

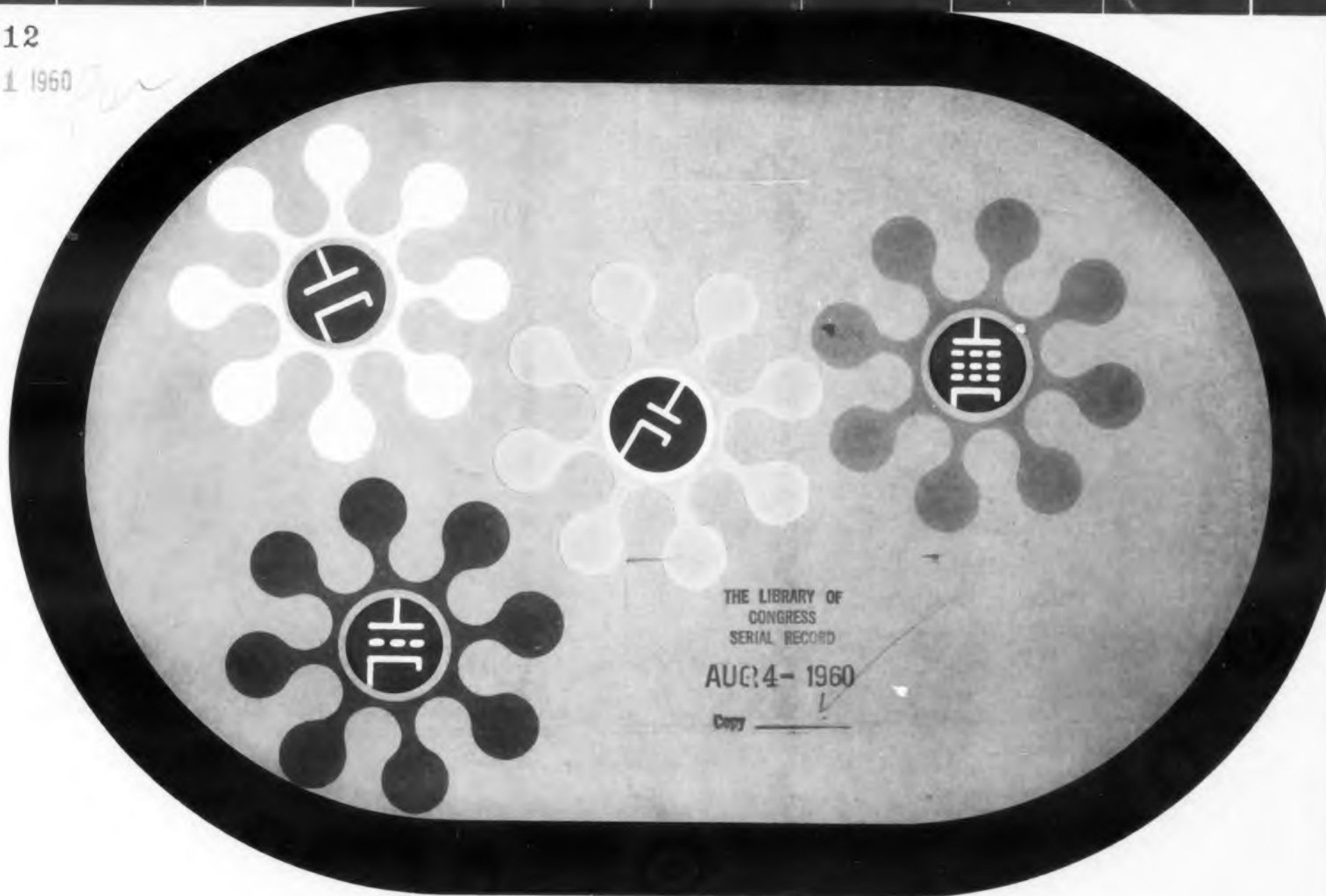
ELECTRONIC DESIGN

JULY 20, 1960

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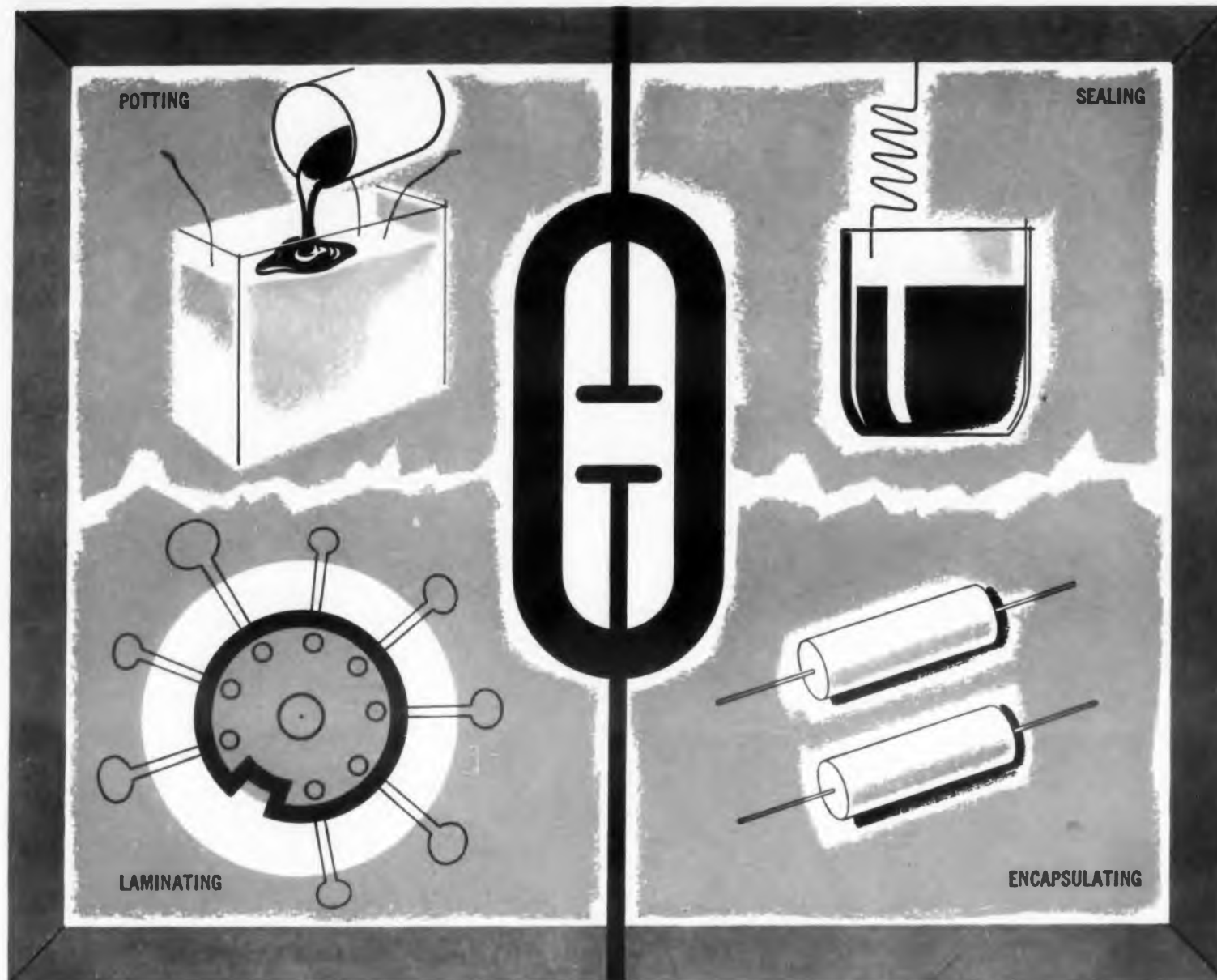
TC7035



Compactron provides four functions in one envelope page 74

ALSO IN THIS ISSUE:

Design for Peace
Detecting A-Bomb Test-Ban Violations
An ELECTRONIC DESIGN Special Report . . . p38



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CIRCLE 1 ON READER-SERVICE CARD



COVER: To illustrate the development of the Compactron, this issue's featured New Product, *ELECTRONIC DESIGN*'s Art Department conceived a drawing of a single tube envelope which performs four individual functions. The schematic drawings show a triode, a pentode, and two diodes, one of which is drawn larger than the other since it represents a power rectifier. The asterisks are symbols to call special attention to the four individual functions now performed by one tube.

Selected Topics In This Issue

Circuit Design

- Generate Variable Delays With DC-Controlled Flip-Flops ... p 50
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Computers

- Simple Analog Circuit Solves Heat-Flow Problems ... p 60
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Sidelights of This Issue

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Who Tested That Bomb?

The possibility of a ban on nuclear testing has raised the old question of how to find out who is testing what, where, and how. On page 38, News Editor Manfred Meisels explores the possibilities for the development of new systems and new devices for the detection of illegal blasts. "It was a digging job," he says. "Most of the stuff was available, but was filed away or pigeonholed in old Congressional committee reports, foundation surveys, industry reports, and the like." Meisels' job was to get it all out, dust it off, and wrap it up into one package. We think it is a pretty thorough job of detailing precisely where the designer can aid the seismologist and rocketeer.

Measuring Heat Flow Through Solids

A constantly recurring headache for engineers in many fields of design is the problem of determining the heat flow through one or more solid materials to a constant temperature sink. Heat flow provides a limit to the power capacity of transistors and to the frequency response of thermal detectors such as bolometers and barretters. Sometimes, the heat may vary. On page 60, Richard J. Allen and Emil C. Muly combine to present a simple analog technique to solve this problem quickly.

RFI—New Developments

In ED's Feb. 3 issue, we began a series on RFI which has had a resounding success in many areas of industry and government. In this issue, Joseph Lorch, president of Empire Devices of Amsterdam, N.Y., discusses the impulse generator and its calibrating qualities in RFI measurement. Its versatility and application to both narrow-band and broad-band measurements are discussed together with the requirements for field-intensity meters. The story is on page 68, and on page 71, the reader will find a list of titles and issue dates for previous articles in this continuing series.

Coming Next Issue

This year's WESCON will usher in the "Soaring '60's" when it opens next month in Los Angeles. For a complete preview of the big show and conference at the Sports Palace, see the Aug. 3 *ELECTRONIC DESIGN*.

CIRCLE 2 ON READER-SERVICE CARD ➤

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CIRCLE 3 ON READER-SERVICE CARD

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M8020*	35 C.T.	3	14.5	29
M8021*	70 C.T.	1	30	60
M8022†	18.5 C.T.	3	7	14
M8023†	35 C.T.	3	14.5	29
M8024†	70 C.T.	1	30	60

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UM 22*	Output	1,000	1,000
UM 23*	Drive	20,000	1,200 C.T.
UM 24*	Output	1,000	50
UM 25*	Output	400	50
UM 26*	Output	400	11
UM 27*	Output	400 C.T.	11
UM 28*	Choke	10 Hy. (0 dc)	8 Hy. (5 ma) 650

*Add either -F or -M to designate construction. See catalog.

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MT8*	P.P. Coll. to P.P. Emit.	25,000	1,200 C.T.
MT9*	Line to P.P. Emit.	600 C.T.	1,200 C.T.
MT11*	P.P. Coll. to P.P. Emit.	4,000 C.T.	600 C.T.
MT13*	P.P. Coll. to Speaker	4,000 C.T.	3.4
MT14*	Coll. to Speaker 2N179	400	10
MT15*	P.P. Servo Output 2N57	500 C.T.	210
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CIRCLE 4 ON READER-SERVICE CARD

Military Meeting Stresses Systems Needs

Tunnel-Diode Amplifiers, Military's Stake in Education, Bulk Semiconductors for Microwave Devices Also Featured

THE LATEST directions in needs and concepts for military systems and devices were outlined in a broad range of papers at the recent National Convention on Military Electronics in Washington, D. C.

Highlights of this fourth annual meeting, which drew some 2,000 registered and nearly 4,000 total conferees, included:

- Steps forward in many phases of satellite and space technology.



Contract award for service application of a parametric amplifier was announced by Microwave Associates during the military electronics convention. An L-band unit, similar to this, will be incorporated into all presently operating AN/MPS-11A acquisition radars by the U.S. Marine Corps. Meeting the specified sensitivity improvement of from 10 db to 3 db or less, this unit dramatically increases range of the 12-year old system to meet jet-age requirements.

- Concentrated efforts on advanced communication techniques to meet the needs of complex systems and new space requirements.

- Widespread activity in electronic simulation equipment for all the services.

- Much work in camera tubes and other surveillance-type equipment.

Among papers of special interest to design engineers were those on the use of bulk semiconductor devices in microwave applications, and design considerations in using tunnel diodes in amplifiers.

A panel discussion on education moderated by Prof. Jerrold R. Zacharias, Massachusetts Institute of Technology, and including top representatives of each of the three services also drew much engineer interest at the three day conference.

Recent advances in the application of bulk semiconductor devices to microwave devices was reported during the convention by five Signal Corps scientists. Laboratory results indicate that an entire new family of microwave devices may evolve, they said.

For several years, it has been known that microwave energy can be modulated when a semiconductor rod is inserted in a waveguide, the authors said. Experiments indicate several different types of device possibilities for amplitude and phase modulation.

Wide Range of Wave-Guide Tests

Basic work was performed in the laboratory using 10 kmc energy, with slabs of semiconductor material of various thicknesses oriented in different ways with respect to the wave guide. Conductivity of the slab was varied during these experiments by some physical means. In one case, uniform injection of excess minority carriers was accomplished through wires soldered to the slab. In other cases, conductivity was varied by light impinging on the semiconductor. Conductivity variation between $\sigma = 2$ and $\sigma = 10$ caused a corresponding change in E_o/E_{in} from about 56 per cent to about 10 per cent.

When the semiconductor slab is oriented so that its long dimension is parallel to the direction of the waveguide, internal reflections were found to be smaller than when the slab is oriented at right angles to this direction. The result of reduced internal reflections is that absorption by conductivity changes of the semiconductor is the more pronounced factor in causing modulation of the transmitted signal. Because of this, amplitude modulation is accomplished with little or no corresponding phase modulation. The ability to minimize the phase shift by proper choice of geometry was verified experimentally.

In much the same way, proper choice of the geometry and orientation of the semiconductor slab can also lead to phase shift with minimum amplitude modulation. In one case, a slab 0.8 x 0.8 x 1.5 cm was inserted in a waveguide with its long dimension across the waveguide. A 30 per cent phase shift was accomplished with very little change in attenuation. This experiment was accomplished by the injection of current in a manner not entirely uniform.

The experiment was further checked by flooding the sample with light to increase its conductivity. Again it was verified that increased conductivity induced by the light source could actually cause an increase in transmission, rather than an expected decrease, at the same time the phase shift was changing.

Gain Variation with Source or Load Conductance

G_L or G_S %	+20	-20	+10	-10	+5	-5	+2	-2
K_{ip}	14.9	*	17.2	25.7	18.4	22.4	19.4	20.5
Diff.	-5.1	-	-2.8	+5.7	-1.6	+2.4	-0.6	+0.5
%	-26	-	-14	+29	-8	+12	-3	+2.5

*oscillation

The ability to modify microwave energy by electrical or light energy by means of a semiconductor, leads to the possibility of several other devices. For example, if the PIN diode is reversed bias, conductivity modulation can occur at higher frequencies than when biased in a forward direction. The design for an amplifier has worked out using this principle. Furthermore, since these principles apply to the infrared as well as the microwave region, various infrared modulators, phase shifters and detectors could possibly be arranged to carry out new electro-optical functions.

Problems in Tunnel-Diode Use

Lumped parameter high-frequency tunnel-diode amplifiers are feasible, however they do not necessarily represent an improvement over existing transistor amplifiers in the same frequency range according to Thomas O. Krueger, electronics engineer, Solid State Development Div., U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

Many new factors must be considered in the use of tunnel diodes in amplifiers, Mr. Krueger said. Some of the problems which exist in practical amplifiers applications include:

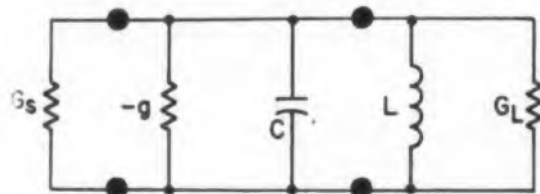
- Temperature effects on negative conductance may cause instability. This effect is more serious with germanium than with silicon or gallium arsenide devices.

- Instability can be caused by small changes in source or load impedance.

- Very low impedance levels, on the order of 10 to 50 Ω , create termination and impedance transforming problems, particularly if the amplifier is used as the first stage of a receiver.

Advantages offered by the tunnel diode if these problems are solved include low power consumption, very-high-frequency operation, and small size.

One of the primary considerations of the tunnel diode amplifier designer is the lead impedance. If this impedance, plus that of the rest of the circuit external to the device, becomes greater than the negative resistance of the diode,



Tunnel diode tuned amplifier equivalent circuit, with G_B and G_L representing source and load conductance, and $-g$ representing the conductance of the diode.

CIRCLE 5 ON READER-SERVICE CARD >

ELECTRONIC DESIGN • July 20, 1960



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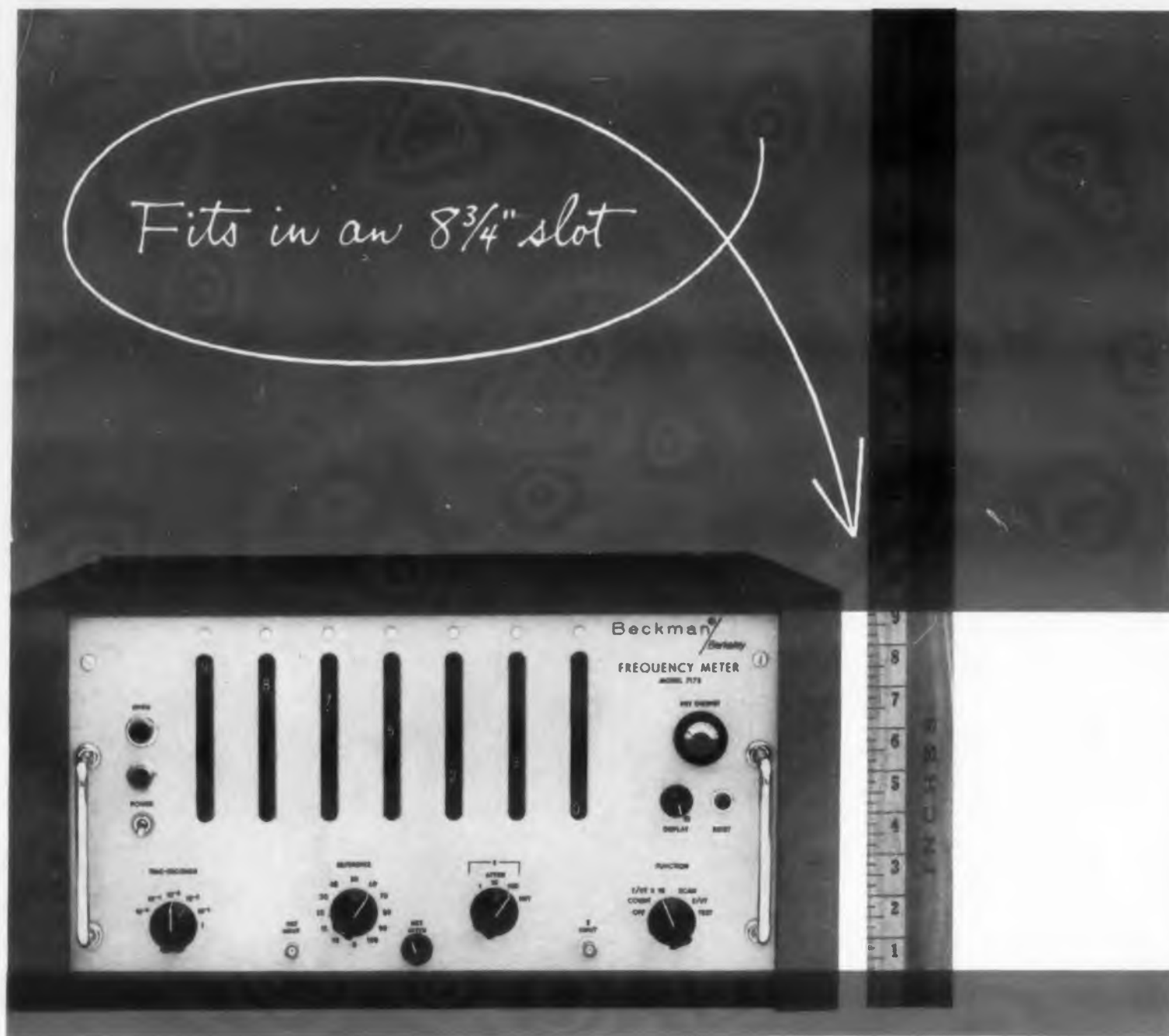
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CIRCLE 6 ON READER-SERVICE CARD

NEWS

junction oscillation occurs. Thus shorter leads, or configurations which integrate the device into the circuit, are desirable.

The tunnel diode is not frequency selective, so that oscillation can occur at more than one frequency simultaneously if conditions in the circuit are right.

The gain of a tunnel diode amplifier depends on the source and load conductance and the negative conductance of the diode. The expression for insertion power gain is:

$$K_{ip} = (G_L + G_S)^2 / (G_L + G_S - g)^2$$

Because of the squared terms small changes in any of the variables causes significant changes in the power gain.

Values of power gain with source and load conductance variations are indicated in the accompanying table for a device with 90 Ω input and output impedance, and a diode $-g$ of 20 mv. Insertion power gain is:

$$K_{ip} = (11.1 + 11.1)^2 / (22.2 - 20)^2 = 20 \text{ db.}$$

Mr. Krueger pointed out the importance of source stability with tunnel diode amplifiers as indicated by the table on page 4.

Changes in $-g$ caused by varying temperatures and different bias points are also important design considerations.

Temperature variations differ with different bias points. Other considerations may enter into a choice of bias point however.

In testing a germanium diode, for example, Mr. Krueger found that $-g$ was almost constant at 70 mv, although changes in $-g$ with temperature occurred at both higher and lower bias points. This suggests operating at 70 mv, however it was found that noise figure is degraded and higher sensitivity to bias voltage changes occurs at this bias point.

Mr. Krueger cited the large bandwidth resulting from low impedance in the device. Smallest bandwidth occurs with high gain, but high gain amplifiers are potentially unstable.

Instability arises from the one-port nature of the diode, which means that a variation in any parameter will have effects on all of the amplifier's characteristics.

Noise figure, he found, is dependent on source and load resistance and dc diode current. It does not appear to have the frequency dependence found in transistors.

Military Stake in Education Cited

The success or failure of the U.S. defense effort is determined by what happens in high schools—perhaps what happens in the fifth grade. This was the subject of a heavy-weight round table discussion on the military stake in education.

MIT's Dr. Zacharias said that high school children must be taught more about wave theory and mid-20th-century physics than is known to most of the people attending the convention, who are admittedly scientists and engineers of a professional caliber. This means, according to Dr. Zacharias, that it must be made digestible. This is a tough assignment, he said, since one must first understand it well.

Dr. Zacharias described a program in which he is involved, using every learning aid available, not just teachers. Kits, movies, and laboratory devices are used in this program.

Because the children who will be coming along 10 or 15 years hence will come up through the semiconductor route, physics will be much more important to them, he said. Therefore they have to learn some real physics and before the learning process can really be effective, these students must be motivated, he added.

Dr. Zacharias said the military has to support education just as much as it has to support an aircraft company's basic research or an electronics company.

Vice-Adm. J. T. Hayward agreed in general with Dr. Zacharias. He went on to say the Navy has several programs already in aiding education, citing the Naval Academy, the ROTC, and enlisted-men educational program. The Navy has not, however, faced up to the massive education problem. Far from being an item of cost to the defense effort, Admiral Hayward said that the cost of the loss due to lack of technically trained people is far greater than that of the program.

Maj. Gen. Marcus F. Cooper stated that the Air Force leans heavily toward on-the-job training and is committed to several WADD training programs. The problem in aiding education is a budget problem, General Cooper said. When the hand is put in the pocket for any program like this, one finds many other hands already there, he added.

Maj. Gen. Earl F. Cook cited experiments in which the Army supplied lesson plans intended for high-school graduates in the service to high-school students at various levels in the Fort Monmouth area. The results were successful.

Summing up, Dr. Zacharias noted that all the participants in the panel discussion agreed with the basic desire to aid education. He said he wondered, however, how much could be expected in this direction. The bogey-man of Federal interference is often raised, according to Dr. Zacharias. He noted, however, that 60 per cent of high-school students are using the same basic physics text. There seems to be plenty of room for variation under such a situation, and his conclusion was that just as much variation is possible under military aid to education. ■ ■



TAMING OF THE SCREW

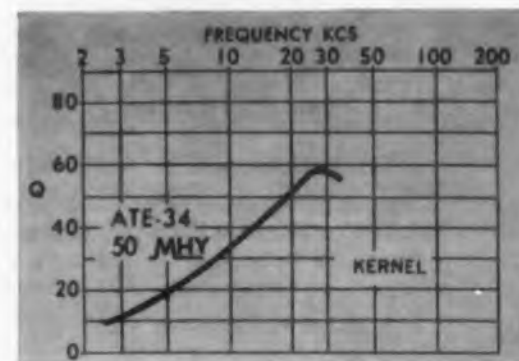
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CIRCLE 8 ON READER-SERVICE CARD

NEWS

CW, Non-Doppler Ranging System For Samos Measurement Will Go to 3,000 Miles With Accuracy Within 300 Feet, Philco Says

A CONTINUOUS-wave, non-doppler type ranging system will be used in measuring slant range to Samos reconnaissance satellites.

A system to provide the range measurement out to 3,000 miles with an accuracy of 0.05 nautical miles has been designed by Philco Corp.'s Western Development Laboratory, Palo Alto, Calif. Some details of the cw ranging system were disclosed at the recent National Convention on Military Electronics in Washington by Frank C. Lanza of the laboratory.

Several of the systems are being built and installed for use in the Samos program, and later in the Midas program. The laboratory is subcontractor to Lockheed Aircraft Corp. for the satellite package in both of these programs.

The planned system will use four low-frequency tones to modulate a telemetry carrier in the 1.5 to 2.5 kmc region. The low-frequency signals are synchronized and phase coherent. The modulated signals

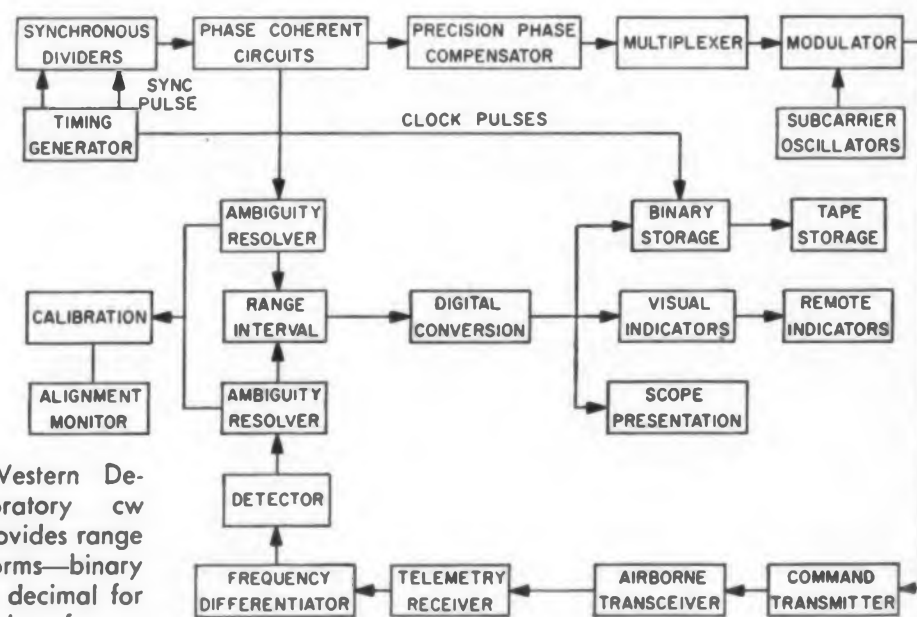
are sent to the satellite, and returned by a transceiver, so that the phase difference between the modulation of the returning signals and present modulation is proportional to the transit time and therefore the range to the vehicle.

Tracking will begin when the satellite comes within 3,000 miles of the station in slant range, and will continue over the station to 3,000 miles on the opposite side. Other instrumentation will be necessary to provide azimuth and elevation measurements.

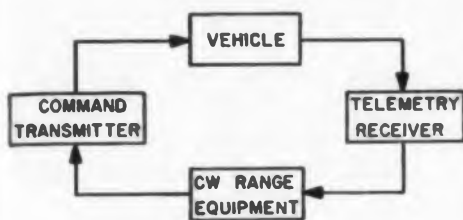
The lowest frequency tone is selected so that its period is longer than the round-trip transit time to the satellite at maximum range, plus the time added in the vehicle transceiver and by the range measurement equipment.

The highest frequency is selected to provide the accuracy required. For 0.05 miles the highest modulating tone must be about 25 to 30 kc, according to Mr. Lanza.

This choice means that phase stability must be held to about 4



Basic Philco Western Development Laboratory cw ranging system provides range output in three forms—binary for computer use, decimal for readout, and analog for an oscilloscope.



Cw ranging system using low frequency tones to modulate a standard telemetry link is achieved by adding the cw range equipment to the basic telemetry loop, as indicated.

degrees, which does not offer excessive circuitry problems, he explained. It also keeps required telemetry bandwidth well within 200 kc.

Intermediate frequencies, used along with the lowest frequency to resolve phase measurement ambiguities, should be separated as much as possible from the highest frequency. Practical compromise ratios between 10:1 and 15:1 are being used in the Samos ranging system.

To complete a range measurement the equipment must select the proper cycle of the highest modulating frequency for making the final phase difference measurement. The number of frequencies required to resolve this ambiguity is determined by the maximum range of the system and the highest modulating frequency selected.

The Philco system uses a specially designed temperature controlled crystal oscillator with stability of 2 parts in 10^6 . A synchronous frequency divider is used to provide the three lower frequency tones, so that stability of all four frequencies is the same.

Phase coherent circuits filter and phase lock the ranging tones to the desired phase angle. A precision phase compensator is used to compensate for the time delay in the range loop.

The phase locked, compensated tones modulate the subcarrier, which is fed to a multiplexer and command transmitter.

Prior to modulation the ranging tones are sent to an ambiguity resolver which selects the proper cycle of the highest frequency to start the range measurement. This proper cycle is the one which starts

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2N496	Switch	f_T -7.2 mc	very low V saturation, TO-1 case
2N1118	Amplifier, Switch, Control	f_{max} -8 mc	electrical equivalent of 2N495, TO-5 case
2N1118A	Amplifier, Switch, Control	f_{max} -8 mc	high beta version 2N1118
2N1119	Switch	f_T -7.2 mc	electrical equivalent of 2N496, TO-5 case
2N1428	Amplifier, Switch, Control	f_{max} -18 mc	low cost, high beta, TO-1 case
2N1429	Amplifier, Switch, Control	f_{max} -18 mc	low cost, high beta, TO-5 case

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(All TO-9 cases)

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2N1199	Switch	f_T -75 mc	superior temperature stability
2N1267	Med. Frequency Amplifier	f_{max} -43 mc	low beta (video amplifier)
2N1268	Med. Frequency Amplifier	f_{max} -43 mc	medium beta
2N1269	Med. Frequency Amplifier	f_{max} -43 mc	high beta
2N1270	High Frequency Amplifier	f_{max} -125 mc	low beta (video amplifier)
2N1271	High Frequency Amplifier	f_{max} -125 mc	medium beta
2N1272	High Frequency Amplifier	f_{max} -125 mc	high beta
2N1472	Switch	f_T -75 mc	very low V saturation
			superior temperature stability
2N1663	Switch	f_T -100 mc	superior temp. stability ... high beta

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NEWS

in synchronism with the start of cycles of all three lower frequencies.

The modulated rf signal is transmitted to the vehicle and returned to the sending station by the airborne transceiver. The signal is then demodulated and filtered to regain the ranging tones. An ambiguity resolver is used to select the proper high frequency cycle to terminate the range interval.

The interval which is measured is converted to a binary word, representing slant range, which is stored for use by a computer. This word is also converted to decimal form for readout and analog form for presentation on an oscilloscope.

Each range measurement can be initiated by a precisely timed sync pulse. When the range interval is added to the sync pulse time, a precise time of acquisition of the satellite is provided.

In order to provide useful positioning of potential military targets, both Samos and Midas satellites must be precisely located in time and space coordinates at the instant of taking a sighting—by TV photography in the case of Samos or by infrared in Midas. The sync pulse could conceivably be used to trigger a shutter for an instantaneous sighting, or to place some identifying timing signal in a continuous scanning infrared system.

There are several sources of potential phase-shift errors in the CW ranging system. These are the signal-to-noise ratio, doppler frequency shift, calibration error, propagation velocity changes, and random phase shifts, Mr. Lanza said.

An average correction of three degrees in phase is applied for the doppler shift, for example, with the sign of the correction changing as the satellite passes over the tracking station. This correction is sufficient to achieve desired accuracy.

Calibration errors depend on the resolution capabilities of the system and the accuracy of the precision phase compensators.

Special narrow-band filters are used to extract the ranging tones at the receiving ends, to greatly limit the noise bandwidth.

He also cited the potential use of cw ranging in space tracking applications, such as in moon shots. The low frequency requirement for the system limits the maximum feasible range to about 15,000 miles, because frequencies below a few cycles per second would be required to resolve ambiguities.

Possible methods for overcoming this problem are being investigated, and a system of range markers appears to be an attractive solution. No extra bandwidth would be required to add range markers to the modulating signals. ■ ■

Optical Maser Developed by Hughes Gives 10-KW Coherent Light Output

An optical maser capable of generating a coherent output in the visible light spectrum has been developed at the Hughes Research Laboratories, Culver City, Calif., by a group under the direction of Dr. Theodore H. Maiman.

The experimental device, dubbed a "laser" (Light Amplification by Stimulated Emission of Radiation) has been operated both as an amplifier and as an oscillator at red light frequencies (6943 angstroms). Peak outputs of 10 kw have been obtained at 1-msec pulses and operating frequency is thought to be tuneable over a band of 100 kmc. The device is about the size of a water glass.

The laser consists essentially of a chrome-doped ruby cylinder surrounded by a high-intensity gas-discharge light source. Polished disks near each end of the ruby cylinder interact with the cylinder to form a resonant cavity effect. Green and blue light in the output spectrum of the discharge tube excites the chrome ions above their ground energy state. The ions then undergo a non-radiative transformation to a lower, metastable energy state. In returning to the ground-energy state from this level, the ions emit coherent, visible light. Emission can be self-initiating, in which case the laser operates as an oscillator, or triggered by an input signal, as in a conventional master, so that amplification is obtained. Spontaneous emission continues, however, even in the amplifying mode, thus resulting in a noise temperature of 15,000 K.

Output is restricted to a band less than one angstrom wide at room temperature operation. At liquid nitrogen temperatures, laser bandwidth is narrowed by a factor of approximately 25. Noise temperature, however, is not appreciably decreased.

The output is highly coherent. Emission by all ions occurs in phase and the radiation is highly polarized. This permits focusing the output into extremely narrow parallel beams (less than 0.01 deg. wide) and suggests applications for the laser in light beam radars, space communications and high resolution optical instruments.

In addition to the resonant cavity type described, a traveling wave laser is also thought feasible. Both types can be designed for cw output. Peak power far higher than the present 10 kw is also thought possible. The present device is only one percent efficient and an improvement of 10 is believed feasible.

The laser was developed by Hughes under an entirely company-supported program.

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2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

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NEWS

NBS Accuracy Standards Called Inadequate

Speakers at Boulder Meeting Call for Revamping

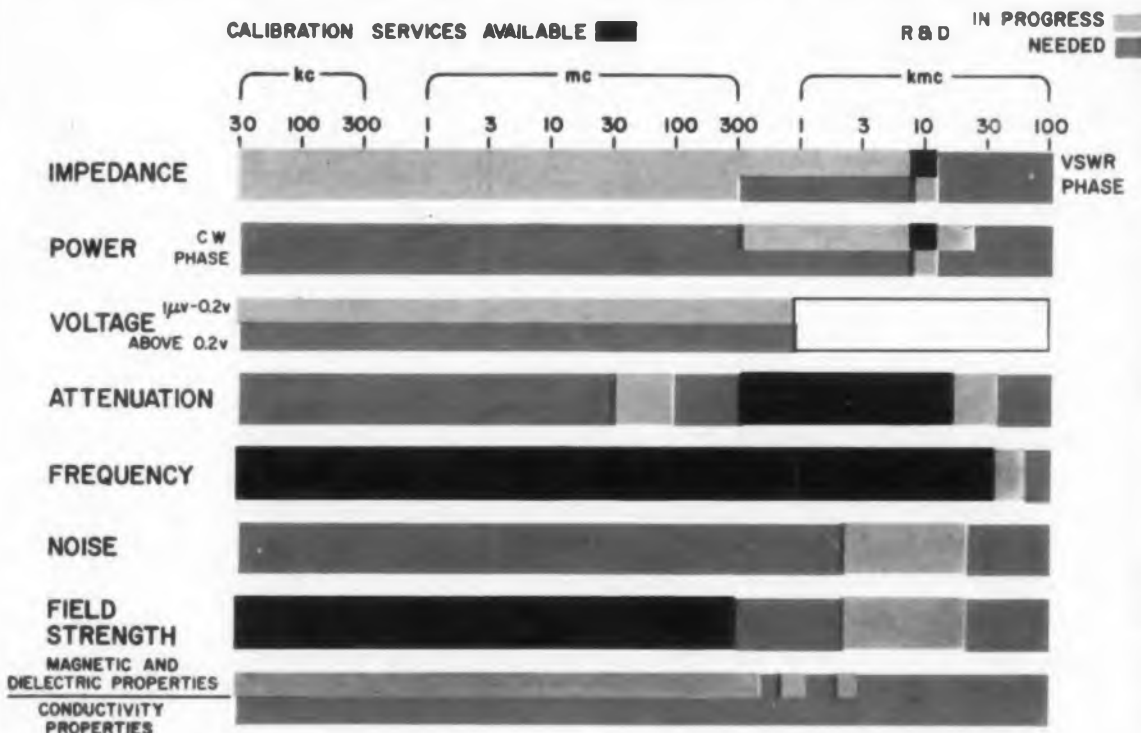
THE CALIBRATION needs of industry are in many cases far beyond the capabilities of the National Bureau of Standards, Sperry Gyroscope's Lloyd B. Wilson told the 1960 Conference on Standards and Electronics Measurements at Boulder, Colo.

Mr. Wilson, the first speaker at the three-day conference said that in metrology, many industries had been forced to adopt their own calibration standards. This, he said, would be acceptable if all

companies had the same procedures and equipment. But standards of each of hundreds of companies may not be compatible with each other or with the military, he said.

Compatibility Lack 'Frightening'

Referring to the lack of national compatibility, Mr. Wilson said it was "shocking, even frightening that we are building a space age technology on such shaky foundations." He cited recent Navy, Air





"Top accuracy standards are not always essential . . ."—Dr. A. G. McNish before 811 registrants at the NBS Conference on Standards and Electronic Measurements.

Force, EIA, and Aerospace Industries Association studies as having revealed urgent need for improved calibration and standards.

Losses in Time and Money

Part of the fault, he said the surveys showed, lay with the financial limitations imposed on the NBS. In one case, he told the convention, proper power-calibration services on the part of NBS would have saved several hundred thousand dollars. In another case cited, he said almost \$1 million could have been saved if 60- to 80-db attenuation calibration had been available for the Ku band with accuracy within a few tenths db.

Russian Creativity Stifled, But . . .

In the welcoming address to the conference, Dr. F. W. Brown, director of the NBS Boulder Laboratories, reported that in the USSR all standardization is under rigid, centralized control. During a recent visit, he said he saw great attention paid to standards and measurements. He said the Russians have five major R&D centers devoted to metrology and 100 calibration centers.

status of electronic standards at the Radio Standards Laboratory of NBS. For some parameters the status at specific frequencies may differ from the status across a band of frequencies. NBS should be contacted for exact information on calibration services available at specific frequencies.

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V_{CER}	40V	
V_{CBO}	75V	
$V_{BE SAT. (Max.)}$	1.3V	
$V_{CE SAT. (Max.)}$	1.5V	
I_{CBO} @ 25°C. (Max.) measured at 60V	25 μ A	



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CIRCLE 14 ON READER-SERVICE CARD

NEWS

This strict control and centralization, he said, may stifle creativity, but it brings results. "We don't work this way," he said, "so we have a great responsibility imposed on us."

Management must recognize the importance of a standards laboratory, Harvey W. Lance, of NBS Boulder said. It should provide adequate facilities, adequate equipment, and proper environment and should not be an adjunct to the tool crib, he told the meeting.

Mr. Lance decried the use of reference standards as working standards. Many companies have been forced to use their reference standards in the shop to meet accuracy requirements of equipment. In other cases, inadequate accurate "standards" have been used because there were none better.

In another presentation, Dr. Alvin G. McNish, chief of the metrology division of NBS-Washington, indicated that NBS-caliber standards are not always essential. He cited the case of six wooden meter sticks he had purchased at local hardware stores and calibrated against the NBS standard. At 20 C and 45 per cent R.H., their average error was 200 ppm. These meter sticks are certainly not acceptable as national standard, commented Dr. McNish, but as carpenters' tools they are perfectly suitable.

Dr. McNish challenged the position that in every case a standard must be 10 times as accurate as the instrument to be tested. This is often the case, said Dr. McNish, but in many cases a much smaller ratio can suffice. He showed that measurement accuracy normally doesn't suffer by a factor of 10 even when a calibration is traceable to a standard three echelons away.

During an evening session, Mr. F. L. Hermach, also of NBS-Washington, developed this concept further and showed that errors from different sources are rarely maximum in the same direction at the same time. Hence, the confidence limit of a calibration is not dictated by the sum of all possible contributing errors, but rather by the worst individual error, he said.

In another paper, Col. Richard F. Stolle of Wright-Patterson AFB used the analogy of the boy racing from a haunted house to dramatize the progress this country has made in standards and calibration. The boy had just broken the 4-minute mile when a pursuing bony finger tapped his shoulder and a spectral voice panted "That was quite a mile we raced."

"Yes," gasped the boy as he started to break his own record, "but it's that next mile I'm worried about."

"So it is with us," Col. Stolle said. "We've made a lot of progress, but it's that next mile I'm worried about." ■ ■

Pre-Planned Workshop Sessions Will Be Feature of WESCON

To augment the usual technical sessions at the August 23rd-26th Western Electronics Show and Convention in Los Angeles, special workshop sessions have been planned, according to Richard G. Leitner, Chairman of the Technical Programs.

Selected authors will be invited to participate in the WESCON workshop sessions, Leitner said. The workshops will be based on material developed during the morning sessions, and will include such subjects as "Stereo-Multiplexing Methods," Information Theory and Modulation Methods," and subjects on microminiaturization, air-traffic control, space science, and bio-instrumentation systems.

A series of four workshops, each three hours long, promises to be of particular interest. These are: "Management of Manned Machine Systems," R. L. Clark, Dept. of Defense, Moderator; "Analysis of Manned Machine Systems," Lieut. Col. Anthony Debbons, Rome (N.Y.) Air Development Division; "Synthesis and Design of Manned Machine Systems," D. T. McRuer, Systems Technology Inc.; "Operation and Training With Manned Machine Systems," J. Lyman, University of California at Los Angeles.

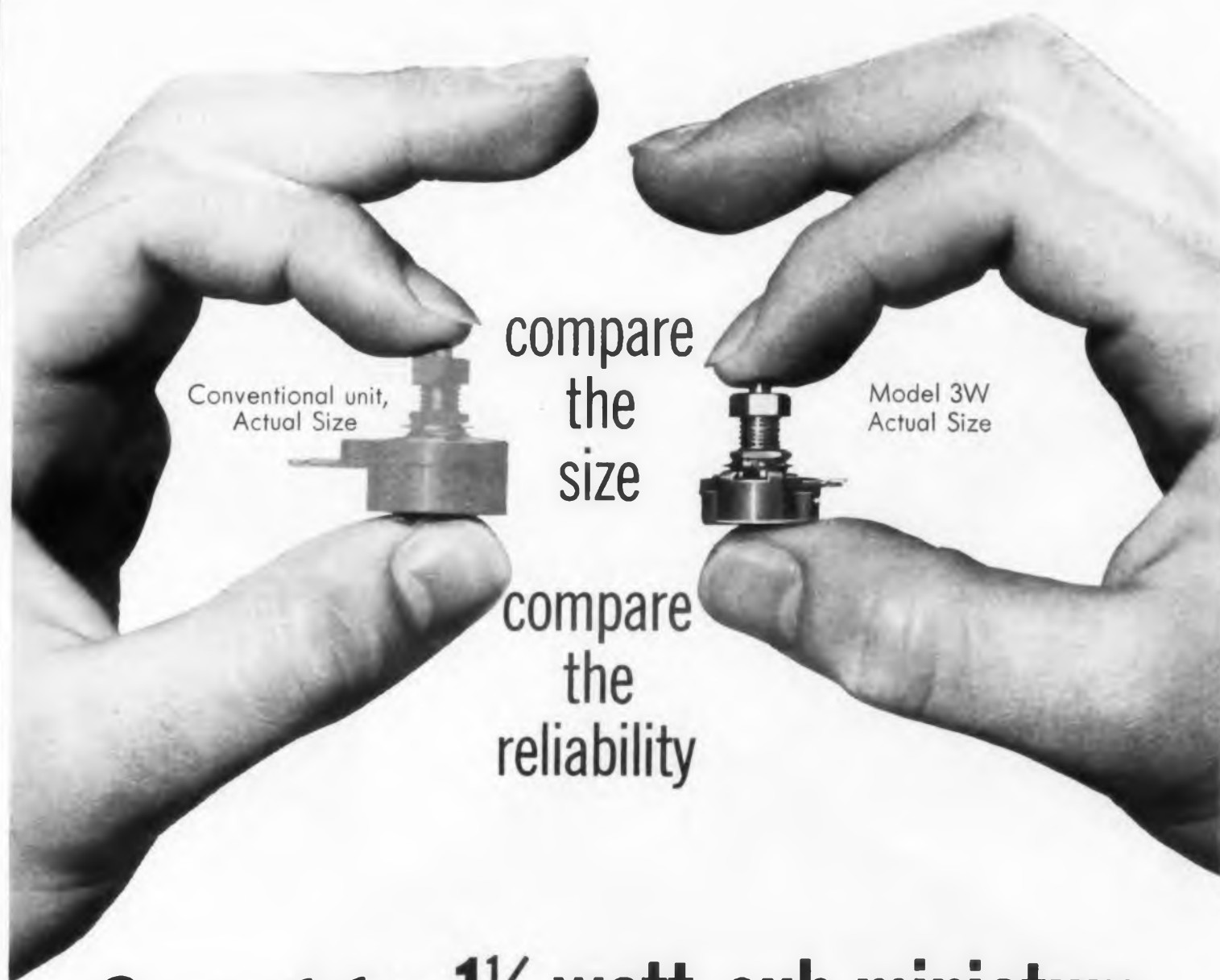
Purpose of the sessions, according to Mr. Leitner, is to enable the audience and speakers to go into greater detail on the subject material of interesting papers.

No Recruiting at Show

"There will be no recruiting at WESCON functions," WESCON manager Don Larson said. He reported that over 100 replies to letters sent out to exhibitors indicated unanimous agreement of WESCON's "no-recruiting policy."

Recruiting, the bane of electronic shows, suffered a blow with the mailing of 2,000 letters to principal exhibitors, signed by WESCON's Chairman, Walt Peterson. Response to this letter has been good, according to Mr. Larson. "We've had such wonderful response from companies," he said, "that we're sure recruiting at WESCON functions will be non-existent." There is no penalty attached to violation of the policy, Mr. Larson added. "It is strictly a gentlemen's agreement."

Careers Inc. will establish a "California Southland Careers Center" at the Shrine Auditorium about a mile from the WESCON location in the Los Angeles Sports Arena, reported Careers president William Douglass. As at IRE in March, Mr. Douglass takes the position that a career center does not run counter to show policy, since it keeps recruiting off the show grounds.



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Dimensions: $\frac{1}{8}$ " maximum diameter over encapsulation. $\frac{3}{16}$ " depth.

Shaft: 0.125" diameter stainless steel.

Terminals: Gold-plated nickel silver.

Resistance range: 4 ohms to 30K ohms $\pm 10\%$, linear taper.

Rating: 1½ watts at 40°C.

Complete specifications on the Model 3W variable resistor are given in CENTRALAB Technical Bulletin EP-891. Write for your free copy.

Centralab

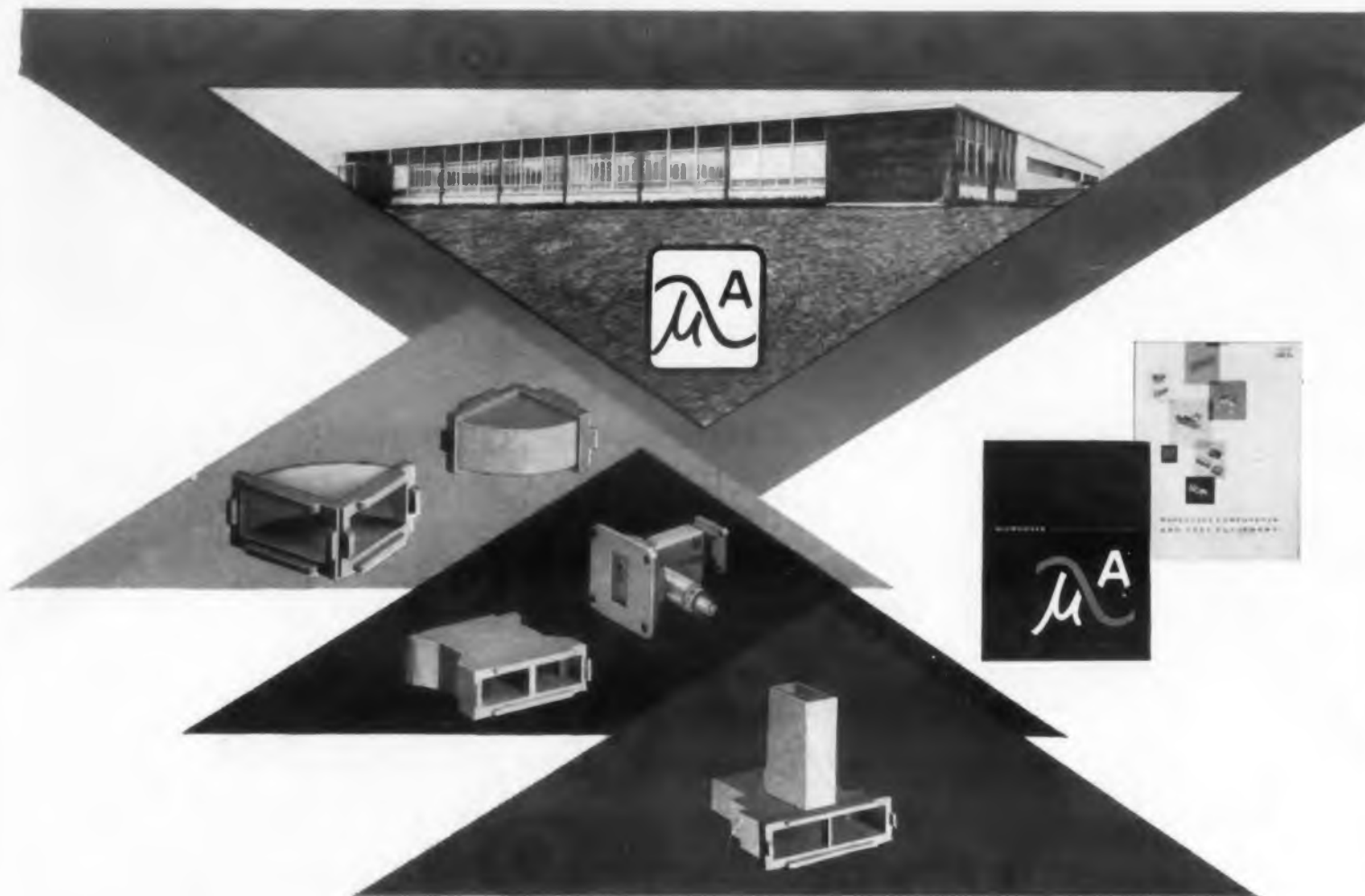
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New High-Power Varactor Harmonic Generators — excellent suppression of unwanted harmonics and record power levels are available from these solid-state harmonic generators.

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Two New Catalogs — Waveguide Components Short-form Catalog (CSF-60) gives data on over 500 items of waveguide components and test equipment.

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CIRCLE 16 ON READER-SERVICE CARD

NEWS

Navy Bureau of Weapons S

**Program Asks Industry's Help;
Classified Data To Be Available**

ELECTRONIC designers will benefit from a new program soon to be implemented by the Bureau of Naval Weapons for speeding the flow of design ideas from industry. Under procedures due to become effective by the year's end, qualified firms and individuals will be given access to classified documents spelling out the Navy's equipment needs, design problems and long-range planning.

In clearing its decks of previous dissemination schemes, BuWeaps has established the following objectives for its new Long-Range Scientific and Technical Planning Program:

- Keep scientific groups well-informed of the operational and technical problems confronting the bureau in planning and developing future systems.
- Encourage scientific groups to provide technical assistance to the bureau in order that more effective long-range research and development plans may be prepared.
- Promote the solution of specific technical problems of interest to the bureau.

Stimulate Navy-Industry Teamwork

Two categories of information will be made available under the program by the Bureau of Weapons. These are: (1) the Research and Development Planning Documents and (2) the Research Problem Document.

The Research and Development Planning Documents contain the Navy's long-range plans and requirements for weapons systems and for various technical areas. Weapons systems plans cover anti-submarine warfare, anti-air warfare, strike warfare, support systems and astronautics. Technical area plans cover such topics as radar, communications, navigation, weapons and mines countermeasures and fire control systems. Some of these classified documents (certain technical area plans) are available now; others are in preparation and will be ready in several months. All documents will be revised periodically.

Navy Wants Feedback From Industry

Recipients of the planning documents must, in return, provide BuWeaps with an analytical critique of the plans covering adequacy and feasibility, alternative approaches for improved performance and lower costs, and other relevant

Weapons Seeks New Design Ideas

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suggestions. This interchange between BuWeaps and industry will help designers by giving them an "inside" view on what the Navy really needs and help BuWeaps by subjecting its plans to intelligent evaluation by industry.

The Research Problems Document describes more than 150 specific needs for components, materials and devices. Among these are: a semi-flexible wave guide in half-wave sizes for missile fuzing applications; an electrical or magnetic shutter for IR fuzes; an electrically and acoustically silent battery powered motor; digital output transducers; and gyros for use time of one minute or less more reliable, cheaper and *less* accurate than present components.

The Research Problem Document carries no obligation for a critical analysis by its recipients. It is designed to elicit fresh approaches and ideas for the solution of specific technical problems. BuWeaps is *not* soliciting proposals or bids for R&D work on the problems outlined in the Research Problem Document. Rather, proposed solutions to a problem should be accompanied by "Test data or other evidence that an answer is in hand, or that a worth-while approach has been sufficiently explored to demonstrate a high probability of success."

How To Participate

To participate in the new BuWeaps program an applicant must:

- Have sufficient technical competence (as judged by the Navy) in the area involved.
- Possess or obtain security clearance to the appropriate level.
- Execute a Dept. of the Navy policy agreement relating to proprietary information, care of government-furnished documents and other related matters.
- Request the published list of Research Documents from BuWeaps.

A pamphlet describing the BuWeaps Long-Range Scientific and Technical Planning Program in detail is available from the Chief, Bureau of Naval Weapons (Code R-2), Washington 25, D.C.

Research Problem Documents can be obtained by persons or organizations with secret clearance upon request from the Chief, Bureau of Naval Weapons (Code RREN-14). ■ ■

You are protected against environment-caused switch failures

When you select a Hermetically-Sealed or Environment-Free switch made by Control Switch Division, you have chosen from the most respected line of sealed switches in the industry.

Now, we aren't claiming to be the "official guardians" of your design... your performance... your reputation... And yet—the failure of a single switch could wipe out a lot of your long, hard work and planning. So, when you need a switch with performance you can depend on under any unusual environment, give careful consideration to these advantages:

Hermetically-Sealed... for use in the most critical, or unknown, environments these switches are completely sealed against all contaminants, atmospheric conditions and altitude changes. Every unit is backfilled with a dry, inert gas and inspected with a mass-spectrometer to a leak rate limit of less than 1 micron cubic foot per hour at one atmosphere. No switch could be more perfectly sealed.

Environment-Free... various seals are used, according to the environmental conditions expected. They are usually sealed against humidity, fumes, dust, oil, and general contaminants. The switches are miniaturized to save vital space and weight. Conforms to MIL-S-6743 and MIL-E-5272A.

And if you do not find the exact switch you need among our hundreds of standard models, we can design and produce a unit to meet your specific requirements.

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90%
smaller
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SYLVANIA MICRO-MIN DIODES

*offer microminiaturization
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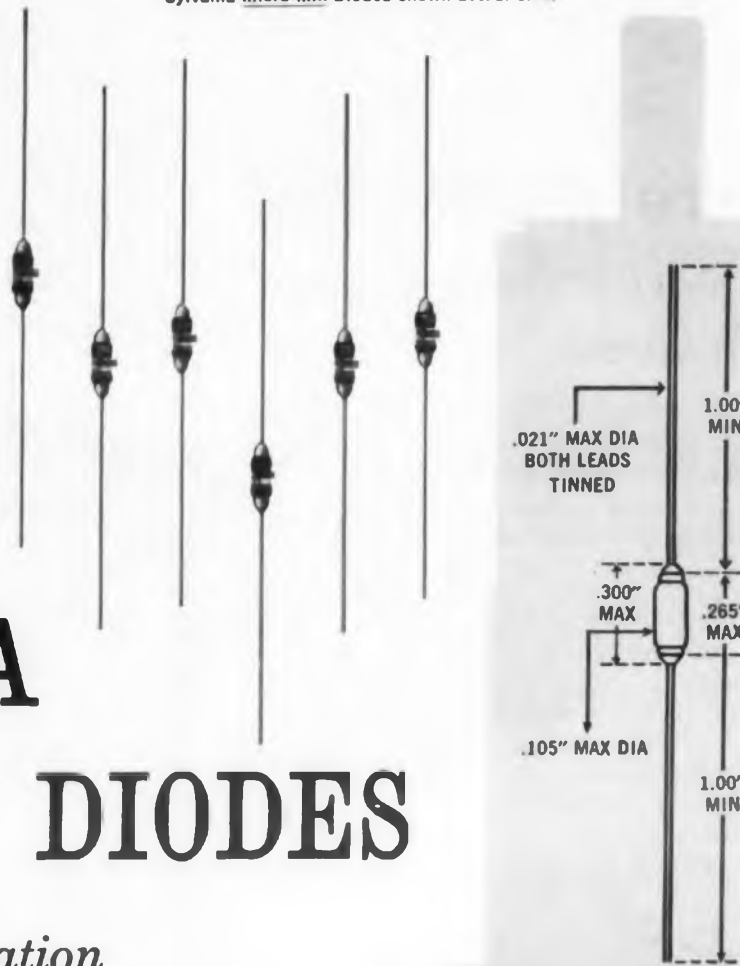
One-tenth the size, one-tenth the weight—90% smaller than their prototypes—Sylvania Micro-Min Diodes extend design possibilities where microminiaturization and reliability are essential to microwave equipment.

Sylvania Micro-Min mixer and detector diodes feature true hermetic seals . . . withstand temperatures of -55°C to $+150^{\circ}\text{C}$. . . meet MIL-S-19500B environmental specs for shock, vibration, lead fatigue, acceleration, moisture resistance, soldering and temperature cycling.

New packages—even smaller than Micro-Min Diodes—are now under development at Sylvania! Our engineers can work with you in developing new microminiaturized equipment. Contact them.

If your present design requirements are for exceptionally small size, extremely lightweight and maximum reliability, specify Sylvania Microwave Micro-Min Diodes. For price and delivery information, contact your Sylvania Field Office or your local franchised Sylvania Semiconductor Distributor. For technical data on specific Sylvania Micro-Min Diodes, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 187, Woburn, Massachusetts.

Sylvania Micro-Min Diodes shown actual size.



MICRO MIN TYPE	APPLICATION	PROTOTYPE
1N830	UHF Detector	—
1N830A	UHF Detector	—
1N831*	S Band Mixer	1N21C*
1N831A*	S Band Mixer	1N21E*
1N832*	X Band Mixer	1N23C*
1N833	X Band Video Detector	1N358
1N918	Ku Band Mixer	1N78

*Available in Matched Pairs

Photo shows Sylvania Micro-Min Diode as used in TRI-PLATE® detector module designed by Sanders Associates, Nashua, N. H. This device illustrates how easily Sylvania Micro-Min Diodes can be integrated into a modular construction.



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NEWS

Five States Testing Infrared Traffic Control

INFRARED detectors for use in traffic analysis and speed control are now being tested in five states.

The infrared traffic detectors are being produced by Infrared Industries, Inc., Waltham, Mass., and distributed by the Eagle Signal Co., Moline, Ill.

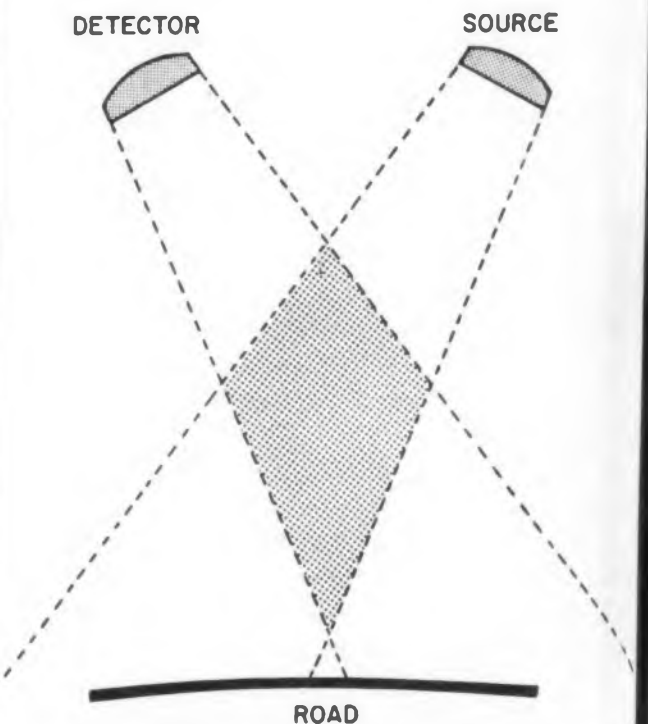
In operation the detectors are mounted over a lane of traffic, providing coverage for a lane of 12 to 14 feet wide, according to Norman C. Anderson, Infrared Industries vice-president.

Infrared equipment has an advantage over pneumatic tubes for counting automobiles because of the short life of rubber tubes across a busy roadway. At least two years of maintenance-free operation is expected. Light-source replacement can be made with a small plug-in package.

The infrared traffic detector has an advantage over radar in some traffic analysis applications because of its ability to spot stalled as well as moving automobiles.

Two infrared traffic detectors, either in a single package or in two units, can be combined to establish speed and direction of traffic, and also to indicate length of vehicles if needed.

Each device consists of an infrared source and a detector. The optics beam source radiation to-



Opened infrared traffic detector shows source, right, and detector, left.

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Infrared traffic detector is shown mounted on an overpass surveying the lane of traffic below.

ward the highway below. The detector's field of view is restricted so that the beam is reflected to the detector only when a vehicle enters the detection field. The device is adjusted so that the highway itself does not reflect the beam.

The possibility that extraneous radiation might excite the source is minimized by proper selection of optics and detector wavelength sensitivity. Further protection is provided by chopping the beam with a motor-driven perforated disk and making the detector circuits sensitive to this modulating frequency.

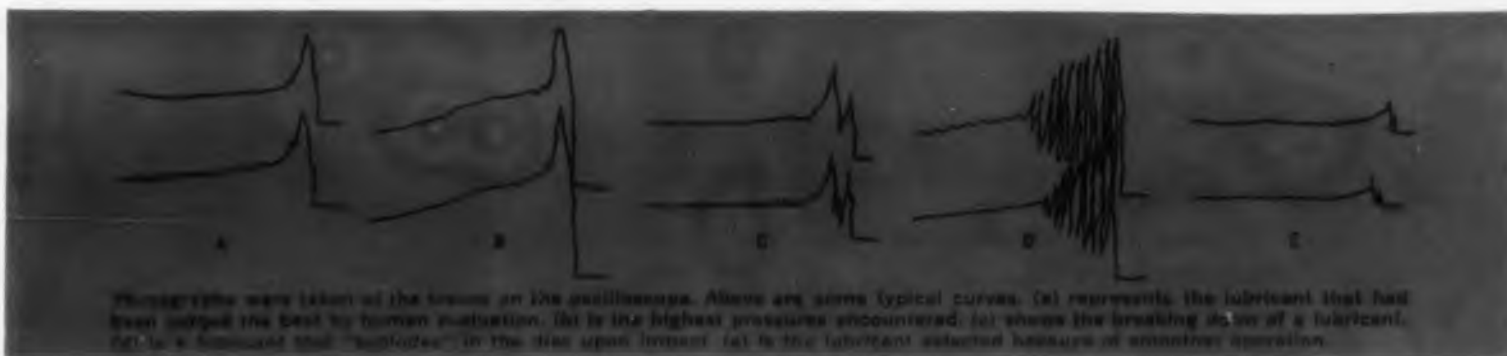
The output of the detector is transmitted to a central station where it is traced on a recording device.

Initially costs of the infrared installations are comparable to radar, according to Mr. Anderson. In fairly small quantities each unit might cost about \$500, with prices going lower for volume orders.

Present installations are in Illinois, Michigan, California, Massachusetts and Connecticut.



Source and detector optics are aligned so that an object passing over the road below the infrared traffic detector reflects the beam to the detector. The road itself does not reflect the beam because it is below the volume of coverage of the device.



Photographs were taken of the traces on the oscilloscope. Above are some typical curves. (a) represents the lubricant that had been judged the best by human evaluation. (b) is the highest pressure encountered. (c) shows the breaking down of a lubricant. (d) is a lubricant that "bubbles" in the die upon impact. (e) is the lubricant selected because of consistent operation.



Transducer set up for testing lubricants under actual cold-extrusion process on large press.

ENDEVCO TRANSDUCER

EXTENDS THE LIFE OF A HIGH-PRESSURE EXTRUSION PRESS

At its plant in Elgin, Illinois, Flexonics Corporation, manufacturers of flexible metal tubing and hose, employs a large press for the cold extrusion of metal parts. This press operates at high, critical pressures (up and beyond 300,000 psi). The key to its efficient operation and life span is the lubricant used.

Problem: The choice of lubricant was generally determined by the sound and feel of the press while in service. As extrusion problems became more complex, a better way of selecting the proper lubricant was needed.

Solution: Flexonics engineers hooked up an ENDEVCO PRESSURE PICKUP with an oscilloscope to compare the performance of lubricants under actual working conditions. Out of 20 lubricants tested, one proved to be superior, which had not been considered under the "sound and feel" method of evaluation. It is now being used exclusively. At the same time, the Endevco instrumentation divulged other valuable information as to correct press speed, and the optimum design of tools and dies. Endevco piezoelectric transducers and amplifiers are available for environmental, flight, shock, impact testing; design studies, control applications, and many others. Write for literature.

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CIRCLE 18 ON READER-SERVICE CARD



THE RAW MATERIALS OF PROGRESS

FC-75 SHOCK-PROOFS "HI-FI SET" FOR ATLAS MISSILE



The Atlas climbs toward outer space! Inside, a delicate instrument—an inertia compensated telemetering device, shown left—is at work. Manufactured by the Speidel Corporation of Providence, Rhode Island, this sealed unit contains a continuously operating magnetic tape recorder that is capable of reporting, via telemetry as required, pre-selected conditions that a missile might encounter, i.e.: temperatures, strains, stresses, vibrations, air pressures.

The problem: find a protective "cushion" that will isolate the telemetering device from the missile's violent motion and even a fall to earth, yet permit it to operate accurately and with great sensitivity.

The answer: 3M Brand Fluorochemical Inert Liquid FC-75. Why? FC-75 protects the tape and all associated moving parts of the tape transport from vibrations, shocks, acceleration. And, at the same time, FC-75 remains stable over the entire temperature span of the missile's effective range. It has a pour point of less than minus 100°F., will not break down even at 750°F.

Furthermore, FC-75 undergoes no chemical or electrical changes. It is completely compatible with various materials such as metals, plastics, elastomers, even above the maximum practical temperatures permissible with other dielectric coolants. Therefore, it will not attack the recording tape or any other part of the telemetering mechanism.

FC-75 is ideally suited for many uses in the field of missiles and rocketry because it is nonexplosive, nonflammable, nontoxic, odorless and noncorrosive. It is one of 300 specialty chemicals from 3M serving industry and country. For complete performance characteristics, write today, specifying area of interest to: 3M Chemical Division, Dept. KAP-70, St. Paul 6, Minnesota.

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CIRCLE 19 ON READER-SERVICE CARD

NEWS

Shipboard Digital Computer Is Keystone of ASROC System

ASROC, the Navy's new anti-submarine Sunday punch, utilizes the first shipboard electronic digital fire-control computer. It was developed especially for the ASROC project by Librascope, Div. of General Precision, Inc.

ASROC was successfully tested and evaluated at sea last month by the Navy and fired publicly for the first time (*ED*, July 6, p 8). The computer is a completely transistorized circuit employing silicon transistors throughout.

The unit was designed to give maximum reliable performance under shipboard conditions with minimum maintenance. This goal apparently has been achieved, since test evaluation personnel have reported no failures in more than 15,000 hours of operation.

The computer collects and handles target information; performs the mathematical calculations of establishing target course, range, and speed; and computes the ballistic path. It thereby frees command and operating personnel for evaluating tactical situations and making final attack decisions.

Because the computer is a general-purpose circuit, it can be readily modified to accept new data developed from changes in the characteris-



The ASROC fire-control system is the first shipboard installation of a digital computer. Scopes are retouched in this photo since ranges and trajectory are classified information. Computer receives data on target course, speed, bearing, and distance, as well as attack ship's course, speed, pitch, and roll. From these and other data, the computer predicts future position of target, launcher angle, and distance missile will fly.

tic of the weapon system. Thus, if the missile payload or warhead is changed, or if new attack tactics are necessary, the computer can be programmed accordingly. Even more important is the possibility that the computer might be used for other shipboard weapons systems.

The ASROC missile itself is a small, relatively inexpensive part of the system. With improved detection gear and tracking devices, it can be fired over greater ranges than those now used. At present, it is only as good as the tracking gear aboard ship; as this improves, so does the missile.

Honeywell 800 Digital Computer Heart of Navy Training Center

A Honeywell 800 digital computer will be the heart of a \$3.6 million nuclear submarine training center being developed by Minneapolis-Honeywell in New London, Conn. The computer will be used by the Navy to simulate electronically full-scale naval battles.

Use of the computer, together with advanced electronic techniques, Navy officials said, will enable the center to provide "a startling degree of realism" in waging mock sea battles to train the crews of submarines in undersea warfare.

The computer, while generating the motion of an ocean full of ships and taking into account the particular characteristics of each type of ship, also will calculate the action of the various weapons. In the case of the homing torpedo, for example, the computer will simulate the search and attack of the torpedo homing onto its target.

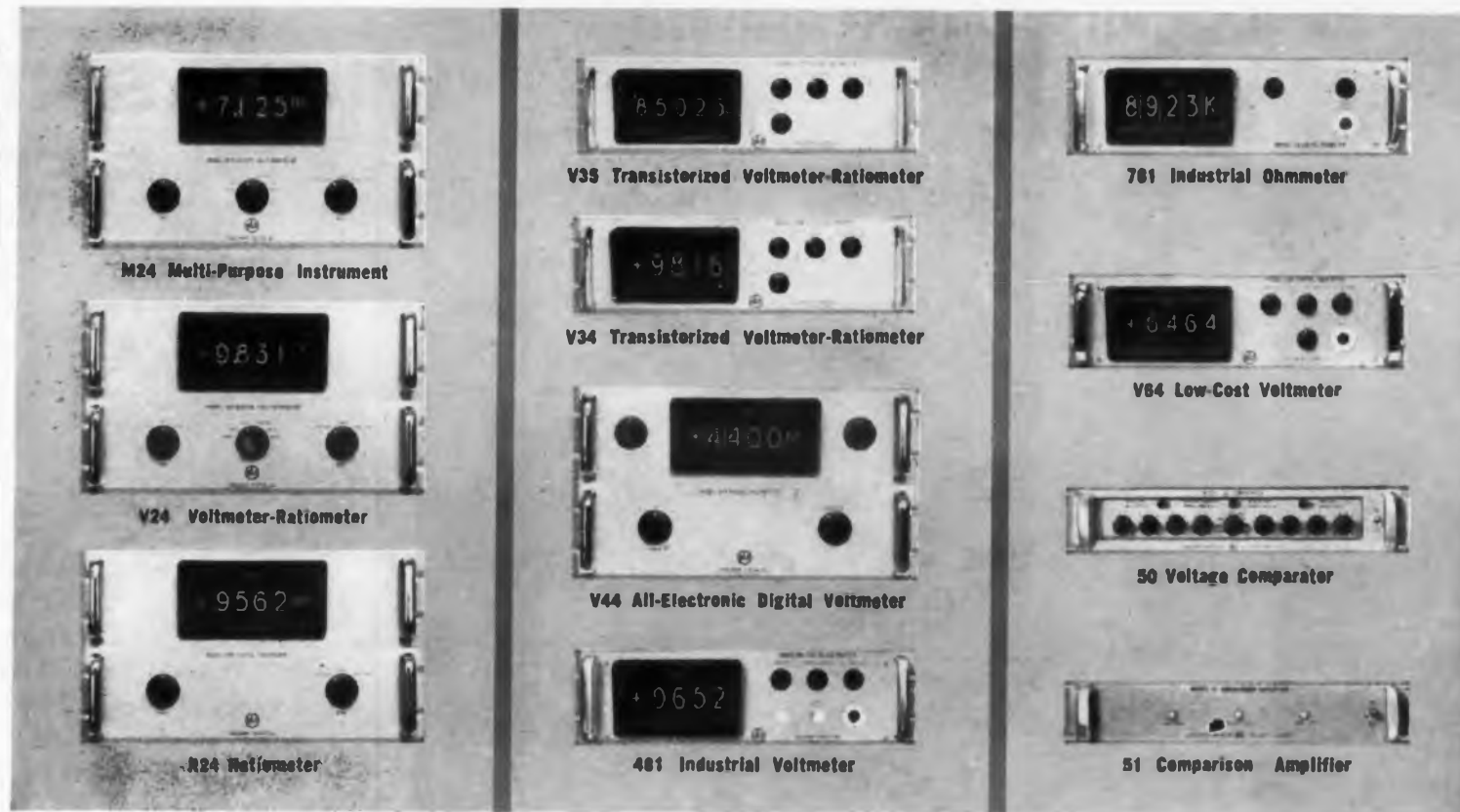
The trainer will occupy an entire wing of a three-story building at the Navy's Submarine School. Within the facility, the attack centers of three nuclear submarines will be duplicated to the minutest detail. Radar and sonar screens at the command posts of the submarine will show the maneuverings of many ships in the complex movements of a sea encounter.

Periscopes for each sub trainer will simulate the view of targets on the surrounding horizon as seen from the periscope of a submerged submarine.

Each target, actually a tiny model on a mock sea viewed by closed-circuit TV, will be automatically positioned to present the correct aspect to the periscopes.

In addition to the simulated submarines, the training facility will have a master instructor's console where training problems can be presented to evaluate new tactics and crew performance.

The changing tides of the encounter will be projected on a giant screen in a War Game Room where all phases of the action will be monitored.



OFFERS YOU THE ONLY COMPLETE LINE OF DIGITAL INSTRUMENTS... BY PURPOSE... BY PRICE

M24 Multi-Purpose Instrument — Measures DC voltage from ± 0.001 to ± 999.9 , DC voltage ratio to ± 9999 , resistance from 0.1 ohm to 1 megohm... 1/3 second balancing time... with accessories, measures AC voltage or AC ratio, low-level DC... completely automatic... output for data logging... transistorized circuitry, mercury-wetted relays... recommended for measuring and data logging demanding best combination of reliability, accuracy, speed and versatility — missile systems checkout, industrial electronic systems, unattended data logging, quality control, laboratory uses. **Complete \$5,650**

V24 Voltmeter-Ratiometer — Same basic features, specifications and applications as the M24 except it does not measure resistance. **Complete \$4,950**

R24 Ratiometer — Measures DC ratio with ranges of $\pm 9999/9.999$... same basic features and applications as M24 and V24. **Complete \$4,650**

V35 Transistorized Voltmeter-Ratiometer — This all-transistorized instrument is the first true 5-digit voltmeter with the Factual Fifth Figure, full 5-digit resolution of 0.001%... measures DC voltage from ± 0.0001 to ± 999.99 , DC voltage ratio from ± 0.0001 to $\pm 99.999\%$... with accessories, measures AC voltage low-level DC... completely automatic... features No-Needless-Nines logic, plug-in oil-bathed stepping switches... output for data logging... recommended for uses requiring maximum accuracy such as automatic missile checkout; production line inspection of transistors, resistors, diodes; readout and printout for computers. **Complete \$3,750**

V34 Transistorized Voltmeter-Ratiometer — 4-digit quality and performance companion to V35 — with No-Needless-Nines logic, plug-in oil-bathed stepping switches and full transistorization... measures DC voltage from ± 0.0001 to ± 999.9 , DC voltage ratio from $\pm 0.001\%$ to $\pm 99.99\%$... with accessories, measures AC voltage, low-level DC... output for data logging... designed for uses requiring Series 30 reliability without the need for full 5-digit resolution. **Complete \$3,150**

V44 All-Electronic Digital Voltmeter — 500 readings per second... measures DC voltage from ± 0.0001 to ± 999.9 ... completely automatic... output for data logging... recommended for applications in which exceptionally high speed is essential. **Complete \$6,500**

481 Industrial Voltmeter — This 4-digit instrument is an outstanding value for applications requiring 0.01% accuracy at lowest cost... designed for visual readout only, does not contain printout connections or oil bath switches... features simple, time-proved 7-tube circuit... measures DC from ± 0.001 to ± 999.9 — AC and low-level DC with accessories... for applications requiring 0.01% accuracy without printout — production testing, instrument calibration, laboratory testing, receiving inspection. **Complete \$1,425**

781 Industrial Ohmmeter — Companion to the 481, this 4-digit ohmmeter equals the performance of other units costing twice as much... measures 0.1 ohm to 10 megohms... accuracy of $\pm 0.05\% + 1$ digit, $\pm 0.1\%$ of reading above 5 megohms... 20 times faster than using a Wheatstone bridge... completely automatic... used for fast, easy resistance measurements not requiring printout, such as receiving inspection, production, quality control, laboratory testing. **Complete \$1,425**

V64 Low-Cost Voltmeter — Only full 4-digit voltmeter in the price range of 3-digit meters and laboratory quality pointer meters... measures DC voltage from ± 0.001 to ± 499.9 ... AC and low-level DC with accessories... features quality NLS construction, design simplicity, time-proved circuitry... designed for measuring applications that require the speed, ease, and accuracy of a digital voltmeter without the need for printout or automatic range-polarity selection... applications include transducer and test equipment calibration, quality control, production line and receiving inspection, laboratory uses. **Complete \$985**

50 Voltage Comparator — This transistorized go/no-go voltage comparator provides a precise, fast, reliable means to determine if a voltage is within prescribed limits — and to transmit go/no-go commands to electrical recording control and warning systems... signals voltage tolerance by colored bulbs and contact closures within 90 milli-seconds... manual limit settings from ± 0.001 to ± 999.9 volts. **Complete \$1,775**

51 Comparison Amplifier — Automatic comparator model for applications where limits are already available in analog voltage form from fixed or automatically programmed voltage dividers... voltage range from -50 volts to $+50$ volts with a limit sensitivity of 500 microvolts. **Complete \$950**

Hundreds of Combinations

A wide range of accessories are available from NLS for easy, plug-in combination with the basic units pictured. This provides you with several hundred combinations from which to select the grouping which best answers your measuring and data logging problems.

- AC/DC Converters with or without automatic ranging
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- Data Printers
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- Flexowriter Systems
- Electric Typewriter Systems
- Tape Punches
- Output to operate almost any device requiring contact closures in parallel decimal form.

For Additional Information... contact your nearest NLS representative or write NLS for complete catalog section on specific instruments of interest to you. Specifications and prices are subject to change without notice.



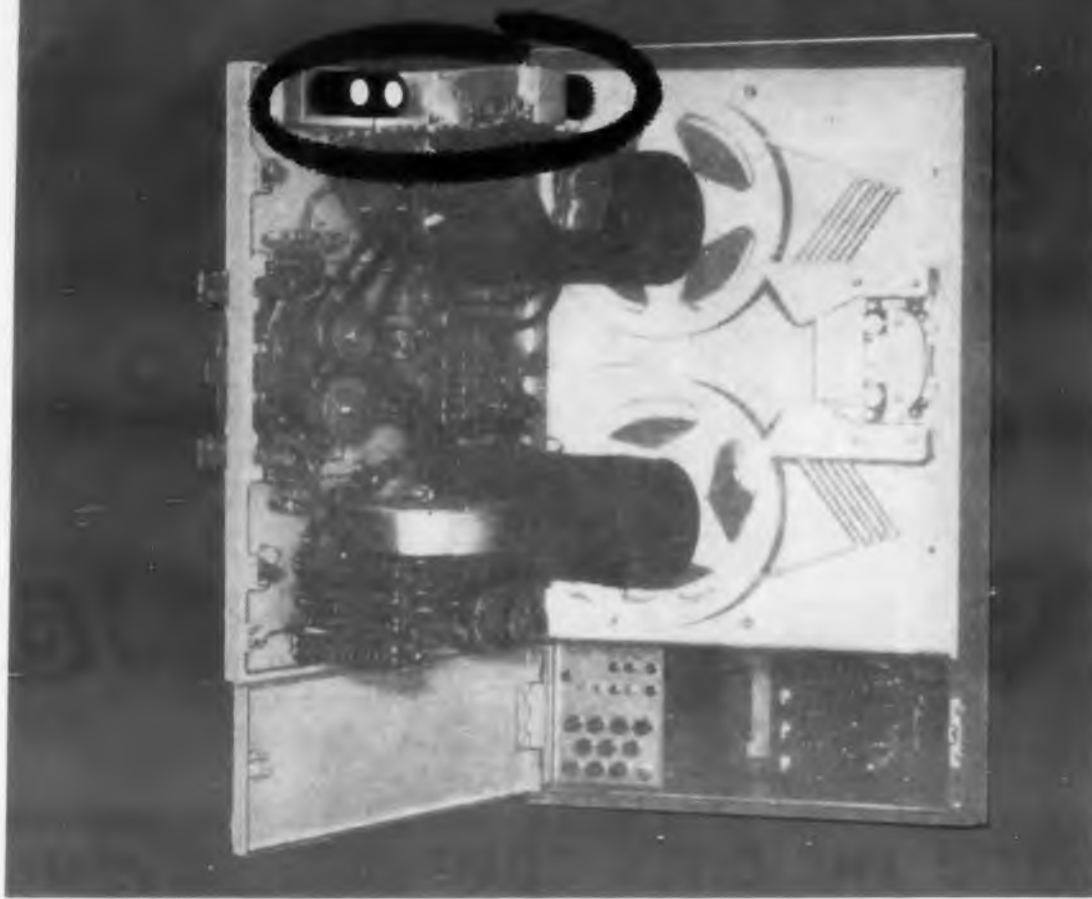
Originator of the Digital Voltmeter

non-linear systems, inc.

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CIRCLE 20 ON READER-SERVICE CARD

Do you need STABILITY?



