

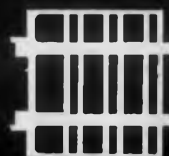
ELECTRONIC DESIGN

MAY 25, 1960

FILE

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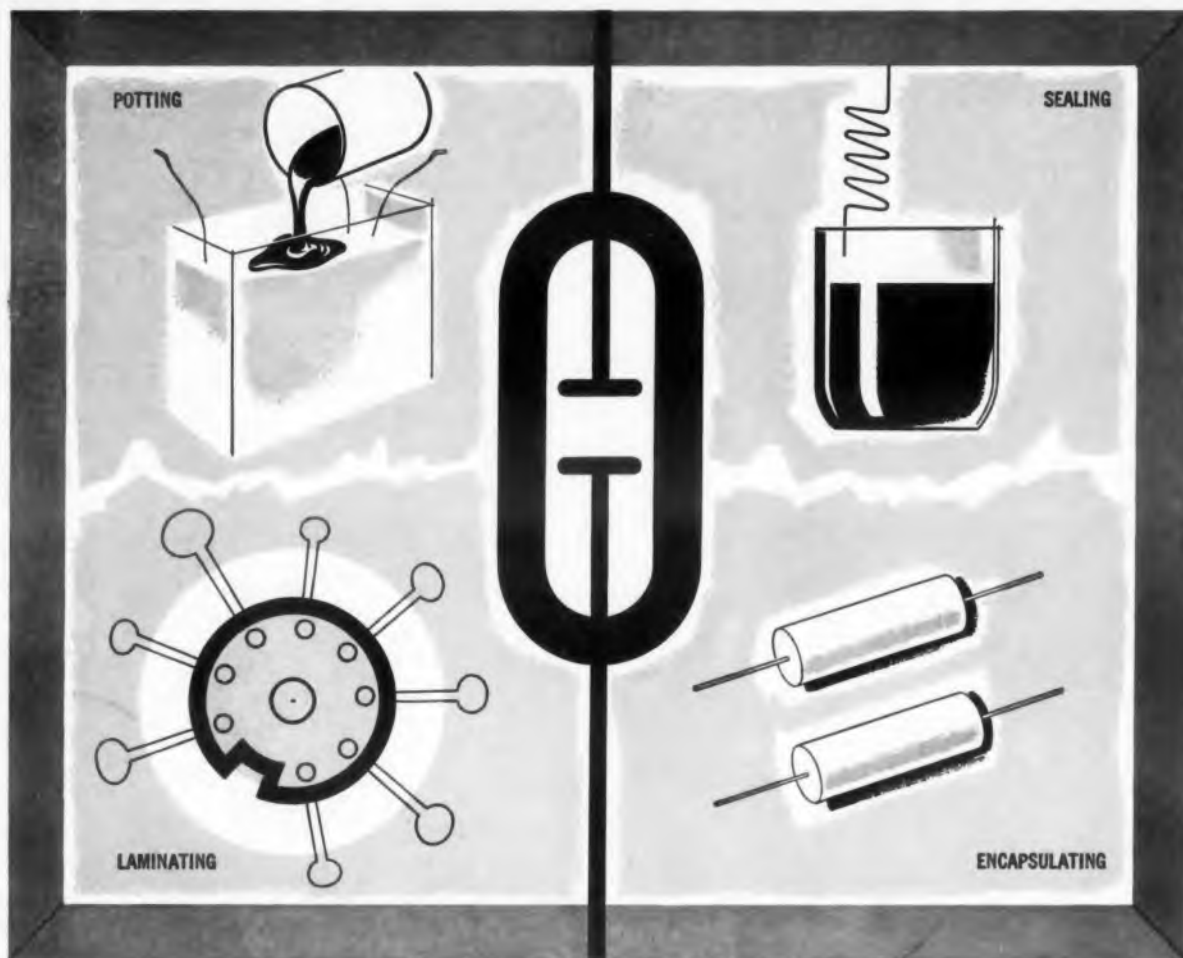
LIGHT-WEIGHT
SPRING CONTACTS
CAN BE
MOVED BY
ONE SMALL
RELAY COIL
... page 60



