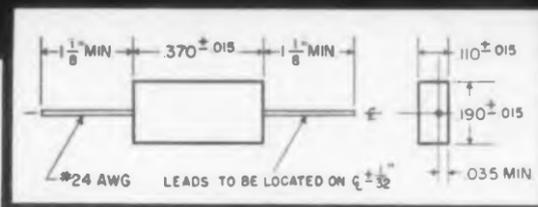
CIRCLE 332 ON READER-SERVICE CARD

Smallest MOLDED*
MICA CAPACITOR
73% Smaller†
Micamold Missilmite
for 55°C to 125°C operation

MEETS AND EXCEEDS MIL-C-5A
MEETS AND EXCEEDS MIL-C-11272A



*Pat. Applied For
 †73% smaller than CM-15.



Micamold's Missilmite subminiature molded mica capacitors are the **Smallest Molded Mica Capacitors Ever Produced...73% SMALLER!** Due to radically new engineering design, new materials and assembly methods, Perfectly Symmetrical Missilmites MEET and EXCEED MIL-C-5A and MIL-C-11272A, Characteristics "C," "D" and "E." These subminiature molded mica capacitors will withstand operating temperatures of -55°C to $+125^{\circ}\text{C}$ (standard range is from -55°C to $+85^{\circ}\text{C}$), and weigh only $\frac{1}{2}$ gram.

Reliable and **stable** Missilmites permit greater design flexibility to the engineer, and are especially desirable in critical miniaturized assemblies. Recommended for use in missiles, delay lines, pulse networks, computers, transistorized assemblies...or wherever minimum size and weight, with stability, are required.



General Instrument Corporation
 also includes
 Automatic Manufacturing
 F. W. Sickles Division
 Radio Receptor Co., Inc.
 (subsidiary)

Send for Bulletin 114A to:

MICAMOLD ELECTRONICS MANUFACTURING CORP.

(Subsidiary of General Instrument Corp.)

1087 FLUSHING AVENUE, BROOKLYN 37, NEW YORK • HYacinth 7-5400

Visit our Booths 2211-17 at the IRE Show

CIRCLE 484 ON READER-SERVICE CARD

NEW LITERATURE

Miniature Plugs 485

MS miniature plugs, Series KM, designed to qualify to Mil-C-25955 (USAF) are described and illustrated in Catalog KM-1. The KM series is used in airborne applications where extremes of humidity and barometric pressure are experienced. The plugs feature crimp-type, snap-in contacts. The 12-page catalog details, among other things, materials and finish, alternate insert arrangements, and end-bell and connector shell variations. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

"Photo-Voltaic" Cells 486

Complete design details, theory of operation and application notes on a newly developed line of silicon "photo-voltaic" readout cells is given in 4-page Bulletin No. 33-58. Illustrated are typical current-voltage curves, variation of available power according to temperature changes and spectral response curves. Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.

Dry-Type Transformers 487

Bulletin GEA-6723, consisting of 24 pages and illustrated, gives original equipment manufacturers a complete reference for selecting small power and control, general-purpose and special-purpose transformers. It contains a complete description of each transformer type including typical ratings, prices and detailed application information. General Electric Co., Schenectady 5, N.Y.

Digital Voltmeter 488

Kin Tel Model 402 ac/dc digital voltmeter is described in this 1 page bulletin. The new digital voltmeter provides 100 μv resolution in dc, 1 mv in ac. A chopper-stabilized control unit drives a projection-type readout which presents 1-1/8 in. digits on a black screen. The readout is connected to the meter by cable and may be rack-mounted at a remote location if desired. Data Sheet No. 19-24 from: Kin Tel, 5725 Kearny Villa Road, San Diego 12, Calif.



CIRCLE 489 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 18, 1959

Resin Finish 490

Properties of "Poly-Ep," a polyamide-epoxy resin finish, including dielectric strength; resistance to moisture, abrasion, organic and inorganic chemicals; adhesion to synthetic materials and metals and other technical data are included in Bulletin #82. This 4-page bulletin is available from D. J. Peterson Company, Sheboygan, Wis.

RFI Strip Shielding 491

This data folder of 4 pages lists 330 standard RFI strips of different sizes, shapes and materials. It covers over 80 per cent of all RFI shielding requirements. Technical Wire Products, Inc., 48 Brown Ave., Springfield, N.J.

Special Charts 492

Bulletin No. Y1906 describes charts for special requirements (including pre-printed photo charts for oscillographic recording). Engineering information and chart samples are included. Manufacturers or users of special instruments may obtain Bulletin Y1906 by writing to The Bristol Co., Waterbury 20, Conn.

Teflon Catalog 493

This 28-page Teflon Stock Catalog and Machining Handbook, prices 1087 sizes of Teflon tubing and rod available for machining into parts, sizes from 3/16 in. to 18 in. diam. All stock prices are on a unit basis, eliminates weight estimating. The manufacturer lists the same sizes as used by them and also details machining methods, speeds, feeds and tool design for machining this unique material. Included are detailed methods for both engine lathe and automatic screw machine work. The catalog also tells how to make envelope gaskets, "O" rings, etc. Write for Catalog C-1, Halogen Insulator and Seal Corp., 9960 Pacific Ave., Franklin Park, Ill.

Ceramic Disc Capacitors 333

This 6-page folder includes complete specification data, charts and graphs on the performance capabilities of the company's ceramic disc capacitors. It covers temperature stable, semistable, general purpose and temperature compensating capacitors. Electro Motive Mfg. Co., Inc., Willimantic, Conn.



Continuous thinking...

...research and experience developed Magnetic Research Corporation's all new DC-DC CONVERTER... a converter whose versatility is adaptable to telemetering, guidance, control and communication groups... or any other application where the DC regulated power is required.

- DC-DC CONVERTER specifications
- OUTPUT POWER: MULTIPLE 150 WATT MAX.
 - SIZE: 5.0" X 3.5" X 3.7". WEIGHT: 3.5 lbs.
 - EFFICIENCY: GREATER THAN 75%
 - LINE REGULATION: LESS THAN $\pm 1\%$
 - SHORT CIRCUIT PROOF... 28V DC INPUT



Pacing the industry in Astro-Magnetics
MAGNETIC RESEARCH CORPORATION
3160 W. El Segundo Boulevard, Hawthorne, California

CIRCLE 335 ON READER-SERVICE CARD

PRECISION RELIABILITY QUALITY

COMPLEX ELECTRONIC EQUIPMENT

- Highest quality standards, low manufacturing costs.
- Complete Engineering services.
- Precision, reliability, and quality guarantee, an integral part of each equipment.
- For computer, data processing, servo, and ground support systems.
- To Applicable MIL Specs.

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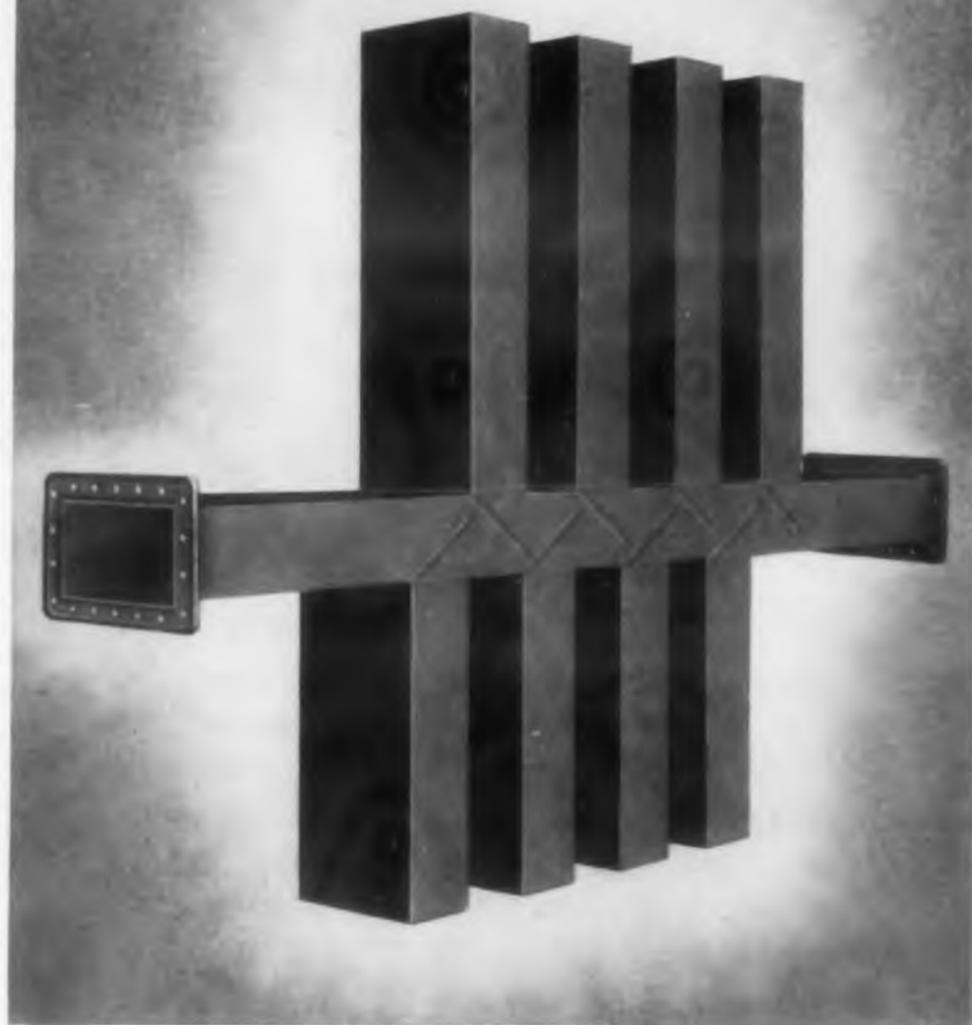
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NEW LITERATURE

Terminal Boards 337

Complete specifications, outline dimensions and general information on Continental Connector series MT terminal Boards are given in a new, illustrated bulletin. This series is available with four or eight turret terminals molded directly into the body material. Optional mounting holes are available in either size. Molding compounds include mineral filled melamine, glass reinforced plaskon or diallyl phthalate, and mineral filled diallyl phthalate. For a copy of Series MT technical bulletin, write to Electronic Sales Division, DeJur-Amsco Corp., 45-01 Northern Boulevard, Long Island City, N.Y.

Photoelectric Controls 338

New Tubeless Photoelectric Control Catalog describes controls with Cad Cell sensing element; with transistor and with magnetic amplifier, including suitable light sources. This 4-page, 3-color, catalog 58-1 available from: Autotron, Inc., Box 722 HA, Danville, Ill.

Ceramic Design Handbook 339

The technical information in this 16-page handbook is intended to enable designers to determine which Centralab engineered ceramics are best suited for existing applications, or for new devices which require their unique electrical and mechanical properties. It describes the electrical and environmental characteristics of the ceramics and contains information on the advantages and disadvantages of various fabricating techniques. Centralab, 900 East Keefe Ave., Milwaukee 1, Wis.

Thermostats 340

Comprising 4 pages and printed in two colors, Bulletin 8400 pictures all major thermostat types and gives condensed technical information on operating ranges, electrical ratings, optional mountings and terminal arrangements of the company's complete line. Stevens Manufacturing Co., Inc., P.O. Box 1007, Mansfield, Ohio.

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ELECTRONIC DESIGN • March 18, 1959

Electronics Catalog 342

Catalog No. 101, is a 160-page volume which includes prices and detailed data on a wide variety of electronic parts and equipment for service and sound applications, as well as particularly comprehensive listings of products for industrial use. The Merquip Catalog, c/o Electronic Publishing Co., Inc., 180 N. Wacker Drive, Chicago 6, Ill.

Radiation Meters 343

A new bulletin describing the company's line of portable radiation survey meters, consists of 8 pages, is printed in two colors, and is profusely illustrated with photographs. Equipment covered includes gamma dose rate meter, Cutie pie, Thyac, Scintillac, Victor series of geiger counters and scintillation detectors, and the Vic-Tic. Detailed specifications, performance data, optional accessories, sizes, weights, etc., are given. Copies of "Victoreen Portable Radiation Survey Meters." Form 3044B, are available on request. The Victoreen Instrument Co., Instruments Div., 5806 Hough Ave., Cleveland 3, Ohio.

Control System 344

Bulletin 106 (16 pages, 2-color) illustrates and describes the design approach, materials, construction and modern facilities used in manufacturing a variety of Centralized Control and Data Presentation Systems. Panellit, Inc., 401 N. Hamlin Ave., Skokie, Ill.

Silicones 345

The 1959 Reference Guide to company's silicone products describes what silicones can best meet the needs of an unbelievable variety of problems ranging from adhesives to release agents, resins to rubbers, dielectrics to water repellents. It contains graphic examples showing where many of these silicone products are currently being used, and it gives information on how to get specific data on the silicone material best suited to any application. This 16-page 2-color, up-to-date reference guide is heavily illustrated and features an expanded indexing system to facilitate quick and easy location of the more than 150 silicone products now commercially available. Dow Corning Corp., Midland, Mich.

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CIRCLE 346 ON READER-SERVICE CARD

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CIRCLE 348 ON READER-SERVICE CARD

NEW LITERATURE

Data Loggers 349

A new four-page brochure describes the features, applications, and specifications of company's Data Logger line. These data loggers are used for recording weight, strain, force, flow, pressure, or temperature. Data is automatically recorded and printed out in visual form for "on-the-spot" evaluation or for later calculating and computing. Model 166 supplies a single range typewriter read-out and Model 167 includes the necessary additional circuitry for multirange selection. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

Precision Gears 350

High-performance, precision gears with tooth-to-tooth spacing accuracies of two ten-thousandths of an inch are described in this 24-page Bulletin (GEA-6430). Typical applications of these precision gears include radar power and data gears and guidance controls. General Electric Co., 1 River Road, Schenectady 5, N.Y.

Circular Slide Rule 351

A handy circular Slide Rule for engineers and for other plant and office executives has been introduced. Any executive who must perform simple calculations will find this convenient, pocket-size calculator extremely useful in his work. Operation is simple and the results are accurate. Used to multiply, divide and find proportions, the circular slide rule has complete easy-to-follow instructions printed on the reverse side. For your free Circular Slide Rule, write to General Industrial Co., 5738 Elston Ave., Chicago 30, Ill.

Servo Motors, Amplifiers 352

Bulletin 501 A, 4-pages and illustrated, covers synchro transmitters, transformers, receivers and differential transmitters. With specifications and outline drawings it describes size 8 servo motor and size 8 amplifiers. Merchandising, Ketay Dept., Norden Div., United Aircraft Corp., Commack, L.I., N.Y.

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CIRCLE 273 ON READER-SERVICE CARD

Magnetic Amplifiers 354

Four-page Bulletin EPD 1296-5 gives full specifications on company's new 1290 series super power gapless core magnetic amplifiers. This series consists of 18 standard sizes with power outputs of 500 va to over 32 kva. Bulletin includes tables of electrical characteristics, curves, basic circuit diagrams, and outline and mounting dimensions for both amplifier reactor units and rectifiers. Vickers Inc., Electric Prod. Div., 1815 Locust St., St. Louis, Mo.

Transformer Catalog 355

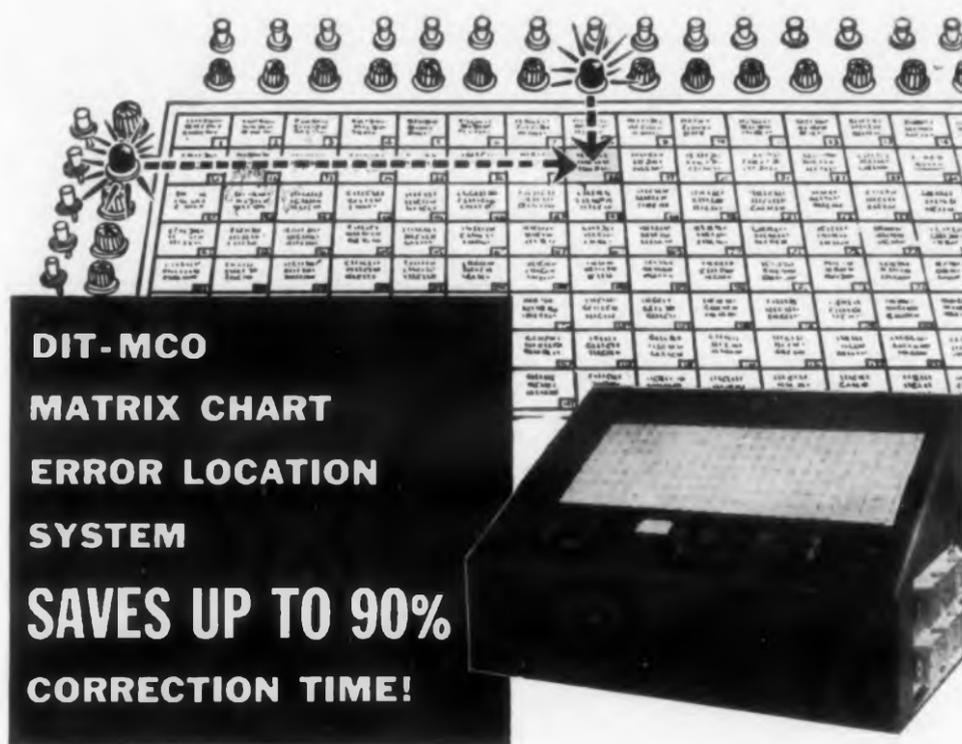
This 24-page catalog, titled "Pulse Transformers," is designed to assist engineers in the application of transformers to their specific needs. Complete with many tables, charts, and schematics, this manual covers a brief history of low-level pulse transformers, their measurements, specifications, applications, interchangeability, dielectric ratings manufacturing and other data. Included is information on some of PCA's 2000 standard design transformers. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Silicon Rectifier Handbook 356

A 2-color, 48-page silicon rectifier handbook contains electrical ratings, performance data and dimensional drawings for every type of silicon rectifier offered by firm. Designated as catalog No. 69, this 1959 handbook also deals with silicon rectifier theory of operation, manufacture and characteristics and offers the design engineer valuable help in silicon rectifier application. Sarkes Tarzian, Inc., Rectifier Div., Bloomington, Ind.

Components, Instruments 357

A new, short-form catalog folder of electronic components and instruments contains condensed descriptive information and applications data on company's beam switching tubes, Nixie® indicator tubes, decade counters, pulse control instruments, optimeters, beamplifiers and visual decoders manufactured by the company. A complete listing of more than twenty items of available literature is included on a convenient literature request card. Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N.J.



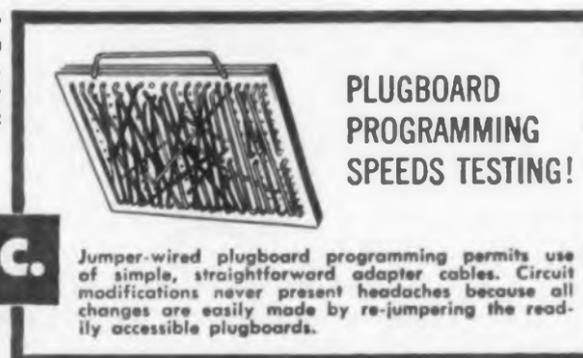
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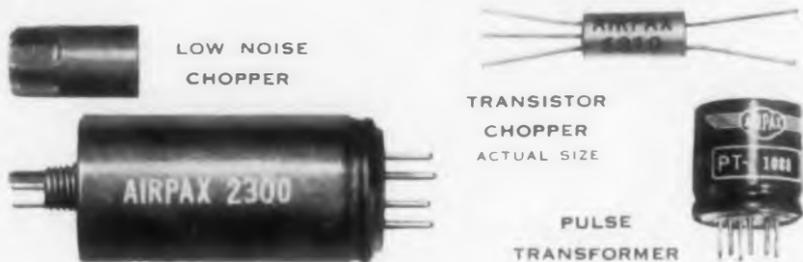


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PATENTS

Transistor Trigger Circuit

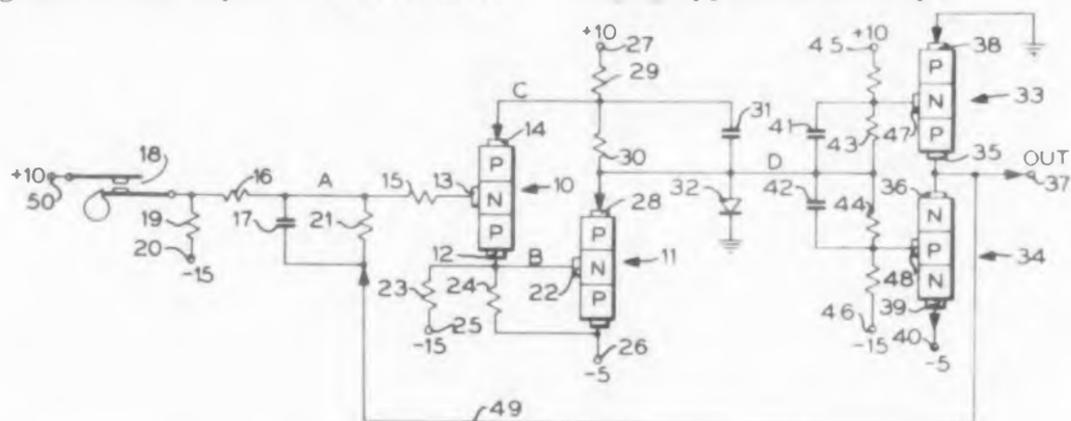
Patent No. 2,864,007, Genung L. Clapper.
(Assigned to IBM.)