Potter Instrument Company design engineers had a requirement for a power resistor on their new hi-speed Model 906II Digital Magnetic Tape Handler; they specified Dalohm Type PH Resistors.

Why? . . . Because Dalohm PH resistors meet all tough requirements and provide the most important feature—**INHERENT STABILITY.**



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Better things in
smaller packages
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1328 28th Ave., Columbus, Nebr.

TYPE PH RESISTORS

• WIRE WOUND

• POWER • PRECISION

These rugged Dalohm resistors are ideal for power applications that also call for precision tolerances. Mounting is through hole in chassis for maximum heat dissipation.

- Rated at 10, 25 and 100 watts.
- Resistance range from 0.1 ohm to 60K ohms, depending on type.
- Tolerances $\pm 0.05\%$, $\pm 0.1\%$, $\pm 0.25\%$, $\pm 0.5\%$, $\pm 1\%$, $\pm 3\%$.
- Temperature coefficient 20 P.P.M.
- Operating temperature range from -55°C . to $+275^{\circ}\text{C}$.
- Welded construction from terminal to terminal.
- Sealed in silicone in a radiator finned black anodized aluminum housing.
- Small in size; ranging from $1\frac{3}{8}'' \times \frac{1}{2}''$ dia. to $3\frac{3}{4}'' \times 1\frac{3}{4}''$ dia.

For complete information request
Bulletin R-36

WASHINGTON REPORT



Ephraim Kahn

GOVERNMENT USE OF COMPUTERS is described in detail in the Budget Bureau's first annual automatic data-processing inventory, which lists most agencies that use computers, their locations, and the models that they have or want. (In some cases, agencies may not have decided, and these are indicated, too.) The inventory, which covers fiscal 1959, does not make the Budget Bureau feel that it can identify actual trends in computer use on the basis of a single year's report. It notes, however, that possible future trends may be recognizable in the agencies' forecasts of need and use for fiscal 1960 and 1961.

TIPS ON COMPUTER USE have been given to government agencies by the Budget Bureau. It has outlined to agency heads the kinds of data and use studies that should be made before automatic data-processing systems are selected and installed. It has also noted that "suitable presentations, orientations, and briefings have proved of considerable value" in convincing Cabinet-level officers of the justification of such major expenditures.

TOUGHER INVENTORY CRITERIA for items to be kept in the military's mobilization reserve have been established by the Defense Department. Electronics' items do not appear likely to be heavily affected. Support of "operational effectiveness under combat conditions" will govern selection of mobilization reserve stocks. This is to include essentials for survival of personnel, for the effectiveness of combat forces (and their supply), and items which would shut down or seriously impair the operations of weapons systems or essential equipment if they were not available.

MILITARY BUDGET FOR FISCAL 1962—almost a year away—is already in the first planning stage. Odds are that the military's fiscal planners will be confronted with some tough decisions. As things stand, it will cost more to maintain today's manpower in years to come. There's no reason to expect any significant drop in equipment prices. On the contrary, conservative planning dictates allowance for a moderate inflationary factor as well as for cost hikes that are attributable to new and more complex weapons systems. Unless the military budget is increased, it looks as though a choice will have to be made between cutting manpower and trimming weapons.

◀ CIRCLE 21 ON READER-SERVICE CARD

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MORE ELECTRONIC INTERFERENCE with civilian airspace users is sure to result from the growing complex of electronic air defense control systems and from good-sized maneuvers, according to Maj. Gen. M. A. Preston of the Flight Operations Office of the Air Force. Efforts will be made, of course, to minimize interference with civil air operations. But some is inevitable.

SUBSTANTIAL SAVINGS will stem from joint studies of problems in Air Force procurement made by the Air Materiel Command, the Electronic Industries Association, the Aerospace Industries Association, and the National Security Industrial Association. Biggest changes are expected in pricing, auditing, and application of the make-or-buy policy—the three areas which came under heaviest fire from industry during industry-military conferences.

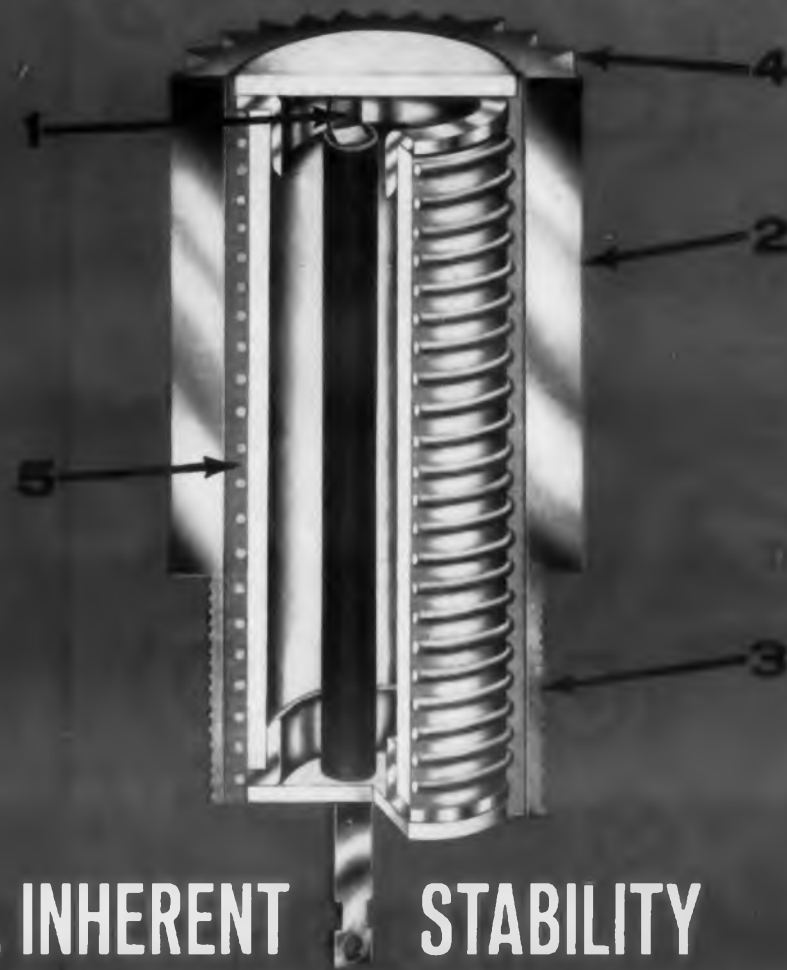
USE OF GOVERNMENT-OWNED FACILITIES in defense production will probably get a searching and broad probing by a House Armed Services Subcommittee. The Budget Bureau has stressed that use of privately owned plants and equipment in working on government contracts is preferable to using government facilities. In fact, the Army and Navy were told how to weight contracting proposals so as to take into account certain apparent cost-savings that occurred when government plant was to be used.

WEAPONS SYSTEM CONTRACTING is defined by the Senate Preparedness Investigating Subcommittee. In a report on the B-58 "Hustler" bomber, the group asserts that "the compelling pressure of time" was the "most important reason for the swing toward a single weapon system manager." The report also asserts that this particular weapon system program "could not have been implemented under the outmoded methods of development and production utilized on previous programs not under the management weapons system concept.

PROGRESS IN MILITARY SUPPLY MANAGEMENT—in the direction of purchase by a single agency of related classes of items—is noted by the House Committee on Government Operations. Electrical and electronic products invite single management, the report notes, "because of the vast number of items, the high dollar value of procurement and inventory, the rapid obsolescence of equipment and associated parts, its vital relationship to communications and the operation of most new weapons, the large and rapidly growing technology, and the important industries that supply the items." The document notes that within those classes fall about 25% of the 3.6 items in the military supply systems, that \$1.5 billion a year is spent to buy them, and that inventory is worth \$2.5 billion all told.

CIRCLE 21 ON READER-SERVICE CARD >

Here's How DALOHM Achieves ...



... INHERENT STABILITY In PH TYPE RESISTORS

Stability is inherent in DALOHM resistors because of advanced design and careful workmanship.

CHECK THESE DESIGN FEATURES:

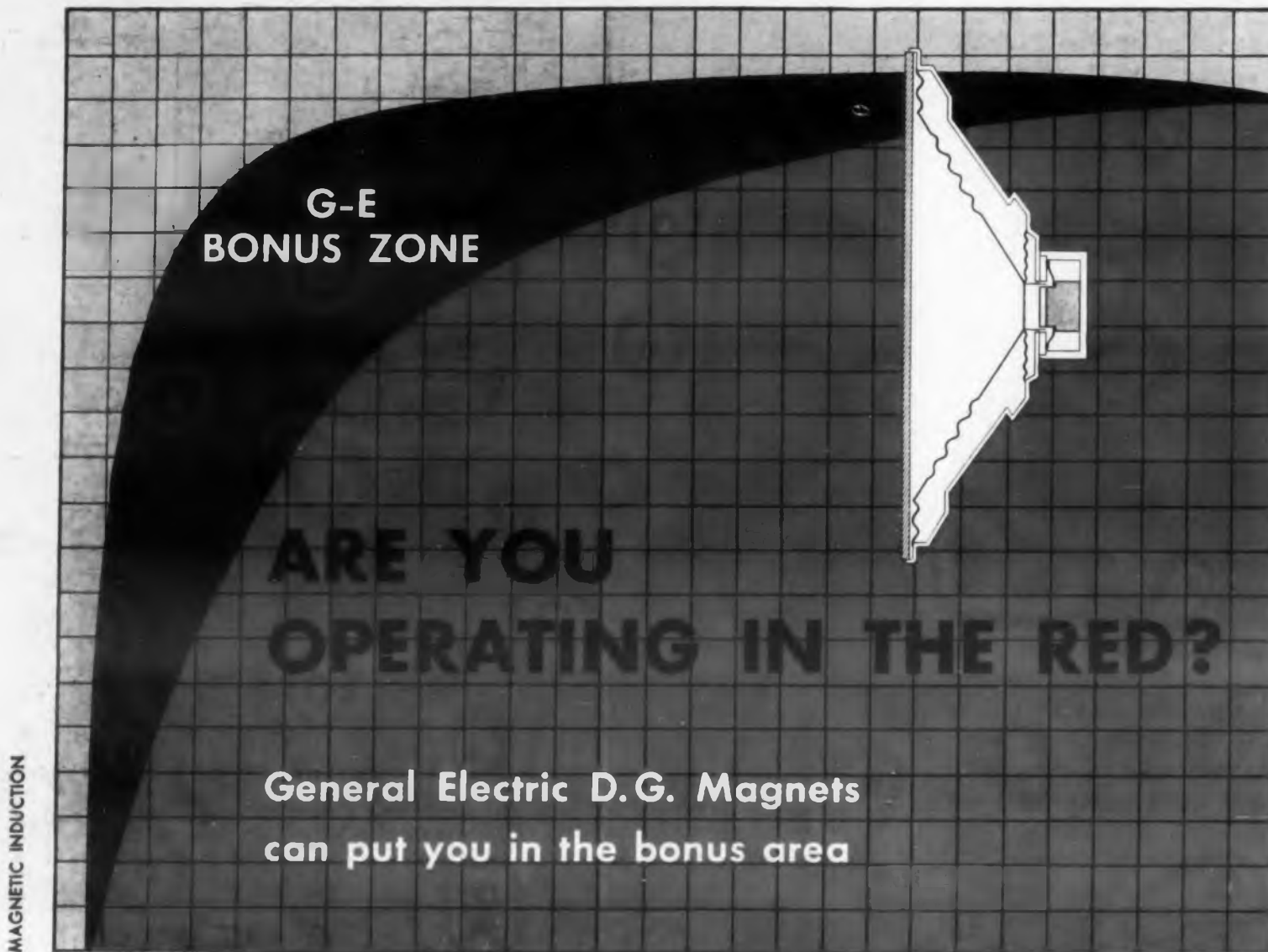
1. Complete welded construction from terminal to terminal.
2. Black anodized aluminum housing rapidly dissipates heat through chassis or heat sink.
3. Space saving design achieved by having vertical mounting through hole with both terminals coming out end to allow rapid, simple wiring.
4. Fins increase cooling surface.
5. Completely encapsulated in hi-temperature silicone material.

Here are some of the extra steps we take to build stability into DALOHM resistors:

- Accurate tension control during winding
- Winding pitch limited to 200%-275% rather than 500% allowable in MIL SPECS
- Greater effective wire coverage than required by MIL SPECS
- A wider selection of wire diameters is used to achieve the resistance ranges advertised. This permits selection of a wire diameter for any value that will use only a narrow portion of the resistance range obtainable for that diameter of wire. This gives longer life stability within the temperature and power ranges specified.

from **DALOHM**
Better things in
smaller packages
DALE PRODUCTS, INC.
1328 28th Ave., Columbus, Nebr.

For complete information request
Bulletin R-36



MAGNETIC POTENTIAL

Here's how to move into the bonus area of high performance and savings as well.

G-E Directional Grain process for manufacturing Alnico 5 magnets gives you the *bonus area* of available energy for your loudspeaker applications. The advantages are important. G-E speaker magnets give external energy products of 0.5 to 0.75 (BH) m x 10⁶ greater than regular Alnico 5. In addition, residual induction is improved and increased efficiency means cost reductions in the magnetic circuit return path.

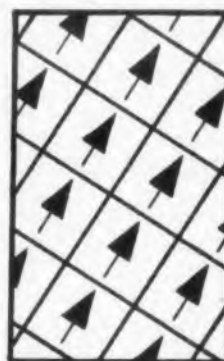
Send for specifications on the superiority of G-E Alnico 5 D.G., and information on the complete line of permanent magnets. Write: Magnetic Materials Section, General Electric Company, 7820 N. Neff Road, Edmore, Michigan.

MAGNETIC MATERIALS SECTION

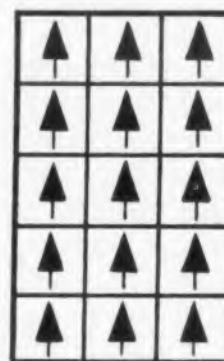
GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS

CIRCLE 23 ON READER-SERVICE CARD



Conventional Magnet



Alnico 5 D.G. Magnet

Schematic representation of the effect of controlling crystal orientation on magnetic structure.



General Electric D.G. crystal controlled magnet produced by controlling heat flow from casting.



Conventional Alnico magnet with random crystal structure.

NEWS

Electronics Used to Simulate 'Cocktail Party Effect' in Voices

The ability of a human listener to pick out one voice from a surrounding babble—the "cocktail party effect"—has been simulated by a gating system developed by investigators at Bell Telephone Laboratories, New York, N.Y.

Humans are able to enhance the effective intensity of a particular voice by 5 to 15 db by suppressing the background noise level. Using a gating system, two Bell Labs investigators E. E. David Jr., and J. F. Kaiser, achieved a 9-db enhancement in effective signal level against a background of a single interfering talker. A 5-db enhancement was achieved against a two-talker background.

This was done by cross-correlating the outputs of two microphones to generate a gating wave, which was applied to the combined output of the two microphones. The effect of the gating was to raise the intensity of the combined signal only when energy from the desired voice arrived simultaneously at both microphones. Otherwise, the gate suppressed the combined signal.

Noise or interfering speech signals passed through the gate if they occurred simultaneously with the desired speech signal. However, in the experiments, these events were rare and the pattern or discontinuity, of the undesired signal was disrupted, reducing its interfering qualities.

CHANGES IN PRICES AND AVAILABILITY

SILICON FLUID AND EMULSION PRODUCTS have been reduced approximately 4 per cent in price by General Electric Co.

MESA SWITCHING TRANSISTORS have been reduced in price by Sylvania Electric Products, Inc. of Woburn, Mass. Types 2N711 have been reduced from \$7 to \$1.95 each for lot purchases of from 100 to 999 units.

STANDARD MICROMODULES have been reduced 1/3 in price by the Radio Corp. of America of Somerville, N.J. Since RCA announced the availability of micromodules in March of last year, they have introduced some 15 different micromodule configurations, all of which will be affected by the price change.

Hot Germanium Transistor Too Good for Press Conference

A hot germanium transistor operated just too well at a recent press conference. As part of a demonstration of a new thermoelectric transistor cooler, General Thermoelectric Corp. of Princeton, N. J. immersed a small transistor amplifier in boiling water. The company planned to show how, without a thermoelectric cooler, the boiled transistor would die.

The germanium transistor should have quit amplifying at 85 C. Obstinate, it continued to amplify at 100 C. The amplified signal showed no attenuation on a scope display.

Sales manager Sol Meister of Needco Cooling Semiconductors, Ltd. (a Montreal firm which developed the high-efficiency cooler) assured the audience that the signal would soon die. After a minute of heavy silence he tried to coax the unwilling transistor to die. He jiggled the transistor in the vessel of boiling water then began to rap the side of the vessel—gently at first—then not so gently. Finally, to his aid came Mr. Roman Post, president of Needco. Mr. Post began rapping the water vessel while Mr. Meister turned to the scope which he began to adjust methodically—first the vertical controls, then the sweep. At last he approached the scope screen which he began to tap—gently at first. The scope was working well. So was the transistor.

The name of the transistor manufacturer was not disclosed.

Experimental Ion Engine A NASA-Hughes Project

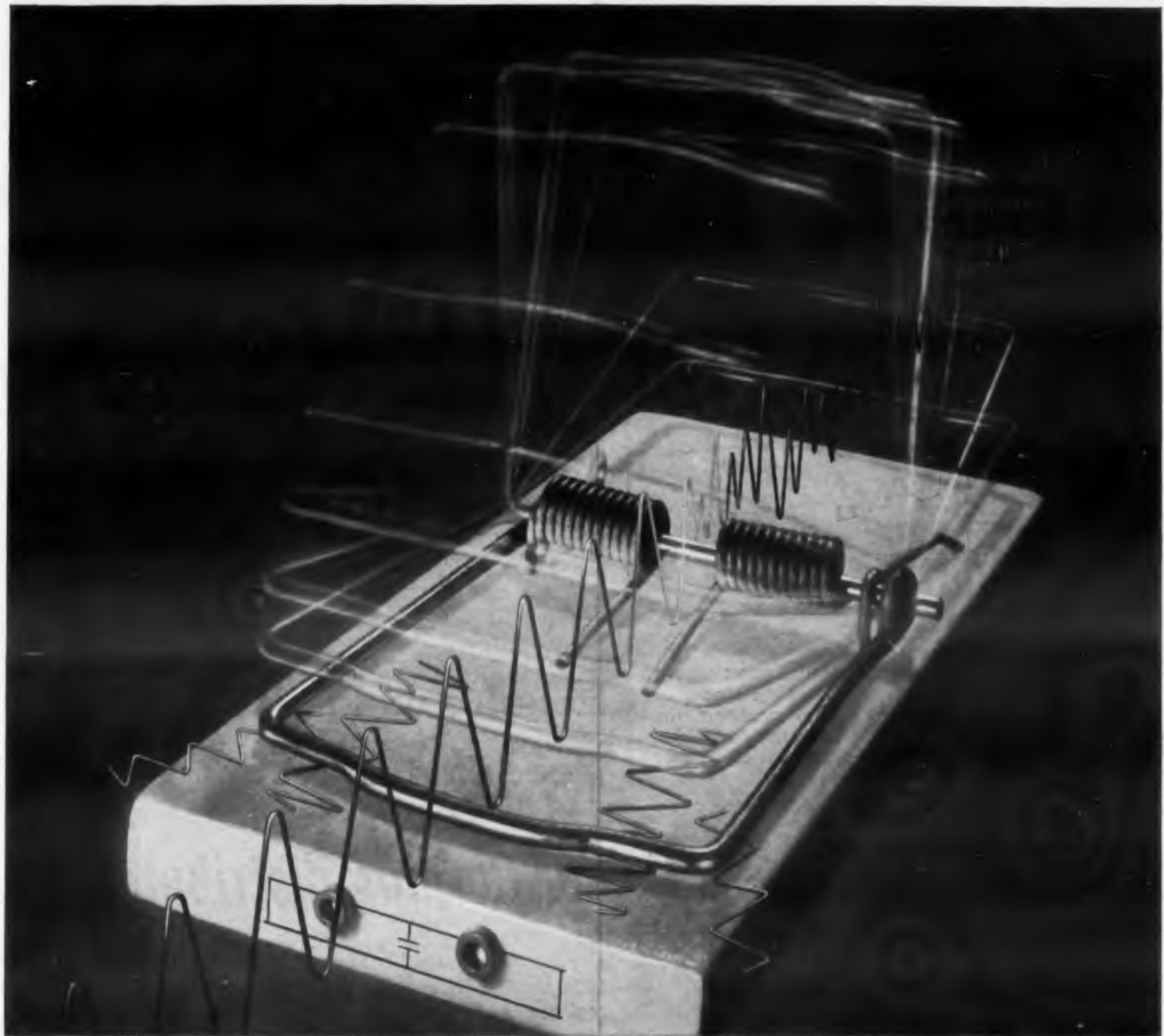
Design and development of an experimental ion engine is in progress for the National Aeronautics and Space Administration.

The engine, under development by Hughes Aircraft Co. of Culver City, Calif., departs from conventional rocket engines in that there is no combustion. Propulsion is provided by an ionized cesium stream, which is electrically accelerated and focussed.

In the space of a few inches, the ion stream develops a speed of more than 100,000 mph. The cylindrical ion engine measures only about 0.8-in. long and 4 in. in diameter.

This laboratory engine will develop only about 0.04 lb of thrust. If test data prove the program feasible, later engines will be built to develop greater thrust.

Ultimately, engines of this type will drive spacecraft, but will require a nuclear auxiliary power source such as SNAP-8 now under development.



How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

Do you, for example, specify our 160-mu cores when space is a problem? With this higher inductance, you need at least 10 percent fewer turns for a given inductance than with the 125-mu core. What's more, you can use heavier wire, and thus cut down d-c resistance.

What about temperature stability? Our linear cores are used with polystyrene capacitors, cutting costs in half compared to temperature stabilized moly-permalloy cores with silvered mica capacitors. Yet frequency stability over a wide swing in ambient temperatures is increased!

And what do you specify when you must rigidly define channel cut-offs, with sharp, permanent attenuation at channel crossovers? Our moly-permalloy cores have virtually no resistive component, so there is almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in high and low band pass ranges.

Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are performance-guaranteed to standards unsurpassed in the industry. Magnetics Inc., Dept. ED-82, Butler, Pa.

MAGNETICS inc.

VISIT OUR BOOTH 521-522 AT THE WESCON SHOW
CIRCLE 24 ON READER-SERVICE CARD

Industry Growth

THE ELECTRONICS industry has reported to the Navy that it plans to produce substantially more equipment in 1960 than it sold in 1959, confirming early estimates that 1960 would be another year of significant growth for the industry.

In a survey made by the Office of Naval Material, 585 companies reported that they plan to produce \$10.9 billion worth of electronics equipment in 1960. A Navy spokesman, in commenting on the annual survey, said that in the past, planned production totals corresponded well with actual production figures.

Only companies manufacturing equipment and systems were included in the survey totals. No

Magnetic-Tape Recorder Monitors 65 Different Variables in Flight

A magnetic-tape flight performance recorder with flexible playback capability has been demonstrated to Federal Aviation Agency officials by Minneapolis-Honeywell Regulator Co. of Minneapolis, Minn.

The device, consisting of three major components, can monitor as many as 65 different variables, including altitude, speed, heading, vertical acceleration and time once each second. The additional conditions can be monitored once a minute and are at the option of the airline.

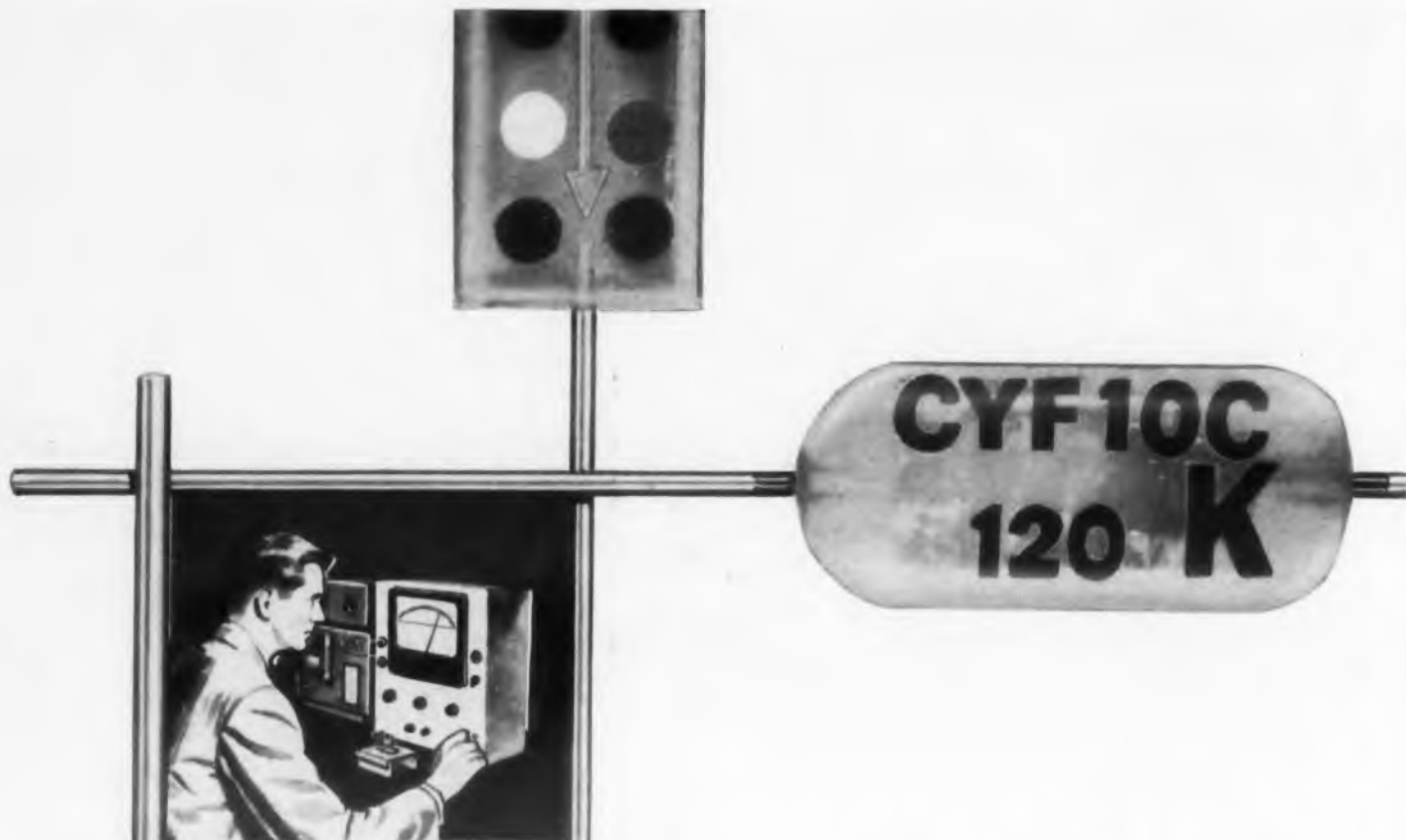
A standard instrument for data reproduction has also been developed to provide a means of utilizing several methods of processing and display of recorded information on the ground. This instrument contains pushbutton data channel selection and the basic playback channel electronics.

The following playback techniques can be used:

- An aircraft instrument-type display to reproduce in-flight situations simultaneously such as air speed, altitude, heading and acceleration.

- Using a Visicorder, either analog or the actual digital pulses recorded on the magnetic tape can be reproduced on continuous recording channels or the digital data can be converted to analog form and be recorded continuously.

- A standard digital counter and printer can be used. The ground playback signals are serially introduced to the digital counter, which in turn provides print-out signals for tabulating the digital data pertinent to any recording channel.



With a deviation meter such as this and complete stocks of Corning glass capacitors, the Erie Distributor Division quickly picks out the exact capacitance values you need.

**Require odd value capacitors?
Need fast delivery?**

call your Corning distributor

Capacitors with specific non-standard values like 873 mmf or 6086 mmf $\pm 1\%$ can be in your hands in a few days. Close coordination with the Erie Distributor Division makes it possible.

As soon as you call your local Corning distributor, he contacts Erie . . . relays your requirements. Technicians there comb through large stocks, pinpoint the exact values. The selected capacitors are sent out quickly with no delay.

You get factory prices, too, reducing the cost of your prototype or short-run work.

Your local Corning distributor wants to give you this service, as well as same-day delivery of standard MIL spec orders. Put him to work for you. You'll like the results.

For the name of your nearest distributor write to: Electronics Distributor Division • ERIE RESISTOR CORPORATION Erie, Pennsylvania.

CORNING

ELECTRONIC COMPONENTS

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CIRCLE 25 ON READER-SERVICE CARD

With Continuing, Navy Survey Shows

purely research-and-development or component companies were asked to report information.

The survey implies that there is no need for expansion of production facilities at this time, reports a Navy source. Although planned production for 1960 totals less than \$11 billion, maximum production for the year, on a one-shift basis, could reach more than 14 billion.

Maximum production capability for 1960 is about \$1.5 billion greater than that reported for the preceding year.

The survey is called "Manufacturers of Electronic Equipment Facilities Data, Ratings, and Production Capabilities." ■ ■

■ Complete analytical processing of the volume of raw data acquired during many hours of flight time can be comprehensively analyzed in a large-scale digital computer.

Large airlines can channel the data through their computers while smaller airlines can also take advantage of the flight information through the use of inexpensive standard electronic playback equipment.



Magnetic tape flight recorder gets final check aboard a Minneapolis-Honeywell airplane. An engineer installs a spool of magnetic tape which will record for 150 hours. The M-H recorder is capable of monitoring as many as 65 different variables.

Capabilities of the Electronics Industry

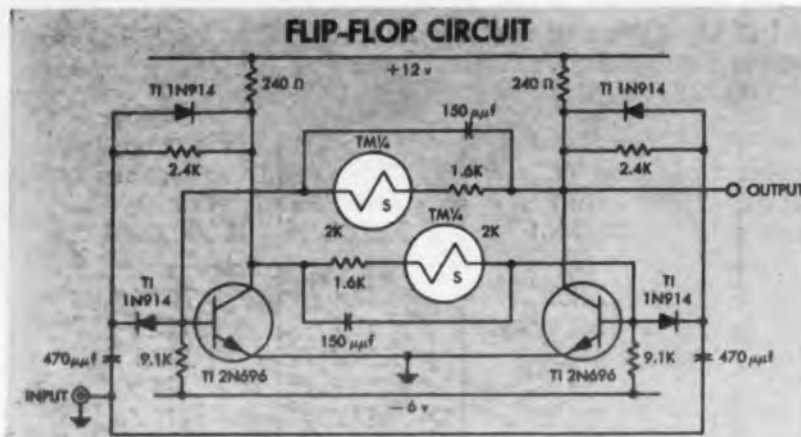
A statistical summary of Section I of the Office of Naval Material report "Manufacturers of Electronic Equipment Facilities Data, Ratings and Production Capabilities."

Number of Electronics Employees	Number of Companies	Total Electronics Employees (1959 Average)	Max. Prod. Per Yr. 1 shift (\$000,000)	1959 Sales (\$000,000)	Planned Production 1960 (\$000,000)
1-50	144	3,578	241.8	57.4	83.4
51-100	87	6,937	244.8	92.9	122.5
100-200	109	15,163	446.9	208.3	272.1
201-500	109	33,853	1,079.2	530.9	672.0
501-1,000	49	35,147	1,000.2	527.2	611.7
1,001-2,000	36	47,513	1,222.5	720.6	875.0
2,001-5,000	31	92,569	2,537.0	1,470.3	1,615.6
5,001-	20	343,163	7,329.8	5,988.1	6,646.3
Total—Current Year	585	577,923	14,102.3	9,595.7	10,898.6
Total—Preceding Year	578	513,636	12,635.1	8,261.3	9,359.0

Number of Electronics Employees	Planned Production 1960 Military (\$000,000)	1/1/60 Total Military Backlog (\$000,000)	1/1/60 Mil. Back-log Prime Contracts (\$000,000)	1/1/60 Mil. Back-log-Sub-Contracts (\$000,000)	Average Sales in 1959 per Employee \$
1-50	42.2	20.7	14.3	6.4	16,039
51-100	66.4	34.2	20.0	14.2	13,396
101-200	148.8	86.2	48.3	37.9	13,737
201-500	353.9	207.3	112.8	94.5	15,681
501-1,000	405.5	267.9	162.9	105.0	14,999
1,001-2,000	484.2	380.9	268.1	112.8	15,165
2,001-5,000	1,099.0	1,045.3	798.9	246.4	15,883
5,001-	3,256.6	3,624.1	3,000.0	624.1	17,449
Total—Current Year	5,856.5	5,666.6	4,425.3	1,241.3	16,603
Total—Preceding Year	5,139.9	5,534.1	4,499.2	1,034.9	16,083

Number of Electronics Employees	1/1/60 Av. Mil. Backlog per Employee \$	Ratio Mil. Back-log to 1959 Sales	1960 No. of Cos. Reporting 100% Planned Mil. Prod.	1960 No. of Cos. Reporting 100% Planned Civ. Prod.	No. of Cos. Applied for Cert. of Necessity	No. of Cos. Having V Loans
1-50	5,681	36	24	28	14	2
51-100	5,161	37	17	16	12	2
101-200	5,280	41	17	11	18	7
201-500	5,739	39	16	13	35	6
501-1,000	7,623	51	14	1	27	3
1,001-2,000	7,541	53	7	3	24	3
2,001-5,000	10,768	71	9	1	22	3
5,001-	10,101	61	0	1	19	2
Total—Current Year	9,380	59	104	74	171	28
Total—Preceding Year	10,149	67	111	79	171	38

How to compensate for temperature variation in a transistorized flip-flop



Sensistor SILICON RESISTORS

Positive TC of +0.7%/°C for temperature compensation and sensing.

Standard available resistances $\pm 10\%$ @ 25°C: 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820, 1000, 1200, 1500, and 1800 ohms.

Additional resistance values and tolerances available on special order.

Type No.	Wattage Rating	Body Dimensions	
	W	Length	Diameter
TM 1/4	1/4	0.585"	0.200"
TM 1/2	1/2	0.406"	0.140"
TC 1/4	1/4	TO-5 Transistor Package	
P-100†	—	0.500"	0.078"

† Hermetically sealed glass package for instrumentation and temperature control available in resistances of 100 ohms, 500 ohms and 1000 ohms $\pm 10\%$ measured at 25°C

This flip-flop circuit, designed by Texas Instruments, uses *sensistor*® silicon resistors in the cross-coupling network to compensate for increases in h_{FE} with temperature. At 125°C, it resolves 100 m μ sec input pulses arriving at a 5 mc rate whereas a fixed resistor version was limited to 3.6 mc. In addition, at +125°C the circuit will operate at a resolution rate greater than 5 mc if the input pulse can be greater than 10 volts when the pulse width is decreased from 100 m μ sec.

Another advantage of *sensistor* silicon resistors in a flip-flop using high h_{FE} transistors is the reduction in input voltage required to trigger at high temperatures. For instance, the *sensistor* silicon resistor circuit requires only 10 volts to trigger whereas the fixed resistor circuit required 14 volts.

In addition, specify from this complete line of TI precision film resistors.

Sensistor silicon resistors are temperature-sensitive devices that feature a positive temperature coefficient of +0.7% per °C. This predictable rate of resistance change makes *sensistor* resistors ideal for temperature compensation from -50°C to +200°C at frequencies up to 20 Kmc.

The *sensistor* silicon resistor, developed by TI, provides circuit design engineers with a lightweight temperature compensating and sensing device. Commercially available for over two years, the devices have been used successfully for bias stabilization in a-c coupled stages and in the first stages of d-c amplifiers; and have found wide application in amplifiers, power supplies, servos, telemetry, magnetic amplifiers, computer switching, and thermometry.

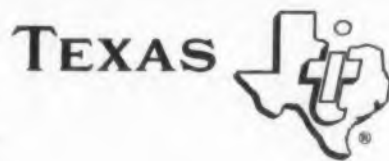
MOLDED				
$\pm 1\%$ tol				
TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDM 1/4	1/4	RN60B	10 Ohm-1 Meg	350
CDM 1/2	1/2	RN65B	10 Ohm-1 Meg	500
CDM 1	1	RN70B	10 Ohm-5 Meg	750
CDM 1	1	RN75B	10 Ohm-10 Meg	1000
CDM 2	2	RN80B	50 Ohm-50 Meg	2000

MIL-LINE				
$\pm 1\%$ tol				
TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CD 1/4 R	1/4	—	10 Ohm-1 Meg	350
CD 1/2 R	1/2	RN10X	10 Ohm-1 Meg	500
CD 1/2 PR	1/2	RN15X	10 Ohm-3 Meg	650
CD 1/2 MR	1/2	RN20X	10 Ohm-5 Meg	750
CD 1/2 SR	1/2	—	50 Ohm-10 Meg	850
CD1R	1	RN25X	10 Ohm-10 Meg	1000
CD2R	2	RN30X	50 Ohm-50 Meg	2000

HERMETICALLY SEALED LINE				
$\pm 1\%$ tol				
TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDH 1/4 M	1/4	—	10 Ohm-500K	250
CDH 1/4	1/4	RN60B	10 Ohm-1 Meg	350
CDH 1/4	1/4	RN65B	10 Ohm-1 Meg	500
CDH 1/2 P	1/2	—	10 Ohm-3 Meg	650
CDH 1/2 A	1/2	RN65B	10 Ohm-3 Meg	650
CDH 1/2 M	1/2	RN70B	10 Ohm-5 Meg	750
CDH 1/2 S	1/2	—	50 Ohm-10 Meg	850
CDH 1	1	RN75B	10 Ohm-10 Meg	1000
CDH 2	2	RN80B	50 Ohm-50 Meg	2000



Write on company letterhead for your copy of "Transistor Bias Compensation with *sensistor* Silicon Resistors."



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NEWS

Anti-Sub Advisory Group

Three-Volume Report Published;
Contains Widespread Proposals

THE ANTI-SUBMARINE Warfare Advisory Committee of the National Security Industrial Association has added two new task committees—Decoys and Countermeasures and Training and Technical Manuals—to the five existing task committees organized to coordinate industry and government ASW efforts.

This action was taken at a meeting of the Central Planning Committee of the Advisory Committee, which was held in Rochester, N.Y., last month. In another action the committee elected Hugh Boyd, of Goodyear Aircraft, as chairman of the Planning Committee.

The committee met to consider how best to implement the recommendations of the advisory committee, which recently released to the navy and industry a three-volume report on anti-submarine warfare which also took into account the rising need for oceanographic electronics. Among the recommendations and endorsements included in the report were:

- Underwater test ranges for evaluation of torpedoes and other ASW missiles to keep pace with submarine development. The committee endorsed establishment of longer, deeper range facilities.

- Special-purpose underwater detection vehicles, equipped with data processing and communication equipment. The committee recognized these as best for ASW work, even though submarines can be used in this capacity. Without giving details, the committee identified the units and recommended consideration of a program to provide adequate numbers of the special-purpose, mobile, manned, sonar, underwater vehicles.

- Oceanographic research, especially in such subjects as ocean-depth contours, currents, tides and wave motion, temperature versus depth for various depths and locations, salinity versus depth and location, and anomalies in gravity and magnetic forces in the ocean.

- Mobile search platforms, placing major emphasis on the ability to survey rapidly an area of ocean to determine positively the presence or absence of submarines.

- Increased acceptance by the Navy of the fixed ammunition concept. The committee explained it feels that planners of Navy equipment must design to eliminate complex testing and

oup Adds Two Committees

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maintenance because the ever-increasing complexity of modern weapons places an insupportable burden upon Navy training and technical maintenance ability. Citing the modern acoustic-homing torpedo, the committee stated there is no present technical reason why the Navy should continue to burden itself with shipboard overhaul and maintenance of torpedoes. New design should provide a completely sealed torpedo with no need or possibility of test or adjustment.

- Establishment of an ASW information center as a centralized source taking advantage of recent advances in library science and data-access techniques, to eliminate much repetitious work within the Navy and industry.

- Endorsement of present fleet assistance in contractor testing of ideas and equipment. The committee referred to the importance of obtaining quantitative data for development from live submarine targets under service environment and expressed a hope that the Navy will look favorably on the industry's acquiring and operating its own target submarines.

- Other recommendations called for greater flexibility in research and development contracts let by the Navy so the technical direction of a program can be changed, if necessary, as it progresses; encouraged service and maintenance contracts with industry to achieve optimum performance of equipment; and strongly advised that more contracts be written for feasibility studies to explore practicability of projects and for preliminary experimentation before specifications are written.

The two new task committees formed by the ASW Advisory Group make a total of seven such committees now functioning. The five original groups are: Detection and Classification, Submarines, Communication and Control, Aircraft, Surface Vessels, and Weapons and Fire Control.

The committee's report cautioned against expecting a major technological breakthrough in the ASW field in the near future. It suggested that step-by-step improvement in present techniques and equipment will result in more real gain than can be realized from operating with inferior equipment while waiting for the 'perfect' system to materialize."

"FREON"-TF SOLVENT



This magnet wire was exposed to "Freon" solvent liquid. The "Glyptal" coating on this wire is completely unaffected by "Freon"-TF.

ORDINARY CHLORINATED SOLVENT



This "Glyptal"-insulated wire was exposed to ordinary chlorinated solvent for the same length of time as the one on the left. The solvent dissolved the resin binder and softened the alkyd finish.

Comparison with ordinary chlorinated solvent proves:

FREON[®] solvents won't damage metal, elastomers or plastics . . . are safer for degreasing precision equipment

"Freon" solvents give you an effective and remarkably safe means of cleaning electric motors, ultra-precision mechanical and electronic equipment, and component parts. They minimize swelling of elastomers and plastics . . . will not soften paint, wire coatings or insulators. "Freon" solvents are also non-corrosive to metals without inhibitors. In addition, "Freon" solvents leave no residue when they

dry and can be recovered and reused readily.

"Freon" solvents are safe for personnel, too. They are non-explosive and non-flammable. "Freon" is virtually non-toxic. Vapors are odorless and will not cause nausea or headaches.

FREE 12-PAGE BOOKLET explains the unique properties of "Freon" solvents and how they minimize cleaning hazards.

FREON[®]
solvents



BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

CIRCLE 27 ON READER-SERVICE CARD

E. I. du Pont de Nemours & Co. (Inc.)
"Freon" Products Division 547
Wilmington 98, Delaware

Send me your free, 12-page booklet on "Freon" solvents.

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Company _____

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City _____

State _____



more news from
Amphenol R & D!

new *Micro Mod* micro-miniature connectors

AMPHENOL's aggressive research and development program in electrical interconnections has, in a short time, produced significant results. A materials "breakthrough" in resilient dielectrics has resulted in a line of environmentally resistant connectors that operate at 400° F continuously for 1000 hours. Advanced Micro Min connectors with contacts on .050" centers and the Micro Mod connectors introduced in this advertisement are the first of many new product developments for micro-miniature circuitry.

A central staff of engineers, physicists, chemists and metallurgists — scientific manpower unrivalled in the connector industry — is concentrating on materials research and advanced product development, seeks to anticipate customer requirements up to five years in the future. Divisional staffs continue to develop specials and standards to current requirements.



Watch AMPHENOL for continued new product excitement! For micro-miniature modular circuitry, AMPHENOL's new 12 contact Micro Mod connectors are now available for evaluation. .380 square and weighing only 0.73 grams (pair), Micro Mod connectors can be obtained in standard and special constructions.

Send for catalog sheets on AMPHENOL Micro Mod and Micro Min connectors.



manufactured by



CONNECTOR DIVISION

Amphenol-Borg Electronics Corporation, General Offices, Broadview, Illinois

CIRCLE 28 ON READER-SERVICE CARD

NEWS

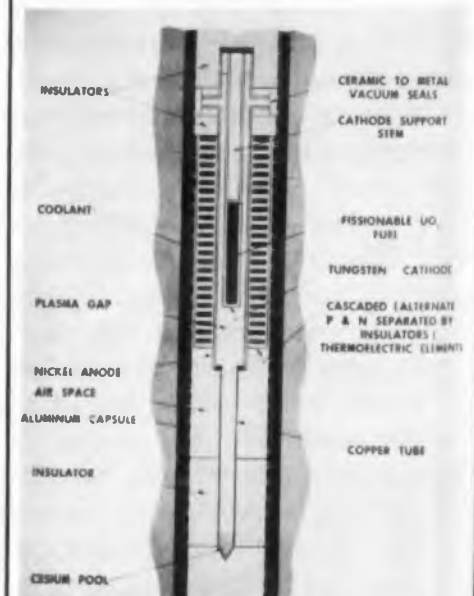
Generator Uses

A THERMIONIC and a thermoelectric generator have been built into a nuclear fuel assembly by Westinghouse engineers and inserted into a reactor to produce electricity from the high temperatures at the reactor center.

The experiment, according to Dr. William E. Shoupp, technical director of Westinghouse's atomic power department, was conducted by Peter J. McCoy at the Westinghouse Testing Reactor in Waltz Mill, N.J., and produced about 1 w. Dr. Shoupp said the experiment was designed to determine the feasibility of such a "dual" generator without consideration of optimum efficiency or high power output.

The scientist said much power is lost in nuclear-powered generating stations since the temperatures at the center of the reactor drop from about 4,000 F to 600 F at the outside, where contact is made with the cooling water. To use the heat energy at the higher temperatures, Westinghouse built a fuel element with the thermionic generator in its center and a thermoelectric generator surrounding it.

This took advantage of the fact that a thermionic generator oper-



Thermoelectric and thermionic generators are placed in tandem for power from core.

Uses

Reactor Core Heat

ates most efficiently at about 3,500 F and has a minimum level of operation at 2,700 F, while the thermoelectric generator functions best at temperatures between 600 and 1,800 F. By putting the two types of generators in tandem, the heat passing through the thermionic generator flows through the thermoelectric unit. The elements are wired in series to give a combined output over a wide temperature range.

Westinghouse said the six-month experiment had determined the feasibility of such a device and that development would continue toward the goal of improved efficiency. ■ ■

Thermoelectric Power for BuShips



Engineers at the Westinghouse Pittsburgh facility test one of the two 2,500-w sub-generators which make up "the largest thermoelectric power plant ever constructed." Development for the Navy's Bureau of Ships, the generator is intended as an experimental unit for materials evaluation. It is said to deliver 5 kw by direct conversion of heat into electricity. The generator is fired by kerosene and operates at 1,200 F. Of modular construction, the unit reportedly can supply a wide range of output voltages and currents.

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Band	Tube Type	Frequency Range (MC)	Minimum Peak Power (KW)	Output Mates with
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V	BL-236	54,000-57,000	10	UG385/U
V	BL-237	57,000-60,000	10	UG385/U
V	BL-221	69,000-70,500	10	UG385/U

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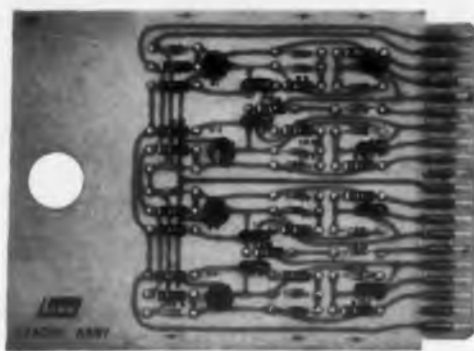
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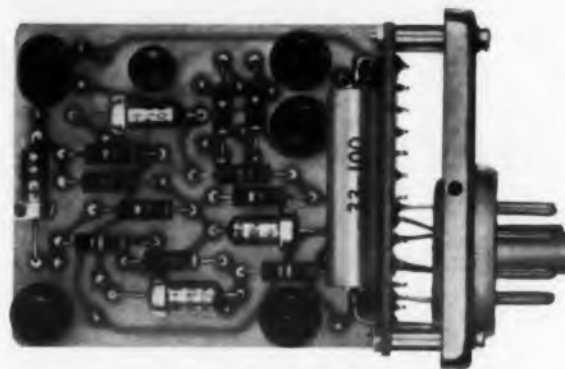
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CIRCLE 30 ON READER-SERVICE CARD

NEWS

RCA Computer Memory

A COMPUTER memory made from a continuous sheet of superconductive material is under development at the Princeton, N.J. research center of Radio Corporation of America. In the device, persistent currents store digital data and coincident current is used for selection.

The advantage of using persistent supercurrents for storage, as outlined by RCA researchers, is that they provide steady-state indication of the stored state without requiring steady-state power dissipation to maintain the state. Forming the superconductor in a continuous sheet emphasizes this, as well as other advantages of superconducting memories.

The memory planes in the RCA storage unit are made by evaporation in high vacuum (10^{-6} mm hg) through metal masks. The masks are made by a photo-resist and etching process described as simple by RCA scientists, who report that they are able to produce inexpensive masks that have sharp edges.

Selection logic for the memory will be provided by thin-film cryotrons, RCA reports.

Computer Recognizes Various Shapes



The computer shown above is capable of recognizing line drawings of geometrical shapes. The light at the top of the apparatus illuminates the shape, which is seen by a scanner from below a clear plastic table. Photo-cells are mounted on the ends of 32 metal rods, pointing up. When a button is pressed, the rods unfold simultaneously, so that each photo-cell is given a radial motion and crosses one boundary of the drawing. These crossings occur at different times for each photo-cell. The differences are used in a special logic circuit to determine the shape. The device was developed by Bell Telephone Laboratories of Murray Hill, N.J. (ED, May 25, p 7)

Memory Uses Superconductivity

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RCA's continuous-sheet memory was one of the developments described at a symposium on superconductive techniques for computing systems, which was held recently in Washington.

Other developments described:

- Progress with cross-field cryotrons at General Electric Co., Schenectady, N.Y. G.E.'s crossed-fil cryotron is composed of a wide superconductive tin "gate" film that can be made resistive by passing a current through a much narrower "grid" film, which crosses the gate at right angles and is insulated from it. GE deposits these elements on top of an insulated "shield" plane to increase operating speed. Company researchers reported depositing operating circuits to densities equivalent to 18,000 per cu ft.

- Two types of cryosars—using compensated and uncompensated materials—were reported built by scientists of MIT's Lincoln Labs, Cambridge, Mass. A. L. McWorter, of Lincoln Labs, said at the symposium that both types use germanium operating at 4.2 K, but that efforts are aimed at using indium-doped silicon at 77 K.

Shapes First Perceptron Displayed



The Mark I Perceptron, Cornell Aeronautical Laboratory's pattern recognition machine, has publicly displayed its ability to distinguish between the 26 letters of the alphabet. The sensing unit in the foreground contains a 20 x 20 array of photocell sensors mounted in a phenolic base plate. Each sufficiently activated sensor actuates a transistor-driven relay, which in turn supplies excitatory and inhibitory signals randomly to an array of transistor-driven relay circuits operating as association units. These units are dc-amplifier driven relays that drive response units, with signals whose amplitude is controlled by a memory device in each association unit. Values are stored in the memory devices by training with an operator.



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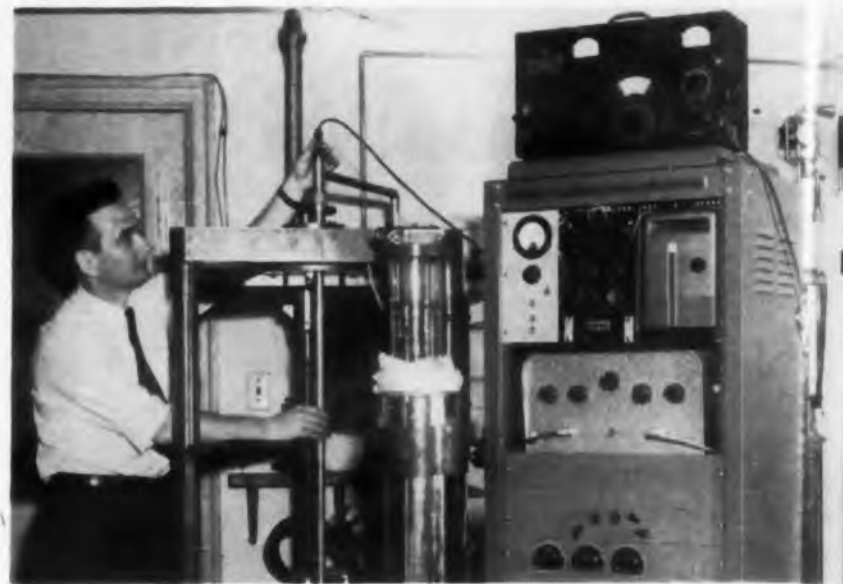
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CIRCLE 32 ON READER-SERVICE CARD

NEWS

Coaxial cable feeding superconducting bolometer is adjusted by Bogoljub Lalevic at the Franklin Institute Laboratories, Philadelphia. Entire assembly is operated in double Dewar flask. Outer flask contains liquid air.



Highly Sensitive Bolometer in Works

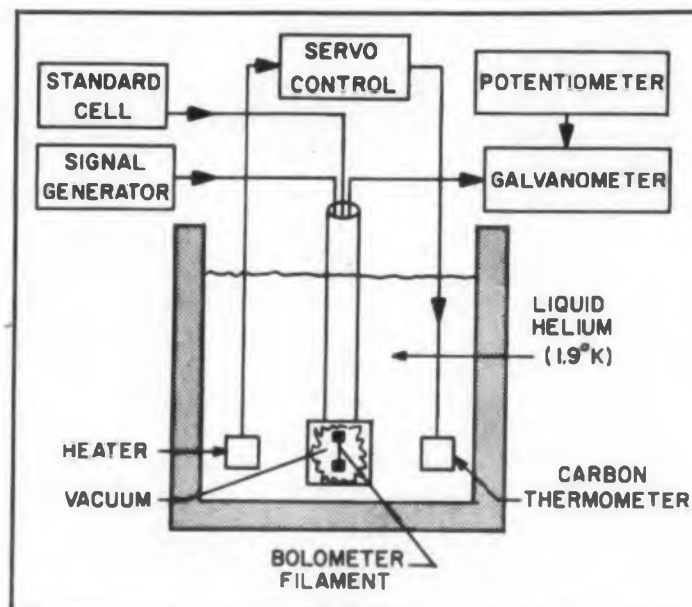
Microwave Measurements to 10^{-15} W Possible

MICROWAVE power measurements down to 10^{-15} w may soon be possible with a superconducting rf bolometer in development at the Franklin Institute, Philadelphia.

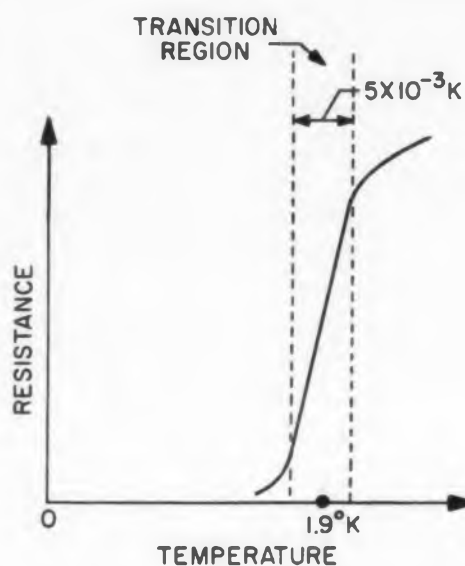
Tests to date indicate a sensitivity of 10^{-10} w or better, and work is continuing to close the gap between this figure and the 10^{-15} -w sensitivity theoretically predicted for the device. The very best laboratory instruments now available are good down to 10^{-9} w. Measuring accuracy of 3 per cent, consistent with that obtainable by present methods, is thought by Franklin Institute's scientists to be feasible for the superconducting bolometer.

The bolometer is being developed under a contract with the Signal Corps Laboratories for use in calibrating signal generators at extremely low power levels. Accordingly, the instrument is being tested at frequencies below 1,000 mc. However, there should not be any difficulties in applying its principle to the ultra-sensitive measurement of rf power over the entire microwave spectrum.

In its present form, the bolometer element consists of a 0.001-in. diam quartz filament about 4 cm long coated with a 200 angstrom-thin layer of tin. The filament is enclosed in a vacuum chamber which is, in turn, immersed in a flask of



Experimental setup for superconducting rf bolometer. The device operates at 1.9 K. The almost perfect thermal conductivity of liquid helium at this temperature enables temperature control to 10^{-5} K. Connection to the bolometer case is via a coaxial cable. Bolometer resistance is measured by voltage drop developed across the filament by a small current from the standard cell. This voltage is determined with extreme accuracy by the galvanometer-potentiometer combination.



Operating point of the rf bolometer lies within the superconductive transition region. A very small temperature increase causes a marked rise of electrical resistance thus permitting ultra-sensitive measurement of rf power. Transition region shown here is for tin and has been lowered to 1.9 K by a magnetic field. Indium and lead could be similarly used but would require a stronger magnetic field to shift their transition regions below 2.19 K, at which helium becomes a "superliquid."

liquid helium maintained at a temperature of 1.9 K. A magnetic field of about 150 gauss applied to the bolometer lowers the tin's superconducting transition region from its normal 3.85 K down to 1.9 K. Within this transition region (about 5×10^{-3} K wide) a very small temperature change of the bolometer due to its absorption of rf power causes an appreciable, easily measured change in resistance. A temperature change of as little as 10^{-4} K produces a detectable effect.

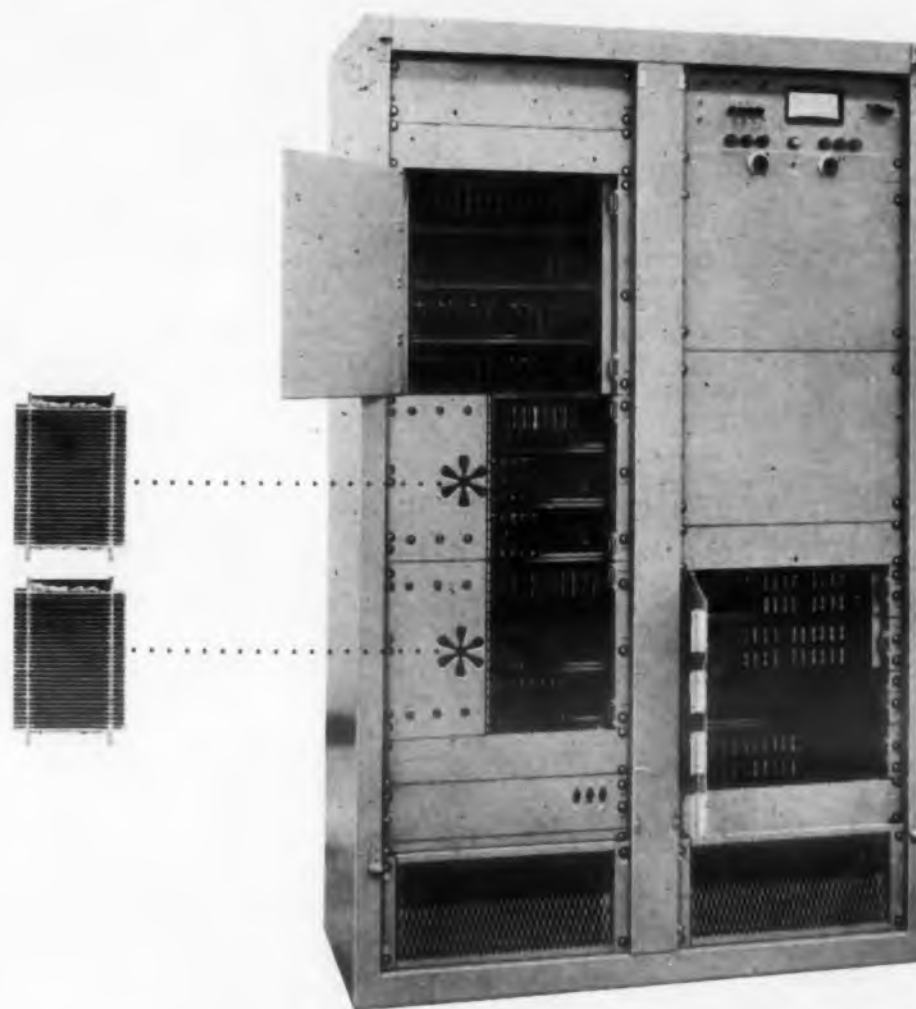
"Superliquid" Helium Used

The ultra-fine temperature control necessary to observe such small effects is made possible by the unusual properties of liquid helium at temperatures below 2.19 K. In this region, helium assumes a "superliquid" state and becomes an almost perfect thermal conductor. Heat applied at one point is immediately distributed throughout the rest of the fluid.

A servo-controlled heating element works against continuous pump cooling of the helium to maintain the desired temperature within 10^{-5} K. Temperature input to the servo is from a carbon thermometer; the high thermal conductivity of the helium eliminates local hot spots and gives immediate feedback from heater to thermometer.

Superconducting Connectors Required

Electrical connection to the bolometer is made through a 1-mm diam lead pellet at each end of the filament. The difference in the thermal coefficients of expansion between tin and quartz tends



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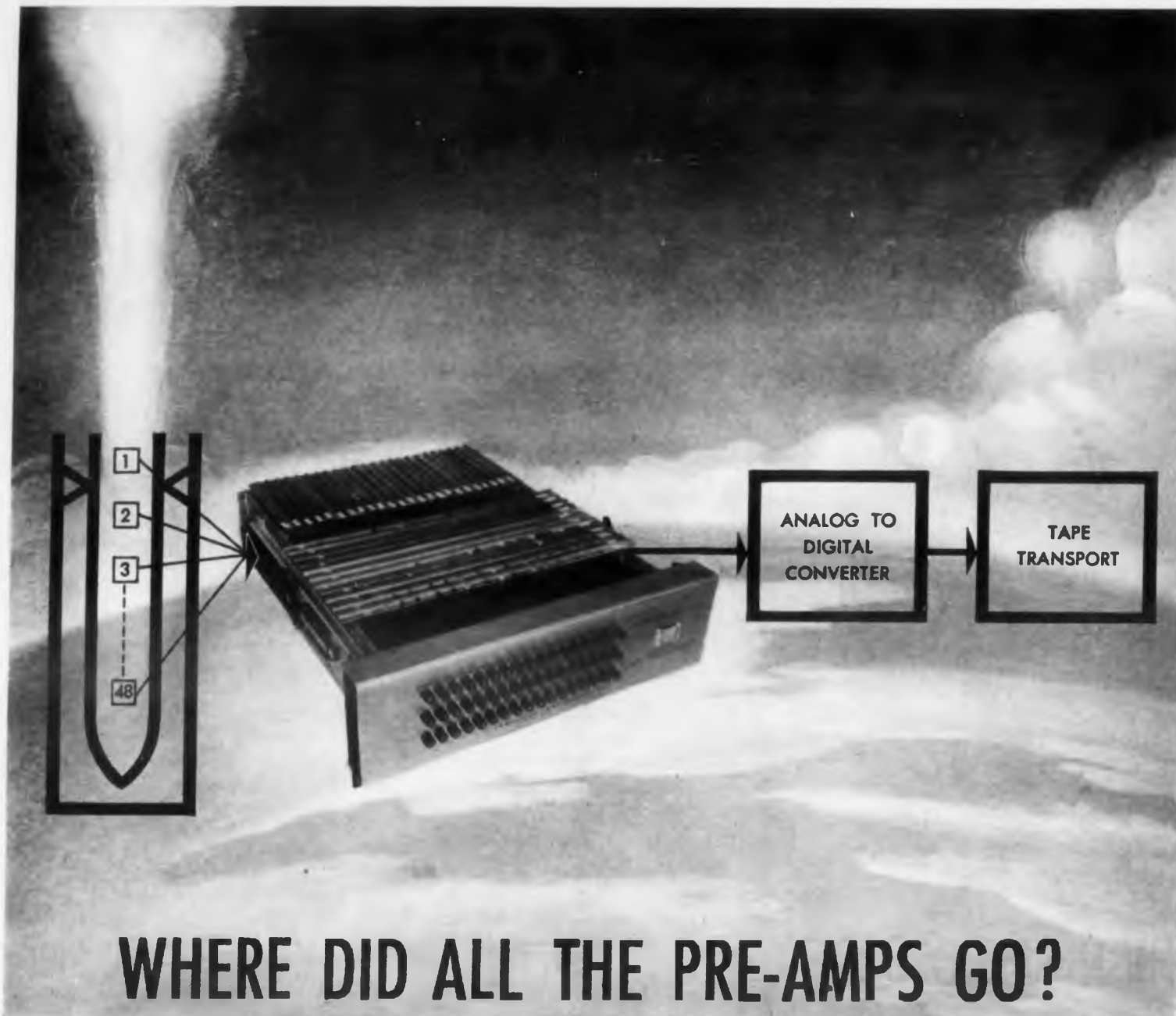


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New low-level multiplexer features high accuracy, programming flexibility in minimum space

Where did the pre-amps go? The Radiplex 89—first true low-level multiplexer—eliminated them. This high-speed, 48-channel unit represents a major breakthrough in PCM systems. Using solid-state circuitry throughout, it confines in a single small chassis equipment that would fill three 6-foot cabinets. Yet the Radiplex 89 in operational tests has actually provided more accurate data than conventional systems.

Some of the outstanding performance features of the Radiplex 89 are: 0.025% resolution, 10 μ v noise level, less than .05% crosstalk, common mode rejection ratio of 10⁶:1 and up to 24 kc samples per second. Flexibility of programming is achieved with alternate programmer boards, and the unit is compatible with most coders.

For other details on the Radiplex 89, write for a technical data bulletin to Radiation Incorporated, Dept. ED-7, Melbourne, Fla.

Circled area indicates small space (5 $\frac{1}{4}$ " high) occupied by 48-channel Radiplex multiplexer in standard cabinet. Unit directly above Radiplex is a Radicon analog-to-digital converter.



RADIATION
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CIRCLE 34 ON READER-SERVICE CARD

NEWS

to deplete the tin at the point where the filament enters the pellet and a small gap forms at the junction. This gap is however readily crossed by the superconducting electrons originating in the lead pellet. (Despite the magnetic field, the superconducting transition region of lead is considerably above 1.9 K.) Very thin superconducting lead wires are then connected to the ends of the pellet. Their low thermal conductivity and the vacuum inside the bolometer case minimize heat loss from the bolometer.

The rf energy is fed to the bolometer by a coaxial cable. For measurements at higher frequencies a wave guide would be used.

Bolometer resistant is determined by measuring voltage drop across the filament due to a small current through the element. A standard cell supplies the current, which is generally on the order of 0.5 ma. A galvanometer indicates the null between bolometer voltage and the voltage developed by a precision potentiometer. Measurements down to 2×10^{-7} have been made in this manner and indicate a power sensitivity to well below 10^{-10} w.

Noise in Transition Region

In operating the bolometer in the region of 10^{-12} w, experimenters have encountered noise peculiar to the superconductive transition region. This noise originates with the random movement of metallic domains into and out of the superconductive state. Thus, in the transition region only a fraction of the tin is superconductive and individual domains are continually changing their state. It appears that this noise can be minimized by the proper choice of bolometer dimensions and experiments are proceeding along those lines.

Another difficulty is presented by the Signal Corps requirement that the bolometer have a 50-ohm impedance to match the output impedance of the equipment with which it is to be used. This calls for exceptionally thin films and generally complicates experimental work. It may ultimately prove necessary to insert a carbon resistor into the bolometer circuit to achieve the desired impedance.

A parallel development at the Franklin Institute involves the refinement of conventional room-temperature rf bridges. Both projects are being sponsored by the Signal Corps which hopes to ultimately incorporate the superconducting bolometer into an improved bridge.

These projects have been in existence for about one year with Bogoljub Lalevic responsible for the low-temperature bolometer and Don Birx in charge of the room-temperature bridge improvement. ■ ■

Test Equipment Symposium Will Be Held Sept. 14-15

Advanced instrumentation techniques will be the theme of the Fourth Annual Joint Military-Industrial Electronic Test Equipment Symposium Sept. 14-15 at the Museum of Science and Industry in Chicago.

The symposium is under the joint sponsorship of the Office of the Director of Defense Research and Engineering and the Department of the Army Signal Corps. Armour Research Foundation will serve as the host.

Technical sessions will cover such areas as new concepts in measurement, latest instrumentation-design techniques and advanced data-processing methods. The program will be diversified to attract industrial and government representatives at both the technical and practical levels.

Stanley I. Cohn, assistant director of electronics research at Armour Research Foundation, is conference chairman. Inquiries concerning the conference should be addressed to Robert Brausch, conference secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

I-Beam Measurement Avoids Waste



A model of a device for measuring and tabulating the lengths of newly rolled I-beams demonstrates how beams may be measured accurately before sawing, in order to avoid waste. The beam passes along rollers where a series of three infrared scanners take its measurements. The results are automatically fed into a digital computer similar to the one shown and transmitted to the steel mill's hot saw plant. Shearmen then check the computer according to job orders and the beam is cut into segments depending on original length and other specifications. A measuring system based on this experiment has been in operation for more than six years in U.S. Steel's South Works in Chicago.



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*Design for Peace:
Underground and Space Tests
Create Urgent Need for*

Electronics in A-Bomb Detection

Manfred W. Meisels

Assistant Editor

SPECIFIC design requirements for an electronic whodunit system to pinpoint nuclear test-ban violations are gradually emerging from the continuing welter of controversy and diplomatic maneuverings that surrounds this highly sensitive area. Alternating periods of optimism and despair, engendered by an almost complete lack of pertinent scientific data, have marked public reaction to the proceedings of the Geneva Conference on the Discontinuance of Nuclear Weapons Tests now entering its third year.

Now, for the first time, the U.S. Government has formulated a definite program and allocated meaningful funds to gather pertinent data and develop operating hardware for policing a nuclear test ban. These are the objectives of the recently announced Project Vela being conducted by the Advanced Research Projects Agency in cooperation with the Atomic Energy Commission, National Aeronautics and Space Agency and other government units. Almost \$10 million have been budgeted for Vela in fiscal 1960 and a many-fold increase in funding is planned as the program moves into high gear.

Vela is divided into the following areas:

- *Vela Uniform*. Detection of underground

nuclear explosions—\$8,535,000 this year.

- *Vela Sierra*. Ground-based detection of nuclear tests in space—\$1,050,000.

- *Vela Hotel*. Satellite-based detection of nuclear tests in space—\$300,000.

Detailed technical management of these programs has been assigned to the Air Force Technical Applications Center under the direction of Dr. Carl Romney.

Improved Equipment Is First Step

The success of Vela and indeed of any nuclear disarmament effort rests largely on the capability of electronic designers to devise instruments and techniques for an effective inspection system. Seismologists, only recently drafted from the relative calm of their earthquake laboratories, have become VIP's but their number and instruments are not sufficient unto the task of wiring the earth for sound. Only through electronic instruments and techniques can the job be done.

As a first step in obtaining accurate seismic data on a world-wide basis, some 100 seismic stations are to be equipped with high-quality seismometers, timers, recorders and other equipment.

Also under Vela Uniform, a 10-seismometer monitoring station of the type recommended by the international panel of experts at the Geneva



conference is being installed at Fort Sill, Okla. The Geotechnical Corp. of Dallas is providing and installing the equipment. A second monitoring station, embodying improvements recommended by a U.S. seismic panel headed by Dr. Lloyd V. Berkner will also be ready shortly.

ARPA is most anxious for industrial participation in Project Vela and will welcome good, solid engineering proposals. As Carelton M. Beyer, project director for Vela, puts it, "Until now a small number of devoted people with limited funds have done a fair job. With additional effort we can make significant improvements." He suggests, however, that designers devote some time to educating themselves in seismology before sending their proposals to ARPA. As a start he recommends the Berkner Report, "The Need for Fundamental Research in Seismology," available from the State Dept. and the transcript of recent Congressional hearings, which can be obtained by writing to the Joint Committee on Atomic Energy.

Such reading could be most rewarding; the cost of a world-wide detection system will amount to several billion dollars with a heavy share going to data processing, telemetry, recorders, and seismometers. Of present Vela funds, about 20 percent have been earmarked for development, testing and purchase of electronic instruments.

Bomb or Earthquake?

Identification rather than detection is the major problem in spotting underground blasts. "To seismologists, the earth is like so much jelly; give it a swift kick and the entire mass quivers," is the comment of one ARPA scientist. The only question, and one which scientists, politicians and diplomats have debated for years, then remains "Is the kick a bomb or an earthquake?"

An earthquake relieves strain over a volume measured in cubic miles and behaves like an extended source. An explosion is essentially a point source. This difference may show up in the seismic signatures of earthquakes and explosions.

The most reliable criterion is the first motion recorded by the seismometer. In an explosion it is generally upward; in an earthquake it is generally downward. But this is not universally true. The monitoring of test explosions may give some indication of other useful differences in frequency content and amplitude.

Natural background noises in the earth, winds, waves, quarry blasts, railroad trains, and other man-made disturbances all generate a background spectrum of so-called microseisms which interferes with the identification of useful signals. In addition, recently advanced theories concerning decoupling (for muffling) of an explosion within large cavities, while not fully proven, indicate that detection may be several orders of magnitude more difficult than previously anticipated. Scientists have also applied themselves to devising techniques for "spoofing" monitoring stations by deliberate explosions to either mask a real test or to overload the detection system with false alarms.

Thus, until science can recognize useful differences between the recorded signatures of earthquakes and nuclear blasts and then design seismometers and associated equipment to identify these differences, any nation can conduct underground tests with impunity.

More effective data-collection systems capable of extracting meaningful information from a background hash of natural, and man-made noises are in early development under Vela Uniform. Systems required include:

- Improved seismometers, some with digital outputs, and deep-hole and ocean-bottom units.
- Large arrays of seismometers.
- Unmanned seismic stations.
- Throw-away seismometers.
- Data-correlating and processing systems.

The need for some of these items is governed to a certain extent by diplomatic considerations. For example, the Soviet Union is reluctant to permit large contingents of seismic policemen within

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Rated Load:	1 MC and 100 KC, 50 ohms nominal; 10 KC, 1 KC, 100 cps, 10 cps, 5000 ohms nominal.
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Size:	$8\frac{3}{4}$ " high, 19" wide, 18" deep behind panel. Weight 35 lbs.
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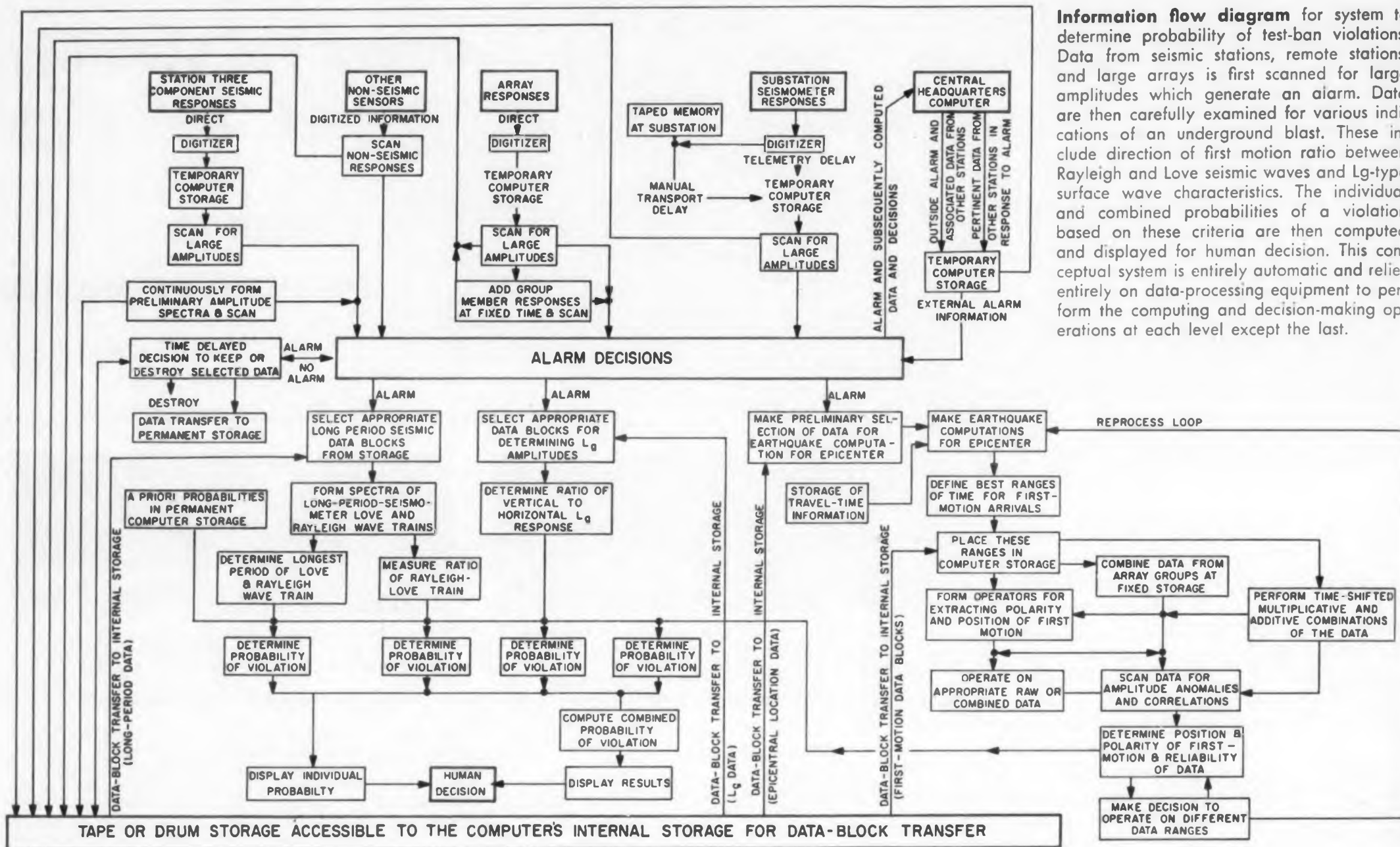
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Information flow diagram for system to determine probability of test-ban violations. Data from seismic stations, remote stations, and large arrays is first scanned for large amplitudes which generate an alarm. Data are then carefully examined for various indications of an underground blast. These include direction of first motion ratio between Rayleigh and Love seismic waves and L_g-type surface wave characteristics. The individual and combined probabilities of a violation based on these criteria are then computed and displayed for human decision. This conceptual system is entirely automatic and relies entirely on data-processing equipment to perform the computing and decision-making operations at each level except the last.

its borders; hence the requirement for unattended stations which may prove more acceptable to the Russian government.

Background Noise A Major Problem

Seismic signals generally consist of compressional and shear waves propagated from the source through the interior of the earth and of surface waves which travel through constant velocity "waveguides" in the earth's crust. The wave spectrum of interest ranges from 0.1 to 10 cps; seismometers adequately responsive to these frequencies have been available for many years. In a sense, the problem is that they are too good and respond indiscriminately to background noise as well as to the desired information. Since microseisms generally peak in a fairly narrow band, instrument designers attempt to suppress re-

sponse in the noise band while enhancing output at the frequencies of interest. The seismometer can be mechanically tuned to a particular frequency, output can be massaged by notch filters or other networks and transducers can likewise be tuned to a specific frequency range. A recent development at the Lamont Geological Observatory of Columbia University, making use of a long-period galvanometer as an electromechanical filter, has resulted in a significant reduction of background noise.

In all electronic equipment associated with seismology, considerable effort is required to reduce instrument noise to acceptable levels. Transducers, both of the velocity and displacement-sensitive types, must be carefully designed with this in mind. Suitable amplifiers, essentially dc units, are limited to just a few types generally

developed by seismometer manufacturers. These are laboratory instruments not particularly suited for field use.

Digital-Output Seismometer Wanted

All seismometers consist essentially of a spring-suspended mass tuned to a specific resonant period. Strain gages (often more than 100 ft long) and torsion-wire suspensions have also been tried but have not been as useful as the classic design. Over the years, much work has gone into the refinement of spring-suspended seismometers but the present state of electronics may well suggest the use of other principles for seismic instruments. A seismometer designed to give a digital rather than an analog output would be particularly suitable for use with modern data-processing systems. Until such instruments are available, the digital



Communications requirements for unmanned seismic stations are discussed by Bell Telephone Laboratory engineers Bruce Bogert (left), Earl Vaughan and John Johannesen. Mr. Vaughan, Director of Systems Research at Murray Hill, N.J. is in charge of Vela studies at Bell Labs. Sandia Corp. is also performing feasibility studies of unmanned stations under contract with ARPA.

seismometer must include some sort of efficient and highly accurate analog-to-digital converter.

Deep-hole and ocean-bottom seismometers offer the possibility of a relatively quiet seismic environment. Deep-hole units and their cables must operate in the corrosive fluids of a deep well at temperatures to 250 F and under pressures of about 10,000 psi. Since a relatively small instrument is indicated, electrical output would be quite low. A typical signal using a 2-lb seismic mass would be about 10^{-17} w and would require an amplifier with an even lower noise output.

Ocean-bottom seismometers must be designed for very low power drain to permit extended operating life. Acoustic telemetry would be employed to transmit data from the instrument.

Arrays Cut Noise

A considerable improvement of signal-to-noise ratio can be achieved by cross-correlating the responses of several seismometers deployed in an area of several square miles. Ideally, the improvement is $n^{1/2}$, where n is the number of seismometers. The seismometer arrays could be three-dimensional, including deep-hole units. Each array would include a suitable computer for on-the-spot data reduction.

Unattended seismic stations would consist of such arrays. Each seismometer of the array should be self-calibrating, tamper-proof, and protected against the weather. A central control unit would contain data storage and processing equipment, time standards, telemetry gear and the main power supply. These stations should be designed for

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Output Volts Amps	Model No.	Input Power Volts Freq.**	Max. Ripple mv RMS	Static Regulation Load*	Line*	Dimensions H x W x D	Approx. Weight Pounds	Price
0-10 0-10	QR-10-10	105-125 55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	\$485
0-18 0-6	QR-18-6	105-125 55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	485
0-36 0-4	QR-36-4	105-125 55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	485
0-60 0-2.5	QR-60-2.5	105-125 55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	510

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servicing at 30-to-60-day intervals and should incorporate modular-type construction for quick repair in case of equipment failure.

Data And Telemetry Requirements

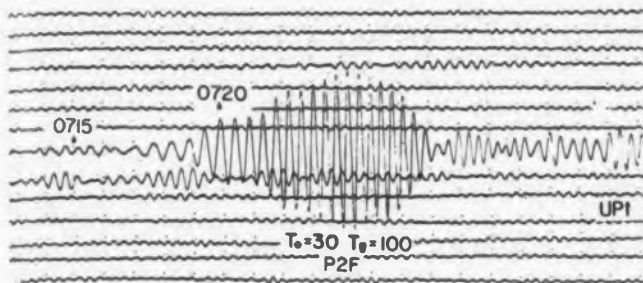
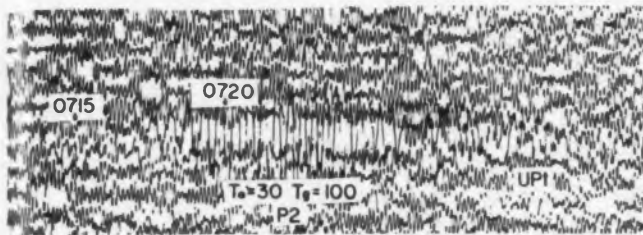
Digital data processing and communications will probably be specified despite the resultant need for analog-to-digital converters at the seismometer. Inherently better accuracy and the convenience of readily adapting a single digital computer model to handle the differing array patterns at each station are the deciding factors here. Data storage would probably be via magnetic drums or tape. However, thermoplastic recording and film storage could win out because of their inherently larger storage capacities. Storage requirements in seismology are high; a single instrument generates almost 3 million words of data in a 24-hr period.

Telemetry will also be digital for maximum signal-to-noise ratio in transmission. The system would be interrogable and broadcast at daily intervals. A single 500-kc channel could transmit some 25,000 bits per second. A 50-w transmitter working on a standard fm band (108 mc, 140-150 mc, etc.) would have a ground-to-air range of up to 500 miles. Constant-altitude balloons or hovering aircraft at the receiving end would relay the signal to monitoring headquarters.

Beware Of Countermeasures

An unmanned station is particularly susceptible to countermeasures. These may include tampering with the instruments and computers, the coupling of false signals into the cable net between seismometers and computer, or spurious transmissions over the telemetry antenna. High-security alarm systems must be designed into the station to telemeter indications of tampering.