SPECIAL SURVEY THIS ISSUE:

ASW — Designers' Challenge ... page 36

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CIRCLE 1 ON READER-SERVICE CARD



COVER: Up to 51 circuits can be transferred by a new relay recently made available. In addition, the unit is designed for 100 million or more operations without re-adjustment. On this issue's cover, *ELECTRONIC DESIGN*'s Art Director has given his stylistic interpretation of the relay's transferring capability.

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Components, Instrumentation

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Sidelights of This Issue

In preparing this issue's Special Report, "Anti-Sub Warfare—Can Designers Meet the Challenge?", ED editors Robert DeFloria and Alan Corneretto spoke to dozens of experts intimately connected with the problem. Getting to these men was the easy part—getting them to open up on the subject of ASW proved to be difficult.

Because the entire area of ASW is highly security-laden, their reluctance to discuss specifications and characteristics of specific systems now in use, or even in the planning stage, can be understood. The editors did not presume to infringe upon the security aspects of this all-important phase of national defense.

They were primarily interested in getting an over-all look at the basic requirements that any effective ASW system must meet. By talking to leaders in the field, the editors were brought up-to-date regarding the types of equipment needed to detect missile-carrying subs.

Presented in the form of a military proposal, the report looks at system-design problems as viewed from an electronic design engineer's standpoint. Their final report was double-checked by ASW experts for accuracy and appropriateness of the included material.

The sober fact remains that in the Navy the hand of ASW now reaches so far into all major activities that 85 to 90 per cent of fleet costs is burned up by undersea operations. In industry, ASW is growing more dependent on the ingenuity of electronic design engineers.

Because the underwater quarry now has a growing advantage in sensing its hunters, and has the speed and weapons to destroy them, it is no longer the mouse in a cat-and-mouse game. As a point of personal information, the editors who compiled this report asked a standard question of the many ASW experts they interviewed.

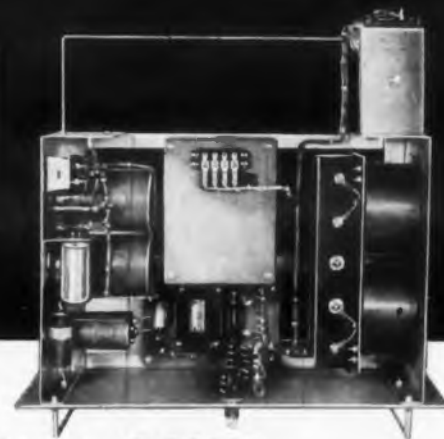
The question: "Aboard which ship would you rather be in an engagement between a submarine and an anti-sub vessel?"

The answer, unanimously: "The submarine!"

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CIRCLE 3 ON READER-SERVICE CARD

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Coming Next Issue

Continuing its policy in bringing you timely Special Reports, **ELECTRONIC DESIGN** has scheduled a series on Digital Communications. The first articles of the three-part Report will appear in the June 8 issue. The lead article will primarily be concerned with a detailed discussion of pulse code modulation. Other articles in Part I will deal with over-wire problems, and advantages and disadvantages of systems now in use.

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Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, Capabilities Engineer