Contact bounce is filtered and gated out in a cam-controlled transistor square wave generator.

With switch 18 open, transistor 10 is conducting and transistor 11 is cut off. The impulse at closure of contact 18 causes the transistors to flip such that transistor 10 is cut off and the conduction current through resistor 30 forces transistor 10 beyond cut off. Subsequent contact bounce is filtered by the RC integrator in the input. The reversal of

transistor 11 couples a voltage to terminal D to cause complementary transistor 33 and 34 to reverse and a positive step appears at output terminal 37; the positive step is fed back via cable 49 to force transistor 10 further beyond cut off.

The bounce of contact 18, upon opening, is similarly decoupled from the output. Transistor 10 conducts, causing transistor 11 to cut off and the step voltage in the output falls to zero. The reversal in output voltage coupled by cable 49 forces transistor 10 to conduct harder to insure cut off of transistor 11 so that no ringing appears in the output.



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ELECTRONIC DESIGN • March 18, 1959

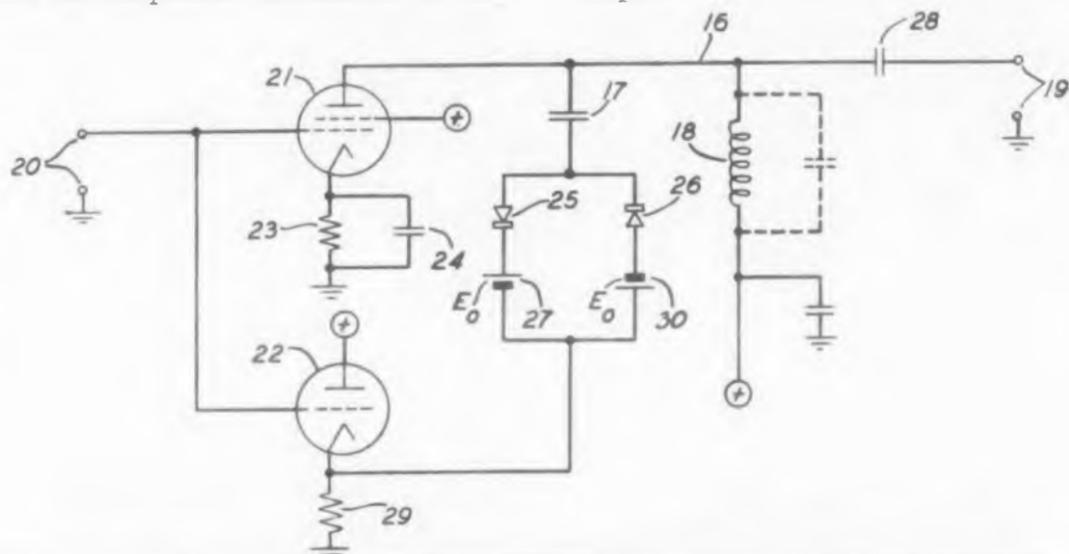
Compensated Plate Type Limiter

Patent No. 2,861,185. Andrew L. Hopper. Assigned to Bell Telephone Laboratories)

Any tendency of an a-m limiter to produce phase modulation is effectively eliminated by circuitry which adjusts the reference level of the clipper stage according to the applied signal.

An improved plate limiter circuit is shown: Diodes 25 and 26, biased by battery supplies 27 and 30, asymmetrically limit the amplitude modulation at the

output of amplifier tube 21. However, since diode resistance decreases with increase in drive voltage, the output without compensation will have a nonlinear phase characteristic. The novelty lies in the circuit arrangement wherein the diodes are returned to ground through cathode follower resistor 29. As the signal varies in amplitude, the output signal is compared with an in-phase component of the applied signal and the diode threshold level is automatically adjusted to completely cancel all of the a-m in the output.



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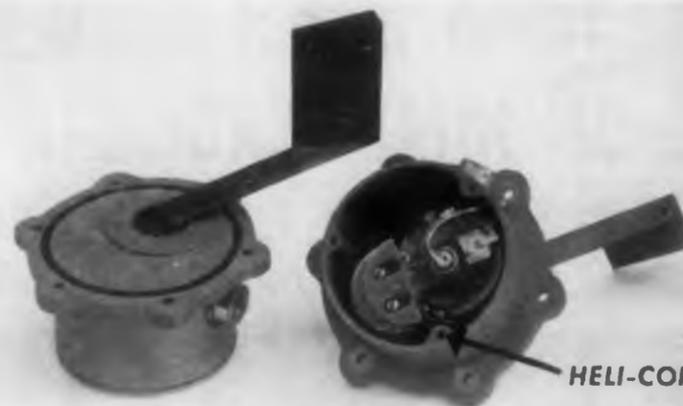
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ELECTRONIC DESIGN • March 18, 1959



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Principle of Heli-Coil Screw-LOCK Insert. Locking center coil grips internally, holds screw firmly.

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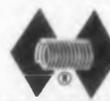
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- eliminate lock nuts, lock wiring, other supplementary locking devices
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- save assembly time, space, weight and cost
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*Patented



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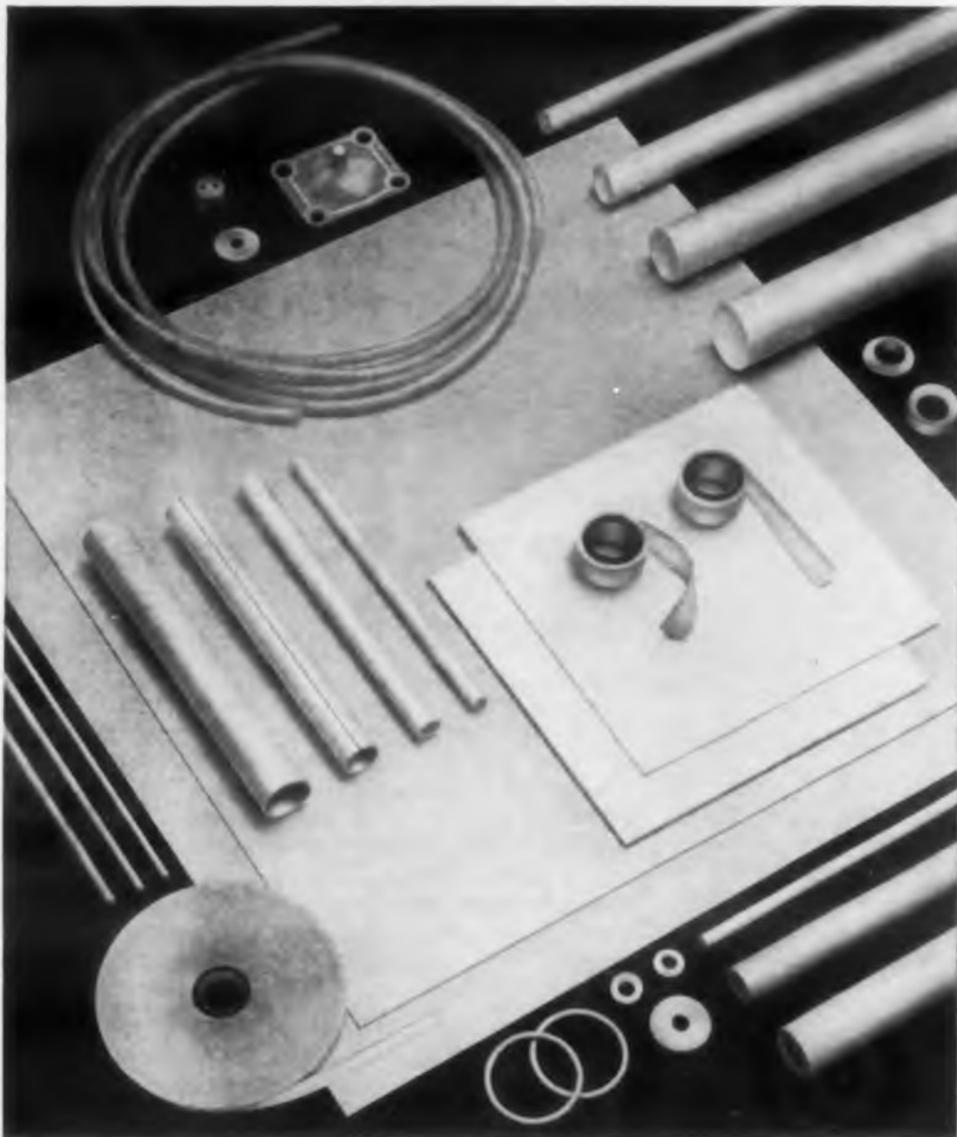
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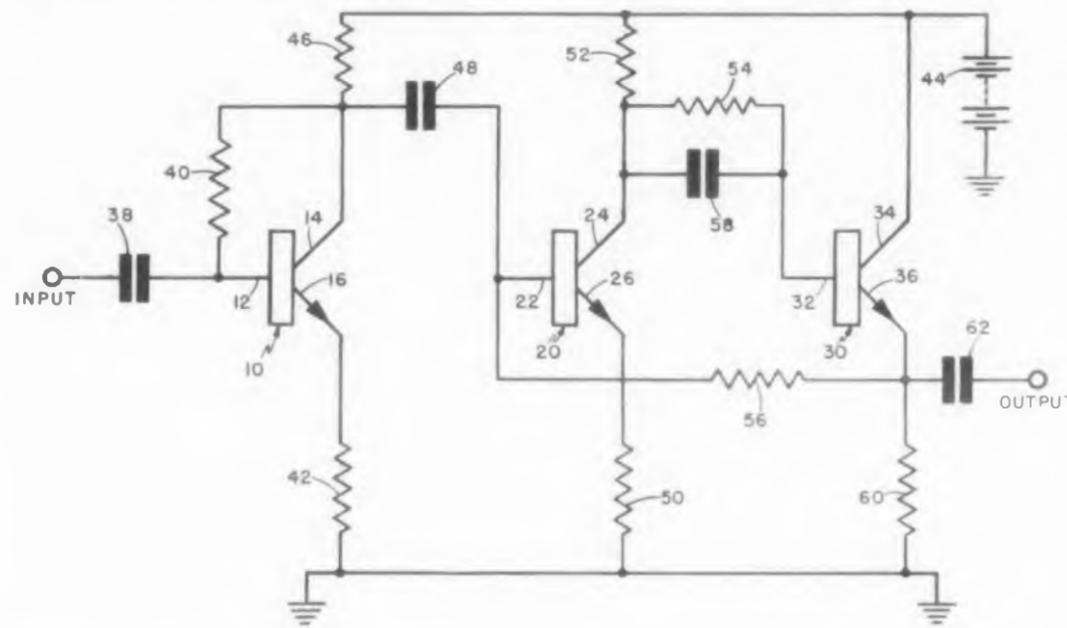
PATENTS

Triad Transistor Amplifier

Patent No. 2,863,957. Robert B. Hamilton. (Assigned to Ryan Aeronautical Co.)

Negative feedback in an ac transistor amplifier minimizes variations in the network parameters. Shunt feedback by resistor 40 between output and input and also series compensation by emitter re-

sistor 42 stabilize transistor 10. Any drift in transistors 20 and 30 is cancelled in the dc path between collector 24, base 32, emitter 36 base 22 and emitter 26. In addition, temperature compensation is obtained by temperature sensitive resistor 50 which adjusts the input impedance of transistor 20 according to temperature change.



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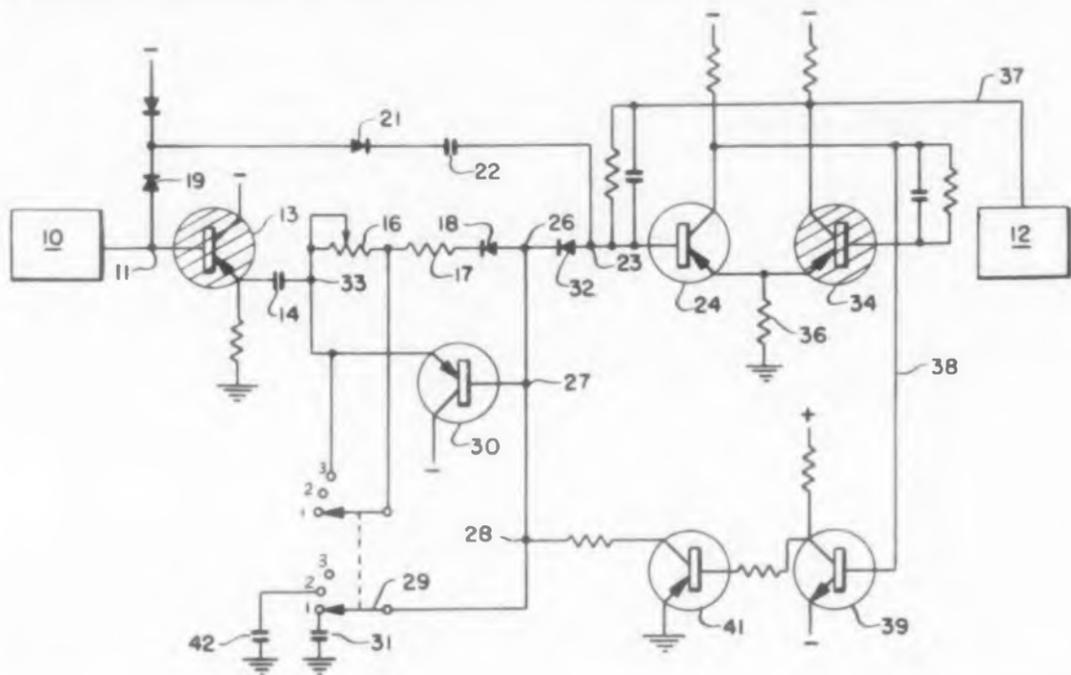
ELECTRONIC DESIGN • March 18, 1959

Frequency Divider Circuit

Patent No. 2,866,104. Frank D. Biggam. Assigned to Teletype Corp.)

By means of a transistor step charging counter, the frequency of a pulse source is divided. Rectangular pulse generator 10 charges capacitor 31 negative through transistor 13, differentiating capacitor 14 and diode 18. Transistor 30 feeds back a

voltage to linearize the step charging. When the bias on diode 32 is overcome, the succeeding pulse cuts off transistor 24. Transistors 34 and 39 conduct and transistor 41 discharged capacitor 31. Thereafter, a positive going pulse through differentiating capacitor 21 flops transistor 24 back to conduction and transistors 34 and 39 cut off to reset the circuit to repeat the count.



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Pictured above is a typical FXC coincident current memory stack; appearing, at left, one of the memory planes used in its assembly.

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See NEL Reliability Design Handbook, Sec. 502 — "Improved Type Miniature Tube Shields," OTS—Jan. 15, 1959



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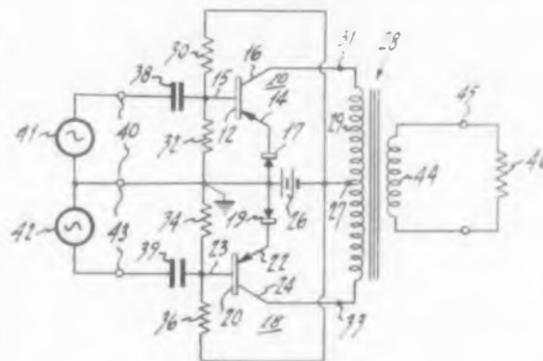
PATENTS

Stabilized Transistor Amplifier

Patent No. 2,860,193. James E. Lindsay
(Assigned to Radio Corporation of America.)

Class B transistor amplifiers are stabilized by means of a series combination of diode and resistor in the emitter-base circuit. The diode provides high degenerative resistance to emitter current under static conditions and relatively low resistance for signal currents.

The basic circuit shows complementary transistors 10 and 18 connected in a class B push-pull output stage driven by a balanced source connected to terminals



40 and 43. A pair of diodes, 17 and 19, is connected between ground and emitters 14 and 22, respectively. Forward bias of each transistor is obtained by means of resistors 30 and 36 connecting base electrodes 15 and 23 to the negative terminal of battery 26. Under quiescent conditions, the diodes impede the emitter currents to stabilize the dc operating point. When signal is applied, however, the increase in emitter current reduces the diode resistance and degeneration of signal current is effectively reduced.

Current Supply Apparatus for Load Voltage Regulation

Patent No. 2,850,695. John D. Bishop.
(Assigned to Bell Telephone Laboratories.)

Transistor regulator action maintains output voltage at 22 v for a maximum load current of 0.1 amp over the temperature range of -40 F to +140 F.

At room temperature, the network comprises a simple degenerative controller. A reduction in output voltage due to an increase in load current is finally



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Outputs:	3-1000 VDC @ 500 MA 6.3 VAC @ 10 Amps
Regulation (DC):	Load: 450 MV Line: 450 MV
Max. Ripple:	8 MV RMS
Size:	19" W. x 17" D. x 10½" H.
Weight:	118 lbs.

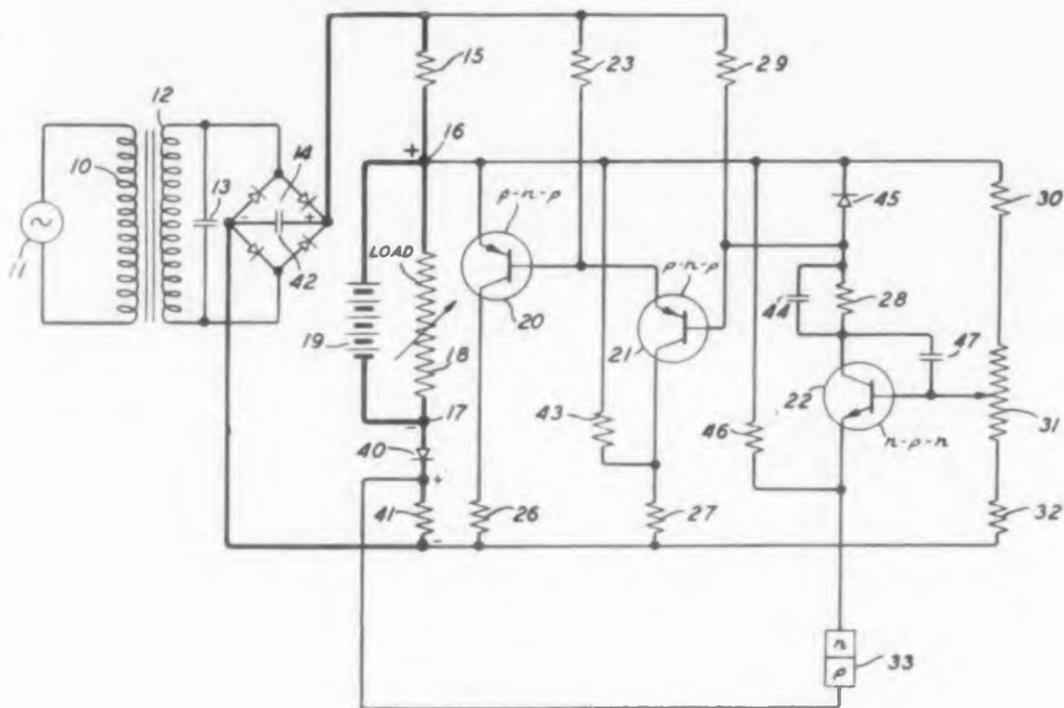
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ELECTRONIC DESIGN • March 18, 1959



compensated by reducing the emitter current of transistor 20 which is in shunt with the load. When the emitter current of transistor 20 is reduced to zero, the network is controlling the maximum load current. However, at +140 F, the emitter-collector current of transistor 20 is not

zero even though the base current is zero. The circuit therefore allows the base current to reverse so as to effectively balance out the emitter-collector current. Diode 45 clamps the operating conditions of the transistors within safe limits to prevent overload and possible damage.