Throw-away telemetering seismometers would be relatively simple in comparison with fixed station units. They would be air-dropped at suspected test sites to check for aftershocks characteristic of genuine earthquakes. Data storage might consist of a short tape loop or be dispensed with in favor of continuous transmission. In either case, digital conversion is not necessary as the units are not expected to work directly into a computer network. Transmission could be fm/fm with at least four subcarrier channels needed to transmit time markers and seismic data. One or 2 w of rf power and 100 mc should suffice for a 100-mile range if phase-lock receivers are em-



Signal-to-noise ratio of seismic records is dramatically improved through use of galvanometers as electromechanical band-rejection filters. Background noise of 1/7th cps in upper record is almost entirely removed by the insertion of a like-period galvanometer in the circuit between seismometer and recorder. Earthquake trace in lower record is clearly discernible with background noise removed. Technique was developed by Paul Pomeroy and George Sutton of the Lamont Geological Observatory.

ployed. At 10 mc the range might be extended to perhaps 500 miles. Aerial relay stations would again be employed at the receiving end.

Maximum detection capability calls for an advanced, large-scale data-processing system for efficient handling of inputs from several thousand seismometers scattered around the world. The computers required will be unique, but well within the present state of the art.

Elaborate Computers Needed

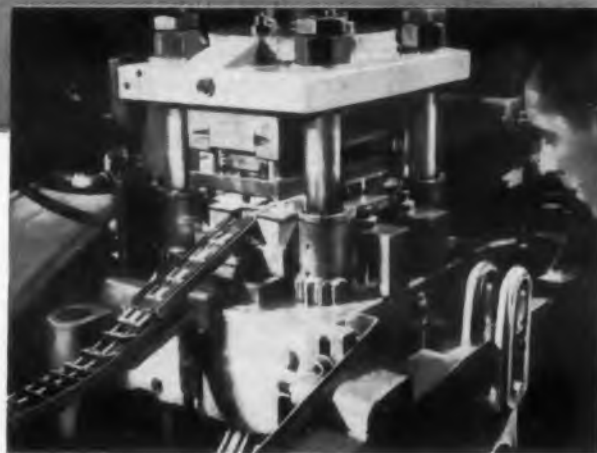
Each of the 180 control stations of the Geneva experts' system plus any additional unmanned stations which may be permitted will be equipped with a computer for immediate data reduction from its own seismometers.

The station computer must be capable of scanning large blocks of data in time and space; iterative time shifting for cross-correlation data; velocity filtering; spectra analysis, time-varying time scale correction; and the use of non-linear or time-varying operators. Multiple-channel reception and storage will be necessary. Data input to the computer may easily exceed 2,000 words per sec.

Experts believe that a suitable computer to these requirements will have to be designed from the ground up. High-speed, general-purpose business computers are designed for maximum flexibility and are not optimized for handling any particular group of mathematical operations. These computers usually have only one arithmetic



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Size 8 Motor Generator

This new Size 8 high performance servo motor-generator features high signal output and extremely low null voltage. The signal-to-noise ratio of 100:1 and linearity of 0.2% make the application of this motor generator to lightweight integrator packages most desirable. Stainless steel construction and thermal stability of this component assure its reliability and long life in the most severe environments.

ELECTRICAL CHARACTERISTICS

Motor Section	Generator Section		
	Phase 1	Phase 2	Excitation
Voltage (volts)	26	40	26
Frequency (cps)	400	400	400
Current (ma)	110	77	72
Power Input (watts)	2.3	2.3	1.3

GENERATOR SECTION OUTPUT

Volts at RPM (mv)	10
Volts at 1000 RPM (volts)	1.1
Output Impedance (ohms)	21 + j2500
Rated Load (ohms)	100,000

MECHANICAL CHARACTERISTICS

No Load Speed (RPM)	6500
Stall Torque (In. Oz.)	0.25
Rotor Moment of Inertia (gm-cm ²)	1.2
Theoretical Acceleration (Rad/Sec ²)	14,400
Weight (Oz.)	3.9

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QUADRATURE REJECTION CIRCUIT

Kearfott's quadrature rejection circuit is designed to operate from a pre-amplifier or gain controlled amplifier into a transistor servo amplifier. This small, light and rugged device rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to load and magnitude of in-phase signal. Kearfott's high-performance rejection circuit is designed to operate in an ambient temperature range of -55°C to +115°C at unlimited altitudes.

TYPICAL CHARACTERISTICS /D4816-01

Input Impedance — In phase signal component (ohms)/5000
+R_L / Quadrature component (ohms)/5000 (min)

Signal Frequency (cps)/400
Max. Signal Input (volts RMS)/6
Bandwidth (cps)/6

Quadrature Rejection Ratio:
Rejection Ratio (min)/50:1/
35:1/35:1

Signal Input/0.15 to 4/4 to 6/
0.005 to 0.15

Meets environmental requirements of MIL-E-5272.

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Highly precise and accurate, Kearfott two-axis accelerometers are pendulous devices which sense airframe acceleration forces acting on them in aircraft and missile guidance systems, navigational computers and wherever acceleration must be measured precisely and translated into electrical output signals.

The pendulum is anchored to a housing by means of a unique Hooke's joint type spring suspension. Whenever there is relative motion between pendulum and housing due to acceleration, an AC excited, air-core differential transformer type pickoff produces a voltage which is a servo error signal that is fed into an AC to DC amplifier. Feedback signal in form of a DC current transmitted to a restoring coil produces a force that exactly balances force of any accelerations acting on pendulous mass.

TYPICAL CHARACTERISTICS

Range of Measurement: ± 25g (can be adjusted upward within amplifier limits.)

Scale Factor (Output): 5.0000 MA/g of applied acceleration.

Operating Temperature: Performance is optimized within any 20°F range between +50°F and +160°F.

Linearity (Output): Within ± 0.005% of the applied acceleration.

Threshold: Less than 2 x 10⁻⁷g.

Zero Stability: ± .00005g day to day; less than ± .00002g over any continuous time interval.

Vibration: Up to ± 5g peak from 20 to 2000 CPS.

Storage Temperature: -60°F to +170°F.

Scale Factor Variation: ± 0.01% randomness.

Write for complete data.

DESIGN FOR PEACE

unit, access to only one word at a time in their fast memory, and slow input-output speeds.

A central headquarters computer would further process the information extracted by the station computers. The central computer would be similar in design to the station computers but on a considerably larger scale. It would embody greater storage capacity, more flexible computation capabilities and a more elaborate output display. It would also automatically control inter-station communication and interrogate the station computers as required.

Space Tests Feasible

Insofar as can be determined, no one has yet conducted nuclear tests in space. But, according to Dr. Byron P. Leonard of the Space Technology Laboratories, Los Angeles, such tests are entirely feasible. In testimony before the Joint Atomic Energy Committee, Dr. Leonard stated, "There is no question about it, the Atlas with appropriate upper-stage rockets could launch a nuclear device together with sufficient instrumentation and radio equipment for a test in space."

With the test vehicle perhaps 10 million miles out, a radio command would separate the instrument package from the bomb. After a preset interval to permit enough separation, the bomb would be detonated while the instrumentation recorded the pertinent data and radioed it back to earth. With larger space vehicles, part of the payload could be used to erect a shield between the bomb and the earth for additional concealment. Tests behind the moon or the sun are also possible. In the latter case, the instrument package would continue in orbit and report the data some time after the actual test. As for the possibility of anyone going to such lengths to test his bombs, Dr. Leonard says, "I think it is clear that for very large yield weapons there is a high probability that a potential violator would tend toward a space experiment rather than one in or near the earth."

Detection of space tests is technically possible both by ground-based and satellite-based systems. The former could well be incorporated into the seismic control stations and operate through their data-processing systems.

Ground-Based Methods

Possible ground-based detection methods include the following:

- Direct optical detectors mounted behind telescopic lenses to detect the visible light from a nuclear explosion. For a 1-kiloton blast this

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Little Falls, New Jersey



GENERAL PRECISION, INC.
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WANTED

A New Way to Digitize



This is the hard way to digitize analog seismometer traces for input to a digital computer. But it's still the most convenient way. With this seismic digitizer developed at the Lamont Geological Observatory, the observer manually follows a slowly revolving chart through the optical viewer. At predetermined intervals, a digital encoder synchronized with the viewing control is automatically sampled. Punched cards are thus prepared at a rate of up to 60 per min. The drum rotates at a maximum speed of 1/2 revolution per hour, which is about the same rate at which the seismometer records the data originally. "We've got a whole basement full of seismic records," commented one scientist, "and could sure use a faster, automatic digitizer." The trouble is that seismic records are usually a tangle of criss-crossing, broken lines. Design ideas, anyone?

system would be effective to a distance of 60,000 miles by day and 180,000 miles at night. Sufficient posts would be provided to minimize the possibility of total cloud cover at all stations.

- Detection of the visible fluorescence created in the upper atmosphere by the thermal radiation from a nuclear explosion. A narrow-band filter and optical detector mounted behind a wide-angle lens would be used. A 10-kiloton explosion could be detected out to several hundred thousand miles by this method.

- Detection of additional ionization in the atmosphere by a network of backscatter radars. Some 50 installations operating at frequencies of 10-30 mc could detect a 1-kiloton test to perhaps 1000 miles out.

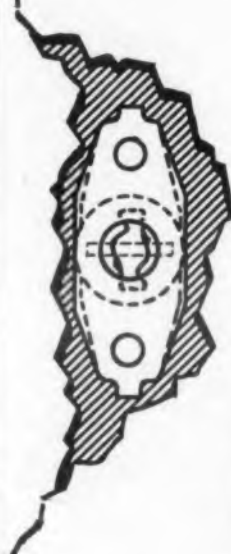
- Detection of the change in cosmic radio noise absorption in the ionosphere caused by nuclear



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DESIGN FOR PEACE

radiation. This method might be effective to 10,000 miles.

- Detection of the electromagnetic pulse generated by a nuclear explosion. This method may be effective to perhaps 1000 miles. Like the backscatter and cosmic noise methods, it is limited by the occurrence of similar natural phenomena.

Various Satellite Systems Possible

Detection satellites can be orbited around the earth below, within, or outside the Van Allen belts. Satellites below the belts would not be very effective in detecting tests outside the belts, but would provide good surveillance of the upper atmosphere. One detection method, based on the Argus effect (trapped electrons) is feasible only with a satellite inside the belts. Outside the belts, satellites in terrestrial or solar orbit could employ a variety of effective detection methods. These include:

- Detection of prompt gamma rays. A 1-kiloton shielded blast can be detected at 20,000 miles. For unshielded bombs, the distance is increased 10 times. A gamma ray detection system might consist of six 100 cm² plastic scintillators each mounted on a two-inch photomultiplier and shielded by lead or beryllium against brehmstrahlung and protons with energies greater than 25 mev.

- Detection of delayed gamma rays by similar methods. This method is insensitive to shielding and thus effective at a distance of up to 200,000 miles for a 1-kiloton explosion.

- Detection of prompt and delayed neutrons. Prompt neutrons can be detected at distances of up to 100,000 miles, but can be greatly reduced by shielding. Delayed neutrons formed after the



Typical seismometer vault, consisting of two horizontal-component seismometers, a vertical-component instrument and film recorder. Similar equipment will be installed in the Geneva-type station. The three seismometers employ magnetic damping and multi-coil variable reluctance pickups. These, in combination with a 237-lb seismic mass, give a 1-mv output per micron of 1-cps earth motion. Equipment is manufactured by the Geotechnical Corp.

Experience—the added alloy in A-L Electrical Steels

shield is destroyed are of lower energy and can be detected at only 10,000 miles or so.

■ Detection of soft thermal X-rays. Unshielded explosions can be detected at ranges up to 500 million miles. This method is sensitive to shielding, by perhaps a factor of 100, but is still the best available. The penalty imposed upon a violator in carrying a shield to distances beyond the range of other detection methods, and the additional stabilizing equipment needed for efficient shielding may restrict his tests.

Typical Inspection Satellite

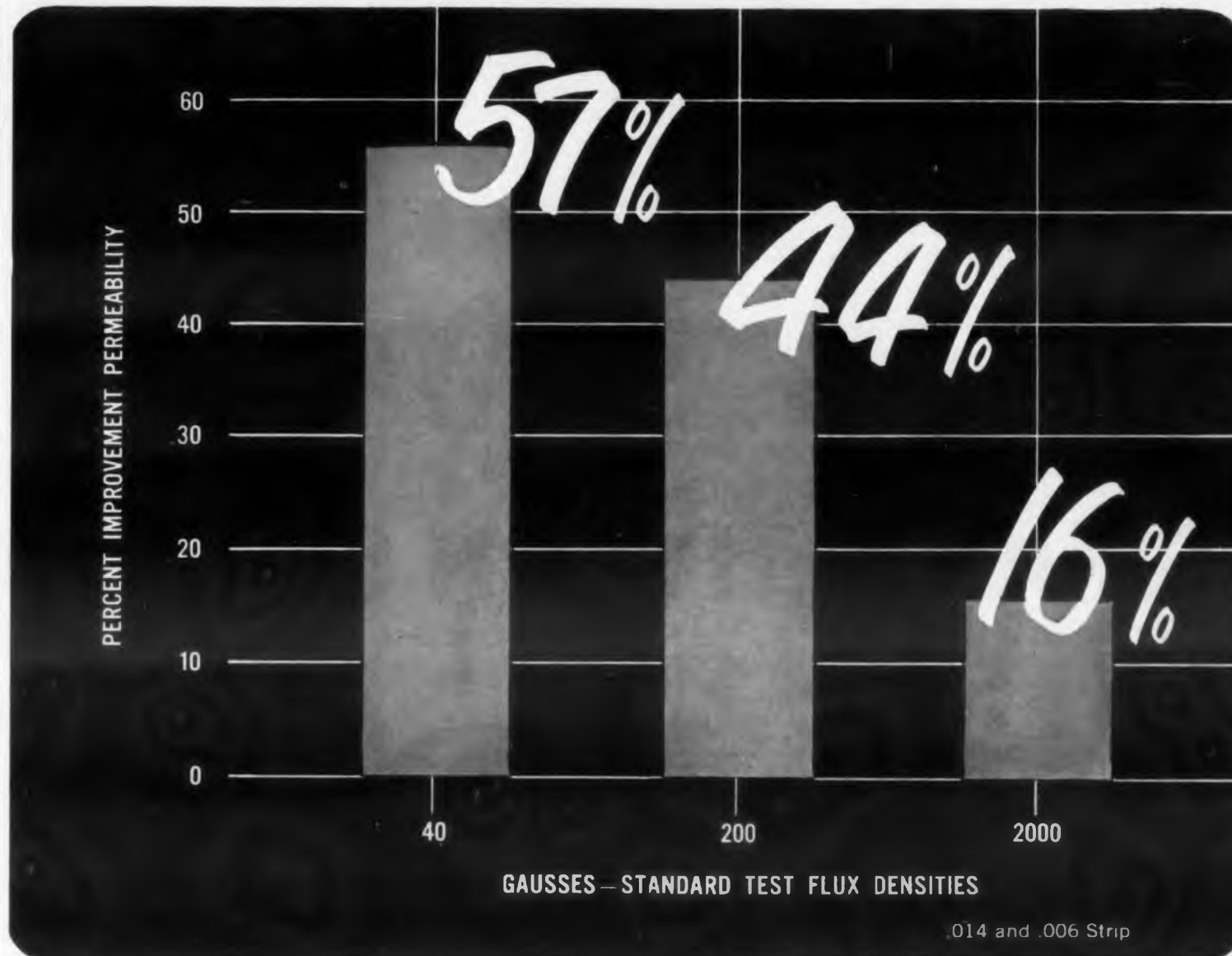
A typical inspection satellite would employ a combination of the above methods. Detection of a nuclear event would occur when the neutron count exceeds the natural background by a predetermined amount and for a considerable interval (perhaps 2,000 sec). Simultaneously, either the gamma-ray detector or the X-ray detector, or both, would have to be triggered.

The total system would have to ensure a negligible false-alarm rate; the Geneva criterion is one false alarm per 100 years due to natural background. The electronic logic elements aboard the satellite must thus be very carefully designed, both from the viewpoint of operational reliability and to eliminate the possibility of false alarms due to component malfunction.

A typical satellite system would include perhaps 20 vehicles orbiting under the Van Allen belts to survey the upper atmosphere; six additional satellites several tens of thousands of miles out would cover the immediate vicinity of the earth; finally, four satellites in various solar orbits could survey the most likely areas where violations might occur in the rest of the solar system.

Experts Disagree On Chances

Recent hearings before the Joint Congressional Committee on Atomic Energy brought testimony from 24 scientists expert in the various areas of the nuclear disarmament problem. Though widely divergent views were expressed, the consensus was pessimistic for a short-term development of a foolproof system, but rather more hopeful over the long run. On the one hand, Dr. Edward Teller of the Lawrence Radiation Laboratory and the "father of the H-bomb," said: "My hunch is that further developments will go in the direction of concealment and that it will be quite difficult for detection to catch up. . . . As for space, the Russians may be testing there at any time and any size right now." Dr. Hans Bethe of Cornell University replied, "In my opinion, the next round ought to go to the detection rather than to the concealment. I want to leave you with the impression that these decoupling schemes are not as simple as they appear." ■ ■



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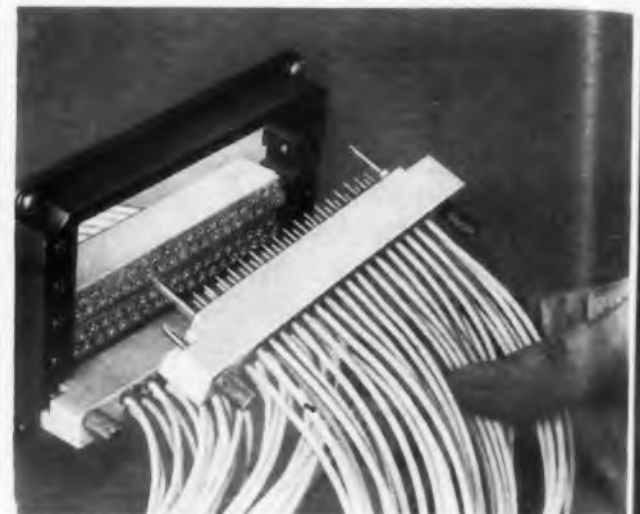
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NEW PRODUCT

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ELECTRONIC DESIGN • July 20, 1960

EDITORIAL

Can You Believe What You Read?

Not too long ago, we received an advance press release on the latest "breakthrough." A few ambiguities, unsupported claims, and non sequiturs in the release caused us to call the company's engineering department for clarification. Unfortunately the engineer we talked to couldn't figure it out, either. He pared the power output by a quarter, knocked the efficiency in half, and said the extreme claims were either theoretical only or obtainable under unusual conditions only.

We mentioned these facts to the company's public-relations man so that he might clarify his release before making it generally available. For ourselves, there just were too many unanswered questions; we couldn't use the item as submitted. Unfortunately, the release went out unchanged, with the same misleading information we received in our advance draft. Several respectable electronic publications published the "facts" as given to them.

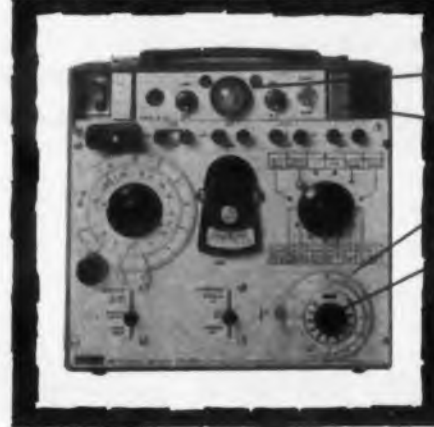
More recently, a release we received reported a device having an increased efficiency of 300 per cent! Sleuthing revealed that this engineering statistic was invented by a PR man. He didn't really mean increased efficiency; he meant increased speed of doing work. Increase over what? The competitor's device? No, the promoter, when pinned down, admitted. He said he was comparing the machine's rate of doing work with that of a manual laborer.

Naturally no publication can check every story. Even if it did, its reporter may not know all the specific details of a project to catch a technical inconsistency. ELECTRONIC DESIGN prides itself on its technical reporting. Every feature is thoroughly reviewed by an engineer. Every major news story is based on answers obtained by engineers or technically competent journalists. We evaluate the probable validity of claims of every new product. With the inauguration of our price-and-availability service we ask for additional information on about 70 per cent of the products coming in.

Despite these efforts, we know we are not 100 per cent accurate; we know less effort on our part would make us far less accurate. And how we feel about accuracy appears each issue in our accuracy-policy statement (see p 176). We are concerned with the amount of misinformation that is purveyed to engineers. Feedback from you will help. If you have reason to suspect statements made in *ED*, call them to our attention. We want you to be able to believe what you read in ELECTRONIC DESIGN.

James G. Kipp

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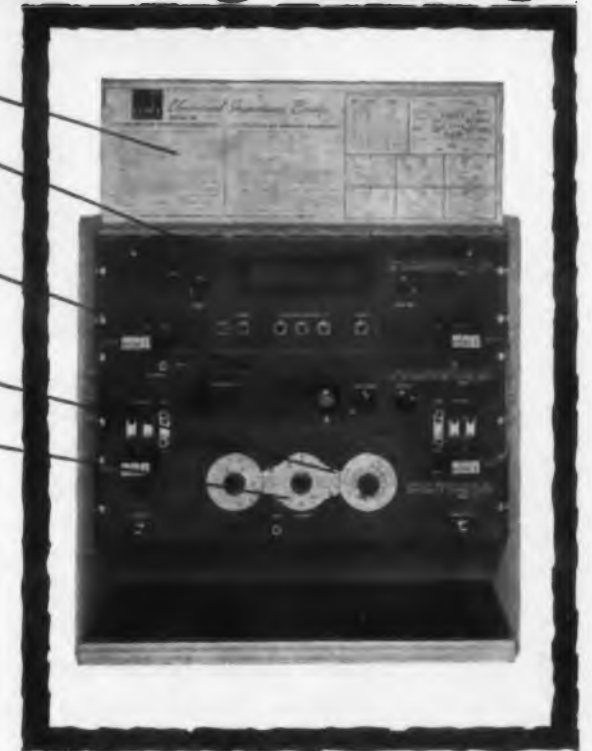
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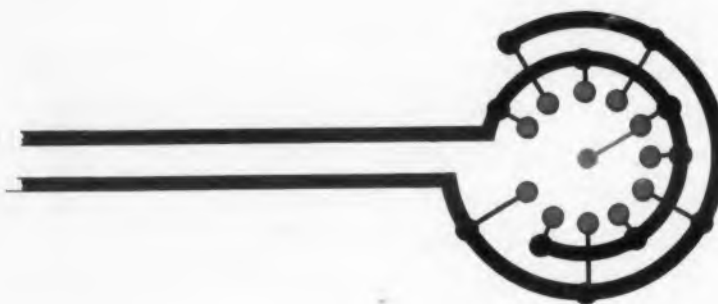
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CIRCLE 46 ON READER-SERVICE CARD



Alfred Corbin
RCA Service Co.
Missile Test Project
Patrick AFB, Florida



Generate Variable Delays With DC-Controlled Flip Flops



Producing precise controllable delays usually requires control switches intimately tied in with the pulse circuits. This makes for cross-talk and loading problems. Alfred Corbin, who has spent much of the past three years designing digital range-timing equipment, here offers a straightforward solution to remote-controlled timing. His solution allows control switches to be placed a great distance from the timing circuitry.

DELAYS ranging from microseconds to seconds can be generated by remote-controlled flip-flops. Dc switch lines can control delays selected by switches a great distance from the circuit's active components.

One such circuit, built for an airborne timing system, is shown in Fig. 1. It uses commercial, transistorized flip-flops, operating from a -12 -v supply, to provide output levels of -11 or -3 v.

The output of each flip-flop in the circuit is coupled through a diode which is biased on or off by dc on the control lines from the selector switches. At each switch position, one line is held at -12 v, cutting off its diode, while the other diode is returned to ground through a resistor.

An input pulse sets the gate-control flip-flop *FF1*, opening the input gate. The gate passes the clock pulses to the variable-delay counter. An output pulse appears when a selected number of pulses have been counted. The output pulse resets *FF1*, blocking the input signal, and resetting the counter to zero.

Though this circuit was built to serve as a precision delay generator, it can be used, with a random input rate, as an events counter signaling the reception of n input events. The instrument's delay range is virtually infinite, being limited only by the switching time of the flip-flops in the zero-delay setting. With transistor circuits, the minimum delay can easily be held to a small fraction of a microsecond per flip-flop.

Scale-of-Sixteen Counter Forms Heart of Circuit

A modification of the familiar scale-of-sixteen counter is at the heart of the delay generator. The flip-flops connected as shown in Fig. 2 generate a positive-going output when they receive 16 positive-going input pulses. If the circuitry is

initially reset and the input time interval is t , the first output pulse is delayed by $15t$.

The delay contributed by each flip-flop depends on its position in the chain. *FF1* contributes a delay equal to t ; *FF2* contributes $2t$, *FF3* contributes $4t$, and *FF4* contributes $8t$.

Complementary Output Eliminates Normal Delay

In Fig. 3, the output from *FF3* is taken from the complementary side, labeled *B*. This output is relatively negative when the flip-flop is reset, so it produces a positive transient when *FF3* is first flipped. Hence, *FF3*'s delay is eliminated by coupling from its *B* output rather than from its *A* output.

If a counter is connected with *A-B* selector switches at the output of each flip-flop, the delay can be programmed from zero to $15t$ by the proper combination of switch settings. For remote control of the delay, diode switches between the counter elements, allow the use of dc control voltages as shown in Fig. 4.

Feedback Around Scale-of-Sixteen Yields Handier Scale-of-Ten

The typical feedback arrangement of Fig. 5 can be used to change the scale-of-sixteen counter to a scale-of-ten unit. With the latter configuration, counter can generate a delay from zero to $9t$.

It should be noted that, though the initial delay from the reset condition to the first output pulse is made variable, the $N/10$ counter remains basically an $N/10$ counter. In effect, the output rate is fixed at one tenth of the input rate while the output phase is shifted in increments. By stacking two or more $N/10$ counters, the initial delay can be varied in units, tens, hundreds, or by other factors of ten. ■ ■

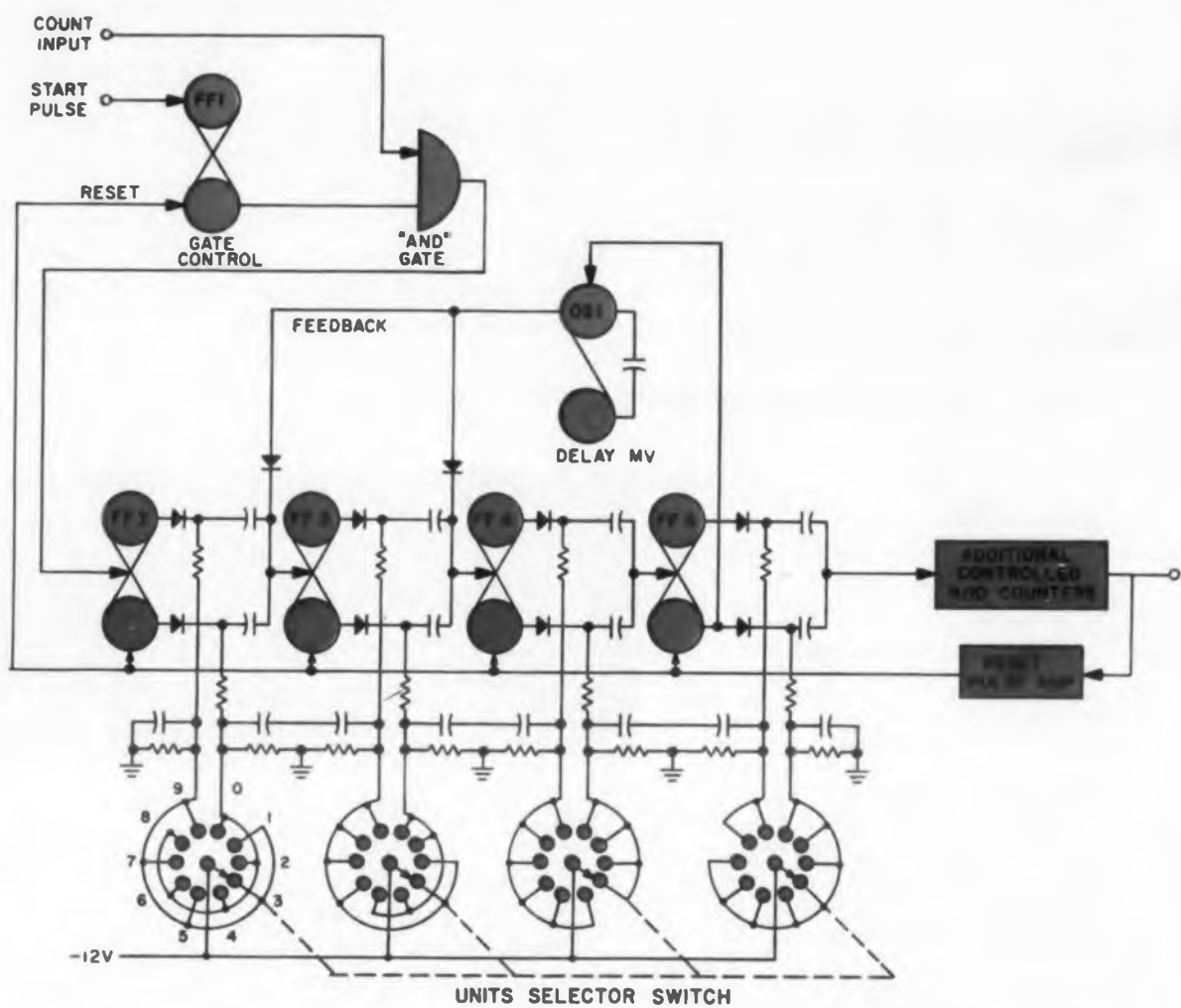


Fig. 1. Modified scale-of-ten counter serves as remote-controlled, variable-delay generator.

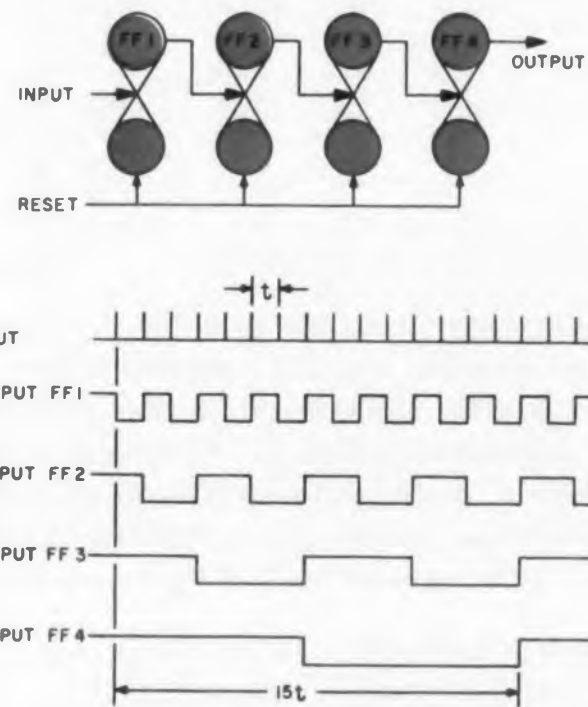


Fig. 2. Basic scale-of-sixteen, flip-flop counter and its timing relationships.

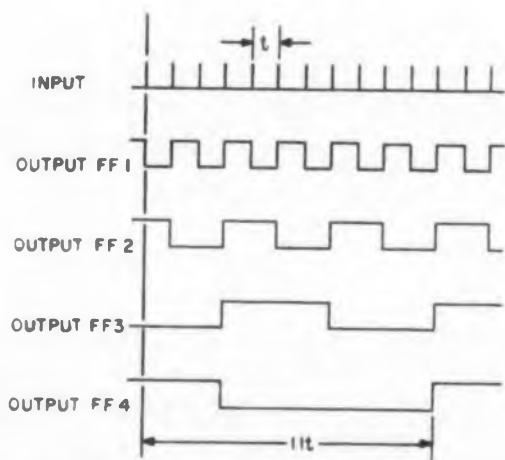
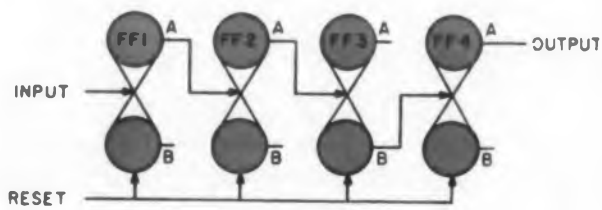


Fig. 3. Drawing the complementary output from FF3 eliminates the delay which FF3 normally contributes in this counter.

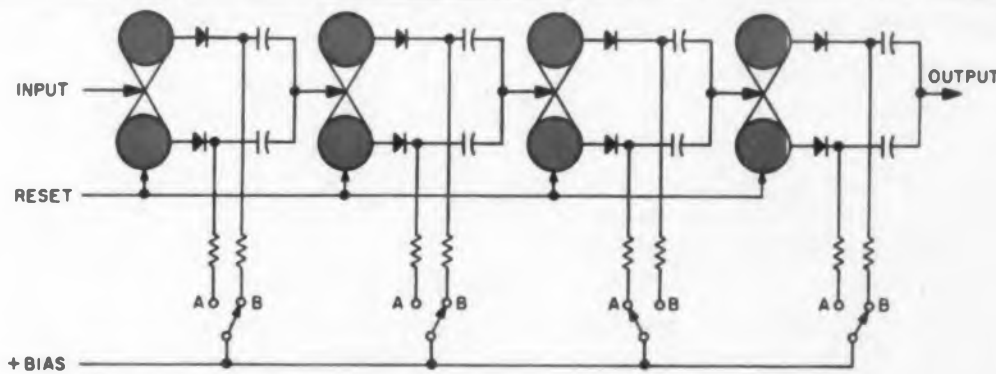


Fig. 4. Over-all delay of this scale-of-sixteen counter can be controlled by dc switch lines.

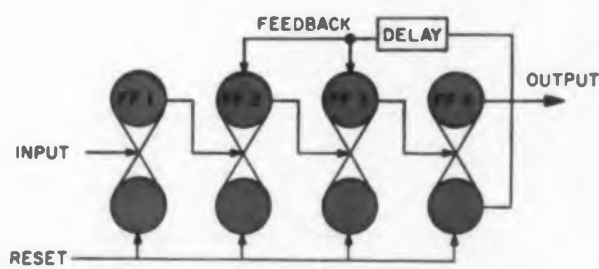
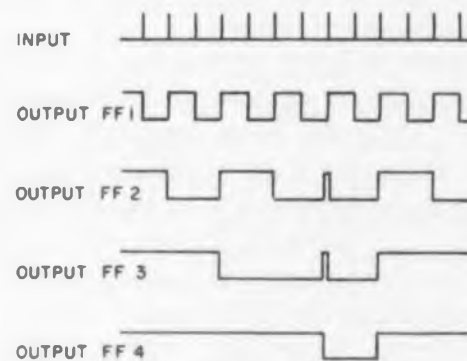


Fig. 5. Feedback around scale-of-sixteen counter yields scale-of-ten counter—convenient for decimal stacking.



Designing Hard Tube Delay Multivibrators

Robert F. Roller
Systems Engineering Div.
Battelle Memorial Institute
Columbus, Ohio

Conventional approaches to the design of cathode-coupled one-shot multivibrators involve several approximations plus trial and error techniques before an acceptable design is achieved. A straightforward method, including graphical procedures, is presented together with a working solution to a typical example.

APPROXIMATIONS, trial and error techniques and generally unsatisfactory design procedures make the design of a delay (cathode-coupled one-shot) multivibrator difficult and time-consuming. One incorrect philosophy quite commonly encountered involves the assumption of full conduction of the first stage. From the detailed step-by-step procedure described, a multivibrator with a linear delay period can be designed in a straightforward sequence.

One-Shot Multivibrator Operation

Fig. 1 shows schematically the configuration for such a circuit. Several definitions are needed before the design method can be established; these are grouped in the Glossary section.

All currents and voltages considered are steady-state values. Some overshoots will be experienced, but will not be treated here.

Normally, to produce triggering, a positive voltage spike is applied to the grid of T_1 , or a negative voltage spike is applied to the plate of T_1 , or to the grid of T_2 .

The current flow through T_2 is designated I_2 , and has a fixed value since T_2 normally operates at clamp level (see Glossary).

If the voltage E (Fig. 1) is increased from zero, it is found that for all voltages less than a minimum level, E_{min} , the stage cannot be triggered. This is because the drop in plate voltage which occurs upon conduction of T_1 is insufficient to cut off T_2 . At E_{min} , however, T_2 just cuts off, when sufficient trigger potential is applied, and a minimum workable current flow through T_1 is experi-

1. All formulas are adapted from Millman and Taub: *Pulse and Digital Circuits*, pp 189-194, McGraw-Hill Book Company, New York, 1956

After encountering difficulties in properly designing a required multivibrator for an analog-to-digital conversion project, Robert Roller decided to prepare a fully-detailed procedure. His step-by-step design outline, with a typical design example, should be of interest to others involved in one-shot multivibrator applications.

enced. This current flow is designated I_o , and may be determined by

$$I_o = \frac{I_2 R_k - E_{co2}}{R_{L1} + R_k} \quad (1)$$

where E_{co2} is the required grid-to-cathode cutoff potential of Tube 2.¹

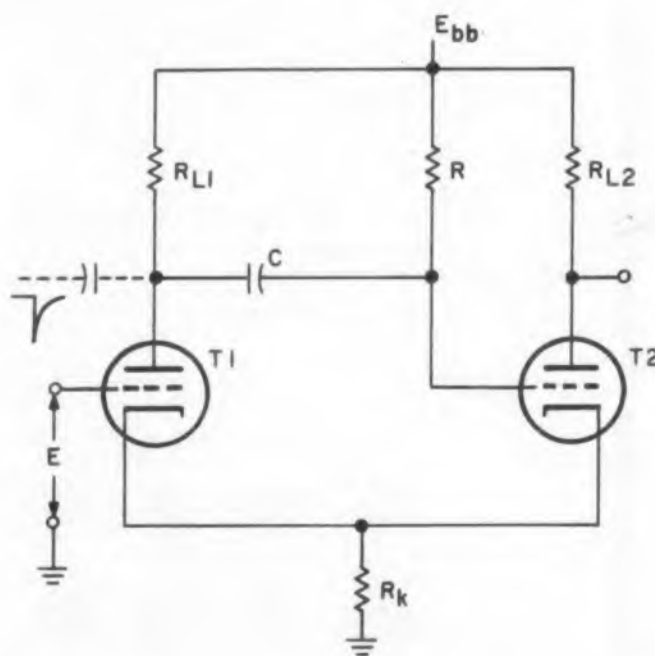


Fig. 1. Cathode-coupled one-shot multivibrator. To produce triggering, a positive pulse may be applied to the grid of T_1 or a negative spike to the grid of T_2 .



If the voltage E is further increased, the delay period of the multivibrator will be linear until a maximum point, E_{max} , is reached. For all voltages $E > E_{max}$, the multivibrator will become astable (free-running). At this potential, E_{max} , a current I_1 will flow through T_1 . I_1 must be found from tube characteristic curves, after E_{max} is calculated. E_{max} is the voltage applied to the grid of T_1 that will just keep it cut off while T_2 conducts.

$$E_{max} = I_2 R_k + E_{co1} \quad (2)$$

Step-By-Step Design Procedure

1. Output is normally taken capacitively from the plate of T_2 . Determine what change of voltage is required to drive the subsequent stages. Call this Δ_{cb2} . Now,

$$\Delta_{cb2} = I_2 R_{L2} \quad (3)$$

Locate the clamp line ($E_c = 0$) on the tube characteristics and select an amount of current safely below the maximum dissipation of the tube, and on the clamp line (see Fig. 2). Call this value I_2 . Solve for R_{L2}

$$R_{L2} = \frac{\Delta_{cb2}}{I_2}$$

If R_{L2} is not a standard resistance value, correct it to standard, and correct I_2 to correspond.

2. Draw a straight line from the chosen point on the clamp line to the E_{bb} voltage used, along the base line. The negative inverse slope of this line is equal to $R_{L2} + R_k$. Since R_{L2} has been previously determined, solve for R_k . Correct R_k to closest standard value, and correct the load line accordingly. It is generally best that $R_{L2} > R_k$.

3. For maximum linearity of the delay period, R_{L1} should be set equal to R_k . Arbitrarily set $R_{L1} = R_k$.

4. All components have now been calculated except R and C . First, however, I_o and I_1 are determined. It is necessary to know I_1 to calculate R and C . I_o , while not necessary in this calculation is helpful in determining E_{min} .

Calculate I_o using Eq. 1. For E_{co2} , use the cut-off voltage indicated for the value of E_{bb} used. This procedure is in error, but will yield a value of I_o as a first approximation.

$$I_o = \frac{I_2 R_k - E_{co2}}{R_{L1} + R_k} = \frac{I_2 R_k - E_{co2}}{2 R_k} \quad (4)$$

(Since $R_{L1} = R_k$)

5. This first approximation is now substituted into:

$$E_{pk2} = E_{bb} - I_o R_k \quad (5)$$

The value of E_{pk2} is then located along the base line, and the associated cut-off potential is then used as the new value of E_{co2} . Using this value, a second approximation for I_o is obtained. Further approximations are usually unnecessary, but could be made in the same manner if desired.

6. Draw the *Tube 1* load line, which will have an inverted negative slope equal to $R_{L1} + R_k = 2 R_k$. Locate the grid-to-cathode voltage associated with the tube when the current I_o is being drawn. Designate this voltage E_{c1} . Then,

$$E_{min} = E_{c1} + I_o R_k \quad (6)$$

This value of E (E_{min}) is associated with a zero delay period, and is the minimum point of linear response.

7. E_{max} is next calculated from Eq. 2:

$$E_{max} = I_2 R_k + E_{co1} \quad (7)$$

E_{co1} is determined using the tube curves and is the cut-off voltage associated with E_{pk1} , as it is given by

$$E_{pk1} = E_{bb} - I_2 R_k \quad (8)$$

8. For the value of $E = E_{max}$, the current flow (when triggered) through *Tube 1*, I_1 , must be determined. First,

$$I' = \frac{E_{max}}{R_k} \quad (9)$$

For this value of current (I'), mark a point on the clamp line ($E_c = 0$). Then, on another grid line associated with some arbitrary value of grid bias K , mark a point for

$$I'' = \frac{E_{max} - K}{R_k} \quad (10)$$

Connect these points with a straight line. Note

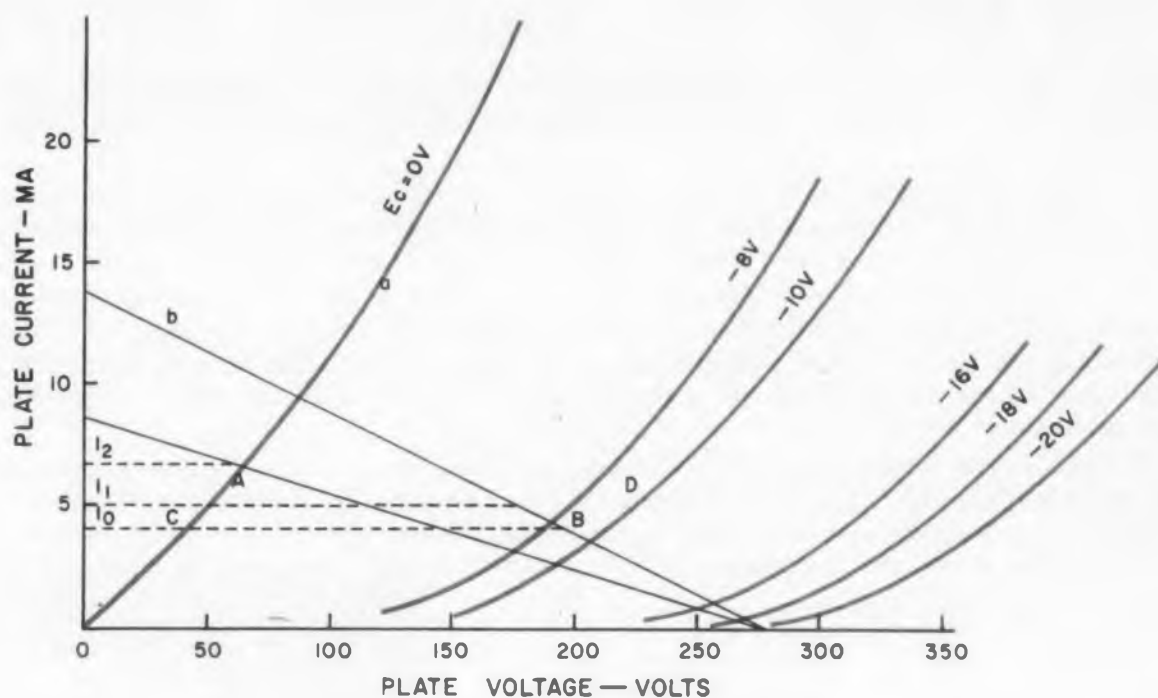


Fig. 2. Plate characteristics of the 5963 dual triode.

the point of intersection of this line with the load line for T_1 . The tube will operate very close to this point when $E = E_{max}$. Load current here is designated I_1 . A closer approximation to the operating point can be made, if desired, by applying Eq. 10, using for K values of grid bias close to the intersection point. Usually, the linearity of the characteristics is sufficient to make this unnecessary.

9. The value T/RC should be kept small for reliable delays. Suggested values are 0.1 to 0.5. The value of T/RC may now be determined from the equation.

$$\frac{T}{RC} = \ln \frac{E_{bb} + I_1 R_{L1} - I_2 R_k}{E_{bb} - E_{co2} - I_1 R_k} \quad (11)$$

If T/RC is too large (above about 0.5), a larger value of I_2 can be used to reduce it. Calculations, starting with Step 1, must then be repeated.

10. After determining T/RC , and knowing the desired maximum delay T , RC may be calculated. For fast recovery, C should be small, and R should not exceed the practical limit of 5 to 10 meg. Large values of R will yield instability due to high-impedance noise pickup.

This completes the design of the multivibrator, which should operate linearly between grid potentials, E_{min} and E_{max} .

Design Example

Using a 5963 tube, it is desired that a multivibrator be constructed which will delay for a variable period up to one msec and will give a negative-going output change at the end of the delay

period of 150 v. The supply potential is 275 v.

The step-by-step procedure described will now be carried out numerically.

1. Given

$$\Delta_{ab2} = 150 \text{ v}$$

$$\Delta_{ab2} = I_2 R_{L2} = 150 \text{ v}$$

On Fig. 2, the clamp line (*a*) is located, and a current below the maximum dissipation is selected. A safe value $I_2 = 7$ ma.

$$I_2 R_{L2} = 150 \text{ v}$$

$$R_{L2} = \frac{150}{7} = 21.4 \text{ K} \approx 22 \text{ K.}$$

The nearest standard value, 22 K, was selected. I_2 is corrected to

$$I_2 = \frac{\Delta_{ab2}}{R_{L2}} = 6.8 \text{ ma.}$$

The clamp point (*A*) of *Tube 2* is now marked at $I_2 = 6.8$ ma on the $E_c = 0$ line.

2. A line is now drawn from *A* to the base line, intersecting at $E_{bb} = 275$ v. The slope is found to correspond to $R_{L2} + R_k = 32$ K. $R_k = (32 - 22)$ K = 10 K. This is a standard value and no correction is required.

3. Arbitrarily set $R_{L1} = R_k = 10$ K.

4. First approximation for I_o . $E_{pk2} = 275$ v. E_{co2} corresponding is found on Fig. 2, and is approximately -20 v.

$$I_o = \frac{I_2 R_k - E_{co2}}{R_{L1} + R_k} = \frac{6.8 (10) + 20}{20} = 4.4 \text{ ma.}$$

(continued on p 54)

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5. Second approximation for I_o .

$$E_{pk2} = E_{bb} - I_o R_k = 275 - 4.4 (10) = 231 \text{ v}$$

E_{co2} corresponding is -17 v .

$$I_o = \frac{6.8 (10) + 17}{20} = 4.25 \text{ ma.}$$

6. The *Tube 1* load line is now drawn with slope equal to $2 R_k = 20 \text{ K}$. This is line (b) on Fig. 2. The grid-to-cathode voltage when $I_o = 4.25 \text{ ma}$ on this line is (point B) -9 v .

$$E_{c1} = -9 \text{ v.}$$

$$E_{min} = E_{c1} + I_o R_k = -9 + 4.25 (10) = 33.5 \text{ v.}$$

Thus, the minimum linear response is obtained when $E = E_{min} = 33.5 \text{ v}$.

7. $E_{max} = I_2 R_k + E_{co1}$. E_{co1} is associated with $E_{pk1} = E_{bb} - I_2 R_k$

$$E_{pk1} = 275 - 6.8 (10) = 207 \text{ v.}$$

$$E_{co1} = -15 \text{ v.}$$

$$E_{max} = 6.8 (10) - 15 = 53 \text{ v.}$$

The operating point of *Tube 1* is next located.

$$8. \quad I' = \frac{E_{max} - 53}{R_k} = \frac{53}{10 \text{ K}} = 5.3 \text{ ma.}$$

This current is located on the clamp line, and marked point (c).

Arbitrarily set $K = -10 \text{ v}$

$$I'' = \frac{E_{max} - K}{R_k} = \frac{53 + 10}{10 \text{ K}} = 6.3 \text{ ma.}$$

On the $E_c = -10 \text{ v}$ line, locate I'' and mark as point D. Connect points C and D with a straight line. The intersection of this line with the *Tube 1* load line (b) gives $I_1 = 5.0 \text{ ma}$.

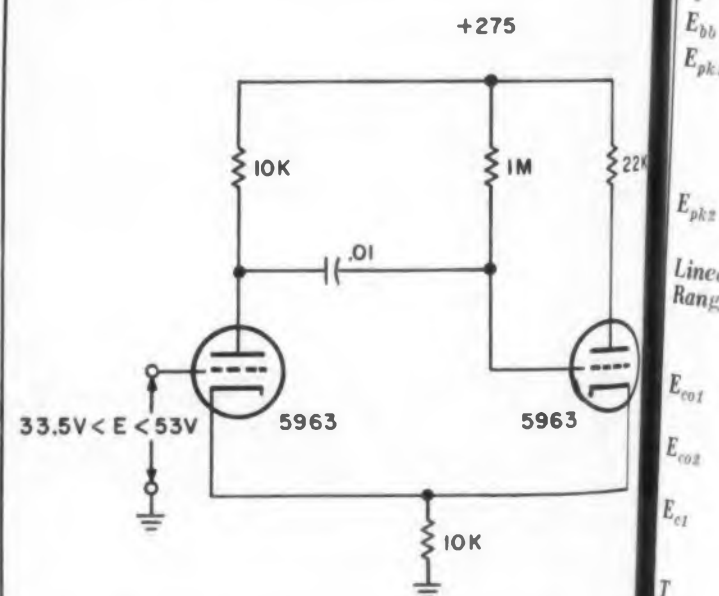


Fig. 3. Final circuit, including component values, of the one-shot multivibrator used in the design example.

$$9. \quad \frac{T}{RC} = \ln \frac{E_{bb} + I_1 R_k - I_2 R_k}{E_{bb} - E_{co2} - I_1 R_k}$$

$$= \ln \frac{275 + 5(10) - 6.8(10)}{275 + 17 - 5(10)}$$

$$= \ln \frac{275}{242} = \ln 1.11 = 0.105.$$

$$10. \quad T = 1 \text{ msec} - 0.001 \text{ sec.}$$

$$RC = \frac{0.001}{0.105} = 9530 \mu\text{sec.}$$

Arbitrarily let $R = 1 \text{ meg.}$

$$C = \frac{9530 \times 10^{-6}}{1 \times 10^6} \approx 10000 \text{ pf} \approx .01 \mu\text{f.}$$

This completes the design. The final circuit is shown in Fig. 3. ■ ■

Glossary

Clamp line	Clamp level. A tube operating with zero bias potential between grid and cathode is said to operate "in clamp". This is because of grid current drawn through the grid resistor. This current will tend to push the bias level toward zero volts. Hence, the "clamp line" is the line on tube Characteristics where $E_c = 0$.
I_t	The highest value of current flow through Tube 1 for which the stage is not free-running. It is also the upper limit of the linear range of delay action.
I_o	The lowest value of current flow through Tube 1 for which the stage can be triggered. It is also the lower limit of the linear range of the delay action.
I_2	Clamp level current in Tube 2.
E_{bb}	The applied B+ potential.
E_{pk1}	The plate-to-cathode potential of Tube 1. Usually used in conjunction with the tube characteristics to determine cutoff bias necessary to cut stage off.
E_{pk2}	Same as E_{pk1} , except applying to Tube 2.
Linear Range	The range of bias potential E (see Fig. 1) applied to Tube 1 grid which produces a linear delay in the Tube 2 plate output waveform.
E_{co1}	The cathode-to-grid voltage required to cut off Tube 1.
E_{co2}	Same as E_{co1} , but applying to Tube 2.
E_{c1}	The grid-to-cathode potential associated with Tube 1 when a current I_o flows in Tube 1.
T	The desired delay period, in seconds.

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Type	DC. Anode Forward Voltage	Peak Cathode Current
7559	18KV	1500A
7568	25KV	800A
7605	25KV	2500A

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Design Considerations for Nonlinear Function Generators



For almost four years, Chalmers Riley has been designing analog and digital systems for missile guidance and ground support. In his work he found many applications for the type of nonlinear function generator he describes here.

Chalmers G. Riley
Guidance and Control Lab.
Army Ballistic Missile Agency
Redstone Arsenal, Ala.

WITH THE CORRECT reference signal, the generator described here can deliver almost any type of nonlinear function. The reference can be controlled by a nonlinear potentiometer with output mechanical or electrical.

Such a nonlinear function generator can be used for a wide variety of applications. Its output can be used, for example, as an input for a servo system being analyzed; it can be used for automatic-pilot control of aircraft and missiles; it can represent the velocity, acceleration, trajectory, wind resistance, and heating effects of a missile in flight; and it can represent the damping and angular frequency of a servo system so the system's stability and frequency response can be measured.

The nonlinear function generator, shown in Fig. 1, generates a required function with a cor-

rect time constant. The device is basically a rate or velocity servo with a simple positioning system.

Design Must Offset Four Basic Error Types

In this type of motor-integrator servo there are four primary causes of error. These are:

1. Motor friction constant,
2. Nonlinear characteristics,
3. Noise,
4. Motor time constant.

There are other sources of error, such as quadrature voltage, temperature variation and gear backlash. These may be minimized by careful design and selection of components.

This type of system requires high gain to minimize steady-state error. With high gain, a step input may cause transient saturation. Nevertheless, linear operation resumes where the motor speed builds up enough for the tachometer voltage to reduce the error below the saturation level. A high-gain integrator helps to reduce the error signal.

Such a system must transfer a nonlinear func-

tion of voltage into a proportional shaft rotation. This requires a transducer to transfer the mechanical rotation to a proportional voltage. The transducer gives the reference voltage required to produce the necessary nonlinear shaft rotation.

The function generator then gives a nonlinear mechanical output. The speed of the function depends on the gear ratio between the motor and the reference transducer.

The closed-loop transfer function of the generator can be derived from the block diagram of Fig. 2. The motor transfer function is

$$\frac{V_m}{\theta_o} = \frac{K_v}{S(1 + T_m S)} \quad (1)$$

The closed-loop transfer function of the system with a step input is

$$\frac{\theta_o}{\theta_i} = \frac{GK_v K_p}{T_m \left[S^2 + \frac{(1 + GK_v K_3)S}{T_m} + \frac{GK_v K_p}{NT_m} \right]} \times \frac{1}{S} \quad (2)$$

The roots may be found by the quadratic equation. Then the function will be in its usual form.

$$\frac{\theta_o}{\theta_i} = \frac{GK_v K_p}{T_m(S + T_1)(S + T_2)S} \quad (3)$$

where $S = -\left(\frac{1 + GK_v K_3}{2T_m}\right)$

$$\pm \frac{1}{2} \sqrt{\left(\frac{1 + GK_v K_3}{T_m}\right)^2 - \frac{4GK_v K_p}{NT_m}} \quad (4)$$

If $S = X \pm Y$, then $T_1 = X + Y$ and $T_2 = X - Y$. Applying the inverse Laplace of the function to the equation, it becomes

$$\frac{\theta_o}{\theta_i} = \frac{GK_v K_p}{T_m} \left[\frac{1}{T_1 T_2} + \frac{T_1 e^{-T_2 t} - T_2 e^{-T_1 t}}{T_1 T_2 (T_2 - T_1)} \right] \quad (5)$$

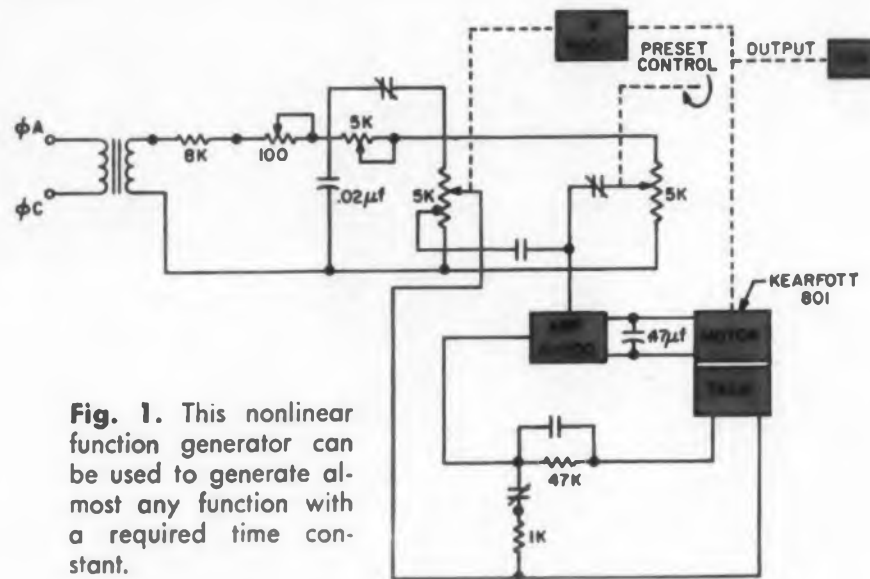


Fig. 1. This nonlinear function generator can be used to generate almost any function with a required time constant.

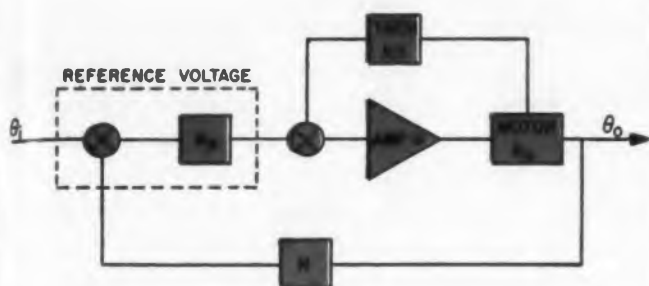


Fig. 2. Block diagram of the function generator helps designer derive system transfer function.

This type of servo system, with the required input reference, can be made to produce almost any kind of nonlinear function with a controlled time constant. There are many ways to accomplish this. One way would be to use a potentiometer with a large number of taps so the reference voltage will follow a certain curve. Another method would be to use a vernistat for reference control.

Nonlinear Function Generator Helps in Missile Guidance

In many applications it is necessary for a missile to follow a prescribed acceleration curve. An error-sensing device must be incorporated in the missile guidance to see that it follows the required acceleration curve. This can be done many different ways depending on the actual curve the missile must follow.

This curve in most cases, approaches an exponential waveform. The exact wave depends on certain characteristics of the missile frame and engine. To match this curve, an exponential generator is required.

As the missile begins to accelerate the programmed acceleration starts and these two signals are compared. The difference between the programmed and the actual curve is fed to a correcting servo unit.

Neglecting Motor Time Constant Simplifies Design

Suppose that an exponential program curve is required with a time constant of 12.5 sec. To illustrate the effect of the motor time constant T_m , it can be considered to be zero. This is a reasonable assumption since the time constant of the generated exponential is approximately 350 times greater than that of the motor.

If the assumption $T_m = 0$ is made, Eq. 2 reduces to

$$\frac{GK_p K_p}{(1 + K_3 K_3 G) \left(s + \frac{GK_p K_p}{(1 + K_3 K_3 G) N} \right)} \times \frac{1}{s} \quad (6)$$

If the open-loop frequency response curve of the system were plotted it would show that the system was slightly unstable. However, the ta-

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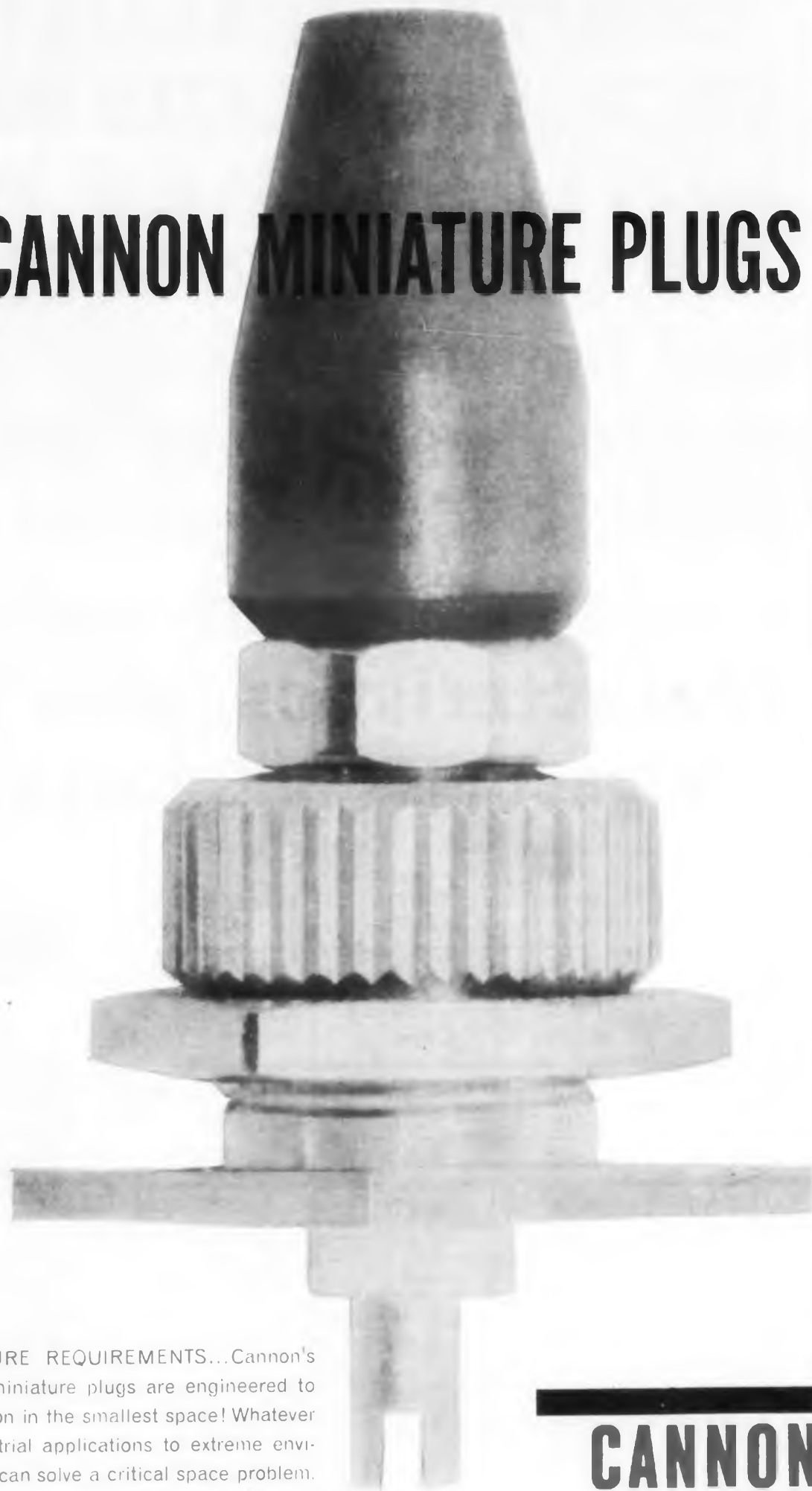
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chometer will furnish negative feedback to give the necessary damping factor for stabilization. In fact, a motor-tachometer can be used instead of an inertially damped motor. An inertially damped motor would introduce three time constants to the system which would not only increase the time-constant error but would make the calculations more cumbersome.

The inverse Laplace when reduced to its natural form is

$$\frac{\theta_o}{\theta_i} = N \left[1 - e^{-\frac{(GK_v K_p) t}{(1 + K_3 K_v G) K_n}} \right] \quad (7)$$

where
$$T = \frac{(1 + K_3 K_v G) N}{GK_v K_p} \quad (8)$$

However, if the assumption $K_3 K_v G \gg 1$ were made

$$T = \frac{N K_3}{K_p} \quad (9)$$

Gear Ratio and Reference Play Dominant Role

Eq. 9 shows that only two factors play an important part in determining the time constant of the exponential—the gear ratio N and the reference signal K_p . K_3 is the scale factor of the tachometer which is constant. The amplifier gain and motor constants have very little effect on the exponential's time constant.

If the exponential's time constant were not too critical, this method, along with the assumption made, would be the most straightforward design. However, if these assumptions cannot be made the calculations become more cumbersome as shown by Eq. 5.

The foregoing derivations can be used to design a typical system. A typical requirement might be to design a program to generate an exponential with a time constant of 12.5 sec. The motor is to drive an error sensing device. With this information and available materials the following constants can be used.

Motor constant = $K_v = 12.2$ rad/sec (Kearney 801 Motortach)

Gear ratio = $N =$ rad/rad

Amplifier gain = $G = 200$ v/v

Motor time constant = $T_m = 0.0345$ sec.

Tachometer scale factor = $K_3 = 0.03$ v/rad

Reference potentiometer scale factor = $K_p = 1.2$ v/rad

First the gear ratio can be determined with motor time constant T_m assumed to be zero $K_3 K_v G$ much greater than 1.

$$N = \frac{TK_p}{K_3} = \frac{12.5 \times 1.2}{0.03} = 500$$

If the assumption $K_s K_v G \gg 1$ were not made the error from 12.5 sec would be 0.17 sec.

$$T = \frac{(1 + K_s K_v G) N}{G K_v K_p} = \frac{(1 + 0.03 \times 12.2 \times 200) 500}{200 \times 12.2 \times 1.2} = 12.67 \text{ sec.}$$

With this information and the previous derivations the three exponentials can be written as

$$\frac{\theta_o}{\theta_i} = 500 (1 - e^{-t/12.5}) \text{ for } T_m = 0$$

$$\frac{\theta_o}{\theta_i} = 500 (1 - e^{-t/12.67}) \text{ for } T_m = 0 \text{ and } K_s K_v G \gg 1$$

$$\frac{\theta_o}{\theta_i} = 500 (1 - e^{-t/12.48}) + 0.018 e^{-t/0.00047} \text{ (No assumptions).}$$

It is noteworthy that, in each equation, the maximum magnitude of the exponential is equal to the gear ratio. Since the motor time constant is included in the third equation, a new term is introduced.

However, this term is so small in comparison with the others it can be neglected. Also in the third equation, there are two time constants, T_1 and T_2 . T_2 is so small it can be neglected. T_1 differs from 12.5 sec by almost the amount of the motor time constant.

A system identical to the one shown in the example has been constructed. The system was first preset, by a dial, to the desired acceleration and when a relay switch was thrown for program operation. The results gave an exponential with a time constant that was less than 10 per cent off the desired results. It took approximately six time constants for the system to null.

Since the curve was not a true exponential, and the time constant has an error, other means were necessary to correct this. The time constant can be regulated by biasing the reference voltage (K_p). This is a logical place for vernier control. This can be done by adding a pot in series with the reference pot. Then the time constant can be adjusted to within two per cent.

This accuracy can be increased if quadrature detection and temperature stabilization are used. The curve can be made to match an exponential by making the reference pot nonlinear. However, this requires external taps on the pot.

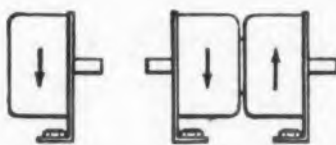
The mechanical output of the function can be fed to an error sensing device, such as a control differential transmitter (CDX). This is a device that will compare a shaft rotation or position with an electrical signal to give an electrical difference. This difference can be fed to a correcting servo which would continuously compare the two values and correct the difference. ■ ■



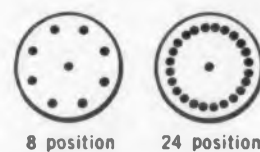
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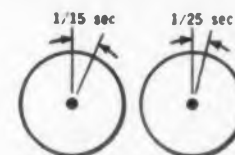


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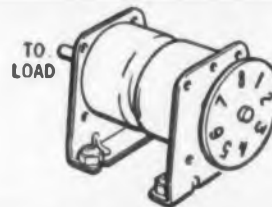
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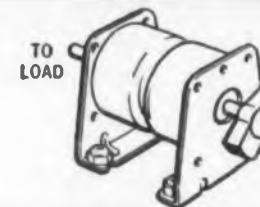
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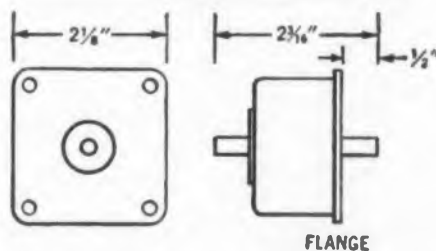
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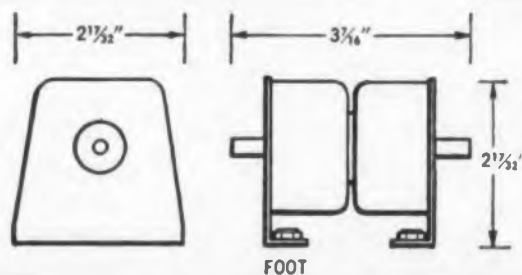
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Simple Analog Circuit Solves Heat Flow Problems

Richard J. Allen, Emil C. Muly*

Missiles and Electronics Div.
The Martin Company
Baltimore, Md.



The problem of determining the heat flow through one or more solid materials to a constant temperature sink is often encountered by the electronic designer. Heat flow provides a limit to the power capacity of transistors and to the frequency response of thermal detectors such as bolometers and barretters. In many practical problems, the incident thermal energy of the heat source may vary periodically. A knowledge of heat flow is therefore required to determine the time constant and thermal phase shift through the conducting mass. In this article, authors Dick Allen (above) and Bud Muly present a beautifully simple analog technique to solve these problems quickly.

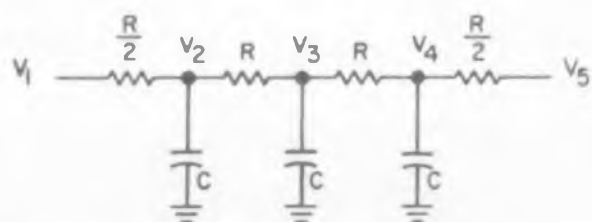


Fig. 1. RC ladder network—basic building block of the analog computing circuit.

THERE are several approaches to solving the problem of one-dimensional heat flow. One approach uses rigorous mathematics to solve the partial differential equations for the particular boundary conditions. While this leads to precise results, it becomes, at times, extremely unwieldy.

A more practical approach is the analog solution. While it is not at all novel, it is often either overlooked or considered unavailable to the designer. An electrical circuit is set up with param-

eters analogous to the thermal parameters of the problem. The vision of using large computers and costly programming time quite often discourages further interest in this approach. However, the problem, even in its more complex forms, may be solved quite rapidly by using an easily assembled "computer" comprised solely of conventional electrical laboratory equipment. This flexible computer circuit will also solve for the thermal phase shift and time constant.

General Heat Flow Equation— Basis For The Analog

The equation of heat conduction is given as follows:

$$\nabla^2 T = \frac{1}{\alpha^2} \frac{\partial T}{\partial t} = \frac{C_p}{K} \frac{\partial T}{\partial t}$$

Where

T = the temperature = $T(x, y, z, t)$

*Now with Dept. of Electrical Engineering, Northwestern University, Evanston, Ill.

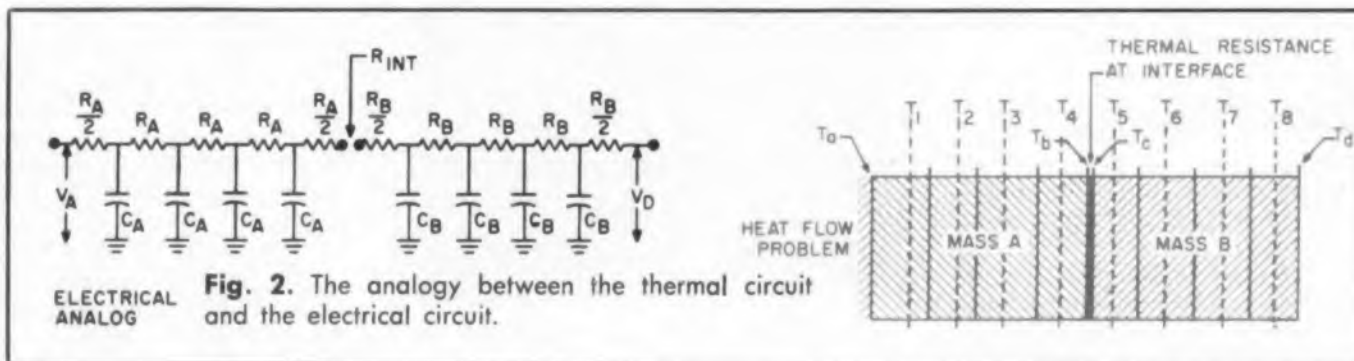


Fig. 2. The analogy between the thermal circuit and the electrical circuit.

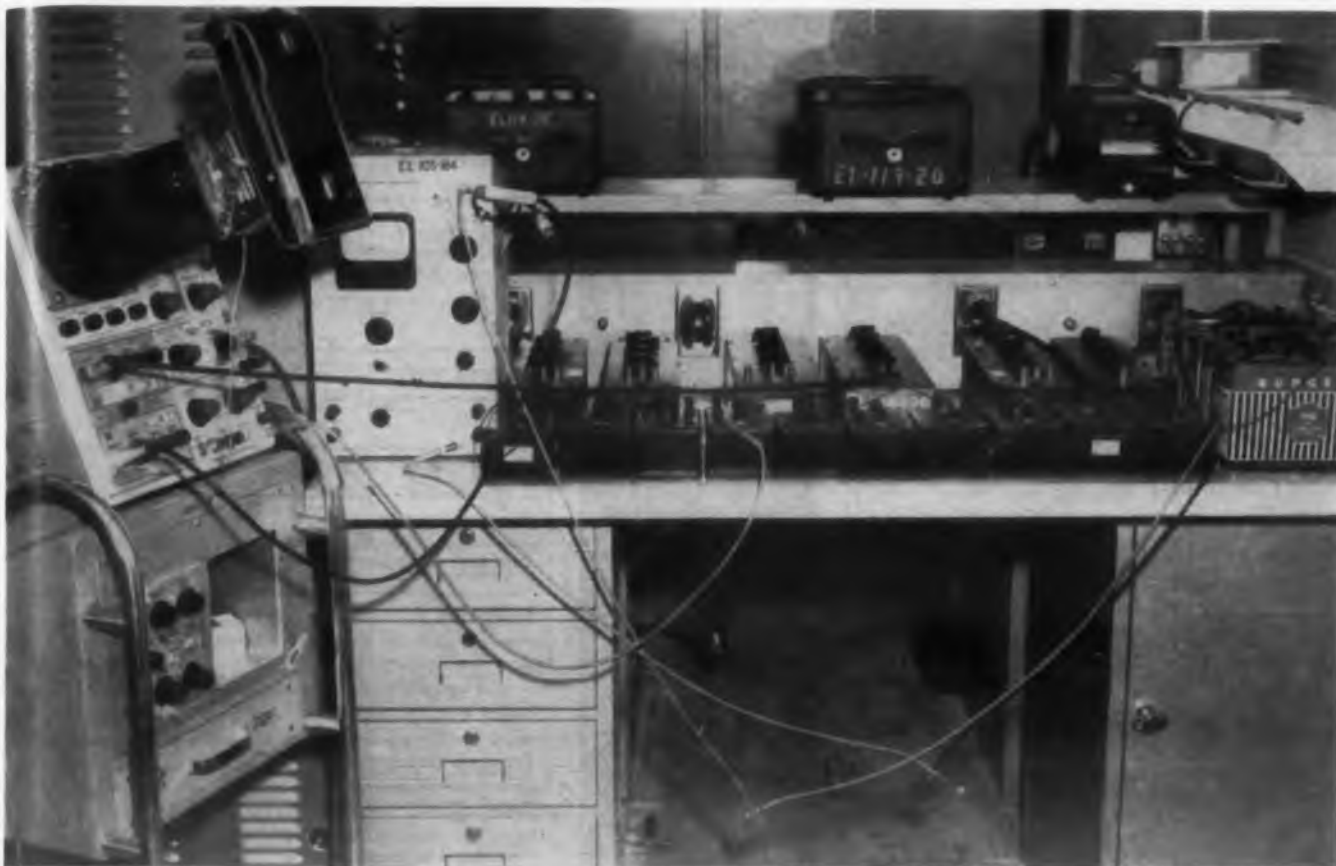


Fig. 3. Decade capacitors and resistors, with power supply and scope form a desk-top computer.

α^2 = the thermal diffusivity of the material

t = time

C_v = specific heat/unit volume

K = thermal conductivity

For the case of one-dimensional heat flow, the heat-conduction equation reduces to:

$$\frac{\partial^2 T}{\partial x^2} = \frac{C_v}{K} \frac{\partial T}{\partial t} \quad (2)$$

Taking Laplace Transform in time, we obtain

$$\frac{\partial^2 T}{\partial x^2} - \frac{C_v}{K} sT = 0 \quad (3)$$

If we make the approximation to the space derivative,

$$\frac{\partial T}{\partial x} = \frac{T_{n-1} - T_n}{\Delta x} \quad (4)$$

$$\frac{\partial^2 T}{\partial x^2} = \frac{T_{n+1} - 2T_n + T_{n-1}}{(\Delta x)^2} \quad (5)$$

the heat-flow equation then becomes

$$\frac{K}{(\Delta x)^2} T_{n+1} = \left(C_v s + \frac{2K}{(\Delta x)^2} \right) T_n - \frac{K}{(\Delta x)^2} T_{n-1} \quad (6)$$

Electrical Analog Of The General Equation

Solving for the nodal voltages of the RC ladder network, Fig. 1, yields an expression of the form

$$\frac{V_{n+1}}{R} = \left(CS + \frac{2}{R} \right) V_n - \frac{V_{n-1}}{R} \quad (7)$$

where $n = 2, 3, \dots$

The similarity with Eq. 6 for the heat flow prob-

lem is quite apparent. The analogies are

$$R \sim \frac{\Delta x}{K}$$

$$C \sim C_v (\Delta x)$$

$$V_i \sim T_i$$

This is also evident from the nomenclature. Electrical resistivity is analogous to the inverse of thermal conductivity, $1/K$ (or thermal resistivity). Electrical capacity, C , is analogous to thermal capacity, C_v , and electrical potential, V_i , is analogous to thermal potential or temperature, T_i .

Table 1 lists the thermal conductivity and specific heats (heat capacity) of a number of materials in general engineering use. For setting up the analog, the values of K and C_v are obtained from this table. The value of Δx is obtained from the thermal circuit itself.

A schematic illustration of the analogous situations is shown in Fig. 2. If an electrical circuit is constructed of components with values proportional to the thermal quantities, scaled where necessary to obtain practical values and if a voltage source is applied which is also related to the thermal source, the solution to the heat flow problem can be computed. The circuit may be readily assembled with components available in almost any electrical laboratory. A computer of this construction is shown in Fig. 3.

A voltage supply with a wave form similar to the input temperature variation is used for transient response. A dc bias may be added to provide the steady-state component. The voltage

Table 1. Thermal Conductivity and Specific Heats of Common Engineering Materials at Room Temperature

Material	K Normal Conductivity [$\frac{\text{cal}}{\text{cm-sec-C}}$]	C, Specific Heat [$\frac{\text{cal}}{\text{gm}}$]
Aluminum	0.480	0.214
Asbestos	0.0006	0.195
Chromium	0.161	0.111
Copper	0.92	0.0928
Germanium	~ 0.137	0.074
Glass		
Crown (window)	0.0025	0.161
Flint	0.002	0.117
Iron	0.174	0.109
Lead	0.082	0.0308
Mica	0.0018	0.206
Polystyrene	0.006	0.182
Quartz (fused)	0.030	0.188
Rubber (synthetic)	0.00045	0.453
Silicon	0.20	0.176
Silver	1.001	0.056
Solder (60-40)	0.135	0.0407
Teflon (tetrafluorethylene)	0.0028	0.137
Tin	0.147	0.0556
Zinc	0.265	0.0936

RND: Heat Flow—ANALOG CIR. Allen & Muly

waveform is then monitored with an oscilloscope at the various nodes. The amplitude of the display gives the temperature profile at that point. The time shift between the input and output waveform gives the phase shift, while the decrease in amplitude, as a function of increased input frequency, yields the thermal time constant.

Approximations and Accuracy Of The Analog

In developing the electrical analog, the distributed parameters of the material, as represented by the differential equations, were approximated by a number of lumped-constant cells as indicated by Eqs. 4 and 5. Since the derivative results from a limit process, a larger number of smaller cells will approximate the derivative more closely. As in any substitution method, the accuracy of the values of the substituted parameters will deter-

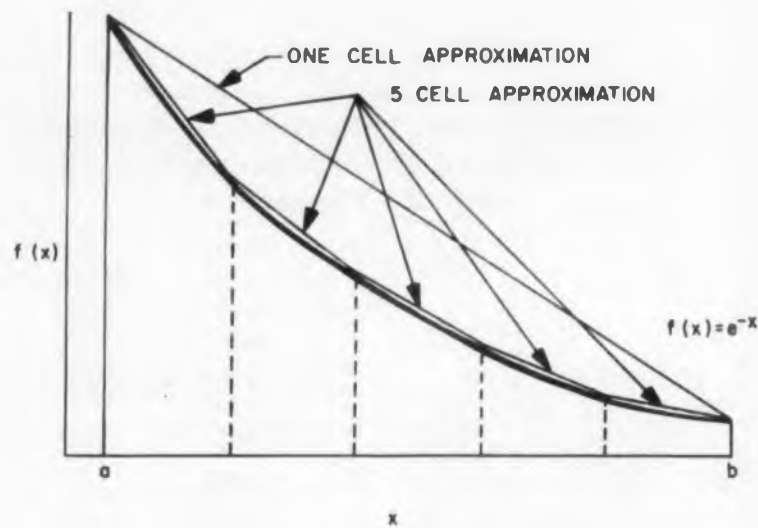


Fig. 4. Approximation of electrical circuits to the actual thermal circuit's characteristics improves with the number of cells.

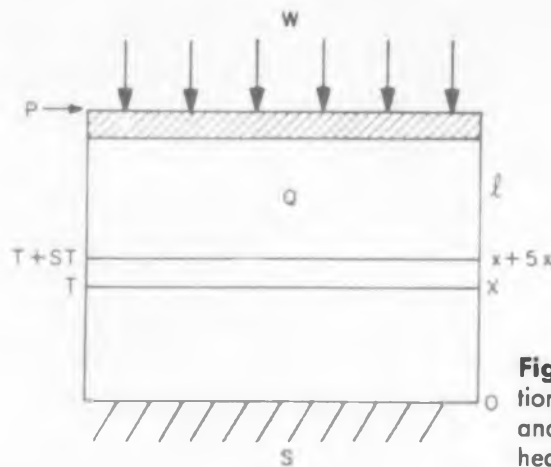


Fig. 5. Schematic representation of the thermal conductor and the parameters involved in heat flow.

mine the accuracy of the analog solution.