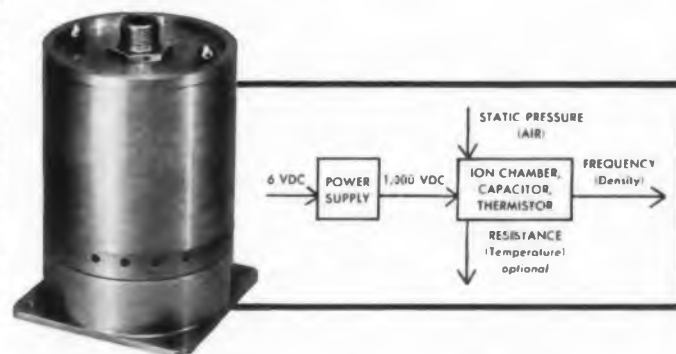


Report No. 7 TR 2043-2 Glow Discharge Densitometer

This instrument was developed by our Research Division from investigations into ionization phenomena. It employs the glow discharge phenomenon between two electrodes to measure the density of a gas between the electrodes, which enables it to measure altitudes of 40,000-250,000 feet to an accuracy of $\pm 1,000$ feet. When this unit is used as a pressure measuring device the accuracy is $\pm 5\%$ of the pressure reading. At these higher altitudes the TR 2043-2 takes over from common barometric instruments or mechanical pressure sensing elements which are impractical because of their inaccuracy at very low pressures. The instrument consists of a power supply and an ion chamber packaged in a cylindrical aluminum case four inches long and three inches in diameter. Because it does not depend on elastic elements, this SM/I sensor is extremely insensitive to shock, vibration and acceleration.

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Inputs:	Static pressure, ram pressure, temperature
Outputs:	Frequency, typical range 0 to 1000 cps Resistance, typical range 20K to 2 Megohm Temperature, thermistor output 20K to 2 Megohm
Accuracy:	$\pm 5\%$ of pressure reading or $\pm 1,000$ feet altitude absolute
Range:	40,000 to 250,000 feet (Adaptable for higher ranges)
Response Time:	0.1 seconds maximum
Power Requirements:	3.5 watts at 6 VDC including 1 watt heater power
Temperature Range:	-65°F to $+170^{\circ}\text{F}$
Vibration:	50 g's 10-2000 cps
Shock:	100 g's
Size:	3 inches dia. x 4 inches long
Weight:	1 lb. 4 oz.



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Pioneer V Signal Fades After Switchover

Satellite's Electronic Payload Had Passed Its Last Major Test; Significant Data Gathered During Experiment; Obeyed Nine Commands

A LEAK in Pioneer V's nickel-cadmium batteries threatens to cut short its telemetry range long before the 100-million-mile limit previously hoped for.

Earlier this month, Pioneer V's electronic payload had passed its last major test by switching from the 5-w transmitter heretofore used to the 150-w telemetry system—this at 8 million miles out from earth. The 5-w transmitter had proved useful to almost twice the distance originally expected and scientists hoped that the 50-million-mile range of the 150-w transmitter would be exceeded by a similar factor.

Soon after switchover, however, signal

strength began dropping and is now down an average of 10 db. Tracking stations are still receiving data, but a battery voltage-actuated cut-off in the vehicle interrupts transmissions well short of the normal two-minute broadcast period. The Jodrell Bank station is still able to interrogate the vehicle, but the smaller dish at Hawaii has not always been successful in triggering Pioneer V's command receiver.

Since launching, Pioneer V has successfully responded to nine commands. These are:

- Transmitter on at 64 pulses per second—sent from Cape Canaveral immediately after Pioneer V's launching.

- Separate payload from third stage—ordered by Jodrell Bank 25 min later.

- Transmitter off—at the conclusion of each telemetry period.

- Transmitter on at 8 pulses per second. This lower pulse rate was required first by the smaller, less sensitive antennas at the Singapore and Hawaii tracking stations and, finally, by the 250 Jodrell Bank dish when the probe was 1.3 million miles out.

- Transmitter on at 1 pulse per second. The 60-ft antenna at Hawaii implemented this command at about 1 million miles and Jodrell Bank at 4.8 million miles.

'Blue-Sky' Computer Planned at WJCC

High-Density Storage Units, Using Ultra-Fast Tunnel Tetrodes, Would Be Used in Solving Many Complex Human Problems

COMPUTERS with the problem-solving capabilities of highly intelligent men and the volume processing capabilities of electronic data processors could be built to help solve the most complex human problem—bargaining. This supermachine was "built," "programmed" and "used" at a session of the Western Joint Computer Conference in San Francisco.