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STANDARD RANGE:

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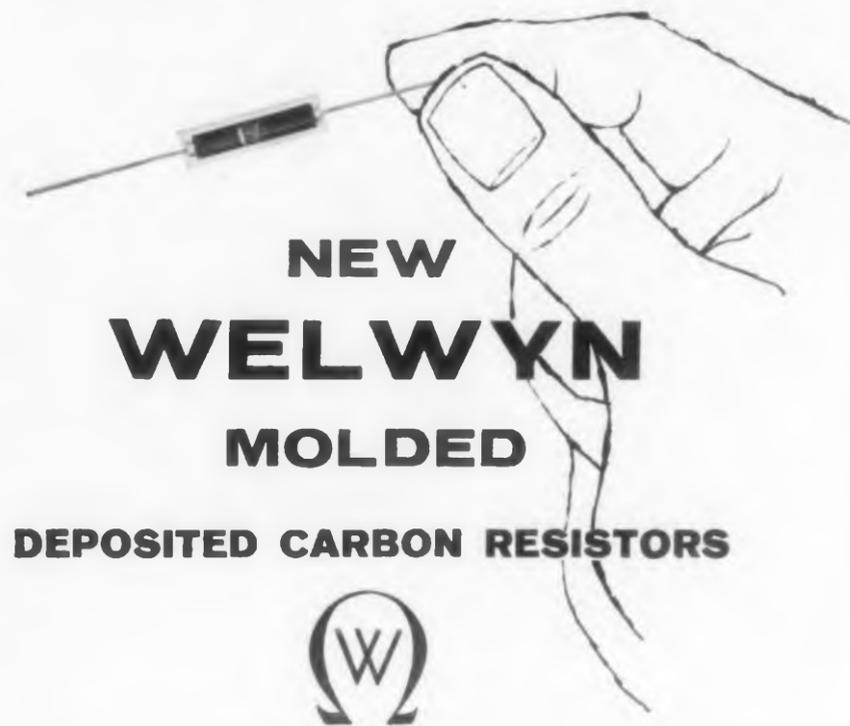
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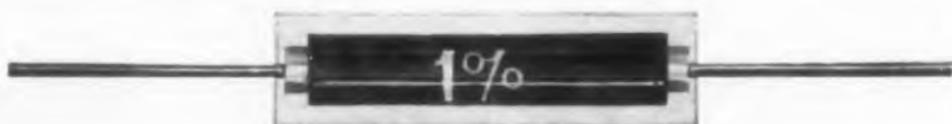
Type N resistors subjected to several one-hour cycles of immersion in boiling water — while DC polarized — have revealed only negligible changes in resistance. Continuous operations at 150°C caused no damage to the component.

The new Type N resistor, a deposited carbon film fired onto a porcelain rod, is first tropicalized with multiple coatings of pancromatic lacquers to give it long term moisture resistance, and is then molded in a thermo-plastic material.

This molded insulation has an effective resistance in the order of 10^{13} ohms. Its inherent thermal conductivity is approximately ten times that of air, resulting in substantially improved load life under conditions involving excessive or high wattage dissipation. Similarly, Type N resistors may be soldered as close to the insulation as desired without fear of melting or deforming the cover.

One added advantage of the Type N is that the original markings on the resistor body remain visible and legible through the transparent molded material.

Welwyn Type N carbon resistors meet the requirements specified by MIL-R-10509B, and are available in all values, ranging from 10 ohms through 1 megohm. For complete data and specifications write to Welwyn International, Inc., 3355 Edgecliff Terrace, Cleveland 11, Ohio.



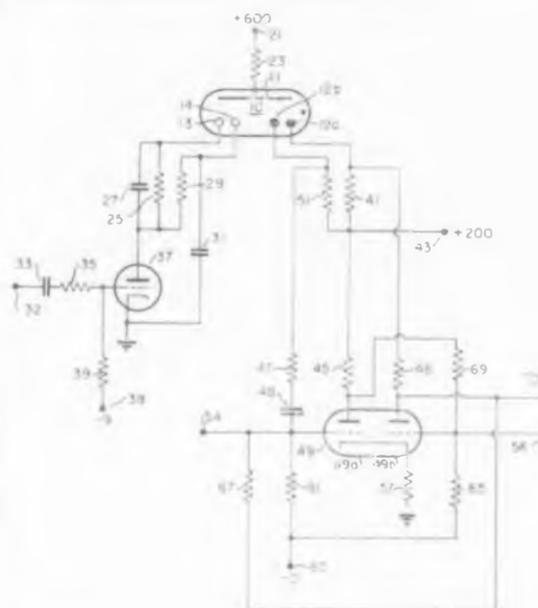
SAMPLES AVAILABLE ON REQUEST.
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PATENTS

Gate Reset Circuit

Patent No. 2,864,034. John E. Adams.
(Assigned to Sylvania Electric Products, Inc.)

Sylvania type 6476 glow discharge transfer counter tube is used in a simple circuit to count only a predetermined quantity and thereafter to reset itself so that the count may be repeated.



Initially, triode 49b is conducting and the voltage on cathode 12a is thereby made sufficiently negative so that the discharge is directed to this cathode. A positive pulse applied to the grid of triode 49a causes multivibrator tube 49 to switch; triode 49b cuts off and the voltage on cathode 12a rises. Now pulses applied to triode 37 will cause the discharge to switch sequentially in the counter tube until the discharge is directed to cathode 12b. On the next pulse to be counted, the glow leaves cathode 12b swinging this cathode negative and the negative pulse coupled to the multivibrator cuts off triode 49a. With triode 49b again conducting, the glow discharge is toward cathode 12a and this condition is maintained until the multivibrator is switched to renew the counting.

Linear Amplifier

Patent No. 2,859,287. Garret F. Ziffer.
(Assigned to Tracerlab Inc.)

Linear amplification of pulses in the dynamic range of 0.25 v to 200 v is ob-

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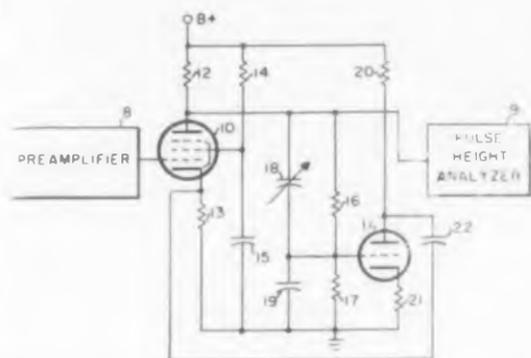
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tained by means of a pentode-triode feedback amplifier.

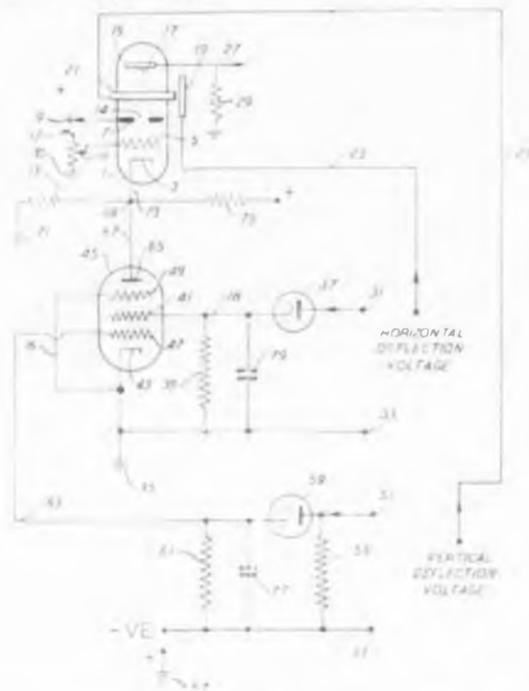
The preamplifier output is amplified by pentode tube 10 and approximately 10 per cent of the amplified signal is coupled back to cathode resistor 13 by means of voltage divider resistors 16, 17, and the unity gain inverter tube 11. For a flat frequency response, series capacitors 18 and 19 are individually in shunt with the indicated resistors. The components of a typical amplifier are given in tabulation.

Electronic Protective System

Patent No. 2,860,283. Irving Horowitz. (Assigned to Irving Horowitz, Eatontown, N.J.)

Cathode-ray tube screen burnout is

prevented by gating the tube beyond cutoff whenever either sweep signal is absent. Essentially, diodes 37 and 59 rectify the horizontal and vertical sweep voltages such that pentode 47 draws sufficient current through load resistor 75 to maintain cathode ray tube 1 above cutoff. A sweep failure reduces tube 45 current and the cathode ray tube beam is extinguished.



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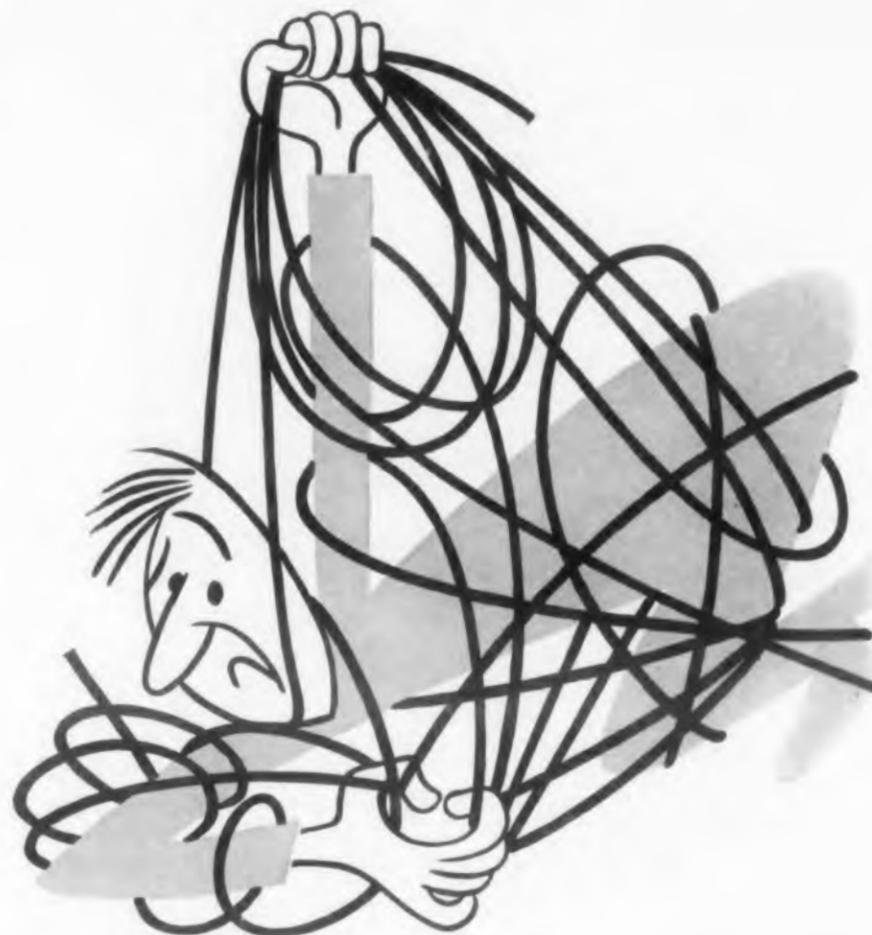
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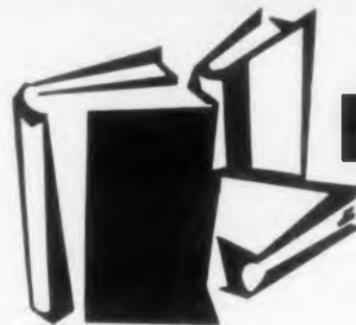
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BOOKS

Process Dynamics: Dynamic Behavior of the Production Process

Donald P. Campbell, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 316 pp, \$10.50.

Emphasizing a general approach to process dynamics, this book examines the characteristics of processes during unsteady-state conditions or in response to periodic disturbances. The author views process design and control design as an integrated problem in process systems. He also considers the use of linear network theory as a means of predicting the dynamic performance of a plant before it is built. Translating process dynamic performance into mathematical form, the text features applications of feedback control theory to industrial processes, particularly chemical and petroleum operations. It also provides a practical

approach to problems in process dynamics such as automatic process control and the damping of pressure and flow pulsation, and suggests methods for controlling process operations involving moving filaments, sheets, and webs. Appendices cover block diagrams and signal-flow diagrams and the use of Fourier and Laplace transformations in treatment-process control problems.

Guide to the Literature of Mathematics and Physics including Related Works on Engineering Science (Second Revised Edition)

Nathan Grier Parke III, Dover Publications, Inc., 920 Broadway, New York 10, N.Y., 436 pp, \$2.49.

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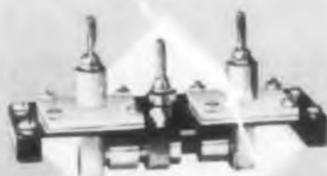
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science, the Guide is an invaluable aid to the researcher. Part I, an orientation to library techniques, is provided in a 74-page section. An extensive listing of bibliographical aids includes: abstracts, indexes, periodicals, reviews, bibliographies, directories, encyclopedias, documentary reproductions, guides, and library sources. Part II contains the literature to 1956 and lists more than 5500 key works, included under 120 subject headings, which are subdivided into an average of 6 subheads. Discussion of the literature under each heading defines the subject matter and provides numerous cross-references and suggestions for further investigation. A complete author and subject index facilitates immediate location of any book. Features many recently available works in Russian and an up-to-date listing of agencies and individuals engaged in Russian translation programs. Translations of all foreign titles are listed.

Physical Laws and Effects

C. Frank Hix, Jr., Robert P. Alley, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 291 pp., \$7.95.

Useful as a quick reference source for

the experienced engineer and scientist, this volume provides a convenient centralized source of information on the subject. Compiled so that a search of laws and effects could become a practical part of the engineering approach to problems, an alphabetic listing of subjects is supplemented by three different cross reference systems. The systems include: a description of laws and effects, including an indication of the expected magnitude and references for further investigation; a cross reference index according to fields of science, which lists laws and effects by the discipline to which they are most applicable; and an index by physical quantities, listing not only the law or effect pertaining to the physical quantity under question, but also other quantities covered by the same law.

The reader will find this volume a handy dictionary, a thought stimulator and a problem approach tool. The authors stress, however, that the text is not complete and is not intended to be since a continuing compilation of background information is necessary to produce a guide which can be utilized in problem synthesis.

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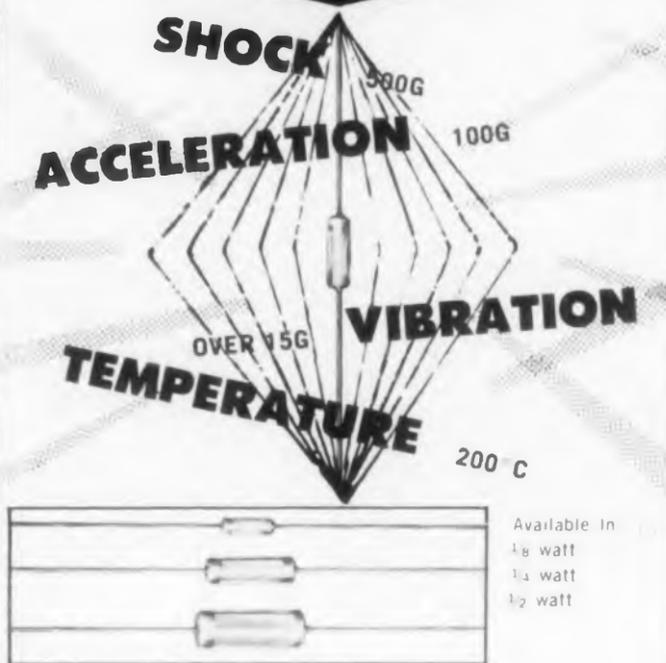
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Resistance Range	—	10 Ohms 1 Meg	10 Ohms 10 Meg	10 Ohms 30 Meg
Voltage Coefficient	—	2x10 ⁻⁴ /Volt max.		
Temperature Coefficient	± .05%/°C	-.02 to -.05%/°C		
Shock Test	50 G	500 G		
Acceleration Test	50 G	100 G		
Vibration Test	15 G	15 G min.		
Temperature Cycling	± .5%	± .02%		
Low Temp. Exposure	± .5%	± .01%		
Overload	± .5%	± .01%		
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Component Holder Speeds Breadboard Circuits

A SIMPLE SPRING clip device promises further time savings in breadboard circuitry.

This device, developed by the Shockley Transistor Corp., Palo Alto, Calif., consists of a phosphor bronze band, shaped like a horseshoe, with a coil spring fastened over the convex top. A rod extends vertically from one leg of the device.

In use, the device, called a component holder, is pushed into a sheet of polystyrene foam. Components, such as resistors, diodes, transistors, or capacitors, are clamped under or within the coils of the spring. The vertical rod is useful for connecting a voltmeter, oscilloscope, or other measuring device to the circuit. Each component holder will hold several component leads, alligator clip leads, or meter leads.

Component holders are readily moved and repeated use does not destroy the polystyrene foam. Furthermore, the coefficient of friction between the legs of the component holder and the polystyrene foam is such that components can be pulled out of the spring without pulling the component holder from the foam.

Many variations of this holder have been fabricated, some of them simpler and less expensive. Some of the simpler devices pull out of the polystyrene foam too easily, don't have enough space for clip leads and are too flimsy.

An engineer working with ten of these component holders and one square foot of two-inch polystyrene foam can assemble a simple low frequency circuit, such as a transistor amplifier, in

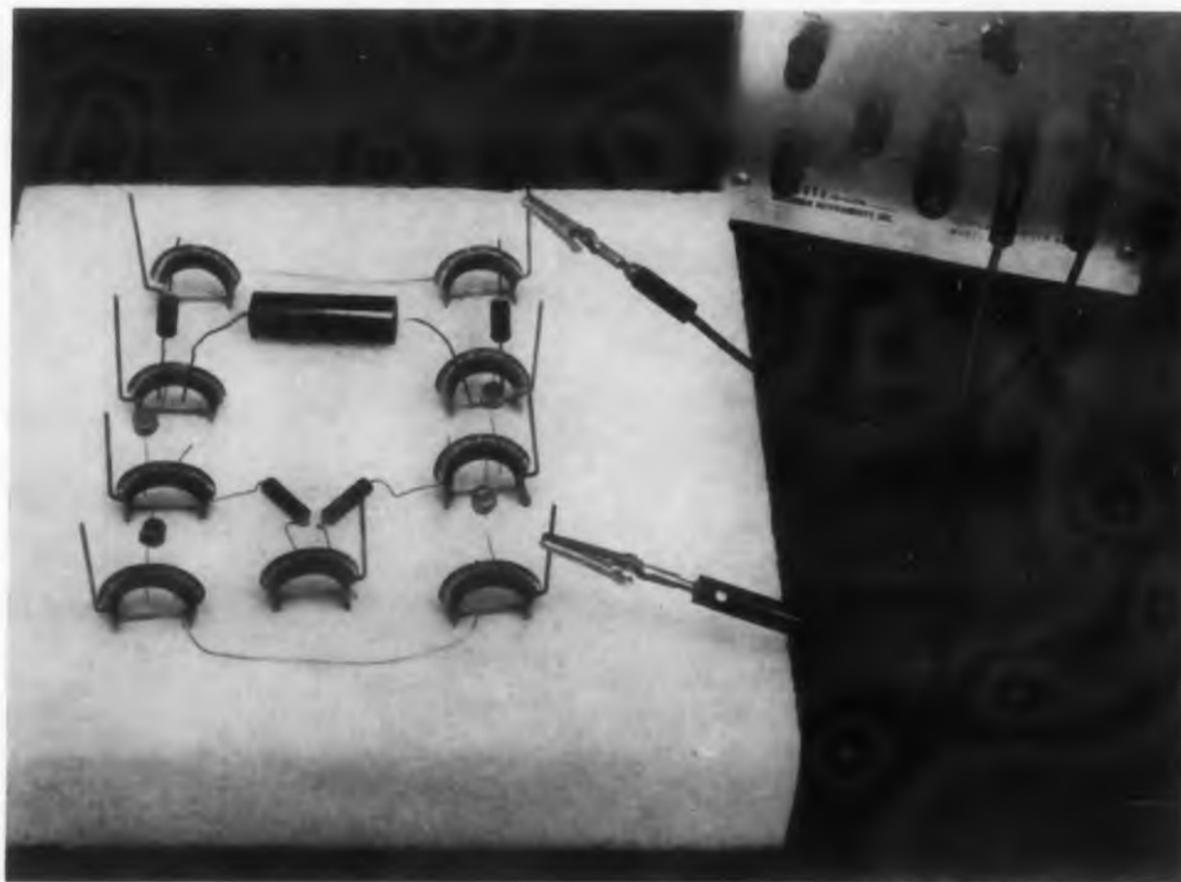


Fig. 2. Components are easily withdrawn from the holder without removing the holder from the polystyrene foam.