In using the analog solution, the approximation of the derivative yields an error as illustrated in Fig. 4. However, since the designer usually knows the general form of the curve, judicious selection of the number of cells can be made to improve the first approximation.

By far the largest error results from the fact that many of the values of the constants which must be substituted into this expression to obtain quantitative results are not known to a high degree of accuracy. This eliminates the need for the mathematical closed form which, as will be shown in the example to follow, can become awkward to handle and time-consuming.

An Example

To see how useful a tool this analog treatment can be, let us look at a sample problem which has been solved using both the mathematical and the analog approaches. Fig. 5 is a schematic diagram of a thermal conductor (actually a solid-backed bolometer operating at 4 K) providing a simple heat flow problem which has been analyzed in a rigorous mathematical fashion.¹ The results of the analysis and the parameters of the problem are presented in summarized form for comparison

with the analog treatment. Let C be the specific heat per unit volume of the region Q ; K , the thermal conductivity of Q ; n be the diffusivity of Q ; G be the total heat capacity of region P ; a , the area of the receiving face and let l be the thickness of Q (0.1 cm). The incoming radiation was assumed sinusoidal and having the form $W = W_0 e^{i\omega t} + 1$, where W_0 is a constant and ω is the angular frequency.

Three Assumptions Made

The following three assumptions have been made in the solution of the problem: The heat flow is one-dimensional and in the direction perpendicular to the receiving face. The element P has a high thermal conductivity so that its temperature is always uniform and equal to that of the adjoining region Q . The temperature of S is constant.

The solution of the heat flow equation is

$$T = \exp(qt) \{ A \exp[(q/n)^{1/2}x] + B \exp[-(q/n)^{1/2}x] \} + Dx + E \quad (8)$$

Where A , B , D , E , and q are to be determined from the boundary conditions. Determining the constants and substituting them, the equation for the temperature distribution then becomes

Table 2. Analogue Solution to Sample Problem

Wave Form	Test Point	Vertical Scale (v/cm)	Scale Horizontal
	Point A	0.2	2 msec/cm
	Square wave	5	2 msec/cm
	Point A	0.2	2 msec/cm
	Square wave	5	2 msec/cm
	Point A	0.1	500 μsec/cm
	Square wave	5	500 μsec/cm
	Point A	0.1	200 μsec/cm
	Square wave	5	200 μsec/cm
	Point B	0.05	200 μsec/cm
	Square wave	5	200 μsec/cm
	Point C	0.05	200 μsec/cm
	Square wave	5	200 μsec/cm
	Point D	0.05	200 μsec/cm
	Square wave	5	200 μsec/cm
	Point E	0.05	200 μsec/cm
	Square wave	5	200 μsec/cm

$$T = \frac{\{ \exp[(q/n)^{1/2}x] - \exp[-(q/n)^{1/2}x] \} \omega_0 \exp(\omega t)}{Ka(q/n)^{1/2} \{ \exp[(q/n)^{1/2}l] + \exp[-(q/n)^{1/2}l] \}} + \frac{\omega_0 x}{Ka} + Gq \{ \exp[(q/n)^{1/2}l] - \exp[-(q/n)^{1/2}l] \}$$

The first term represents how well the element P is able to respond or follow variations in the intensity of the incident radiation. The second term gives the mean temperature rise.

For the purpose of this example, the incident radiation is treated as modulated with a square wave instead of the sine wave used in the mathematical approach. This will not hamper the comparison of the two techniques. If anything, the treatment of the square modulation for the mathematical approach would prove more difficult than that of the sine wave modulation.

Setting Up The Analog

To solve the problem by the analog method, a ladder network analogous to the situation is set up, which is that given in Fig. 1. The values of R , C and V are determined by the proportional relations given following Eq. 7, and from the numerical values of the thermal parameters, such as given in Table 1. In this case, the values differ slightly from those listed due to the different temperature range of the problem, a factor to note

scale
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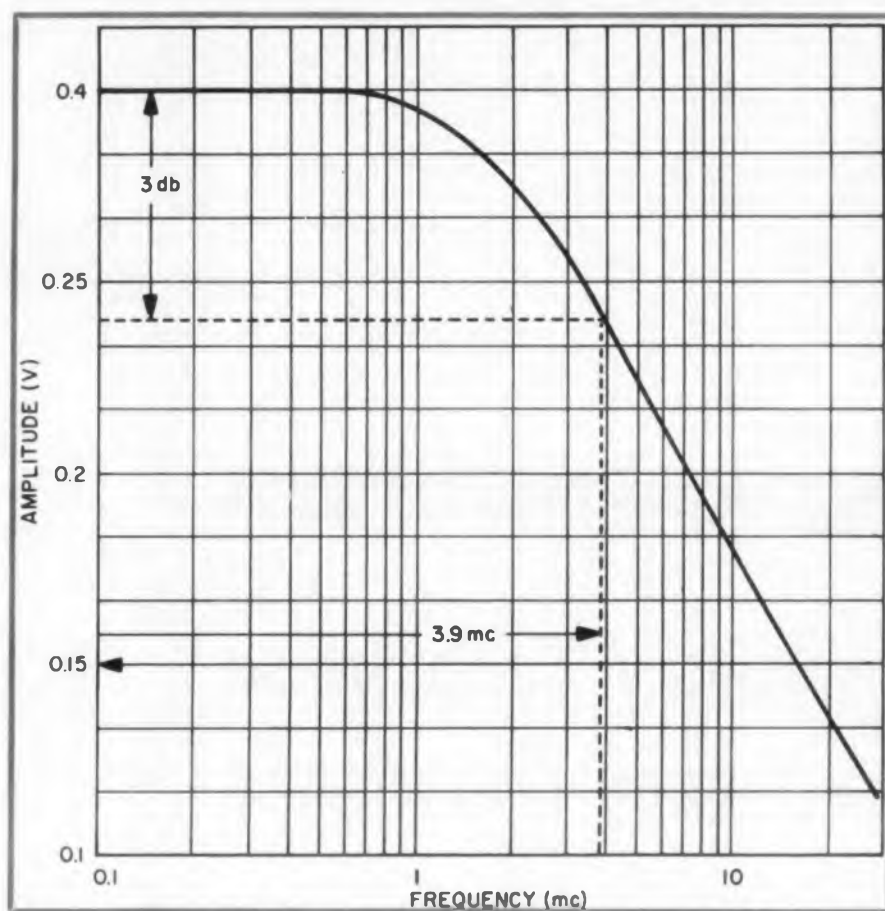


Fig. 6. Frequency response of a 0.1-cm thick aluminum sample, by electrical analog.

Amplitude (v)	Analog Period	Scale Period (sec)	Frequency (cps)
0.4	$7.4 \times 2 \times 10^{-3} 10^{-4}$	14.8×10^{-7}	0.675×10^6
0.34	$2 \times 2 \times 10^{-3} 10^{-4}$	4×10^{-7}	2.5×10^6
0.2	$3 \times 5 \times 10^{-4} 10^{-4}$	15×10^{-8}	6.66×10^6
0.13	$2.3 \times 2 \times 10^{-4} 10^{-4}$	4.6×10^{-8}	21.7×10^6

before applying the listed values to all situations. At the temperature of interest, the value of specific heat of the material under question (that is aluminum), is 5.33×10^{-5} cal/gm deg K.²

In addition to the knowledge of the value of specific heat and thermal conductance of the aluminum, the (ρ) or mass density must also be known. This will allow us to change the specific heat/mass into specific heat/volume. The mass density for aluminum is 2.70 gm/cm³. It was decided that the analog could be given by the use of 5 RC network combinations. This meant that Δx then became 0.02 cm.

Therefore,

$$\frac{\Delta x}{K} = 0.0027$$

$$C\rho\Delta x = 28.8 \times 10^{-7}$$

Scaling the computer as follows:

$$R_a = 0.0027 \times 10^5 = 270 \text{ ohms}$$

$C_a = 28.8 \times 10^{-7} \times 10^{-1} = 0.288 \mu\text{f}$, computer time, T_n , then becomes

$$T_n = 10^{-4} T$$

*This is specific heat/unit mass—while the thermal conductivity is 7.41 cal/cm deg Ksec.³

Where T is the time associated with the thermal response of the bolometer.

Results

Table 2 represents the results obtained from the analog. The test point A gives the value of the temperature directly at the P - Q interface and, as such, gives the thermal frequency response of the bolometer. The points B, C, D, E and F represent the temperature at points spaced 0.02 cm apart in the bolometer and give a temperature profile across the bolometer itself. The waveforms also indicate the thermal phase shift. Fig. 6 is a plot of the data obtained at point A giving the frequency response to incident thermal radiation upon the bolometer.

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1. Fray, S. J., and Robert, L. M., "A Simple Theory for Solid-Backed Bolometers," *Journal of Scientific Instruments*, Vol 33, March 1956.
2. Dillinger, J. R., "Low Temperature Physics and Chemistry, Proceedings of the Fifth International Conference on Low Temperature Physics and Chemistry," The University of Wisconsin Press, 1958.
3. Communicated by R. B. Scott, National Bureau of Standards Cryogenic Engineering Laboratory, Boulder, Colo.

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Sweep-Frequency Techniques For Measuring High-Frequency Impedance

Ken Simons

Jerrold Electronics Corp.

Philadelphia, Pa.

"The combination of accurate impedance measurements at single frequencies with a sweep presentation yields a tremendously powerful and little-used technique." So says author Ken Simons. He sees sweep measurement as a "wide-screen" view of a situation and contrasts it with the "peep-hole" single-frequency approach. Ken Simons has spent 8 of his 30 years in electronics with Jerrold.

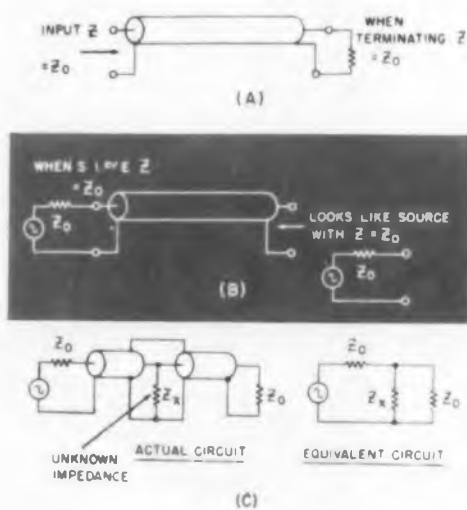
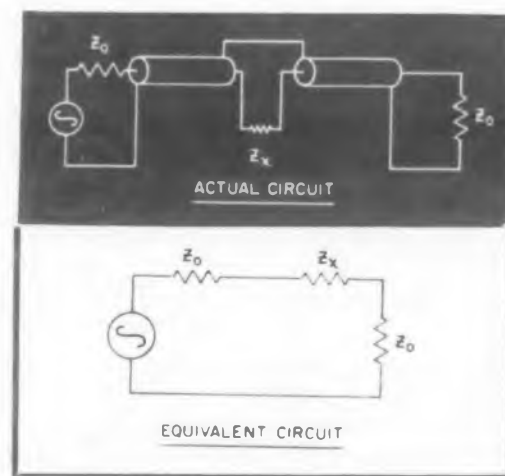


Fig. 1. Measurement by bridging loss is possible because a matched line has the same impedance at any point along the line.

Fig. 2. Series-loss measurements may be more convenient than bridging-loss measurements—depending on impedance level and physical configuration of the tested circuit.



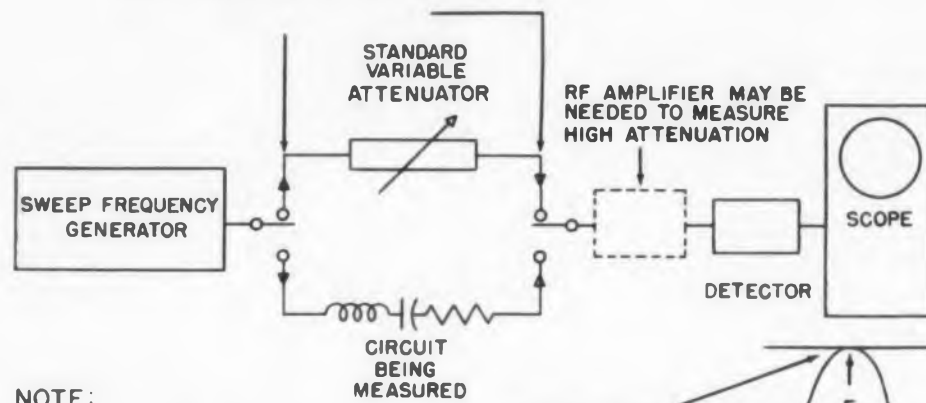
FOR MEASURING high-frequency impedances sweep-frequency techniques can offer a great convenience. They can often avoid the need for expensive specialized equipment. They can help avoid oversights which can result from a single-frequency view.

When the impedance to be measured is part of a resonant system with a bandwidth less than about 10 per cent of center frequency, two measurement techniques are particularly useful—measurement by bridging loss and measurement by series loss.

Measurement by Bridging Loss

The impedance seen at the input of a section of transmission line which is terminated by its characteristic impedance is the characteristic impedance, as illustrated in Fig. 1A. For low-loss lines it is a pure resistance.

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NOTE:

5 OR 10db PADS AT POINTS MARKED \uparrow INCREASE MEASUREMENT ACCURACY BY IMPROVING IMPEDANCE MATCH

AT FREQUENCY F WHERE LINE CROSSES CURVE ATTENUATION OF UNKNOWN EQUALS THAT OF STANDARD.

Fig. 3. A sweep-frequency technique for accurate attenuation measurement.

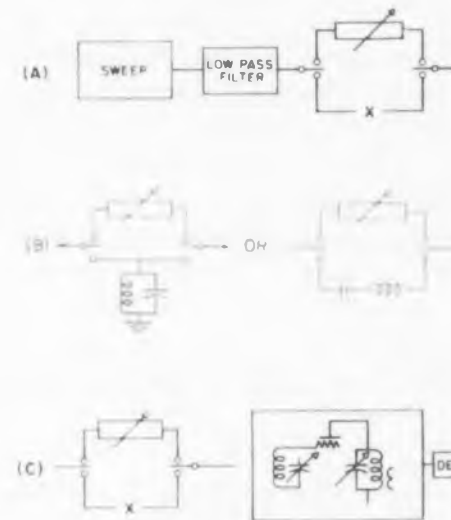


Fig. 5. Techniques for minimizing harmonic errors. (A) shows the use of a low-pass filter; (B) suggests configurations with attenuation minima at resonance; (C) suggests use of a tuned amplifier or receiver following the test jig.

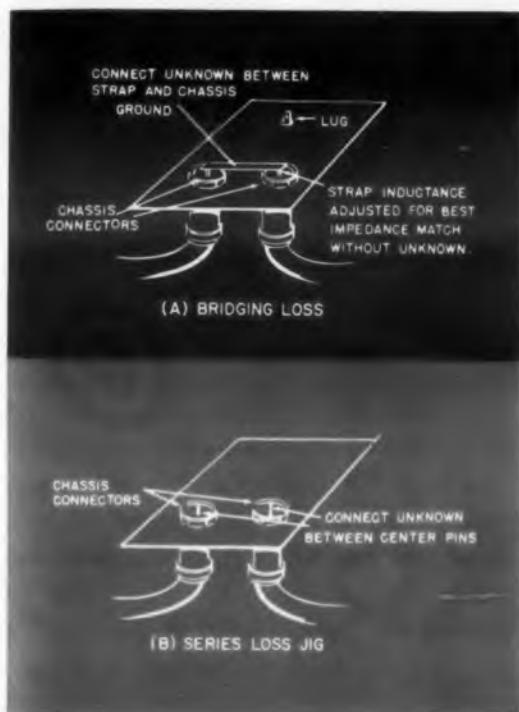


Fig. 4. Convenient test jigs for connecting unknowns.

measure both quantities, it is possible to relate the resistance and reactance of the unknown to the magnitude and phase angle of the loss. However, in many practical situations, other factors indicate that the unknown is either a pure resistance or a pure reactance.

In these cases, the magnitude of the unknown is determined by a simple attenuation measurement. The relationships can be calculated as shown in Appendix 1 or read from Nomogram 1 which relates bridging loss to attenuation.

Measurement by Series Loss

Bridging is not the only way an unknown impedance can be connected into a matched system. One may also open the center conductor at a junction and insert the unknown in series as shown in Fig. 2.

The loss that is introduced is a measure of the impedance in this case also. For unknowns that are purely resistive or purely reactive, the loss can be calculated as in Appendix 1 and the resulting relationship drawn up in the form of Nomogram 2.

Measurement Technique

For reasonable accuracy, certain precautions are essential:

- Accurate impedance measurement depends on accurate attenuation measurement. The comparison technique of Fig. 3 is one of the recommended approaches.

In this technique, a high-speed coaxial switch compares the insertion loss of the circuit under test with that of a standard variable attenuator. For a 60-cps sweep rate the switch should operate 30 times a second.

The scope display shows a horizontal line as well as the response curve of the circuit under test. The line crosses the response curve at points where the attenuation of the standard equals the attenuation of the circuit under test. The accuracy of this measurement is limited chiefly by the accuracy of the standard attenuator.

The use of carefully matched fixed attenuator pads with 5 or 10-db loss will guard against impedance mismatch in associated equipment and will increase accuracy. Such pads are only useful where the unknown has moderate loss or measuring set-up includes a high-gain rf amplifier.

- Any convenient physical arrangement can be used for a test jig if the system characteristic impedance is maintained. Two connectors mounted on a metal sheet can be used as shown in Fig. 4. The sheet should be several times larger than the spacing between the connectors to minimize stray coupling from the circuit under test to the rest of the universe.

Where the unknown circuit is itself coaxial (as when a short piece of cable is being tested) it is most convenient to use a "Tee" connector to attach the unknown to the junction.

- Harmonics or other spurious components in the output of the sweep-frequency generator can

Looking back into a line fed from a matched source, the equivalent circuit is a constant voltage in series with a resistor equal to the characteristic impedance Z_0 (Fig. 1B).

Along a matched transmission system, at any point where the line from the source joins the line to the load, the circuit looks like a resistive source feeding a resistive load.

When a given impedance is bridged across an otherwise matched system, the loss of energy transferred to the load is the same as the loss that is calculated when that same impedance is bridged across the load in the equivalent circuit (Fig. 1C).

In general, where the unknown impedance has both resistance and reactance, it is necessary to know both the magnitude and phase angle of the loss introduced to determine the unknown constants. Where suitable equipment is available to

cause errors, particularly when the unknown gives an attenuation maximum at resonance. Fig. 5 shows ways to minimize the effects of spurious signals.

When the measurements are made within an octave band, a low-pass filter cutting off at the upper end of the octave can be used to reduce harmonic errors. Where there is a choice in circuit configurations, the use of those that give attenuation minima at resonance will help reduce the effects of harmonics. Finally, a tuned amplifier or receiver of moderate bandwidth (that is, a television or radar receiver) can be used to minimize harmonics as well as to increase system gain.

Applications of Measurement Techniques

Tuned Circuit Q. (Fig. 6). A convenient way to measure the unloaded Q of a resonant circuit is to determine its resonant resistance by the bridging or series loss method. The Q is then found by comparing this resistance with the reactance of either reactor at resonance, calculated from a known L or C value. The choice of bridging or series connection, and series or parallel resonance is determined by the impedance level and physical configuration of the circuit being tested.

As an example, a coil, space-wound with 15 turns of 16-gage copper wire, is connected in series with a 15 pf TCZ ceramic capacitor. Its bridging loss as a series resonant circuit connected across a 75-ohm system is 31 db at 35 mc. For 31 db, Nomogram 1 indicates a series resistance of 1.1 ohms. The reactance of 15 pf at 35 mc is 303 ohms, so the circuit Q is 303/1.1 or 275.

Attenuation of Short Cables. (Fig. 7). The input resistance of a short section of transmission line

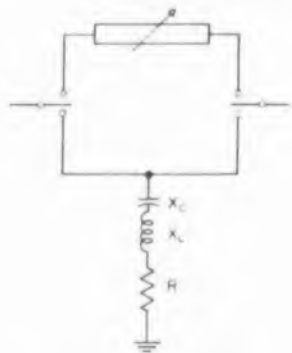


Fig. 6. Test configuration for setup of Fig. 3 and scope waveform for measuring Q. Bridging loss is measured at resonance where $X_C = X_L$ and R is read from the nomogram. Q is given by X_L/R .

Fig. 8. Setup for measuring the input impedance of a vacuum tube.

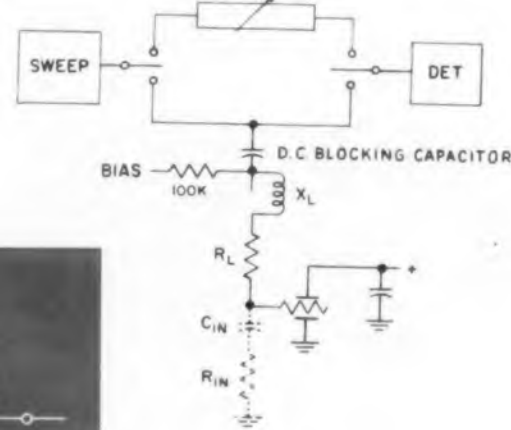
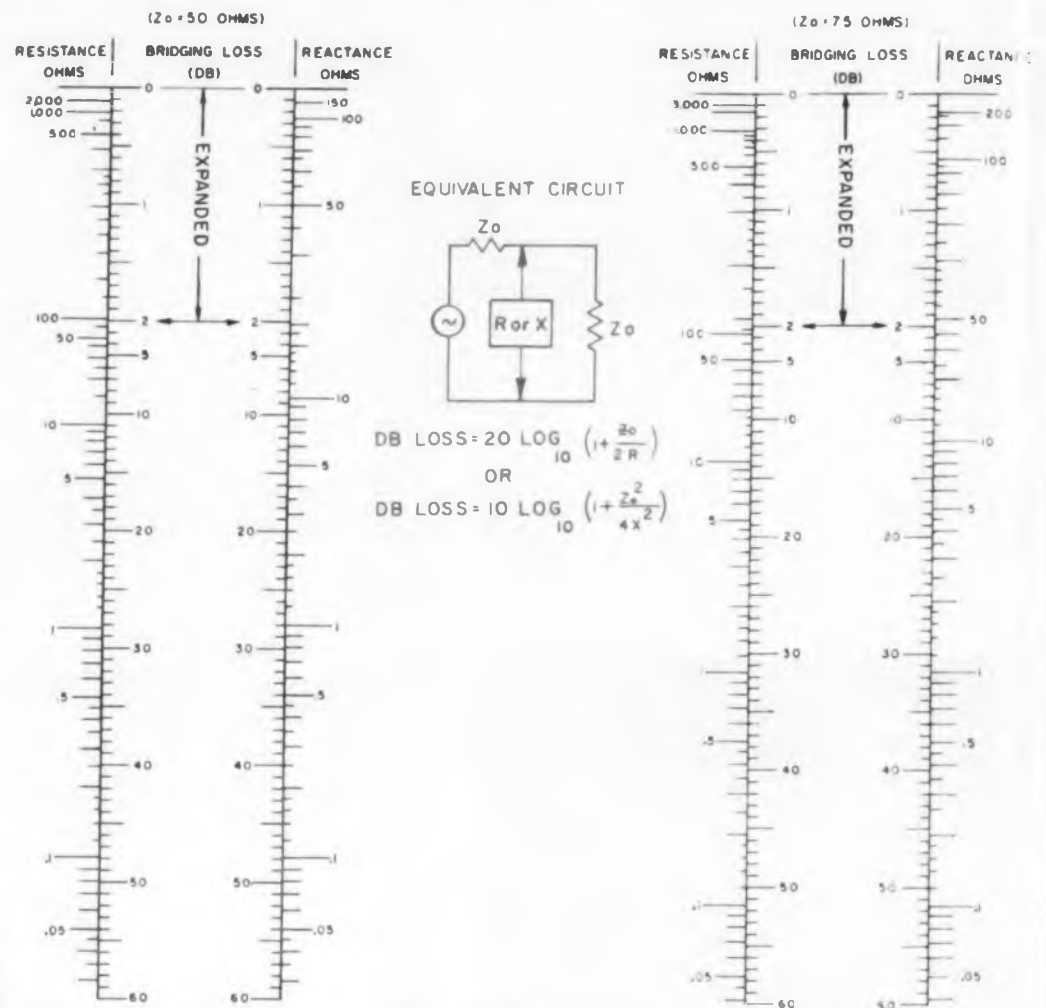
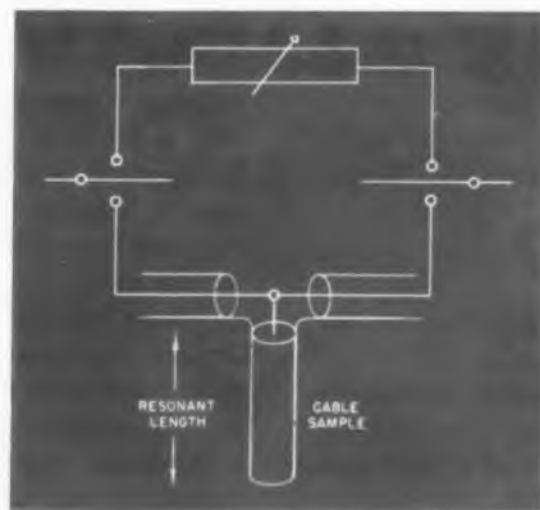


Fig. 7. Setup for measuring loss of short cable sections. At an impedance maximum, A is defined as $(R_{in} - Z_0)/(R_{in} + Z_0)$. The loss in db is then $10 \log A$. At an impedance minimum $A = (Z_0 - R_{in})/(Z_0 + R_{in})$. Again, cable loss is $10 \log A$.



which is open or shorted at the far end is a function of the loss of this line section. Using a coaxial measuring system, the input resistance of a resonant section of coaxial line can be measured most conveniently by the bridging method. The measured resistance is directly related to the attenuation of that line section, and can be used to calculate it. (See Appendix 2).

As an example, the input resistance of a 3-ft section of RG-6/U, open at the far end, is measured by the bridging method and found to give a bridging loss of 31 db at its quarter-wave resonant frequency of 160 mc. Nomogram 1 shows this to correspond to a resistance of 1.1 ohms. This gives an attenuation for this sample of $10 \log (75 - 1.1)/(75 + 1.1)$ or 0.12 db, which is a loss of 4.0 db per 100 ft.

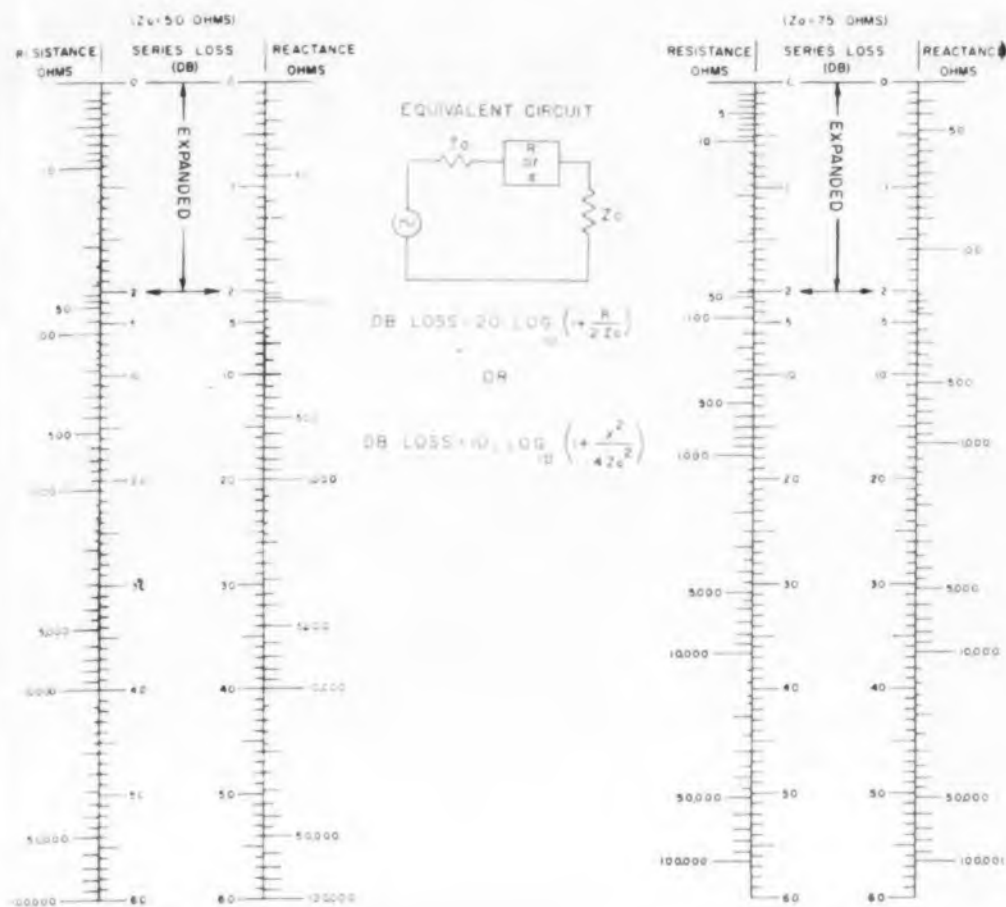
Input Impedance of a Vacuum Tube. (Fig. 8). The input impedance of a vacuum tube at high frequencies can be measured simply by making this impedance part of a series resonant circuit by connecting an inductor in series with the grid. Connecting the other end of the inductor as a bridging load across the measuring circuit allows rapid determination of the bridging loss, and thus of the total series resistance.

The measured resistance includes the losses of the inductor R_L , as well as those of the tube R_{in} . R_L is small if a high Q inductor is chosen, but it can be measured quite accurately by replacing the tube with a high-frade air trimmer, set to give resonance at the same frequency, and measuring the bridging loss of the resulting circuit.

Appendix 1

Calculation of Bridging Loss

Equivalent circuit in Fig. 9.
For Z_L = a pure resistance " R_L ."



Nomogram 2 for Series-Loss Calculations

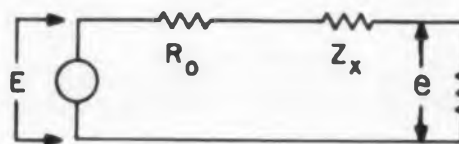


Fig. 9. Equivalent circuit for bridging-loss measurements.

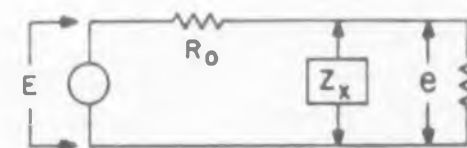


Fig. 10. Equivalent circuit for series-loss measurements.

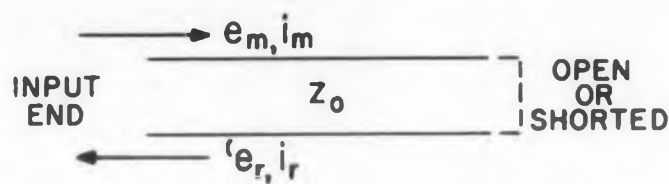


Fig. 11. Main and reflected waves in a transmission line with characteristic impedance Z_0 .

$$e = E \frac{R_x}{R_0 - 2R_x}$$

$$e_{max} = \frac{E}{2}$$

$$\frac{e_{max}}{e} = \frac{R_0}{2R_x} + 1$$

$$e_{max} = \frac{E}{2} \text{ (when } R_x = 0) \frac{e_{max}}{e} = \frac{R_0}{2R_x} + 1$$

$$\text{Insertion loss due to } R_x = 20 \log \left(\frac{R_0}{2R_x} + 1 \right)$$

$$\text{Insertion loss due to } R_x = 20 \log \left(\frac{R_0}{2R_x} + 1 \right)$$

For $Z_x = a$ pure reactance " jx ."

$$e = E \frac{jx}{R_0 + 2jx}$$

$$\frac{e_{max}}{e} = \sqrt{\left(\frac{R_0}{2x}\right)^2 + 1}$$

$$\text{Insertion loss due to } x = 20 \log \sqrt{\left(\frac{R_0}{2x}\right)^2 + 1}$$

Calculation of Series Loss

Equivalent circuit in Fig. 10.
For $Z_x = a$ pure resistance " R_x ."

$$e = E \frac{R_0}{2R_0 + R_x}$$

For $Z_x = a$ pure reactance " jx ."

$$e = E \frac{R_0}{2R_0 + jx}$$

$$\frac{e_{max}}{e} = \frac{jx}{2R_0} + 1$$

$$\text{Insertion loss due to } x = 20 \log \sqrt{\left(\frac{x}{2R_0}\right)^2 + 1}$$

Appendix 2

Input Resistance and Attenuation for A Resonant Length of Transmission Line

When a line, like the one in Fig. 11, with characteristic impedance Z_0 , is open or shorted at the far end, the reflected voltage or current wave at the input terminals is reduced compared with the main wave. Since the reflected wave makes

one trip down and one trip back to reach the input terminals, it is reduced by twice the attenuation of the line.

Calling the round trip attenuation a as a current or voltage ratio:

$$e_r = ae_m, i_r = ai_m$$

At a frequency where the input impedance is a maximum

$$R_{in} = Z_0 \left(\frac{1+a}{1-a} \right)$$

$$a = \frac{R_{in} - Z_0}{R_{in} + Z_0}$$

The one-way attenuation of this section in db is
Attenuation = $10 \log \frac{R_{in} - Z_0}{R_{in} + Z_0}$

At a frequency where the input impedance is a minimum

$$R_{in} = Z_0 \frac{1-a}{1+a}$$

$$a = \frac{Z_0 - R_{in}}{Z_0 + R_{in}}$$

The one-way attenuation of this section in db is
Attenuation = $10 \log \frac{Z_0 - R_{in}}{Z_0 + R_{in}}$

The Impulse Generator— An RFI Measurement Tool

RFI

For accuracy, simplicity and speed during RFI tests, an impulse generator is the calibrating tool to use. Its versatility and application to both narrow-band and broad-band measurements are discussed together with the requirements for field intensity meters.

Joseph Lorch

President, Empire Devices Inc.
Amsterdam, N. Y.

FOR MEASUREMENT of broad-band and narrow-band interference, the impulse generator offers advantages of accuracy, compact size, equipment simplicity and lower cost compared to a signal generator. In addition, the impulse generator does not require the frequent recalibration necessary for signal generators during extensive field use. The wide range versatility of the impulse generator can be noted in that two units can cover the range from 150 kc to 10,000 mc.

Narrow Vs Broad-Band Interference

There are essentially two types of radio frequency interference, namely narrow-band and broad-band interference. Narrow-band interference covers a frequency spectrum narrower than the pass-band of the receiver or test instrument

and is normally a modulated or unmodulated continuous wave (cw). Narrow-band interference is produced by undesired transmission of transmitters (for example, harmonic or parasitic output) or by receivers (for example, local oscillator radiation). Broad-band interference covers a frequency spectrum in excess of the bandwidth of the receiver or test equipment and is produced by switching transients in electrical and electronic equipment (switches, relays, commutators). Broad-band interference is most commonly of the impulsive type.

The effect of broad-band interference on a receiver is a function of the bandwidth of the receiver. Therefore, for measuring purposes, it is necessary to express broad-band interference in terms of microvolts per unit bandwidth, such as

$\mu\text{v}/\text{kc}$ bandwidth or $\mu\text{v}/\text{mc}$ bandwidth. It is generally recognized that the best practical way of expressing broadband interference is by its peak value. A signal of one $\mu\text{v}/\text{mc}$ bandwidth is defined as the peak value of that broad-band signal which, when applied to the input of a receiver having an equivalent noise bandwidth of one mc, produces the same output on this receiver as a cw signal of one μv applied to the receiver input at the center of the receiver's pass band.

Conducted and Radiated RFI Measurements

Radio interference of both the narrow-band and the broad-band type may be measured in one of two principal manners: as conducted or as radiated interference. For conducted measurements, the power or control leads of the test

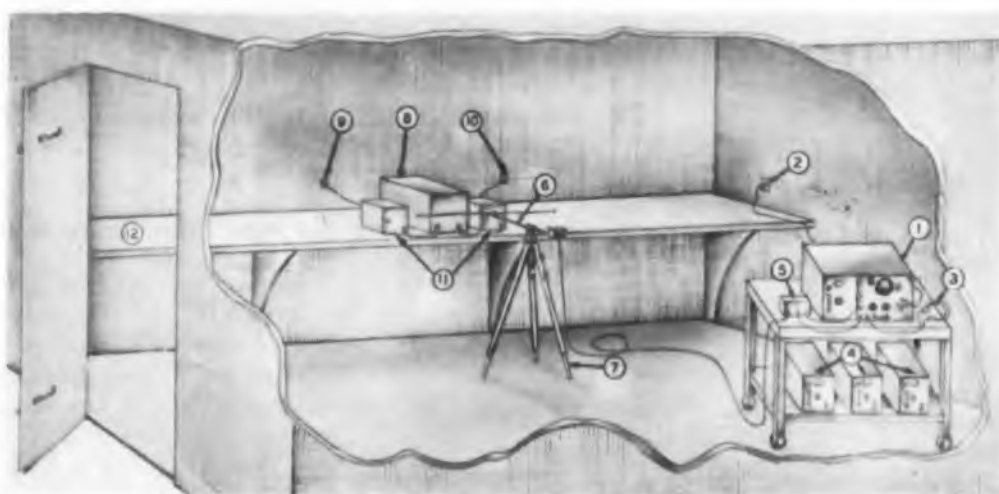
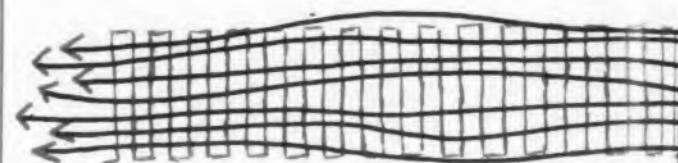
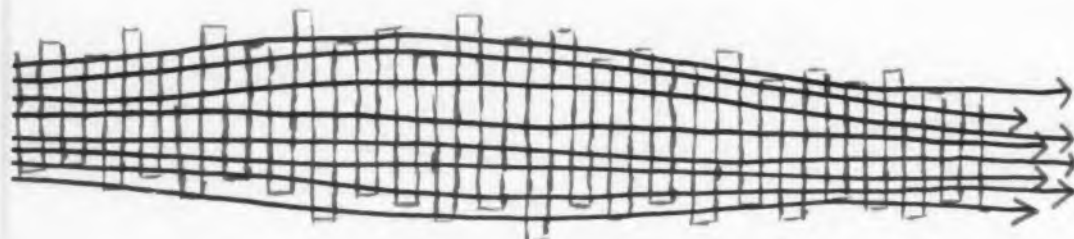


Fig. 1. Typical set-up in a shielded room includes (1) field intensity meter (2) power source (110 v, 50-400 cps) (3) earphones (4) additional tuning units (5) switching unit (6) dipole antenna with balun (7) tripod (8) test sample (9) dc power source (10) ac power source (11) line stabilization networks and (12) metal top bench.

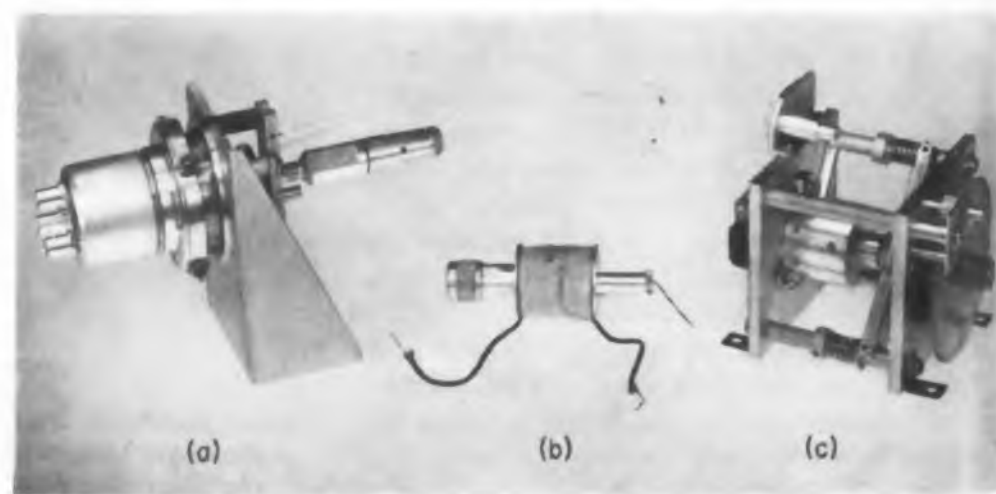


Fig. 2. Three types of impulse generators. (a) 1,000-10,000 mc, variable repetition rate (2.5-2500 pps) (b) 150 kc-1000 mc, fixed repetition rate (60 pps) (c) 150 kc-1000 mc, variable repetition rate (2.5-2500 pps)

sample are connected to the input of the measuring instrument, usually by means of a special coupling network. For radiated measurements, an antenna or pick-up device is placed at a prescribed distance from the test sample. Radiated measurements, to be meaningful, must be taken in an area which is relatively free of interference. For this reason, some military specifications favor measurements in a shielded room. A typical set-up in a shielded room is shown in Fig. 1.

The Signal Corps prefers to take measurements without the use of a shielded room. It copes with the problem of area interference by placing an antenna sufficiently close to the test sample so that the interference, if any, emanating from the test sample becomes of high amplitude compared to the area interference.

Available Impulse Generators Flat to 10,000 Mc

Basically the test instrument for RFI measurement is a field intensity meter which consists of a calibrator, a pickup device, a receiver, and an indicator. A proper calibrator is the most important component of an interference meter and the most versatile calibrator is the impulse generator. This device generates an exceedingly short pulse whose spectral components are flat throughout the operating range of the interference meter. To provide a flat spectrum to 1,000 mc, the width of the pulse generated is a maximum of 5×10^{-10} sec or 0.5 msec. For a spectrum flat to 10,000 mc, the pulse width is 5×10^{-11} sec.

In spite of its impressive performance, the impulse generator itself is a relatively simple, highly reliable device. It produces a pulse electromechanically by discharging a charged line through a set of contacts. The line uses distributed constants and determines the pulse width; the discharge frequency becomes the pulse repetition rate. The impulse amplitude is determined by the line charging voltage and, in some types of impulse generators, by an rf step attenuator placed in the output circuit of the impulse generator. The output of the impulse generator is calibrated in terms of $\mu\text{v}/\text{mc}$ bandwidth.

RFI Measurement by Substitution Method

An impulse generator is an ideal device for measuring broad-band interference by direct substitution. In this method, the receiver serves only to amplify and indicate the unknown signal level. Having observed the indication caused by the unknown signal, the operator substitutes the calibrated voltage obtained from the impulse generator and varies this voltage until its indication in the receiver output matches that previously obtained from the unknown signal. The output level setting of the impulse generator, in $\mu\text{v}/\text{mc}$ bandwidth, represents the amplitude of the unknown signal. This method of measurement is



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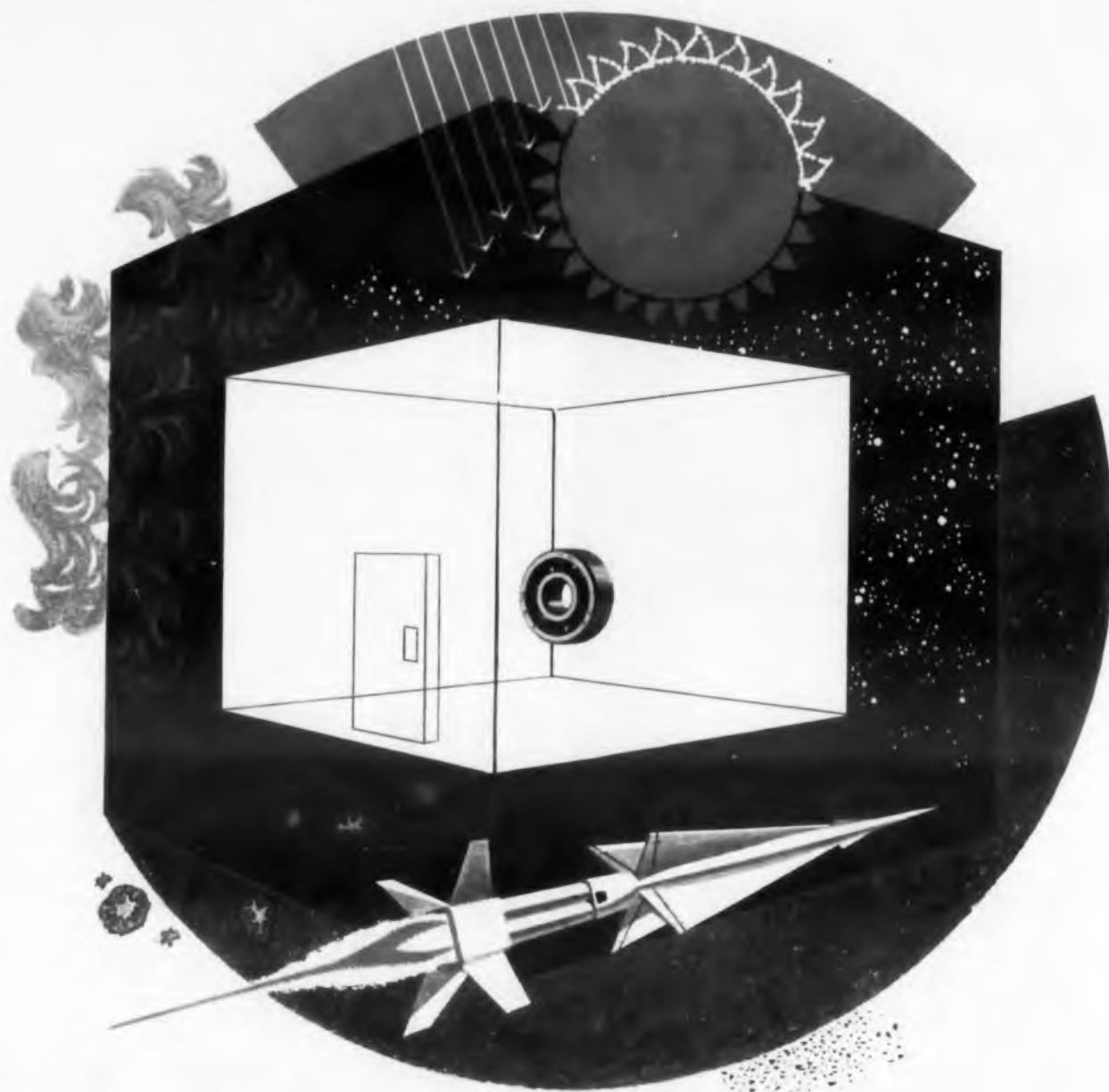
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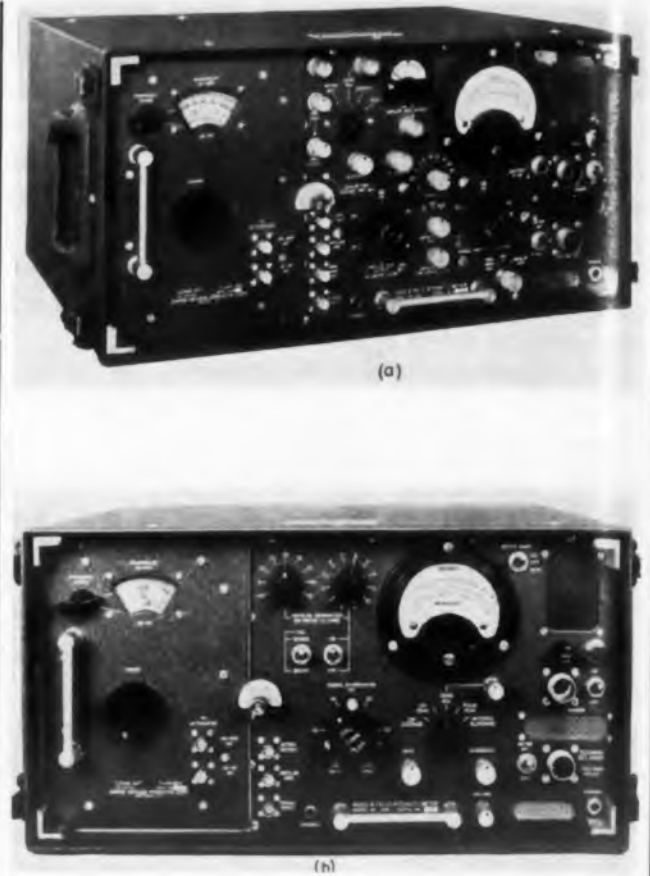


Fig. 3. These two noise and field intensity meters cover a frequency range of 150 kc to 10,000 mc. Empire Devices' NF-105 (a) and NF 205 (b) serve the range from 150 kc to 1,000 mc.

exceedingly accurate, simple, and rapid since it does not require prior calibration of the receiver; it need not take into account the receiver bandwidth and thus avoids the use of calibration charts. The impulse generator output is reliable in amplitude and needs no field recalibration.

The impulse generator's versatility is not limited to measurement of broad-band interference. By taking the receiver bandwidth into account, it can be used as an equally reliable calibrator for cw measurements as well.

Requirements for RFI Field Intensity Meters

The receiver portion of an RFI field intensity meter must:

- (1) be well shielded to prevent entry of stray signals
- (2) provide rf input attenuation to avoid input circuit overload
- (3) possess a high degree of rejection of undesired signals
- (4) demonstrate a relatively flat frequency response over its useful range and
- (5) assure a high degree of stability so that data can be reliably compared over a long period of time.

The indicating circuits must be capable of reading the carrier intensity of unmodulated or modu-

**RFI Articles Previously Published In
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RFI Check-List, L. Thomas Feb. 3, 1960 p 38
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FCC Control of RFI, J. Deitz March 30, 1960 p 56
Generation of High Power Sin² Video Pulses, A. P. Standing May 11, 1960 p 60
Optimum Shielding of Equipment Enclosures, A. Albin Feb. 3, 1960 p 48

lated narrow-band signals; it must also permit the measurement of the peak value of a broad-band voltage.

Pickup Devices

The pick-up devices can assume a large variety of shapes, mostly depending on the frequency range to be covered.

The best known antenna used both for field intensity and screen room measurements is the dipole antenna. This type of antenna is satisfactorily employed over the frequency range from 20 to 1,000 mc. In order to apply its balanced output to the unbalanced input of the receiver, a balanced-to-unbalanced broad-band transformer is used. The dipole antenna includes movable arms which are usually adjusted to the operating frequency of the receiver.

At frequencies below 20 mc, loop antennas and rod antennas are employed. For interference measurements, the rod antenna is normally used, while for field intensity measurements, the loop antenna is preferred. Since the output impedance of both the rod and the loop antennas varies widely with frequency, built-in matching transformers adapt these antennas to the 50-ohm receiver input impedance.

At frequencies above 1,000 mc, horn antennas are used, although broadband antennas similar to those employed at lower frequencies are equally applied. ■ ■

COOL



Standby time is no problem with the new, cool (all-transistorized) Mincom C-100. No blowers necessary — and the new Mincom Model C-100 Instrumentation Recorder/Reproducer is particularly new in its simplicity and reliability. Six speeds record frequencies from 50 cps to 100 kc. Only 500 watts input for 14-track system. No mechanical brakes. Only 0.1% flutter and wow. Instant push-button speed control, no belt changes. Interested? Write Mincom for specifications today.



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MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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CIRCLE 55 ON READER-SERVICE CARD

Newest

In 1N Series

Silicon Power Rectifiers

FROM

FANSTEEL



20 AMP. (Type 68)

Highly stable, low-loss unit for all types of power circuits. Full 20 amp. load in half-wave circuits, up to 50 amps. in bridge at 150°C maximum case temperature. Peak reverse voltages from 50 to 400 volts. Unquestionably reliable.

35 AMP. (Type 48)

For industrial power, controls, utility and communications equipment—or wherever high reliability is critical. Full 35 amp. load in half-wave, up to 100 amps. in bridge circuits. Storage —65° to +200°C. Peak reverse voltages 50 to 400 volts.

50 AMP. (Type 3C)

Newest in the line-up of the world's finest high reliability silicon power rectifiers. Full 50 amp. load in half-wave circuits, up to 150 amps. in bridge at 150°C maximum case temperature. Storage —65°C to +200°C. Peak reverse voltages 50 to 400 volts.

70 AMP. (Type 88)

Provides a heavy industrial power source unsurpassed for reliability . . . with full 70 amp. load in half-wave circuits, up to 210 amps. in bridge. Operating temperature up to 150°C case temperature. Storage from —65° to +200°C. Peak reverse voltages from 50 to 400 volts.

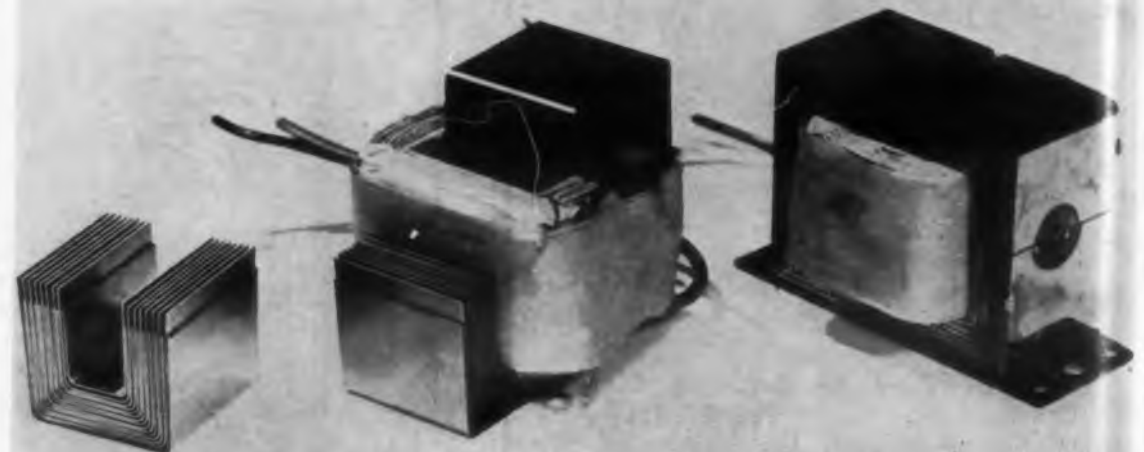
Write for latest technical literature

FANSTEEL

where reliability defines standards

FANSTEEL METALLURGICAL CORPORATION, North Chicago, Illinois, U.S.A.

CIRCLE 56 ON READER-SERVICE CARD



Left: one of the four nests of squared "U" shape laminations that are used to complete a transformer. Center: the transformer's coil and leads have been added. Right: the unit is completed with the addition of the nested laminations that have been secured by welds.

U-Shaped Laminations Help Cut Transformers' Size, Weight

TRANSFORMERS that are lighter and smaller than conventional units with identical operating characteristics are now reported possible through the use of interleaved, nested "U"-shaped laminations. These new laminations, which form the transformer's core, allow the magnetic lines of force to flow continually with the grain of the steel used in the core, rather than across the grain.

Called Flexi-core transformers, they are made by Sylvania Electric Products Inc., Ipswich, Mass. The units range from 2 to 30 per cent smaller and lighter than types now in use, depending upon the electrical characteristics required, according to a company spokesman.

The formed core, which is the heart of the new transformers, consists of nests of laminations made of fabricated steel strips from a continuous roll, said Mr. O. Howard Biggs, divisional vice president, Research and Engineering. Each of these cores consists of two "U"-shaped nests of strips. Two nests are fitted together, with the strips at the top of the "U's" inter-

leaved. The resulting unit is a hollow rectangle, square or other shape.

A "core" type transformer uses one of these hollow units; in a shell-type transformer, two of these units are placed together so that a center post is formed.

Since the magnetic lines of force flow with the grain of the steel, the resistance of the magnetic circuit is reduced. Thus a Flexi-core transformer, Mr. Biggs said, operates as efficiently as a conventional transformer that has a larger and heavier core.

The new design concept allows transformers to be produced in any size ranging, at present, up to 18 x 18 x 36 in. With Flexi-core, it is claimed, the shape and size of the transformer core can be designed to fit a specific need within broad limits. In addition, this transformer design permits "one hundred per cent application of computer results to design and production," said Mr. Biggs.

For more information on these transformers, turn to the Reader-Service Card and circle number 250.



Guidance Disk: Partially plated disk of Irtran material has been polished with methods normally used for glass. It is designed to serve as one of a pair of missile "eyes."

Optical materials find applications in

Dual Infrared-Radar Systems

"WINDOWS" in dual infrared-radar systems can now be made from optical materials that have already proved valuable in "heat-seeking" systems. The materials are among the few accepted for both infrared and radar use, according to the manufacturer.

Made by Eastman Kodak Co., 343 State St., Rochester 4, N.Y., the materials are called Irtran type AB-1 and type ABC-2. Both are polycrystalline compounds and show low energy loss in transmitting microwave energy. Finished parts are available on a custom order basis.

Irtran ABC-2, according to Kodak, shows useful transmittance from 1 to 15 microns and has an index of refraction in the vicinity of 2.2. Exposure to a temperature of 600 C in laboratory air does



Defense Dome: Irtran forms a dome for the nose of an infrared-missile. It transmits radiation efficiently up to 8 microns in the infrared.

show a measurable effect on transmittance—it increases. This is due, it is presumed, to an "anti-reflection" coating of oxidation products. Experiments at Kodak show promise that Irtran ABC-2 examples will successfully stand temperatures approaching 1000 C in inert atmosphere or in air, if a protective coating is provided.

Preliminary microwave measurements in the 8.5 to 12 kmc range show Irtran ABC-2 to have a dielectric constant of 8, while untuned samples show a maximum reflection coefficient of 0.89 and a maximum standing wave ratio of 17.2.

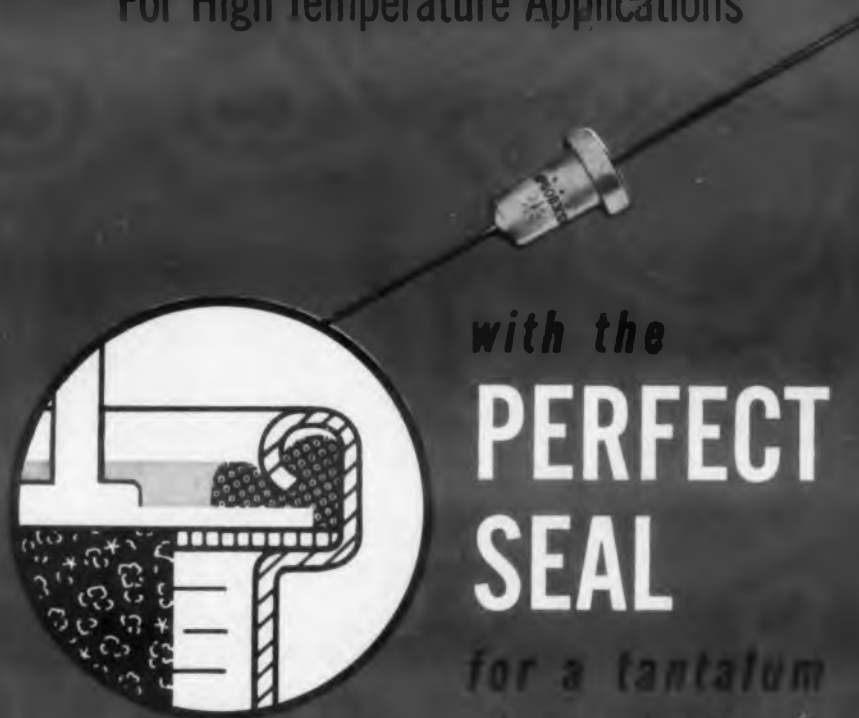
Irtran AB-1 appears to be, according to Kodak, an "excellent" radome material for the 1 to 8 micron region. Its index of refraction in this region is 1.38 to 1.31. It is also suitable for radome or dual-mode use, having a dielectric constant of 5.1 and a loss tangent of about 10^{-4} in the 8 to 12 kmc region.

The company feels that the thermal characteristics of AB-1, as far as they have been explored to date, make it eligible for Mach 3 to 6 applications and possibly much higher. Samples of AB-1 have been heated to 800 C in laboratory air for 45 min with no noticeable change in transmission. Prolonged exposure to air at temperatures above 800 C will produce a thin coating of oxide that can be easily removed by polishing.

For more information on these materials, turn to the Reader Service Card and circle number 251.

FANSTEEL HP Type Tantalum Capacitors

For High Temperature Applications



with the
PERFECT SEAL

for a tantalum electrolytic capacitor

... possible only with this Fansteel shoulder and curl design (Pat. No. 2,744,217), a design that has proved best in millions of applications. This is one of the big reasons Fansteel HP's assure you reliable operation over the -55° to $+125^{\circ}$ C ambient temperature range. Here's more:

- ... outstanding frequency stability
- ... rugged construction for maximum resistance to vibration and shock
- ... negligible electrical leakage
- ... unlimited storage life... hermetically sealed... still the most rugged in the smallest package

Bulletin 6.111, containing all technical data, sent on request.

FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U.S.A.

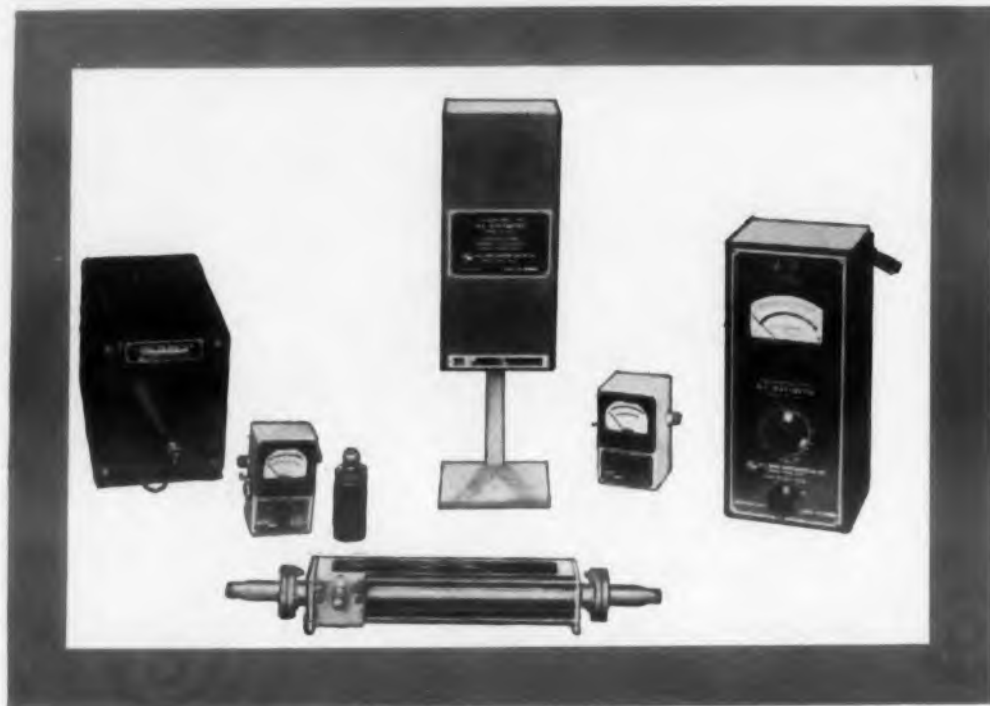
FANSTEEL

where reliability means standards

CIRCLE 57 ON READER-SERVICE CARD

MicroMatch

RF POWER STANDARDS LABORATORY



MicroMatch

equipment is used to establish a reference standard of RF power to an accuracy of better than 1% of absolute.

THE 64IN CALORIMETRIC WATTMETER establishes RF power reference of an accuracy of 1% of value read, and is used to calibrate other wattmeters. Five power scales, 0-3, 3-10, 10-30, 30-100, and 100-300 watts, are incorporated in the wattmeters for use in the 0-3000 mcs range.

711N and 712N FEED-THROUGH WATTMETERS, after comparison with the 64IN, can be used continuously as secondary standards and over the same frequency range as covered by the primary standard. The MODEL 711N is a multirange instrument covering power levels from 0 to 300 watts in three ranges, 0-30, 30-75, and 75-300 watts. MODEL 712N covers power levels of 0 to 10 watts in three switch positions, 0-2.5, 2.5-5, and 5-10 watts full scale.

636N and 603N RF LOAD RESISTORS absorb incident power during measurements. MODEL 636N is rated at 600 watts, and MODEL 603N is rated at 20 watts. Both models perform satisfactorily over the entire frequency range to 3000 mcs. These loads, in conjunction with the MODELS 711N and 712N Feed-through Wattmeters, form excellent absorption type Wattmeters.

152N COAXIAL TUNER is used to decrease to 1.000 the residual VSWR in a load. The tuner is rated at 100 watts, and its frequency range is 500-4000 mcs.

For more information on Tuners, Directional Couplers, R. F. Leads, etc., write



M. C. JONES ELECTRONICS CO., INC.

185 N. MAIN STREET, BRISTOL, CONN.

SUBSIDIARY OF



CIRCLE 60 ON READER-SERVICE CARD

Two-Tube Radio, Ten-Tube TV on Way with Multi-Function "Compactrons"

MULTI-FUNCTION tubes, combining diodes, triodes and pentodes in various combinations, were recently announced (see *ED*, July 6, p 14) to reduce size and components in entertainment and industrial devices. For example, two multi-function types are available which fulfill the identical duties of five conventional miniature tubes in a table model radio.

"Compactrons," developed by the General Electric Owensboro, Ky., staff, have 12 pins arranged around a 3/4 in. diam. base to provide adequate isolation between electrodes as well as a structurally sound support for internal elements. Bulbs are 1-1/8 in. diam. and overall height ranges from 1 in. to 2-3/4 in. depending on tube type. To minimize height, the new design eliminates the familiar exhaust tip, usually 5/16 in. high, seen on conventional miniature tubes. Instead, compactron design has the exhaust tip located at the bottom of the bulb, surrounded by the 12 tube pins.

Presently available on a sample quantity basis are:

- A combined oscillator, converter and if amplifier
- A second detector, audio amplifier, power amplifier and rectifier.

The two types above contain the equivalent of a 12BE6, 12BA6, 12AV6, 50C5 and 35W4, the most popular tube lineup in table radios.

- Horizontal oscillator and afc (equivalent to a double triode, (6CG7) and double diode (6AL5)
- Horizontal damper diode (equivalent 6AX4GTB)
- Vertical deflection oscillator and amplifier (equivalent 6DN7)
- Horizontal deflection amplifier (equivalent 6DQ6B)

For TV applications, where heat and high voltage isolation problems are common, single rather than multi-element compactrons are available. By locating a high potential plate at one base pin and allowing two unused pins on either side,



Two compactrons (right) replace five conventional miniature tubes (left) in a table-model radio. A TV set would require 10 compactrons.



The 1-1/8 in. bulb diameter is sufficient to permit horizontal mounting of internal electrodes where low height is needed. A proposed design for a combination converter-if amplifier is shown.

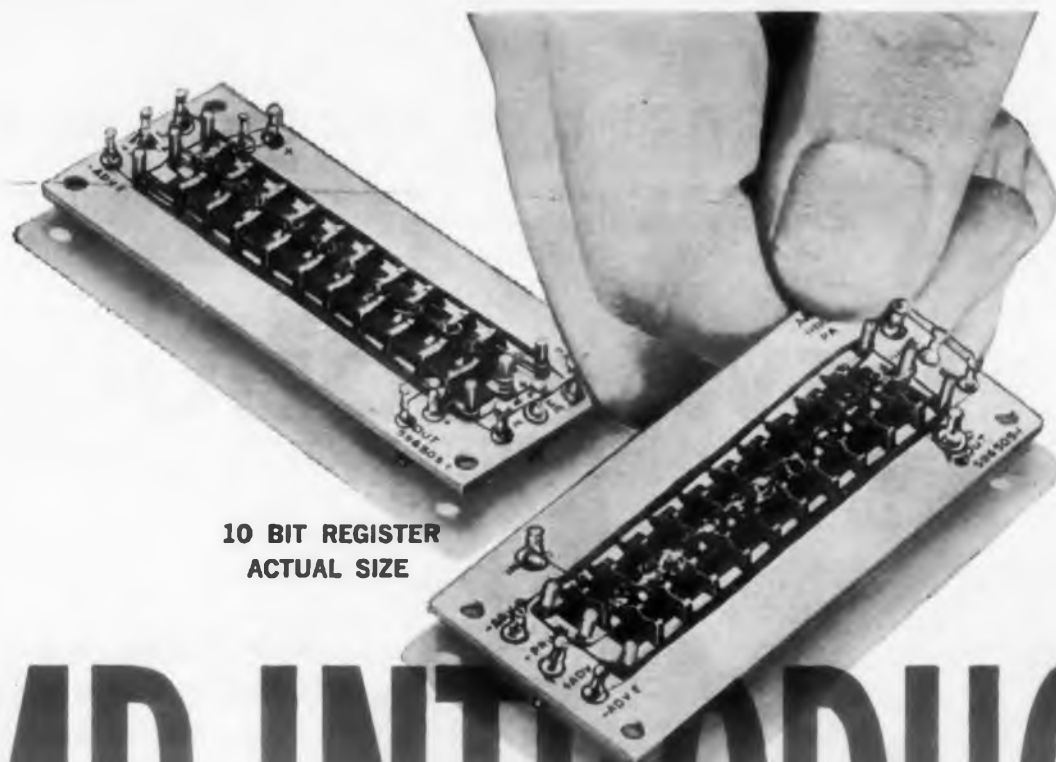
voltage isolation up to 10 kv is obtained.

As an indication of the device capabilities, GE engineers foresee a two compactron radio replacing the standard five tube complement (7 transistors needed for the same performance), a 10 compactron TV set replacing 15 tubes and three diodes or 24 transistors and 11 diodes, and a seven compactron stereo hi-fi unit replacing 10 tubes or as many as 26 transistors.

In applications where one integral heater supplies three cathodes, only two heater welds are required as compared with six welds if three separate tubes were made. Lower production costs and higher inherent reliability are thus expected. In addition, several metallurgical advances have been included into anode and cathode design enabling up to 40 per cent reduction in heater power; this represents another step towards improved reliability.

A multi-function compactron will eventually sell for 20 per cent less than an equivalent number of tubes needed to perform the same service, GE marketing officials promised.

For further information on this new device turn to the Reader-Service Card and circle 252.



10 BIT REGISTER
ACTUAL SIZE

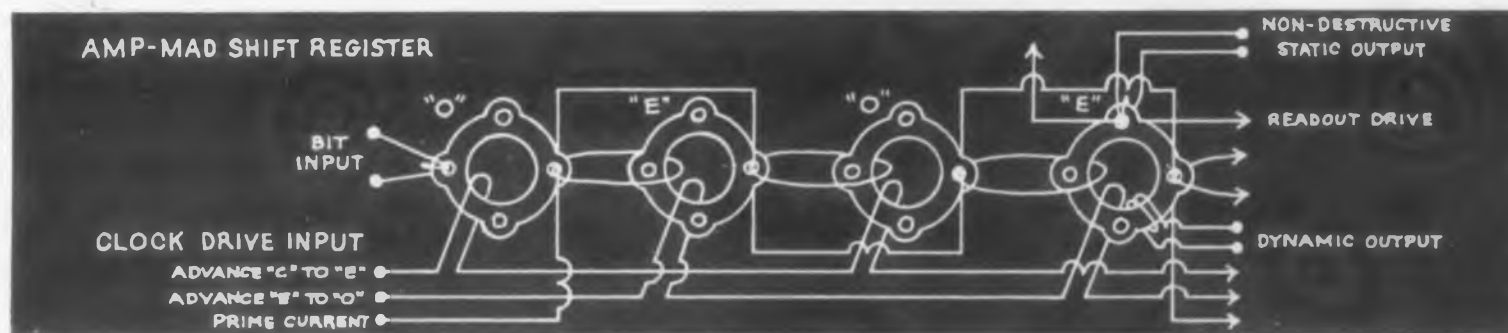
AMP INTRODUCES

A COMPLETELY NEW KIND OF SHIFT REGISTER USING MAGNETIC ELEMENTS ONLY...

Here is the first commercially available line of all-magnetic shift registers. Now you can have both non-destructive dynamic and static output in the same register. Now you can have the minimum number of components, the minimum number bit to bit interconnections and any serial/parallel input and output combination. Made with AMP multiaperture ferrite cores and copper wire only (see schematic below),

the AMP Shift Register line has a number of other useful features:

- -40°C to $+75^{\circ}\text{C}$ temperature operating range
- minor aperture output level up to 100 mw at several volts
- immune to nuclear radiation
- small size—ideal for miniaturization requirements
- ultimate in reliability and simplification



For complete information, including operating data, send for our AMP-MAD* Shift Register brochure.

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NEW PRODUCTS

Includes items generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



DC Meter Measures 10 μ v 380 to 1000 v, 1 μ ma to 1 amp

Model 95A dc meter has 17 voltage ranges and 25 current ranges. The full scale voltage ranges are 10 μ v to 1000 v; full scale current ranges are 1 μ ma to 1 amp. Input resistance on the voltage ranges is 10 meg on all ranges. Accuracy is 3% of full scale on all but the most sensitive voltage and current ranges; there it is 4%. The unit has a dial that displays the full scale digits of the range selected in a window while a second dial displays the unit of measure in an adjoining window. Dc output is available at the front panel, and there are separate controls for output level and zero reference.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

Price & Availability: \$495 per unit; available from stock this September.



Displacement Gyro Has Four Moving Parts 384

Designated the Genie, this gas-driven displacement gyro has fewer than 40 parts, and only four of them move. It can be used as a reference instrument for short-range missiles, drones and target vehicles. It takes 100 msec to get the unit into operation. The unit has an average angular momentum of 1.25×10^6 g-cm² per sec, and is designed for a drift rate of 2 to 4 deg per min under extreme missile environments.

Lear, Inc., Dept. ED, P.O. Box 688, Grand Rapids, Mich.



Frequency Meter Gives Digital Reading 381

Models 838, 839, and 840 frequency meters, designed for the X, KU, and K bands, indicate frequency directly on a digital counter. They are adaptable to remote indication and may be panel-mounted for system applications. The high Q cavities are precision bored and coupled to the narrow wall of a section of waveguide. The units are electrically equivalent to a straight section of waveguide when detuned; vswr is 1.05 except at resonance. At resonance, a small amount of power is reflected, resulting in a dip in transmitted power.

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

Price: Models 838, 839, and 840 are priced at \$195, \$250, and \$275.



Flip-Flop's Speed 382 Ranges from 0 to 500 kc

Type 4213 flip-flop has a speed range of 0 to 500 kc. The quadruple, static unit has built-in gates for use in shift registers or buffer applications. Gating is accomplished with capacitor-diode gates. The unit has a built-in pulse amplifier for driving the four flip-flops. Up to 100 flip-flops can be contained in 5.25 in. of panel space in a standard 19-in. rack.

Digital Equipment Corp., Dept. ED, Maynard, Mass.
Price & Availability: Off the shelf delivery; \$96 per unit.



Transistor Curve Generator 383 Designed for Power Units

Model 81 transistor curve generator provides a collector curve for low and medium power transistors. It generates a single curve in the grounded-emitter configuration for display on an external oscilloscope. Collector voltages are continuously variable to 40 v. The range of collector currents is 200 to 500 ma; base currents range from 20 μ a to 10 ma. The unit operates on 117 v ac; it requires no batteries.

Trans-Western Electronics, Dept. ED, P.O. Box 1473, Ventura, Calif.
Price & Availability: Available in 30 days; price is \$118.50 per unit.

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 3

RAYTHEON 1,000,000-WATT MAGNETRON LOGS OVER 13,000 HOURS IN MOBILE RADAR

This is the first reported history of a Raytheon QK-358 magnetron substantiated with an exhibit. Still, there are numerous other cases in which these exceptional Raytheon tubes have been clocked in excess of 10,000 hours, radiating at peak power.

The case in point concerns the application of a QK-358 magnetron in an AN/FPS-8 radar, for which the General Electric Company is the prime contractor. When the tube was replaced after 13,000 hours of service for "preventative maintenance" reasons, it was returned to Raytheon where the tube was found to be operating within specifications. Findings showed it to be highly stable and still capable of radiating more than one megawatt of power.

A large measure of the reliable operation and outstanding life of the QK-358 was achieved through special attention given to its unique characteristics in the overall design of the radar transmitter.

For your information, the QK-358 is a mechanically tunable pulsed-type oscillator with an integral magnet and is designed for coupling to a standard 3" x 6" waveguide. Typical operating characteristics include:

Frequency Range "L" Band
Peak Power Output 1.3 Mw
Average Power Output 1,630 W



AN/FPS-8 high-power search system by General Electric, used primarily in aircraft control and early-warning operation. The complete mobile version (AN/MPS-11A) shown here, can be airlifted or carried on nine trucks and two trailers.



Life testing of Raytheon tubes, such as the QK-358 magnetron, for six weeks or more serves as a quality check of their performance characteristics as recorded and plotted against time.

Excellence in Electronics



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Co., Waltham 54, Mass. In Canada: E. Waterloo, Ontario. In Europe: Zurich, Switzerland.

SEE THESE TUBES AT RAYTHEON'S WESCON BOOTH

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

CIRCLE 63 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Pressure Transducer 448

Measures 0.1 to 5000 psi

Type 701 quartz crystal pressure transducers measures from 0.1 to 5000 psi. Sensitivity is 200 mv per psi when used with a 1-ft cable. The unit has a natural frequency of 100,000 cps and a rise time of 5 msec. It operates accurately over the temperature range of -400 to +500 F. Special units can be furnished to cover up to 10,000 psi.

Kistler Instrument Corp., Dept. ED, 15 Webster St., North Tonawanda, N.Y.

Price & Availability: \$320; from stock.

Welding Gun 492

Orbiting type

This orbiting welding gun provides a solution for the following: circumferential welds, welding of difficult-to-join materials, and welding where the part cannot be rotated as it is welded. The gun is adaptable to dry-box welders, to special vacuum chambers for loop welding, and for butt welding long sections of reactive and heat-sensitive metal tubing. Long lengths of tubing can be welded without moving the work.

High Vacuum Equipment Corp., Dept. ED, 2 Churchill Rd., Hingham, Mass.

Availability: Delivery time is two weeks.

Power Oscillator 385

Distortion is less than 8%

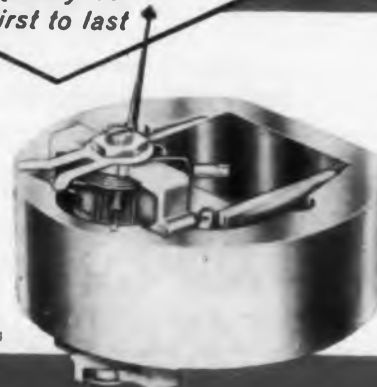
Model 828 power oscillator is for driving motors operating at about 100,000 rpm and for furnishing demodulation signals to amplifier circuits. Harmonic distortion is less than 8%. The hermetically sealed package measures 2 x 3 x 4 in. and meets MIL-E-5272B. The circuit is fully transistorized. Input is 5 kc at ±15 v.

Metrolog Corp., Dept. ED, 169 N. Halstead St., Pasadena, Calif.

Price & Availability: Price is \$325 ea; delivery time is 20 to 30 days.



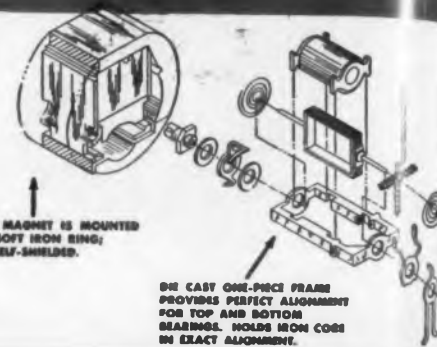
COMPLETE PANEL METERS



BURTON BROWNE ADVERTISING

BAR-RING TYPE MOVEMENTS (Exclusively Triplet)

- Self Shielded
- Not affected by magnetic panels or substantially by stray magnetic fields.
- More Torque
- Lower Terminal Resistance
- Faster Response
- Exceedingly Rugged and Accurate
- All Case Sizes



Round Flush Mounting (2 1/4")
Model DC 331-T, AC 331-S, RF 341-T



Rectangular Flush Mounting (2 1/4")
Model DC 327-PL, AC 337-PL, RF 347-PL



Round Flush Mounting (2 1/4")
Model DC 331-T, AC 331-S, RF 341-T
Dyn. 341



Rectangular Flush Mounting (2 1/4")
Model DC 227-T, AC 237-S, RF 247-T



Rectangular Flush Mounting (4 1/4")
Model: DC 420-PL, AC 430-PL, RF 440-PL



Rectangular Flush Mounting (2 1/4")
Model: DC 227-PL, AC 237-PL, RF 247-PL



Rectangular Flush Mounting (6")
Model: DC 626, AC 636, RF 646



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In addition to the popular conventional line of panel instruments, Triplet supplies a complete line of specialized and coded instruments designed to meet government specifications MIL-N-10304A.



Specialized Instruments—SW, SW and SW
In addition to the popular conventional line of panel instruments, Triplet supplies a complete line of specialized and coded instruments designed to meet government specifications MIL-N-10304A.



Round Flush Mounting (1 1/4")
Model DC 221-PL, AC 231-PL, RF 241-PL



Rectangular Flush Mounting (7")
Model DC 337-T, AC 337-S, RF 347-T
Dyn. 347-A

For complete details see your Electronic Parts Distributor, or write

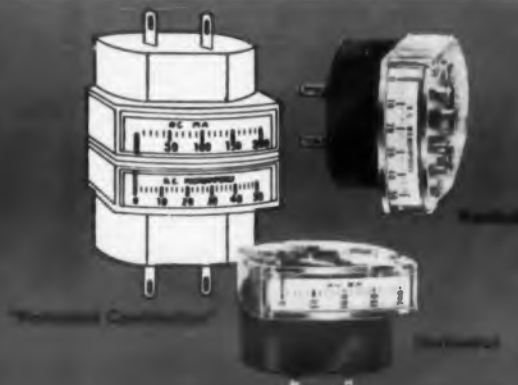
TRIPLETT FULLY MEETS YOUR NEEDS

The name TRIPLETT has been on instruments of our manufacture for more than 55 years, and is regarded as a symbol of customer satisfaction to industrials and distributors in all parts of the world. Our instruments can be built to customer

specifications or provided from our large stocks of standard ranges in hundreds of sizes and types. We also carry in stock many semi-finished movements which can be converted readily to special customer needs.



Angular Peak Mounting (4 1/2")
Models DC 470, AC 480, RF 440



Standard Modular Panel Meters
Model 150



Model 227-U Unimeter 2 1/2"
Assembled



Model 354 Relay



Tilting Case Portable
Models: 325 (DC), 335 (AC)



Model 420-U Unimeter 4 1/2"
with mirror scale



Model 234 Unimeter Stand



Angular Peak Mounting (2 1/2")
Models DC 331-PL, AC 331-PL,
RF 341-PL



Angular Peak Mounting (2 1/2")
Models DC 720, AC 730, RF 740



Model 800 1 1/2" Meter
Type A Series



1 1/2" Mounting Case 4 1/2" Peak-to-Peak
Models 322 (DC), 321 (AC)

Terminal Setter 628

Processes 100 pieces per min

Able to handle a wide range of terminals including split lugs and feed-throughs, model FST-1 terminal setter processes up to 100 terminals per min. The machine consists of an electropunch and vibratory feeder, orienting devices, trackage controls, electrical controls, and power feed. Power requirement is 115 v ac, 60 cps, single-phase. The unit, including bench, weighs about 200 lb and has an over-all height of about 18 in. above the bench.

Black & Webster, Inc., Dept. ED, 570 Pleasant St., Watertown 72, Mass.

Availability: Made to customer requirements, the unit can be delivered in 90 days.