The four participants in the session each attacked one of the following phases of building

this theoretical computer:

- If I could solve the following problems, I could provide several hundred million logic and storage elements per cubic inch.

- If I had available such a high density of logic and storage elements, this is the kind of computer I would build.

- If I had such a computer available, this is what I would program it to do.

- If a computer so programmed were available,

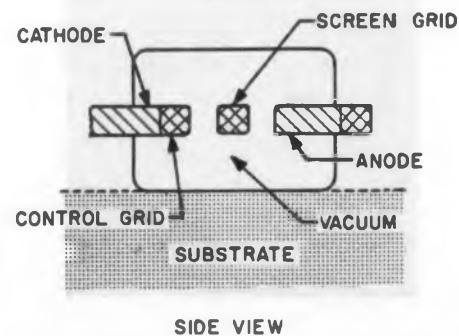
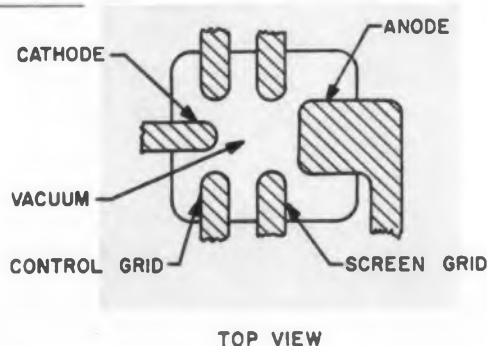
this is how it might be used and what it would mean in solving problems.

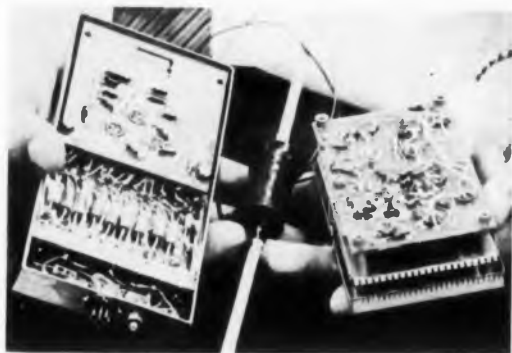
Getting the vast number of logic and storage elements was the problem of Kenneth R. Shoulders of the Stanford Research Center at Menlo Park, Calif., who told the session that the key to high-density storage lay in the development of tunnel-effect vacuum tetrodes, which would have an estimated switching time of 10^{-10} seconds and immunity to temperature variations. The quantum mechanical tunneling of electrons into vacuum makes such speeds possible.

Mr. Shoulders said the device can be built using a method for electron-beam-activated micromachining of thin film materials. A thin, chemi-

(continued on page 6)

This hypothetical tunnel tetrode is seen as a boon to building a "supercomputer" with high-density logic and storage elements. Tunneling into a vacuum would make 10^{-10} switching speeds possible. Cathode properties in the tetrode are such that current density would be 10^7 amp per sq cm. Cathode is nominally 3,000 angstroms wide. With maximum input power of 100 w, the 1 mw of input per device would allow 10^6 devices to operate simultaneously.





Search coil magnetometer for Pioneer V. This device measured the newly discovered hydromagnetic ring current and interplanetary magnetic field. Assembly consists of wire-wound mumetal core (center) and two collection and evaluation units. Total weight is 1 lb.

■ The sixth command, transmitted by Jodrell Bank, altered the search frequency of Pioneer V's receiver from 40 to 180 kc, search time from 10 sec to 3 min, and receiver bandwidth from 250 to 40 cps. This boosted the payload receiver's sensitivity by 10 db.

■ The final three commands accomplished the switch-over from 5-w to 150-w transmission.

The 5-w transmitter has not been bypassed, but now doubles as an amplifier in the 150-w system. Duty cycle is down to 1 or two per cent rather than the 10-per-cent possible with the 5-w transmitter. This is due to limited charging current available from the solar cells.