Fig. 1. Simple component holder saves breadboarding time.

about five minutes. The circuit can be revised or salvaged in much less time.

With some of the existing methods of making breadboard circuits, a simple circuit may take from thirty minutes to several hours to construct before tests can be started. On one occasion, some one telephoned a laboratory equipped with component holders, and asked if a certain semiconductor device would work in a certain circuit. He was told, "Just a minute—we'll try it." Within five minutes he was told that the application was satisfactory—at least at room temperature.

Oftentimes a designer is reluctant to try a small circuit change that will take a half an hour of reassembly to accomplish. He may spend an hour calculating or thinking out the problem before attacking it with a soldering iron. A breadboarding device that allows fast changes can save time in assembly, soldering, and unsoldering, and can help overcome time-consuming mental inertia.

Walter F. Dimmik, Shockley Transistor Corp., Palo Alto, Calif.

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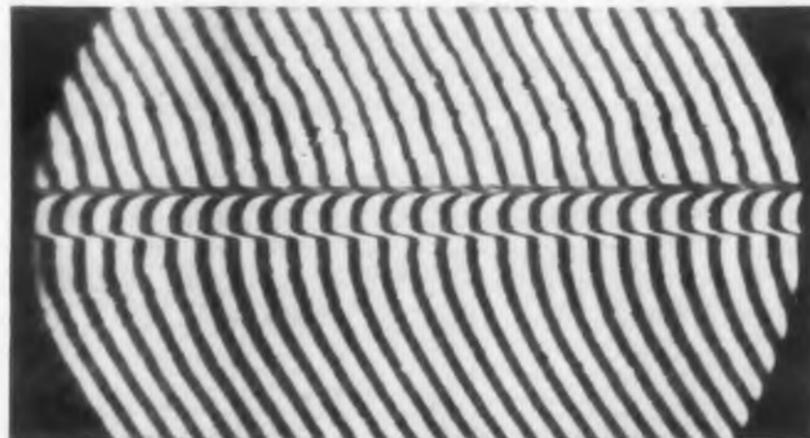
who is growing faster

than his associates



Bright Field ↑

↓ Interference



INTERFERENCE FRINGES are useful in determining slight changes in elevation and measurement of thin coatings such as those that might be laid down by vacuum evaporation. The above photomicrographs (112x) show gallium diffused silicon used in making Raytheon diffused base NPN silicon high frequency transistors. The silicon is at the bottom of each picture. The depth of the gallium penetration is .0007". The height of the junction step after etching is .000088". The bright field picture shows how the junction looks normally under a metallurgical microscope. The interference picture shows how this same junction looks under an interference microscope.

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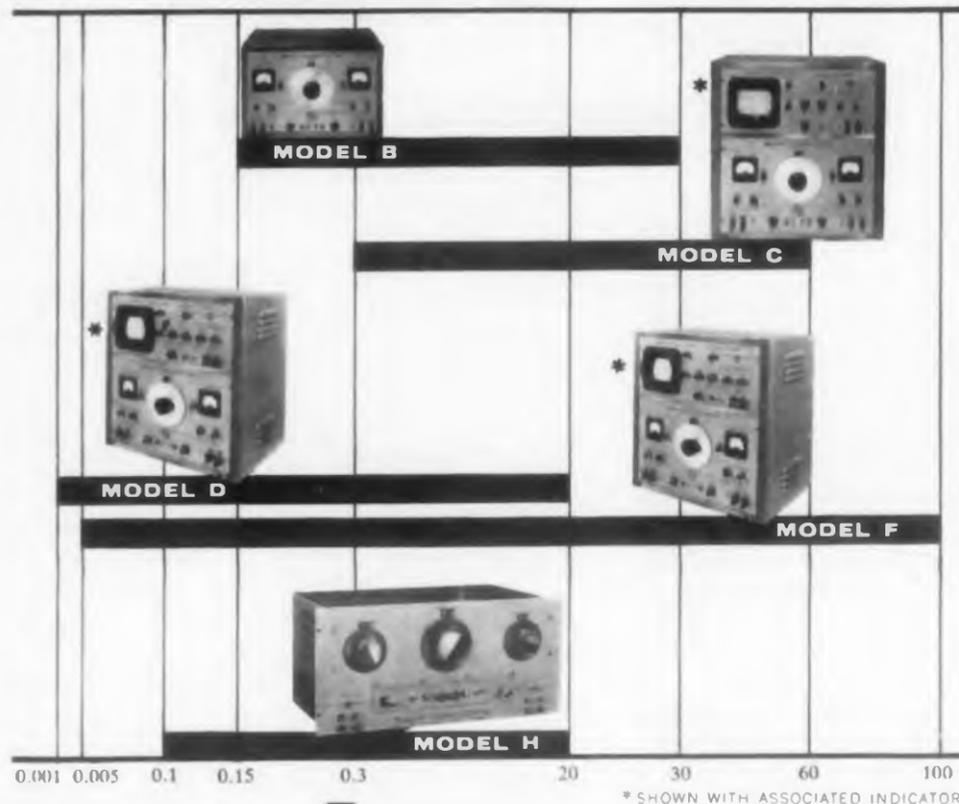
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IDEAS FOR DESIGN

Manual Input Circuit For Digital Equipment

The circuit designer must often provide push-button input for digital equipment. He has three basic problems: contact bounce in the switch; noise pickup when the electronic circuit is far from the pushbutton; and the need for a fast signal transition which will be independent of circuit packaging.

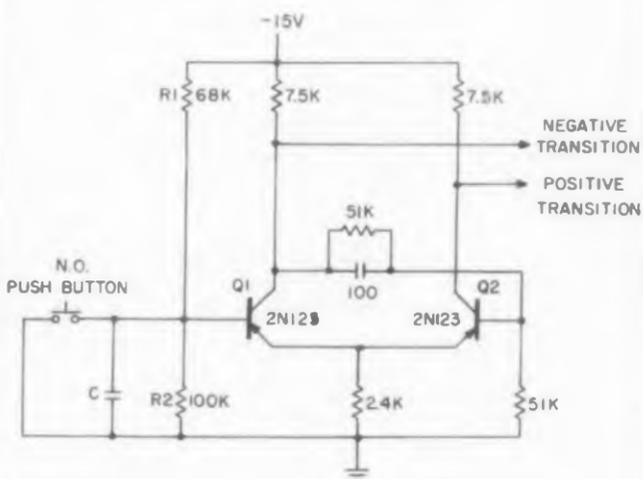
The Schmitt trigger is an ideal solution. In the diagram, $Q1$ and $Q2$ together with their resistor networks form a normal Schmitt trigger. $R1$ and $R2$ are chosen so $Q1$ conducts, holding $Q2$ off when the pushbutton is released. When the button is depressed, the base of $Q1$ is grounded, causing the trigger to reverse, turning $Q1$ off and $Q2$ on.

Capacitor C is discharged almost instantly through the low contact resistance of the pushbutton. But it must recharge through $R1$ before $Q1$ will conduct again when the pushbutton is released. A suitable time constant will eliminate contact bounce from the output.

The capacitor also bypasses the wire connecting the electronic circuit and the pushbutton, thus reducing stray pickup.

Since Schmitt transitions are essentially independent of the rate of rise or fall of the input waveform, the transitions at the collectors of $Q1$ and $Q2$ provide very reliable triggers.

Norman E. Peterson, Project Engineer, Stelma Inc., Stamford, Conn.



Manual input for digital equipment. These values are typical for $C = 0.1 \mu\text{fd}$.

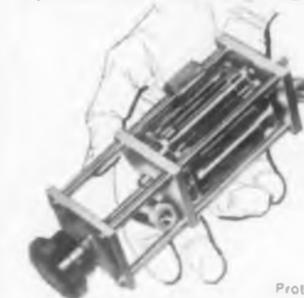
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- Consolidated Electrodynamics—for Diatron Mass Spectrometers
- Stoddard Aircraft Radio—for Power Supplies
- Hevi-Duty Electric Company—for Airport Lighting Brightness Control

How you may use REGOHM in your own applications will become clear to you from design data, performance specs and case histories, available to you on request.



REGOHM



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NORWALK CONNECTICUT
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Aircraft gyro electrodes use epoxy resins to support and encapsulate a silver ring inside an index ring. Minneapolis-Honeywell Regulator Co. selected Bake-lite epoxy for this job for its high strength and for matching the temperature coefficient of expansion of the metals over a range from -65 to 165 F.

Chopper Amplifiers Can Be Used At Higher Frequencies

Many engineers feel that operation of a chopper amplifier at frequencies much higher than 10 per cent of the chopping frequency is not satisfactory. But this is not the case. Mechanical chopper amplifiers are in use which reproduce, for instance, 80 cps from a 100 cycle chopper, and 40 cps from a 60 cycle chopper.

In both cases, the recorders are mechanical direct writers, so paper speed limits good resolution at the higher frequencies. But it is probable that at much over one-third of the chopping frequency, deviations from sinusoidal response will not be important as long as peak amplitude and adequate rise time are reproduced by the pen writer.

At higher frequencies, the response depends mainly on two factors: rapid changeover in the chopper so sampling time or allocation time are as close to 360 deg as possible, and good low frequency response in the carrier amplifier so flat-topped waves (after chopping) are reproduced with minimum slope.

At the higher signal frequencies, a single chopping cycle may involve a considerable part of a sine wave, perhaps both positive and negative parts of it. This does not matter if the rapid changeover and good low frequency response are maintained. Sine waves will be reproduced, after rectification, with useful fidelity.

Dr. E. E. Suckling, State University of New York, Brooklyn, N. Y.



Union Relays meet all requirements of Talos guidance system

The Talos, the Navy's long-range guided missile, is very important to the nation's defense. And Bendix Aviation Corporation, builder of the Talos, chose a relay made by Union Switch & Signal to meet the *extreme reliability* needs of that missile's guidance control system. That relay is the UNION miniature 6PDT.

Its clean, simple, *rotary* design gives it fewer inherent problems than other relays. Probability of flight failure of a contact pair is only once in 600,000 operations. In vibration tests,

it is absolutely solid to 2,000 C.P.S. at 15G. In temperature tests, it has performed reliably for six minutes at up to 177°C .

Union Switch & Signal makes a complete line of *dependable* miniature relays, manufactured to meet MIL-R-25018, MIL-R-6106C, and MIL-R-5757C requirements. Advanced design and close quality control have made Union Switch & Signal a leading supplier of relays for missile control. Write today for complete technical information.

Three UNION miniature 6PDT relays positioned in part of the Talos guidance control system.



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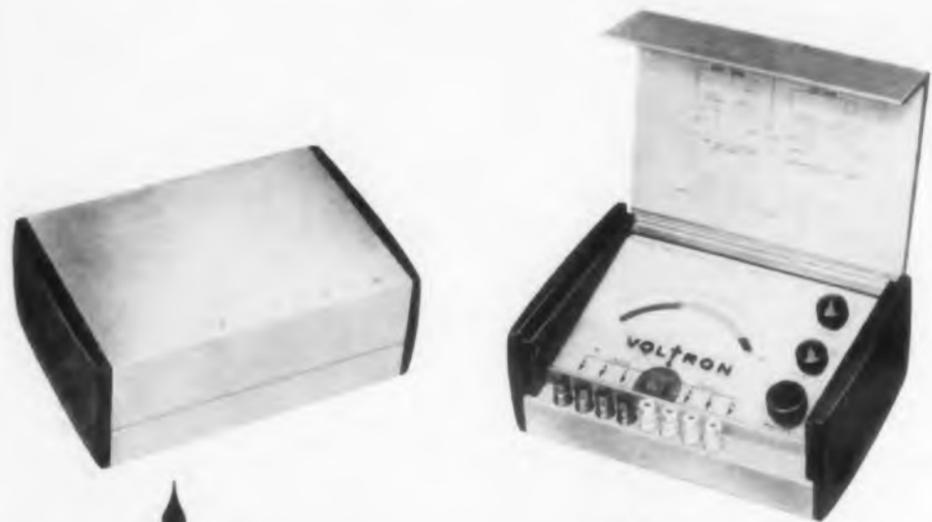


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DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY—

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- Rugged Taut Band Suspension
- Low Power Factor
- Full-Scale Range: 0-1.2 Watt
- Low Current Circuit Consumption

SPECIFICATIONS:

CONSTRUCTION	Meter consists of d'Arsonval type D.C. milliammeter and one A.C. power to D.C. current transducer for each phase. Taut band suspension eliminates the static friction and the delicacy of conventional jewels and pivots. Solid state circuit components are used in the transducer.		
INPUT VOLTAGE	26/115 ± 10%		
WATTAGE RANGE	26 volt input — 1.2/3/12/30 115 volt input — 1.2/3/12/30/120		
FREQUENCY RANGE	Flat from 50 to 2000 cycles		
ACCURACY	1.0% of full scale watts		
PHASE	1, 2, or 3 phase. The 3-phase meter is suitable for 3-phase, 3-wire, or 3-phase 4-wire measurements.		
POWER FACTOR	0.1 to 1.0 Lag or Lead.		
WAVE FORM FACTOR	Calibrated for use with both sine and square wave. For distorted waveforms, the error will be less than 2% for 5% harmonic distortion.		
ERROR DUE TO	VOLTAGE CIRCUIT: 0%		
	CURRENT CIRCUIT:	Max. Error (% watts indicated)	P.F.
		0.2	1.0
		2.0	0.1
		linear between these values	
OVERLOAD	VOLTAGE CIRCUIT: 100% continuous overload without damage CURRENT CIRCUIT: 25% at 0.1 PF continuous without damage		
SIZE	8½" x 12" x 4"		
WEIGHT	15 lbs.		
ORDERING INFORMATION	Model No.	PW-1	PW-2
	PHASE	1	1/2
	PRICE	\$385.00	\$485.00
			PW-3
			1/2/3
			\$585.00

DELIVERY: From stock subject to prior sale.

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VOLTRON Products
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IDEAS FOR DESIGN

Faster, Linear Sweeps On Larger Pedestals

Unless large B supplies are used when designing large pedestals for sweep circuits, sweep linearity and fall time are usually sacrificed. The circuit shown, however, provides a much faster fall time and better linearity with large amplitudes, all with one dual triode.

In this circuit, $P2$ could be the positive pulse output plate of a ppi radar sweep gate generator, and e_1 the negative pulse output of the same tube. At time $t1$, the triode VI_A cuts off and $P3$ starts to charge toward E_{bb} . Through resistive addition, parts of the pulse in the ratio

$$\frac{R2}{R1 + R2 + R_L} (E_{bb} - e_1)$$

and the sweep in the ratio

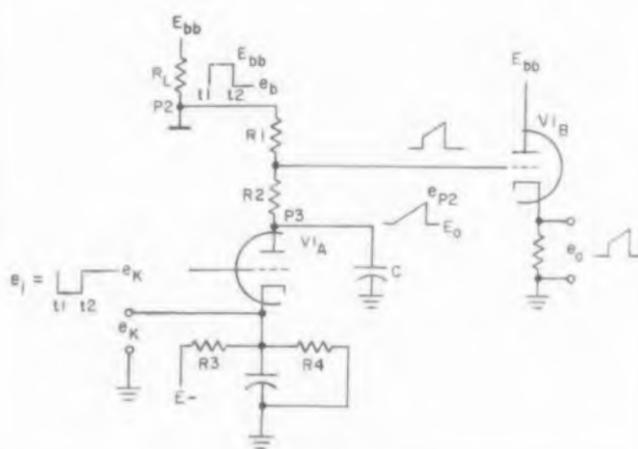
$$\frac{R1 + R2}{R1 + R2 + R_L} (e_{p2} - E_0)$$

are superimposed on each other. Hence,

$$e_o = \frac{R2}{R1 + R2 + R_L} (E_{bb} - e_1) + \frac{R1 + R2}{R1 + R2 + R_L} [E_{bb} + (E_0 - E_{bb}) e^{-(R1+R2+R_L)t/C}]$$

The dc level of E_0 can be adjusted by varying the ratio $R3/R4$. At $t2$, VI_A conducts fully again and C discharges through the plate resistance of VI_A in series with the parallel combination of $R3$ and $R4$. Therefore $(R3/R4)/(R3 + R4)$ should be kept as low as possible. The cathode follower VI_B prevents loading of the sweep generator.

Irving Bayer, Project Engineer, Skiatron Electronics and TV Corp., New York City.



Without very large B supplies, this circuit provides good sweep linearity and fast fall time on a large pedestal.



a good way to measure 0.00003 ohm

The Keithley 502 Milliohmeter offers speed, ease, and accuracy in the measurement of low resistances. Typical uses are corrosion tests, checking resistivity of metals, semi-conductors, printed circuits, switch and relay contacts.

Battery operation, a ruggedized meter, and protective cover make the 502 ideal for field tests of squibs, carbon bridges and other explosive devices. Features include:

- 13 overlapping ranges from 0.001 ohm to 1000 ohms full scale.
- accuracy within 3% of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.
- 2 microwatts maximum dissipation across sample.
- no calibration or zero adjustments.
- instantaneous indication of resistance without zero drift or errors due to thermal EMF's.
- lightweight and portable. Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

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Fuse Wound Peaking Coils For Faster Breadboarding

The usual process for adjusting peaking coils to the correct value in a circuit involves unsoldering one lead, peeling off a number of turns of the coil wire, skinning the insulation, then resoldering to a terminal. This process is tedious and often damages the coil.

A more convenient method involves winding a number of test coils on burned out fuses, preferably of the glass AG type. The wire is wound to the proper inductance and the ends soldered to the metal caps of the glass fuse. Each coil can be color coded. Instead of normal terminals, the breadboard can be equipped with a plug-in type fuse holder (except in very high frequency circuits, where the added capacitance may affect circuit performance).

The coil fuse forms can then be changed as easily as ordinary fuses.

Sol Abrams, Design Engineer, Polarad Electronics Corp., Long Island City, N. Y.



Missile telemetry package, designed for Boeing's IM-99 Bomarc by Texas Instruments, Inc., must operate to beyond 145 deg. F. Since the transistors in the package will not work well beyond 145 F, and since the missile's surface temperature, at Cape Canaveral, may reach 160 F, cooling was required.

Engineers at the Boeing Airplane Co. solved the problem by designing an auxiliary cooling system for ground use only. It blows a jet of cool air through the interior of the wing where the equipment is housed.

In flight, a small methyl alcohol evaporator keeps the equipment cool for the relatively brief period necessary.

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...and now for a spot of welding!

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



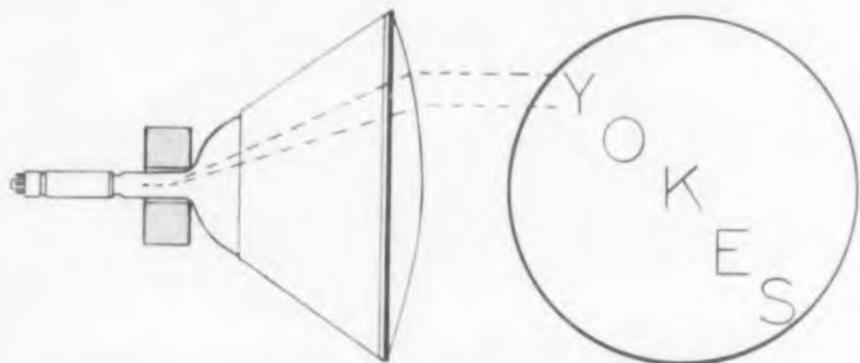
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IDEAS FOR DESIGN



Standard horizontal deflection coils and toroidal vertical deflection coils are wound on a ferrite wedge-shaped ring in this TV yoke made by the Videon Company in France.

Two small Ferroxdur permanent magnets are supported by the yoke, along the horizontal axis. By bending or twisting the long lugs to which they are attached, any pincushion or barrel distortion on the sides of the raster can be corrected to within five per cent.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh 13, Pa.