Digital Recorder 449

Plots computer results

Model 575 magnetic tape system is for plotting digital computer results in continuous curve form on an X-Y recorder. Included in the system are a digital tape transport, a magnetic tape translator, a tape control unit, record-playback amplifiers, and an X-Y recorder.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Thermometers 406

Are accurate to ± 0.5

Accurate to ± 0.5 C, these expanded-scale thermometers are for temperatures from 0 to 200 C and have standard expansions of ± 25 C max or ± 10 C min. Models range from battery-powered, portable styles to rugged, sealed, panel-mounting instruments. Probes are furnished for measuring the temperature of gases, liquids, or solids. The devices are suited for use in ground support systems where fuel and component temperatures must be read remotely. Input for panel-mounting units is 6 v ac or dc.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Rd., Fullerton, Calif.

Availability: Custom built.

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TRIPLETT
Quality...
First to last

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

write



range: 40 H at 12 Amp. rms

NWL's latest unit is especially designed and engineered for air-blast operation at a temperature rise not exceeding 10°C. Radial ducts permit free flow of air along both sides of the pie-wound coils. Rigid mechanical support assures permanent alignment of coils.

The reactor illustrated, is only one of many special units manufactured by NWL, such as: Iron core reactors, large power, electronic and pulse transformers, chokes, etc.

Each NWL unit is thoroughly tested and must meet all customer requirements before shipment. We shall be pleased to quote you up to 300 KV and up to 500 KVA, depending on your individual requirements.



Nothelfer

NOTHELPER WINDING LABORATORIES, INC., P. O. Box 455, Dept. ED7, Trenton, N. J.
(Specialists in custom-building)

CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

Tube Testers

428

Grid leakage as high as 100 meg

The Mighty Mite, a compact tube tester, measures 8 x 9 x 2-1/2 in. and weighs less than 8 lb. It checks over 1,300 tubes for cathode emission, shorts between all elements, gas, grid emission, and grid leakage as high as 100 meg. The tester has a 3-1/2 in. D'Arsonval meter, a stainless steel mirror, and a separate inner chassis. Installation can be permanent or temporary.

Sencore, Dept. ED, Addison, Ill.
Price & Availability: Price is \$59.50.

Filament Transformer

640

Is rated at 30 kv



Model FT-300 low-capacitance, high-voltage-insulated filament transformer is rated at 30 kv ac or dc pulse in air, 300 kv pulse in oil. A variety of output voltages and currents can be furnished including the common heater voltages for high-power klystrons, TWT's 3 hydrogen thyratrons, high-voltage diodes, and magnetrons.

Pearson Electronics, Inc., Dept. ED, 707 Urban Lane, Palo Alto, Calif.

Price & Availability: \$350 ea; from stock.

Resistance Meter

371

For measurements to 50,000,000 meg

Type L high-resistance meter is for measuring up to 50,000,000 meg. It is for laboratory and production testing of motor and transformer winding insulation, cable insulation, high-value resistors, capacitor insulation, and for measuring surface and volume resistivity of insulating materials.

Industrial Instruments Inc., Dept. ED, 89 Commerce Road, Cedar Grove, Essex County, N.J.

Price & Availability: \$175 to \$383 ea; ordinarily in stock.



There's really
not much to
custom-designing
rotary switches...

It's a matter of routine . . . when you have talented engineers with lots of experience . . . first quality materials . . . and advanced manufacturing techniques.

Fortunately, The Gamewell Company has all three. When customers' specifications come in, our engineers get busy. The precious metal ring, heart of a Gamewell Rotary Switch, is designed with as many segments as required. Brushes are provided which assure smooth, trouble-free action with either MAKE-BEFORE-BREAK or BREAK-BEFORE-MAKE contacts. Then a highly versatile arrangement of terminals connecting to ring segments is devised for the periphery of the switch housing. And so on, depending on requirements.

The end result is a highly versatile, reliable switching component. Cased in special plastic, it's inherently fungus resistant and stable at high temperatures. It can be used with confidence over a wide range of environmental conditions.

Gamewell is well qualified to design rotary switches for circuit sampling, programming, digital generators and various electronic data processing systems. Your specs will receive prompt attention.

Write to THE GAMEWELL COMPANY, 1392 Chestnut Street, Newton Upper Falls 64, Massachusetts. A Subsidiary of E. W. Bliss Company.

The Gamewell SG-270 Switch is available with diameters of 3/8", 1 1/4", 1 3/8", 2", 3" and 5" in various mounting styles.



BLISS
Gamewell

PRECISION POTENTIOMETERS

"INTEGRALS OF
HIGH PERFORMANCE"

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ELECTRONIC DESIGN • July 20, 1960

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Silicon and Germanium Diodes

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Want semiconductors in a special package? General Instrument will make up rectifiers and diodes in any packaged assembly needed to fit your specific requirements. Units can also include resistors, capacitors, etc. to produce complete circuit packages if you desire.

Let us accept the shrinkage and other technical problems — it's our business and we have the experience and facilities to do a superior job. Result will be a compact package virtually unlimited in PIV, with all the reliability General Instrument semiconductors are noted for. Total cost? Even less than if you developed your own package. Write or call today for further information.

Semiconductor Division

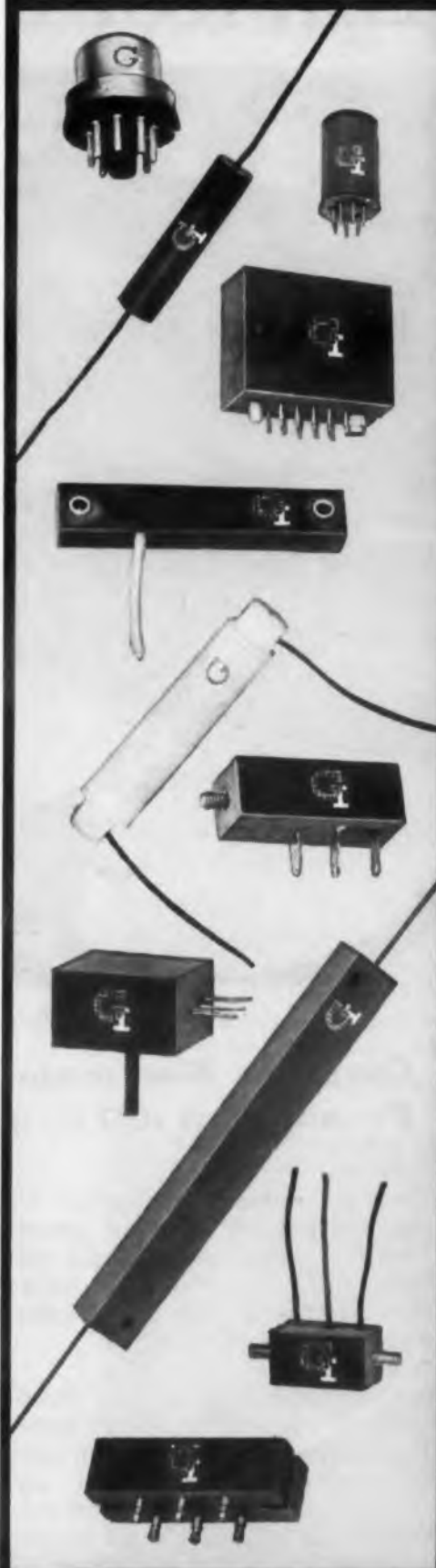
GENERAL INSTRUMENT CORPORATION

65 Gouverneur Street, Newark 4, N. J.

Midwest office: 5249 West Diversey Ave., Chicago 39

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GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, SEMICONDUCTOR DIVISION, RADIO RECEPTOR COMPANY, INC., THE HARRIS TRANSDUCER CORPORATION, MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND GENERAL INSTRUMENT-F. W. SICKLES OF CANADA LTD. (SUBSIDIARIES)



CIRCLE 79 ON READER-SERVICE CARD

CIRCLE 80 ON READER-SERVICE CARD

NEW PRODUCTS

Polystyrene Film Capacitors 423

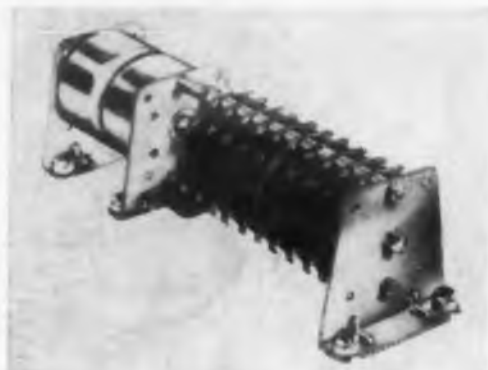
Range is 0.0047 to 1 μ f

Designed for critical applications requiring high-insulation resistance, good stability, and good retrace characteristics, these polystyrene-film capacitors have voltage rating of 100 to 600 v and a capacitance range of 0.0047 to 1 μ f. Standard tolerances are 1% and 5%. Temperature range is -55 to +70 C. Dissipation factor is 0.02% at 25 C at 1 kc. Temperature coefficient is -70 ppm per deg C.

Scientific Electronics Corp., Dept. ED, 3810 Cohasset St., Burbank, Calif.

Rotary Switch 644

Has stepping rate of 6 to 8 pps



This rotary circuit selector or stepping switch is powered by a size 5 Digimotor. Self-stepping is provided by a transistorized pulser; stepping rate is 6 to 8 pps. The free-turning shaft allows manual setting of the switch to any position clockwise or counterclockwise. The switch can be ordered with 1 to 10 switch decks and in 8, 10, 12, 18, 20, and 24 positions. Uses are stepping, counting, adding, subtracting, programing, and sequencing.

Ledex, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

Price & Availability: \$12.75 to \$26 ea; from stock.

AC Breakdown Testers 372

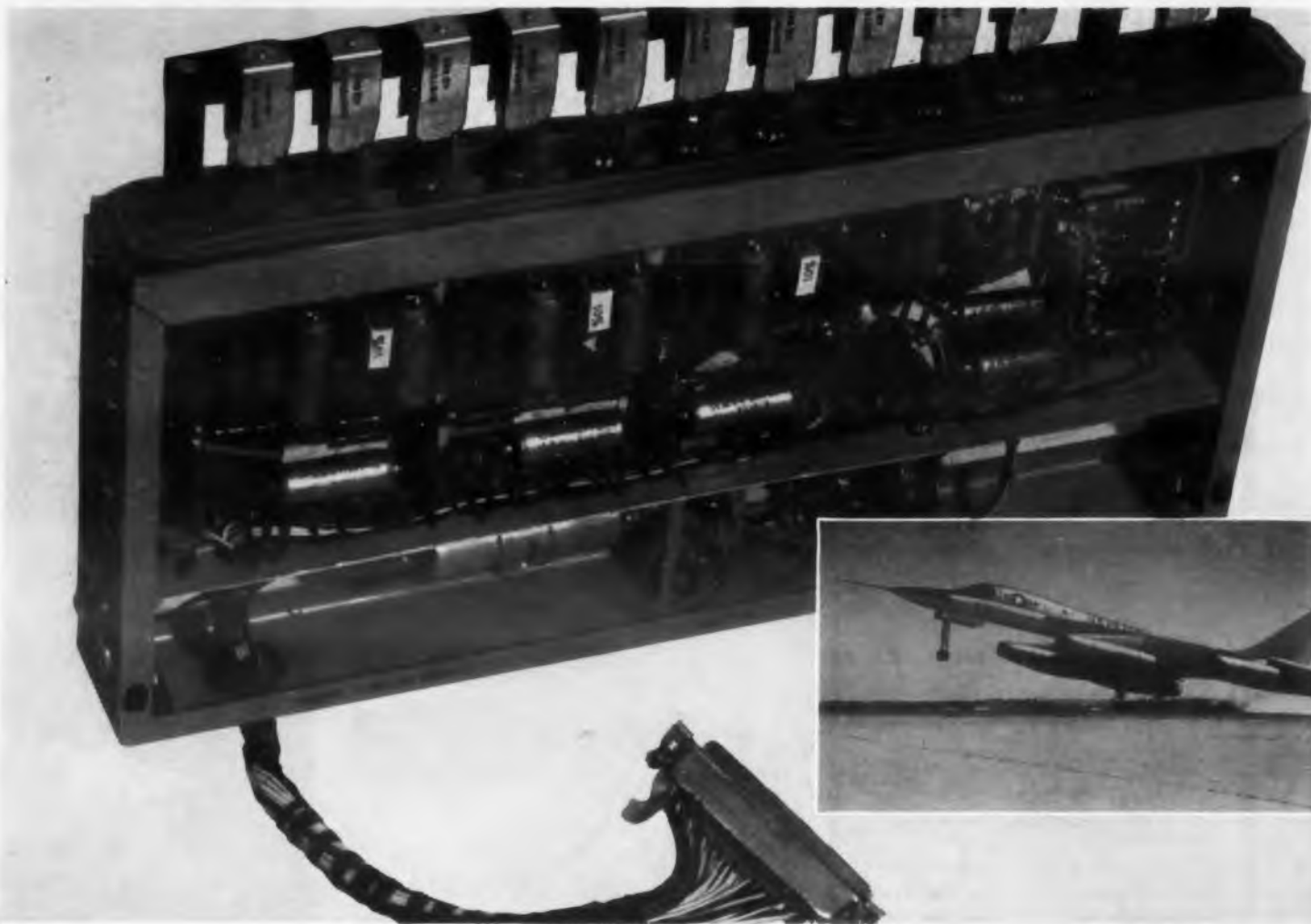
Various models offered

This complete line of ac breakdown testers is designed for testing in accordance with ASTM D-149 and LP-406, method 4031. They determine breakdown voltage and dielectric strength in both laboratory and production applications. All units are self-contained. Dual-range models are offered; some units have up to six voltmeter ranges.

Industrial Instruments Inc., Dept. ED, 89 Commerce Road, Cedar Grove, Essex County, N.J.
Price & Availability: Most units are in stock. Price is \$1150 to \$4300.

SILICONE NEWS from Dow Corning

Better Environmental Design



SILASTIC® Cushions Electronic Packages at -90 to 250C

Where environmental conditions are extreme, or fluctuate from one extreme to another, specify resilient Silastic® to protect sensitive components. Silastic, the Dow Corning silicone rubber, is not affected by temperatures from -90 to 250 C (-130 to 500 F), nor by rapid thermal cycling. It retains its excellent dielectric and physical properties . . . resists the effects of ozone, storage, moisture, corona.

For these reasons, Silastic was selected by engineers of the Emerson Electric Manufacturing Company, St. Louis, for several parts of the electronics package shown. Part of the fire control system on Convair B-58 Mach 2 bombers, this unit must function at -65 F . . . continue to function dependably despite vibration and operating temperatures up to 350 F around the miniature tubes. A molding of heat resistant Silastic holds the tubes gently but firmly to protect them from vibration and shock. Silastic grommets, feed-throughs, and connector insulation are also part of the package. In any climate and under any environments, Silastic gives required protection to Emerson's assemblies.

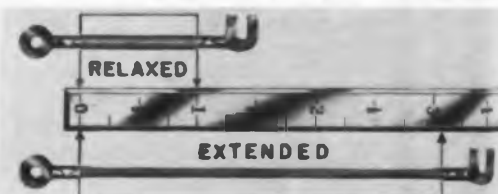
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Your nearest Dow Corning office is the number one source for information and technical service on silicones.



Dow Corning

ELECTRONIC DESIGN • July 20, 1960

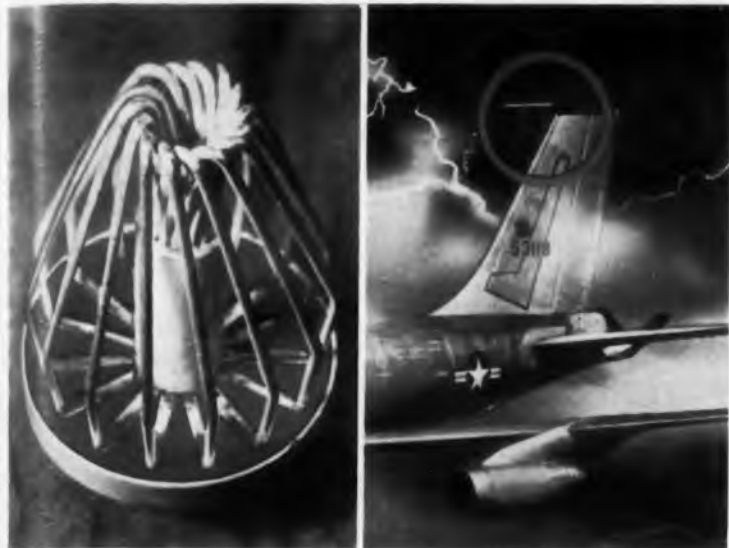


Wire That STRETCHES

Like a stretch-to-fit sock, this snappy new product extends itself to meet your needs. Available with insulation of Silastic, it is called Stretch Wire, and is manufactured by the Stretch Wire Corporation.

Stretch Wire elongates to 165% of its original length . . . then springs back. It has already proven itself in missile and ordnance electronics, withstanding launchings at speeds of 1000 fps and inertial loads of 800 G's. Because of the properties of Silastic, the insulating sheath remains elastic under the temperature extremes encountered.

gn...silicones provide lasting protection



Laminate Parries Lightning Thrust

Long range HF communication systems employing probe-type antennas are now safe from lightning strikes with the new Aircraft Lightning Arrester made by Joslyn Manufacturing and Supply Company, Chicago.

Key component: a 0.0625 inch thick slotted silicone-glass laminate part that serves as retainer and insulator for 15 phosphor bronze spring elements. Made of Dow Corning silicone resins and glass cloth, this part enables the arrester to safely discharge lightning strokes with a peak current of 100,000 amperes and 200 coulombs charge. The silicone laminate is strong, resists moisture, vibration and fungus growth, and is inexpensive to fabricate. Electric strength is . . . obviously . . . excellent.

CIRCLE 801 ON READER-SERVICE CARD

997 Varnish Ups Power, Cuts Weight

When designing transformers to operate at high temperatures in standby control power supplies for submarine nuclear reactors, Milro Controls Co. faced three major demands: maximum power output for minimum weight; great resistance to moisture; ample overload protection.

Impregnating with Dow Corning 997 Varnish, and using silicone insulating components, proved to be the right answer on all three counts. This silicone varnish withstands operating temperatures up to 250 C . . . provides superior protection against all the well-known enemies of electronic and electrical equipment. Each of the new Milro power supplies contains three compact, light-weight transformers, impregnated with 997.

CIRCLE 802 ON READER-SERVICE CARD

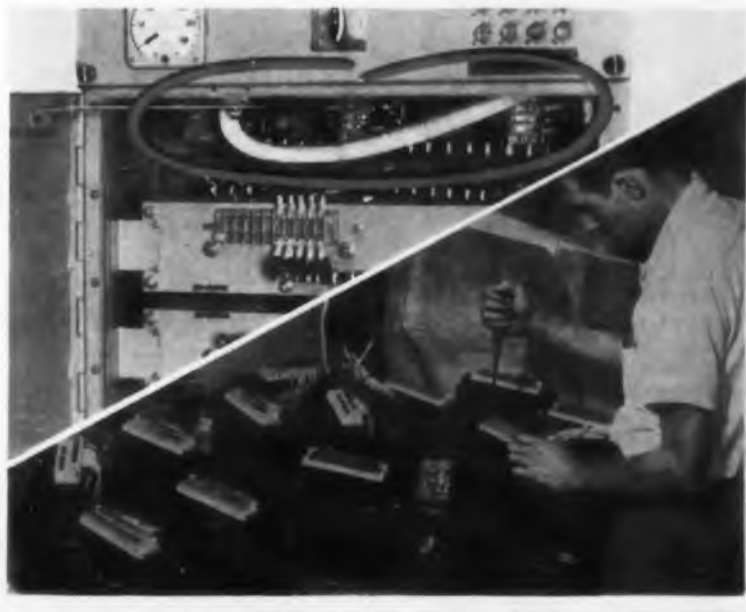


New Gel Gives "View-Through" Protection

Poured as a liquid, transparent Dow Corning Dielectric Gel fills all voids, then sets up to form a heat stable gel. Dielectric strength is excellent; stress on components almost nil. Potted components and circuitry remain clearly visible . . . can be checked by eye. Probes can be inserted for instrument checks . . . the gel re-seals itself when probes are removed. Individual components can be removed and replaced.

Dielectric Gel enabled CBS Laboratories to meet stringent reliability requirements on its Photoscan power supplies. Despite high temperatures, high voltages, and high vibration levels in this remarkably small unit, Dielectric Gel prevents arcing. Components are spaced less than 1/4" apart, yet output voltages run from 1,000 to 25,000 volts!

CIRCLE 803 ON READER-SERVICE CARD



Connector

421

For continuous duty at 1000 F

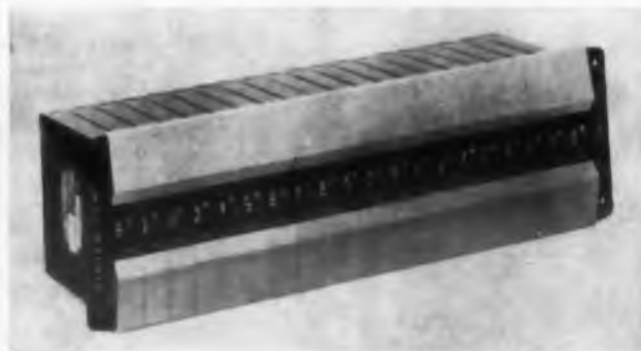
For thermocouple or power use, this connector can be used to 1000 F in continuous duty. Available in sizes 16, 18, 20, and 22 with up to 19 contacts, the connector is made of corrosion-resistant stainless steel and has ceramic insulators. Both male and female connectors are available.

Revere Corp. of America, Dept. ED, Wallingford, Conn.

Digital, Rotary Switch

625

Has 16 positions



Series 7320 rotary switch has 16 single-pole switching positions plus an "off" position. Features include in-line visual readout, positive finger-dependent operation, and modular construction. Color coding of decades, internal lighting, and special dial characteristics are optional. Life is 100,000 counts.

The Digitran Co., Dept. ED, 660 S. Arroyo Parkway, Pasadena, Calif.

Price & Availability: \$310 ea, for absolute type; \$12.50 ea and up. Delivery time is two weeks.

Pressure Transducers

376

Ranges extend to 5000 psia

Series 295 miniature pressure transducers includes absolute, gage, bidirectional and unidirectional differential pressure transducers. Pressure ranges are from 0 to 5 to as high as 0 to 5000 psia. Absolute units provide 42 to 56 mv nominal output with an excitation of 7 v ac or dc. Gage type units are rated for 5 v ac or dc excitation and 30 to 40 mv output. Bidirectional units vary from ± 2.5 to ± 25 psid, are rated for 5 v dc or ac excitation and ± 20 mv output; unidirectional differential pressure transducer have a 0 to 5 up to 0 to 100 psid range and have an output of 40 mv at dc or ac excitation.

Satham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Price & Availability: Standard units are priced at \$270 ea, for differential or gage type. Delivery is from stock.

ing CORPORATION MIDLAND, MICHIGAN

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CIRCLE 800, 801, 802, 803 ON READER-SERVICE CARD

for the service
you need...
for the sizes you want...

SPEER RESISTORS

You're sure to find the sizes and types you want in Speer's complete line of 1/2-, 1- and 2-watt fixed composition resistors, which meet or exceed the requirements of specifications MIL R11 and RS 172. The fast, efficient service for which Speer has gained a wide reputation can also help you eliminate costly production delays. So next time, specify Speer! Speer now offers these new sizes:

Speer Type	MIL Style	Rating in watts	Body		Lead	
			Nominal Diameter	Nominal Length	Wire Size	Nominal Length
SR 1/2	RC 20	1/2	.138	.390	A. W. G. # 20	1 1/2
SR 1	RC 32	1	.225	.562	# 18	1 1/2
SR 2	RC 42	2	.312	.688	# 17	1 1/2

Other Electronics Divisions of Speer Carbon Company
Jeffers Electronics, Du Bois, Pa.
Onondaga Electronics, Syracuse, N. Y.



Speer Resistor Division
Speer Carbon Company, Bradford, Pennsylvania

CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS

Indicator Lamp

424

Meets Mil specs

Model 855S-D panel indicator lamp, designed for front lamp servicing, meets all applicable Mil specs. The lamp is white when unlit and colored when lighted. Types 327 and 328 bulbs can be mounted in the 3/8-in. diam mounting hole.

The Sloan Co., Dept. ED, 7704 San Fernando Road, Sun Valley, Calif.

Reed Relays

641

Life is about 200,000,000 operations



These reed relays can be used in computers, data processing equipment, transistor drive, and other applications. A hermetically-sealed, glass-encapsulated magnetic reed switch is surrounded by an operating coil to provide spst, normally-open relay action. It is suited for low-level switching or for low power switching of loads up to 15 w and 250 v. Maximum operating current is 1 amp. Load life at 1/4 of maximum rating is about 200,000,000 operations. Minimum operating power is about 100 mw.

Struthers-Dunn, Inc., Dept. ED, Pitman, N.J.
Availability: 30-day delivery.

Indium Spheres

437

99.9995% pure

Used in forming alloy junctions in germanium transistors and diodes, these indium spheres are 99.9995% pure. The spheres are available in a range of diameters from 0.001 to 0.25 in., ± 0.0001 in.; sphericity is held to ± 0.0001 in. Indium alloys available in spheres using the 99.9995% indium are: indium-gallium, indium-zinc, indium-gallium-gold, indium-gallium-zinc, indium-gallium-aluminum, indium-germanium, and indium-germanium-gallium.

Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

Price & Availability: Lots of 1 million spheres delivered within 10 days from receipt of order. Prices vary with specifications.

Pushbutton Switches

393

Have nylon molded actuator

These pushbutton switches have a nylon insert molded actuator. Depth behind the panel is 2-5/8 in. for standard types and 4-1/4 in. for lighted units. A wide choice of contact arrangements is offered. Uses are in data systems, signal controls, test sets, and computers.

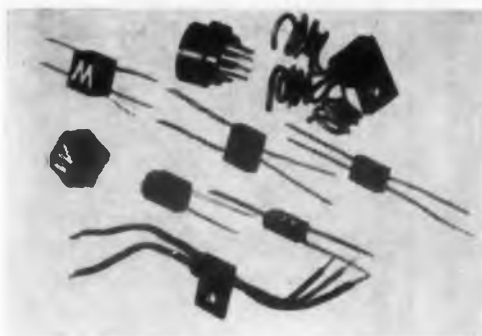
General Control Co., Dept. ED, 1200 Soldiers Field Road, Boston 34, Mass.

Price & Availability: Price begins at \$5.70 ea. Delivery time is 14 to 21 days.

Encapsulated Diodes

645

From 2 to 12 in one assembly



From 2 to 12 diodes can be assembled in this package by varying one dimension. Type PC is a plug-in unit for printed circuit use; type TB has a miniature 7-pin tube base, and type CC is a cylindrical clamp-on unit made to stand severe vibration. The smallest package measures 0.172 x 0.422 x 0.281 in. and the largest measures 0.5 x 0.5 x 0.481 in.

Wells Electronics Co., Dept. ED, 1701 S. Main St., South Bend 23, Ind.

Availability: Some units from stock.

Silicon Rectifier

442

Delivers 3 amp half wave

Type MR series of double-diffused junction silicon rectifiers deliver up to 3 amp, half wave, with proper heat sink, in ambients up to 150 C. In full wave circuits, currents as high as 9 amp can be realized. The units are hermetically sealed cells suited for power supply and magnetic amplifier applications. Designed for conduction cooling by mounting directly on to the chassis, the stud-mounted rectifiers may also be installed with the electrical insulating mica washers supplied with each.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.

Price & Availability: Delivery from stock takes 5 days. Price is between \$1.70 and \$12 when ordered in quantities of 1000.

How can you use **SPRING-LOCK?**

THE FASTENER WITH USES UNLIMITED



As a standard removable fastener or a blind rivet

A quarter-turn locks, un-locks. Load-carrying steel arms lock securely, don't loosen under vibration. One-piece (no receptacle) simplifies blind fastening.



As a roller axle

Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.



As cup hooks

High-strength polystyrene or chrome-plated die cast zinc. Inexpensive, sturdy and good-looking. Simply and quickly installed with a twist of the wrist.



As a cabinet door strike

Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.



As a plastic shelf support

... with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

What is your application for **SPRING-LOCK?**

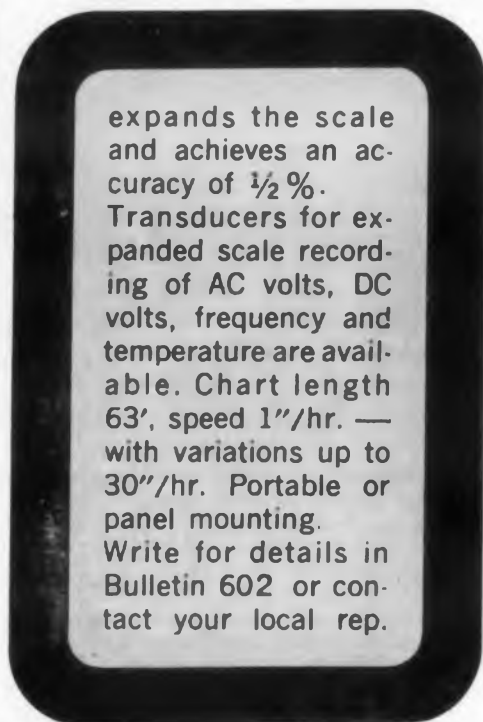
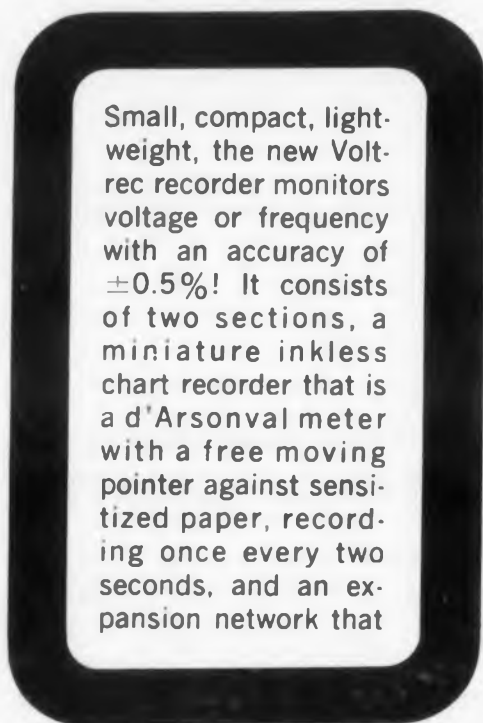
Send us your application inquiries. Our engineers will answer you specifically and promptly. Or, write today for the Simmons Catalog. **SPRING-LOCK** samples are available upon request.

SIMMONS FASTENER CORPORATION

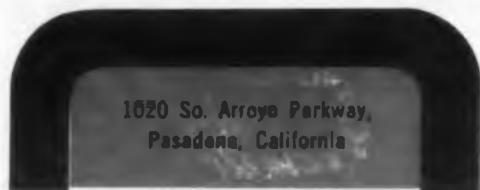
1763 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK • DUAL-LOCK

SEE OUR 8 PAGE CATALOG IN SWEET'S PRODUCT DESIGN FILE
CIRCLE 59 ON READER-SERVICE CARD



VOLTRON PRODUCTS, INC.,



CIRCLE 68 ON READER-SERVICE CARD

NEW PRODUCTS

Amplifier and Power Supply 394

For the 225 to 400 mc band

Model 42A 1-kw amplifier and power supply operates in the 225- to 400-mc band, providing a means for increasing the reliability of aircraft communications circuits. All high voltages are housed in a hermetically sealed container filled with silicone oil. The amplifier weighs 38 lb and measures 6-1/2 x 10-1/2 x 16 in. The power supply weighs 32 lb and measures 6-1/2 x 4-7/8 x 16 in.

Electronic Communications, Inc., Dept. ED, 1501-72nd St., N., St. Petersburg, Fla.

Telemetry Decommutator 627



Solid state, digital

Model 185A solid-state, digital decommutator accepts most pulse-type telemetry signal inputs, PAM, PDM, or PCM, from 10 to 4,600 pps. It can provide digital or analog outputs. For digital outputs, accuracy is 10 bits at sampling rates of 1,150 pps and 8 bits at higher rates. Between 10 and 128 channels or words per frame can be accommodated. The 48-channel unit occupies 52.5 in. of rack height.

Electro-Mechanical Research, Inc., Dept. ED, Sarasota, Fla.

Availability: The unit is made on order.

Thermal Impedance Meter 427

Uses pulse techniques

This thermal impedance measuring equipment uses pulse techniques to measure junction thermal impedance. The junction is heated with a stable dc which is pulsed off for 500 μsec at the rate of 10 pps. During the off interval, the forward voltage drop is measured and compared to the initial drop. The quotient of the temperature rise and the applied heating power is thermal impedance. Heating currents are up to 50 amp.

Wallson Associates, Inc., Dept. ED, 912-914 Westfield Ave., Elizabeth, N.J.

Here's a simple, portable sound analyzer



THE ALLISON 532 OCTAVE BAND ANALYZER

The Allison 532 is a small, light weight instrument that is exceedingly easy to operate. It separates sound into frequency components for analysis. The 532 is suitable for use with sound level meters, tape recorders, microphone preamplifiers and similar equipment. For complete information, write for Technical Bulletin #532.

532 SPECIFICATIONS

- Five 10 db step attenuator
- Dynamic range of 66 db
- Eight bands with passive network
- Transistorized and battery operated
- Approximate shelf life for battery
- 33 db per octave attenuation rate with flat pass band
- Input level adjustable — nominally 1 volt
- Cutoff frequencies conform to ASA S-1.6-1960 Preferred Frequencies
- Meter circuit meets ASA Standard for S.L.M.S.
- Weight 6.5 lbs; 6 3/4" x 6 3/4" x 5 1/2"
- Price \$425.00 F.O.B. factory

Write for new catalog of Allison Analyzing Instruments



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Allison Laboratories, Inc.

11301 OCEAN AVENUE
LA HABRA, CALIFORNIA

CIRCLE 69 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

Coaxial Plug

671

Needs no adaptor

This ConheX cable-plug eliminates the usual adaptor necessary in running subminiature coaxial cables into BNC and TNC panel connectors. The plug provides a vise-like grip on the cable. It is gold-plated to resist corrosion and to provide lower contact resistance.

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

Relay Analyzer

458

Tests seven characteristics in 4 sec



Able to test seven characteristics in 4 sec, model 708 relay analyzer handles all dc and ac, 60 and 400 cps, relays with up to six poles. Information is presented on a meter and on go/no-go lights. Automatic presentation of pull-in and drop-out voltages or current, pull-in and release times, and coil times are provided.

Moletronics Corp., Dept. ED, 1717 N. Potrero Ave., S. El Monte, Calif.

Data Logger System

435

Balances, samples 1000 bridges

This data logger system automatically balances from one to 1000 bridges and logs their millivolt output signals in a programed mode. It samples 210 channels of analog data per minute sequentially, commutates and converts them, and punches tabulated data in a paper tape at the rate of 60 five-digit characters per second. Sensitivity control is in increments of 0.01%, for a total of 10,000 increments. Accuracy of $\pm 0.15\%$ full scale and resolution of $5 \mu\text{v}$ are built into the system. The system is applicable to one-, two-, or four-arm bridges in a voltage offset range to 50 mv across 1000 ohms. Weighing 1200 lb, it measures 32 x 60 x 67 in.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Price & Availability: \$60,000 to \$75,000, depending on options required; made on order only; 150-day delivery.



YOU
DIAL

THE DELAY TIME

with the *New ESC Direct Readout Variable Decade Delay Line*

Now you can make your own rapid selection of desired delay with the new Direct Readout Variable Decade Delay Line — the newest product developed and manufactured by ESC, America's leading manufacturer of custom-built and stock delay lines! Increments of 1/1,000 of the total delay may be selected by the turn of a dial. And there are three models:

- Model 101 — a total delay of 9.99 usec.
- Model 102 — a total delay of 99.9 usec.
- Model 103 — a total delay of 999 usec.

There is a constant impedance of 1,000 ohms between input and output terminals for any delay increment.

Delay/rise time ratio at maximum delay is 33:1. The ESC Direct Readout Variable Decade Delay Line is a passive delay network and will not introduce noise or jitter. Mechanical and electrical modifications available on special order.



ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

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

ELECTRONICS CORP. 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Shift registers • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 70 ON READER-SERVICE CARD

THIS IS YOUR FIRST LOOK AT CEC'S TWO NEWEST CONNECTORS



HIGH-ENVIRONMENT CIRCULAR TYPE designed to meet MIL-C-26500. This is CEC Series 600, 700, 800 for critical altitude, temperature, and reliability requirements of high-performance aircraft, missiles, and space vehicles. Resilient silicon-rubber seals provide liquid immersion resistant assembly. Available with 24, 31, and 55 removable, crimp-type contacts and choice of square flange or jam-nut receptacle mounting. Write for Bulletin CEC 4005-X1.



RACK AND PANEL RECTANGULAR TYPE with die-cast aluminum shell. CEC 500L Series with crimp-type contacts designed to meet MIL-C-26636. Available in 48- and 63-contact configurations with sizes 16 and 20 contacts. Two standard RG58/U coaxial contacts are included in the 48-contact connector. Insulator blocks of both new connectors are high-strength, glass-filled Diallyl Phthalate. Write for Bulletin CEC 4006-X1.

CEC also manufactures a full line of rectangular connectors (Series 500C) which feature snap-in, crimp-type contacts. This series is available in a wide variety of mounting configurations with 26 to 104 contacts. Write for Bulletin CEC 4004-X25.



A complete line of accessory tools for easy crimping, insertion, and removal of contacts is available.

Electro Mechanical
Instrument Division

CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

NEW PRODUCTS

Potentiometer 630

Sine-cosine function type

Type API1C sine-cosine function potentiometer measures 1-1/16 in. and comes in both single and multi-gang configurations. The standard units have a conformity of 0.5% of amplitude, peak to peak, for the resistance range of 25 to 60 K. Lower conformities can be furnished on special units. Other resistance ranges are 1 to 25 K and 60 to 80 K. Power rating is 2 w at 60 C; ambient temperature limit is 125 C. Resolution is 0.05%. The unit meets all environmental Mil specs and has a rotational life of 1,000,000 cycles.

Ace Electronics Associates, Inc., Dept. ED, 99 Dover St., Somerville 44, Mass.

Price & Availability: Price varies with unit. Standard units are in stock; special units can be delivered two weeks after receipt of order.

Digital Modules 530

Drive up to 20 gates



Model 346 digital systems modules provide all possible gating functions with a high fan-out capability and sufficient amplification to drive 20 additional gates. Model 346A provides the Nor function; it contains a diode OR gate followed by an inverting amplifier and an emitter follower. Model 346B provides the OR function; it contains a diode OR gate followed by two emitter followers. Model 346C provides the NAND function and contains a diode AND gate followed by an emitter follower and an inverting amplifier. Model 346D provides the AND function and contains a diode

AND gate followed by two inverting amplifiers.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

Price & Availability: \$99 ea; four weeks after receipt of order.

Synchronous Demodulator 525

For ac-to-dc conversion

Developed for converting ac to dc, model DM 60-C synchronous demodulator has built-in phase-compensating networks which keep linearity of to within 1% of full output. The unit is for use with linear-variable-differential transformers or with transducers containing LVDT's. Capable of operating from -65 to +185 F, the unit has a ripple characteristic of 200 μ f or 0.01% of input and requires an excitation frequency of 50 to 5000 cps. Weight is 1 lb and dimensions are 2 x 4 x 4 in.

Schaevitz Engineering, Dept. ED, Rt. 30 at Schaevitz Blvd., Pennsauken, N.J.

Price & Availability: Price is \$125; delivery time is 10 days.

Glass Dielectric Material 690

For use in electroluminescent devices

These two glasses, designated codes 1970 and 1971, are for use as the dielectric material in electroluminescent devices. Code 1971 has linear expansion of 104 to 114 x 10⁻⁷ per deg C. Code 1970 can be sealed to substrate materials with expansion from 84 to 94 x 10⁻⁷ per deg C. The dielectric constant at 20 C and 1 kc is 5.46 for code 1970 and 8.29 for code 1971. Powder or frits can be supplied.

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

Price & Availability: \$30 per lb in quantities. The product is in stock and can be delivered in 7 to 14 days.

← CIRCLE 58 ON READER-SERVICE CARD

IMMEDIATE DELIVERY OF ELMENCO

capacitors

IN QUANTITIES UP TO

500 Per Item

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TENNESSEE: Electra Distributing Co., 1914 West End Ave., Nashville 4

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CIRCLE 66 ON READER-SERVICE CARD

Another New Achievement from El-Menco

A New Smaller Size

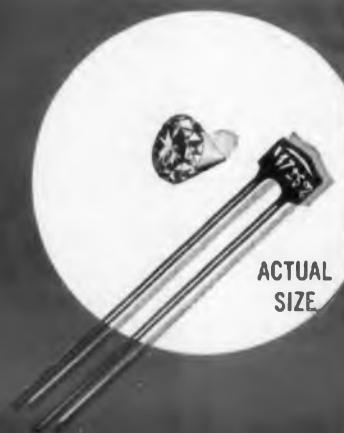
Dipped Silvered

Mica Capacitor

El-Menco's

SUB-MINIATURE

DM-10



Approx. 5/16" long...

1/4" wide...

1/8" thick!

Smaller than a
1-carat diamond!

Mica Capacitor...

Sets New Standard in Miniature Reliability!

■ This sub-miniature DM-10 Mica Capacitor retains the same superior electrical characteristics of silvered mica capacitors as found in much larger sizes. It assures a high order of performance in extreme miniaturization applications — missiles, printed circuits and all compact electronic equipment. Parallel leads provide greater versatility. Tough phenolic casings protect against physical damage and penetration of moisture.

Capacity and Voltage Ranges

Working Voltage	Capacity Range
100 WVDC	1 MMF thru 360 MMF
300 WVDC	1 MMF thru 300 MMF
500 WVDC	1 MMF thru 250 MMF

Operating Temperature: up to 150° C.

Characteristics: C, D, E and F, depending on capacitance value

Leads: #26 AWG (.0159") Copperweld wire

EL-MENCO'S SUB-MIDGET DM-10 . . . THE NEW SMALLER MINIATURE MICA CAPACITOR

EL-MENCO'S DM-10 MEETS ALL THE ELECTRICAL REQUIREMENTS OF MILITARY SPEC. #MIL-C-5B AND EIA SPECIFICATION RS-153

Other sizes also ideal for miniaturization applications —

DM-15 . . . up to 820 mmf at 300 VDCW, up to 400 mmf at 500 VDCW.

DM-19 . . . up to 5400 mmf at 300 VDCW, up to 4000 mmf at 500 VDCW.

WRITE FOR SAMPLES OF EL-MENCO DM-10 CAPACITORS and brochures describing El-Menco's complete line of capacitors.

El-Menco

Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors
WILLIMANTIC CONNECTICUT

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- tubular paper ● ceramic ● silvered mica films ● ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

CIRCLE 67 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Striping Machine 609

Color codes with 1, 2, or 3 stripes

Capable of color coding nylon and PVC jacketed wire with 1, 2, or 3 stripes at one time, model 1-S striping machine operates at speeds up to 150 ft per minute. It can be used with wire from 0.05 to 5/16 in. The machine will handle wire reels up to 30 in. in diameter and is equipped with a variable transverse-level winding mechanism that is adjustable for different spool widths. The machine area measures 90 x 28 x 134 in.; motor requirement is 220 v, 3 phase.

Electronic Production & Development, Inc., Electronic Div., Dept. ED, 138 Nevada St., El Segundo, Calif.

Price & Availability: Can be delivered within 6 weeks. Price is \$5200 per unit, fob El Segundo, Calif.

Motor Starting Switch 494

Is thermally actuated

For simplified starting control of single-phase motors, series 47-000.0-P switches can be used attached to the motor or for remote operation. Able to be installed in any position, the switch has no sliding parts and resists contact freezing or flutter. Units are rated at 200 ma to 10 amp at 250 v ac with a life span up to 1,000,000 cycles. They can be modified for thermal relay use.

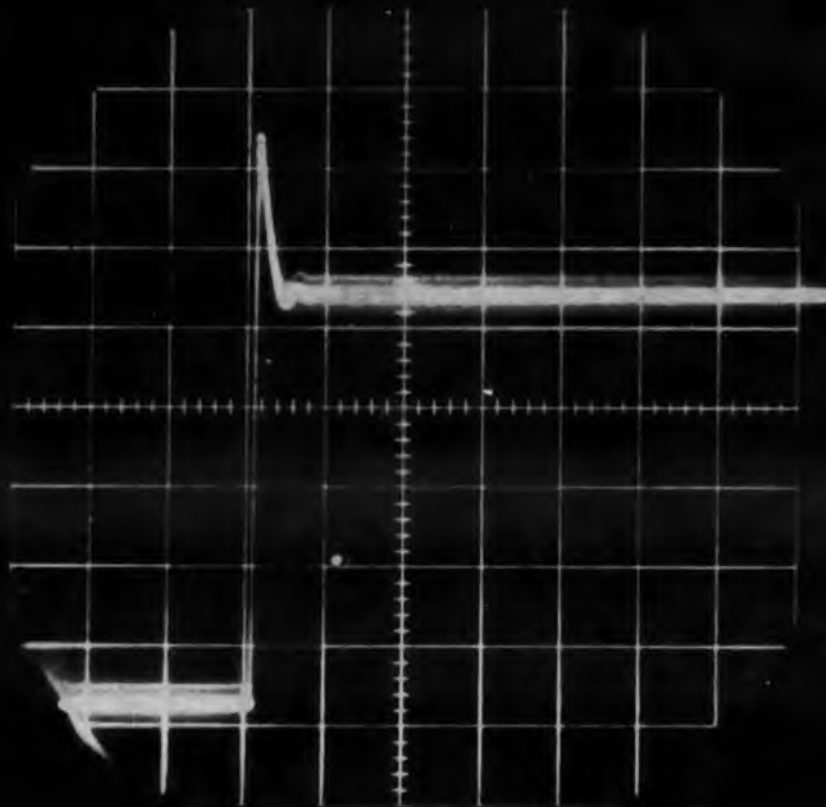
E-T-A Products Co. of America, Dept. ED, 6284 N. Cicero Ave., Chicago 46, Ill.

Price & Availability: Units are priced at \$0.73 ea in quantities of 100. Delivery is within three weeks.

Digital Recorder 692

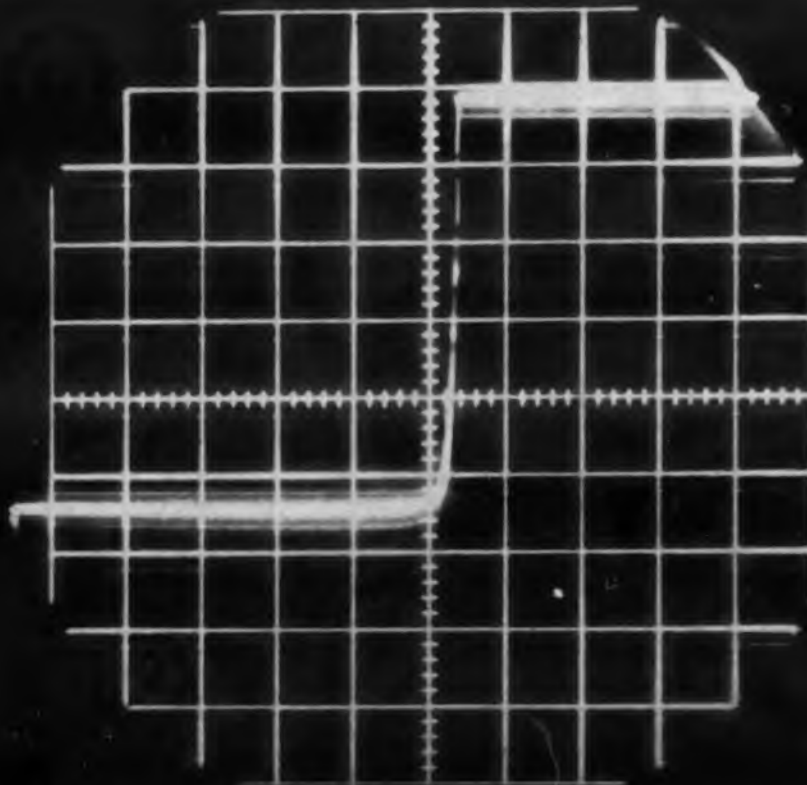
Scans 100 channels

Designed for all combinations of strain gages and strain gage transducers, model ASB-100VS recorder scans automatically 100 channels of information. By adding modular



Actual photographs of power supply turn-on at 28v setting. Scope settings: 5v per cm vertical, 0.2 sec. per cm horizontal.

TRANSISTOR KILLER: THE VOLTAGE SPIKE...



TAMED BY NEW PERKIN MTR DC POWER SUPPLIES

The voltage spike in the top photo could destroy the transistors in your circuit in microseconds. This one happens to be a "turn-on" transient—one of several treacherous, instantaneous overshoots encountered in the everyday use of dc supplies. For complete protection against line and load transients, use new Perkin MTR power

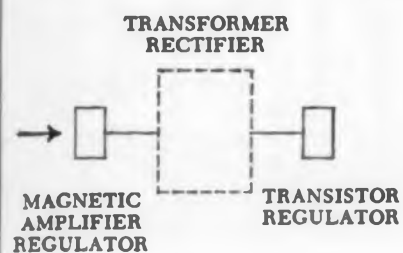
supplies. Combining the best two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous regulation and low ripple. Made without tubes or moving parts, they give you long, trouble-free service. They're ideal for continuous-duty and unattended operation. Perkin MTR units sustain shorts and overloads indefinitely without suffering internal damage or shooting spikes into the load. After shorts, they resume normal operation automatically. And their protection is constant... even if an internal transistor fails, your Perkin MTR power supply continues to regulate smoothly and safely!

PERKIN



MODEL NO. MTR-636-15

PERKIN



NEW SOLID STATE REGULATION PRINCIPLE:

magnetic amplifiers for efficiency and reliability, transistors for fast response

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES

prompt delivery

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	RMS
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	±.2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	±.3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	±.2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	±.2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	±.4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	±.5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Over-

loads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

WRITE FOR COMPLETE PERKIN CATALOG on tubeless power supplies and new technical article on dc power sources for transistorized circuits.



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units, the capacity can be extended to 200 channels. Bridges with 1, 2, and 4 arms and with gage resistances 60 to 1000 ohms may be used interchangeably in all channels. Strain is read directly in micro-inches per in. over the range of +10,000 to -10,000 at the rate of 1 channel per sec. Accuracy of indication is ±1%.

Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.

Price & Availability: Prices range from \$15,000 to \$24,000. Delivery time is 90 days.

Digital Distribution 577 Unit

For missile tracking systems

Designed for missile tracking systems, model DH-10 digital distribution unit accepts range timing signals up to 27 bits, and provides for interrogation of any tracking device of which the output can be digitized. It extracts and stores tracking data up to three 24-bit words in any combination, plus up to 20 bits of auxiliary data. All data is arranged for transmission on data link and is recorded on magnetic tape. Sampling rates are 10, 20, and 40 pps.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price & Availability: \$35,000; 90 to 120 days.

Thyratron Tubes 386

Has a piv of 2500 v

Type 710A 2.5-amp inert-gas and mercury-vapor thyratron is rated at 2500 v for peak inverse and forward voltages. It can be used as an ignitor firing tube in spike welding applications. Filament voltage is -2.5 v, filament current is -9 amp, and average anode current is -2.5 amp. Temperature range is -40 to +80 C.

National Electronics, Inc., Dept. ED, Geneva, Ill.

Price & Availability: \$10.61 ea, from stock.

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INTERMEDIATE
POWER
TRANSISTORS



• Now in stud-mounted package

For regulated power supplies and amplifier output stages —
replaces 2N1047-50 and 2N1483-86—offering low R_{cs} , good Beta
linearity and voltage ratings to 120V.

Type	Maximum Power Dissipation @ 100°C (watts)	Typical DC Current Gain @ $I_c = 1$ amp	Maximum Collector Voltage (Volts)	Typical Saturation Resistance (ohms)	Typical DC Input Voltage (Volts)
2N1647	20	25	80V.	1.7 @ 1A.	2 @ 1A.
2N1648	20	25	120V.	1.7 @ 1A.	2 @ 1A.
2N1649	20	45	80V.	1.7 @ 1A.	2 @ 1A.
2N1650	20	45	120V.	1.7 @ 1A.	2 @ 1A.

WRITE FOR BULLETIN /TE-1335S

With these new transistors, Transitron offers improved performance and outstanding features in all power ratings from 100 microamps to 5 amps. Each functions in a wide operating range — permitting use of fewer types, simplifying equipment manufacture. All provide the ruggedness and reliability of mesa silicon construction. All are available now, at prices competitive with lower-performance devices.

HIGH POWER
TRANSISTORS



• Available in two package styles — 11/16" hex stud mount and square flange

For regulated power supplies and amplifier output stages —
replaces 2N1015-16, 2N424, 2N389, 2N1487-90 — with low R_{cs}
(typical .8 ohms), good Beta linearity, high cut-off frequencies, and high voltage.

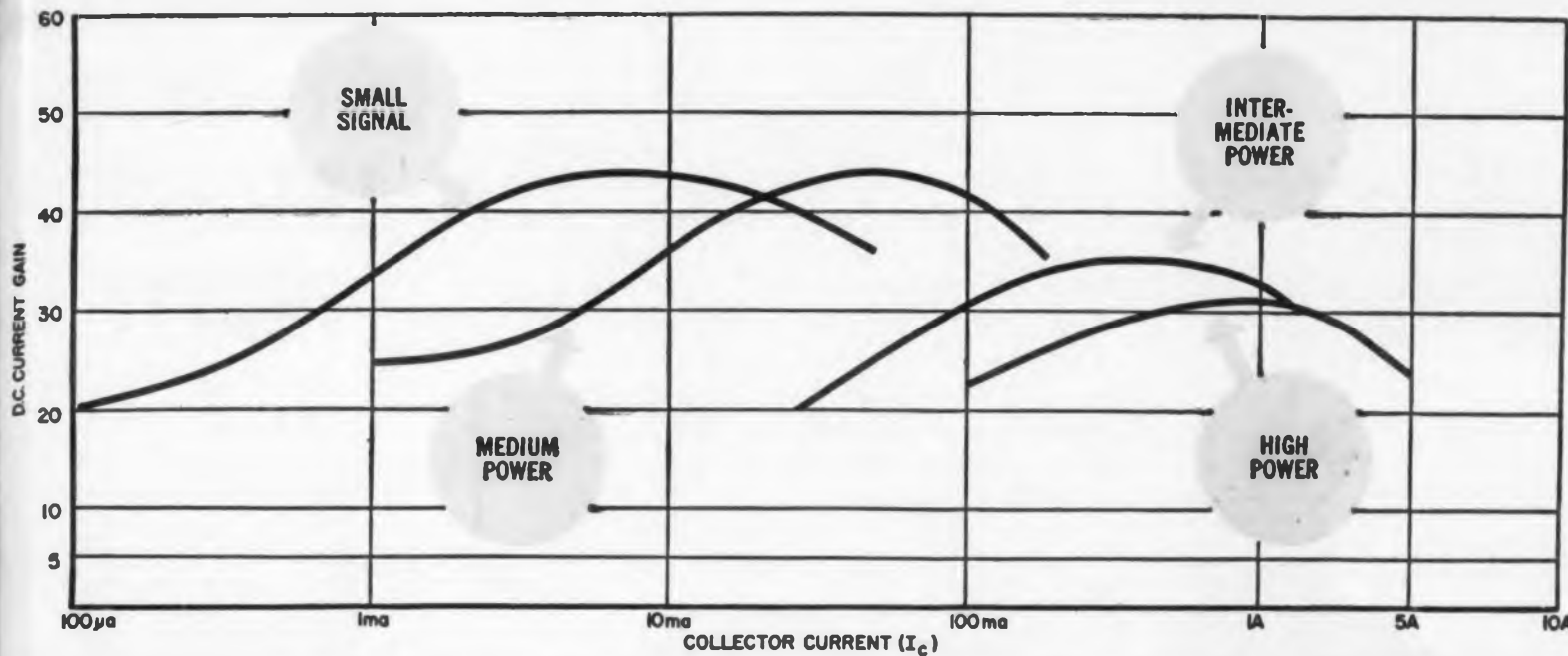
Type	Maximum Power Dissipation @ 100°C (Watts)	Maximum Collector Current (amps)	Maximum Collector Voltage (Volts)	Maximum Saturation Resistance (ohms)	Maximum DC Input Voltage (Volts)	DC Beta @ 2 amps	
						Min.	Max.
2N1616 2N1210	30	5	60	1 @ 2A.	3 @ 2A.	15	75
2N1617 2N1211	30	5	80	1 @ 2A.	3 @ 2A.	15	75
2N1618 2N1620	30	5	100	1 @ 2A.	3 @ 2A.	15	75

WRITE FOR BULLETIN /TE-1335R

COMPUTER DESIGNERS
ATTENTION

Watch for announcement of
Transitron's revolutionary
new switching device —
coming next month and at
WESCON show!

Booth 2638-39



ES, HIGH CUT-OFF FREQUENCIES, LOW R_{CS} AND BETA LINEARITY

SMALL SIGNAL TRANSISTORS



For low level high voltage switching and amplification. Replaces 2N332-2N343 with higher cut-off frequencies (30mc), lower R_{CS} , smaller sized TO-18 package, and higher voltages.

SMALL SIGNAL TO-18						
Type	Maximum Collector Voltage	Minimum DC Beta			Maximum Power Dissipation @ 25°C Ambient (mw)	Typical Saturation Resistance (ohms)
		I_c 500µa	I_c 5ma	I_c 50ma		
ST1504	60	15	20	20	300	40
ST1505	100	15	20	20	300	50

WRITE FOR BULLETIN /TE-1353T

MEDIUM POWER TRANSISTORS



- Collector lead isolated from case — greatly simplifying heat dissipation measures and increasing reliability
 - Include highest standard voltage ratings available (to 125V) — for extra safety margin against overloads.
- To replace 2N332-343, with improved high frequency characteristics, good Beta linearity, and low R_{CS} .

Type	Maximum Collector Voltage (volts)	Minimum Beta			Maximum Power Dissipation (Watts) @ 25°C Case	Maximum Saturation Resistance (ohms)
		I_c 1ma AC	I_c 5ma AC	I_c 50ma DC		
•2N339A †	60	15	25	20	1	50
•2N340A	85	15	25	20	1	70
•2N341A †	125	15	25	20	1	70
••2N1054	125	20(DC) @ 200ma			5	20
•••2N696	60	20(DC) @ 150ma			2	10
••••2N697	60	40(DC) @ 150ma			2	10

† Electrical equivalents available in TO-5 package as 2N1208 and 2N1207

- WRITE FOR BULLETIN /TE-1355J1 •• WRITE FOR BULLETIN /TE-1355E-2
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530 Canal St.
BEakman 3-2980

N. CAROLINA, Winston-Salem
Dalton Hege Radio Supply Co.
938 Burke St.
PARK 5-8711

N. CAROLINA, Winston-Salem
Electronic Distributors
823 S. Marshall
PARK 4-0541

OHIO, Cincinnati
Hughes-Peters, Inc.
1128 Sycamore St.
DUmbar 1-7625

OHIO, Cleveland 15
Radio & Electronic Parts Corp.
3235 Prospect Ave.
UTah 1-6060

OHIO, Dayton 2
The Stotts-Friedman Co.
108-112 N. Jefferson St.
BALdwin 4-1111

OKLAHOMA, Tulsa
Radio, Inc.
1000 S. Main St.
GIBson 7-9124

PENNSYLVANIA, Philadelphia
Radio Electric Service Co.
of Pa., Inc.
701 Arch St.
WAInut 5-5840

RHODE ISLAND, Providence
DeMambo Radio Supply Co., Inc.
90 Broadway
JAckson 1-5600

TEXAS, Dallas 7
Contact Electronics, Inc.
P.O. Box 10393
2403 Farrington St.
Riverside 7-9831

TEXAS, Houston 19
Busacher Electronic
Equipment Co.
P.O. Box 13204
1216 W. Clay
JAckson 9-4626

UTAH, Salt Lake City
Kimball Distributing Co.
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NEW PRODUCTS

Printed Circuits

473

Laminated

Called Encapsulayer, these printed circuits are manufactured in many layers and laminated together under heat and pressure. They can be used to perform complex interconnections as the miniaturized replacement for cumbersome back-panel wiring in computers. They can be used in other switches and coding applications. A typical six-layered sandwich measures 0.026 in. thick.

Photocircuits Corp., Dept. ED, 31 Sea Cliff Ave., Glen Cove, N.Y.

Cyclic Timer

631

Is preset for 1/4 to 2-1/4 hr



Designed for use in triggering or cycle testing of external equipment, this cycle timer can be preset for any period from 1/4 to 2-1/4 hr in 1/4-hr increments. At the end of each interval, a set of spdt contacts operate and remain actuated for 15 min. At the same time the dpdt contacts change position and remain changed until the next interval is completed.

Industrial Electronics, Inc., Dept. ED, 4730 Earlham Dr., Indianapolis 27, Inc.

Availability: Delivery time is currently 30 days.

Varactor Diodes

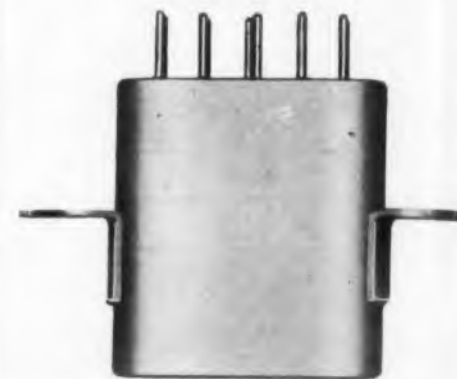
678

Complete series offered

Models MA-4280 through MA-4292 diffused-junction varactor diodes range in junction capacitance from 0.4 to 35 pf, measured at -6 v. Junction capacitance at 0 v is about twice the value at -6 v; at -30 v, it is about one-half its value at -6 v. The piv rating is -30 v. Typical cut-off frequency is 30 kmc; the large-capacitance units have about 2 ohms series resistance. Housed in hermetically sealed, reversible cartridges with ceramic-to-metal seals, the diodes can be used as modulators for microwave links, in multiplier circuits in rf receivers, and in transmitter equipment with a range of 1 to 10,000 mc.

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

**2 MEGACYCLE
DRY CIRCUIT
LATCHING
RELAY!**



YES! The 101 relay series has operated continuously for over two million cycles without failure.

Only U. S. Relay-Electronics 101 series has unsurpassed sensitivity of 3 milliseconds latching time.

The 101 is a micro-miniature latching relay series that offers BIG RELAY performance in crystal can size. Designed for continuous use at -65°C to +125°C temperature range. This relay series has been designed to meet applicable portions of Military Specifications, MIL-R-25018 and MIL-R-5757. Completely adaptable for missile, military, computer and industrial usage where size, weight and environmental extremes are critical. In addition, the 101 series will withstand 100 G shock for a limited duration.

During the WESCON show at Los Angeles, we will have an operating unit on display. Stop by our booth and guess at what cycle this unit will fail. The closest guess will win a valuable citizen band transceiver!

For further information on the 101 Series, and certified test reports, write:



U. S. RELAY-ELECTRONICS

717 No. Coney Ave., Azusa, Calif.
a division of A*S*R Products Co.

CIRCLE 72 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

Pressure Transducers 387

Ranges are from ± 300
to ± 5000 psia

Type H-137 differential pressure transducers can be offered in 16 ranges between ± 300 and ± 5000 psia. For use from -65 to $+125$ C, the units have a standard resistance value of 7500 ohms $\pm 5\%$. Linearity error is 1% max; error due to hysteresis efforts is 0.5% max. Proof pressure is 150% of rated pressure and burst pressure is 200%.

Servonic Instruments, Inc., Dept. ED, 640 Terminal Way, Costa Mesa, Calif.

Availability: Eight-week delivery time.

Synchronous Motors 443

Have positive clutch and
instantaneous brake

The PC-SM series unidirectional motors and the PC-RSM series reversible motors have a positive clutch and an instantaneous brake. The input shaft of these 40 and 80 oz-in. motors can be started in 10 msec or less and stopped at 1 rpm within 0.1 deg. The motors measure 2-1/2 in. in diameter and 2-1/16 in. deep and are supplied for 95 to 130 v operation at 60 cps, drawing 7 w.

Hurst Manufacturing Corp., Dept. ED, P. O. Box 326, Princeton, Ind.

Inertia Switch 445

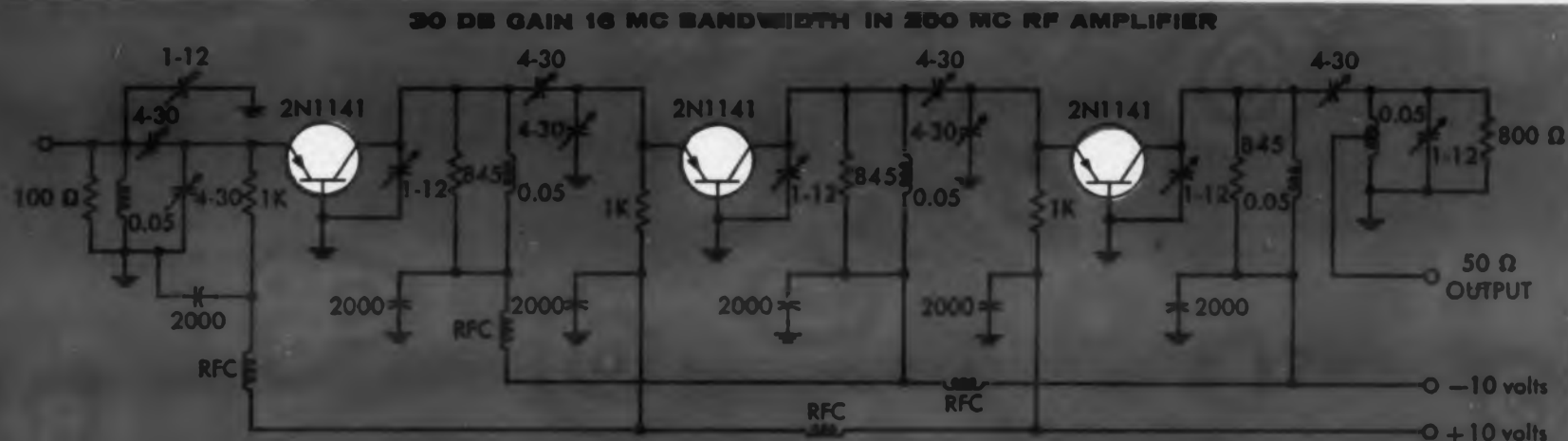
Delay time is from 0.55 to 1.65 sec

This electrical contact-closure delay device is designed to function when acceleration forces of appropriate magnitude, direction, and duration are sensed. It can be modified for a wide range of acceleration and timing values. Delay times are 0.55 to 1.65 sec, accuracy is ± 200 msec variation at rated acceleration. One spst provides NC or NO operation at the end of the time delay. The unit weighs 3.5 lb and measures 1.6 in. long and 1.5 in. in diameter.

Elgin Micronics, Dept. ED, 21001 Nordhoff St., Los Angeles, Calif.

CIRCLE 73 ON READER-SERVICE CARD

30 db gain in 200 mc RF amplifier



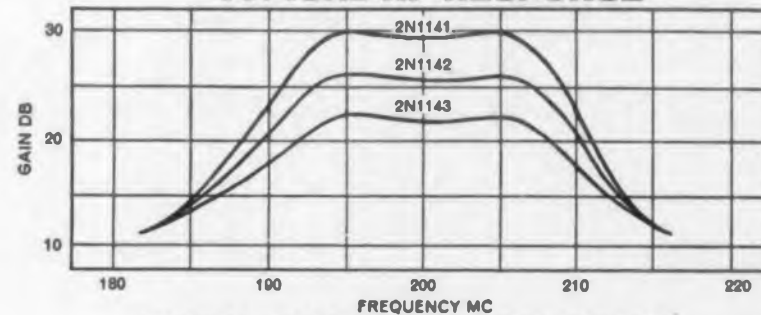
.05 μ h coils: 1 turn #14 Tinned Buss Wire; Air Core Diameter 3/16"; All Capacitors in mmfd;
All Resistors are TI MIL-Line Precision Carbon Film; All RFC's encapsulated and self resonant @ 200 mc.

... with TI 2N1141 series germanium mesa transistors

Exceptionally high ac beta TI 2N1141 germanium mesa transistors provide 30 db gain — with 16 mc bandwidth — in a 200 mc RF amplifier. Ideal for your high frequency amplifiers and power oscillators, 2N1141 series diffused base transistors give you ... maximum dissipation to 750 mw ... voltage ratings to 35v at 100 μ a I_C ... 750 mc alpha cutoff.

These devices are backed by more than 3,500,000 unit hours of life test reliability data ... see curves below.

TYPICAL RF RESPONSE

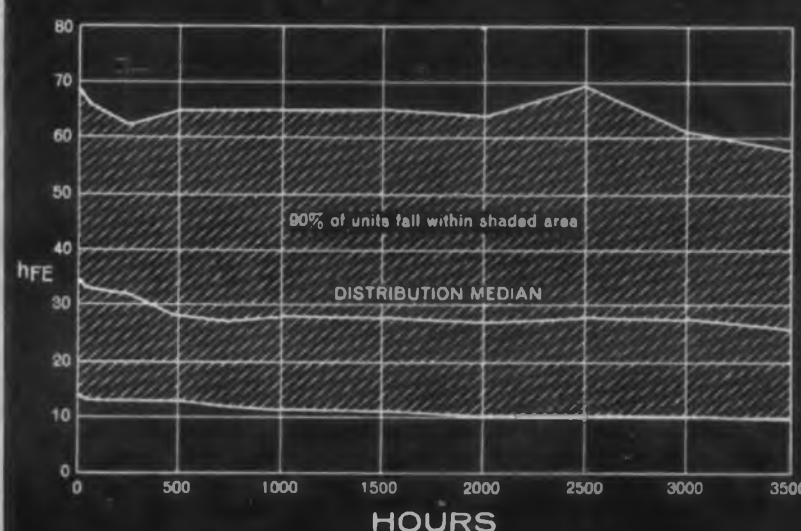
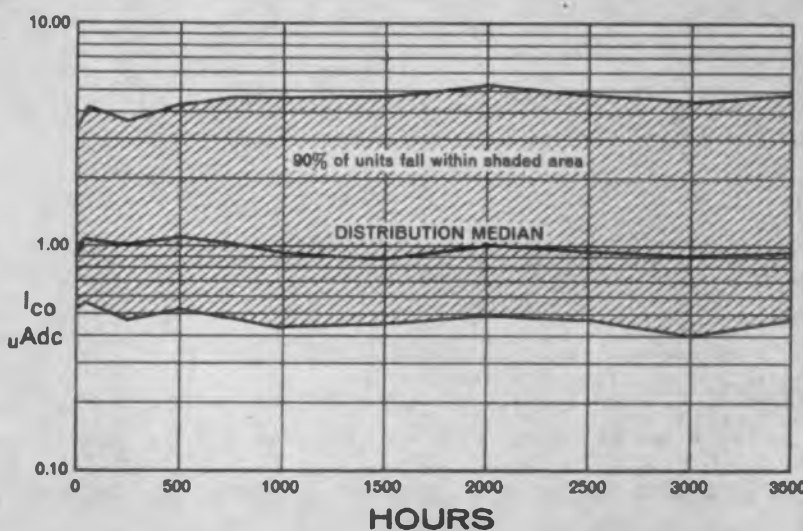


TYPICAL CHARACTERISTICS AT 25°C

	2N1141	2N1142	2N1143	unit
f_{ab}	750	600	480	mc
C_{Tc}	1.2	1.4	1.5	μ sec
r_b'	65	80	110	ohms

UNIT TYPE 2N1142: I_{CBO} AND h_{FE} VS HOURS OF STORAGE AT +100°C

TEST LEGEND: Sample Size: 1000 units ■ Test Condition: Storage at +100°C ■ I_{CBO} Measured at: $V_{CB} = -20v, I_E = 0$ ■ h_{FE} Measured at: $V_{CE} = -6v, I_C = -10ma$



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The MC-1B, consisting of a Liquid Circulator and a Calorimetric RF Termination, is a precision instrument suitable for simple operation by non-technical personnel in production or field areas, yet providing primary standard accuracy for check-out of magnetrons and radar systems.

The Liquid Circulator contains a float-type flow meter, with a visual monitor of the fluid flow rate, control valves, pump assembly, reservoir and heat exchanger, all parts of nonferrous materials to prevent contamination of the fluid, distilled water.

The RF Termination is suited for the measurement of power in the microwave region, with adapters available for achieving an RF match greater than 1.15 in VSWR from 2600 to 26,500 mcs . . . without problems associated with the excitation and propagation of higher waveguide modes.

Features include a good RF match with the Termination, metered fluid flow, precision temperature readings and well designed control of heat transfer.

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design



NEW LOW COST ELAPSED TIME INDICATOR

Unsealed, bakelite case design provides low cost. Self-starting synchronous motor drives 5-digit counter; records hours to 99999 or hours and tenths to 9999.9. Square Model 53 SET 3 1/2" also available. For 110 or 220 volt, 60 cycle AC. Standard ASA/MIL 3 1/2" mounting. Data on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, New Hampshire, U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario.

Honeywell

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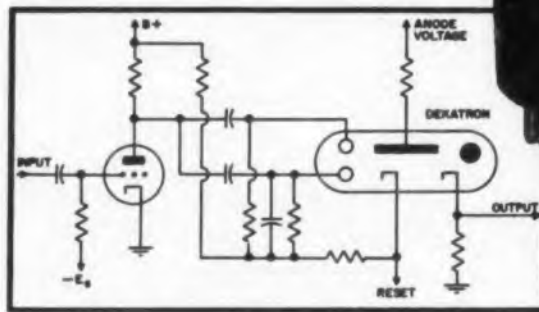
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Instrumentation for Better Analysis

CIRCLE 83 ON READER-SERVICE CARD

NEW PRODUCTS

DC Amplifier

€ 34



Power gain is over
1,000,000

Having a power gain of over 1,000,000, model 9018H solid-state, dc amplifier has input impedances up to 100 K. An input signal of 0 to 10 mv provides an output voltage of 0 to ± 5 v dc with an output impedance of 5 K. Linearity is $\pm 1\%$ over a wide temperature range. The unit consists of an input chopper, a high gain ac amplifier, and a demodulator. Power requirement is 28 ± 3 v dc at 30 ma; reference signal is 400 cps at 5 v rms and 0.2 ma.

Natel Engineering Co., Dept. ED, 15922 Strathern St., Van Nuys, Calif.

Price & Availability: Having a temperature range of -55 to $+71$ C, the unit is priced at \$275 to \$300; having a -10 to $+55$ C range, the unit is priced at \$175 to \$260. Small quantities can be delivered in two to three weeks.

Rotary DC Solenoids

639

Stroke length is 0 to 60 deg



These rotary, dc solenoids are available in sizes of 8, 10, 13, 15, and 18 and in stroke lengths from 0 to 60 deg, clockwise or counter-clockwise. Output voltage range is 6 to 300 v dc. The solenoids can be operated in high temperatures, in pressurized mechanisms, and in aircraft systems. They can also be used in installations where axial travel of the output shaft must be eliminated or where the rotary stroke may be externally stopped before the electro-magnetic stroke is completed.

PSP Engineering Co., Dept. ED, 6058 Walker Ave., Maywood, Calif.

Price & Availability: Some units will be in stock by September; units are ordinarily made to customer specs. Price ranges from \$20 to \$35 ea.

ELECTRONIC DESIGN • July 20, 1960

Brazing Fixture 495

Uses induction heating

This line of production fixtures is for brazing metal assemblies under a controlled atmosphere by induction heating. The reducing atmosphere prevents oxidation on the work during heating, eliminating the need for flux. The joints produced with these units are uniformly sound, free of residual or entrapped flux, and corrosion-resistant.

Lepel High Frequency Laboratories, Inc., Dept. ED, 55th St. and 37th Ave., Woodstock, N.Y.

Microwave Antenna Pattern Range 510

Measures from 2500 to 26,500 mc

This indoor, microwave-antenna-pattern testing range gives performance data for one-way and two-way microwave antenna pattern measurements from 2500 to 26,500. An 11-ft octagon in cross section about 40 ft long, the range measures antennas with a gain of up to 30 db in azimuth and elevation planes.

Budd-Stanley Co., Dept. ED, Long Island City, N.Y.

IF Amplifier 493

Has 90 db gain

This transistorized, logarithmic, if amplifier has a nominal center frequency of 10.7 mc, a bandwidth of 0.75 mc, and a small signal gain of 90 db. The input dynamic range is 45 db and the output dynamic range is 12.8 db. The dc output is logarithmic to within ± 1 db for inputs from 40 to 6000 mv. The ac output is constant to within ± 1 db for constant percentage modulation of input signals of 40 to 6000 mv. Input impedance is 50 ohms; output impedance is 500 ohms. The operating temperature range is 0 to 55 C. Silicon semiconductors are used throughout.

Electronics Systems, Inc., Dept. ED, 105 Chauncy St., Boston 11, Mass.

Availability: Delivery time is 90 to 120 days.

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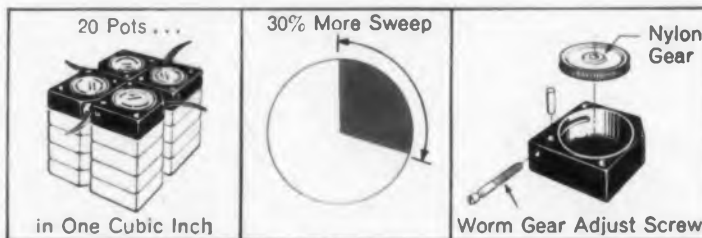
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CIRCLE 85 ON READER-SERVICE CARD

← CIRCLE 86 ON READER-SERVICE CARD

NEW PRODUCTS

Thermal Timer

425

Is completely housed

Model 261 completely housed thermal timer has two terminals for the contact circuit and two terminals for the heater circuit. Timer settings are up to 2 min. Contacts can be normally open, closing after being energized, or normally closed, opening after being energized. Contact rating is 100 w, 115 v ac non-inductive load. The stock heater winding is rated at 24 v.

George Ulanet Co., Dept. ED, 413 Market St., Newark 5, N.J.

Transistor Tester

520

For industrial and lab use



Model 160 transistor tester is for servicing, laboratory, and industrial use. It uses a true small ac signal measurement for current gain, reads directly in beta, and has an accuracy of $\pm 3\%$ for beta measurements. All transistors are automatically biased to a 1-ma collector current. The instrument operates on 105 to 125 v at 50 or 60 cps, measures 9 x 7 x 2.75 in., and weighs 4.5 lb.

B & K Manufacturing Co., Dept. ED, 1801 W. Belle Plaine, Chicago 13, Ill.

Price: \$69.50.

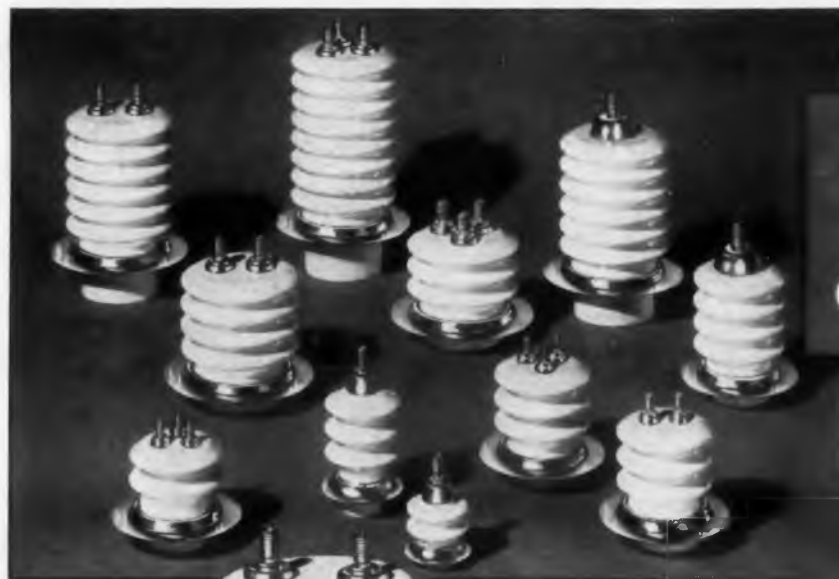
Glass-Reinforced Epoxy Laminate 431

For flush printed circuits

Textolite 11585, a glass-reinforced epoxy laminate, is for use where circuits must be forced into the laminate to produce a flush surface. It is suited for high-reliability applications such as missiles, computers, and military electronic equipment. This grade has high insulation resistance, low water absorption, high stability in humidity, and superior bonding strength. It is available in standard sheet sizes of 36 x 36 in. and 36 x 72 in., as well as sheets measuring 36 x 48 in.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

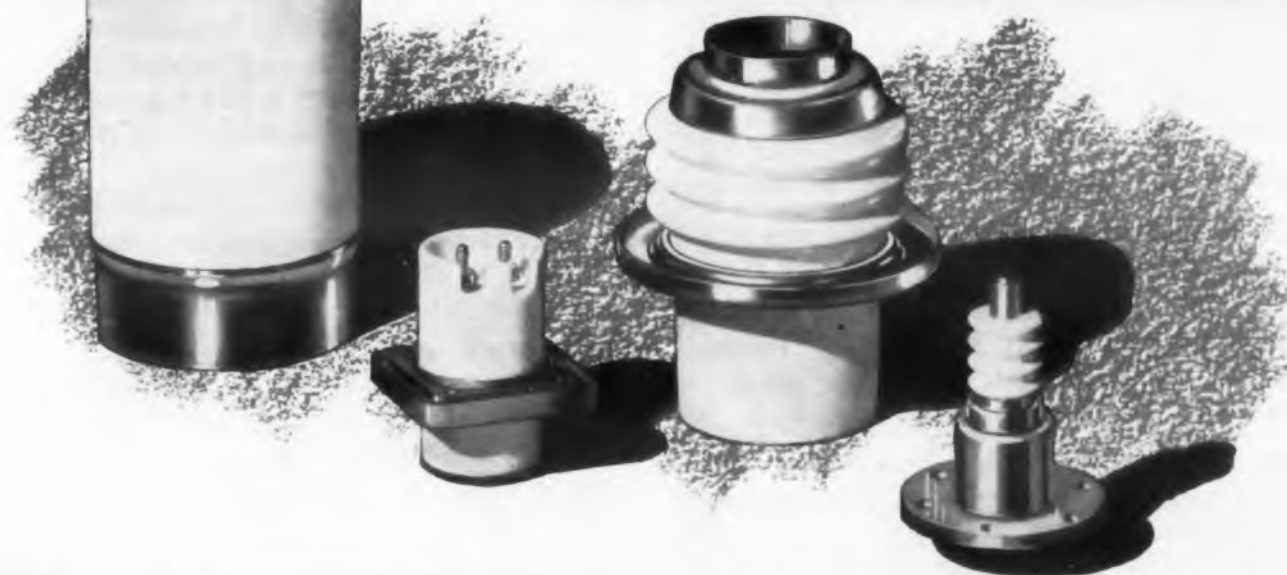
ELECTRONIC DESIGN • July 20, 1960



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*Standard Bushings
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Hermetic seals and bushings made of high alumina Alite are recommended for electromechanical applications where service conditions are extremely severe or critical. Alite has high mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide frequency and temperature range. It resists corrosion, abrasion and nuclear radiation. Its extra-smooth, hard, high-fired glaze assures high surface resistivity.

To simplify design problems and speed delivery, Alite high voltage terminals, feed-throughs and cable end seals are available in over 100 standard sizes. However, when specifications call for special units for unusual applications, you can rely on expert assistance from Alite engineers to help you take full advantage of Alite's superior properties.

Write us about your specific requirements today.

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Bulletin A-7R gives useful comparative data. Bulletin A-40 describes Alite facilities and complete line of Alite Standard Bushings.