The command system has been successfully operated about 300 times, and more than 100 hours of telemetry data are on tape.

Repair Job In Space

An earlier failure, this of a diode in the satellite's telebit memory, had also threatened the success of the experiment. Each number transmitted could have one of two possible values. Fortunately, however, Space Technology Laboratories' engineer Robert E. Gottfried was able to work back from reasonable assumptions of the true values and derived a conversion code from which a computer can select the proper value from the two alternatives. This long-armed "repair" job earned Mr. Gottfried personal congratulations from NASA chief Dr. T. Keith Glennan.

Discovered Ring Current and Interplanetary Field

The incipient failure of Pioneer V's batteries will terminate an experiment which has for the first time provided significant data on regions of space beyond the influence of the earth's magnetic field. This has led to findings of major scientific importance, has invalidated previously held theories and has presented several new problems for consideration by astrophysicists.

(continued on page 6)

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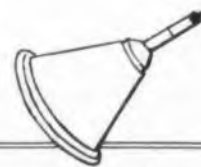


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Choose from stock tubes listed below — available with all standard radar phosphors and special infrared-stimulable storage phosphors — or let Raytheon's custom engineering service assist you in developing or adapting a tube to meet specific new applications. Write direct to Dept. 2527.



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CK1352	high-voltage (3300 to 4300 Vdc)									
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CIRCLE 5 ON READER-SERVICE CARD

NEWS

Pioneer V *(continued from page 5)*

entists associated with the Pioneer V experiment. The major conclusions derived from analysis of the data collected by Pioneer V are:

- A hydromagnetic ring current of perhaps 5 million amp encircles the earth at an altitude of 10 earth radii.
- The earth's magnetic field extends twice as far out as had been previously supposed.
- An interplanetary magnetic field of unknown origin exists in space.

'Blue-Sky' Computer *(continued from page 4)*

cally resistant film is formed with an electron beam to protect selectively the film being machined during a subsequent beam etching. The process has resolution capabilities of several hundred angstrom units and it "may ultimately be suited for the economical production of 1-cu-in. data-processing systems having 10^{11} active components."

Putting the tunnel tetrodes to work in a new computer was the task of the University of Michigan's John M. Holland. "It should be possible," he said, "to process arbitrarily many words of stored data at the same time, each by a different sub-program, if desired."