Battery Savers Be Careful

On page 69 of the Dec. 24 '58 issue of ELECTRONIC DESIGN, Mr. Robert W. Blanchard suggests a warning light in series with a diode between the automobile ignition switch and the main light switch in such a manner that the warning light will be illuminated if the lights are on and the key off, thus acting as a battery saver to hurried drivers.

There is a note of caution to be recalled, however. Although many modern automobiles ground the lead to the ignition coil when the key is off, still others let the lead float. Even with a small panel lamp in series from the battery supply to the otherwise floating ignition lead, sufficient current may flow to keep the spark plugs firing under the condition of key off, lights on, with Mr. Blanchard's circuit.

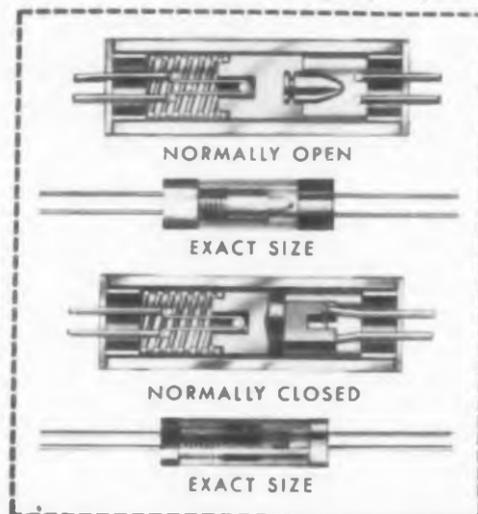
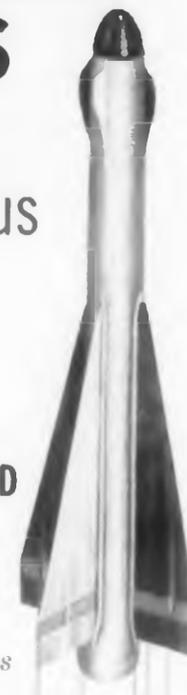
One solution is to connect the lamp not to the ignition coil wire but to the accessory terminal of the switch. Then a 15 ohm or so resistor from the accessory terminal to ground will complete the circuit even with no accessories (heater fan, radio, etc.) turned on. This is convenient for

MINIATURE THERMAL RELAYS

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Reliability

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Temperature: -100°F. to +450°F.
Vibration: 20-3000 CPS at 40 G's
Shock: 250 G's

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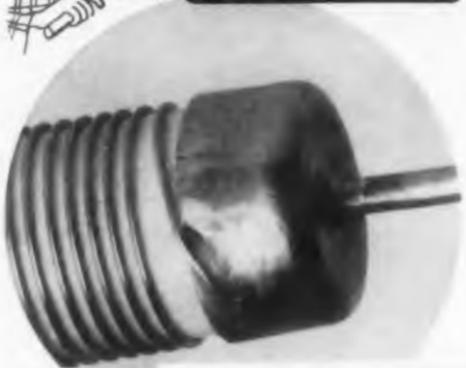
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AN INSIDE LOOK AT



SAGE



Unretouched photograph of SAGE Resistor (Magnified 6 times)

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those cars that have separate terminals on the ignition switch, as is the case usually when the ignition key is used also to actuate the starter.

If, however, the car doesn't ground the ignition coil lead with the key off and doesn't have a separate accessory terminal on the switch, some method of more elaborate safety feature must be installed. On my car I found it convenient to interconnect the light and ignition circuits so that, under normal operation, turning off the lights completely will drop out a holding relay to the ignition circuit, thus turning off all lights, radio, etc., with one switch. Either circuit can be operated independently, however.

There is no end to the gadgetry one can profitably add to the electrical circuit of a vehicle. At any rate, letting even a small amount of current (such as from a warning light) leak into the ignition circuit may be hazardous and should be avoided.

Roger L. Boyell, Hempstead, New York.

Another Battery Saver

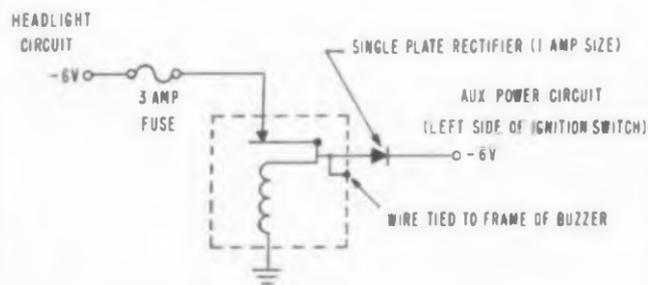
The operation of the "battery saver" circuit given in the December 24th issue depends on the ignition circuit having a ground when it is shut off. This is true only in three cases:

1. When there are other loads connected to the ignition circuit.
2. When the ignition switch intentionally grounds the circuit.
3. When the engine happens to stop with the breaker points closed.

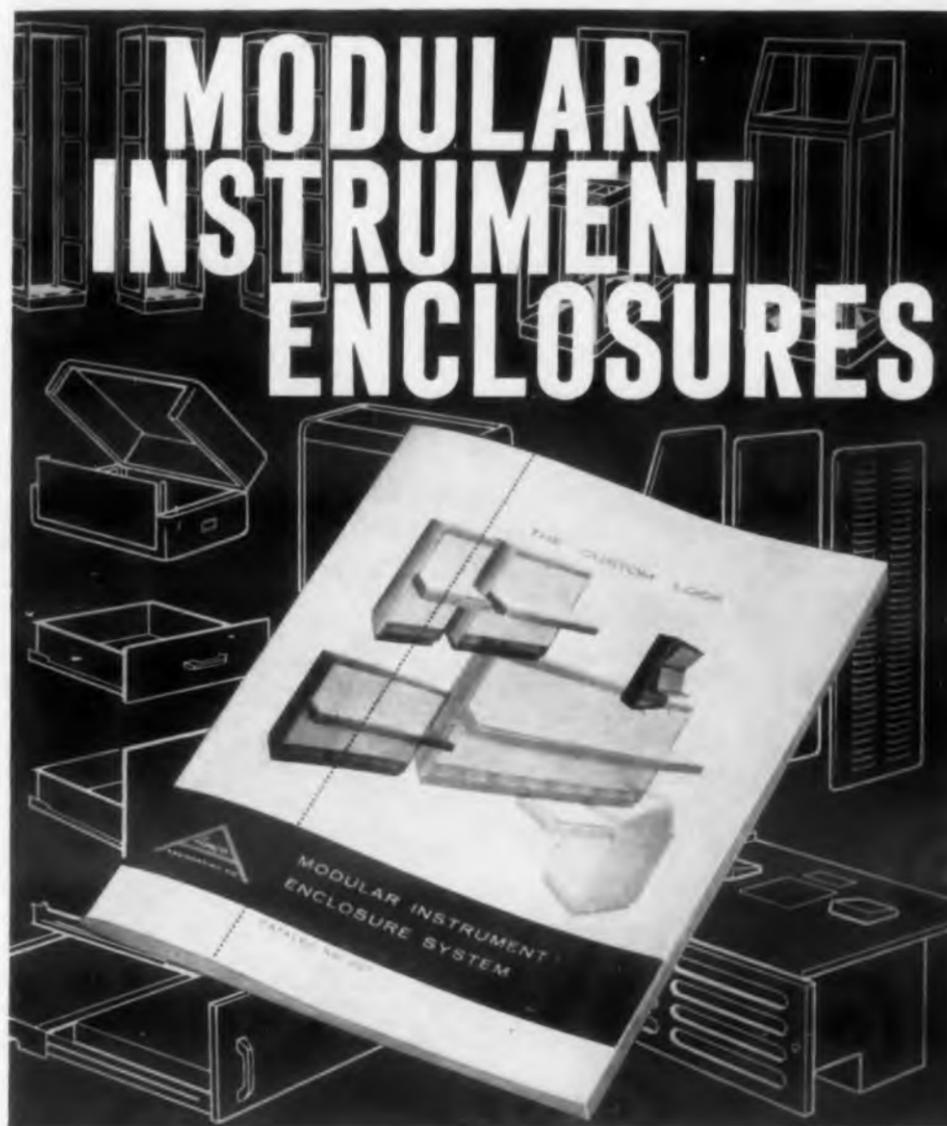
Possibly you will receive sad letters from readers who install this circuit and discover that it does not always work.

The circuit shown here has its own ground. The buzzer works as a logic device, not merely as an indicator. Blocking voltage for the buzzer is taken from the auxiliary power circuit instead of the ignition circuit, so that the headlights may be left on quietly, if desired, by leaving the auxiliary power on. There is nothing in the circuit to impair the reliability of the headlights.

Marriott Dickey, Richmond, California.



The buzzer in this automobile "battery saver" serves as a logic device as well as a warning device. (The buzzer is an Edwards Model O. Its frame is insulated from the car.)



Look to AMCO for enclosures that—in appearance and quality—are truly worthy of your instrument engineering achievements!

Only Amco has the wide background in both electronics and enclosure manufacturing to assure your complete satisfaction in the appearance, strength and durability of every unit supplied. An exclusive custom appearance is achieved through use of Amco multi-width panels, cowlings and writing surfaces. They're all factory assembled for your convenience (and shipped within three weeks!)

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REPORT BRIEFS

Transistor Magnetic Amplifier Circuits

Advantages and disadvantages of transistor and magnetic amplifiers. A combination of the two is discussed and schematic diagrams are given for various example circuits and applications which utilize the better points of each. *Transistor Magnetic Amplifier Circuits*, Niels Jasper, James C. Taylor, and William T. White. U. S. Army Ballistic Missile Agency, Development Operations Division, Guidance and Control Laboratory, Huntsville, Ala. Mar. 1957, 21p, microfilm \$2.70, photocopy \$4.80. Order from Library of Congress, PB 132806, Washington 25, D. C.

Dielectric-Filled Waveguides

Dielectric-filled waveguides were developed in an effort to eliminate the decrease in power handling capacity of waveguides in airborne equipment at high altitudes and temperatures. Although they exhibited temperature limitations, the new waveguides proved suitable for high-altitude operation. The temperature limit of 71C could be raised to 150C at the expense of slightly increased attenuation. The report also discusses the problem of maintenance of sea-level power handling capacity of the waveguide at high altitudes and wide temperature ranges. *A Dielectric-Filled Waveguide Development*, J. I. Meulemans, Wright Air Development Center for the U.S. Air Force, April 1958, 19p, \$0.75. Order PB 151213 from OTS, U.S. Department of Commerce, Washington 25, D.C.

Airborne Data Recorder Development

An improved airborne data recorder was developed for recording aircraft environmental conditions and physiological measurements of flight personnel. The device, developed during a study of cockpit air conditioning, is described as being reliable and accurate in extreme environmental changes. The NS-2 is a small, direct-writing, 20-channel recorder which employs special transducers to measure relative humidity within the aircraft and physiological temperature of the flight personnel. Operating, calibration, and maintenance instructions are included in the illustrated report. *Development of Type NS-2 Airborne Data Recorder*, W. B. M. Clark, Douglas Aircraft Company, Inc., for Wright-Air Development Center, U. S. Air Force, Feb. 1958, 30 pp, \$1.00. Order PB 131806 from OTS, U. S. Department of Commerce, Washington 25, D. C.

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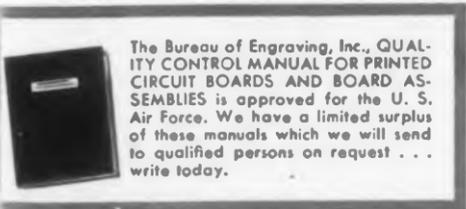
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Vanguard Sequence Diagram

Featured in this report is a description of the Vanguard sequence diagram, a system which shows at a glance the state of every component in a complex device as well as all events occurring and the components involved in each event. According to the report, the sequence diagram fills a need for a means of graphically presenting the operation of a complex device in which a predetermined sequence of events occurs. The diagram represents system components and their changing states as they interact sequentially. Utility and applications of the sequence diagram are discussed and method of interpreting the diagram is illustrated. A complete application of the diagram to the complete nominal flight operation of the first Project Vanguard rocket test vehicle is also presented. *Project Vanguard Report No. 31: The Vanguard Sequence Diagram, a Graphical Method of Presenting Complex System Operation*, W. J. D. Escher and R. W. Foster, U.S. Naval Research Laboratory, Aug. 1958, 15 p, \$1.75. PB 131922 from: OTS, U.S. Dept. of Commerce, Washington 25, D.C.

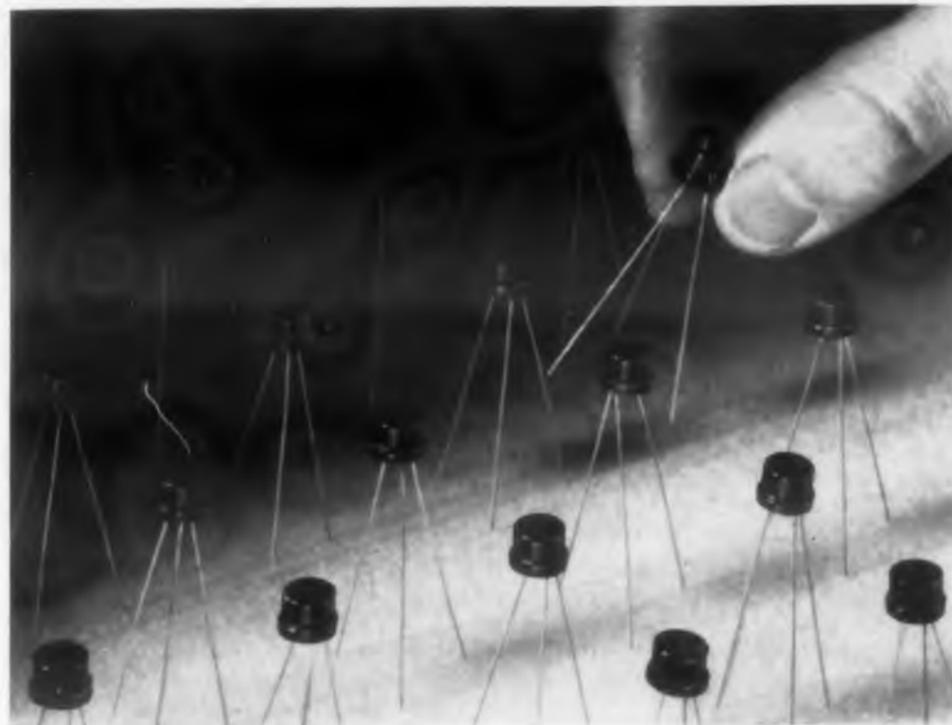
Cooling Design of Airborne Electronic Equipment

Design data, methods, and principles for cooling of airborne electronic equipment with both gaseous and liquid coolants are presented including application to the redesign of four typical equipments for which design procedures and thermal evaluation of the constructed equipment are shown. The first five sections contain general thermal design principles and thermal classification of electronic equipment. *Cooling Design of Airborne Electronic Equipment*, Charles D. Jones, Ohio State University Research Foundation, Columbus, Ohio. Dec. 1957, 458pp, photocopy \$69.60, microfilm \$11.10. Order PB 135164 from Library of Congress, Washington 25, D.C.

Ferrite Loop Antenna Theory

Simplified theory for electrically small ferrite-loaded loop antennas is presented. The theory is based on the principle of reciprocity and known solutions for fields in and about an ellipsoidal core. Approximate methods are given which extend the theory to cores of almost arbitrary cross section. Example calculations for antenna Q and efficiency show good correlation with experiment. *Research in Magnetic Antennas. Final report under Contract No. DA 36-039-sc-73189*, J. L. Stewart, California Institute of Technology, Pasadena, Calif. Sep. 1957, 70p, microfilm \$3.90, photocopy \$10.80. Order from Library of Congress, PB 132459, Washington 25, D. C.

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FLAME-RETARDANT POLYETHYLENE. Just published, and now available to IMPULSE readers, is an interesting 12-page bulletin entitled "Flame-retardant Polyethylene for Wire and Cable." Co-authored by R. C. Graham of Rome Cable and C. A. Neros of Diamond Alkali Company, this paper was presented at the 7th Annual Wire and Cable Symposium, held under the auspices of the U. S. Army Signal Corps. Contact your nearest Rome Cable salesman for a copy of this paper.

FREE INFO. You can get this free 9-page illustrated bulletin that discusses cable insulation and jacketing material and lists typical multi-conductor cable constructions available for use with telemetering equipment, data recording equipment, circuit control testing and electronic computers. Every design engineer working with electrical cable should have a copy! To obtain yours, get in touch with the Rome Cable salesman near you.



"BLUE SKY" DEPT. The National Inventors Council, speaking for the military services, let it be known recently that the Military needs inventions to answer some of its more baffling "blue sky" problems. One of the most unusual inventions requested was a man-made "electric eel" generator to power repeater amplifiers in undersea cables. The point is to emulate the generation process used by the electric eel. That start you thinking? If so, the NIC might like to hear about it. They also would like to hear about a whole list of items they have recently released . . . you can probably get a copy by writing them at the Department of Commerce, Washington, D. C.

CABLEMAN'S CORNER. The subject of circuit identification in cables is somewhat complex. Its purpose is obvious—to identify a particular circuit, phase, polarity or other end use, thus bringing about easier installation and maintenance. The means of circuit identification range all the way from the most conservative, in which all the conductors are alike, to the most liberal, in which each conductor has its own distinctive color combination.

Industry standards for a particular type of circuit identity have been established by many groups such as IPCEA, NEMA, NEC, ASA, IMSA and Underwriters' Laboratories. Military specifications written to cover specific cable constructions indicate the required color coding. Military specifications written to cover a general class of cable constructions many times list a coding table and a recommended method of conductor identification. Caution should be exercised in referring to these particular specifications to make sure that the coding combinations will do the job you are after. For instance, Table V of MIL-C-3432A makes provision for 21 color combinations. For cables containing more than 21 conductors, these color combinations are repeated. Therefore, in a 45-conductor cable you will find 3 colors repeated 3 times and 18 color combinations repeated 2 times.

Under today's rather hectic conditions, delivery schedules are always of prime importance. When circuit identification requires a variety of solid base colors, delivery schedules have to be adjusted accordingly to compensate for machine setups and change-overs, etc. Careful consideration should be given to the use of a solid neutral base color and colored identifying stripes. A very satisfactory combination has been the use of solid white as the base color. With the employment of one or two colored stripes, a total of 73 color combinations can be achieved.

The ways and means of circuit identification are numerous. The methods employed to gain the desired objectives must result in quick and clear intelligible information, conveyed in a method which is reasonably permanent and economical to achieve. Circuit identification is important in your work. Make sure you have competent cable identification. Call in a cable specialist. Our number is Rome 3000.

These news items represent a digest of information found in many of the publications and periodicals of the electronic industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

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REPORT BRIEFS

Training Devices to Motivate Trainee

Training devices designed to furnish varied training may provide greater transfer to operational equipment, and may also help to maintain interest and motivation of the trainee, according to the results of this study. Transfer among perceptual-motor paired-associates tasks was studied as a function of the two variables: the degree of variation in training, and the amount of training. It was found that transfer increased as a direct function of the number of sets of training stimuli. The transfer superiority of varied-over-constant training was not significantly affected by variations in the amount of training. Another conclusion was that training with different sets of stimuli leads to the development of general skill which facilitates dealing with new stimuli. It is suggested that this skill is an observational or perceptual nature. *The Effect on Transfer of Varying Stimulation During Training*, C. P. Duncan and B. J. Underwood, Northwestern University for Wright Air Development Center, U. S. Air Force, Dec. 1957, 38 pp, \$1.25. Order PB 131-653 from OTS, U. S. Department of Commerce, Washington 25, D. C.

Synthesis of Voltage Transfer Functions

The synthesis of voltage transfer functions in the form of linear, lumped, finite, passive, bilateral networks containing no ideal transformers or mutual coupling, is considered. The basic realizability conditions are derived and realization procedures are developed based on these conditions, showing them to be both necessary and sufficient. *Synthesis of Voltage Transfer Functions*, Philip M. Lewis, II, Massachusetts Institute of Technology, Research Laboratory of Electronics, Cambridge, Mass. Jun. 1956, 107p, microfilm \$5.70, photocopy \$16.80. Order from Library of Congress PB 133460, Washington 25, D. C.