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insulated
power
resistors

- HANDLE MORE WATTS PER SIZE. This is particularly so in the higher resistance values.
- OFFER HIGHER RESISTANCE RANGES PER SIZE. For example, up to 47K in the 4W F32 size.
- ARE VIRTUALLY NON-INDUCTIVE.
- INSURE RELIABILITY. Comprehensive tests have proved that operating these resistors under the most arduous conditions will not cause failure.
- HAVE SUPERIOR OVERLOAD PERFORMANCE. The application of ten times the rated load for 5 seconds results in a typical resistance change of less than 0.5%.
- ARE LOWER IN COST TO THE USER. In terms of both purchase value and reliability F30's offer a saving to the customer.

UNIQUELY DIFFERENT AND RADICALLY NEW

The Welwyn F Series power resistors are composed of a metal oxide element, bonded to a porcelain rod at red heat. This process results in a resistor which is extremely rugged, both electrically and mechanically. The durable coating is intended to provide an insulating cover rather than to protect the element which in itself is highly resistant to mechanical damage and effects of moisture.

WELWYN TYPE DESIGNATION	MAXIMUM LENGTH	POWER RATING	RANGE OF VALUES*
F32	29/32 inches	4 Watts	20 Ω to 47K
F33	1-5/16 inches	6 Watts	30 Ω to 56K
F34	1-23/32 inches	8 Watts	40 Ω to 68K
F35	2-3/32 inches	10 Watts	50 Ω to 75K

*Rated Wattage may be dissipated up to that resistance value set by a potential limitation of 500 V/inch.

Where less than full Wattage is involved, potentials up to 1000 V/inch may be applied.

For further information write for data sheet W-1014.

WELWYN INTERNATIONAL INC.

3355 EDGECLIFFE TERRACE, CLEVELAND 11, OHIO
Factories in Canada and England

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NEW PRODUCTS

Sample-Hold Module

500

For rapidly-moving waveforms



Model SA1 sample-and-hold module samples rapidly moving waveforms and holds the sampled value long enough for it to be converted to digital form in the firm's Voldicon. As a separate device, the module functions as an input operational amplifier connected through a switch to an RC filter followed by a low-impedance output-amplifier. With the switch closed, the output follows the input in a manner similar to a 2- μ sec RC delay network. When the switch opens, the voltage is held within 0.05% for 1 msec. The unit is assembled on a 5 x 8 in. plug-in, printed-circuit card and can be incorporated in a Voldicon.

Adage, Inc., Dept. ED, 292 Main St., Cambridge 42, Mass.

Price & Availability: \$1000 ea; from stock after July 1, 1960.

Accelerometer

369

Available with ± 1 to ± 30 g



Model GMB potentiometer-type, gas-damped accelerometer is offered in ranges from ± 1 g to ± 30 g. The output is provided by a low-noise, wirewound potentiometer. Accuracy is $\pm 1\%$, including linearity, hysteresis, and resolution errors. Frequency response is flat within $\pm 5\%$ to 0.4 of the natural frequency. Suited for airborne applications, the unit weighs 5 oz, measures 1.25 x 1.25 x 2.5 in., and stands environmental extremes.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

Availability: Units are made on order.

PLANNING FUNNEL TYPE EYELETS FOR PRINTED CIRCUIT BOARDS?

this Edward Segal
automatic machine
feeds, inserts and
flares with utmost
reliability!



Part of the secret's in Segal's unique anvil tool holder and spring loaded work table (shown at left) which allow the eyelet to pass through the assembly before staking or flaring. Avoids loose settings, compensates for material variations, too.

There's a Segal machine for every eyeletting application. Tell us about your requirements and we'll gladly lead you into it without obligation. And write today for new bulletin ED-100.



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WHAT'S WHAT AT WESCON

You'll get a preview of the show in the next issue of ELECTRONIC DESIGN.

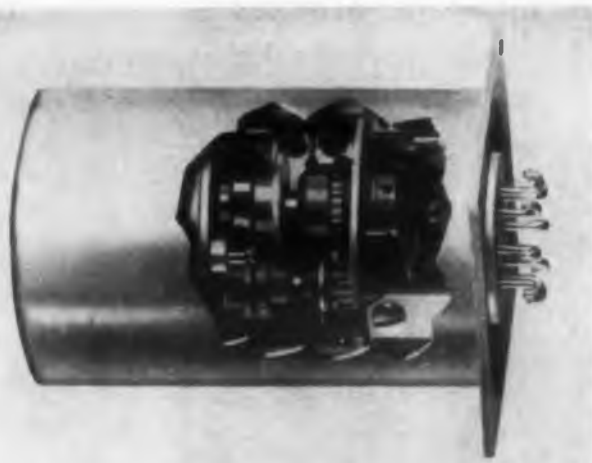
Special editorial coverage and the largest WESCON New Product preview of any electronic publication will make this issue a program for you who are going to the show, and a guided tour in print for you who are not.

Watch for the WESCON Issue—August 3rd.

Time Delay Timer

480

Time cycles are 1 sec to 60 hr



Series D hermetically sealed, automatic-reset time delay timer is specifically designed for applications requiring extreme accuracy and dependable service operating under extreme ambient conditions. The series meets military environmental specs. The switch is rated at 5 amp, at 115 v and 60 cps. Switch contacts are spdt. Voltages are 6 to 230 v at 25, 50, 60, or 400 cycles and 6, 12, 24, 28 or 115 v dc.

Industrial Timer Corp., Dept. ED, 1407 McCarter Highway, Newark, N. J.

Price & Availability: Price is \$53.50 for one 115-v, 60-cps model. Price is subject to standard quantity discount. Delivery is 8 to 10 weeks.

Capacitance Bridge

367

Provides for 60 or 400 cps modulation



Model 910-1 rf capacitance bridge, a general purpose unit for non-contact or capacitive gaging, provides for 60 or 400 cps modulation of the carrier. The unit is transistorized and is portable. A battery-powered unit, also offered, has a frequency response of 13 kc. Two 10-ft cables provide a sensitivity of 3.5 v per pf or one 30-ft cable provides a sensitivity of 0.9 v per pf. Cables up to 50 ft long can be used.

The Decker Corp., 45 Monument Road, Dept. ED, Bala-Cynwyd, Pa.

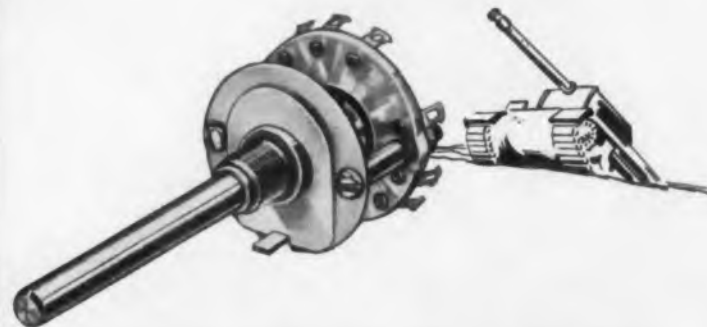
Price & Availability: \$750; 30-day delivery.

OAK Switches for Tough Jobs!

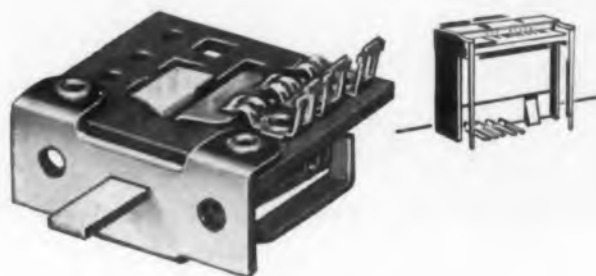
(File these tough MILITARY and INDUSTRIAL solutions for future reference)



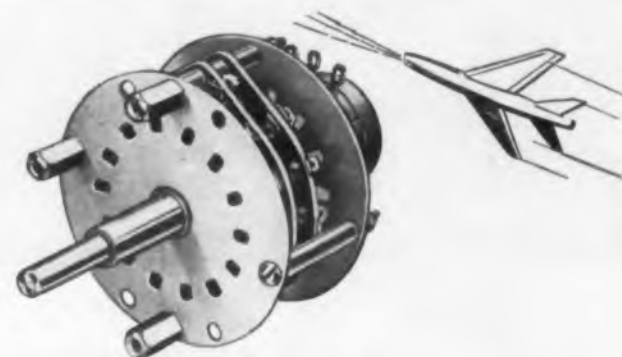
OVER 2,000,000 OPERATIONS PER BUTTON (AND NO MAINTENANCE) IS REQUIRED FOR THIS TICKET RESERVATION APPLICATION.



WITHSTANDS MORE THAN 200 G's OF SHOCK FROM GUN RECOIL, ETC. NO MAINTENANCE OR REPLACEMENT.



MORE THAN 5,000,000 OPERATIONS WITHOUT FAILURE IN LIFE TEST BY ORGAN BUILDER.



AFTER YEARS OF RADIO FREQUENCY SELECTION IN MILITARY AND COMMERCIAL AIRCRAFT, THE FAILURE RATE IS STILL NOT CALCULABLE.



CONSTANT
150° C AMBIENT

NO FAILURES . . . NO MAINTENANCE IN MORE THAN 50,000 CYCLES AT THIS CONSTANT AMBIENT OF 150°C.

Your tough switch job may be easier to handle than you think

Almost any environmental condition can be met within the *rated* capabilities of Oak Switch designs. The exotic applications, such as shown above, require merely changes in materials, finishes, and details which have been developed exclusively by Oak. Whether you require such extreme operational characteristics or not, you still receive the same basic trouble-free design. Many switch users have found that an Oak type switch does an equal or better job than other types—and at considerable savings in cost. You may, too. Send in your application, today.

OAK

MANUFACTURING CO.

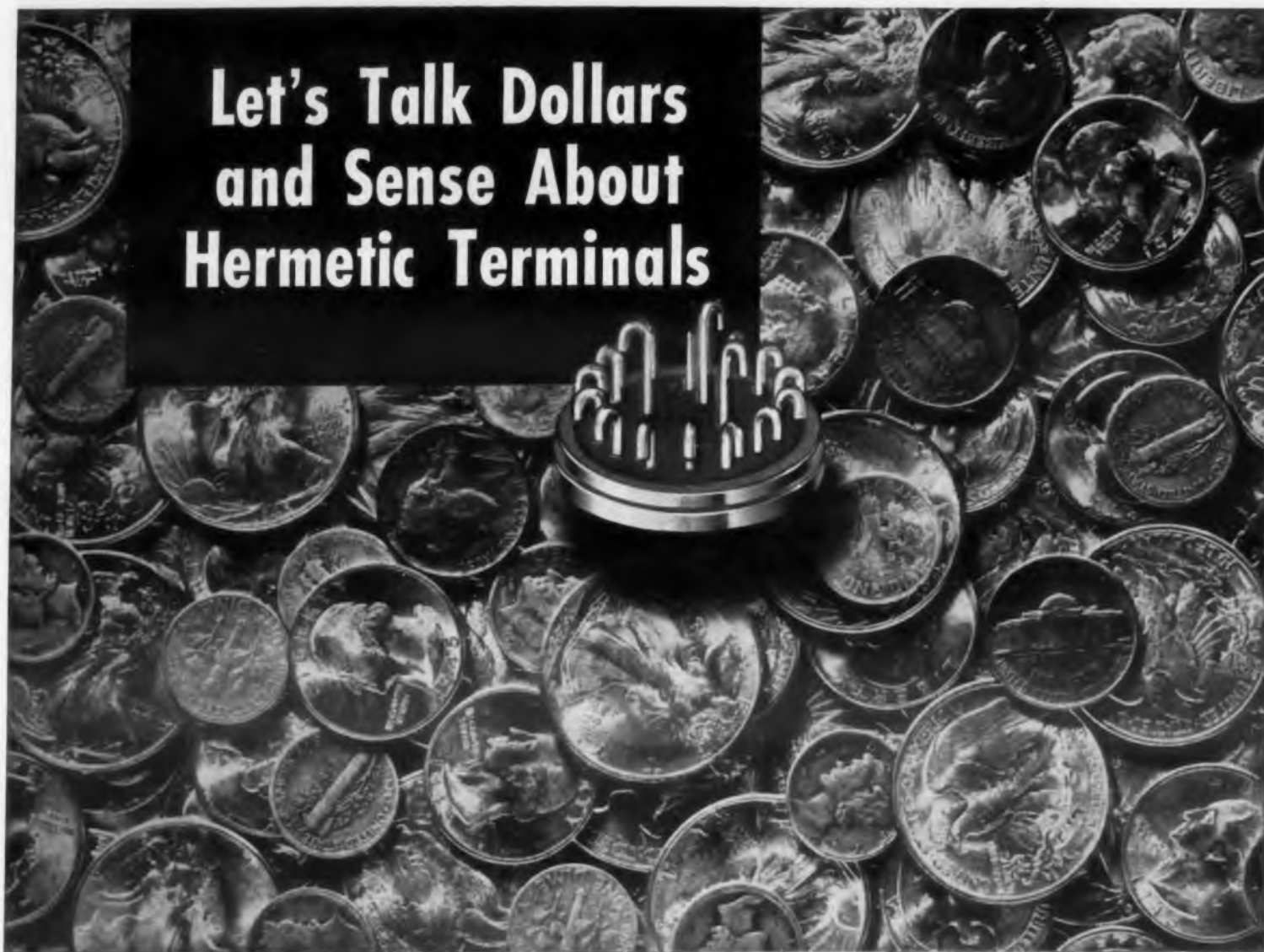
1260 Clybourn Ave., Dept. Chicago 10, Ill. • Phone: MOhawk 4-2222
West Coast Div.: Oak Electronics Corp.
11252 Playa Court, Culver City, Calif. • Phone: EXmont 1-6367

write for
new stock catalog 398



CIRCLE 91 ON READER-SERVICE CARD

Let's Talk Dollars and Sense About Hermetic Terminals



A manufacturer of electrical or electronic components becomes a customer for Fusite Glass-to-Metal Hermetic Terminals when the very guts of his fabricated product depend on the ability of the terminal to remain hermetic when roughly handled or when subjected to extreme thermal shock.

Only Fusite Terminals with their exclusive V-24M glass can assure an inter-fusion between the glass and metal parts that is the basis for their great ruggedness.

While Fusite Terminals are usually competitive in price, the important cost cutting opportunities they offer are in the extremely low rate of production rejections and field failures. When installed in your product, Fusite Terminals promote a high yield at the end of your production line where profits are made or lost.

The way to find out if Fusite Terminals can do your job better is to test them yourself.

Samples are yours for the asking. Write Fusite C-4.



THE **FUSITE** CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

Woodford Mfg. Co., Versailles, Kentucky.

In Europe: FUSITE N. V. Koningsweg 16, Almelo, Holland

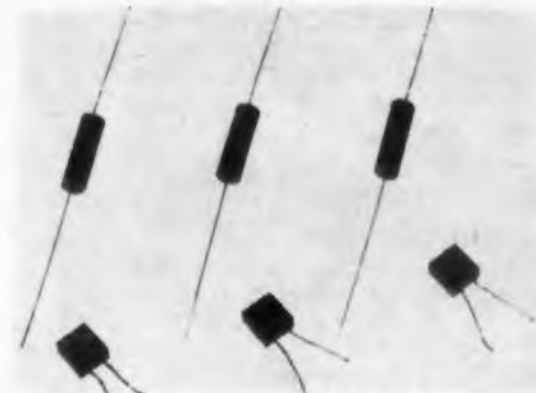
CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

Encapsulated Chokes

511

Contain ferrite shielding beads



Offered in two types, these encapsulated chokes contain ferrite shielding beads and provide large values of rf reactance and resistance in hf and vhf regions for broadband isolation and decoupling. The tubular type uses coaxial leads and the transistor modular type has both leads projecting from one side. They are suitable for radar and microwave if strips, parasitic suppression in parallel tube amplifiers, tube life test racks, radio interference suppression, relay contacts, and other applications.

Magnetic Products Div. of Stanwyck Winding Co., Inc., Dept. ED, P.O. Box 70, Newburgh, N.Y.

Price: An engineering kit containing 20 chokes can be furnished for \$10.

Germanium Transistors

457

Handle 0.5 at 160 mc



Types 2N1561 and 2N1562 germanium, power, mesa transistors produce 0.5 w at 160 mc. They are designed for use as amplifiers in vhf applications and can be used in telemetering devices for missiles and aircraft radio communications equipment. Collector current capability is 500 ma. With a heat sink, the units dissipate up to 3 w at 25 C case temperature. Designed to meet MIL-S-19500, the units are pnp, diffused-junction type and have a cold-welded copper package.

Motorola Inc., Semiconductor Products Div., 5005 E. McDowell Road, Phoenix, Ariz.

ELECTRONIC DESIGN • July 20, 1960

Trimmer Potentiometers

515

Height is 0.195 in.



Series 312 Squaretrim potentiometers have a height-of-board dimension of 0.195 in. and are for applications that require stacking printed circuit boards together into modular assemblies. The units are particularly suitable for airborne, missile, and ground instruments and systems where extreme stability is required. Long windings are used, providing good resistance and fine resolution. The units are housed in machined aluminum cases.

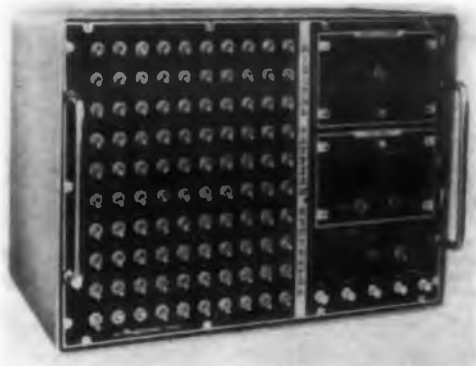
Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Price & Availability: Price is \$6 ea for one to nine units, \$4.10 ea for 500 to 999. Standard units are furnished from stock.

Digital Pattern Generator

352

For use in the computer field



For use in the computer field, this digital pattern generator provides a simulated and flexible time division pattern output. It supplies a repeating bit pattern for testing computers. The pattern length is adjustable from 1 to 100 bits with each bit independently controlled. The output impedance is 500 ohms and remains constant. Positive and negative levels of 0 to ± 15 v are independently adjustable. Two clock generators are offered; one variable from 10 to 100,000 bits per sec, the other from 20 to 200,000 bits per sec.

Magnavox Co., Government & Industrial Div., Dept. ED, Fort Wayne, Ind.

Price & Availability: \$3700 ea; made on order; 45-day delivery.



FAST SWITCHING plus HIGH CONDUCTANCE in SILICON JUNCTION DIODES

SWITCHING TYPES

New circuit possibilities for low impedance, high current applications are opened up by Clevite's switching diodes. Type CSD-2542, for example, switches from 30 ma to -35 v. in 0.5 microseconds in a modified IBM Y circuit and has a forward conductance of 100 ma min@1 volt.

Combining high reverse voltage, high forward conductance, fast switching and high temperature operation, these diodes approach the ideal multi-purpose device sought by designers.

GENERAL PURPOSE TYPES

Optimum rectification efficiency rather than rate of switching has been built into these silicon diodes. They feature very high forward conductance and low reverse current. These diodes find their principal use in various instrumentation applications where the accuracy or reproducibility of performance of the circuit requires a diode of negligible reverse current. In this line of general purpose types Clevite has available, in addition to the JAN types listed below, commercial diodes of the 1N482 series.

MILITARY TYPES

JAN	SIGNAL CORPS
1N457 - MIL-E-1/1026	1N662 - MIL-E-1/1139
1N458 - MIL-E-1/1027	1N663 - MIL-E-1/1140
1N459 - MIL-E-1/1028	1N658 - MIL-E-1/1160
	1N643 - MIL-E-1/1171

All these diodes are available for immediate delivery. Write now for Bulletins B217A-1, B217A-2 and B217-4.

Reliability In Volume . . .



CLEVITE TRANSISTOR

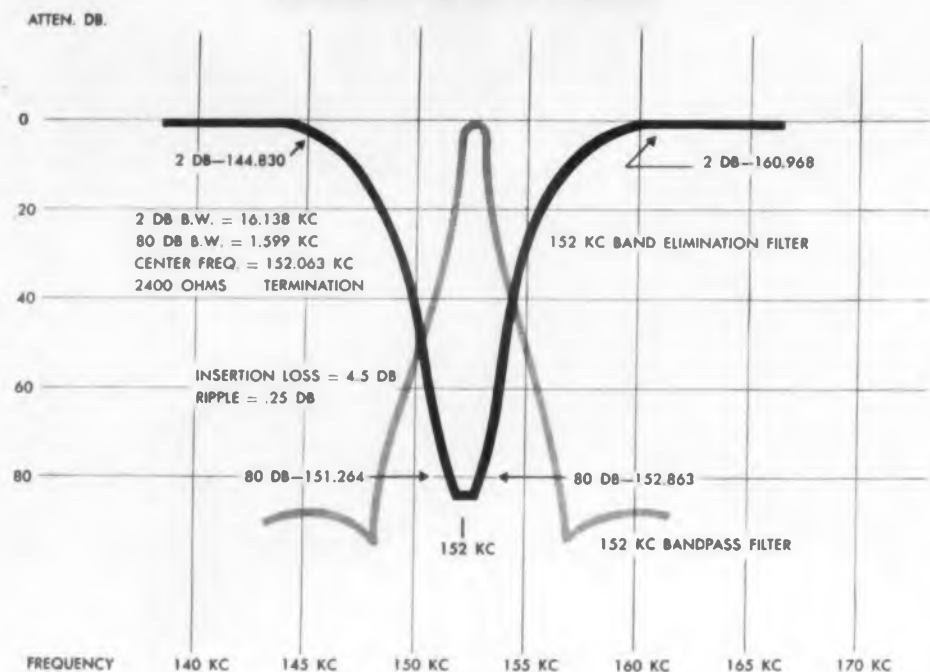
254 Crescent Street Waltham 54, Mass. Tel: TWInbrook 4-9330

CIRCLE 93 ON READER-SERVICE CARD



High selectivity,
attenuation and precision matching of . . .

NEW HILL FILTERS ASSURE FAST, PRECISE MEASUREMENT OF INTER-MODULATION DISTORTION



Actual operational curves, obtained from point-to-point readings, from Hill 34900 and 34800 filters developed to fulfill customers' specific requirements.

These two highly stable, precision-matched Hill Electronic filters permit fast, exceptionally accurate measurement of inter-modulation distortion in communications systems. A band elimination filter places a narrow, deep notch in the white noise being passed through the equipment under test. Distortion generated in the notch is then isolated for measurement by the narrow band filter.

The high degree of selectivity and attenuation of these filters, and the excellent alignment of one within the other are demonstrated in the actual operational curves shown above. Used together, these filters provide 80 db attenuation from 6 to 252 kc.

This is a typical example of Hill's creative engineering that develops outstanding solutions to customers' specific problems involving LC and crystal control filters as well as precision frequency sources and other crystal devices.

WRITE FOR BULLETINS 34800/900

They contain details and specifications concerning the filters described above.



HILL ELECTRONICS, INC.

MECHANICSBURG, PENNSYLVANIA

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS

General Purpose Relays 623

Pull-in time is 9 to 12 msec

These general purpose relays have a pull-in time of 9 to 12 msec. The plug-in series measures 1-3/8 x 1-3/8 x 2-1/8 in. and the CE open type measures 1-11/16 x 1-3/16 x 3/4 in. Contact rating is 5 or 10 amp, non-inductive. The contact arrangement can be spdt, dpdt, or 3pdt. Plug-in basing is octal for spdt and dpdt types, 11-pin for 3pdt types. Temperature range is specified by the user. Applications include signal devices, amplifier circuits, photo-relay circuits, power supplies, switching systems, and any load circuit requiring positive switching of ac or dc power.

Crown Electric Products Co., Dept. ED, P.O. Box 171, Orange, N.J.

Price: Depends on model, starts at \$2.85 for spdt, 5-amp unit.

Power Transistors 411

Silicon, npn type

These diffused-junction, silicon, npn power transistors are for industrial and military applications requiring a temperature range of -65 to +175 C. Included in this line are medium-power types 2N1479, 2N1480, 2N1481, and 2N1482 in the JEDEC TO-5 package, intermediate-power types 2N1483, 2N1484, 2N1485, and 2N1486 in the JEDEC TO-8 package, and high-power types 2N1487, 2N1488, 2N1489, and 2N1490 in the JEDEC TO-3 package. The units are suited for switching circuits in dc-dc converters, choppers, solenoid and relay controls; in oscillator, regulator, and pulse amplifier circuits; and as class A and B push-pull audio and servo amplifiers.

Radio Corp of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

VERSATILE VOLTAGE- CURRENT CALIBRATOR



CAPABILITY . . . measures a-c, d-c or pulse signals from 1 mv to 10 v.
STABILITY . . . from temperature compensated cascaded zener diodes.
ACCURACY . . . 0.1% fs. Chopper mounts at oscilloscope input.
CONVENIENCE . . . calibrator slips into instrument slot of scope dolly.
Model 1082 Precision Voltage-Current Calibrator . . . immediately available. Write for Bulletin 60-C.

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engineering, inc.

731 ARCH ST., PHILADELPHIA 6

MAGNETIC CORE TESTERS • HIGH SPEED MEMORIES • LOGIC CIRCUIT PLUG-INS

CIRCLE 95 ON READER-SERVICE CARD

CIRCLE 96 ON READER-SERVICE CARD

Time Delay Relays

456

Delay Range is 10 to 250 sec



Model 300 transistor time delay relays consist of a transistor time delay circuit operating two dpdt relays. The time delay can be adjusted over a range of 10% above and below nominal. Delay range is 10 to 250 sec. Suitable for military as well as commercial uses, the units can be used in instrumentation switching of computers, programmers, and high-speed cameras. They can also be used in control of semi-automated machines. Having an over-all accuracy of 2%, the units stand shock of 100 ± 5 g, one-half sine wave, of 2 to 10 msec duration, and vibration of 10 g from 5 to 2000 cps.

Sloan Co., Dept. ED, 7704 San Fernando Road, Sun Valley, Calif.

Servo and Instrument Mechanisms

461

Complete line offered



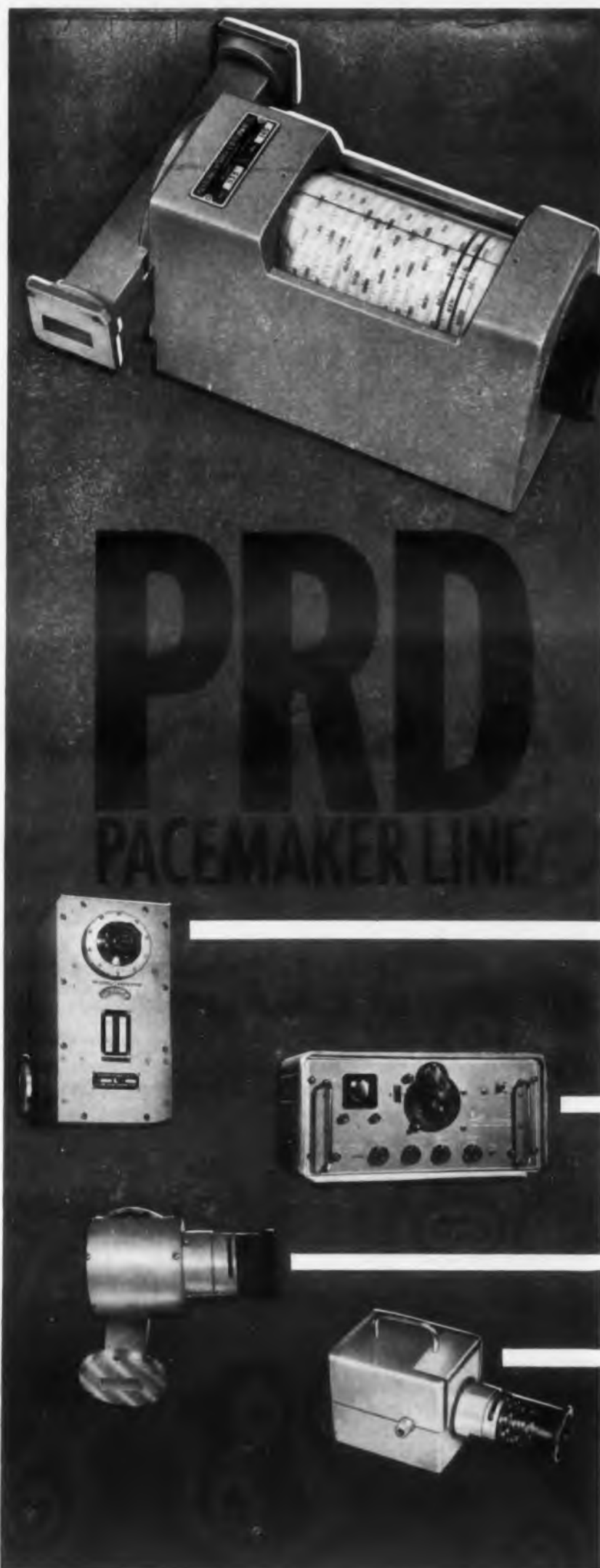
This complete line of precision servo and instrument mechanisms includes gears, shafts, ball-bearing gear boxes, and component mounting plates. A typical mechanism is assembled from stocked components and is housed in an O-ring enclosure. Bearings are ABEC 7 and construction is of stainless steel and anodized aluminum. Requirements of MIL-E-5400 are met.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.

Price & Availability: Price ranges from \$0.90 to \$72 ea; production quantities are furnished from stock.

◀ CIRCLE 96 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960



Seven full waveguide bandwidths are each covered by a separate meter in this 532 series of nine reaction-coupled frequency meters, extending over the complete range from 3.95 to 40.0 kmc/s.

These frequency meters consist of a TE₁₁₁ mode cavity resonator tuned by a non-contacting plunger. Ruggedness for long trouble-free life is assured by the all-metal housing. Maximum readability, resolution and accuracy to $\pm 0.08\%$ are the result of an optimized design distinguished by a drum type spiral scale more than 8 feet long.

Type No.	Frequency Range (kmc/sec)	Waveguide (Size in Inches)	Flange	Accuracy (%)	Price
532	3.95 to 5.85	2 x 1	UG-149/U	± 0.08	\$380
533	5.85 to 8.2	1½ x ¾	UG-344/U	± 0.08	\$295
534	7.0 to 10.0	1¼ x ¾	UG-51/U	± 0.08	\$290
535	8.2 to 12.4	1 x ½	UG-39/U	± 0.08	\$175
536	12.4 to 18.0	.702 x .391	UG-419/U	± 0.1	\$285
537	18.0 to 26.5	.500 x .250	UG-425/U	± 0.1	\$290
537-F1	18.0 to 26.5	.500 x .250	UG-595/U	± 0.1	\$290
538	26.5 to 40.0	.360 x .220	UG-381/U	± 0.2	\$300
538-F1	26.5 to 40.0	.360 x .220	UG-599/U	± 0.2	\$300

BROADBAND DIRECT READING FREQUENCY METERS

Most Complete Line...

For Every Purpose, Every Budget

High Precision, Direct Reading Meters (0.015%)

Series 555 to 579 consists of 30 different types covering from 0.925 to 39.0 kmc/s. Representing highest state of the art, these frequency meters fully qualify as transfer or secondary standards for exacting laboratory or production service. Features include: hermetically sealed invar cavity, temperature-compensation, high Q, optimum cavity geometry, high conductivity plating. Price range: \$1200.-\$1500.

Precision Heterodyne Frequency Meter (0.002%)

PRD 504, for 100 to 10,000 mc/s with accuracy of 0.002% at crystal check points every 5 mc/s and 0.03% or better between check points. Automatic interpolation by unique patented spiral-scale dial. Beat indication by both external earphones and built-in CRT. Meter is self-contained and portable. Price: \$695.

Inexpensive, Direct Reading Meters (0.08%)

Series 585-A to 590-A affords excellent accuracy at lowest cost from 5.1 to 10.0 kmc/s. Ideally suited for panel mounting and systems use. Price range: \$150.-\$350.

Direct Reading UHF Meter ($\pm 0.2\%$)

PRD 587-A, covers range 250 to 1000 mc/s. Spiral drum scale 60 inches long enables precision direct reading. May also be used as a tunable narrow band filter. Price: \$275.

PRD ELECTRONICS, INC.

A Subsidiary of Harris-Intertype Corporation

Formerly Polytechnic Research & Development Co., Inc.

202 Tillary Street, Brooklyn 1, New York, ULater 2-6800
2639 So. La Cienega Blvd., Los Angeles 34, Calif., UPTon 0-1940

CIRCLE 97 ON READER-SERVICE CARD

The
next
step
forward
for
entertainment
equipment



NEW RCA-6CW4
nuvistor
TV AND FM TUNER
TRIODE

Now commercially available for TV and FM tuner designs
2 to 4 db better **NOISE FACTOR** than tubes currently in use in TV receivers.

Superlative Performance—and not just tiny size—is the reason this latest RCA nuvistor triode should soon be the preferred rf-amplifier tube in entertainment equipment. Nuvistorized TV tuner circuits can make possible excellent reception in fringe areas where reception is now unsatisfactory.

Noise Factor is 2 to 4 db better than that of other tuner tubes in commercial use. In addition, this mighty midget provides this unmatched combination of advantages:

Excellent Signal Power Gain

High Transconductance PLUS high gm to I_b ratio (12500 μ mhos at 8 milliamperes and 70 volts)

Very Small Power Requirements: Plate and heater input—each less than 1 watt. PLUS ALL THE INHERENT ADVANTAGES OF NUVISTOR DESIGN: exceptional reliability, excellent stability, extreme ruggedness, small size, light weight, high unit-to-unit uniformity, extreme sensitivity, very high input impedance, and high perveance. The last word in entertainment rf-amplifier triodes is nuvistor 6CW4!

For further information, see your RCA Field Representative—or write to RCA Electron Tube Division, Commercial Engineering, Section G-18-DE-2, Harrison, N. J.

Heater, for Unipotential Cathode:

Voltage (AC or DC) 6.3 \pm 10% volts

Current at 6.3 volts 0.13 amp.

TYPICAL OPERATION

Plate Voltage	70 volts
Grid Supply Voltage	0 volts
Grid Resistor	47000 ohms
Amplification Factor	68
Plate Resistance (Approx.)	5440 ohms
Transconductance	12500 μ mhos
Plate Current	8 ma

RCA ELECTRON TUBE DIVISION—FIELD OFFICES

EAST: 744 Broad Street, Newark 2, New Jersey
HUMboldt 5-3900

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

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The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

NEW PRODUCTS

Vacuum Furnace 488

Measures 2 x 3 ft

Measuring 2 x 3 ft, model VF-92 vacuum furnace performs many operations for which a larger machine is usually required. Some applications are heat treating, all kinds of brazing, and single crystal growing in high-vacuum or inert atmospheres. The vacuum chamber measures 11 in. in diameter and 20 in. in length and is protected by double walls and water cooling.

MRC Manufacturing Corp., Dept. ED, 47 Buena Vista Ave., Yonkers, N.Y.

Microwave Test Equipment 487

Frequency range is 15 to 22 kmc

This precision microwave test equipment is designed to operate over a frequency range of 15 to 22 kmc. Among the items included are: crossguide directional couplers, calibrated variable attenuators, variable screw tuners, multi-hole broad-wall couplers, low and high power terminations, and transitions from RG-91/U to WR-51 waveguide and from RG-53/U to WR-51 waveguide.

Waveline, Inc., Dept. ED, Caldwell, N.J.

Linear Accelerometer 489

Measures from ± 0.25 to ± 50 g

For missile and aircraft applications, model TA-400 hermetically sealed linear accelerometer measures acceleration from ± 0.25 to ± 50 g. The unit has an extremely sensitive differential transformer pick-off. It has partially controlled damping over the temperature range of -55 to $+100$ C. The pickoff is wired with additional taps to allow dc or ac excitation.

Fairchild Camera and Instrument Corp., Dept. ED, Robbins Lane, Syosset, L.I., N.Y.

Availability: Delivery time is 40 to 60 days.

TV Picture Tube 410

Bonded-shield, 19-in. type

This 19-in., bonded-shield TV picture tube, for use in portable and table receivers, has a deflection angle of 114 deg and a viewing area of 175 sq in. Bonded-shield design eliminates dead space between the tube and the safety panel, resulting in clearer pictures.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

IF Transformer Kit 624

Has 10 matched-input units

This kit contains 10 matched-input, 455 kc, if transformers. All units, having a size of 1/2 x 1/2 x 1/2 in., are of ferrite construction with maximum coupling and low insertion loss. Bandwidth is 13 kc and tuning range is 50 kc. With the kit it is possible to match a primary impedance of 10, 25, or 100 K to a secondary impedance of 600 or 1000 ohms in five different combinations. The units are ruggedly built, with phenolic bases, top and bottom tuning, and lugs with standard spacing for wired and printed circuit board applications. The kit is valuable for building prototype transistor circuits.

Wells Electronic Co., Dept. ED, 1701 S. Main St., South Bend 23, Ind.

Price & Availability: \$19.95; immediate delivery from factory.

Germanium Transistors 408

Switch 3 to 4 amp in 10 μ sec

Suitable for core drivers, TV deflection circuits, and other high frequency applications, the 2N1046 series of alloy-diffused, germanium power transistors switch 3 to 4 amp in 10 μ sec. At 100 C, dissipation is 30 w. Collector current is 10 amp and cutoff frequency is 15 mc. Collector voltage can be 100 or 130 v.

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

Availability: Through distributors or sales offices.



50% lighter . . . 40% Smaller . . . Daven's new miniature Egg Crate LC Filters

Now, for airborne and missile applications, Daven offers a miniature version of the popular Egg Crate LC Filter; 50% lighter and 40% smaller than any previous filter!

Frequency range is 0.4 MC to 60.0 megacycles . . . temperature range is -55°C . to $+125^{\circ}\text{C}$. . . different physical configurations are available depending on allowable space.

The new Filter is suitable for pulse-type circuits and those where the phase shift characteristics must be uniform. It can be pre-tuned in the actual circuit, thus eliminating additional adjustment during assembly. With new production facilities,

these Filters are available in quantity, and each unit is identical in performance to the prototype.

Utilizing no critical materials, the LC Filter is also excellent for medium and wide band-width filters. It can be used for bandwidths down to 0.5%, if under-coupled response is permitted.

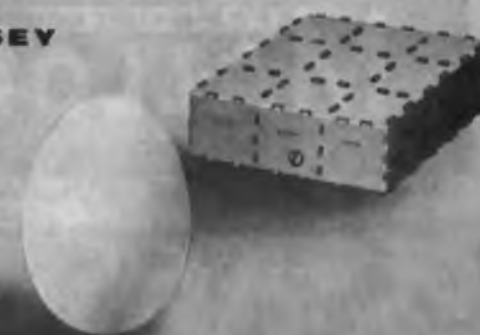
Daven's extensive engineering staff, also producing other types of filters extending into the low audio range, is ready to assist you in your filter problems. Just send details of your specific requirement.

THE **DAVEN** CO.



LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN \odot STANDS FOR DEPENDABILITY



Cost-cutting Carbon controls!



Here are strip mounted carbon controls that are masterpieces of cost-saving design. Mallory product engineers have worked out every detail of Type "EC" Carbon Controls to bring the cost DOWN . . . without sacrificing performance.

Developed primarily for back-of-chassis adjustments in TV, radio, hi-fi, and stereo designs, Mallory "EC" Controls are made with a molecularly bonded carbon composition of great density and high surface hardness. This carbon element is the same low-noise, high-stability type used in all Mallory volume controls. "EC" controls have high resistance to contamination by grease, grit, dust, or moisture in the air. Controls are available in multiple units that save on mounting costs. Units are furnished with solder or printed circuit terminals.

Mallory ingenuity in engineering controls with various types of hardware, switches and configurations can go a long way in holding control costs DOWN. We welcome the challenge of saving you money.

Mallory Controls Company
Frankfort, Indiana
a division of

P. R. MALLORY & CO. Inc.
MALLORY

See Mallory Controls Company for



wire-wound controls

vitreous resistors

power rheostats

rotary switches

plugs & jacks

NEW PRODUCTS

Molded Harnesses

422

Stand 320 to 500 F

This line of custom-designed, molded harnesses is for ground support equipment, missiles, and aircraft. Furnished in neoprene, vinyl, and silicone rubber, they meet MIL-R-3065, stand temperatures of 320 to 500 F, and have a high dielectric strength. Virtually any type and number of wires may be incorporated.

Revere Corp. of America, Dept. ED, 1001 N. Colony Road, Wallingford, Conn.

Thermocouples

357



Stand up to 40,000 psi pressure

The A+ thermocouples have compacted, swaged MgO insulated design. Electrical insulation characteristics are good to 2500 F. The units stand up to 40,000 psi pressure and are made to ISA standards. They can be used in electric motors, generators, bearings, transformers and other devices.

Atkins Technical Co., Dept. ED, 1276 W. Third St., Cleveland 13, Ohio.

Availability: Delivery is from stock.

Fibre-Glass-Reinforced Polyester

375

For structural insulation

This fibre-glass-reinforced polyester stock may be cut into angles or channels and is available in widths of a 2-3/16 to 9-21/32 in. and in lengths of 28-7/8 to 75-7/8 in. It meets class B temperature requirements and NEMA GPO-1 specs. It is flame retardant as per UL specs.

The Clastic Corp., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.

Price & Availability: Prices range from \$0.80 and \$15.40 per length. Delivery is from stock.

CIRCLE 100 ON READER-SERVICE CARD



For Immediate
Delivery Of

MOTOROLA

- TRANSISTORS
- ZENERS
- RECTIFIERS

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DISTRIBUTORS

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Lafayette Radio 110 Federal St. HUBbard 2-7850	NEWARK, N.J. Lafayette Radio 24 Central Ave. MARKet 2-1661
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LOWER I_{CBO}
at
HIGH
TEMPERATURES

MOTOROLA ALLOY TRANSISTORS

Motorola industrial alloy transistors offer many desirable features including:

- Lower I_{CBO} at high temperatures — reducing thermal runaway problems
- 100°C operating junction temperature
- High current gain

Rugged, dependable and versatile, the Motorola 2N650 series and the companion "Meg-A-Life" devices provide maximum reliability for industrial audio and switching applications.

Units are immediately available from stock through your local Motorola Semiconductor distributor. For complete technical information, contact your Motorola district office.



*2N652A, 2N651A and 2N650A are Motorola "Meg-A-Life" devices. These units are certified to Military-type specifications and are subjected to complete mechanical, environmental and life tests according to MIL-S-19500. Written certification and life-test data is available to users.

Type No.	$I_{CBO}(\mu A)$ ($T_A = +71^\circ C$, $V_{CB} = 10V$)		BV_{CEO} (volts) ($I_C = 50\mu A$)	BV_{CER} (volts) ($I_C = 0.6mA$, $R_{RE} = 10K$)	h_{FE} ($V_{CE} = 6V$, $I_E = 1mA$)	
	Typ.	Max.			Min.	Max.
2N652 & 2N652A*	55	100	45	30	100	225
2N651 & 2N651A*	55	100	45	30	50	120
2N650 & 2N650A*	55	100	45	30	30	70

$T_j = 100^\circ C$ Operating & Storage

$P_c = 200$ mw

BOSTON 385 Concord Ave., Belmont 78, Mass.	IVanhoe 4-5070
CHICAGO 39, 5234 West Diversey Avenue	AVenue 2-4300
DETROIT 27, 13131 Lyndon Avenue	BRoadway 3-7171
LOS ANGELES 1741 Ivar Avenue, Hollywood 28, Calif.	HOLlywood 2-0821
MINNEAPOLIS 27, 7731 6th Avenue North	Liberty 5-2198
NEW YORK 1051 Bloomfield Ave., Clifton, N.J.	GRegory 2-5300
from New York	WISconsin 7-2980
ORLANDO Knowel Building, Winter Park, Fla.	Midway 7-2507
PHILADELPHIA 130 South Easton Rd., Glenside, Pa.	TURner 7-7020
SAN FRANCISCO 1299 Bayshore Highway, Burlingame, Calif.	Diamond 2-3228
SYRACUSE 101 South Salina	GRanite 4-3321
WASHINGTON 8605 Cameron St., Silver Spring, Md.	JUNiper 5-4485



MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA INC.

CIRCLE 101 ON READER-SERVICE CARD

POTTER SETS THE PACE

WITH...THE ONLY PERFORATED STRIP READER IN ITS CLASS

A single speed, unidirectional, photo-electric, perforated strip reader, the Potter 909 is

OBEDIENT...stops on the stop character at speeds up to 600 characters per second and it can be stepped one character at a time where synchronous readout is needed.

VERSATILE...output is a timed, shaped pulse for input to a computer, high speed printer, or control system.

...parallel NPN, PNP amplifier output circuit supplies up to 40 ma to loads returned to any bias voltage.

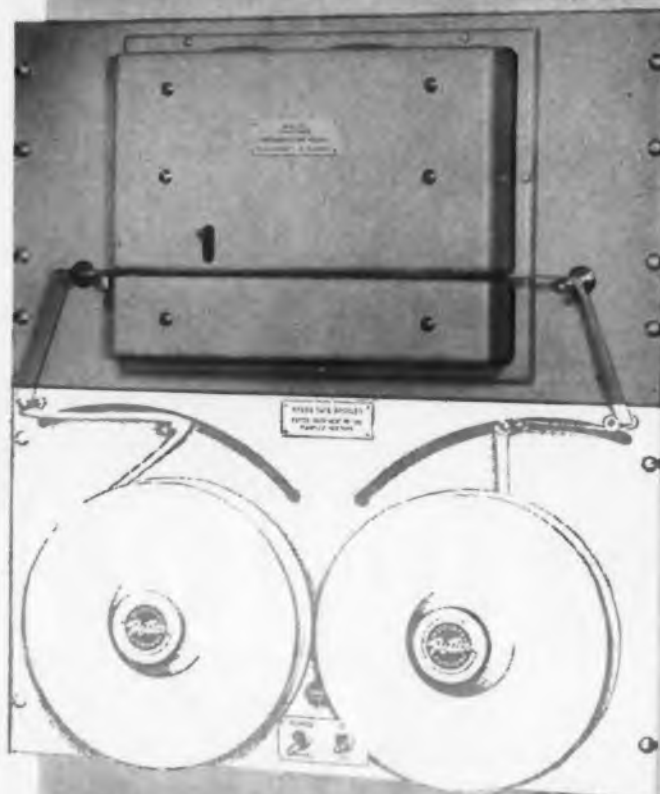
FAST...operates at speeds up to 1000 characters per second with complete dependability.

SENSITIVE...a broad image light source eliminates the effects of filament variations in the lamp.

COMPACT...fits into a 10½ in. case—with its own power supply and amplifiers.

The Potter 909 perforated tape reader includes a tape transport system, tape reading system, power system, and control system. It is designed for panel, rack, or cabinet mounting. Accessories available include tape spoolers and tape bin, cooling fan, mounting adapters and extension frames.

WRITE FOR DETAILED SPECS AND LATEST PRICE AND DELIVERY INFORMATION



MODEL 909 PERFORATED STRIP READER WITH MODEL 3299 SPOOLER

WITH...THE MOST TAPE HANDLER FOR YOUR MONEY



MODEL 906 II MAGNETIC TAPE HANDLER

The Potter 906 II is the high speed digital magnetic tape handler that gives you higher performance, greater reliability, and lower cost than any other tape handler on the market—bar none.

Only with the 906 II do you get such advantages as:

...full forward reverse cycling at 120 ips with 1 inch tape.

...low skew tape guide that permits conventional recording at 400 bpi density.

...1500 bpi recording densities which are made possible by using the 906 II with the Potter Contiguous Double Transition System. 450,000 8-bit characters per second can be recorded on 1 inch tape.

...transistorized control of all functions that simplifies computer design.

...simplified packaging for easy maintenance.

...a price—far below other makes—that proves the economy of superior design.

Compare them any way you like—spec for spec, dollar for dollar, space for space—and you'll agree that the high performance, low cost Potter 906 II is the most tape transport at any price.

WRITE FOR DETAILED SPECS AND LATEST PRICE AND DELIVERY INFORMATION

POTTER INSTRUMENT CO., INC.



Sunnyside Boulevard, Plainview, L. I., N.Y.
Overbrook 1-3200

NEW PRODUCTS

Gaussmeter

363

For use with electrodynamic vibration systems

Model G/M gaussmeter is for use with electrodynamic vibration systems for measuring stray magnetic field at critical specimen locations. Range is 50 gauss, full scale, and accuracy is better than $\pm 10\%$. The instrument weighs about 6 oz.

Wrisley Engineering, Inc., Dept. ED, P. O. Box 56, Winchester, Mass.
Price: \$31.75 fob Winchester.

Filament Tester Kit 535

Portable, battery-operated

Model T-5 filament tester kit, a portable, battery-operated unit, rapidly locates tubes with open filaments in series string TV and radio receivers. It also makes continuity tests of any low-resistance electrical circuit. It checks filaments of all tube types, including 7-pin miniature, 9-pin miniature, 7-pin battery type, octal, located, and CRT tubes. Indication is by panel lamps.

PACO Electronics Co., Inc., Dept. ED, Glendale, L.I., N.Y.

Price & Availability: Sold through distributors, the unit is net priced at \$4.50. Factory-wired units are priced at \$6.50.

Current Transformer 366

Measures to 400 amp ac

This current transformer measures up to 400 amp ac with an accuracy of 0.1%. The unit can be used for measurement, control, or protection of high-power current and is especially suited for missile and aircraft use. Model 876 measures bus currents of 0 to 50 amp and has three meter currents. Model 875 measures bus currents from 0 to 100, 0 to 200, and 0 to 400 amp and has six meter currents.

Arnold Magnetics Corp., Dept. ED, 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Price & Availability: \$25 to \$60 ea; four to six weeks.

◀ CIRCLE 102 ON READER-SERVICE CARD

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Blvd., Los

to \$60 ea.

Silver-Solder Alloys 529

Come in sheets, strips, and foil

These composites of silver or noble-metal solder alloys clad to base or precious metals come in sheets, strips, and foil. Silver-solder alloys contain various percentages of one or more of the following: copper, zinc, tin, cadmium, nickel, manganese phosphorus, and lead. Clad metals comprising noble-metal-solder alloys for all kinds of gold, platinum, or palladium brazing are also produced.

Texas Instruments, Inc., Metals & Controls Div., 34 Forest St., Attleboro, Mass.

Life-Test Oven 360

Handles 660 bi-polar components

This high-temperature, thermostatically controlled life-test oven handles 660 bi-polar components or 330 tri-polar devices. Standard units are rated at 125 C. The components are carried in low-resistance electrical clips on mounting racks of expanded metal. Test circuitry is rated at 750 v and at 5 amp with less than 0.5 ohms resistance. Power requirement is 1600 w at 115 or 230 v at 50 or 60 cps. The unit weighs 250 lb.

ITT, Components Division, Dept. ED, 815 San Antonio Road, Palo Alto, Calif.

Price: Starts at about \$4000.

DC-AC Inverter 532

Output is 115 v

Operating from a 12.6-v dc input, model IA-1260-25 transistorized inverter provides an output of 115 v ac at 60 \pm 3 cps. Continuous power rating is 250 w; maximum power is 350 w. Efficiency at full load is 80%. The transformer has a low-loss, grain-oriented ribbon core to conserve battery power. The ambient temperature range is -55 to +60 C. Dimensions are 4.5 x 5.75 x 8 in. and weight is 10 lb.

Kupfrian Manufacturing Corp., Dept. ED, 167 Prospect Ave., Binghamton, N.Y.

Price: Under \$90.

CIRCLE 103 ON READER-SERVICE CARD >



... in Electronics
Nearly Everybody
Reads the Experimenter

Just as Philadelphians read the Bulletin, electrical engineers read the General Radio *Experimenter*. Published monthly and sent without charge to 130,000 engineers, scientists, and technicians, the *Experimenter* features articles written by engineers for engineers.

In the *Experimenter's* pages you'll find descriptions of new G-R products, details of electronic measuring techniques, tips on how to get more use out of your test equipment, and accounts of interesting and unusual measurements problems and their solutions.

Many informative articles are scheduled for the *Experimenter's* pages, including: details of a new high-speed stroboscope; a discussion of the characteristics of tunnel diodes at ultra-high frequencies; and an announcement of a new Frequency Meter and F-M Discriminator that will measure from a few cycles to 1.5 Mc with 1/4% accuracy. This new instrument is also capable of measuring one part-per-million of incidental fm.

If you would like to receive the *Experimenter* and keep up with new developments such as these, fill out the coupon at the right and send it to us. We will see that your request is processed promptly.

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630

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West Concord, Massachusetts

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NEW PRODUCTS

Thermocouple Components 526

For connecting thermocouples to extension wire

The QuiK-Konnect thermocouple components are for fast and easy connecting of thermocouples to extension wire. Claimed to provide foolproof connection, the components are suitable for use wherever periodic connection or disconnection of thermocouples is required such as in laboratories or test cells.

Minneapolis-Honeywell Regulator Co., Dept. ED, Penn and Bay Sts., Fall River, Mass.

Price & Availability: Plugs, jacks, and standard accessories are in stock. Multiple-point panels are made on order for 30-day delivery. Plugs are priced at \$1.70 ea; jacks, \$3.30 ea. Quantity discounts are offered.

Varistor Kit 534

Covers 6 to 100 v

For design and experiment use, type KV1001 varistor disk kit contains 9 general-purpose varistor disks. A range of 6 to 100 v is covered.

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

Price & Availability: \$7.50 ea; from jobbers or directly from the company.

Magnetic Amplifier 407

Load is 12,000 ohms

This low-power level magnetic amplifier has a load rating of 12,000 ohms. Input is 115 v at 400 cps and output is 0 to 3 v and 0 to 2.5 v with a reversible phase. The dc-signal input is 0 to $\pm 100 \mu\text{a}$ with a maximum output distortion of 20%.

Freed Transformer Co., Inc., Dept. ED, 1718 Weirfield St., Brooklyn 27, N.Y.

Price & Availability: Price is \$150 ea; delivery time is three to four weeks.

SCR PRICES

(C35B)

1958-1960



General Electric's C. G. Lloyd brings you up-to-date on the revolutionary Silicon Controlled Rectifier

The Controlled Rectifier picture changes so rapidly, information you may have obtained six months ago is now out-of-date. For this reason, C. G. Lloyd, General Manager of General Electric's Semiconductor Rectifier organization, answers here some of the questions most frequently asked — questions about a device many authorities consider the most revolutionary development since the transistor itself.

Q. Last year I looked into the SCR and found it too expensive. Has this situation changed?

Lloyd. Indeed it has. The C35B (16 amps, 200 volts) was originally introduced at \$160 in 1958, was priced at \$65 a year ago and has just now been reduced to \$20.

Q. How does the SCR compare with similar devices in prices?

Lloyd. SCR's are in the same price bracket as many germanium power transistors and actually cost less than silicon power transistors, magnetic amplifiers, many relays, thyratrons and other devices the SCR has replaced.

Q. What about associated circuitry? Doesn't that bring up the cost?

Lloyd. The drive circuits for SCR's are generally simpler than for the other devices, and in particular, protection against overvoltage and current is easier to accomplish than for power transistors — making the SCR-equipped device more reliable and much less expensive over-all.

Q. But your C35 is still too high-priced for my application, and the current rating is more than I need. What would you suggest that I do?

Lloyd. Perhaps you could use the C10B. It's rated at 4.7 amperes single phase and 6 amperes d-c and costs as low as \$11.10. Lower rated units go down to \$5.00.

Q. What else should I know about the C10?

Lloyd. Well, it has a more sensitive gate trigger and lower

leakage current. And surprisingly, even though it's smaller, it can operate at a higher temperature.

Q. The C10 sounds like it might be in the right range. How is it on power?

Lloyd. Two C10B's will control over 1 kw on 117 volts for about \$25. Compare this with any other method — power transistors, saturable reactor or thyatron.

Q. Do you have any other types?

Lloyd. We sure have! The C50 Series is a high-current unit that performs up to 50 amperes. It also has a 1000-amp. surge current rating. Then there's the C40 Series, with high-speed turn-off for inverter applications. That's an important field for the SCR.

And also there's the C36 Series. It goes to 10 amperes.

Q. General Electric has talked a lot about the SCR in the past couple of years. Have your customers brought SCR-equipped devices to market?

Lloyd. They've been doing so for a year or more and the pace of conversion to SCR devices keeps stepping up all the time. Our customers are now selling many types of SCR-equipped products. The applications are numerous. Some of the prominent ones are regulated power supplies, light dimmers, static switches, inverters, power-control circuits, radar modulators and ultra-sonic generators. And I'm sure there are many that haven't been reported back to us as yet.

Even at last year's prices many of these people found the SCR the best solution to their problems. We believe our new prices will bring in hundreds of new users.

Q. What about General Electric? Do you use the SCR?

Lloyd. Some 40 departments of General Electric are now using the SCR. Why we even use SCR's to make SCR's. Our ovens, furnaces and test fixtures are equipped with controlled rectifiers to provide very precise, reliable and low-maintenance temperature control for our processes.

To bring you completely up-to-date on the SCR, contact your General Electric SPD Sales Representative, or write Section 8370 Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, N. Y. In Canada, 189 Dufferin St., Toronto, Ontario. Export: International General Electric, 240 East 42 St., N. Y. 17, N. Y.

GENERAL  ELECTRIC

For fast delivery at factory-low prices, see your General Electric Semiconductor Distributor.

Temperature Indicator 595

Has a range from -65 to +160 F

This temperature indicating system consists of 4 sensing devices, a computer package, and an indicator package. It has an operating range of -65 to 160 F, and an accuracy of ± 5 F. The sensing devices can be cemented, taped, or clip-mounted to small components such as tubes, transformers, and transistors. The system displays the highest of 4 temperature sensor signals on an aircraft or missile. Maximum weight of the system is 3.85 lb.

John Oster Manufacturing Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

Price & Availability: Made on order only. Delivered 150 days after receipt of order. Price is approximately \$4000 per system.

Yagi Antenna 402

Handles up to 750 w

Designed for use in the range of 76 to 82 mc, the Y-45-5 yagi antenna handles up to 750 W. Elements are made of aluminum tubing 3/4 in. in OD with 7/8-in sleeves. The cross-arms are 2 x 2 in. The antenna consists of two active dipoles, two parasitic directors and one parasitic reflector. Input impedance is 50 ohms.

Technical Appliance Corp., Dept. ED, Sherburne, N.Y.

Price & Availability: \$130 ea; from stock.

Mesa Transistor 496

Is rated at 30 mc

Type 2N741 30-mc, mesa transistor is for hf applications, including TV video amplifiers, and critical dc direct-coupling amplifiers. A germanium, pnp, diffused-junction type, the unit is housed in a TO-18 package.

Motorola Inc., Semiconductor Products Div., 5005 E. McDowell Road, Phoenix, Ariz.

Price & Availability: Price is \$11 ea for 1 to 99 units. Delivery is from stock.

← CIRCLE 104 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage Monitoring System 476

For use with power supplies

Model VSIB-1 automatic voltage monitoring system detects and signals over-voltage and under-voltage in any of eight separate external power supplies. It contains a switch-type magnetic amplifier for each of the eight sensing channels and a dc reference unit. The system stands extremes in temperature, moisture, shock, and vibration. It operates from 120 v ac.

Magnetic Controls Co., Dept. ED, 6405 Cambridge St., Minneapolis 26, Minn.

Microminiature Components 486

Transformers, filters, and inductors



This line of microminiature components includes transformers, filters, and inductors identified as Pico Tran, Pico Filters, Pico Ductors, and Pico Coils. The Pico Ductor, for delay lines, shown, has an inductance of $13 \mu\text{h} \pm 1\%$ and a Q-factor of 125 at 2.5 mc. Temperature stability with a constant inductance is $\pm 0.5\%$ over the range of -20 to $+75$ C. Shielding is provided by a well closed magnetic circuit. Dimensions are $3/8 \times 1/4 \times 1/4$ in.

Polyphase Instrument Co., Dept. ED, E. 4th St., Bridgeport, Montgomery County, Pa.

Digital Modules 373

For high speed operation

These solid-state modules of printed circuitry are for use in building digital systems for the acquisition and processing of test data at high speeds. A system can be assembled to multiplex and digitize data at rates to 15,000 samples per sec with an accuracy of 0.05%. Each block performs a specific function. Twenty modules can be accommodated across a 19-in. rack.

Minneapolis-Honeywell Regulator Co., Dept. ED, Wayne & Windrim Ave., Philadelphia 44, Pa.

Price: \$200 per printed circuit card.

Precision in Small Packages...



Series "V3"



Series "SM"



Series "TB"



Series "15X"



Series "Z"

All basic switches shown approximately actual size.

The actuators which form the background on this page are only a few of the hundreds available for these MICRO SWITCH Basic Switches. MICRO SWITCH engineers can help you choose not only the right switch, but also the right actuation method for your particular application.



Start with the Best in Basic Switches!

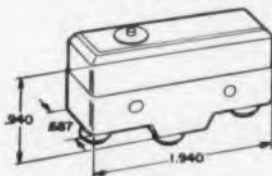
When design dimensions get you thinking small, don't let that carry over into the consideration of switch quality. MICRO SWITCH Basic Switches consistently save you space, but never at a sacrifice in precision and reliability. Start with the best and be sure of the exclusive MICRO SWITCH spring and anchor designs; get the protection of materials testing "by the inch" and operational tests that exactly duplicate the conditions under which your switch must operate. You also get more years of experience for design consultation because MICRO SWITCH pioneered the subminiature switch industry. Variations on these basic switches number in the thousands, including those designed to meet military standards. You'll find it easy to select exactly the right answer with the prompt help of the nearby MICRO SWITCH branch office listed in the Yellow Pages.



This 72-foot control panel is part of equipment for monitoring tests where your operating methods and environmental conditions can be duplicated exactly for millions of switch operations.

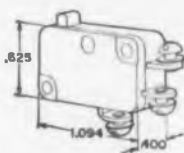
75 HONEYWELL
PIONEERING THE FUTURE

TYPE "Z" AND "A" BASIC SWITCHES



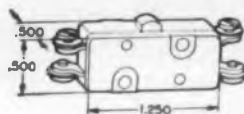
These are the original basic switches that were the pioneers in small snap-action precision switches. Today hundreds of variations serve with precision and reliability in thousands of jobs throughout industry.

TYPE "V3" BASIC SWITCHES



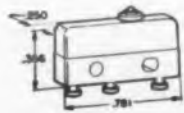
Miniature size with very high electrical capacity. The "V3" Series includes many different types of terminals, contact arrangements, and materials for a wide range of operating temperatures.

TYPE "TB" BASIC SWITCHES



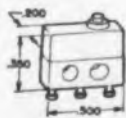
These are small, two-circuit double-break switches for controlling two isolated circuits. They save space and weight, allow flexibility and simplicity of circuit design.

TYPE "SM" BASIC SWITCHES



"SM" Subminiature Switches bring MICRO SWITCH precision to applications where space and weight limitations are critical. Many different "SM" types are available to meet varying requirements for high-temperature applications and long operating life. Special gold or bifurcated contacts are also available.

TYPE "1SX" BASIC SWITCH



This sub-subminiature is the smallest single-pole double-throw snap-action switch available. Despite its tiny size it combines long operating life with ample electrical capacity. This is a perfect example of MICRO SWITCH precision in space-saving sub-subminiature size.

Write for New Catalogs 62 and 63
on Small Basic Switches.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario



Honeywell
MICRO SWITCH Precision Switches

Flux Analyzer 517

Measures absolute flux density with
a 10⁵ accuracy

Developed specifically to measure magnetic fields in traveling-wave tube solenoids, this flux analyzer can be used for determining flux density in magnets, Klystron coils, and other devices having a linear field. It measures absolute flux density to an accuracy of 10⁵ with a differential capability of 10⁶. The field density is 100 to 10,000 gauss.

Automation Industries, Inc., Dept. ED, 3613 Aviation Blvd., Manhattan Beach, Calif.

Price & Availability: Delivery time is 90 days. Price is \$2000.

Shaft-Angle Encoder 540

Has sine and cosine data in cyclic
binary form

This shaft-angle encoder, model DV-SC11A, has a precision code disc containing sine and cosine information in cyclic binary form. Accuracy of the instrument is 2¹¹ ± 1 bit of the sine or cosine value. When used with a servo shaft positioner, linear to sine-cosine conversion can be accomplished without complicated storage or computational facilities. The unit has a size 23 or 35 synchro mount with an outer diameter of 3-3/4 in. and an overall length of 6-1/2 in.

Dychro Corp., Dept. ED, 49 Walnut St., Wellesley 81, Mass.

Mylar Capacitors 523

Capacities are 0.001 to 1 µf

Offered in capacities from 0.001 to 1 µf and in 100, 200, 400, and 600 v dc ratings, type 623 mylar capacitors may be used at full rated voltages to 85 and 125 C without derating. Typical applications are in TV, radio, hi-fi, and industrial instrumentation. The tolerance is ±5%. The units are encapsulated in epoxy.

Good-All Electric Manufacturing Co., Dept. ED, 112 W. 1st St., Ogallala, Nebr.

Availability: Units can be delivered three days after receipt of order.

CIRCLE 105 ON READER-SERVICE CARD

EXPANDING TH





Herodotus, the historian, records (490 B.C.) the use of burnished shields for military signaling. This was the forerunner of the heliograph, invented by Sir Henry C. Mance, which came into wide use centuries later.

FRONTIERS OF SPACE TECHNOLOGY IN COMMUNICATIONS

Lockheed's interest in developing the science of communications extends from the depths of the oceans to deep space. Its Missiles and Space Division research programs deal with the development and application of statistical communication and decision theory in such areas as countermeasures; telemetry multiplexing and modulation; scatter communications; multiple vehicle tracking; millimeter wave generation and utilization; sonic signal detection and processing; avoidance of multipath degradation; and interference avoidance.

Associated research and development efforts are directed toward propagation studies and advanced antenna design; low noise amplifiers; vehicle borne signal transmission and reception, data storage and processing; solid state materials and devices.

Activities range from advanced studies of naval communication problems on and under the oceans; the many applications to satellite vehicles; on to the specialized communication problems of deep space explorations. Latter needs are exemplified by high frequencies, low weight and power, high stability, low effective bandwidth, extreme reliability and basic simplicity requirements.

Engineers and Scientists: Investigating the entire spectrum of communications is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology—from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; communications; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space medicine; space navigation; and space physics.

If you are experienced in work related to any of the above areas, you are invited to inquire into the interesting programs being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. G-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER.

MIDAS and SAMOS Programs; Air Force X-7; and Army KINGFISHER

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

CIRCLE 921 ON CAREER INQUIRY FORM, PAGE 169

NEW!
**RAYTHEON
CONTROL
KNOBS**

virtually eliminate parallax



For instruments that
deserve the precision
engineered look.

TWO SLOPING-POINTER KNOBS have just been added to Raytheon's widely used industrial and military knob line. Fully comply with military specifications. Black or grey. Mirror or matte finish. 70-series for 1/4" shaft.

**SEND TODAY FOR
FACT-PACKED FOLDER**

on Raytheon control knobs, electrical components and panel hardware. Address Raytheon Company, 55 Chapel St., Newton, Mass.



RAYTHEON COMPANY
Industrial Components Division
55 Chapel Street, Newton, Mass.

CIRCLE 106 ON READER-SERVICE CARD

NEW PRODUCTS

Trimmer Capacitor

613

Has 0.4 pf change per turn



This miniature trimmer capacitor provides linear turning at the rate of 0.4 pf per turn. Metal parts are made of invar and brass to provide a temperature coefficient of capacitance of ± 50 ppm per deg C. Silver plating provides minimum corrosion resistance as well as a minimum Q-factor of 500 at 50 mc. Dielectric strength is 1500 v or higher. Four models offer capacitance ranges of 1 to 4.5 pf, 1 to 8.5 pf, 1 to 12 pf, and 1 to 18 pf. Behind-panel lengths are 27/64, 5/8, 13/16, and 1-1/32 in. Uses in airborne transmitters, computers, and communications receivers.

Corning Glass Works, Dept. ED, Bradford, Pa.
Availability: From stock.

Null Detector

621

Operates on 50, 60, 400, or 1,000 cps

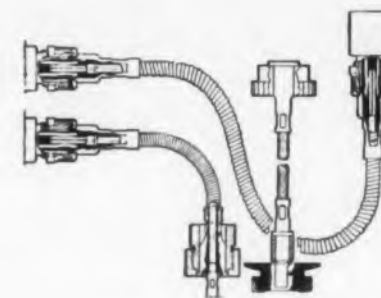


Model 9844 ac null detector, for use with ac bridges, electrolytic conductivity bridges, and current and potential transformer test sets, comes with interchangeable filter units that permit the detector to operate at 50, 60, 400, or 1,000 cps. The instrument provides five choices of sensitivity from 10,000 to 1 with a maximum sensitivity of 0.3 μ v per scale division for source resistances to 20,000 ohms.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia 44, Pa.

Availability: From stock.

**Flexible Shafting For The
DESIGN ENGINEER**



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ELECTRONIC DESIGN • July 20, 1960

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Frequency Monitor

454

Range is 400 cps to 10 kc



These solid-state frequency monitors operate over the range of 400 cps to 10 kc at an accuracy of $\pm 1\%$. The input supply voltage is 28 v dc with a minimum input signal of 900 mv. Output is spdt. The units operate over the temperature range of -55 to $+125$ C and are able to stand shock, vibration, and altitude as specified in MIL-T-5422C. Functions such as time delays for opening or closing contacts and activating warning or control devices may be incorporated in the basic monitor.

Voi-Shan Electronics, Dept. ED, 13259 Sherman Way, North Hollywood, Calif.

Modular Amplifiers

615

Three types are offered



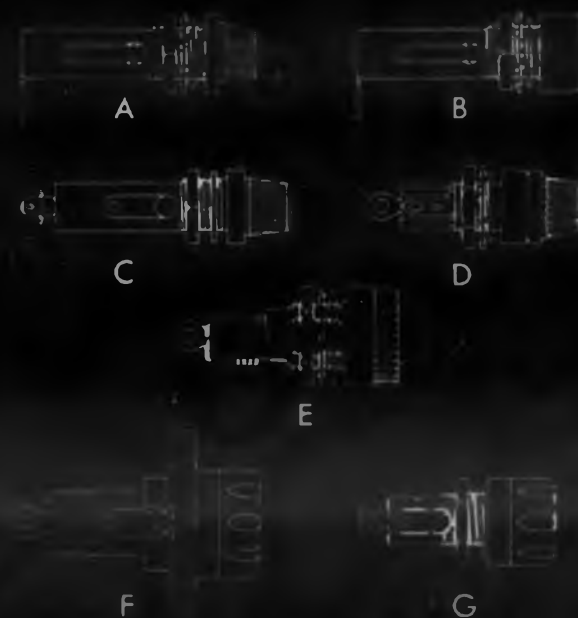
The 1000 series subminiature modular amplifiers are basic building blocks for 400-cps analog computers and instruments. Three types are offered. The servo amplifiers with outputs to 6-w, have good gain control field tuning capacitors, and need no external heat sink. The booster summing amplifiers have an accuracy of 0.05% and can sum up to six inputs; they can drive a size 11 resolver or one or more computing potentiometers. The automatic-gain-control amplifiers have an AGC range of better than 200:1; these units have low-noise output and negligible distortion and phase shift.

Modular Electronics Corp., Dept. ED, 149 N. Franklin St., Hempstead, L.I., N.Y.

Price: \$279 to \$299 ea.

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DEVICES
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Each mammoth Saturn vehicle may have three sub-miniature FAIRCHILD RG-101 RATE GYROS at the heart of the main control system. Now under evaluation by NASA at Huntsville, each of these thimble-sized gyros (weighs only two ounces) measures rates about one of three mutually perpendicular axes—generates anticipatory corrective signals to keep Saturn on course.

Built to the most demanding specifications, these RG-101 floated gyros represent the most advanced state of the art—another reason why Fairchild is the foremost manufacturer of high-performance precision sensing devices.

Fairchild RG-101 floated rate gyros are the smallest made by anyone! And the most rugged!—Only $\frac{1}{8}$ " diam. x $1\frac{1}{2}$ " long. Withstand 150 g's of shock and 30 g's vibration to 2000 cycles without damage, over the entire design range 5 degs./sec. to 1000 degs./sec. max. rate. Threshold rate is less than .025 degs./sec. Self-test capabilities for easy remote checkout. Gimbal system's freedom of movement can be checked over entire range of travel, from limit stop to limit stop in most designs. Friction or threshold level, sensitivity, and even damping ratio can be checked from the blockhouse. Run-up time is less than five seconds, using over-voltage techniques.

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NEW PRODUCTS

Rejection Filter

For 60, 120, and 400 cps

528



Model 201 selective rejection filter is for use as a notch marker in swept audio frequency measurements, in isolating sources of hum, ripple, and other frequency components, and in eliminating frequencies not wanted. The unit can be supplied with three to 10 rejection frequencies. The standard model is supplied for 60, 120, and 400 cps.

C. E. S. Electronic Products, Dept. ED, P. O. 7504, San Diego 7, Calif.

Price & Availability: \$85 ea for the standard model; 14-day delivery.

Silicon Diodes

618



Forward current is up to
 $\frac{3}{4}$ amp

These silicon JEDEC diodes are for use in applications requiring forward currents up to $\frac{3}{4}$ amp and low leakage current at temperatures to 165 C. Designated types 1N440 through 1N444, 1N440B through 1N444B, 1N1487 through 1N1492, and 1N1692 through 1N1695, the units are hermetically-sealed and do not need heat sinks. The 1N440 and 440B series provide dc output currents of 300 to 750 ma at 40 C over a piv range of 100 to 500 v. The B series is for use where low leak-

North Atlantic Series RB500 Ratio Boxes



Model RB-504
Bench mount

Measure A.C. Ratios
From -0.11111
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With any of North Atlantic's RB500 Ratio Boxes you can now measure voltage ratios about zero and unity—without disrupting test set-ups.

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Name your ratio measurement and its probable there's a North Atlantic Ratio Box to meet them—precisely. Write for complete data in Bulletin 11 N

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5513 Kearny Villa Road,
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age current and high forward current are required.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price & Availability: The 1N440 and 440B series are priced at \$1.90 to \$4.45 ea. Other units are priced as low as \$0.70. Delivery is from stock.

Magnetron Modulators 455

Replace thyratrons



Made to replace thyratrons for pulsing magnetrons, type SCR modulator operates from 115 v ac at 60 or 400 cps, or 28 v dc. These solid-state, plug-in, modular units meet the shock and vibration requirements of MIL-T-5422C, operate over the temperature range of -65 to $+125$ C, and have a transfer efficiency of 85%.

Voi-Shan Electronics, Dept. ED, 13259 Sherman Way, North Hollywood, Calif.

Environmental Chamber 484



Temperature range is
 -20 to -85 C

Providing temperatures from -20 to -85 C, model 6L-A2-20 environmental chamber has point control of ± 0.1 C in repeatability and temperature variation of less than 1 C. Having a capacity of 6 cu ft, the chamber is protected against high pressure build-up or loss of refrigerant. Air circulation is positively controlled by two blowers operating in a plenum chamber.

Harris Refrigeration Co., Dept. ED, 308 River St., Cambridge 39, Mass.

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CIRCLE 114 ON READER-SERVICE CARD

CIRCLE 913 ON CAREER INQUIRY FORM, PAGE 169

ELECTRONIC DESIGN • July 20, 1960

NEW PRODUCTS

Multi-Turn Potentiometer

617



Linearity tolerance is 0.5%

Type 150 multi-turn potentiometer has a resistance tolerance of $\pm 10\%$, a linearity tolerance of 0.5% and a power figure of 5 w at 4 C derated to zero at 100 C. Closer tolerances can be furnished. Resolution is claimed to be infinite. A slide wire resistance element is used. The 2.6-oz unit operates in the temperature range of -55 to $+100$ C and is available with resistances of 2 to 35 ohms.

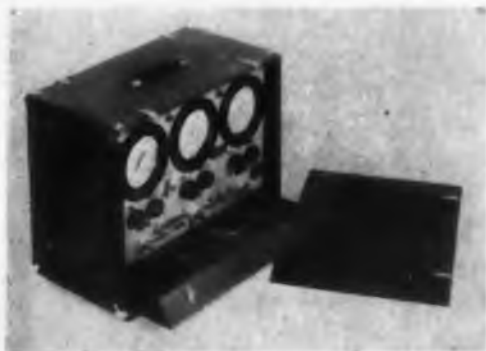
International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Price & Availability: About \$12; four to six weeks for delivery.

Pneumatic Check Bench

518

For pressure or vacuum testing



This portable pneumatic check bench is for testing pressure switches, vacuum switches, and other pressure or vacuum operated equipment. The unit is controlled by a selector valve which turns on pressure or vacuum supplied by a compressor that operates on 28 v dc. This compressor is controlled for 400 psi. Low and high pressure ports are furnished and can be used individually or simultaneously. The bench weighs 56 lb and measures 21 x 16-1/2 x 11-1/2 in.

Custom Components, Dept. ED, 2928 Empire, Burbank, Calif.

Price & Availability: \$2300 ea; 30-day delivery time.

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MILITARY TYPE

Silicon Mesa Transistors

USA 2N696

USA 2N697

Per: MIL-S-19500/99A

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These and *all* Rheem transistors are subjected to reliability testing which includes: 100%—300°C storage; 100%—two hermetic seal tests; 100%—temperature cycling. A sample of every lot must pass 15 environmental tests which exceed the most stringent combination of military specifications. And complete individual lot control is maintained. These tests are only part of the Rheem "Mark XII: Master Test Specification for Silicon Mesa Transistors". Applied to all Rheem transistors, "Mark XII" is the industry's tightest synthesis of reliability test specifications.

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	2N1420		
	2N1507		
	2N1613		

*Certified to meet MIL-T-19500/74 (USN)



Transducers

610

Differential transformer type



Series 103A linear-displacement, differential-transformer transducers offer resolution to 0.5 μ m. and linear ranges to ± 0.1 in. Linearity is 0.25%. Output is 3 mv per 0.001 in. per v of excitation.

Daytronic Corp., Dept. ED, 225 S. Jefferson St., Dayton 2, Ohio.

Price: \$120.

Quartz Pick-Up

460

Measures to 200,000 psi



Model 601/633 miniature quartz pick-up measures ballistic pressures to 200,000 psi. It has a natural frequency of 100,000 cps, a rise time of 5 μ sec, and can be mounted in a 3/8-in. threaded hole. The unit is virtually unaffected by temperature, time, or mechanical stress.

Kistler Instrument Corp., Dept. ED, 15 Webster St., North Tonawanda, N.Y.

Price & Availability: \$520 ea; from stock.

Coaxial Terminations

430

For 50-ohm lines

The TC series of coaxial terminations, for 50-ohm lines, is useful over a frequency range from dc to over 2 kmc. The maximum vswr varies from 1.15 to 1.25, depending on the type of connector required. Types N and C are rated at 2 w and types TNC and BNC are rated at 0.5 w. Other types are available on special order.

Coax Devices, Dept. ED, Chelsea 50, Mass.

Price & Availability: Price is from \$14 to \$25 ea.

New LAMBDA

Regulated Power Supplies

5 and 10 AMP 0-34 VDC

CONVECTION COOLED



3 1/2" PANEL HEIGHT ON 5 AMP MODELS

- Convection cooled—no internal blowers to wear out
- Guaranteed for a full 5 years
- Ambient temperature 50°C
- Excess ambient thermal protection
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- Hermetically sealed transformer designed to MIL-T-27A
- Remote sensing and DC vernier

New LAMBDA LA Series Condensed Data

DC OUTPUT:

(Regulated for line and load)

MODEL	VOLTAGE RANGE ¹	CURRENT RANGE ²	PRICE
LA50-03A	0-34 VDC	0- 5A	\$395
LA50-03AM	0-34 VDC	0- 5A	\$425
LA100-03A	0-34 VDC	0-10A	\$510
LA100-03AM	0-34 VDC	0-10A	\$540

¹ The output voltage for each model is completely covered in four steps by selector switches plus vernier control and is obtained by summation of voltage steps and continuously variable DC vernier as follows:

MODEL	VOLTAGE STEPS
LA 50-03A, LA 50-03AM	—2, 4, 8, 16 and 0-4 volt vernier
LA100-03A, LA100-03AM	—2, 4, 8, 16 and 0-4 volt vernier

² Current rating applies over entire output voltage range

Regulation: Line: Better than 0.15 per cent or 20 millivolts (whichever is greater).
Load: Better than 0.15 per cent or 20 millivolts (whichever is greater).

Transient Response: Line or Load: Output voltage is constant within regulation specifications for step function line voltage change from 100-130 VAC or 130-100 VAC or for step-function load change from 0 to full load or full load to 0 within 50 microseconds after application.

Ripple

and Noise: Less than 1 millivolt rms with either terminal grounded.

AC INPUT:

100-130 VAC, 60 ± 0.3 cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

OVERLOAD PROTECTION:

Electrical: Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

REMOTE SENSING:

Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

PHYSICAL DATA:

Size: LA 50-03A... 3 1/2" H x 19" W x 14 3/8" D
LA100-03A... 7" H x 19" W x 14 3/8" D
Panel Finish: Black ripple enamel (standard). Special finishes available to customers specifications at moderate surcharge. Quotation upon request.

Send today for complete data



LAMBDA ELECTRONICS CORP.

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Terminal

629

Breakdown factor is 9000 v

Type ST-1150 triple-turret, press-fit terminal, made for multi-layer or very complex circuitry requiring terminations of three or more conductors at one point, has a voltage breakdown factor of 9000 v, flash-over. It is for use in a chassis 0.11 in. thick and mounts in a hole measuring 0.158 ± 0.002 in. Height above the chassis is 0.218 in. and Teflon body diameter above the chassis is 0.187 in. The terminal resists high torque pulling under both assembly and operational conditions.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.
Availability: Delivery time is 30 days.

Stress-Testing Oven 514

Temperature range is 35 to 150 C

To permit continual heating of test materials during stress-measurement trials, this oven provides temperatures of 35 to 150 C regulated to within ± 0.5 C. Controls include wattage selector switch and automatic thermostat plus an over-temperature controller. A remotely mounted temperature recorder responds to instant temperature changes. Forced air circulation provides uniform heat distribution.

The Electric Hotpack Co., Inc., Dept. ED, 5065 Cottman St., Philadelphia 35, Pa.

Availability: Units are made on order.

DC Amplifier

497

Operates from -5 to +212 F

Designated the DA-10, this transistorized dc amplifier operates from -5 to +212 F, and handles signals as low as 0 to 10 mv, and as high as 250 mv. Under conditions of maximum gain, an input signal of ± 10 mv will give an output of ± 5 v. The unit withstands vibration of 20 g from 15 to 2000 cps, shock of 200 g, and acceleration of 200 g, each axis. It meets the humidity re-

◀ CIRCLE 116 ON READER-SERVICE CARD

requirements of MIL-E-5272B Procedure III. The unit measures 3 x 1.87 x 2.62 in. and weighs 11 oz. Applications include thermocouple and resistive transducer output signal amplification.

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

Price & Availability: Delivery from stock takes from 10 to 30 days. Price is \$1240 for quantities of 1 to 9; \$1190 for 10 to 49; and \$1150 for 50 to 99.

Strain Gage Calibrator 356

Accuracy is $\pm 0.05\%$ of reading

Having an accuracy of $\pm 0.05\%$ of reading, model 170-P strain-gage, transducer calibrator has a base range of 0% to 20%, with add-to reading ranges of 20%, 40%, 60%, and 80%. The system consists of a digital indicator with a remote cable connected case. The remote case provides input for any of six separate transducers. Span adjustments are variable from 1.5 to 3.03 mv per v. By selector switch, the operator selects a fixed 3 mv per v or the remote case variable span. An absolute zero or the remote case variable zero can also be selected.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

Arbor Press 536

Has a working force of 2/5 ton

Called the Micro-Press 100, this machine has a throat opening of 2-1/2 in. and is rated for a working force of 2/5 ton. It can be used in the assembly of miniaturized parts and electronic components. It comes with adjustable front and side gibs for alignment and application of force throughout the stroke of the ram. The press has a 2.5 x 1.5-in. working surface, cast iron frame, and ground base sides and mounting surfaces. For precision depth control, it can be fitted with a dial indicator.

Dickinson & Associates, Dept. ED, 940 Alma St., Glendale 2, Calif.
Price: Unit price is \$32, job Glendale. Quantity discounts available.