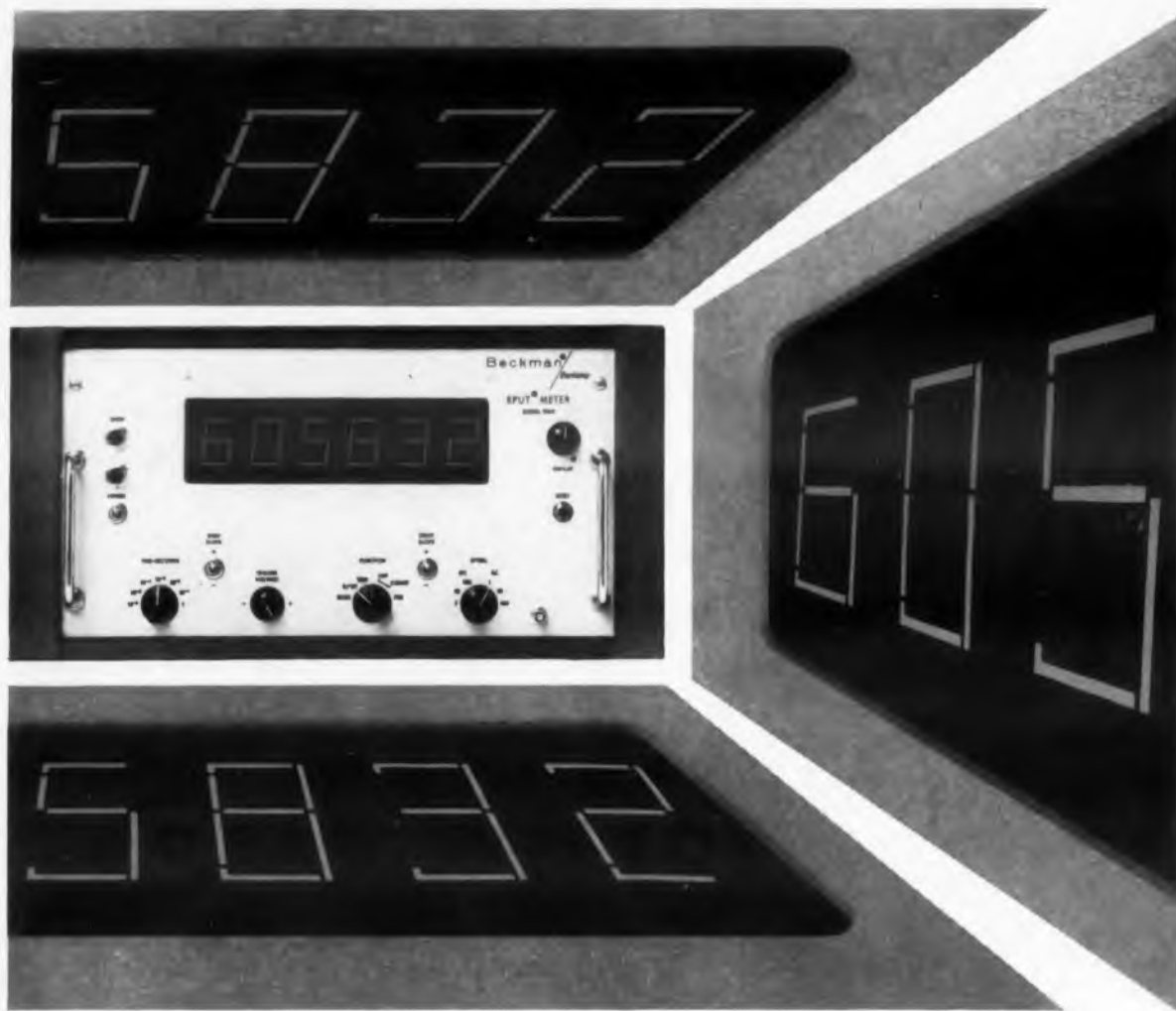
Because the sub-programs can be spatially organized, its operation is considerably different from that of present computers.

The modules in Mr. Holland's computer would be arranged in a two-dimensional rectangular grid. "The computer is homogeneous—or iterative—in the sense that each of the modules can be represented by the same fixed logical network."

Programming to Get Intelligence

Allen Newell, of the RAND Corp., Santa Monica, Calif., said a machine which is an intelligent processor of information "is frightfully difficult to differentiate from an extremely compliant, fairly bright human technical assistant, backed up by a large computing establishment."

An external language is used between the machine and those things with which it communicates. The expressions in the external language are taken in bodily by the machine and made available in the input-output area. In addition, there are three stores for information, each one structurally distinct because of different reading and writing requirements. The program store contains the large number of program



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New Beckman counter display is right out front, visible from any angle and unobscured by interposed elements. Most EPUT® meters, timers and other Beckman counters are now available with this bright red in-line display 1-1/2" high. The display is carefully designed to minimize reader fatigue and prevent reading errors. Because the digits are formed by illuminated segments on the face of the panel, the indication can be read from almost any position in front of the instrument—from above or from either side at angles as close as 30° to the panel. Deep red color makes the display stand out boldly in brightly lit rooms—even in sunlight. The price per digit is only \$30 to \$45 more than the price of counters with the standard vertical column display.



Sophisticated packaging characterizes this most recent advance in in-line displays. Counting unit, decoding circuitry and decimal display form one compact plug-in module. Modules may be purchased separately for use as digital building blocks.