Frequency Swept Oscillator

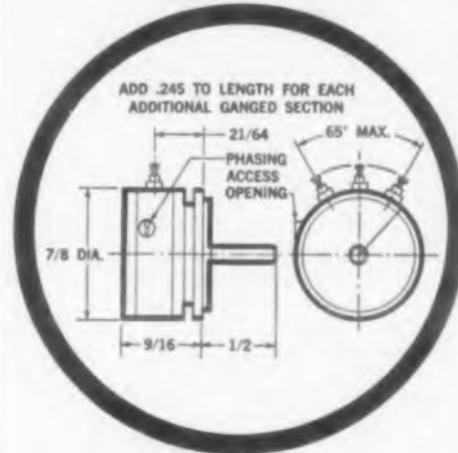
Principal advantage of slot antenna-oscillators are their simplicity of circuit and mechanical construction. They also present possibilities as wide-range tuning systems. Their principal disadvantage, as compared to "lumped-circuit" units, lies in the presence of dragloops which generally make it impossible for a specific unit to generate certain frequencies. *Frequency Swept Oscillator*, Ellis L. Roney, Sylvania Electric Products, Inc., Mountain View, Calif. Mar. 1956, 56 pp, microfilm \$3.60, photocopy \$9.30. Order PB 134884 from Library of Congress, Washington 25, D. C.

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Semiconductor Devices Research Program

Silicon power transistors can be fabricated by diffusing impurities in from the surface to form the base and emitter regions. Transistor structures can be formed using a number of impurities, but gallium and phosphorus were most thoroughly studied. Suitable emitter, base, and collector contacts can be made using titanium or tungsten support plates and the transistors mounted in a hermetically sealed, welded package of low thermal resistance. The fabrication process, consisting of diffusion, lead attachment, etching, and packaging is described. The performance of the units in typical circuits is shown. *Semiconductor Devices Research Program, James E. Keister, General Electric Co., Syracuse, N.Y. July 1958, 157pp, OTS U.S. Dept. of Commerce, Washington 25, D.C., \$3.00 PB 151201.*

Transistor Blocking Oscillators With Variable Pulse Lengths

The length of the output pulse of a given transistor blocking oscillator can be electrically varied by as much as 50:1. For low power alloy junction transistors and ferrite cup transformers, variations in pulse length from 2 to 100 μ sec have been obtained with a variation of the bias voltage. This variation is studied for a blocking oscillator having collector-to-base feedback. *Transistor Blocking Oscillators with Variable Pulse Lengths, S. H. Dinsmore and D. O. Pederson, California University, Berkeley, Calif. July 1957, 22pp, microfilm \$2.70, photocopy \$4.80. Order PB 134745 from Library of Congress, Washington 25, D.C.*

Realization of Broadband Matching Networks For Arbitrary Impedances

The general problem of the realization of optimum lossless matching networks for an arbitrary load impedance is investigated. The starting point for this investigation is Fano's work on the theoretical limitations on the tolerance and the bandwidth of match. It is shown how any arbitrary impedance can be matched to a resistive generator by considering examples of several important types of loads. *Realization of Broadband Matching Networks for Arbitrary Impedances, Bharat K. Kinariwala, California University, Electronics Research Laboratory, Berkeley, Calif. Feb. 1957, 103pp, microfilm \$5.70, photocopy \$16.80. Order PB 133536 from Library of Congress, Washington 25, D.C.*

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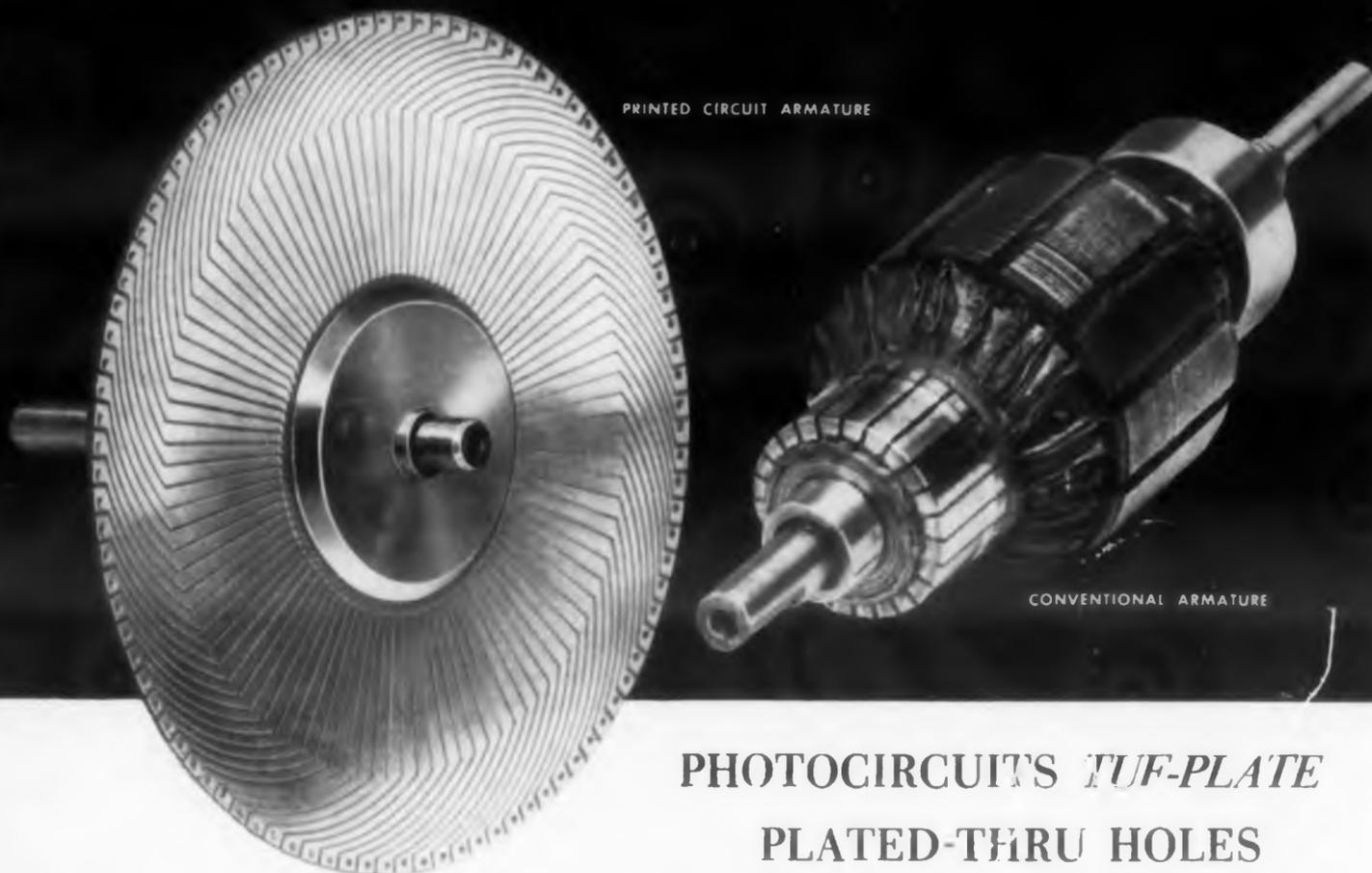
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RUSSIAN TRANSLATIONS

Nonlinear and Parametric Phenomena

Part 14

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 2

Generation of Oscillations

21. Excitation of Oscillations in a Generator

After considering the steady-state mode of the generator, we examine how the steady-state is excited. We shall trace the development of the oscillations from the instant the circuit is turned on until the instant when the amplitude and the frequency are practically constant, i.e., when the oscillations can be considered steady.

The problem reduces to tracing the time variation of the quantities that characterize the oscillation, i.e., of the amplitude and frequency. The waveform of the oscillations will be assumed to be close to sinusoidal.

The problem will be solved by a method known as the method of slowly varying amplitudes. This is essentially a quasi-linear method; the possibility of applying it to this problem is based on the fact that the amplitude, although not as constant as in the steady state case, is

in Radio Engineering

assumed to vary slowly. A criterion for "slowness" will be given below.

Let us write the oscillator equation in the form

$$L \frac{dI}{dt} + RI + \frac{1}{C} \int I dt = M \frac{dI_a}{dt} \quad (1)$$

We have already employed this equation in Sections 17 and 20. But in Section 17 we assumed $I_a = S_a U$ and thus reduced eq (1) to a linear one since our purpose was to find the self-excitation condition. In Section 20 we wrote the equation for the first harmonic in complex form, introducing the average transconductance into the equation. Our problem then was that of investigating the steady-state mode. Now, however, we shall write eq (1) in a general nonlinear form.

The dependence of the plate current on the grid voltage is represented by the nonlinear function

$$I_a = f(U)$$

Let us write the right half of eq (1) in the form

$$M \frac{dI_a}{dt} = M \frac{dI_a}{dU} \frac{dU}{dt}$$

But

$$\frac{dI_a}{dU} = \frac{df(U)}{dU} = S(U)$$

is the differential transconductance, expressed

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RUSSIAN TRANSLATIONS

graphically by the slope of the characteristic of
the triode at a given point i.e., (at a point with
abscissa U). Introducing, as before

$$U = \frac{1}{C} \int I dt$$

we obtain instead of eq (1), the initial oscillator
equation in the form

$$\frac{d^2U}{dt^2} + \frac{1}{L} \left[R - \frac{M}{C} S(U) \right] \frac{dU}{dt} + \omega_0^2 U = 0 \quad (2)$$

Assume that the system considered is soft. In
this case the nonlinear characteristic can be ap-
proximated by a third-degree polynomial:

$$I_a = a_0 + a_1 U + a_3 U^3$$

Differentiating, we obtain an expression for the
transconductance

$$S = \frac{dI_a}{dU} = a_1 + 3a_3 U^2$$

Inserting this in eq (1) we obtain a nonlinear
equation

$$\frac{d^2U}{dt^2} + (2\beta_0 + \gamma U^2) \frac{dU}{dt} + \omega_0^2 U = 0 \quad (3)$$

Here

$$\beta_0 = \alpha - \frac{1}{2} \omega_0^2 MS_0$$

is the initial damping factor (taking the feedback
into account), and γ is shorthand for

$$\gamma = 3 \omega_0^2 M a_3$$

The method of solving eq (3) consists of assum-
ing a solution in the form

$$U = A(t) \sin \omega t$$

The quantity A is the variable "amplitude" of
the oscillation; the function $A(t)$ represents what
is called in electronics the envelope. As to the still
unknown frequency ω , we shall assume it con-
stant.*

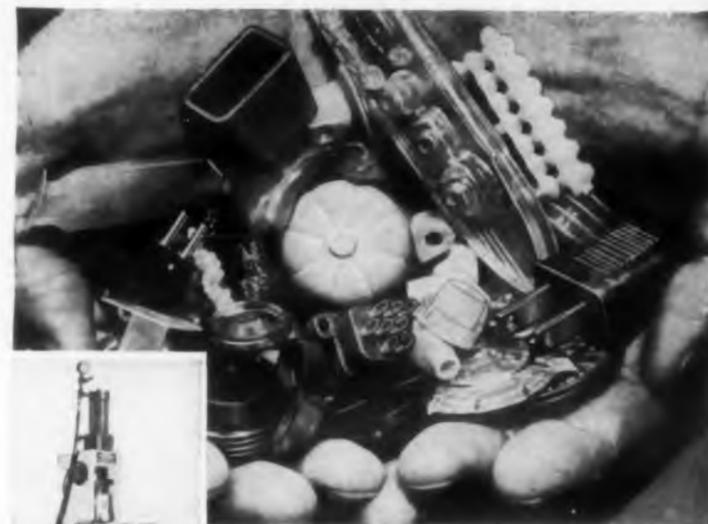
Differentiating the assumed solution in eq (3)
twice

$$U' = A' \sin \omega t + A \omega \cos \omega t$$

$$U'' = A'' \sin \omega t + 2A' \omega \cos \omega t - A \omega^2 \sin \omega t$$

and inserting the values of U and its derivatives
into eq (2) we get

*This is only a first approximation. Actually both the
amplitude and the frequency of the oscillations vary
during the transient. But the change in the frequency
is usually small. Allowance for this change would yield
in second approximation only a slight correction to the
amplitude variation.



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$$A'' \sin \omega t + 2A' \omega \cos \omega t - A \omega^2 \sin \omega t \\ + (2\beta_0 + \gamma A^2 \sin^2 \omega t)(A' \sin \omega t + A \omega \cos \omega t) \\ + \omega_0^2 A \sin \omega t = 0$$

After trigonometric transformations and equating to zero the coefficients of $\sin \omega t$ and $\cos \omega t$ separately, we obtain the two equations

$$A'' + \left(2\beta_0 + \frac{3}{4}\gamma A^2\right)A' + (\omega_0^2 - \omega^2)A = 0 \\ 2A' + \left(2\beta_0 + \frac{1}{4}\gamma A^2\right)A = 0 \quad (5)$$

Here the terms containing the triple argument ($3\omega t$) are discarded by virtue of the initial assumption that the oscillation is sinusoidal [see eq (4)].

Equation (5) can be simplified further. The point is that the various terms of these equations have different orders of smallness. We assume that the function $A(t)$, which represents the variation of the amplitude, is a slowly-varying function.

This means that the changes in the amplitude are much slower than the voltage oscillations themselves. The function $f_1(t)$ is assumed to be slowly-varying compared with any other function $f_2(t)$, if its derivative $f_1'(t)$ is much less than the derivative $f_2'(t)$. For comparison it is first necessary to normalize the derivatives, for example, by dividing by the rms values of the functions themselves.

The absolute value of the derivative of the function that represents the oscillation, i.e., of $U = A \sin \omega t$, does not exceed ωA . Denoting the derivative of the envelope $A(t)$, by A' , we can write the condition for the slowness of $A(t)$ in the form

$$|A'| \ll \omega A$$

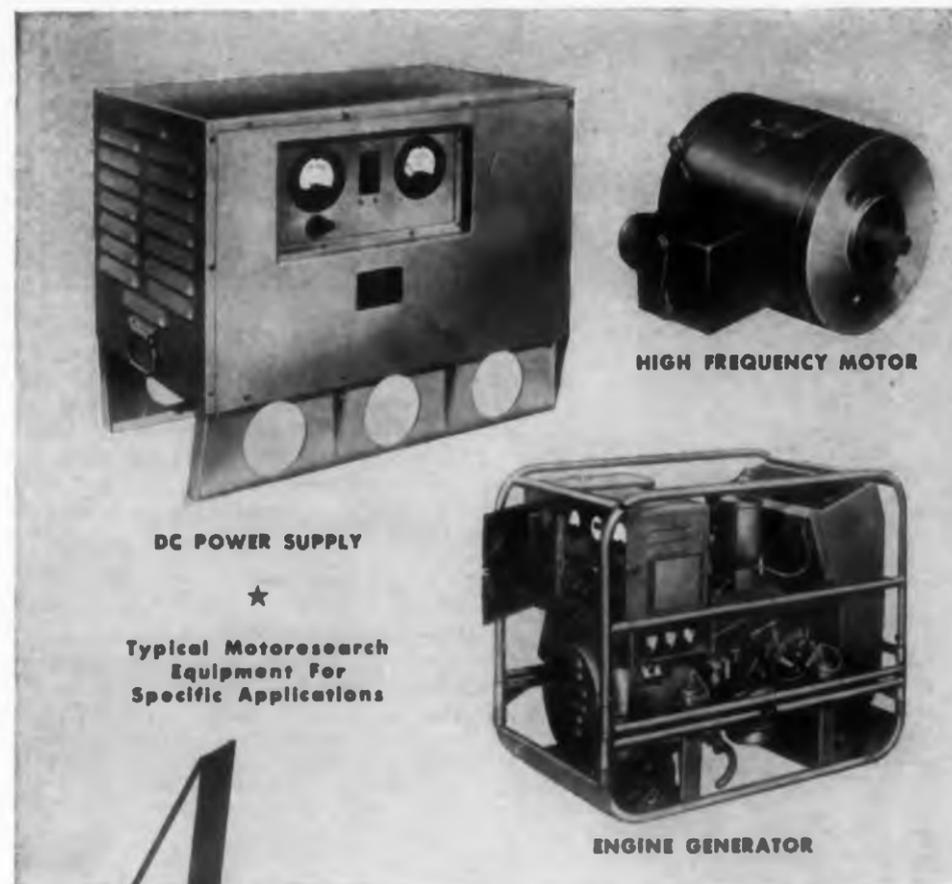
In other words, the quantity A' is of first-order of smallness compared with ωA . But if this is so, then the second derivative of the function $A(t)$ will now become a second-order quantity compared with the second derivative of U , which is of the order $\omega^2 A$.

On the basis of these considerations, it is possible to eliminate from the first equation (5) the term A'' , which is of second order compared with the last term.

As a result we obtain instead of (5)

$$\left(2\beta_0 + \frac{3}{4}\gamma A^2\right)A' + (\omega_0^2 - \omega^2)A = 0 \\ 2A' + \left(2\beta_0 + \frac{1}{4}\gamma A^2\right)A = 0 \quad (6)$$

The equations obtained by crossing out the higher-order terms are called simplified equations. The simplification of equations is a general procedure in the method of slowly-varying amplitudes. It makes it possible to reduce the order of



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RUSSIAN TRANSLATIONS

the equation and simplify the structure. Incidentally, in our case these advantages will remain unused, since we shall employ only the second of the two equations in (6). This has not been simplified.

Eqs. (6) are nonlinear, since the coefficients depend on the amplitude. Let us first find the steady-state amplitude and frequency from these equations.

In the steady-state mode $A' = 0$ and $A = A_0$. The first equation gives immediately

$$\omega = \omega_0$$

and from the second equation

$$A_0 = \sqrt{\frac{8\beta_0}{\gamma}} \quad (7)$$

or expressing β_0 and γ in terms of the initial parameters

$$A_0 = \frac{2}{\sqrt{3}} \sqrt{\frac{a_1}{a_3} - \frac{2\alpha}{\omega_0^2 M a_3}} = \frac{2}{\sqrt{3a_3}} \sqrt{S_0 - \frac{RC}{M}} \quad (8)$$

This is the same value we would have obtained from eq (7) of Section 20 by putting $a_2 = 0$. We see that the oscillation amplitude is determined by the nonlinearity, which is expressed in our case by the coefficient a_3 ; the amplitude depends also on the attenuation of the tank circuit proper, on the initial transconductance, and on the extent of the feedback.

If we examine eq (8), we see that the amplitude diminishes with increasing nonlinearity (i.e., with increasing a_3); the greater the margin with which the self-excitation condition, i.e., condition

$$S_0 > \frac{RC}{M}$$

is satisfied, the greater the amplitude.

Let us now find the law by which the ampli-

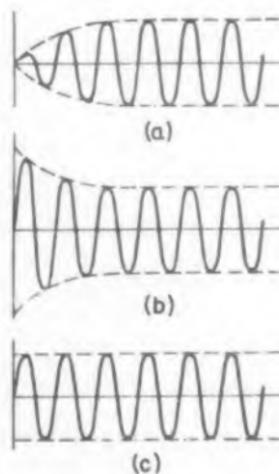


Fig. 73. Steady state oscillations may be established after various initial conditions.

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ture assumes it steady state, i.e., the function $A(t)$, using the second equation of (6). To solve this equation we multiply each term by A , so that we can write

$$\frac{dA^2}{dt} + \left(2\beta_0 + \frac{1}{4}\gamma A^2\right)A^2 = 0$$

Separating the variables

$$\frac{dA^2}{\left(2\beta_0 + \frac{1}{4}\gamma A^2\right)A^2} = -dt$$

We expand the left hand side of this equation into partial fractions

$$\frac{dA^2}{A^2} - \frac{d\left(2\beta_0 + \frac{1}{4}\gamma A^2\right)}{2\beta_0 + \frac{1}{4}\gamma A^2} = -2\beta_0 dt$$

Integrating, we get

$$\ln A^2 - \ln\left(2\beta_0 + \frac{1}{4}\gamma A^2\right) = -2\beta_0 t + C$$

or

$$\ln\left(\frac{1}{4}\gamma + 2\beta_0 \frac{1}{A^2}\right) = 2\beta_0 t - C$$

hence

$$\frac{\alpha}{8\beta_0} + \frac{1}{A^2} = \frac{1}{2\beta_0} e^{-C/2\beta_0} = Be^{2\beta_0 t}$$

and finally [see (7)]

$$A(t) = \frac{A_0}{\sqrt{1 + D e^{2\beta_0 t}}}$$

In this expression $D = BA^2_0$ is a constant of integration, determined by the initial conditions. Depending on the value of D , the amplitude at the first instant can have values of A_0 which are either less or greater than the steady-state ones, or may be exactly equal to the steady-state values when $D = 0$). The quantity β_0 is the resultant initial attenuation factor. This quantity is always negative—this is inherent in self-excitation. Taking this into account, we see that the exponential term under the radical will diminish with time, and we will obtain in the limit (when t approaches infinity) the steady-state value of the amplitude, as given by eq (7).