CIRCLE 811, 812 ON READER-SERVICE CARD

INTERNATIONAL RECTIFIER CORPORATION



RECTIFIER NEWS

High Voltage Cartridge Rectifiers Eliminate Warm-Up Time and Filament Losses Common to Tube Rectification . . . Save Space!

Cigar-Size High Current Silicon Cartridge Rectifiers Handle up to 20,000 volts!

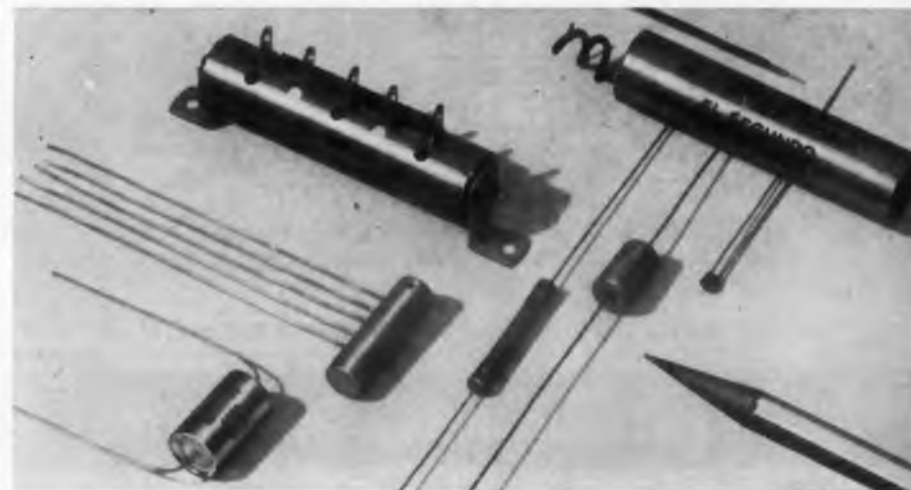
If your application calls for high-voltage rectification in high temperatures or cramped quarters . . . these are the rectifiers to specify! You'll get all the basic advantages of tubeless rectification plus higher current ratings, wider operating temperature range (-55°C to $+150^{\circ}\text{C}$) and a smaller unit than other rectifier types can offer. In some cases the reduction in space requirement can be as much as 95% over conventional types!

These hermetically sealed, ceramic housed units withstand the severe vibration and shock encountered in aircraft and missile flight with full reliability. For specialized industrial equipment such as magnetrons, electrostatic precipitators, dc overpotential test units, electric welders, etc., they offer characteristics you will want to know about for your future projects.



This rectifier configuration was developed and introduced to industry by International Rectifier. The recent addition of high current types makes this the widest selection available. The current range is from 45 to 440ma. PIV voltages range from 1500 to 16,000 volts in standard types. With modification, the PIV can be increased to 20,000. On special order, 72,000 PIV units can be supplied. For complete technical data on these units . . .

CIRCLE READER SERVICE CARD NO. 811



TYPICAL CONFIGURATIONS AVAILABLE IN OVER 500 STANDARD TYPES

Semiconductor "cartridge type" rectifiers can bring simplicity and compactness to your high voltage power supply design. Freedom from warm-up time filament circuit complications, reduced heat radiation, increased physical ruggedness and a reduction in space requirements are advantages these components offer you over vacuum rectifier tube types you might be using.

Single selenium cartridge rectifiers may be employed in conventional and special voltage doubler, tripler and quadrupler circuits, as well as in simple half-wave and full-wave circuits. Poly-phase operation is also possible. In addition to half-wave units, standard cartridges are available in full-wave,

center tap, voltage doubler, and single-phase bridge types.

Over 500 standard selenium cartridge types are now in full production at International Rectifier Corporation, the firm that pioneered this configuration. With a voltage range of from 20 to 20,000 volts PIV and current ratings from 0.2 to 195ma, there is sure to be a type to meet your most exacting need. Operating temperature range for standard types is -65°C to $+100^{\circ}\text{C}$ with specially processed cells available to extend the upper limit to $+125^{\circ}\text{C}$ if needed. For complete technical data on selenium cartridges . . .

CIRCLE READER SERVICE CARD NO. 812

Compact High Voltage "Packaged" Rectifiers Now Provide Ratings to 100,000 volts . . . Up to 1 Amp!



Specially "packaged" rectifiers comprised of either silicon or selenium units in hermetically sealed housings provide up to 100,000 volts at current ratings from 1 milliamperes to 1 ampere. They are operable in temperatures to $+150^{\circ}\text{C}$. Individual units are available in half-wave, doubler or any of the conventional rectifier circuits.

If rectifiers in this voltage range fit into your project plans, write to our Electronics Products Department where ratings, configurations and package designs can be tailored to your most exacting requirements.

FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

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WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

'TWTXT TRIMMERS...

there's little difference in shape

not much difference in size

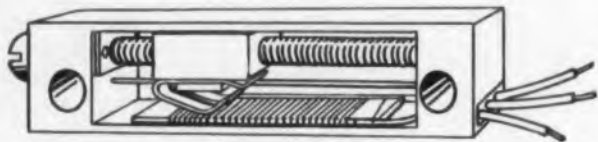
but a BIG DIFFERENCE INSIDE

Reliability thru proven manufacturing techniques is inherent in TIC Trimmers. TIC Standard Trimmers are not only dependable but are **AVAILABLE FROM STOCK** throughout the nation for fast deliveries.

And as an extra feature TIC has simplified your selection — military types in a choice of 4 mountings — all have a temperature range of -55°C to -225°C .

TIC box trimmers with recessed lid are designed for the most efficient four point sealing against moisture and dust.

Standard box trimmers are individually subjected to bubble testing.



All welded connections and dual contacts on both resistance element and slip rings are quality manufacturing features of TIC Trimmers.

COMPARE you'll see the BIG DIFFERENCE INSIDE

distributed nationally by **AVNET**

TYPE

RTW-W1 (Wire Leads)

RTW-L1 (Solder Lugs)

RTW-L2 (Solder Lugs)

RTW-P1 (Printed Circuit Pins)

25 turn lead screw adjustment (9000°). Standard Resistance Values: 50 — 100K ohms. Non-standard values between 10 ohms and 125K ohms available on special order. Values below 10 ohms and between 125K and 225K ohms also available through the use of special techniques.

Subminiature TPC-P1 for printed circuit application.

37 turn lead screw adjustment (13320°). Standard Resistance Values 50 — 30K ohms. Non-standard values between 10 ohms and 30K ohms available on special order.

TYPE RWT-C1 (Wire Leads)

25 turn lead screw adjustment (9000°).

Commercial type, low cost trimmers have a temperature range of -55°C to $+85^{\circ}\text{C}$. Anodized metal cases and eyelet mounts permit stacking multiple units in limited areas.

Standard Resistance Values 50 — 20K ohms. Non-standard resistance values between 10 ohms and 25K ohms available on special order.

For full details write, wire, or call



TECHNOLOGY INSTRUMENT CORP.
OF ILLINOIS

10130 West Pacific Ave., Franklin Park, Illinois, GLadstone 1-1140

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CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Instrument Tubes

474

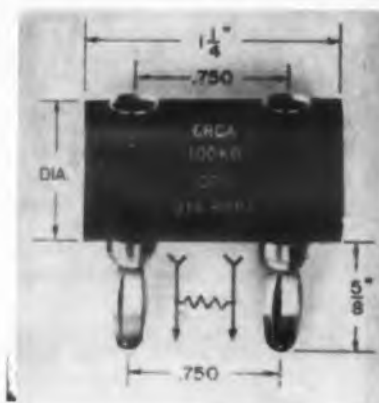
Plate currents are balanced within 15%

Types 7728, 7729, 7730, 7731, 7732, and 7733 miniature instrument tubes replace 12AT7, 12AX7, 12AU7, 6U8A, and 6CB6; the 7733 is the instrument counterpart of 12BY7A. They have coil heaters, 48-hr stabilization of electrical characteristics, and are tested for 1000 hr life. Plate currents are balanced within 15%. Microphonics, hiss noise, and leakage currents are minimized. CBS Electronics, Dept. ED, Danvers, Mass.

Banana-Plug Resistors

614

Power dissipation is 1/4 to 2 w



These banana-plug resistors are offered in eight sizes with from 1/4 to 2 w power dissipation. Most units are non-inductively wirewound; carbon and film metal types can also be furnished. Tolerances are 1% through 0.005% absolute; stability is 0.001%, and temperature coefficient is 5 ppm per deg C. The units meet MIL-R93B and MIL-R9444. Plug spacing is 3/4 or 3/8 in.

Consolidated Resistance Co. of America, Inc., Dept. ED, 44 Prospect St., Yonkers, N.Y.

Price & Availability: About \$2 ea for 0.1%-tolerance units in lots of 100. Made to order, units are ordinarily delivered in four weeks. Faster delivery is possible on request.

Wirewound Resistors

472

Rated at 1 and 7 w

These molded wirewound resistors are rated at 1 and 7 w. The 1-w units measure 0.417 in. long and 0.15 in. in diameter for up to 4,500 ohms or 0.542 in. long and 0.15 in. in diameter for up to 6,500 ohms. The 7-w units measure 1.218 in. long and 0.323 in. in diameter with a range to 30,000 ohms. Both types derate linearly to 0 w at 275 C. Temperature coefficient is ± 20 ppm per deg C. Tolerances can be as low as 0.1%.

Ohmite Manufacturing Co., Dept. ED, 3642 Howard St., Skokie, Ill.

TIC
TRIMMERS

are dependable because they are designed and manufactured by

TECHNOLOGY Instrument Corp.



TIC SERVICE

is dependable because a wide selection of types and standards are

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where and when you need them. Quantities 1 to 250 of an item at factory prices.

Call your Avnet Sales Engineer for dependable service and immediate delivery



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AVNET-45 Winn St., Burlington, Mass. - RP 2-3060
AVNET-4180 Kettering Blvd., Dayton 39, Ohio - AX 8-1458
AVNET-2728 N. Mannheim Rd., Melrose Park, Ill. - GL 5-6160
AVNET-1262 N. Lawrence Sta. Rd., Sunnyvale, Cal. - PE 3-0300

CIRCLE 119 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 20, 1960

Balanced-Phase Flex-Guide

404

For uhf transmission lines

The B-φ flex-guide, for uhf waveguide transmission lines, is essentially a convoluted flexible tube with two, lapped axially seams, one on each broad waveguide wall. The use of two seams minimizes distortion. The flexible tubing that is soldered or welded to flange fittings at the extremities is supported at the corners by specially designed brackets.

E. M. T. Corp., Dept. ED, Newton, N.J.

Availability: The product is available for immediate delivery.

Silicone Dioxide Microspheres

607

Have a density of 4 lb per cu ft

Called Globe-O-Sil, these hollow spheres of silicone dioxide have a density of 4 lb per cu ft, a 2300 F melting point, and come in 300 to 600 micron size. When used either alone or with binders, this filler is suitable as a material in insulation, adhesive, and refractory applications.

Hastings Plastics, Inc., Dept. ED, 1551 12th St., Santa Monica, Calif.

Price & Availability: Available from stock. Delivered 7 days after order received. Price is \$2 per unit when ordered in quantities of 1 to 25; \$1 per unit for quantities over 2000.

Tantalum Capacitors 450

Range is 0.5 to 200 μf

These etched foil tantalum electrolytic capacitors provide a range of 0.5 to 200 μf and working voltages to 150 v dc. Three case sizes, equal to C1, C2, and C3 of MIL-CO8965B, are offered. The etched foil provides higher maximum capacitance and has lower leakage-current characteristics than plain foil.

Ohmite Manufacturing Co., Dept. ED, 1684 Howard St., Skokie, Ill.

NEW

from

TI

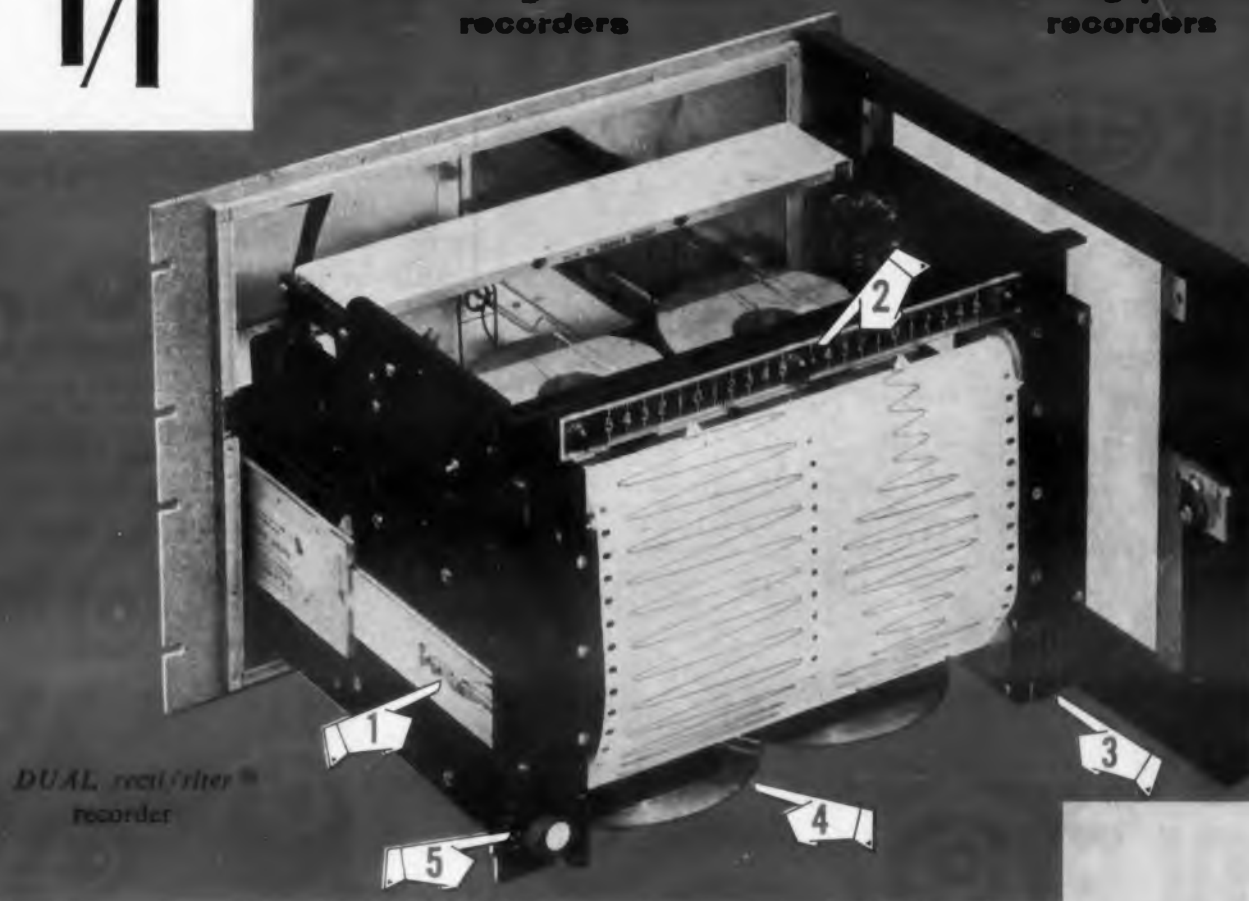
FLUSH-MOUNTING

recti/riter

rectilinear galvanometric
recorders

servo/riter

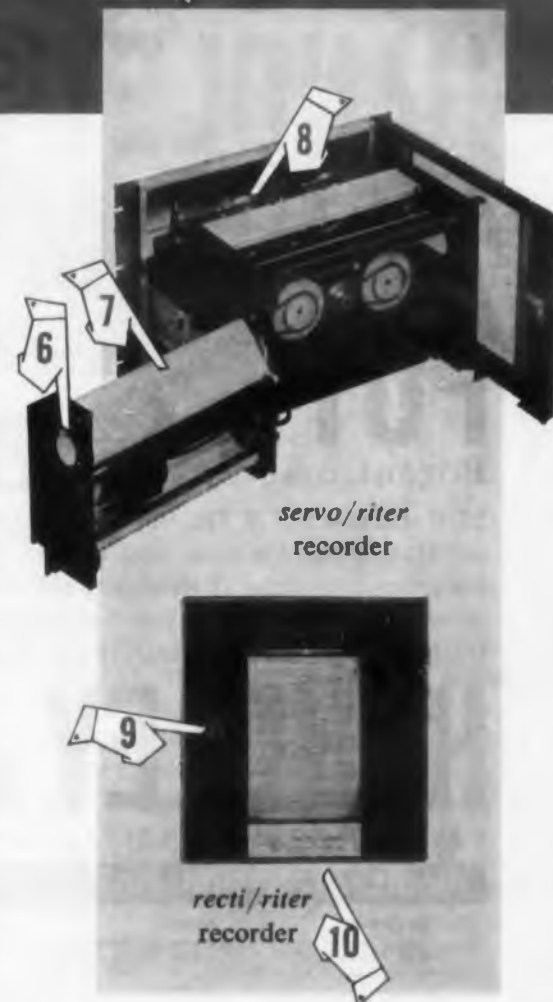
self-balancing potentiometric
recorders



Exclusive convenience features are added to industry-proved recording performance

The NEW flush-mounting *recti/riter* and *servo/riter* recorders (single, dual, and wide channel) contain these operating conveniences, while retaining the reliability and performance characteristics of the proved TI portable recorders.

1. Chassis rolls out and quickly disconnects for maximum ease of installation, adjustment or servicing.
2. Illuminated scales and pointers maintain high readability regardless of room light level.
3. Fingertip releases for chassis roll-out and swing-open chart carriage.
4. Flexible wide range zero adjustment on *recti/riter* recorder. One-half span of calibrated zero suppression provided in each direction.
5. Four-position switch provides off-on, in./hr., standby, and in./min.
6. Chart speed change gears provide 10 standard speeds.
7. Swing-open chart carriage permits easy paper loading and adjustment. Simply lift up to remove carriage. Advanced design eliminates chart drive gear train lash . . . gives better paper position accuracy.
8. Interior design provides flexibility and adequate space to add special functions with ease.
9. Dust tight case has key lock available for limited access. Dimensions: Single recorders—11½" W., 12½" H., 16" D.; Dual recorders—16¾" W., 12½" H., 16" D.
10. Panel may be easily modified to permit paper feed through bottom of door.



Write for complete information . . .

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NEW! TAKE A LOOK AT THE GUTS OF HANDLEY'S WEETRIM POT

...the Precision Trimming Potentiometer that will Standardize the Industry The Handley WeeTrim trimming potentiometer will standardize the type...and, as with other Wee Line products, WeeTrim is manufactured under strict quality control. Lightweight, wee in size, extremely stable, and WeeTrim has the other exclusive Handley Wee Line features. Write today! Literature will be provided immediately.

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Samuel A. Jeffries, Inc.
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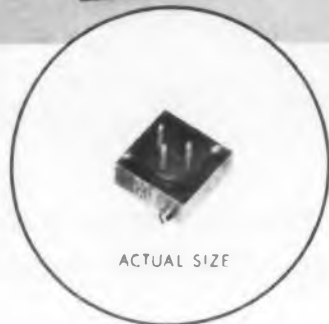
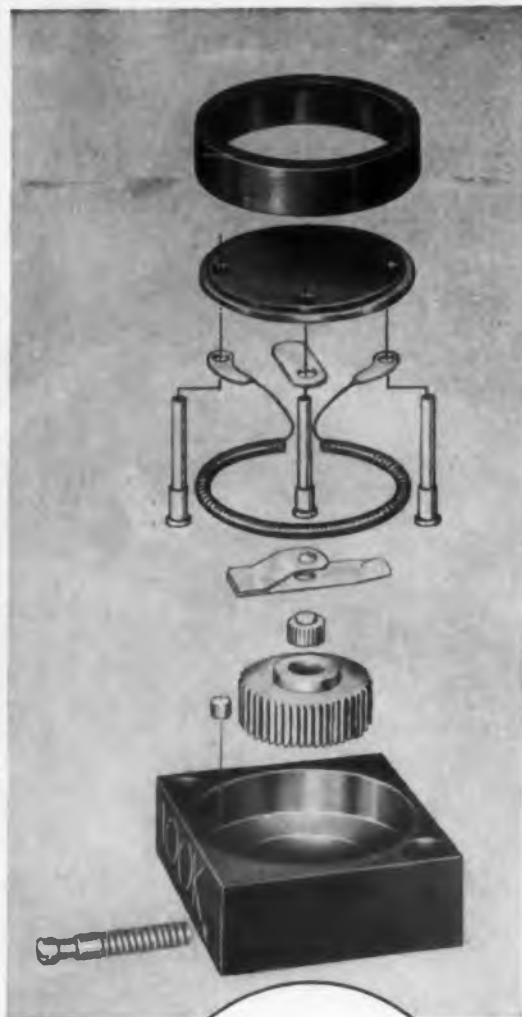
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CIRCLE 121 ON READER-SERVICE CARD



PAT.
PEND

NEW PRODUCTS

Insulation Material

374

For drawn or formed materials

Types 507 and 509 insulation materials, for drawn or formed insulators, are cloth and Mylar and creped paper and Mylar, respectively. Type 507 has a dielectric strength of 300 v per mil and a breakdown voltage of 2750 v for a 0.01 in.-thickness. Type 509 has a dielectric strength of 200 v per mil and a breakdown voltage of 2350 v for a 0.016-in. thickness.

Wm. H. Welsh Co., Inc., Dept. ED, 2241 S. Indiana Ave., Chicago 16, Ill.

Availability: 30-day delivery time.

Meter Calibrator

612

For production or lab use



Model 600 meter calibrator checks the operation of panel meters, VOM's, VTVM's and portable instruments of 1% accuracy or less. Completely solid state, the unit is suited for production or lab use. The ac and dc ranges are 0 to 2.5, 0 to 5, 0 to 10, 0 to 25, 0 to 50, 0 to 100, 0 to 250, and 0 to 500 v. DC range is 1 μ a to 1 amp. For ohmmeters precision resistor ranges are 25 ohms to 2.5 meg. Accuracy on all ranges is $\pm 0.5\%$ of full scale.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price & Availability: \$995 ea; 90-day delivery.

Cylindrical Band Heaters

399

For plastic molding and extruding machines

These cylindrical band heaters are for plastic molding and extruding machines. Made of an aluminized steel sheet and a one-piece alloy clamping band, the heaters are 1.5 in. wide and have an ID of 1-5/8 to 18 in. A wide range of wattage and voltage ratings is offered. Smooth internal contour provides a tight fit between the band and the cylinder.

Vulcan Electric Co., Dept. ED, 88 Holten St., Danvers, Mass.

Availability: The product is usually made on order.



HIGH TEMPERATURE WIRE

When you specify Teflon[®] FLEXLEAD for lead wire and cable applications, you're buying from the Line of Excellence... assurance of reliable performance. FLEXLEAD's tough coating of precision-extruded Teflon resists abrasion, moisture, corrosion; and withstands temperatures to 250°C without affecting its flexibility or superior electricals.

Markel processing includes careful and complete testing of every foot at several times rated voltage. FLEXLEAD, to MIL-W-16878C, is stocked for immediate delivery in all the standard colors and sizes. Ask for samples, data, and prices.

*Du Pont Trademark

L. FRANK MARKEL & SONS
SINCE 1922



SOURCE for EXCELLENCE
Insulating Tubings, Sleeveings, and Lead Wire

NORRISTOWN, PENNSYLVANIA

CIRCLE 122 ON READER-SERVICE CARD

CIRCLE 123 ON READER-SERVICE CARD

CLEAN

Electronic, Electrical,
Mechanical Components
and Contacts with
NO Film or Residue

Cobehn

HIGH-VELOCITY
SPRAY-CLEAN TECHNIQUE



APPLICATIONS

Electronic Components & Assemblies: Diodes, Transistors, Slip-Ring Commutators, Crystals, Vacuum Tube Components, Sub-Miniature Assemblies.

Meter & Instrument Components: Instrument Bearings, Jewel Bearings & Pivots, Gear Trains, Lapped Surfaces.

Electrical Contacts: Relays, Vibrators, Voltage Regulators, Sensitive Switches.

FEATURES

No film, residue, or corrosive effect to damage surface, fire and explosion hazard nil, non-polar, non-ionic, an all around safe operation.

For specific information about your critical cleaning problems, send product information and production requirements.

Cobehn Inc.
226 Passaic Avenue
Caldwell, N. J. CApital 6-6675

CIRCLE 126 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 20, 1960

Ceramic Capacitors

426

For use in rf circuits

Types 90C and 91C high-voltage ceramic capacitors, for use in rf circuits, have applications in transmitters, electronic welding equipment, and induction heaters. The ceramic dielectric used has an extremely high Q-factor and very stable retrace characteristics. A typical capacitor is rated at 100 μf at 5 kv and can carry 16.6 amp at 30 mc.

Sprague Electric Co., Dept. ED, North Adams, Mass.

Scan Conversion Tube

440

Has variable erase time

Type 1300.32 scan conversion tube is a storage device with variable erase time, capable of simultaneous reading and writing. It uses magnetic deflection and focus on both sides with provision of electrostatic focus and electrostatic dynamic. Its overall length is 23.77 in., and maximum diameter is 4 in. The tube has a hard glass envelope and an 8-pin base.

General Electrodynamics Corp., Electronic Tube Div., Dept. ED, 4430 Forest Lane, Garland, Tex.

Availability: The tube is available in sample quantities only. Delivery can be made 30 days after order received.

Time Code Generator

409

Stability is 3 ppb



Model ZA-810 time code generator, for laboratory or field use in an instrument timing system, has a stability of 3 ppb. The two outputs are in dc level shift form and modulated 1000 cps carrier. The 36-bit code indicates time of day and days of the year and is read out once per second at a rate of 100 pps. Provision is made for WWV synchronization. Plug-in circuits are used. The unit occupies 7 x 19 x 18 in.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price & Availability: Price is \$11,180. Delivery time is 90 days.



LACROSSE . . .

one of those rare accomplishments
that makes a man proud he's an engineer

When Lacrosse split a 2 x 4 from 19 miles away, Martin-Orlando engineers knew they had a winner . . . a one-shot killer.

Lacrosse is the Army's most accurate surface-to-surface missile. It is fired from a highly mobile launcher somewhere in a rear area. A forward guidance team electronically picks up control of the missile in flight, and lays it dead on target.

Lacrosse is the kind of accomplishment engineers dream about. It came out of Martin-Orlando. So did Pershing, Bullpup, and Missile Master.

If you want success, recognition, and the feeling of being first with

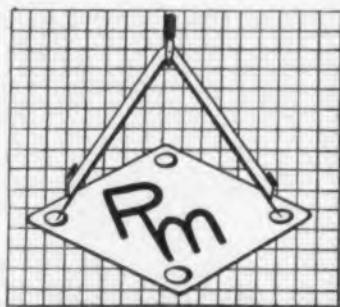
the most, we'd like to hear from you. Florida sunshine, sparkling lakes and palm trees aren't hard to take, either. Send resume to C. H. Lang, Director of Employment, The Martin Company, Orlando 12, Florida.

CURRENT OPENINGS for engineers in these areas: ground and airborne electronics • advance design • systems • aerodynamics • quality and test • reliability • electronic manufacturing

WORK IN THE CLIMATE OF ACHIEVEMENT

MARTIN
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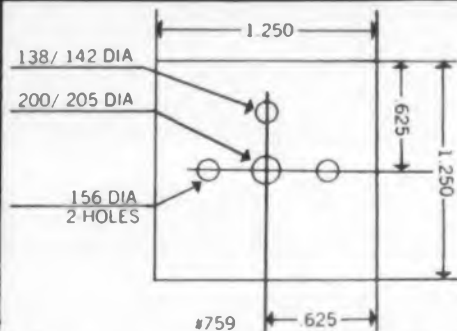
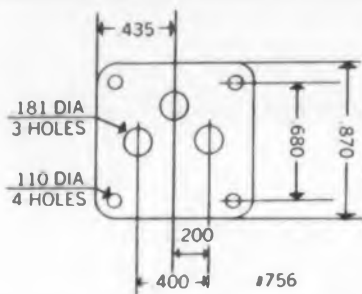
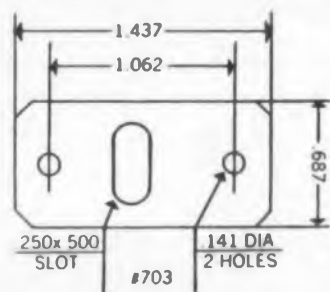
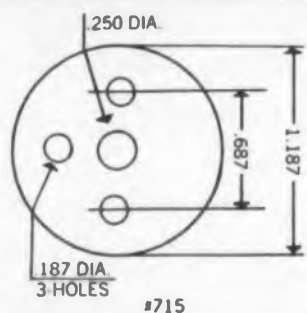
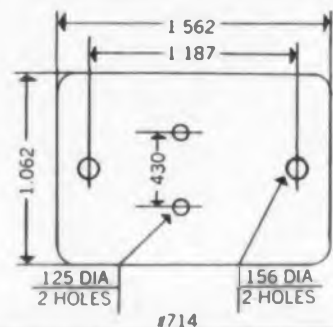
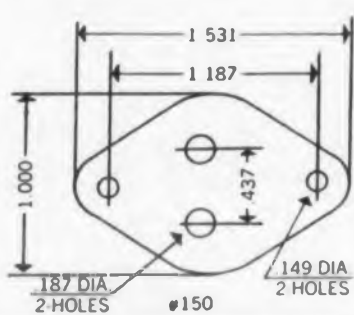


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Transistor & Diode MOUNTING WASHERS

Representative Specs of only a few standard Mounting Washers.
Many others available . . . plus any "special" you specify!



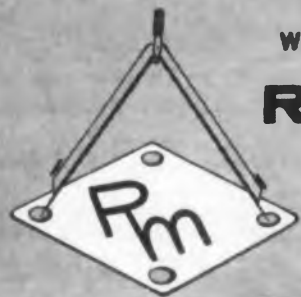
Dielectrically Perfect . . . for maximum insulation and rapid heat dissipation. RELIANCE MICA washers insure semi-conductor efficiency. "Precision-Engineered" from start to finish . . . RELIANCE MICA offers better performance at less cost! For example . . .

- All parts made of quality .002 Mica, Mylar or Silicone varnished Fiberglass.
- G.E. SF85 (50) Silicone Fluid available as an aid in heat dissipation.
- Microminiature Film Washers, Mesa Transistor Types, available.

Write today for technical information, and price lists.

RELIANCE MICA CO., INC.

341 39th Street • Brooklyn 32, N. Y.



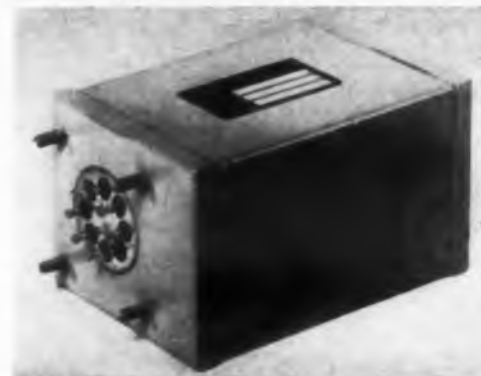
CIRCLE 125 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage Regulator

453

Regulation is within $\pm 1\%$



This magnetic voltage regulator provides voltage regulation of $\pm 1\%$ with load variation up to 100%. Designed for airborne and ground applications, the unit has a power handling capacity of 5 to 500 va and meets the shock, vibration, and altitude requirements of MIL-T-5422C. Input voltage is 115 v ac or 28 v dc with frequencies of 60, 360, or 1000 cps.

Voi-Shan Electronics, Dept. ED, 13259 Sherman Way, North Hollywood, Calif.

Magnetic Amplifiers

635



Sense 1 $\mu\mu\text{w}$

Capable of sensing dc signals of 1 $\mu\mu\text{w}$, the Acromag magnetic amplifiers have gains up to 1,000,000. They deliver 1 v dc output per micro-ampere of dc control signal. The equivalent input drift is less than 10 μv under moderate environments and 50 μv under severe environments. Gains are accurate to 3%. Units can measure weak dc signals from thermocouples, strain gages, and other low-level signal sources. Model 103 shown operates on less than 2 w of 115-v, 400-cps, unregulated power.

Acromag, Inc., Dept. ED, 22515 Telegraph Road, Southfield, Mich.

Price & Availability: \$195 ea in quantities of one to five; from stock.

Environmental conditioning

for
*missile
guidance
systems*



AiResearch Gyro Conditioners for the U.S. Army Sergeant missile are the most complete and efficient systems of their type.

The 8 lb. package, consisting of heat exchanger, heater, thermal switches and three fans, maintains a hermetic atmosphere of 85°F. to 160°F. in an outside ambient temperature of -20°F. to 140°F. Even temperature levels throughout the electronic compartment are maintained by an internal fan and low velocity air movement.

AiResearch is the leading designer of such advanced electronic conditioning equipment and systems, and this production unit is but one example of many produced for missile and ground support applications.

When fast attention to your problem, high reliability and small unit size and weight are important, contact AiResearch first.

Environmental conditioning equipment has been produced for the following electronic systems:
Detection • Communication • Control • Ground Support • Guidance

Write for literature today.



AiResearch Manufacturing Division

Los Angeles 45, California

CIRCLE 201 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

Soldering Iron Tips 379

Are non-sticking

These armor-clad electric soldering iron tips are made from pure copper rod and iron-plated with electrolytic iron to a high standard of non-porosity. The alloy sleeves around the shanks prevent freezing or sticking and eliminate the need for frequency removal of tips.

Engineering & Electronic Devices, Inc., Dept. ED, 1220 Sunset Plaza Drive, Los Angeles 46, Calif.
Availability: From stock.

Silicon Rectifiers 632

For military applications

Types 1N1614, 1N1615, and 1N1616 silicon rectifiers, for use in missiles and space probes, are designed to meet Mil specs E-1/1240, E-1/1241, and E-1/1242. Able to operate from -65 to $+150$ C at 5 amp, they are also suitable for use in power supplies, magnetic amplifiers and regulators in guidance systems, and in aircraft. Reverse voltage ranges are from 200 to 600 v dc. At 150 C, the maximum reverse current at rated piv is 1 ma. At 25 C, the maximum forward voltage drop at 10 amp is 1.5 v dc. A copper mounting stud, glass-to-metal hermetic seal, and welded construction are used.

Bendix Aviation Corp., Dept. ED, Long Branch, N.J.

Pressure Transducer 490

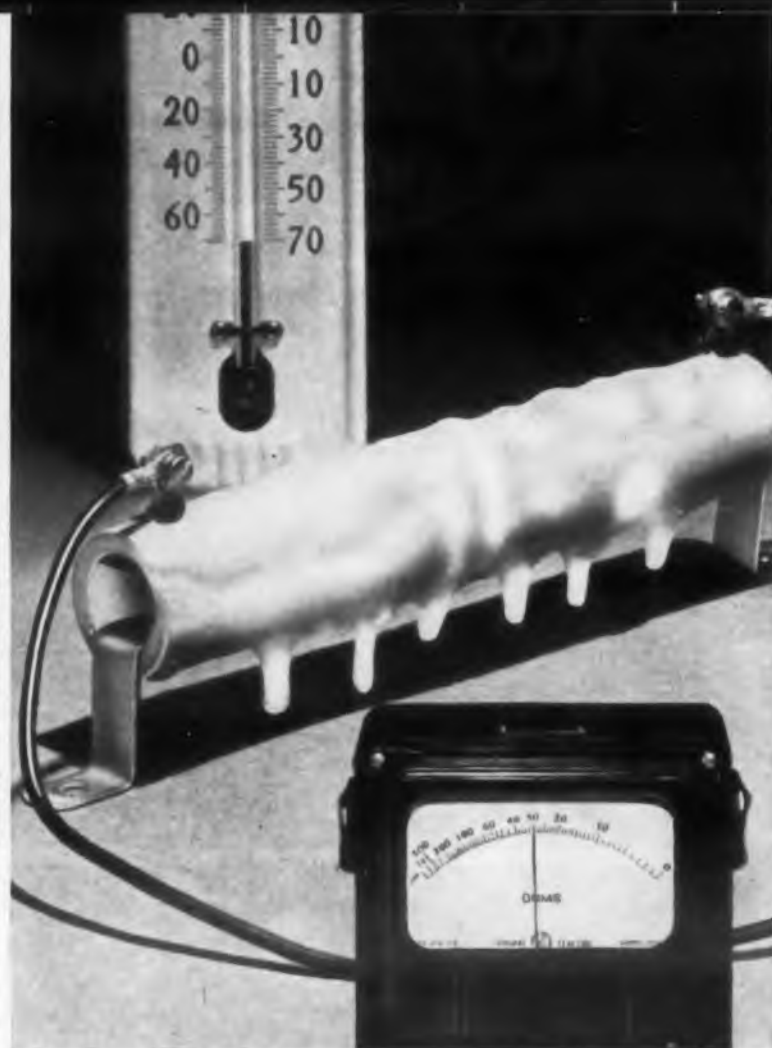
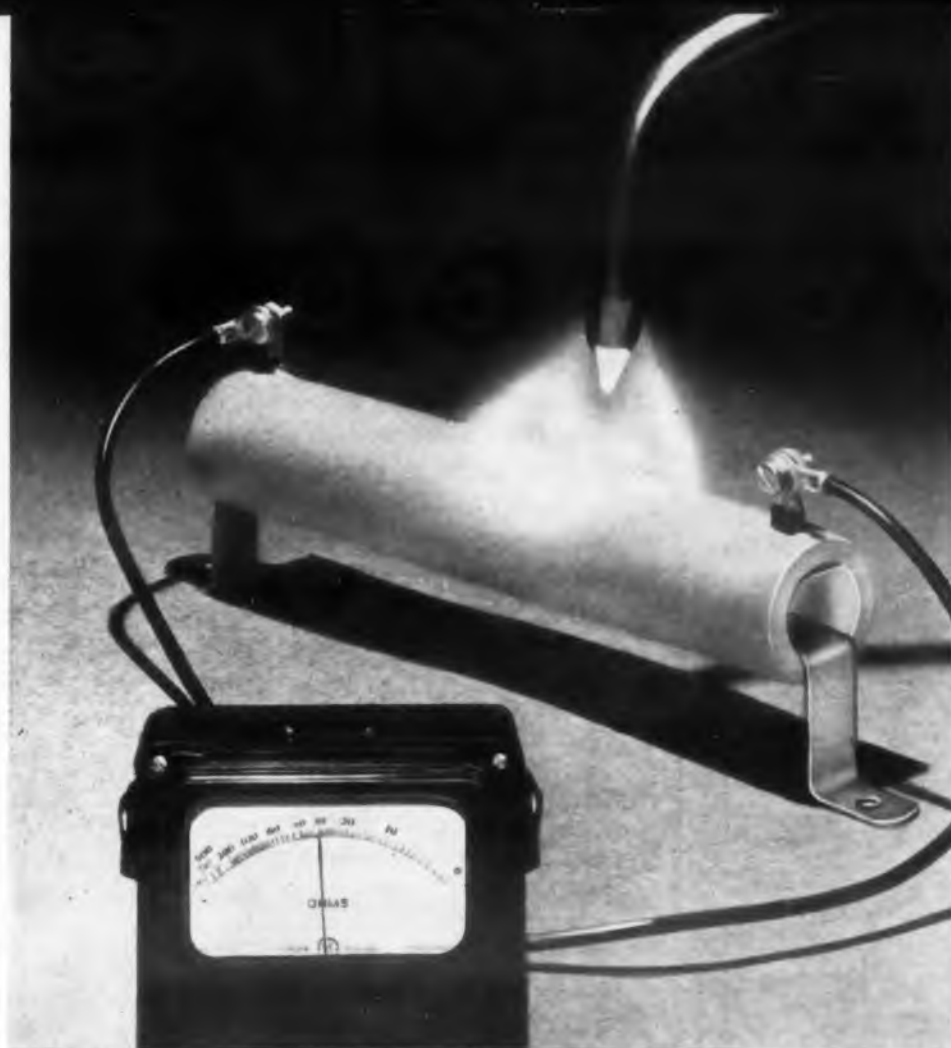
Measures pressure of corrosive fuels

Type TP-100 1-in. pressure transducer is designed to measure the pressure of corrosive fuels. To isolate the potentiometer mechanism, it uses an evacuated, stainless steel inner case. Output signal resolution is 0.25% for most ranges. The unit stands to 100% over-pressure. Pressure ranges are from 0 to 5 up to 0 to 350 psi absolute, gage or differential.

Fairchild Camera And Instrument Corp., Dept. ED, Robbins Lane, Syosset, L.I., N.Y.

Availability: Delivery time is 40 to 60 days.

CIRCLE 124 ON READER-SERVICE CARD



TESTS ON NEW GENERAL ELECTRIC RESISTORS PROVE . . .

Stable operation from $+700^{\circ}$ to -70° F

Under searing heat or sub-zero cold, General Electric resistors maintain their rated ohmic values. Actual laboratory tests have proved that these vitreous-enameled resistors hold their rated resistance under ambient temperatures from $+700$ F to -70 F.

These General Electric resistors are available in over 1400 combinations of ratings (5 to 200 watts), types, and mountings. Stable operation is but one

of their outstanding qualities: They have sufficient terminal strength to hold up to 21 pounds of right-angle pull, and special terminals are available to hold up to 34 pounds. Their vitreous-enamel coating provides resistance to adverse atmospheric conditions.

Like to know more? Ask your General Electric Apparatus Sales Engineer for a free set of sample resistors and test them yourself! And mail this cou-

pon today for the 36-page catalog containing complete information on ratings, dimensions and ordering directions.

NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays, and plate rheostats for all your control needs. For more information, contact your General Electric Sales Engineer or mail this coupon today! Industry Control Department, Salem, Virginia.

GENERAL ELECTRIC

D-c contactors and relays—feature new “building-block” construction to give maximum flexibility with minimum inventory.



Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.



To: Section E784-23
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- GEA-6592—Vitreous-enameled resistors
- GEA-6474—Plate-type field rheostats
- GEA-6621—D-c contactors and relays

Name _____

Company _____

Address _____

City _____ State _____



MICRO-MINIATURE RELAY STYLE 6A For Printed Circuits

Less Space

Lower Mounting Height

Terminals & Mounting
Conform to 0.2" Grid Spacing

For reliable switching of low-level as well as power loads. Style 6A will operate at coil power levels below most larger current-sensitive relays in its general class, yet easily switches load currents of 2 amps resistive and higher at 26.5 VDC or 115 VAC. Contact arrangement to DPDT.

Unique construction permits flexible wiring and a variety of schematics. Withstands 50 G shock and 20 G vibration to 2000 cycles.

Meets applicable portions of specification: MIL-R-5757C and MIL-R-25018 (USAF) Class B, Type II, Grade 3.

Call Or Write For Additional Information

PRICE ELECTRIC CORPORATION



302 E. Church Street • Frederick, Maryland
MONument 3-5141 • TWX: Fred 565-U

CIRCLE 128 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Filling Machines 260

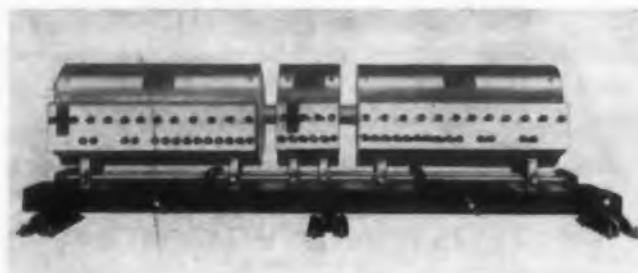
Inject compounds into components

This line of automatic, high-speed filling machines injects viscous compounds into small components. The machines fill circular apertures in such components as drawn or molded shells of diameters up to 2 in. and which lend themselves to automatic hopper feeding. All machines have variable volume-controlled filling cycles compatible with the material being dispensed.

Swanson-Erie Corp., Dept. ED, 816 E. Eighth St., Erie, Pa.

Furnace 261

For semiconductors and crystals



Model 60-SC furnace apparatus is for semiconductor preparation and for growing single crystal materials. Consisting of two or more tubular furnaces, mounted on a common axis, the apparatus permits zone refining, directional freezing, slow crystallization, seeding, and crystal growing in the quartz work tube.

Marshall Products Co., Dept. ED, 270 W. Lane Ave., Columbus 2, Ohio.

Availability: Depends on applications.

Component Processing Machine 262

Tapes components into continuous strip

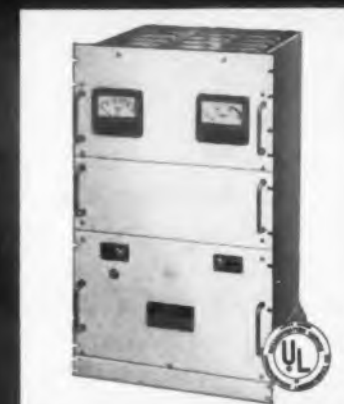
This axial-lead, component processing machine automatically tapes resistors, capacitors, or diodes into a continuous strip; it then cuts or perforates the strip into packages containing any desired uniform quantity of sequence of quantities. Components are automatically counted while being packaged. Capacity of the machine is 8,000 per hr. On components with up to 3-in. body lengths, the machine will also straighten leads, trim lead wires, and automatically shut off.

Universal Instruments Corp., Dept. ED, Binghamton, N. Y.

Price & Availability: Made on order only; delivered within 8 weeks. Price ranges between \$2,500 and \$15,000.

D-C POWER

Precisely Regulated for
Missile Testing, Battery
Charging and General Use



CHRISTIE

SILICON POWER SUPPLIES

Over 200 standardized and militarized models up to 1500 amps... 6 to 135 volts. CHRISTIE'S QUALITY CONTROL is approved by the leading aircraft and missile manufacturers.

Write for
Power Supply Bulletin AC-60
Battery Charger Bulletin BC-60

**CHRISTIE
ELECTRIC CORP.**

3416 W. 67th Street
Los Angeles 43, Calif.

CIRCLE 129 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

button
button
who's
got
the
button?

Push-button frequency selection is one reason why the **TO-258 Telemetry Test Oscillator** is a standard in several major missile programs. This standout performer provides extremely accurate, convenient calibration of sub-carrier units in FM/FM telemetry systems. The unique deviation control is calibrated directly in percent doing away with "slipstick" manipulation. High frequency stability makes the instrument ideal for production testing and other applications utilizing standard FM/FM test frequencies.



Model TO-258
Crosby-Teletronics
Telemetry Test Oscillator

Housed in a gray steel cabinet (17 1/4" x 8 3/4" x 9"), the unit is a full size module in Crosby-Teletronics' Modular Instrumentation System. Rack-adaptor RA-81 available. (Bulletin 249)

Model TO-258 — \$425. Special models can be supplied at extra cost with any 20 frequencies from 20 cycles to 100 KC.

For complete information and specifications, write:

Crosby-Teletronics Corporation

Sales Office:

54 Finkel Street, Westbury 4, L.I., N.Y.

CIRCLE 130 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 20, 1960

Furnace

263

For semiconductors and crystals

Model 60-SC furnace apparatus is for semiconductor preparation and for growing single crystal materials. Consisting of two or more tubular furnaces mounted on a common axis, the apparatus permits zone refining, directional freezing, slow crystallization, seeding, and crystal growing in the quartz work tube.

Marshall Products Co., Dept. ED, 270 W. Lane Ave., Columbus 2, Ohio.

Availability: Depends on applications.

Electric Furnace

264

Provides 300 to 2300 F

Model LP-2472H electric furnace, for use in heat-treating, drawing, and glass annealing, provides controlled temperatures of 300 to 2300 F with the fans removed and 150 to 1875 F with a forced convection fan. Zone gradient control operates by multiple circuits, with each circuit having its own input controller. Gradients are indicated by a pyrometer and thermocouples.

L and L Manufacturing Co., Dept. ED, 804 Mulberry St., Upland, Chester, Pa.

Step and Repeat Machines

265

Speed is up to 350 repeat steps per hr

The Misomex step and repeat machine is for use in the production of dials, name plates, and printed circuits. Designed for single and multi-color, multiple image production as well as photo-composing, the equipment operates at speeds to 350 repeat steps per hour with photographic materials and 70 steps per hour with metal plates. Operation is automatic; a buzzer indicates the completion of each run.

Royal Zenith Corp., Dept. ED, 180 Varick St., New York 14, N.Y.

Vacuum Furnace

266

Continuous firing

Designed for mass volume production, model 3423 continuous-firing vacuum furnace measures 5 x 3-1/2 x 18 ft. The firing chamber is below atmospheric pressure and can be maintained as low as 0.01 micron continuously. The rate of production is governed by the firing cycle. Normal power consumption is 30 kw. It is used in the production of electronic tubes, semiconductors, lamps, and related devices.

Kahle Engineering Co., Dept. ED, 3322 Hudson Ave., Union City, N.J.

THE AMCO MODULAR INSTRUMENT ENCLOSURE SYSTEM



TWO COMPLETELY NEW LINES ADDED IN STEEL AND ALUMINUM TO GIVE 3 COMPLETE MODULAR FRAME LINES IN ONE OVER-ALL SYSTEM

- A Amco Custom Line.** Removable multi-panels and cowlings based on 19" increments of width. Custom, single-unit appearance for frames mounted in series—ideally suited for complex console arrangements. The 19 1/8" width of frame saves space in series mounting of frames. Constructed of double-channel 16 gauge cold-rolled steel. Conforms to EIA mounting standards.
 - B Amco Semi-Custom Line.** Removable multi-width cowlings provide a semi-custom, single-unit appearance for frames mounted in series. Extra rugged, wide box-type channel frames provide greater internal mounting area. 19" wide panels of any thickness can be recessed—from a flush-mounted position to any desired depth. Box type channel construction of 14 gauge cold-rolled steel. Conforms to EIA mounting standards.
 - C Amco Aluminum Line.** This system of aluminum box extrusions and cast corners allows easy assembly of cabinets in any size from 7" to 20" in height, width or depth. Corners and extrusions lock together by hand with built-in locking device. All sizes are standard. Ideal for stocking and odd-ball sizes. Cast and hardened corners of 356-T6 aluminum as described in Federal Spec. QQ-A-596a. Extrusions of 6061-T6 aluminum as described in Federal Spec. QQ-A-270a.
 - D Amco Accessories.** A full line of Amco integrated accessories such as blowers, chassis slides and mounts, lighting, doors, drawers, dollies and many more available for A, B and C shown.
- Cost savings.** All the above—or any part thereof—may be ordered under one combined discount schedule base determined by order dollar value. Orders received at one time with one delivery date may also be combined. Free pre-assembly by Amco provides additional savings in time and installation.
- 3 week delivery on all standard parts.** We welcome inspection of our plant and facilities. Send for your free literature now.

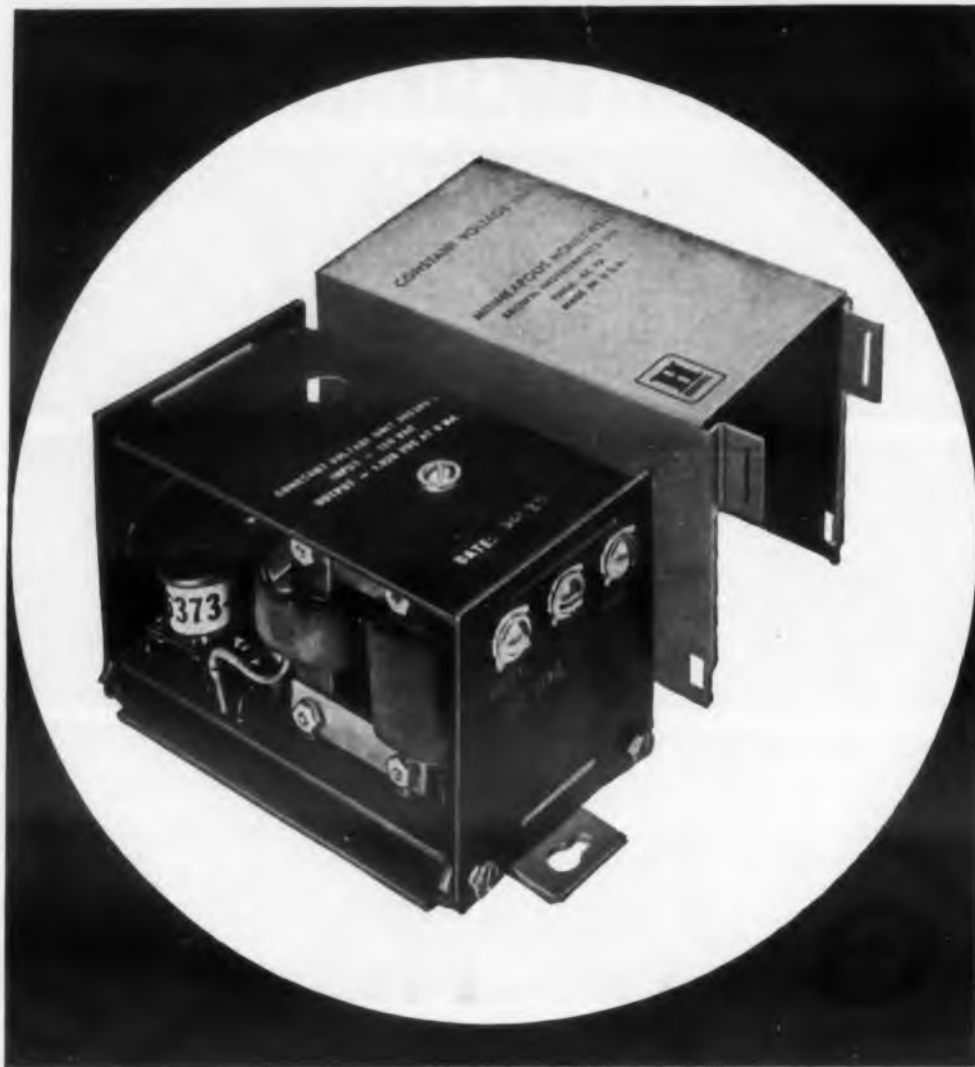


Factory-trained representatives in all principal U. S. cities and in Canada

AMCO ENGINEERING CO.

7333 W. Ainslie Street, Chicago 31, Illinois

CIRCLE 131 ON READER-SERVICE CARD



STABILIZE ELECTRONIC CIRCUITS WITH THIS CONSTANT VOLTAGE UNIT

The Honeywell Constant Voltage Unit supplies extremely stable voltage or current to any electronic circuit. Use it to regulate power to suppression, bridge or measuring circuits, to retransmitting slide-wires . . . or in many other fixed load applications. It can also be used with varying loads at a somewhat lower accuracy.

The unit consists of a step-down transformer to reduce a-c line voltage, a diode rectifier, and a two-stage Zener diode network to regulate voltage. It is accurately temperature-compensated from 0 to 160°F. There are no moving parts, and no adjustment or maintenance is required. It's installed with five simple connections.

This is the same Constant Voltage Unit that has been field-proved in *ElectroniK* potentiometers. Your nearby Honeywell field engineer can give you full details, call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Aves., Phila. 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

ELECTRICAL DATA:

Input	Normal Operating Conditions		
	Nominal Output Voltage dc	Current Rating ma $\pm 0.04\%$	Load Resistance
120 v ac 50-60 cycles	1.029	6	171.5
	1.029	8	128.6
	4.200	6	700.0

ACCURACY:

$\pm 0.03\%$	± 10 v variation from 117 v line supply
$\pm 0.15\%$	± 10 v variation from 117 v line supply and $\pm 55^\circ\text{F}$ variation from base temperature of 85°F

75th
PIONEERING THE FUTURE
YEAR

Honeywell

H First in Control
SINCE 1885

CIRCLE 132 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Soldering Machine

267

For printed-circuit board soldering

Model 197 soldering machine, for laboratory and production use, is especially suited for printed-circuit board soldering. Tip heat is controlled by varying the current and by an adjustable timer. The heating cycle is initiated by a trigger in the soldering gun, eliminating the arcing that causes pitting of the soldered surfaces.

Virginia Electronics Co., Inc., Dept. ED, River Road, and B & O Railroad, Washington 16, D.C.

Annealing Furnace

268

For rare metals wire

This furnace can be used for annealing and straightening of rare metals wire, such as molybdenum, tungsten and gallium. It handles molybdenum wires with diameters of 0.0012 to 0.0079 in., tungsten wires 0.0008 in. and up, and gallium wires 0.0016 in. and up. Furnace operations are done in a protected atmosphere of hydrogen, cracked ammonia and argon. The control panel permits control of protecting gas, cooling water, wire speed and facilitates the reading of meters.

Materials for Electronics, Inc., Dept. ED, 152-25 138th Ave., Jamaica 34, N.Y.

Price & Availability: Available from stock. Can be delivered 30 days after order received. Unit is priced at \$3893, fob N.Y.

Automatic Winding Machine

269

For communication type coils

The Blu-Red automatic winding machine winds radio, TV and communication coils. Intended for high-production runs of universal coils, such as crosswound or lattice type windings, the Model KWA-58 winder has a speed of 200 to 3,000 rpm, steplessly adjustable. Wire diameter ranges from 0.004 to 0.02 in.; coil width can be up to 0.945 in. The maximum core length is 2.75 in.; coil diameter is 2 in., max.

Associated American Winding Machinery, Inc., Dept. ED, 750 St. Ann's Ave., New York 56, N. Y.
Availability: Delivery can be made in 60 days.

Vibration Table

270

Develops 3,000 lb of force

This electromechanical vibration table for environmental testing is designed as a single unit in which the table is directly mounted between two shaker heads. It develops 3,000 lb of force through push-pull operation of two shaker heads,

FAST



. . . accurate

D-C resistance measurements with L&N's 4735 Guarded Wheatstone Bridge

Perform laboratory experiments, make routine resistance measurements or calibrate resistors faster—more accurately—with L&N's 4735 Guarded Wheatstone Bridge.

This advanced instrument has many new features including: high accuracy with a wide operating range . . . guarding of detector circuit to prevent resistance errors due to humidity effects . . . minimizing of thermals by special construction features . . . elimination of tedious plug and block ratio settings due to use of a single rotary switch.

List No. 4735 Guarded Wheatstone Bridge, normally available for delivery from stock.

Range—0.01 ohm to 1,111 megohms.

Limit of Error— $\pm(0.05\% + 0.001 \text{ ohm})$ up to 100 megohms; $\pm 0.5\%$ above.

Rheostat Switches—Five decades of enclosed switches in steps of $10 \times (1000 + 100 + 10 + 1 + 0.1)$.

Multiplier Dial—Eleven-position enclosed switch. Multipliers: 10^{-5} to 10^5 .

Current Rating (of rheostat arm used as resistance box, determined by highest decade in use)—For 0.1Ω , 1.1 amp; for 1.0Ω , 0.35 amp; for 10Ω , 0.11 amp; for 100Ω , 0.035 amp; for 1000Ω , 0.011 amp.

Galvanometer Sensitivity Keys—Three tap keys provide sensitivities of approximately 1, 1/100 and 1/1000. A battery reverse key is provided.

Case—Metal, gray enamel finish; $19" \times 9" \times 7"$ for bench use. Wt. is 13 lbs.

Price—\$475.00 f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Order List No. 4735 from L&N, 4908 Stenton Ave., Phila. 44, Pa.

LEEDS **NORTHRUP**
Instruments Automatic Controls • Furnaces

CIRCLE 133 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

NEW STROMBERG-CARLSON TELEPHONE HANDSET CRADLE



... for positive retention
in all mobile applications

There's no jump, no sway—when a telephone handset is in the firm grip of this new handset cradle by Stromberg-Carlson.

Retaining clip spring assembly assures positive retention in any mobile application on land or sea, or in the air. Even extremely severe jars,

jolts and vibrations fail to dislodge the handset.

The cradle is strong and resilient, fits any Stromberg-Carlson handset. Different models provide varying switch combinations with 2 or 4 Form C contacts. All models available with or without the clip assembly.

Specifications on request. In Atlanta call TRinity 5-7467; Chicago: STate 2-4235; Kansas City: HARrison 1-6618; Rochester: HUBbard 2-2200; San Francisco: OXFord 7-3630. Or write to Telecommunication Industrial Sales, 116 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

permitting equally distributed first vibration as well as a valid picture of complex motion. Enclosed in an aluminum housing, the equipment weighs 5,000 lb. The table measures 33.5 x 78 x 29 in.

Westinghouse Industrial Electronics Dept., Dept. ED, 2519 Wilkins Ave., Baltimore 3, Md.

Spray Etcher 271

Accepts large printed-circuit boards

Model 300 large printed-circuit board spray etcher provides single-sided, single-sided back-to-back, or double-sided etching. The machine is suited for low volume production or prototype etching. The power required is 220 v ac at 60 cps, single-phase. The machine weighs 280 lb and has dimensions of 59 x 25 x 45 in.

Centre Circuits, Inc., Dept. ED, P. O. Box 165, 1101 N. Atherton St., State College, Pa.

Price & Availability: \$4000 ea; finished to customer specs and delivered in two to three weeks.

Vacuum Systems 272

Produce 2×10^{-6} mm Hg

Able to produce a low, ultimate pressure of 2×10^{-6} mm Hg, these vacuum systems are suitable for use in electronics, research and development, and where functional vapor deposition or general high-vacuum processes permit the use of an evacuated chamber with a 14- or 10-in. diameter. Having a 14-in. chamber, the LC1-14B system reaches a working pressure of 5×10^{-4} mm Hg in 3 min with a 4-in. PMC diffusion pump and a 13-cfm mechanical roughing pump. The LC1-18B system reaches a working pressure of 1×10^{-4} mm Hg in 5 min with a 6-in. PMC diffusion pump and a 13-cfm mechanical roughing pump.

Consolidated Vacuum Corp., Dept. ED, 1775 Mt. Read Blvd., Rochester 3, N.Y.

Price & Availability: Model 14B, \$2,795; model 18B, \$3,580. Delivery is from stock.

Bench Welding Head 273

Is air-operated

Designed for production welding of small parts, model WHD 4AP bench welding head is air-operated, eliminating electrode bounce. The electrode pressure is adjustable from 1 to 20 lb. The pressure arm moves in linear ball bushings and has an inertia of 4 oz to insure fast follow-through forging action. The head can be used with stored-energy power supplies rated at up to 200 w-sec or ac welders rated at up to 2.5 kva at welding times to 10 cycles.

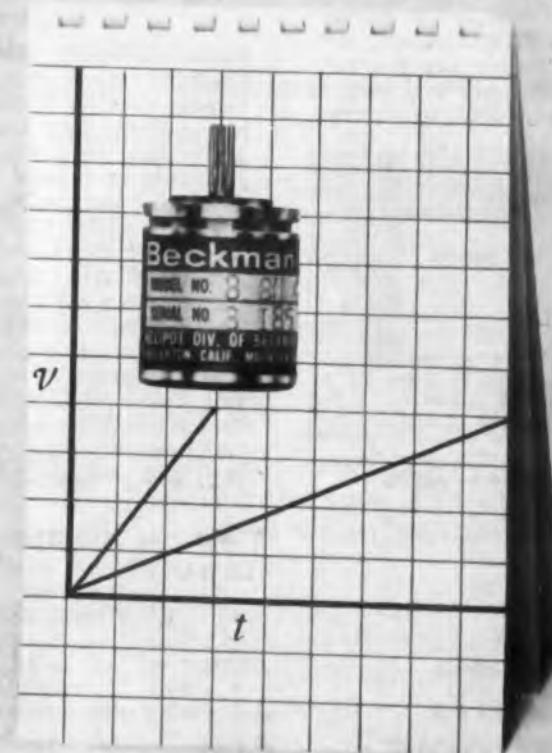
Ewald Instruments, Dept. ED, Kent, Conn.
Availability: Stock to one week.

NEW SIZE 8 SERVOMOTOR RESPONDS 3-TIMES FASTER

These fast response Size 8's have a whopping acceleration of 86,500 rad/sec²...and feature torque at stall of 0.22 oz. in., rotor inertia, 0.18 gm. cm.². That's at least three times faster than any other Size 8's available.

The entire BECKMAN® Size 8 line is available in standard models for 26-volt or 115-volt sources—Servomotors, Inertia-Damps, Velocity Damps, or Servomotor Rate-Generators (special models available for other voltages). For the servosystems man working with 115-volt reference supplies, this can mean an end to accessory gear that so often compounds reliability and cost problems.

At the Breadboard stage? Several BECKMAN® Size 8 and Size 11 Servomotors are available from stock for immediate delivery in prototype quantities. Check with your Helipot rep, write us for the list of stock Servomotors and for the Size 8 and 11 Catalog.



Beckman / **Helipot**

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California



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CIRCLE 135 ON READER-SERVICE CARD

CIRCLE 134 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

Power Supplies

7000 SHORT CIRCUITS WITHOUT A SINGLE FAILURE

*Wide Range Transistorized High Current
Power Supplies Set New High In Reliability*

Con Avionics proves extreme reliability of its zero to 50V rack mounted power supplies with a graphic demonstration at the 1960 I.R.E. Show.

Throughout the Show a new model Z50-15 Power Supply was short-circuited every 30 seconds, yielding a total of 7,000 short circuits without a single failure. Several thousands more shorts were applied during laboratory tests.

The company's new line of power supplies was designed under a "worst case analysis" program. The supplies are designed using standard non-selected components; performance is then mathematically and experimentally checked with the worst possible combination of component characteristics. This design technique is largely responsible for the new high set in reliability and insures long life and easy field maintenance.



"Worst Case Analysis" Program Helps Set New High In Reliability

Specifications

Input Power
Output Voltage
Output Current

Regulation

- a) for line variations
b) for load variation
no load to full load

Stability for 8 hours after 30

minute warm up

Ripple (rms)

Response time

Ambient temperature range

Temperature coefficient (% per °C)

Output impedance at 10 KC (ohms)



Wide Voltage Range, High Current Capacity, Among Electrical Features • The units are available in two series with 0.1% and 0.01% regulation. They have an unusually wide range of output voltage: 0 to 50 V.D.C., and an output current of 2, 5, 10 and 15 amperes.



"Flip Top Box" Permits Accessibility For Maintenance

Mechanical Features Highlight Flexibility •

The new units are constructed with remote sensing to maintain regulation at the load and remote programming to permit output adjustment at remote control point. A floating output is also provided, through which either positive or negative terminals may be grounded. All the power supply units have a voltmeter and an ammeter. The front panel has a power switch, circuit breaker, coarse and fine voltage adjustment knobs, input fuse, pilot light and output terminals. Rear panels have an input line cord, output, remote sensing, and programming terminals.

Y Series

105 to 125 VAC, single phase, 48 to 62 cps.

0 to 50 VDC

2, 5, 10 and 15 amperes

Z Series

± 0.1%

0.1% or 5 mv

(whichever is greater)

± 0.25%

2 mv

50 microseconds

0°C to + 50°C

0.02

0.003

± 0.01%

0.01% or 1 mv

(whichever is greater)

± 0.05%

1 mv

0.01

0.0003

CON AVIONICS

Consolidated Avionics Corporation
800 Shames Drive, Westbury, New York
EDgewood 4-8400

See us
at Wescon:
Booth 2255



CIRCLE 136 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

Environmental Testing

275

A new environmental testing facility instituted primarily as a service to New Hampshire electronics organizations is now available to any firm requesting its service.

Among the environmental conditions that the facility is prepared to simulate are vibration, shock, temperature, salt spray, humidity and vacuum. Testing services that are offered include environmental qualification tests, design evaluation tests, research and development, production sampling tests, test equipment, design analysis and quality control analysis.

The facility is prepared to conduct all tests in strict accordance to customer requirements. Government surveillance of testing will be available when required.

Richard D. Brew & Co., Inc., Dept. ED, Concord, N.H.

Fabricating Finned Type Heat Exchangers

276

This specialized electroforming service deals with fabricating finned type heat exchangers for use as transistor heat sinks or cold plates. The process used permits fabrication of virtually any size plate, either straight through, curved, S type, rectangular, round, or combination cross section, the company claims.

Fin thickness is unrestricted and can be varied from 0.001 in. up. Outer skin thickness also is unrestricted and can be varied from 0.01 in. up. The fabrication process is entirely cold, requiring no brazing, soldering or other elevated temperature operations.

Four metals, or combinations of these basic four are available: Copper, Nickel, Silver and Iron. The service is said to include unlimited design qualifications.

Electroforms, Inc., Dept. ED, 239 E. 165th St., Gardena, Calif.

Ultrasonic Machining

277

Prototype and production shaping of microminiature and other components from hard and brittle materials is now provided through an ultrasonic machining service. The technique requires no contact of the cutting tool with the work, but uses instead high speed vibration of fluid abrasives.

Services offered include: fabrication of micro-module wafers from ceramics and glass; shaping and drilling of ferrite components for microwave and other equipment; manufacture of silicon and

Resistance

up to

100 Million

(1 × 10¹¹)

MEGOHMS!



High Voltage Resistors

From a miniature ¼ watt resistor, rated at 250 volts, to the 100 watt resistor, rated up to 125 KV.

Tapped resistors and matched pairs also available. Low temperature and voltage coefficients.

Few can match—and none can exceed—the stability and performance of rpc HIGH VOLTAGE RESISTORS! Ask anybody who uses them.

Tolerance—15% standard. 10%, 5% and 3% available. 2% in matched pairs.

Further information or engineering assistance gladly supplied.

RESISTANCE PRODUCTS COMPANY

914 S. 13th St., Harrisburg, Pa.

CIRCLE 137 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 20, 1960

be SMART

be sure
you have the
latest data
on one of the
industry's
most complete
lines...



LABORATORY FOR ELECTRONICS
COMPUTER PRODUCTS DIVISION
1079 COMMONWEALTH AVE.,
BOSTON, MASS., Dept. 720-E

Please send me a copy of the new
Ultrasonic Delay Line catalog

Name _____

Title _____

Company _____

Division _____

Address _____

germanium transistor pellets and machining of carbon brushes and bearing blanks.

Materials are machined to required shapes and can be drilled, slotted and broached to meet specific requirements. Dimensional tolerances of ± 0.0005 in. are said to be maintained on sizes of apertures and spacing. Where desired, optical techniques are used to provide surface finishes.

Zenith Optical Corp., Ultrasonic Machining Div., Dept. ED, 1940 Great Neck Road, Copiague, L.I., N.Y.

Technical Abstracts 278

Technical abstracts of articles related to the solid-state and computer fields are now available in journal and card form.

The journal, called SOLID STATE ABSTRACTS, covers articles, U.S. patents, conference papers, and manufacturers' new product releases. A comprehensive subject index and a complete author index are included in every issue. Annual cumulative subject and author indexes are also provided.

The abstracts prepared for the journal are also printed on standard size index cards. Each card contains one or more classification numbers for easy filing. Printed index tabs are provided with each order.

The major categories covered by the service include: Solid state metallurgy, solid state physics, solid state devices, solid state device circuits and solid state device applications. Computer abstracts cover such topics as equipment, programs and mathematics.

Volume 1 of the journal is priced at \$25.00. The abstracts on cards are priced at \$50.00 per category, except for the physics category which is priced at \$75.00. Computer abstracts on cards are priced at \$100.00.

Cambridge Communications, Dept. ED, 238 Main St., Cambridge, Mass.

High-Speed Photo 279

Facilities for a new consulting service on high-speed photo instrumentation have been established. Organized primarily around the applications of the Dynafax and Magnifax cameras, the service will involve taking the necessary personnel and equipment to the customer's plant.

With this service, the company makes available analytical applications with picture-taking rates from 200 to 26,000 frames per second. Charges are being based on \$200 per day for Dynafax, and \$100 per day for Magnifax.

Beckman & Whitley, Inc., Dept. ED, San Carlos, Calif.



Effective component protection is hard to supply under conditions of violent acceleration, high ambient temperature, and vicious vibration. But in military electronic gear, transistors must get unflinching protection against these threats to reliable operation.

They get it, most fully, with **atlee** mounting clips.

atlee clips are provably better in three ways:

HOLDING POWER. Under severe shock and vibration, these clips actually mold themselves tighter to the transistors. There's no visible shifting or twisting, no lead-breaking resonance, and the dislodging force actually increases.

COOLING EFFICIENCY. With **atlee** clips, this approaches to within 10% of "infinity" — the ideal derating curve for a transistor with an infinite heat sink which keeps the case temperature from rising above the ambient level.

ELECTRICAL INSULATION. When required, these clips can be coated with Dalcoat B — an exclusive high-dielectric enamel that has twice the dielectric strength of Teflon but conducts heat as well as mica.

There are still more reasons why engineers who seek perfection choose **atlee** transistor clips. They know that Atlas E-E is the pioneering company in the development of component holders of all types, with unequalled years of specialized experience, and a complete line of clips for all case sizes and mounting requirements. They have learned it costs no more to get the best... and that Atlas E-E makes these "little things" as though they were the biggest things in the circuit.

DESIGN FOR RELIABILITY WITH atlee — a complete line of superior heat-dissipating holders and shields, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.



atlee corporation

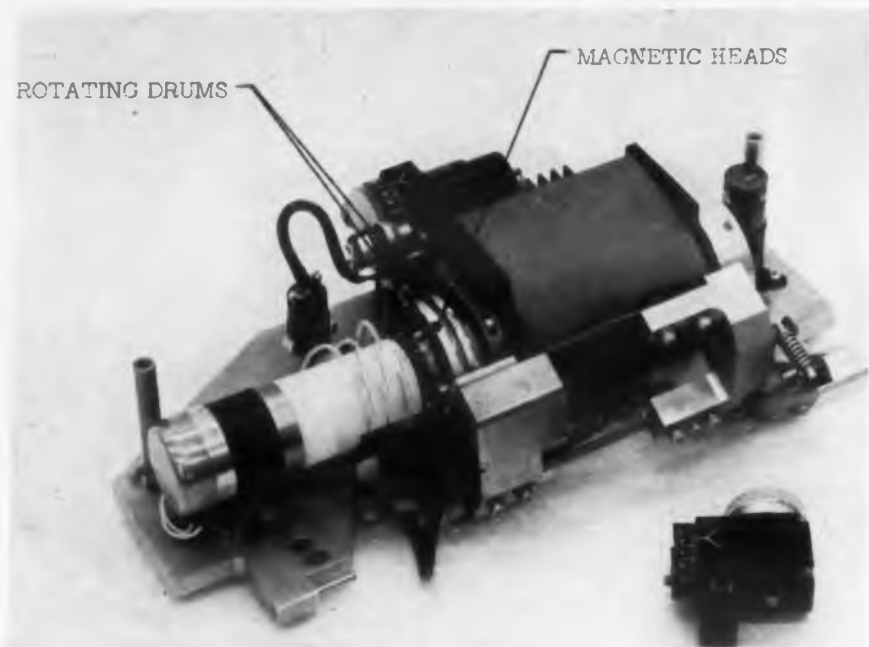
47 PROSPECT STREET, WOBURN, MASSACHUSETTS

CIRCLE 139 ON READER-SERVICE CARD

CIRCLE 138 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 20, 1960

DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.



Exposed head assembly of the 4-mc recorder. Foreground shows tape-quantity meter.



Engineer checks rotating head assembly on airborne wideband recorder.

Performance of Wideband Recorder Boosted

By Transverse Recording, Heated Tape, and DC Monitor Track

THE ART of recording wideband digital information on magnetic tape has been pretty well established. But for analog information, a really wideband recording system makes news.

Designing a 10-cps to 4-mc magnetic tape system, like the one Ampex Data Products Co. of Redwood City, Calif., delivered to Wright-Patterson Air Force Base a few weeks ago, requires sophisticated techniques.

The system, including an airborne AR-300 recorder, and a ground-based FR-700 recorder/reproducer, uses a number of techniques first found in Ampex's Videotape TV recorder.

High Tape-to-Head Speed, Low Reel Speed

Most important of these is the use of transverse recording with rotating magnetic heads. By recording across the width of the tape, rather than along its length, the machine achieves a head-to-tape speed of 1300 ips, while the reel-to-reel speed is low.

Tape velocity is only 12-1/2 ips for recording or playing back one wideband channel for an

hour, or 25 ips for recording or playing back a half hour of two wideband channels.

Small Track Width Ups Information Density

The transverse recording technique uses a narrower track width, so much more information can be recorded on a square inch of tape. Tracks are only 10-mils wide and 15-mils center-to-center. Longitudinal recording usually uses 50-mil tracks on 70-mil centers.

Four Heads Are Better Than One

Transverse recording would, of course, be highly impractical with only one read or write head since the head would contact the tape during only a portion of its rotation. The Ampex units use four tiny heads, mounted on the periphery of a rotating drum, so there is always at least one head in contact with the tape. The heads receive the same information signals. Two drums are used to record two-channel information.

In addition to the eight heads (four on each of

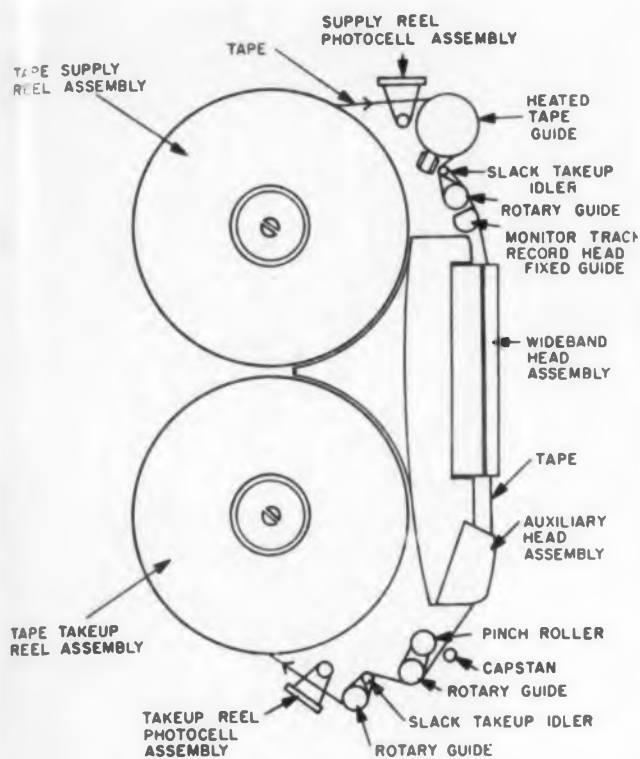
two drums), there are five more. Two are used for auxiliary, low-frequency (200 cps to 15 kc) information; two more are for control tracks; and the fifth provides an unusual monitor track.

Recorder Proves It's Recording By Erasing

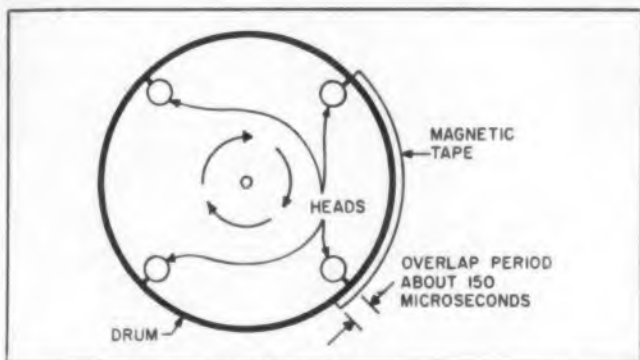
The monitor head, mounted within a tape guide at the entry to the rotating-head assembly, records a saturation-level track on the tape. This dc track is recorded, in conventional fashion, longitudinally along the edge of the tape. Each time a rotating head crosses this track, it generates a signal which lights a lamp on the control panel. The light confirms that the wideband heads are recording.

Equipment-Generated Hot Air Preheats Tape

Since magnetic tape expands as ambient temperature rises, and since an airborne instrumentation recorder must operate in different environments, something must be done to preserve the accuracy in recording information. In conventional



Magnetic heads are spaced around periphery of drum so 2-in.-wide tape is always in contact with at least one head.



Tape-handling components are arranged so tape is heated and dc monitor recorded on it; before it reaches wideband heads.

recording, it is relatively easy. A parallel reference track, with a precisely recorded timing track on it, helps compensate for expansion and contraction of the tape.

Transverse recording requires such an accurate time base, that this technique won't do. Instead, it is necessary to keep the tape at a constant temperature level.

In the Ampex machine, the tape is kept at 60 C by air, heated by the electronic equipment and circulated through a tape guide mounted on the tape transport. The tape is at the proper temperature before it reaches the rotating heads. The heating protects the head from further temperature shock at other critical points in the tape-handling sequence.

The heating process is necessary because the tape reel may be quite cold when placed in the transport and, with its 8-lb mass, it would tend to remain cold. ■ ■

3 good ways to make dc measurements

KEITHLEY ELECTROMETERS have up to **64** voltage, resistance and current ranges

1 Model 610A, 64 ranges

The line-operated 610A is a refinement of the popular 610, covering virtually every dc laboratory test. It measures nine voltage ranges from 0.01 to 100 volts full scale with 2% accuracy, current from three amperes to 1×10^{-13} ampere full scale, and resistance from 10 ohms to 10^{14} ohms full scale. The 610A also serves as a useful dc pre-amplifier with precise gains to 1000 and outputs for driving scopes and recorders. Input resistance is variable from one ohm to over 10^{14} ohms. The instrument checks its own resistance standards. Zero drift is within two millivolts per hour.

\$480.00



2 Model 600A, 54 ranges

This portable instrument is a battery-operated counterpart of the 610A. Its ranges cover 10 mv to 10 volts, 3 amperes to 10^{-13} ampere, and 10^4 to 10^{13} ohms full scale. Like the 610A, it has selectable input resistance, a dc to 100 cps bandwidth, and output sufficient to drive recorders directly. Battery life is 500 hours; condition may be checked on the panel meter.

\$380.00



Three accessory probes and test shield are available to facilitate measurements and extend voltage ranges to 30 kv (Model 610A) or 10 kv (Model 600A).

3 Model 603, differential input

This instrument is a wide-band dc amplifier, with an extremely high input impedance, high voltage and current sensitivity, and a remote differential input. Its separate input head permits measurements up to 24 feet from the amplifier. The 603 has nine ranges from 2.5 to 1000 mv, with precise gains up to 4000, and a 10-volt output at 10 ma. Bandwidth is dc to 10 kc on the 2.5 mv range, rising to 30 kc on the 1000 mv range.

\$650.00

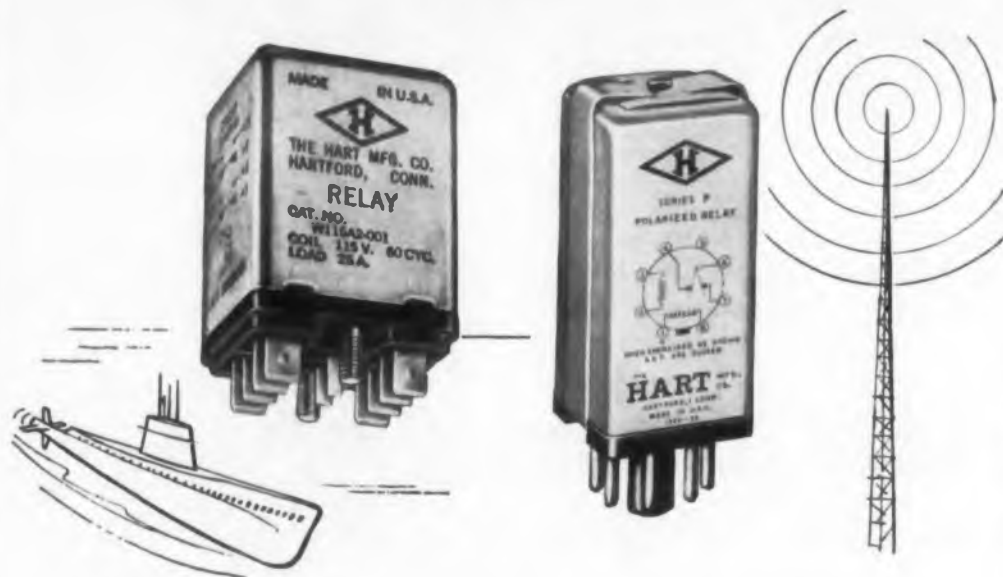


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Punched Cards Program Diode Function Generator

The use of king-sized punched cards to program a diode function generator yields several important advantages. Most obvious of these is that the computer need not lie idle while a new program is being prepared on a separate card punch. Functions may be pre-programmed on these punched cards and stored till needed.

The function generator is programmed as its door is closed over a punched card. Spring-load plungers in the door pass through appropriately punched holes in a card to actuate subminiature switches.