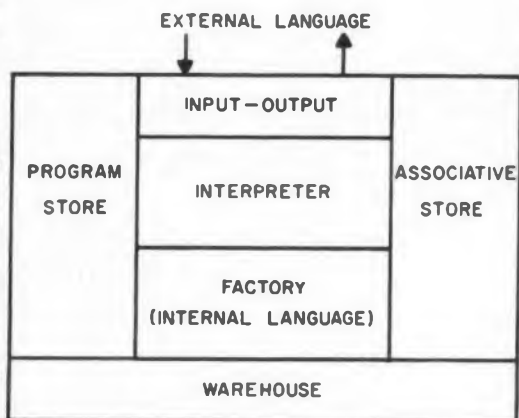
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■ Cosmic-ray intensity is not affected by the earth's magnetic field.

■ Solar flares eject plasma into interplanetary space.

The ring current was first observed by Explorer IV. Its orbit, however, was designed so that the apogee always occurred on the night side of the earth. Pioneer V, reaching the same altitude by day, also encountered the current and therefore established that the current system closes around the earth rather than being only a nighttime phenomenon. The existence of the ring current, debated by geophysicists for more than half a century, has thus been confirmed by experimental evidence. ■ ■



Supercomputer would be an abstract automaton, consisting of a regular lattice of active modules, each possessing both processing and memory functions.

forms required by the interpreter and the factory. The associative store contains entities with the properties normally associated with symbols. The warehouse is a third store that backs up all the other areas.

The computer described could be put to work to help solve the problem of bargaining, which C. West Churchman of the University of California at Berkeley called "the most difficult problem the human being faces today." A bargaining problem, he told the session, is essentially one in which "the decision to be made must be composed of the decision of two or more individuals with partially conflicting objectives."

In other sessions of the WJCC:

■ A dilating circular scan has been applied to data processing and has resulted in a computer being able to recognize line drawings of different geometric shapes. The new technique was described by Leon D. Harmon of Bell Telephone Laboratories, Murray Hill, N.J.



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ATE-4	1 3/16"	1 3/16"	3.5 oz.	1 kc to 16 kc	6 kc	15 hys
ATE-6	1 1/16"	1"	1 1/2 oz.	10 kc to 100 kc	30 kc	.75 hys
ATE-10	1 3/16"	1 3/16"	.1 oz.	3 kc to 50 kc	20 kc	.75 hys
ATE-11	3/4"	1 3/16"	.75 oz.	2 kc to 25 kc	15 kc	5 hys
ATE-12	3/4"	1 3/16"	.75 oz.	15 kc to 150 kc	60 kc	1 hy
ATE-34	2 3/4"	2 1/2"	.1 oz.	3 kc to 30 kc	55 kc	1 hy

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If you haven't already done so—send for your free membership in the Space Shrinkers Club.