Fig. 73 shows the establishment of the steady-state oscillations for various initial conditions. The physical meaning of the various initial conditions is best determined by using a graphic representation of the settling process, as will be done in Section 23.

(To be continued.)

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Specifications and details for the waveguide RSWI's can be found on page H-5 of the latest PRD catalog, E-8. Specs and data for the PRD Type 219 can be found on page B-13. If you do not happen to have ready access to this 160-page reference manual, a complimentary copy can be obtained through your local PRD representative or by dropping us a line on your company letterhead.

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When you say "sound reproduction has been developed to the point where further improvement probably could not be heard," you are being far too optimistic. As applied to present day commercial loudspeakers, pickups, and tape equipment, this simply isn't so.

Talking about turntable speed control, you say "frequency at any one time may be as much as five per cent off." As applied to most of the users of phonographs, this is rather pessimistic. Most power users today are served from network sources; these have sensitive frequency recorders on the line at all times. A brief checkup seems to indicate an absolute peak deviation of 0.05 per cent as much more realistic. Granted that you can point to a summer hotel with its own waterwheel generator, or a little gasoline driven control station in Northern Minnesota. In such cases the frequency is so unsteady, and perhaps cyclically modulated, that a mere speed adjustment would mean little. These examples are not of any statistical or practical significance.

You complain about lack of measurement standards and refer especially to turntable noise. There has been an NARTB standard in this field since 1953, and if truly "no one" is able to compare, it is not for lack of a standard.

C. J. LeBel

Audio Instrument Company, Inc.
135 West 14th Street
New York 11, New York

► There are several methods used to relieve overload on a power system including: (1) voltage reduction; and (2) reduction of frequency. When equipment becomes overloaded, frequency on the system may be dropped slightly. While few power systems suffer equipment shortages that would force them to resort to this scheme, it is always a possibility to consider. The 60 cps supply was not intended as a frequency standard.

There is no argument that the standards for

ELECTRONIC DESIGN • March 18, 1959

LETTERS

measurement exist. But the problem is having manufacturers interpret them properly.

Lack of Communication

Dear Sir:

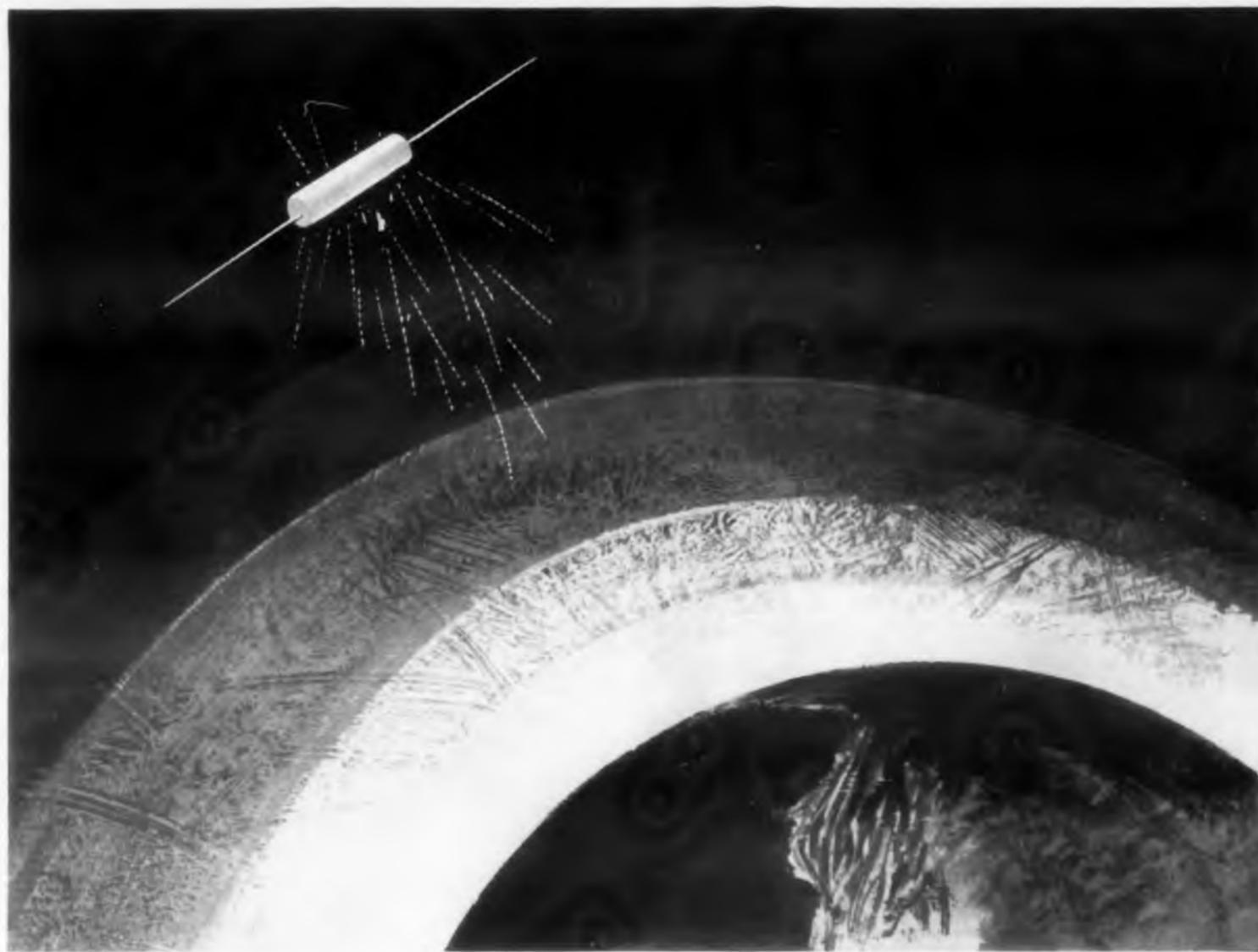
While perusing the article concerning communication in the January 7, 1959 issue of *ELECTRONIC DESIGN*, it was rather disconcerting to read in the section on meteor communication the statement that "design engineers will have to come up with something to detect a useable trail, start a transmitter, etc . . .". This in view of the fact that meteor-burst communication links for both teletype and voice have been developed and operated successfully by the Canadian Defense Research Board, National Bureau of Standards, Naval Electronics Laboratory, Stanford Research Institute (for AFCRC), and others; in the case of the Canadian group, as long ago as 1955.

This work has been described in many of the leading electronic and scientific periodicals notably the IRE Proceedings for December 1957. Ferranti Electric Ltd. of Canada even markets a package meteor-burst teletype system. This does not mean to imply that the meteor-trail propagation mode is understood sufficiently to make possible optimum system design. On the contrary, a tremendous amount of theoretical study and experimentation will be required to achieve this end. But the contributions already made have been most encouraging and to say the least, spectacular.

Russell Wolfram, Research Engineer
Stanford Research Institute
Menlo Park, Calif.

► True, meteor-burst systems have been in limited use for some time. But the real problem is to determine when to turn them on. That is, detecting a useable meteor trail, then sending as much information as possible over the link while the trail is still in existence. All this involves, for example, ways to store the necessary information and have it available for instant transmission. There is still a great deal of work to be done to make the method practical.

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IEC No. 91, RECOMMENDED METHODS OF MEASUREMENT ON RECEIVERS FOR FREQUENCY-MODULATION BROADCAST TRANSMISSIONS

Use of this publication enables comparison of the performance of radio receivers for fm sound broadcasting in the range of 87.5 to 108 mc, as determined by different observers. A catalog of selected measurements recommended for assessing the essential properties of these receivers is neither mandatory nor limiting. A choice of measurements and additional measurements can be made in each case. Methods proposed in this standard assess the performance of the particular receiver without going into the details of the apparatus or its components. Sensitivity, interference, frequency response, distortion, stability, and other aspects are covered. Copies of this publication may be purchased from ASA.

Measurements

ASME PTC 19.14, LINEAR MEASUREMENTS, 1955

Contains descriptions and illustrations of the following types of instruments which are used to obtain the linear dimensions of objects: tapes, rules and scales, calipers, dividers, slide calipers, depth gages, vernier calipers, vernier depth gages, micrometer calipers, thickness gages, gage blocks, etc. Copies of this publication are available from the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y., for \$1.50 per copy.

ASME PTC 19.12, MEASUREMENT OF TIME, 1955

Describes the following types of time keepers: general purpose clocks, chronometers, clocks or regulators for indicating time to the nearest second, astronomical clocks, watches, stop watches, timers, chronographs, and oscillographs. Methods that are available for measuring time and time intervals are also included. Copies of this publication are available from the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y., for \$1.50 per copy.

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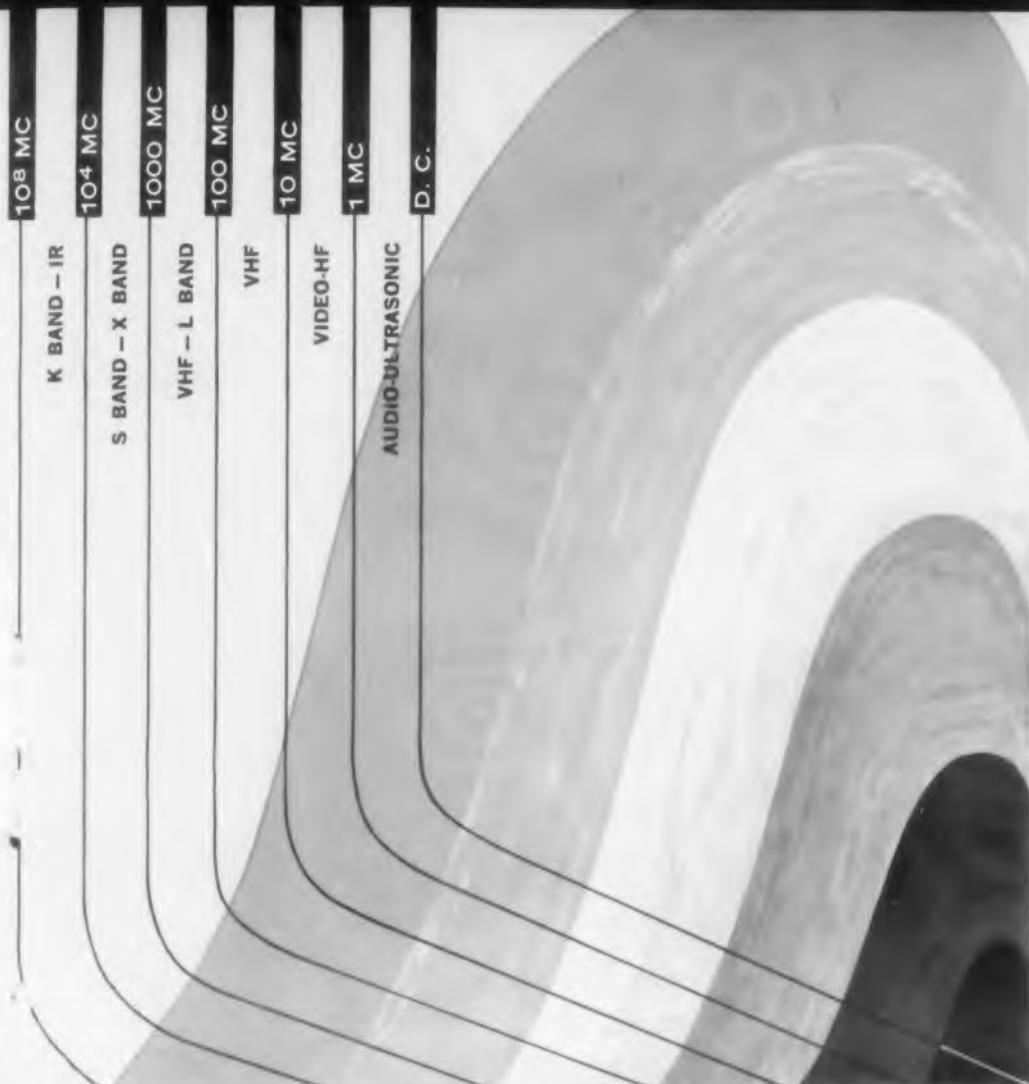
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A few examples of projects now in progress at Light Military are described below. Each of them provides opportunities for—and often demands—contributions advancing the state of the art ▼

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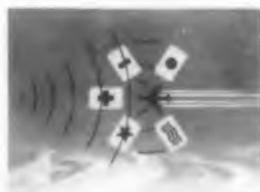
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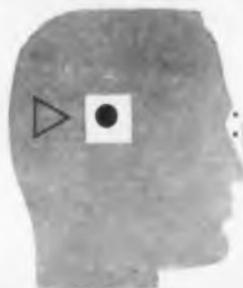
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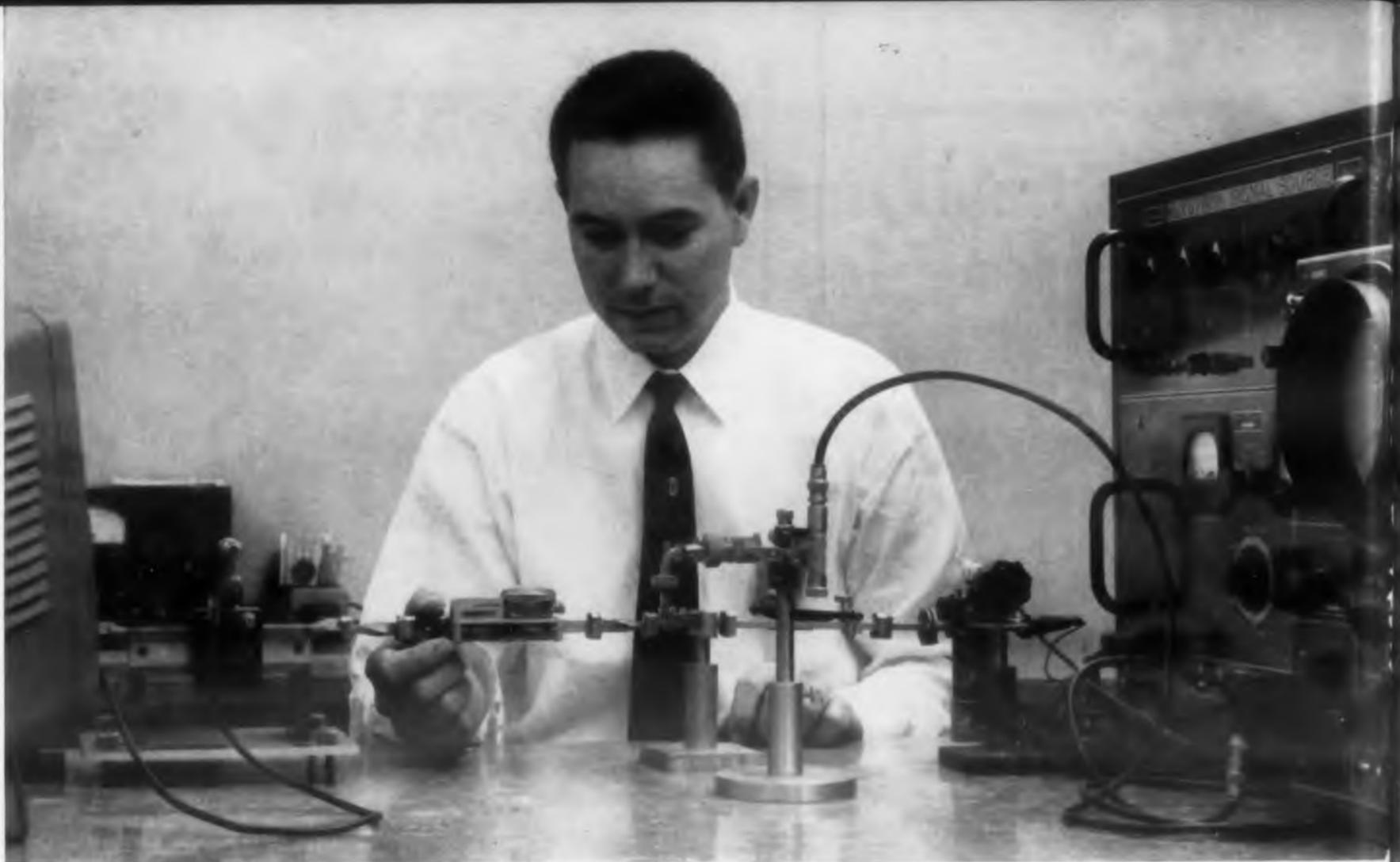
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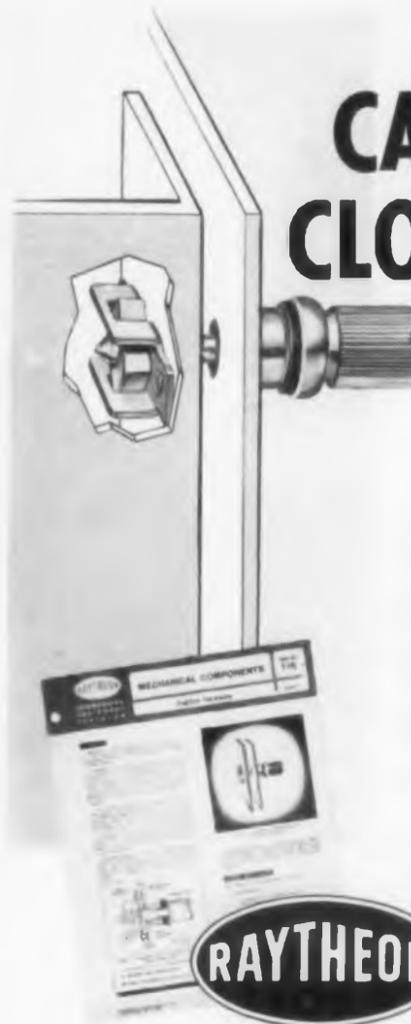
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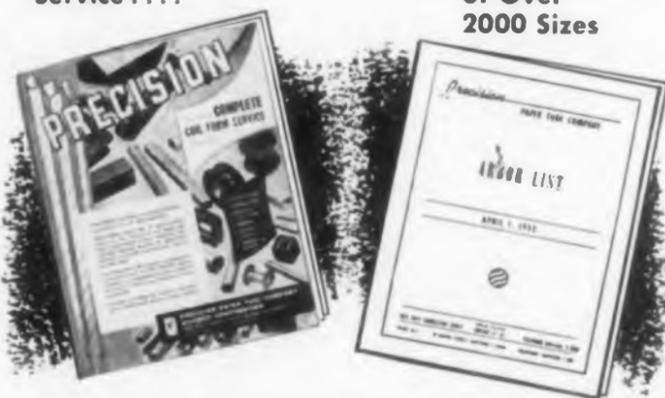
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GERMAN ABSTRACTS

Regulated Transistor Power Supplies

E. Brenner

CONSTANT supply voltages, required in transistorized equipment, demand regulated power supplies which can be well attained with transistor circuits. A comparison of three regulator methods shows that circuits in which transistors are used as switches have certain advantages over those circuits in which a control transistor is continuously in the circuit.

A typical regulator, in which a transistor is continuously in series with the load ("series compounding") is shown in Fig. 1. A reference voltage is derived from a zener diode and compared to a fraction of the output voltage. The difference is amplified and used to control the series transistor so as to minimize the error. The circuit is characterized by comparatively large power dissipation in the control transistor (see Table) but has low hum content in the output.

The losses in the control transistor can be reduced materially by use of a switched transistor as in the "two-point" circuit, Fig. 2. The error voltage in this circuit activates a Schmitt trigger which gates the control transistor as the tolerated error is exceeded. At full load and overvoltage, power loss occurs in the series resistor R_s . The efficiency is the same as in Fig. 1 but the

transistor loss is reduced. The maximum current is limited by the peak collector current of the series transistor. A continuously varying output

**Comparison of the Properties of
Three 12v 100 ma regulated
transistor power supplies.**

	Continuous Regulator Fig. 1	Two-point Regulator Fig. 2	Controlled Rectifier Fig. 3
Output Impedance ohms	0.3	0.3	0.5
Voltage variation for 10% input variations (%)	0.2	0.2	0.2
Overall Efficiency at full load and 10% overvoltage (%)	45	45	60
Loss in control transistors at full load and 10% overvoltage (mw)	600	50	100
Control speed	high	high	low
Output noise voltage at full load (mv eff.)	1	20	60

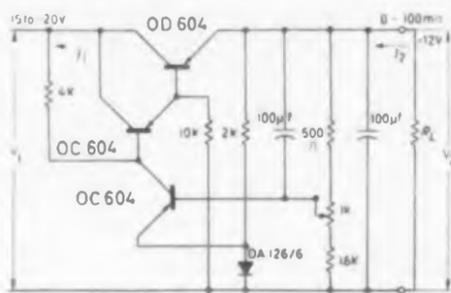


Fig. 1. Regulated power supply using a continuously active transistor.