Eight switches are mounted on each of 22 circuit cards which also include plug-in precision



Unique contact head reads 80 holes on punched tape at one reading, obviates buffer memories.

resistors. Since switch contacts are solid gold and all connector contacts are gold plated, the function generator can be used for very low signal levels.

Using fixed precision resistors rather than potentiometers, the generator provides an accuracy of 0.1 per cent with long-term repeatability of 0.02 per cent. The diode function generator is manufactured by General Computers, Inc., 9000 W. Pico Blvd., Los Angeles .

Powerless Pilot Lamp Glows Even in Bright Daylight

In most instruments, the power consumed by a pilot lamp is negligible. But in battery-operated, transistorized equipment, pilot-light power consumption can be an important part of the battery's load.

Hewlett-Packard's solution to this problem eliminates pilot-light drain completely. In the H-P 456A Current Probe, the "pilot light" is a tab of light-reflecting red tape. When this tran-

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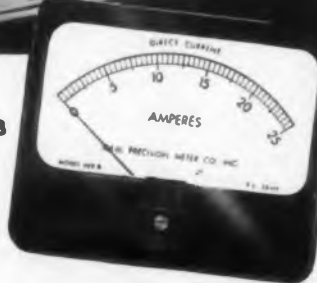
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Light-reflecting red tape, pivoted into position by on-off switch, serves as powerless pilot lamp.

sistorized instrument is switched on, the tape appears behind a clear plastic jewel.

At first glance, anybody would believe that this "pilot lamp" is the real thing—except for one fact, its glow is bright even in daylight.

Female PC Cards Improve Computer Maintainability

Plug-in printed-circuit cards normally come with male connectors. But when a pc connector fails, it's usually the female end that has the trouble. Recognizing this, engineers at Remington Rand's Univac Div. have mounted female connectors on all the plug-in cards in the Univac Larc and in Univac III.

Hence, when there's a defective connector, the chances are greater that the computer can be kept going by a substitute card.



Female connector (more likely to fail than male) is mounted on plug-in card in Univac III and Larc computers rather than in equipment rack.

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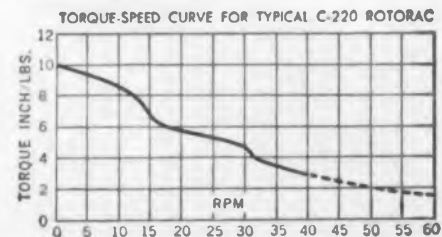
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Output torque is transmitted from the armature through a unique



Standard C-220 adjusted for 20 rpm $\pm 20\%$ at 6 in.-lb. Speed may be adjusted for other load points. Curve is based on 115 v a-c and 400 ma.

rapid-action, one-way clutch to the output shaft, resulting theoretically in a very rapid start-stop rotation. Under very light loads, however, the inertia of clutch and output shaft is sufficient to cause practically uniform rotary motion. Under heavy loads, or with the addition of detenting action, the motion is of a stepping type where full torque is delivered and complete stopping obtained within each half of an a-c cycle. Because of this start-stop motion, the starting torque and the running torque of the motor are approximately equal.

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NEW LITERATURE

Tantalum Capacitors 280

Bulletin No. 159 furnishes information on the firm's TS Series capacitors, which meet military specification MIL-C-3965B for tantalum slug electrolytic capacitors, styles CL44 uninsulated, and CL45 insulated, case size T1. Ohmite Manufacturing Co., 3693 Howard St., Skokie, Ill.

Microwave Data Sheets 281

The firm is currently issuing a series of approximately 60 two-page data sheets covering over 1000 coaxial and microwave test components available from stock. Physical and electrical specifications, dimensional drawings and price are given for each model. Omega Laboratories, Inc. Haverhill St., Rowley, Mass.

Thermistors

This 39-page data book discusses theory, construction, operating characteristics and applications of thermistors and varistors. Voltage-current and temperature-resistance curves and tables for the firm's line of thermistors are provided. Several circuits utilizing thermistors are suggested. Varistors and related devices are similarly, but more briefly, considered. For VECO Data Book, send \$1.00 to Victory Engineering Corp., Springfield Road, Union, N. J.

Insulating Parchment 282

Electrical and physical specifications, comparison with other insulating papers, samples and prices of Patapar insulating parchment are included in this brochure. Paterson Parchment Paper Co., Bristol, Pa.

Rotary DC Solenoids 283

This six-page brochure illustrates five basic frame sizes of rotary solenoids with detailed specifications, dimensional drawings, typical torque characteristics, applications and special design features. PSP Engineering Co., Dept. RS, Maywood, Calif.

Pressure Instruments 284


This four-page short form brochure, No. S-60-1, lists operating specifications, design requirements, dimensions, weight and accuracy of the firm's lines of pressure transducers, rectilinear potentiometers and pressure switches. Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif.

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CIRCLE 902 ON CAREER INQUIRY FORM, PAGE 169

ELECTRONIC DESIGN • July 20, 1960

Epoxy Pellets 285

This four-page bulletin, No. 3, on epoxy E-Form pellets for electronic components discusses the variety of pellet compounds available and various epoxy packaging techniques. The illustrated bulletin also considers typical application and previous use of the pellets in packaging resistors, diodes, transistors, capacitors and coils. Epoxy Products, 137 Coit St., Irvington, N. J.

Precious Metals 286

Gold, silver and platinum-group metals in various solid, clad and cored mill forms are described in this six-page brochure, "Precious Metals for Industrial Applications," GP-22. Size, composition and application of strip, tubing, wire, brazing alloys, waveguide tubing, thermocouple wire, electrical contacts and semiconductor components are described. Texas Instruments Inc., Metals and Controls Div., 34 Forrest St., Attleboro, Mass.

Reactive and Precious Metals 287

Temperature characteristics of reactive and precious metals are tabulated in this four-page pamphlet. The firm's ability to prepare the metals in wire and sheet form is described and illustrated. Consolidated Reactive Metals, Inc., 115 Hoyt St., Mamaroneck, N. Y.

Epoxies 288

Among the applications of the firm's line of tooling plastics suggested in this eight-page illustrated brochure are blow core boxes, loose pieces, spotting slugs, match plates, core sticks, cope and drag patterns, fillet pastes and pattern coating resins. Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Calif.

Heating and Cooling Coil 289

Two-page bulletin suggests application of Panel-coil for heating or cooling flat or curved surfaces. Available shapes and sizes of eleven embossed panels are illustrated and described. Dean Products, Inc., 616 Franklin Ave., Brooklyn 38, N. Y.

Thermistor and Varistor Kits 290

Kits intended to acquaint engineers with a variety of thermistor and varistor applications are described in this two-page data sheet, No. SE 102. The sheet lists the contents of seven kits with electrical characteristics of the components. Victory Engineering Corp., 519 Springfield Road, Union, N. J.



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NEW LITERATURE

Transistorized Chopper 291

Several applications of Chopperettes, circuits and typical characteristics included, are suggested in this four-page data sheet, V383. Size, electrical characteristics and environmental data on the firm's miniature silicon and germanium choppers suitable for missile application are included. Victory Engineering Corp., 519 Springfield Road, Union, N. J.

Tubes vs. Transistors 292

A 64-page treatise described as "a compendium of current information on the characteristics and capabilities of vacuum and solid-state devices," "Tubes and Transistors: A Comparative Study" discusses the advantages and limitations of both components in specific applications. Electron Tube Information Council, 554 Fifth Ave., New York 36, N. Y.

Recording Spectrophotometer 293

In 12 pages this bulletin, No. GEZ-3031, describes the operation and application of the firm's recording spectrophotometer with built-in automatic tri-stimulus integrator and accessories. The machine measures and records the colors of materials. Optical, physical and electrical specifications are included. General Electric Co., Schenectady 5, N. Y.

Dielectric Test Bridge 294

A dielectric test bridge developed in West Germany is described in this four-page illustrated bulletin, No. 352000. The bridge, Type VKB, determines the dielectric constant and dissipation factor of solids and liquids at frequencies of 50 to 300,000 cps and capacitances of 10 to 1000 pf. Electrical specifications as well as dimensions are given for the bridge and five auxiliary units: an extension unit, a guard-ring type capacitor, two liquid specimen containers, and a wire test jig. Rhode and Schwarz Sales Co., Inc., P. O. Box 275, Passaic, N. J.

Glass-to-Metal Terminals 295

The company's series of hermetically sealed compression terminals is described in this six-page bulletin No. SCT-60-101. Dimensions, voltage and current capacities, installation data and allowable gap spacing curves are given for the line. Electrical Industries Div., Philips Electronics and Pharmaceutical Industries Corp., 691 Central Ave., Murray Hill, N. J.

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Phenolic Molding Materials 296

Two versatile and fast-curing Bakelite phenolics are described in the six pages of Molding Technical Release No. 40. Plunger molding applications, necessary temperature conditions and physical properties are discussed in textual, tabular and graphic form. Union Carbide Plastics Co., 30 E. 42nd St., New York 17, N. Y.

Aluminum Foil Capacitors 297

Operational factors covered in 8-page bulletin, No. 81558, include dc leakage current, dissipation factor, capacitance and tolerance, operating temperature range, dc working voltage rating and surge voltage on miniature and sub-miniature aluminum foil capacitors. Separate standard rating and selection charts are listed according to size and voltage rating. International Electronic Industries, Inc., Box R-23, Nashville, Tenn.

Precision Potentiometers 298

This four-page data sheet describes the firm's Series 7230, 10-turn precision potentiometers for servo mounting. Included in data sheet No. 60150 are complete preliminary specifications, environmental characteristics, coil data, dimensional drawings and photographs. Helipot Div. Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif.

Potentiometers 299

This two-page data sheet contains electrical, environmental, and physical characteristics on the firm's Model 215 Trimpot potentiometer. Detailed size specifications are included. Bourns, Inc., Trimpot Div., P. O. Box 2112, Riverside, Calif.

Microwave Insulation 300

This single-page data sheet gives electrical, physical and chemical properties of Rexolite 2200, a thermosetting plastic insulation for use at ultra high and microwave frequencies. Rex Corp., Hayward Road, West Acton, Mass.

Glass Capacitors

This four-page bulletin describes fusion sealed CYF capacitors designed to withstand extreme environments. Electrical, physical and environmental characteristics are given. Operational curves are included. For Reference File CE-1.01—CYF Capacitors—write on company letterhead to Corning Glass Works, Dept. ED, Electronic Components Dept., Bradford, Pa.

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IDEAS FOR DESIGN

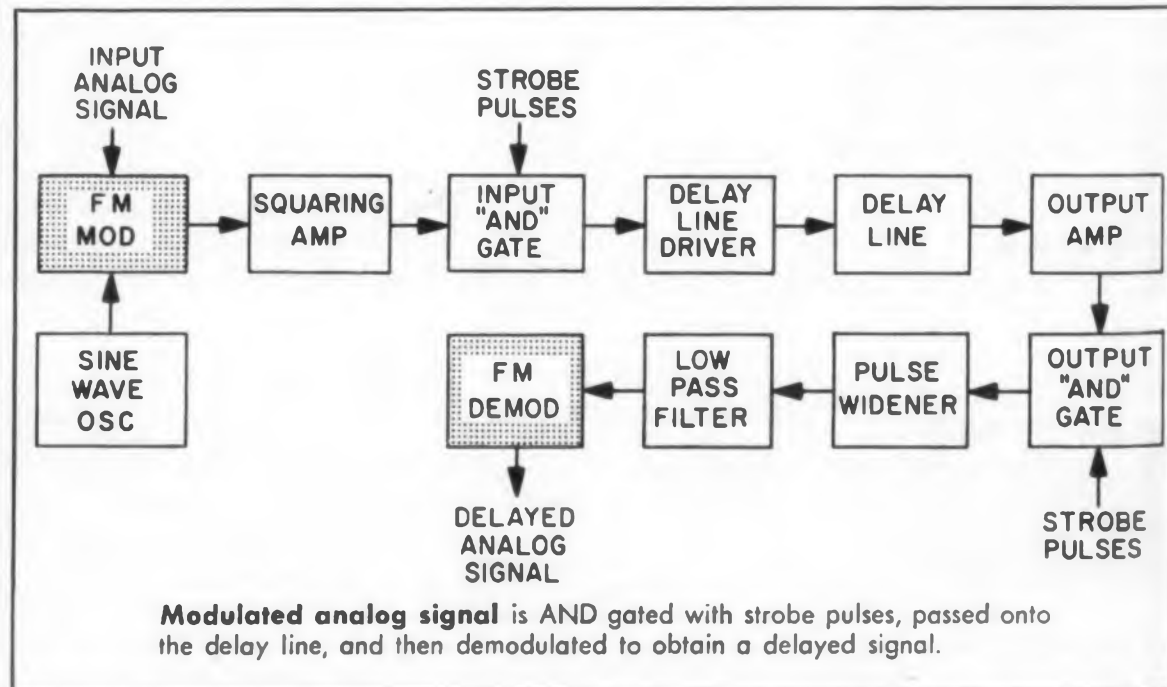
Get \$10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Digital FM Technique Delays on Magnetostrictive

DELAY of an analog signal by a magnetostrictive line can be accomplished with the digital FM technique outlined in the block diagram. This technique avoids several of the disadvantages of the more conventional delaying methods.

Conventional Methods Employ AM, FM, or PCM

An analog signal can be delayed by a magnetostrictive line by amplitude or frequency modulating either a pulse or a sine-wave carrier. Although simple to apply, these methods suffer because the signal distortion and noise factor grow progressively worse with increasing delay time. These disadvantages can be eliminated by using the digital techniques of pulse code modulation (PCM). In a PCM, system distortion and signal-to-noise ratio are independent of time de-



Analog Signal

Line

lay. They are functions only of the characteristics of the pulse code modulator and demodulator. However, for these characteristics to be acceptable, it is necessary to use many quantizing levels. This requires unduly complicated terminal equipment.

Analog Signal AND-Gated With Strobe Pulses

The digital FM technique outlined here is midway in design complexity between the simple analog methods and the PCM system. Referring to the block diagram, a sine-wave oscillator is frequency modulated by the input analog signal. The modulated output is first squared and then sampled in an AND gate by digital strobe pulses. The repetition rate of the strobe pulses is at least twice the frequency of the highest sideband in the modulated signal.

The pulses from the AND gate pass into the delay-line driver where they are shaped for transmission along the delay line. The received signal from the delay line is amplified and strobed in an output gate. Then the pulses are widened before being sent through a low-pass filter to recover the frequency modulated signal. This signal is then fed to a frequency demodulator the output of which is a delayed replica of the input analog signal.

The maximum analog bandwidth which can be delayed is a function of the peak digital frequency at which the delay line can be operated. There are commercial delay lines available which can operate at a frequency of 5 mc in a non-return-to-zero (NRZ) mode. If such a delay line is used, the maximum bandwidth of the entire modulated signal including the carrier and all sidebands is limited to 2.5 mc.

Arthur Rothbart, Consulting Engineer, New York, N. Y.



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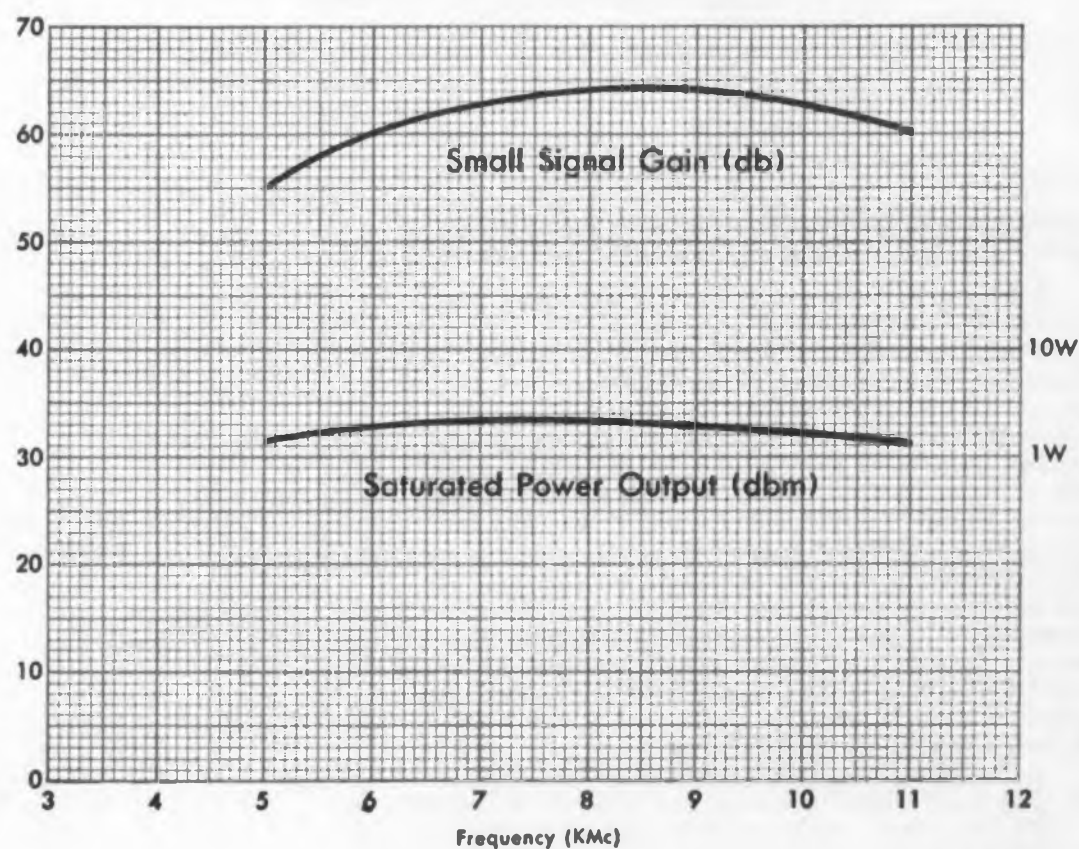
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General Performance Characteristics
Eimac X778 Traveling Wave Tube



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MHX ventilated cabinet with heavy duty dolly. Note adjustable rear chassis-slide mounting rail, center stiffener on rear door, louvered top.



Rear view—same cabinet. Note recessed stainless steel handle, lift-off door, clean-cut design.

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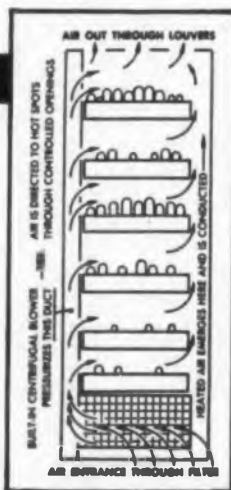
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SCHEMATIC OF AIR FLOW IN VENTILATED MODELS

IDEAS FOR DESIGN

Copper Laminate Board Ideal for RF Breadboarding

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Robert H. Pickard, *Electronic Scientist, Goddard Space Flight Center, U.S. Naval Station, Washington, D.C.*

Tunnel Diode Is Sensitive Level Detector

We needed a voltage level detector which would switch over within 50 mv of the reference level. It had to operate at 1 mc. Several different types of Schmitt trigger circuits were designed,

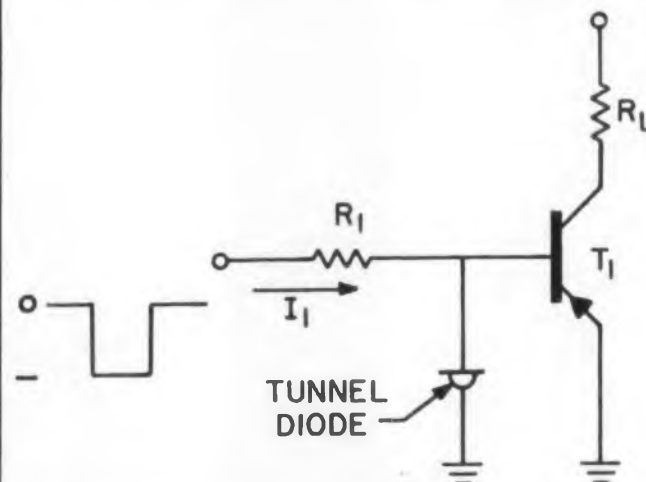


Fig. 1. The tunnel diode sets the voltage level at which transistor *T* will be switched on.

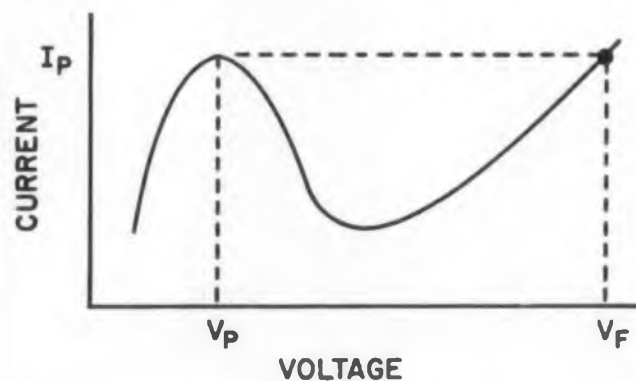


Fig. 2. Tunnel diode voltage-current characteristics.

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but these all had unstable switching regions of 0.1 v or more.

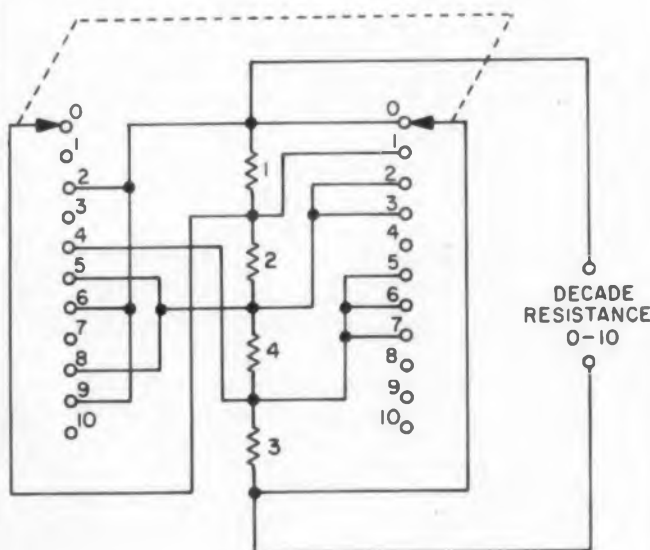
The desired operation was achieved by using a tunnel diode as the level detector, Fig. 1. The diode's voltage-current characteristic is shown in Fig. 2.

Before I_1 reaches I_p , the diode is conducting and has less than V_p volts across it. V_p is not enough to turn the transistor on. However, after I_p is reached (0.05 v) the diode breaks over to voltage V_f . This voltage is great enough to turn the transistor on. The tunnel diode not only is an excellent level detector, but also limits the saturation of the transistor. This reduces the storage time and allows faster pulse operation.

J. F. Martin, Design Engineer, Stromberg-Carlson Co., Rochester, N. Y.

Four-Resistor Decade Uses Standard Rotary Switch

Here's a resistor decade we set up using four resistors and a common two-section, two-pole, 11-position rotary switch. A special decade rotary switch is not required. The resistor values are in the indicated ratios.



Ralph U. Moody, Design Specialist, Lockheed Missiles and Space Div., Van Nuys, Calif.

Switched Figures Corrected

Figs. 1 and 2 in the Idea for design "Log-Log Slide Rule Converts Voltage, Power Ratios Directly to Db" (ED, May 11, p 231) were inadvertently reversed. Fig. 1 should be used for power ratios and Fig. 2 for voltage ratios.

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CIRCLE 915 ON CAREER INQUIRY FORM, PAGE 169



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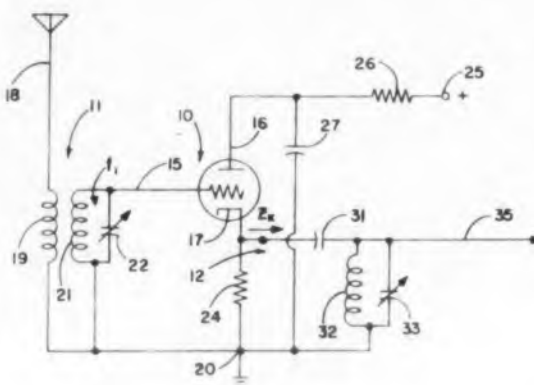
PATENTS

Benjamin Bernstein

RF Amplifier

Patent No. 2,934,711. S. L. Dawson (Assigned to Collins Radio Co.)

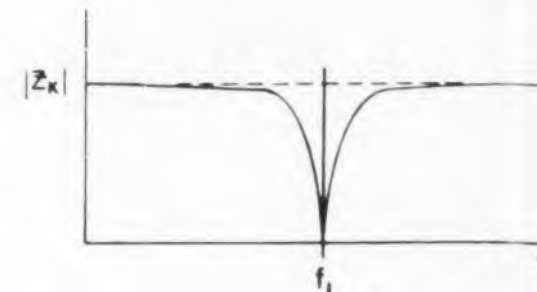
Adaptable in the first amplifier stage of a radio receiver, this circuit provides 50 db suppression of adjacent channel cross-modulation, has a low noise figure



and provides a high gain in the 3- to 7-mc range.

The invention lies in the application of a cathode-follower amplifier, of which

matched low-impedance load changes very rapidly on either side of the desired carrier frequency f_1 . Capacitor 31 is series-resonant with the shunt resonant combination of inductance 32 and capacitor 33. Off resonance, the mismatch



of cathode and load impedance is so severe that signals are sharply attenuated by the high inverse feedback. However, at resonance the matched condition favors optimum power transfer to the load. Neutralization is not required.

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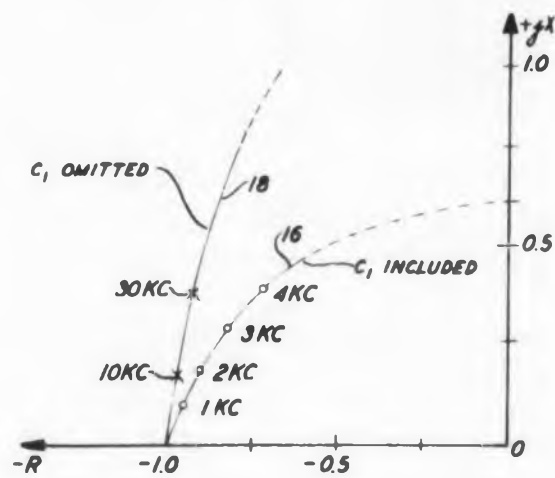
ELECTRONIC DESIGN • July 20, 1960

Negative Impedance Circuit

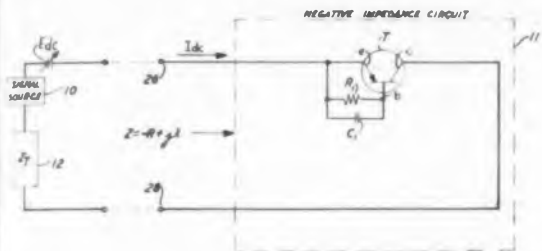
Patent No. 2,936,431. R. Guenther (Assigned to Bell Telephone Labs).

The negative impedance characteristic of a transistor operating in the avalanche breakdown region may be shaped by an RC network connected between the emitter and base electrodes. This insures stability of the circuit outside the desired frequency range.

In the circuit shown, the transistor's emitter and collector are the terminals of a two-terminal negative impedance circuit. The transistor is adjusted by E_{dc} to



operate in its avalanche region. With capacitor C_1 removed, the negative resistance characteristic 18 slowly changes to positive resistance at about 100 kc. However, with capacitor C_1 , the characteristic 16 may be shaped to develop positive resistance within the audio frequency range.



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BOOKS

Industrial Electronics and Control

Royce Gerald Kloeffler, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 540 pp, \$10.00.

Aimed at the undergraduate engineering student, this book tries to meet the requirements of those who desire a knowledge of industrial electronic applications. No attempt is made to present a quantitative approach to the design of electronic circuits. Rather, a survey is given of the theory and applications of electronics in industry.

The early chapters of the book are prepared for the student whose training has not included the basic theory of semiconductors and electron tubes. The material begins with the theory of solid state conduction and leads to the theory of rectification and amplification with semicon-

ductor devices, transistors, diodes, etc.

Industrial electronic devices using both semiconductors and vacuum tubes are next discussed. Chapter headings include: Components and Circuits for Control, Principles of Control and Servomechanisms, Electronic Operation of Direct Current Motors, X-Ray Applications, and Principles of Electronic Computers.

The volume is profusely illustrated and includes problems and a reference list at the end of each chapter.

Radargrammetry

Daniel Levine, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 330 p, \$12.00.

Radargrammetry is the science of obtaining reliable measurements by means



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of radar. This text analyzes the sources of error found in real radar displays. It outlines a unified system design for keeping individual errors within bounds necessary to meet an over-all system performance.

Using cartographic principles the book correlates radar display with different map projections. It shows how this correlation is applied to map-matching, including navigation, air-traffic control, weather surveillance, and long-range plotting boards for air defense, bombing, and missile guidance.

Basic design considerations for achieving cartographic accuracy are stressed. Covered are such topics as image motion compensation and antenna stabilization, ground-range sweep over a spherical earth, the theory of radar return, and errors in radar systems influenced by navigational equipment and the airframe. Other sources of error described are the influence of noise in positioning accuracy, the effect of the earth's magnetic field, and shading on the cathode-ray tube.

The book treats modern advance such as the theory of linear apertures for opti-

cal systems as expounded by Schade, and Swerling's analysis of angular accuracy of a pulsed radar system. The work of Enenstein and Bailin on transient build-up of antenna patterns is applied to determine the minimum ground area resolved by a linear array.

Applications of Electronics

Bernard Grob, Milton S. Kiver, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y. 628 pp, \$7.00

Designed specifically for servicemen and technicians, this volume discusses principles and equipment for many of the specialized fields of electronics and communications.

Circuits and equipment are described for amplifier and rectifier circuits using electron tubes and transistors, oscillator circuits including microwave tubes, receivers and transmitters, industrial electronics, electronic navigational aids, test equipment, and military electronics. The approach to these topics is largely practical and mathematics is kept to a minimum. The text is illustrated throughout with circuits and photographs.

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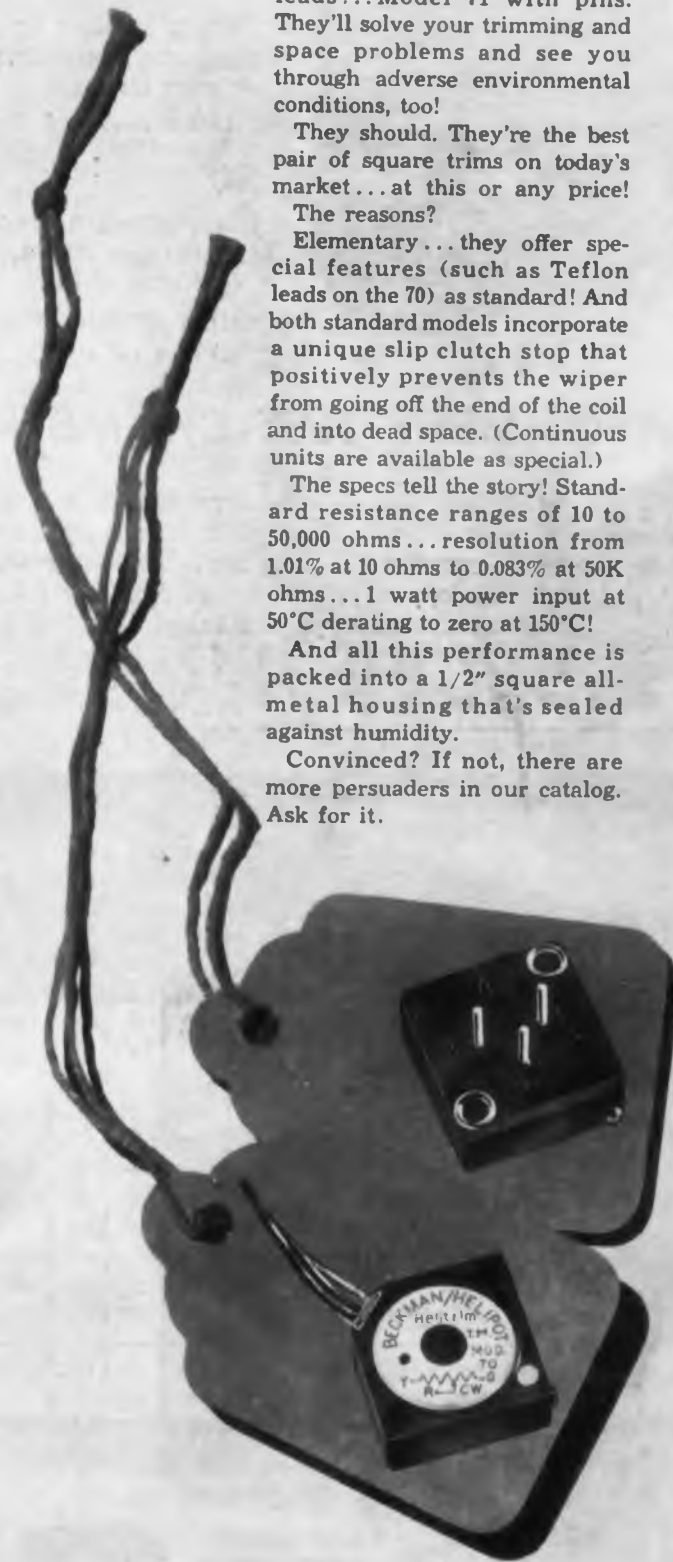
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B .001—20MF	600—20KV	-55°C +70°C	.02% 1KC	+800 PPM	10' MEG	1.0%	3.00%
C .001—20MF	100—30KV	-55°C +200°C	.02% 1KC	-50 PPM/C	10' MEG	0.1—	0.01%
D .0001—20MF	100—60KV	-55°C +125°C	.5% 1KC	+500 PPM	10' MEG	1.0%	0.10%

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BOOKS

Encyclopedia Dictionary of Electronics And Nuclear Engineering

Robert I. Sarbacher, Prentice-Hall, Inc.,
70 Fifth Ave., New York 11, N.Y., 1417
pp, \$35.00.

This encyclopedic dictionary, a comprehensive reference work in electronics and nuclear engineering, is designed for the scientist, technician, or student working in these related fields. It is a readily usable dictionary of the specialized vocabulary which does not fall within the scope of general dictionaries of the English language. The author claims that this is the only single source which provides all the standard definitions approved by official technical societies. Authorized Armed Forces definitions and abbreviations, and designations of all military establishments concerned with electronics and nuclear engineering are included. In many instances, pertinent supplementary information is provided in addition to the basic definition of a term. Terms from elemental electric and magnetic theory and atomic physics are given, as well as

a number of definitions from the broader principles of physics. Extensive cross-referencing is provided so that related entries may be studied and compared or contrasted. Where helpful, detail drawings and circuit diagrams are provided to aid in describing the terms.

Mathematical Methods for Digital Computers

Anthony Ralston and Herbert S. Wilf,
John Wiley & Sons, Inc., New York City,
293 pp.

Digital computer techniques for solving mathematical equations and analysis methods are described in this multi-authored text. It presents many of the more commonly used tools of the numerical analyst, along with some of the more promising, newly developed procedures. In effect, it is a partial survey of modern numerical methods and computer capabilities for their solution.

Each chapter is divided into several separate sections and each section has been authored by an individual working in the field. Sections follow a standard format—giving in order the purpose of the

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program, a mathematical analysis of the problem, the calculation procedures to be used, a detailed computer flow chart, the memory requirements, an estimate of running time and a list of references. Chapter headings include: Matrices and Linear Equations, Partial Differential Equations and Statistics. Chapter sub-sections deal, in part with various Monte Carlo methods, Fourier Analysis, auto correlation and spectral analysis, elliptic and hyperbolic differential equations.

Quantum Electronics—A Symposium

Edited by Charles H. Townes, Columbia University Press, 2960 Broadway, New York 27, N. Y., 606 pp, \$15.00.

In recent years, physics and electrical engineering have moved closer together as a result of intensive study of quantum phenomena at radio and microwave frequencies. A new field has emerged from the interaction of these two disciplines—quantum electronics. This book is a result of the international conference on Quantum Electronics—Resonance Phenomena which was held in September, 1959. "The wide variety of interests represented

here," writes the editor, Dr. Charles H. Townes of Columbia University and the inventor of the maser, "provides an opportunity for clarifying and unifying basic ideas which are common or may become common to both disciplines, for discussing recent developments, and possibly for preliminary examination of areas where important research developments may be expected in the future."

Papers discussing recent developments in masers, atomic clocks, paramagnetic resonance, optical pumping, parametric amplifiers, the application of very sensitive amplifiers to radio-astronomy, and quantum effects in amplifiers and communication are presented which give a comprehensive view of current research. For greater unity, summarizing papers on the principal topics of the conference are in most cases followed by related specialized papers.

To increase the usefulness of this book to electrical engineers, to physicists, to libraries, and as a general reference, much of the discussion which followed each paper has been included in the present volume.

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RUSSIAN TRANSLATIONS

J. George Adashko

Decade Counting Circuit

THE DECADE counting circuit of Fig. 1 was recently designed at the Leningrad Institute of Precision Mechanics and Optics. The counter is reset on the tenth input pulse by a triode, T_1 , connected between the first and fourth binaries. All other interconnections are made with double diodes as in ordinary scaling devices.

In discussing the operation of the circuit, the "zero" binary state will mean that the left hand triode is conducting while the right hand triode is cut off. The "one" state will refer to the opposite condition. Note that the control grid of the

triode is connected through R_1 to B_{4a} . The inputs to B_4 are separated, with anode a connected to the output of B_3 and anode b connected to the output of B_1 .

Circuit Counts Normally to 9, Resets at 10

The circuit operates as follows: As long as B_4 is in the "0" state (number of input pulses is less than 8), a high positive potential is applied to the grid of T_1 . Thus the negative pulses from B_{1a} pass freely to B_2 . Although grid current is drawn, there is no interaction between B_4 and the triode

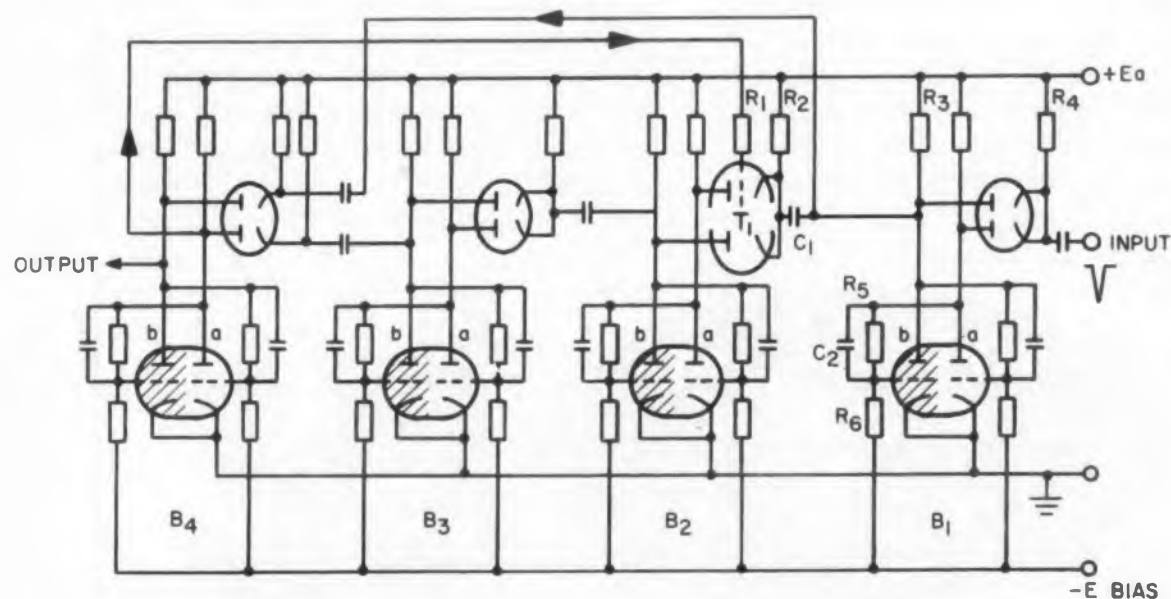


Fig. 1. Voltage level fed back from B_{4a} to triode grid helps to reset binary counter after tenth input pulse.

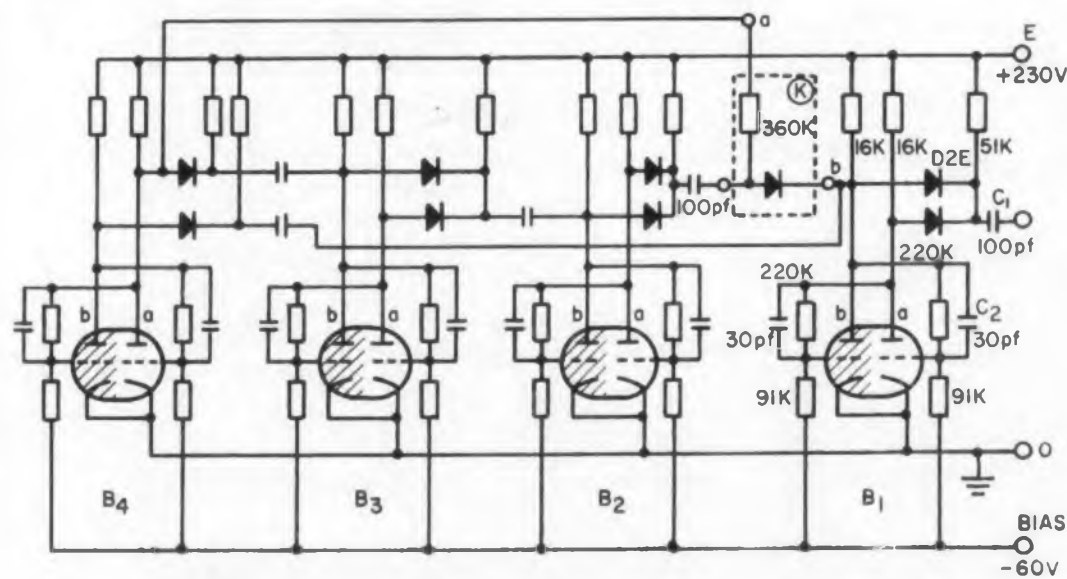


Fig. 2. Version similar to Fig. 1 uses semiconductor diodes as the coupling elements.

because R_1 is much greater than R_3 . Until the count 0111 inclusive is reached, the circuit operates as an ordinary binary counter.

At the 8th pulse, the circuit is set to state 1000 and the grid of the triode is at low potential. At the ninth pulse B_1 flips over into the "1" state and the binaries indicate 1001.

With the tenth pulse, B_1 changes to the "0" state and its output voltage (from P_{1b}) drops to the same low level as the grid voltage of T_1 . However, the negative pulse fed to the cathode of T_1 , is too small to be passed on to B_2 . Thus, B_2 will still remain in the "0" state after the tenth pulse.

Also on the tenth pulse, B_1 sends a pulse to P_{4a} which flips that binary into the "0" state, unblocking T_1 . However, although the triode can now conduct, the sharp pulse front from B_{1b} has passed and B_2 remains in the "0" state.

Thus, after the tenth pulse, the decade counter returns to the 0000 state and is ready to count the next ten pulses.

The principal advantage of this circuit is that it can be readily assembled from available binaries without any additional calculations and investigations. If the binaries and coupling elements are adjusted for operation in an ordinary binary scaling circuit, they will be fit for this counter.

Second Version of Counter Uses Semiconductor Diodes As Coupling Elements

Another version of the decade is shown in Fig. 2 where semiconductor diodes are used as the coupling elements.

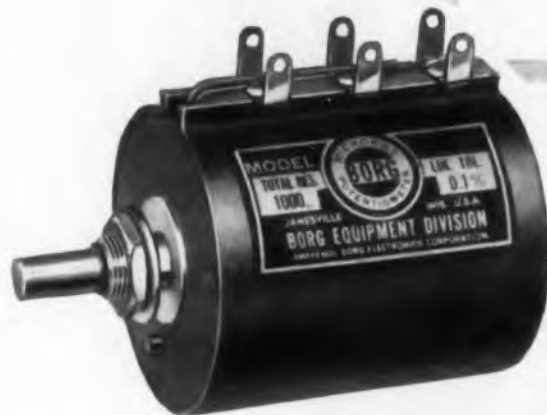
Again, the decade has three binaries with common inputs and one binary, B_4 , with separated inputs. The coupling between B_1 and B_2 is through the control diode K (shown in the dotted rectangle). This diode replaces the triode of Fig. 1. The voltage for the control diode is applied from the right anode of B_4 to the anode, b , of the diode. If B_4 is in the "1" state, the low voltage on its a anode keeps the control diode open. When binary B_4 is set in its "0" state the high voltage level on its right anode closes the control diode and the coupling between B_1 and B_2 is uninterrupted. On the tenth pulse B_4 is reset to zero directly from the output of B_{1b} .

The decade counter of Fig. 2 is readily obtained from an ordinary scaling circuit by adding a diode and separating the inputs of one binary.

Fig. 3 shows the parameters of a binary using a 6N5S tube. The remaining binaries are similar to the one shown. The adjustment of these decades is no more complicated than the adjustment of binary scalars. The decades operate reliably and can attain high counting speeds.

Translated from "Decade Scaling Circuits" by F. Ya Galkin, M. N. Ivanov, News of the Higher Institutions of Learning-Instrument Building, Vol 11, No. 5, 1959 pp 91-96.

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GERMAN ABSTRACTS

E. Brenner

Precision Audio Frequency Measurement

FREQUENCY measurement with electronic counters is simple and precise for frequencies above the audio range. However, at the lower frequencies (0.1 to 10 kc) the precision is impaired unless comparatively long counting times are used. For example, at a frequency of 100 cycles a 1-sec gate results in a precision of ± 1 cycle. With frequency multiplication the advantages of direct digital display together with high precision of measurement can be obtained.

The frequency multiplier shown in the figure contains a cathode-ray counting tube with a grid, g_4 , having 10, equally spaced, slits. A triangular deflecting voltage, with maximum value equal to half that required for maximum deflecting, is applied to the tube. Scanning 5 slits in each half cycle yields an output of 10 anode-current pulses per cycle.

To make the measured result independent of input harmonics, the rectangular pulse frequency obtained from the Schmitt trigger is divided by two before integration. Also, the output pulse frequency is doubled before counting. While in principle the use of all 10 grid slits would make the final frequency doubling unnecessary, the non-uniform slit spacing of the commercial tube used makes this procedure undesirable.

Abstracted from an article by R. Mitterer, *Frequenz*, Vol. 14, No. 1, January 1960, pp 14-18.

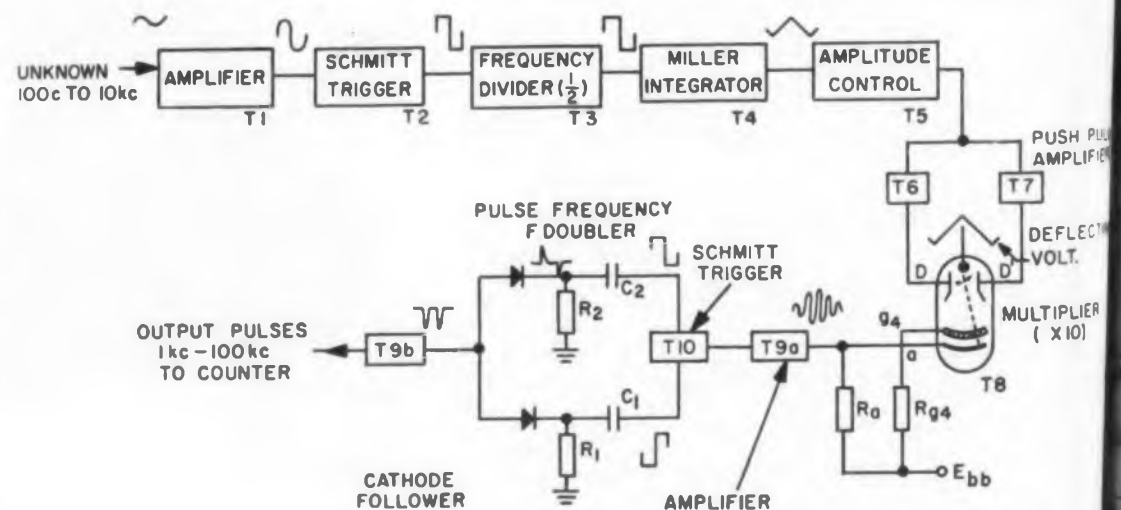


Fig. 1. Block diagram of frequency multiplier

Information And The Human Memory

STUDY of the human brain can serve as the basis for judging the performance of computing machines. This is shown in the accompanying table.

Valuable as background material, this survey article includes a classified, 46-item bibliography. The categories of this bibliography are: general brain studies, information theory applied to humans, psychology and phenomenology of the brain, physiology of the brain and information storage in machines.

Abstracted from an article by E. Schaefer, *Elektronische Rundschau*, Vol. 14, No. 3, March, 1960, pp. 79-84.

Advantages of the Human Brain Over Machine Memories

Property	Machine	Human
Maximum capacity of storage units	10^5 - 10^8 bit	Probably 10^{15} bit
Storage density	less than 10^4 bit/cm ³	10^{12} bit/cm ³
Number of operations before probable error	Relay 10^0 Tube 10^{12}	neuron 10^3 brain 10^{12}
Expense	Tape 0.001-0.01 DM/bit Drum 0.05-0.2 DM/bit Core 1-2 DM/bit Computer 300-3000 DM/hr	Human 1-25 DM/hr
Arbitrary access time	10^{-5} sec	1 sec
Storage capacity	10^0 bit sec/bit	10^{10} bit sec/bit
Power consumption per bit system	Tubes 10^8 w Transistor 10 w	Storage cycle 10^{-2} w brain 100 w



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Radar Interference with Microwave Communications

THE EXPANDING numbers of radar installations, both civilian and military, throughout the country, have greatly increased the likelihood of their troublesome interference with microwave communications systems. Several experiments have been performed to better understand how this interference can be dealt with and controlled.

Spurious Radar Emissions Have Varying Interference Effects

Although radars are assigned frequencies outside the bands assigned to the common-carrier microwave systems, the high powers some radars use, along with their wide dispersion across the countryside, leads to the interference problems. Such interference does not necessarily come from the direct, powerful radar pulses; it may be from harmonics or from spurious emissions. Interfering signals may arise also from maladjustments of a radar, causing occasional full power pulses to be transmitted in the frequency bands assigned to radio communications. Or, the interference may originate in the frequency spectra of the pulses transmitted by the radar.

Radar interference appears as a rough buzzing noise in telephone circuits; as moving, almost randomly located white dashes in a television picture; and as errors in data signals. Such interference is likely to be of a fleeting nature, de-

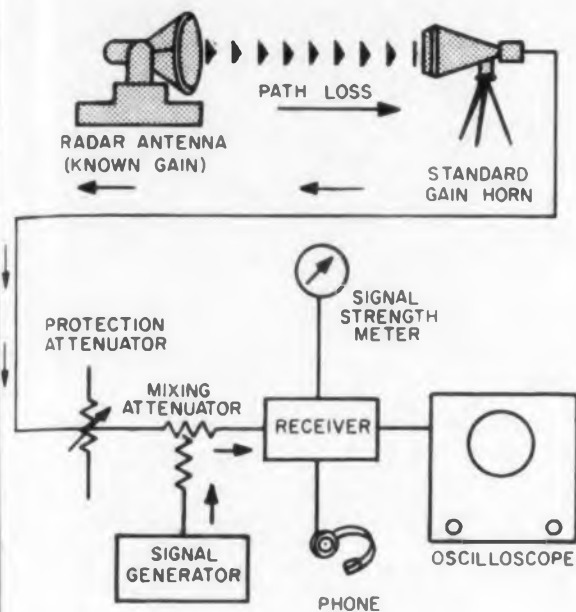
pending on the hours of operation of the radar, and on how rapidly the radar scans its assigned sector. Interference with ordinary telephone conversations and with television viewing is a commercially objectionable nuisance. However, with circuits carrying data signals, especially those required for national defense by systems such as SAGE, any interference cannot be tolerated.

Lab and Field Experiments Strive to Determine Interference Extent

One series of laboratory investigations tried to determine how strong an interfering radar signal could be without causing excessive interference. In another series, the radiation from operational radars in the field was measured to determine the frequency and power of the unwanted emission components.

The laboratory experiments simulated an interference condition by injecting a pulsed microwave signal (representing the radar interference) and a signal from a microwave transmitter (representing the desired transmission) into a receiver. By using an assembly of waveguide couplers and variable attenuators, engineers were able to adjust independently the strength of each of these signals at the receiver input. They found that as the peak value of the interference signal approached the peak value of the desired signal, the interfering noise in telephone circuits rose

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+ PATH LOSS (DB)
- RECEIVING ANTENNA GAIN (DB)



MOBILE LABORATORY

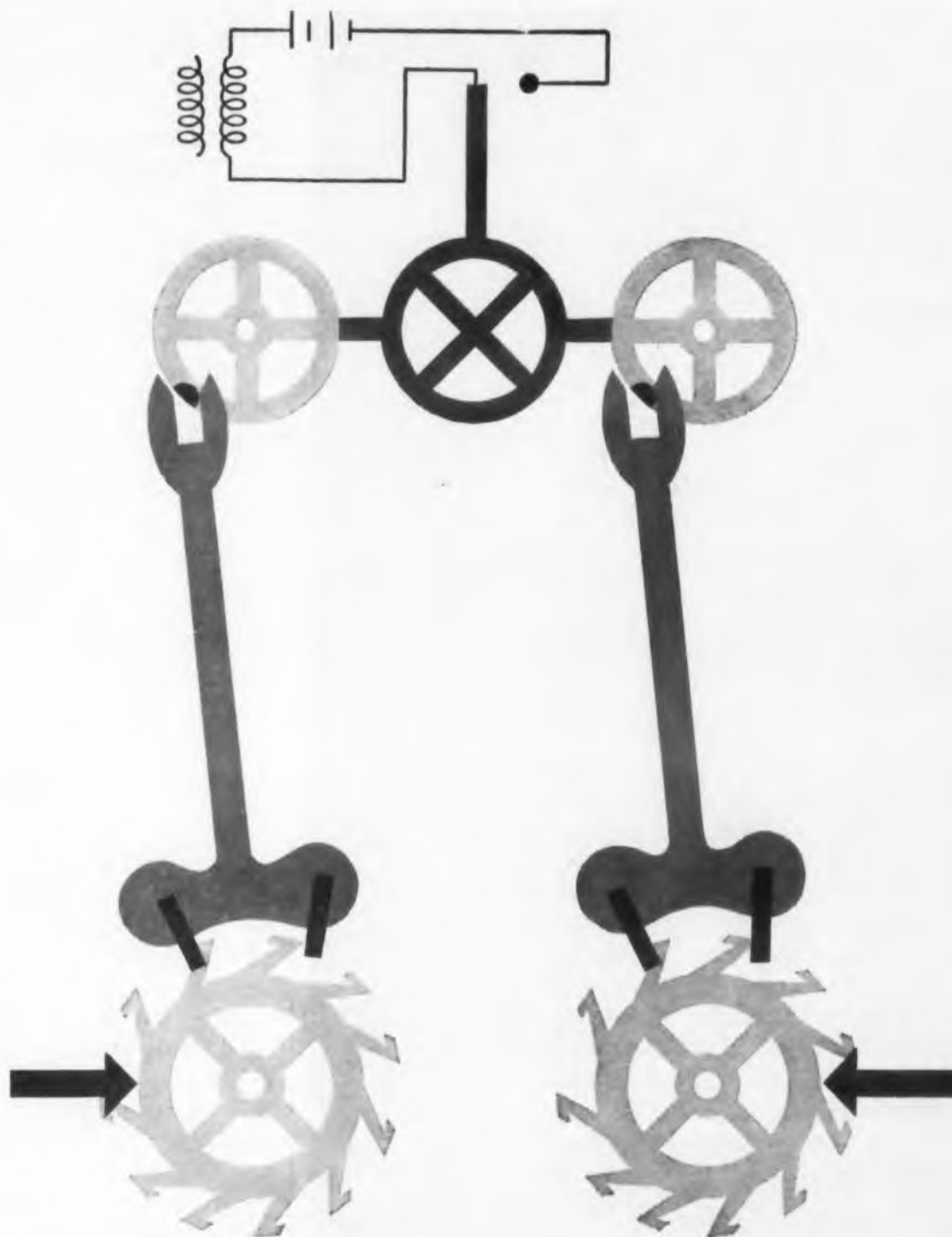
With interference-measuring equipment, operator can determine actual loss of signal strength in propagation path, then scan entire frequency band for harmonics and spurious signals from radar.

The noise is negligible when the ratio of peak signal to peak interference at the receiver input is more than 5 db. But it is intolerable when the ratio is unity (0 db or less), because at 0 db the interference is as strong as the wanted signals. Other tests have indicated that data signals, such as are used in the SAGE system, are not seriously affected by radar interference when the circuits do not have too much interference for ordinary telephone use.

TV Signals Have Greater Interference Sensitivity

Similar tests with television signals indicated that they are more sensitive to radar pulse interference than are telephone signals. Here it appears that the ratio of peak signal to peak interference must be more than 15 db—the signal power must be about 32 times stronger than the interference—in order to avoid degraded television pictures.

For typical Bell System microwave receiving systems, the maximum tolerable interference power which may be radiated from a radar without causing interference was estimated. A tabulation of the estimates is given in the table for various relative locations of the radar and the receiver. Since some radars have spurious outputs of effective radiated power as high as five megawatts (+97 dbm), steps must be taken either to reduce the spurious emission or to keep



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In any given escapement, the principal variables which must be established are:

- balance wheel frequency, f_b ;
- the gear reduction from scape wheel to mainspring, R ;
- and the torsional spring constant, Q , of the balance wheel hairspring.

The desired time per balance wheel cycle is determined by

$$(1) \quad t = \frac{\beta n R}{2\pi f_b}$$

For optimum scape wheel functions over the range of mainspring torques, it is desirable to use the maximum balance wheel amplitude, just short of overbanking. Thus the balance wheel will have sufficient amplitude, Q , at lower mainspring torques.

The maximum energy imparted to the lever by the scape wheel must not exceed the energy absorbed by the balance hairspring. Therefore

$$(2) \quad \frac{1}{2} Q (\Delta\theta)^2 \geq \eta \frac{T_m (\Delta\theta)}{R}$$

where η is the efficiency of energy transmission from mainspring to hairspring, T_m , the maximum torque at hairspring, and θ , the angular displacement of the pallet. The factor, η , must generally be experimentally determined.

The third equation takes into account the fact that the balance wheel vibration system exhibits, by its nature, simple harmonic motion. Thus

$$(3) \quad f_b = \frac{1}{2\pi} \sqrt{\frac{Q}{I}}$$

Where I is balance wheel inertia (constant for a given system).

The design procedure involves the choice of a convenient gear ratio and the definition of Q . Once Q is determined, f_b can be found by using Equ. (3). The R and f_b selected must be compatible with t .

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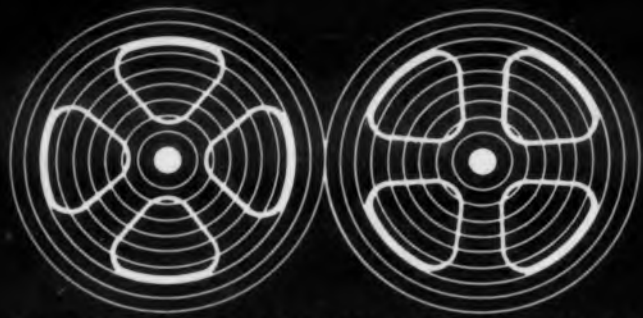
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DIGEST

it from reaching the microwave receiver input. Each course of action has a number of practical limitations.

Mobile Laboratory Used for Field Tests

To investigate the radiation from radars in the field, a "mobile" laboratory was used. A test truck was driven to a site having an unobstructed view of the radar to be tested. This site must have no apparent reflecting areas, such as a flat highway or pond, in or near the transmission path.

A receiving "horn" was then set up on a tripod on the roof of the truck. It was aimed toward the radar by a simple optical sight. The testing engineer tunes in the main radar signal on his receiver and directs the radar operator by telephone to aim the beam of the radar precisely on the receiving horn. The radar signal is observed on a signal-strength meter and on an oscilloscope.

When aiming is completed, pulses are matched from a signal generator with those from the radar in frequency pulse length and pulse rate. Also measured is the peak pulse power received. The actual loss in the propagation path from the radar to the test truck is then determined. Measured path loss is compared with the theoretical value. If the two are in good agreement, the engineer proceeds with the tests. If not, he must move to a better test site.

Once the propagation path loss is checked (and incidentally the operation of the radar), the entire frequency band is scanned for harmonics and spurious signals. When a spurious signal is found the signal generator is matched to it. From this, the effective radiated peak power of the radar at that frequency can be computed. Measuring equipment now available covers the frequency spectrum between 950 and 26,000 mc.

Although Spurious Emissions Are Prevalent Few RFI Cases Are Reported

With the cooperation of the armed services, eleven different types of radars were investigated. Their peak power outputs ranged from 140 kw to 5 mw. All were found to radiate harmonics or spurious signals of substantial strength, and all of them radiated signals in one or more of the common-carrier frequency bands. These, therefore, are potential sources of interference to communications.

Fortunately, however, there have been relatively few cases of actual radar interference reported. Laboratories engineers give several possible reasons for this. First, many of the microwave receivers are shielded from the radars by natural obstructions such as tall buildings. Second, potentially interfering radars may be operating

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STANDARDS AND SPECS

Sherman H. Hubelbank

Dry Cells and Batteries

Issued by the National Bureau of Standards, this new spec reflects the most recent advances in the dry-battery industry. The handbook includes many new types of mercury cells and a complete revision in their nomenclature. Specs are given for dry cells and batteries for use with transistor circuits.

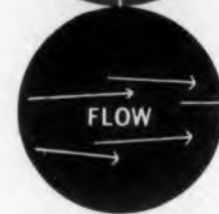
Also included are dimensions in the metric and English systems and cell designations adopted by the International Electrochemical Commission. A detailed description is given of the test methods used to rate dry cells, and of the construction and performance specs which must be met. Order Specification for Dry Cells and Batteries, NBS Handbook 71, from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., price 25¢.

Two New Classes Of Magnet Wire Added To MIL-W-583B

Two new classes of magnet wire, capable of continuous operation at 155 and 180 C, have been added to MIL-W-583B. Class designation of temperature characteristics has been changed from letters to numbers. The numbers coincide with the maximum continuous operating temperature. Responsibility for inspection prior to submission for Government inspection and acceptance has been assigned the supplier. The full title of the spec is Electrical Magnet Wire, MIL-W-583B, dated 15 December 1959.

Resonance Method Used For Determining Crystal Constants

The resonance method for determining elastic and piezoelectric constants of piezoelectric crystals is used in a new ASA standard. These constants are derived from the motional parameters of the equivalent electric circuit of piezoelectric vibrators made from the material considered. Evaluation of the dielectric constants is accomplished by measuring the capacitance of large plates provided with electrodes adhering to the major surfaces. *Standard C83.23-1960 is available from American Standards Association, 10 E. 40 St., New York 16, N.Y. for 75 cents per copy.*



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NEW low cost multi-purpose electronic counter

Model 720 events-per-unit-time counter is designed for uses requiring flexibility. Measurement of most physical variables such as flow, RPM, frequency or time interval is simple with NIXIE in-line readout, which reduces operator fatigue and errors. Low cost starts at \$475 for 3-decade model. Send for technical literature.

DECADES: 3, 4, 5 or 6
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CIRCLE 186 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 20, 1960

Time-Sharing Problem?



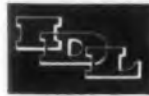
IDL MAY HAVE A SOLUTION -

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency.

In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.

Then IDL introduced multi-fingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60 data channels, each operating at 5 rps.



For further information, write for Technical Bulletin No. 500660; or let us propose a solution to your Time-Sharing Problem.

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CIRCLE 187 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 20, 1960

New IEC Spec Covers Fixed Mica Capacitors; MIL-C-25 Revised

IEC (International Electrotechnical Commission) recommendation No. 116 applies to fixed capacitors with a mica dielectric and electrodes directly deposited on the mica sheets. Order from *American Standards Association, 10 E. 40 St., New York 16, N.Y. at \$3.20 per copy.*

MIL-C-25 has been revised to include the vibration grade in the type designation. A new typical type designation is CP10A1KB273K3. The last digit (3) represents the vibration grade. Vibration grades 1 (10 to 60 cps) and 3 (10 to 2000 cps) have been added. Characteristic "D" has been deleted. The list of referenced specs and publications, and the requirements for packing and packaging have been revised. The quality assurance provisions have been modified to incorporate the standard paragraphs on responsibility for inspection. A new production inspection has been specified. This revision, MIL-C-25C, dated 8 February 1960, supersedes MIL-C-25A and MIL-C-0025B (USAF).

IEC Establishes Requirements For Fixed, Non-Wirewound Resistors

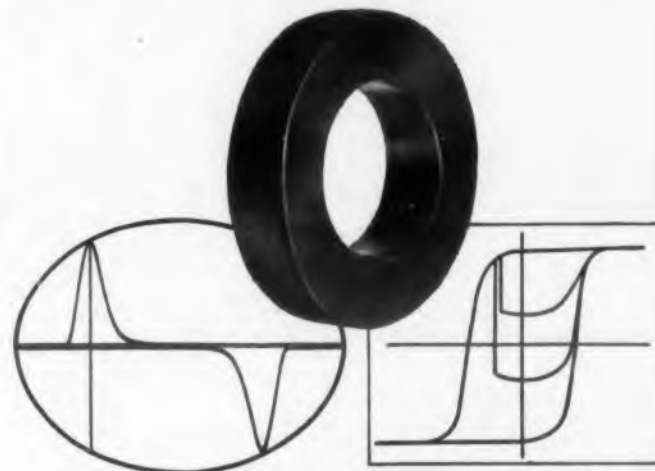
Fixed resistors, other than wirewound, are covered in this new IEC recommendation. This publication establishes the requirements for resistors having a rated dissipation of less than 2 w, and a resistance range between 10 ohms and 10 meg. These resistors are especially suited for circuits where high-stability properties are essential. *Copies are available from The American Standards Association, 10 E. 40 St., New York 16, N.Y. Specify IEC No. 115. Price is \$3.20 per copy.*

Save Money With Standards: 15 Papers Explain How

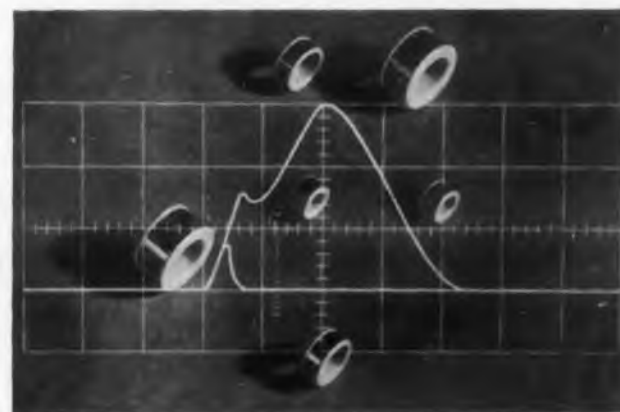
Using standards to achieve savings is the prime topic covered in 15 papers that were presented at the Eighth Annual Meeting of the Standard Engineers Society. Subjects include the use of standards to aid creativity, the waste in design engineering when standards are lacking, their value to consumers, the necessity for completely integrated company standards when modern automation, data processing and microfilming are used, and several facets of governmental experience with standardization. The proceedings of the 1959 Annual Meeting, "Philosophy, Research, Education, and Management in Standardization," cost \$5.00 for non-members. *Write to Standards Engineers Society, 1025 Connecticut Ave., N.W., Washington 6, D.C.*



Tape Wound Cores



Bobbin Cores



Not only G-L but our customers, too, claim consistent uniformity with every G-L Tape Wound Core and Bobbin Core. This consistent uniformity is the result of: an accuracy of control never before achieved in each and every step of the manufacturing process; the use of the highest quality raw materials and new and exclusive manufacturing technologies.

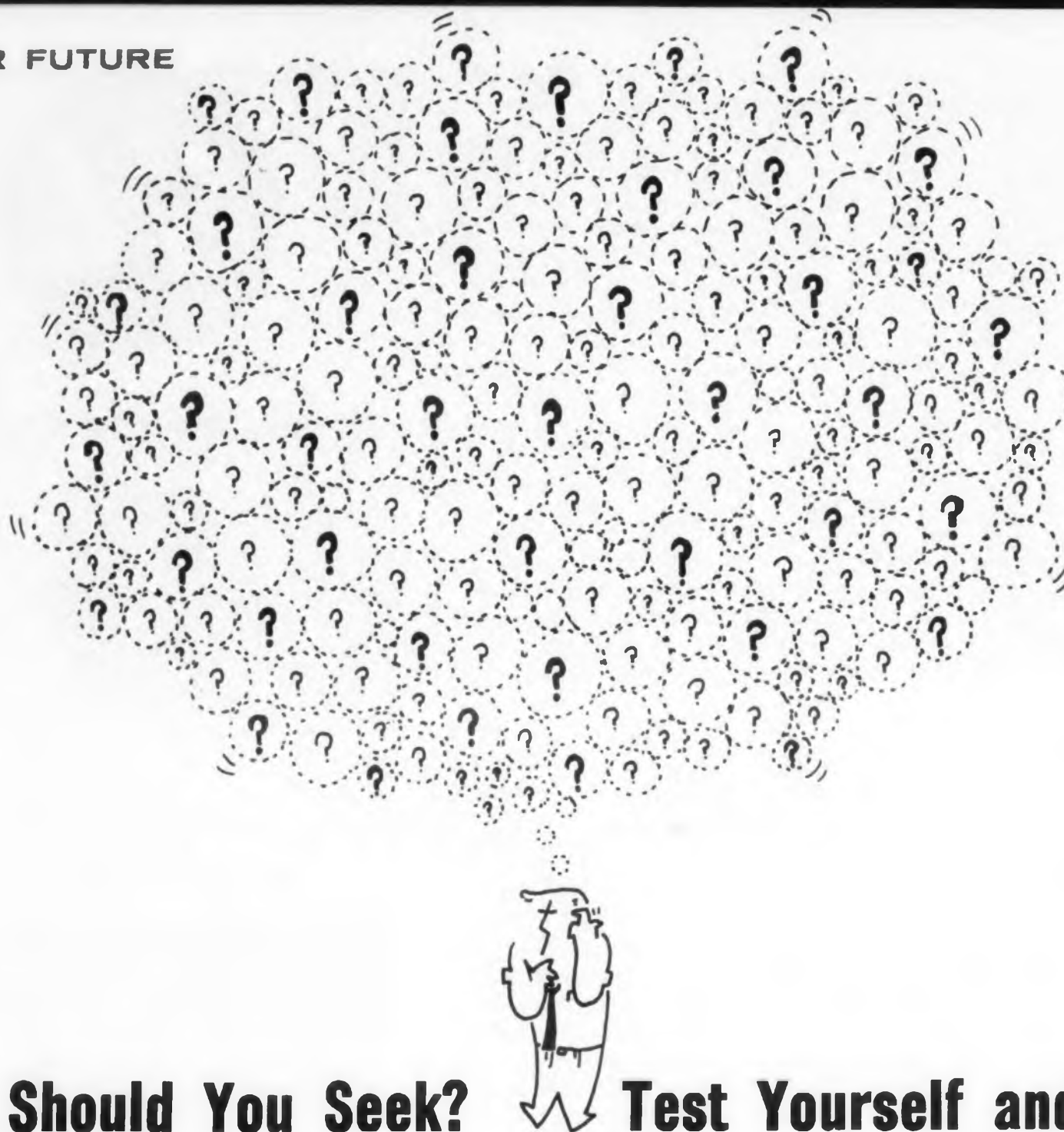
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What Job Should You Seek? Test Yourself and Find Out

BY A SERIES of self-administered tests, young engineers can now determine for themselves their suitability for various areas of electronics engineering.

The tests, developed over a six-month period by Deutsch and Shea, personnel consultants, and by engineers in General Electric's Light Military Electronics Dept., are for the exclusive use of the person taking them. Results are not communicated to GE or Deutsch and Shea.

The multiple-choice questions are of a practical nature and are concerned with work in the field rather than theory or textbook material. Grades achieved can be compared with an interpretive scale based on performance of Light Military Electronics Dept. engineers.

So far, the tests cover the fields of radar, microwave, communications, and electronic packaging. A fifth, non-technical test on human relations, is designed to indicate a person's talent for adminis-

tration or technical contribution.

Each test consists of 30 to 40 questions, and answers are bound into the last pages of each test pamphlet. When the test is finished, the last pages may be cut open and the test scored. A professional evaluation of possible scores appears on the facing page.

In the period of planning and pre-testing, GE engineers worked with Deutsch and Shea consultants to make sure each question was clear and concise—and fair. If questions were found to be misleading, too easy, or too hard, they were modified or discarded.

Any qualified engineer holding a BS or advanced degree can receive copies of the tests by writing to Ron Bach, Light Military Electronics Dept., General Electric, French Road, Utica, N.Y. Only two tests are distributed to each person, so the engineer should state what fields he is interested in.

What Do You Know?

The following are some questions from tests for electronics engineers drawn up by General Electric's Light Military Electronics Dept. and a personnel consulting firm:

Microwave Engineering

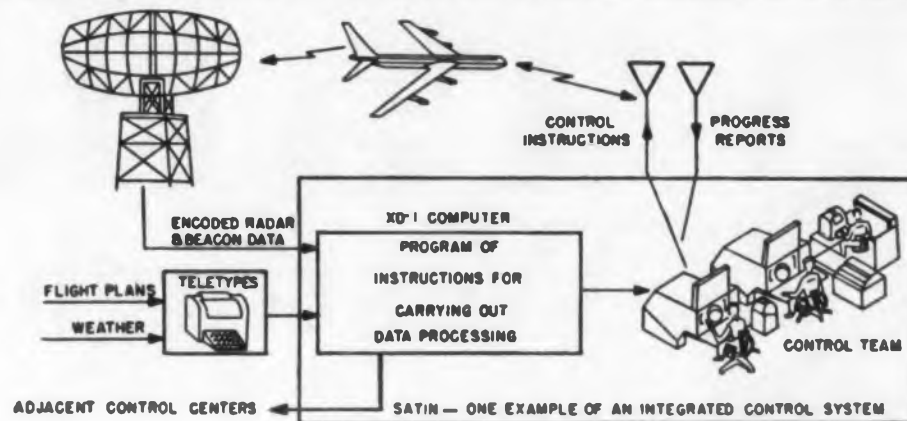
- The shortest microwave pulse length available presently is approximately:
 - 1 μsec .
 - 0.7 μsec .
 - 0.1 μsec .
 - 7 nsec
 - 0.1 nsec
- The broadest stable tuning range is obtained with a:
 - Magnetron.
 - Traveling wave tube.
 - Maser.
 - Backward wave oscillator.
 - Klystron.
- A radar set has a pulse width of 0.2 μsec . and a beam width of 1 mil. Azimuth and range resolution will be the same at the following range:
 - 5 miles.
 - 10 miles.
 - 20 miles.
 - 100 miles.
 - 200 miles.

Airborne Radar

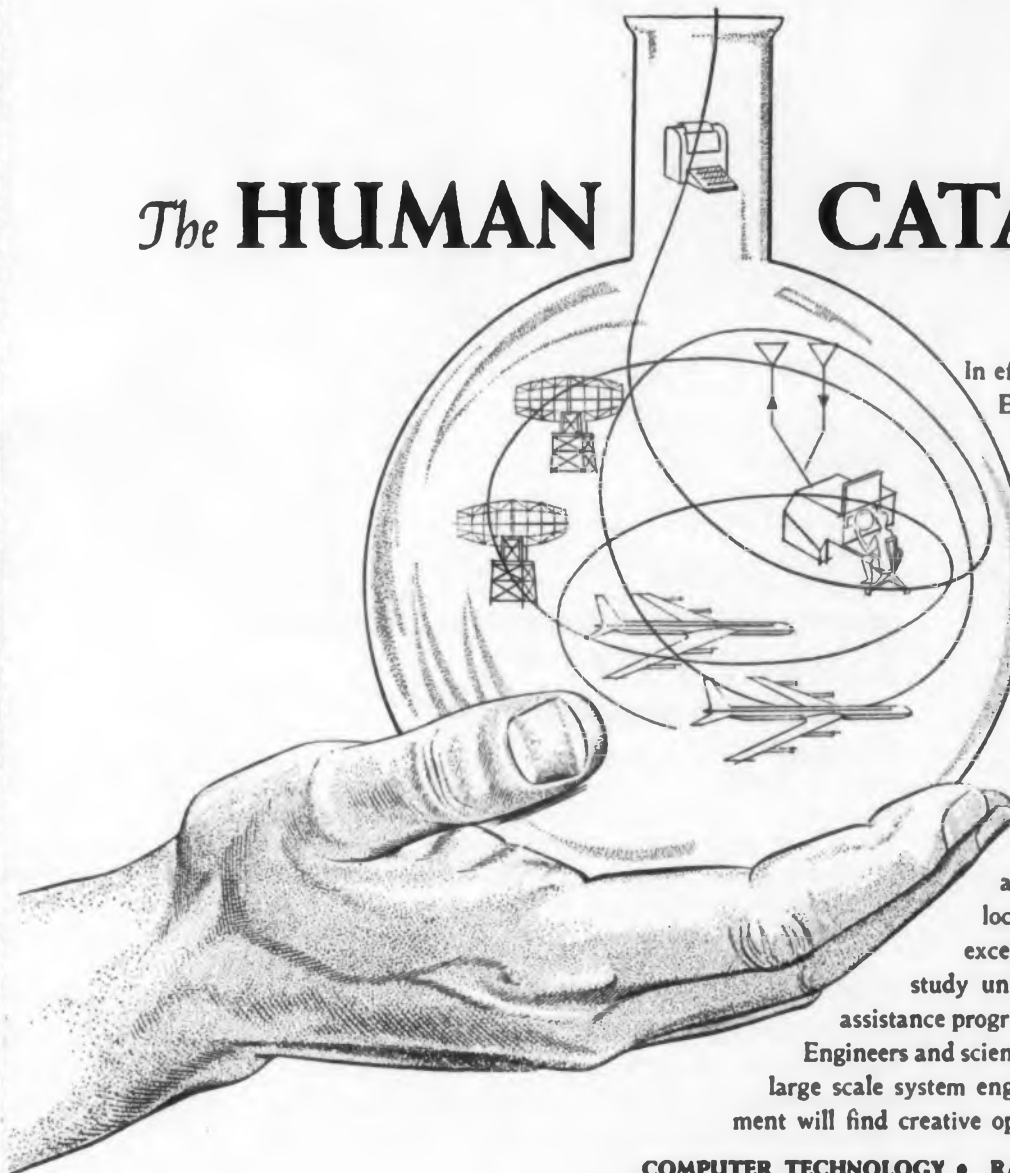
- Airborne Doppler radars often are used for measurement of:
 - Drift and ground speed.
 - Drift and heading.
 - Air speed and heading.
 - Speed made good.
 - Range rate.
- A 1,000-cps sine wave with a peak amplitude of 0.1 v is applied to the grid of a triode amplifier biased at cut-off. Following an amplification of 10, the output from the plate of triode #1 is capacitively coupled to the grid of a second amplifier. What is the average value of the waveform applied to the grid of amplifier #2, excluding bias of amplifier #2:
 - 0.636.
 - 0.636.
 - 0.5.
 - 0.318.
 - 0.

(continued on p 168)

ENGINEERS
SCIENTISTS



The HUMAN CATALYST



In effect, this is the role of the System Engineer at MITRE.

His technical competence and objectivity must maximize the effectiveness of complex interacting communications networks, radar systems, digital computers and countermeasures. The end result must be an integrated command and control system.

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CIRCLE 904 ON CAREER INQUIRY FORM

DESIGNING YOUR FUTURE



6. The over-all efficiency of a typical airborne pulse radar in terms of power to the antenna vs. supply line power to the transmitter and its associated modulator and power supply is approximately:
- 2%.
 - 10%.
 - 30%.
 - 50%.
 - 70%.

Packaging Requirements for Airborne Electronic Systems

7. Select the column below which lists the respective materials in the correct order for increasing coefficient of expansion:
- Steel, Aluminum, Nylon, Magnesium.
 - Aluminum, Magnesium, Nylon, Steel.
 - Steel, Nylon, Aluminum, Magnesium.
 - Aluminum, Steel, Magnesium, Nylon.
 - Steel, Aluminum, Magnesium, Nylon.
8. Cooling of airborne electronic systems often requires that cool air be supplied at high pressures. Of the fans listed below, the best for this type of operation is:
- Axial flow fan.
 - Centrifugal fan.
 - Propeller fan.
 - Vane-axial flow fan.
 - Blower.
9. If other factors are considered to be equal, one of the following statements has particular significance in comparing a gear mesh using 20-deg pressure angle gears with a gear mesh using 14.5-deg pressure angle gears:
- It will have more backlash.
 - It will have less backlash.
 - It will have the same backlash.
 - It will wear out faster.
 - It will wear out slower.

(continued on p 170)

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE**

USE BEFORE AUG. 31, 1960

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

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(Please print with a soft pencil or type.)

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 Home Address _____ City _____ Zone _____ State _____
 Date of Birth _____ Place of Birth _____ Citizenship _____
 Position Desired _____

Educational History

College	Dates	Degree	Major	Honors

Recent Special Training _____

Employment History

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

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 Your Goal?
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 CONFIDENTIAL
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ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

*Opportunities in
Systems Development*



Switching logic circuits by light

In this experimental device, six photoconducting cells surround a neon lamp. The unit serves as one of the logical elements in an elementary digital device built by IBM engineers and scientists investigating light as a switching medium in logic circuits.

The Potential of Photoconductivity

Because neon-photoconductor pairs are simple, reliable and versatile in their circuit applications, they are being thoroughly studied at IBM from both theoretical and engineering viewpoints. Physicists and mathematicians are examining fundamental aspects of photoconductivity. Other scientists and engineers are looking into alternate methods by which photoconductors might become part of future low-speed computing systems.

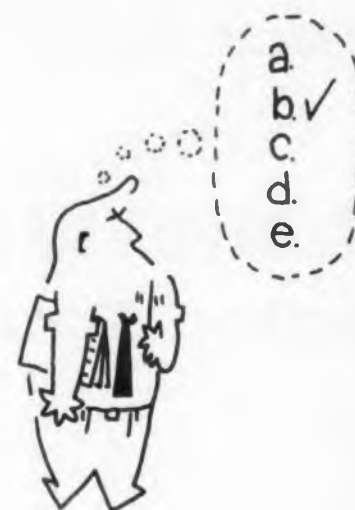
With the advent of light on the electronic scene, there are new skills to be learned and new problems to be solved that have never before been encountered. To attack these problems, it takes the varied skills of many different types of engineers and scientists. It also takes the progressive spirit of a company very much in step with the future.

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Manager of Technical Employment
IBM Corporation, Dept. 555S3
590 Madison Avenue, New York 22, N. Y.

DESIGNING YOUR FUTURE



Airborne Communications

10. A vhf signal with high frequency stability is best generated by:
 - a. Hartley oscillator.
 - b. X-cut quartz crystal oscillator.
 - c. AT-cut quartz crystal oscillator.
 - d. AT-cut galena crystal oscillator.
 - e. Molecular resonance phenomenon of gases.
11. Which of the following types of amplifiers is well known as a high efficiency rf linear amplifier:
 - a. Wallman amplifier.
 - b. Doherty amplifier.
 - c. Grid modulated Class B amplifier.
 - d. Warner linear amplifier.
 - e. Class B linear amplifier.
12. The spectrum of an fm carrier:
 - a. Narrows with modulation index increase.
 - b. Becomes more dense with modulation index increase.
 - c. Is independent of modulation index.
 - d. Width varies as the square of the modulation index ■ ■

The Answers

9-21	9-9
9-11	5-5
10-0	4-4
9-a	3-3
9-b	2-2
7-c	1-1

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◀ CIRCLE 905 ON CAREER INQUIRY FORM

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