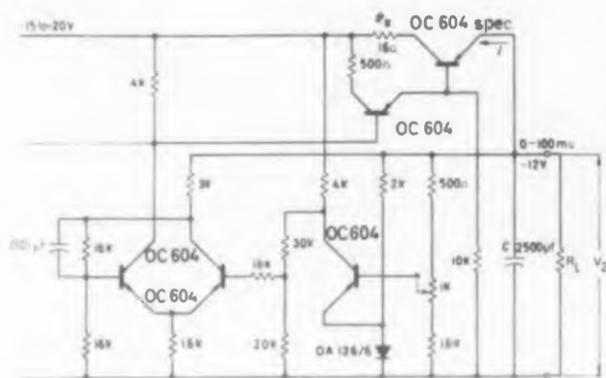


Bild 6. Stabilisierschaltung mit Transistor-Zweipunktregler

Fig. 2. Regulated power supply using transistor two-point control.

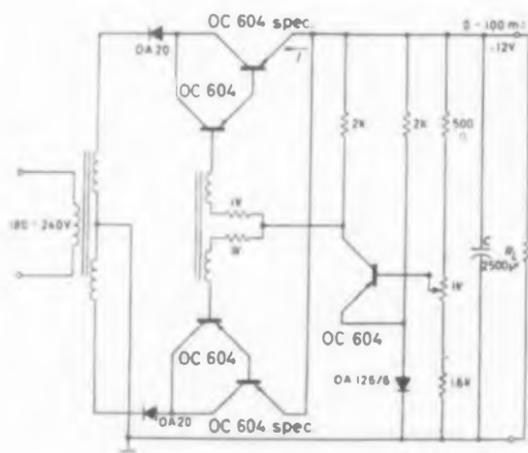


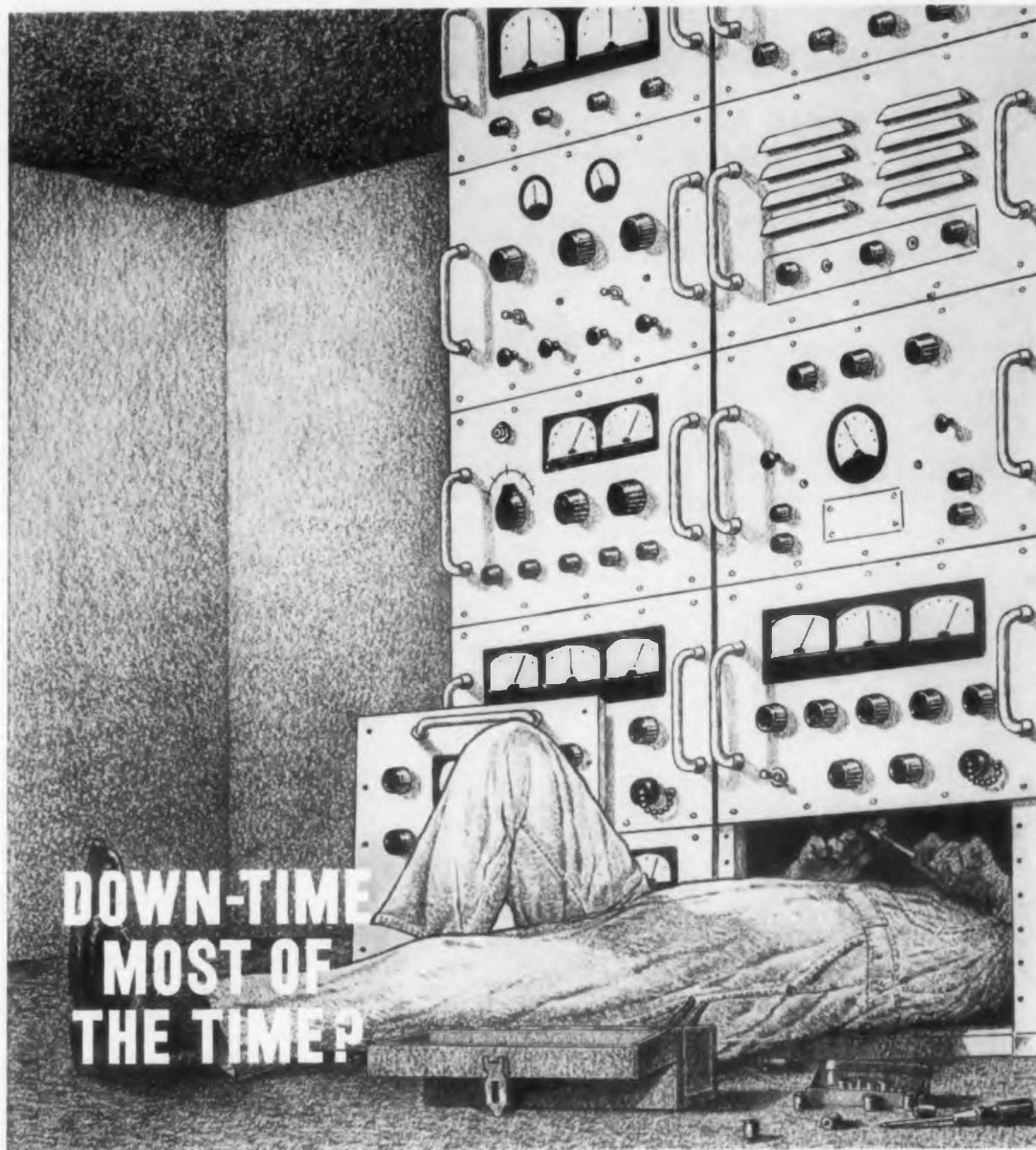
Fig. 3. Transistor controlled rectifier.

voltage is necessary for operation (see output noise voltage in Table).

In the controlled rectifier (Fig. 3), the conduction angle is controlled in the same manner as in power Thyatron circuits. Hum voltages are therefore not reduced by the regulator action; only the filter counteracts this component of the noise. Except for this error, it is possible in practice to obtain perfect regulation with this circuit.

Comparison between the three circuits is made in the Table. The efficiency values include a 66 per cent transformer efficiency figure.

Abstracted from an article by G. Meyer Broetz, Elektronische Rundschau, Vol. 12, No. 10, October 1958, pp 342-344.



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GERMAN ABSTRACTS

E. Brenner

Noise In Silicon Diodes And Transistors

ON THE BASIS of the Shockley diffusion equation, it can be shown that, for a p-n junction, noise current through noise resistance R_n is given by

$$\bar{i}_n^2 = 4kT \Delta f / R_n \quad (1)$$

where

$$2R_n = R [1 + \exp(-eV/kT)] \quad (2)$$

and

$$R = \frac{kT}{e(I_D + I_s)}$$

I_s = saturation current

I_E = diffusion current

While this formula is adequate for alloyed germanium diodes, significant deviations occur for silicon junctions. One of the reasons for these deviations is the recombination and generation of carriers in the depletion layer. On the basis of this theory, the equivalent noise resistance can be shown to be half of the total (differential) resistance in the forward direction.

The mean squared noise current is calculated (using certain simplifying assumptions which are eventually justified by experimental confirmation) by adding the contributions due to recombination and diffusion. The result is the formula

$$\bar{i}_n^2 = 4kT (ReY) \Delta f - 2eI \Delta f / m \quad (3)$$

where Y is the total junction admittance, I is the total current through the junction and m is an empirical parameter which is determined by fitting the dc volt-ampere curve of the diode to the form $I = I_0' \exp(eV/kTm)$. Usual values of m are between one and two. At low frequencies,

for $I \gg I_0$, an adequate approximation for Y is

$$ReY + eI/mkT$$

and then

$$\bar{i}_n^2 = 2eI \Delta f / m \quad (4)$$

so that using an equivalent noise resistance R_n ,

$$2R_n = 1/ReY \quad (5)$$

To take the recombination effect into account for transistor noise calculations, two separate diodes are calculated. Eq. (3) applies to the emitter noise if Y is replaced by Y_{11} , the short circuit input admittance of the intrinsic transistor and I and m are replaced correspondingly by I_c , m_c . The collector noise can be approximated by

$$\bar{i}_{nC}^2 = 2eI_c \Delta f \quad (6)$$

The noise factor is approximated by

$$F = \frac{2eI_c(I/Y_{11} + R_n + R_b)/\alpha_{fb}^2 - 2eI_c(R_b + R_n)^2/m_c}{4kT R_n} \quad (7)$$

where

R_b = base resistance

R_n = source resistance

α_{fb} = ac current amplification factor in the common base configuration.

The original paper includes experimental results as well as other analytical work and proofs.

Abstracted from an article by B. Schneider and M. J. O. Strutt, Archiv der Elektrischen Uebertragung, Vol. 12, October 1958, pp 429-440.

Polynomial Approximation for Complex Transfer Functions

IN THE synthesis of two-ports, it is often the practice to approximate the desired amplitude response and subsequently to correct the phase response with cascaded all-pass two-ports. It is, however, possible to form polynomials so that in a given band of frequencies, both amplitude and phase response can be approximated with any desired degree of accuracy.

The frequency band over which the approximation is to hold is normalized to be the band $0 \leq \omega \leq 1$. The problem can then be formulated as follows:

A given complex function $F(j\omega)$ is to be ap-

proximated in the stated band by an n th order Hurwitz polynomial. Since the roots of this polynomial $F^{(n)}(p)$, where p is the complex frequency variable, must have negative real parts, the angle of $F(j\omega)$ must increase monotonically with increasing frequency and the locus of $F(j\omega)$ must encircle the origin $n/4$ times where n is the order of the approximating polynomial. If ϕ_0 is the angle of $F(j)$, n is chosen by the rule

$$\phi_0 \geq n \pi/4$$

where the inequality is used for $n > 6$.

According to the scheme mentioned below, m points on the complex locus $F(j\omega)$ are chosen and it is desired that the approximating polynomial exhibit least squared error property. Using the substitution

$$\omega = \cos \theta$$

the approximating polynomial can be written as

$$F^{(n)} = a_0 + a_1 \cos \theta + a_2 \cos 2\theta + \dots + a_n \cos n\theta \quad (2)$$

where the coefficients a_k are real for even values of k and imaginary when k is odd. While these coefficients can be evaluated analytically by expanding the real and imaginary parts of $F(j\omega)$ in Fourier series when F is known analytically, the schedule type method of Fourier analysis is well suited to this problem. The scheme for choosing the m points mentioned above consists then of calculating $F(j\omega)$ at the radian frequencies

$$k = \cos(k \pi / 2m) \quad (3)$$

and the equation

$$F(\omega=1) = \sum_{k=0}^m a_{2k} + j \sum_{k=1}^m a_{2k-1} \quad (4)$$

serves as a check of the numerical work.

Once the coefficients a_k are known, the polynomial is obtained by the use of the n th order Tschhebscheff polynomial, $T_n(\omega)$, i. e.

$$T_n(\omega) = \cos(n \cos^{-1} \omega)$$

in Eq. 2 so that

$$F^{(n)}(\omega) = \sum_{k=0}^n a_k T_k(\omega) = \sum_{k=0}^n b_k \omega^k$$

Then, $F(p)$ is obtained by setting $\omega = -jp$ and the result is checked using the Routh criterion.

In the original paper, the procedure is illustrated in detail. The function

$$F = \exp(\omega^2 + j 5 \omega \pi/4)$$

is approximated by

$$F^{(5)} = 1.032 + 4.012p + 7.302p^2 + 6.824p^3 + 4.317p^4 + 0.877p^5$$

Abstracted from an article by E. Schuon, Frequenz, Vol. 12, No. 10, October 1958, pp 318-323.

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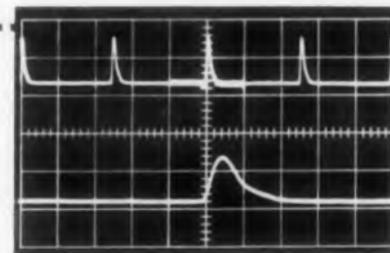
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MEETINGS

1959 IRE National Convention Technical Program

All A. M. sessions begin at 10:00;
P. M. sessions at 2:30; Eve. sessions at 8:00

Abbreviation Key: Waldorf—Astor Gallery (A), Empire Room (E), Grand Ballroom (G), Jade Room (J), Sert Room (Se), Starlight Roof (St), Coliseum—Morse Hall (Mo), Marconi Hall (Ma), Faraday Hall (F).

Session and Number

Time and Location

Audio

Contributions to Stereo
Sound Reproduction (12) Tues am-Se
Speech and Circuits (20) Tues pm-Se

Automation and Control System

Adaptive Control Processes
and Allied Systems (1) Mon pm-St
Theory and Practice in
Russian Technology (40) Thur am-St
Frontiers of Industrial
Electronics (44) Thur am-E

Broadcasting

Broadcasting—I (11) Tues am-J
Broadcasting—II (19) Tues pm-J
Communication Engineering
in Broadcasting (52) Thur pm-Mo

Circuit Theory

New Techniques for
Analysis (9) Tues am-St
The Statistical Theory of
Signals and Circuits (25) Wed am-St
Symposium on Sequential
Circuit Theory (34) Wed pm-A
Circuit Theory II—Analysis
and Synthesis (41) Thur am-A
Circuit Theory III—
Applications (49) Thur pm-A

Communications

Vehicular Communica-
tions (2) Mon pm-A
Communication by HF Radio
and by Wire Line (37) Wed am-Mo
Communication Engineering
in Broadcasting (52) Thur pm-Mo

Components

Component Parts—I Wed am-J
Component Parts—II Wed pm-J

Concepts

Concepts and Programs (51) Thur pm-Se

Education

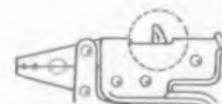
Symposium: Psychology and
and Electronics in the
Teaching-Learning
System (29) Wed am-G

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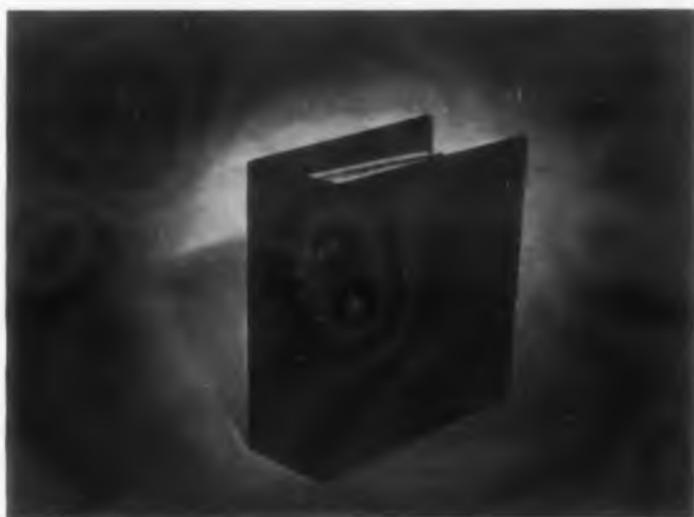
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Session and Number Time and Location

Computers and Data Systems

Digital Telemetry (28)	Wed am-Se
Electronic Computers: Systems and Applica- tions (33)	Wed pm-St
Symposium on Sequential Circuit Theory (34)	Wed pm-A
Theory and Practice in Rus- sian Technology (40)	Thur am-St
Electronic Computers: Components and Circuits (48)	Thur pm-St
Instrumentation for High Speed Data Acquisition (54)	Thur pm-F

Electron Devices

Electronic Devices (8)	Mon pm-F
Panel: Widening Horizons in Solid State Electronics (16)	Tues am-F

Human Engineering

Man-Machine System Design (45)	Thur am-Mo
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Information Theory

Information Theory (17)	Tues pm-St
The Statistical Theory of Signals and Circuits (25)	Wed am-St
Theory and Practice in Rus- sian Technology (40)	Thur am-St

Instrumentation

Nuclear Instrumentation Techniques—I (10)	Tues am-A
Nuclear Instrumentation Techniques—II (18)	Tues pm-A
Instrumentation: Devices and Circuits (47)	Thurs am-F
Instrumentation for High Speed Data Acquisition (54)	Thur pm-F

Interference

Radio Frequency Interference (4)	Mon pm-Se
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Land and Space

Navigation and Traffic Control (7)	Mon pm-F
Land and Space Electronics (15)	Tues am-Ma
Panel: Future Developments in Space (24)	Tues eve-St
Space Electronics (38)	Wed pm-Se
Military Electronics—Looks Forward (43)	Thur am-Se
Communication by HF Radio and by Wire Line (37)	Wed pm-Mo

Management

Engineering Management Techniques (5)	Mon pm-E
Engineering Management— II (13)	Tues am-G

(Continued on page 184)

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MEETINGS

Session and Number	Time and Location
Medical Electronics	
Medical Electronics—I (14)	Tues am-Mo
Medical Electronics—II (21)	Tues pm-Mo
Panel: Future Developments in Space (24)	Tues eve-St
Microwaves	
Microwave Tubes (23)	Tues pm-F
Microwave Devices (32)	Wed am-F
Microwave Theory and Techniques (39)	Wed pm-F
Military Electronics	
Panel: Future Developments in Space (24)	Tues eve-St
Military Electronics Looks Forward (43)	Thur am-Se
Navigation and Traffic Control	
Navigation and Traffic Control (7)	Mon pm-Ma
Panel: Future Developments in Space (24)	Tues eve-St
Production	
Production Techniques (8)	Mon pm-Mo
Propagation	
Communication by Scatter System (30)	Wed am-Mo
Propagation and Antennas—I (38)	Wed pm-Ma
Antennas—II (46)	Thur am-Ma
Communication Engineering in Broadcasting (52)	Thur pm-Mo
Antennas—III	Thur pm-Ma
Radio and TV Receivers	
Speech and Circuits (20)	Tues pm-Se
Radio and Television Receivers (26)	Wed am-A
Reliability	
Reliability Techniques (22)	Tues pm-Ma
Mathematical Approaches for Reliability (31)	Wed am-Ma
Russian Technology	
Theory and Practice in Russian Technology (40)	Thur am-St
Telemetry	
Digital Telemetry (28)	Wed am-Se
Ultrasonics	
Ultrasonic Engineering—I (42)	Thur am-J
Ultrasonic Engineering—II (50)	Thur pm-J
Writing and Speech	
Engineering Writing and Speech (3)	Mon pm-J

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340B Noise Figure Meter



343A vhf Noise Source



342A Noise Figure Meter



345B IF Noise Source



347A Waveguide Noise Source

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SPECIFICATIONS

Model 340B Noise Figure Meter

Frequency Range:	Depends on noise source used
Noise Figure Range:	3 to 30 db, indication to infinity with Waveguide Noise Source, 0 to 15 db indication to infinity, with vhf and IF Noise Sources
Zero Offset:	Permits low values to be read on sensitive external meter.
Accuracy:	Noise Diode Scale, +0.5 db, 0 to 15 db Gas Tube Scale, -0.5 db, 10 to 25 db; -1 db, 3 to 10 db and 25 to 30 db
Input:	-60 to -10 dbm (noise source on). Corresponds to gain between noise source and 342A of: vhf or IF Noise Source, Approx. 50 to 100 db Waveguide Noise Source, Approx. 40 to 90 db
Input Frequency:	30 and 60 MC. Any two frequencies between 10 and 60 MC on special order
Bandwidth:	1 MC minimum.

Input Impedance:	50 ohms
Price:	\$700.00 (rack mount) \$715.00 (cabinet)

(Note: This instrument is available in the U.S.A. and Canada only)

Model 342A Noise Figure Meter (same as 340B except)

Input Frequency:	30, 60, 70, 105 and 200 MC. 30 MC and any four other frequencies between 38 and 200 MC are available on special order.
Price:	\$800.00 (rack mount) \$815.00 (cabinet mount)

(Note: This instrument is available in the U.S.A. and Canada only)
Data subject to change without notice. Prices f.o.b. factory

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