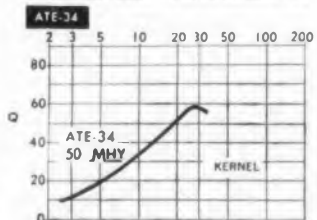
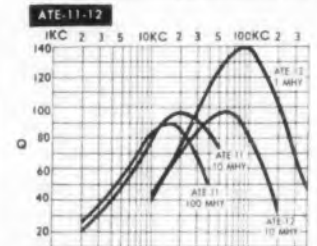
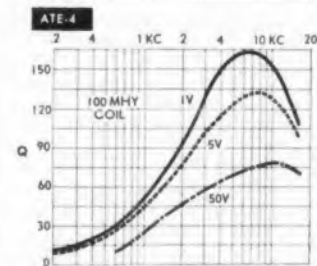
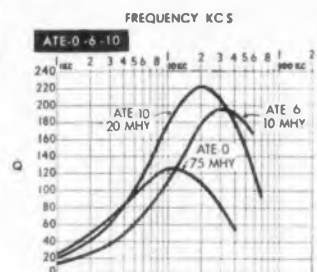
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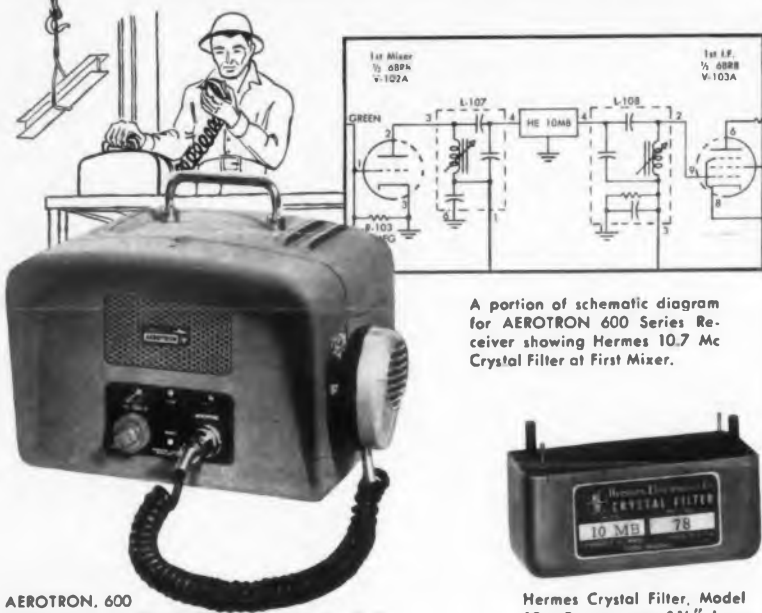
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FIRST 2-Way Crystal Filter Radio to Guarantee Lifetime Receiver Selectivity Uses HERMES CRYSTAL FILTERS



AEROTRON, 600 Series, Two-way VHF-FM Radio Communications Equipment

A portion of schematic diagram for AEROTRON 600 Series Receiver showing Hermes 10.7 Mc Crystal Filter at First Mixer.

Hermes Crystal Filter, Model 10 MB, measures 2 3/8" long x 1" wide x 1/32" high.

The AEROTRON, Model 600 Series, is the first commercially available two-way VHF-FM Mobile Radio Equipment to use a high frequency crystal filter to guarantee Receiver selectivity for the life of the equipment. This equipment is designed by Aeronautical Electronics, Inc. of Raleigh, North Carolina, for the new "split channel" frequency allocations where exceptional frequency stability and selectivity are imperative. The use of a Hermes Crystal Filter at the highest intermediate frequency eliminates any desensitization from very strong, adjacent channel stations and offers a very flat response throughout the bandpass of the filter.

Hermes crystal filters were selected because of their superior performance, small size, and immediate availability. Close cooperation between the engineering departments of the two companies contributed to the rapid development of this new Mobile Radio Equipment. Receiver characteristics include: *Frequency Stability*: $\pm 0.0005\%$ over -40 to $+75^\circ\text{C}$; *Sensitivity*: 0.6 microvolt or less for 20 db quieting; *Selectivity*: ± 7.5 kc at 6 db down; *Modulation Acceptance*: $\pm 1/2$ db throughout bandpass range of ± 6 kc.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, you can call on Hermes engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. Write for Crystal Filter Bulletin.

A limited number of opportunities are available to experienced circuit designers. Send résumé to Dr. D. I. Kosowsky.

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CIRCLE 8 ON READER-SERVICE CARD

NEWS

Aerial Reconnaissance R&D Bringing Radar, IR, TV and Photo Advances

U-2 Incident over Russia Illustrates Growing Need For Advances in Pilotless Surveillance Systems

THE RECENT U-2 aircraft incident, in which a U.S. reconnaissance plane was shot down deep over Russian territory, dramatically points up the need for unmanned aerial-surveillance systems.

This requirement for equipment to gather intelligence necessary for protecting the U.S. in the cold war has not been overlooked by the military. Present Air Force planning puts Project Samos (for Satellite Anti-Missile Observation System) on the highest priority list. Another high-priority program, Project Midas (ED, March 16, p 4), is directed at anti-missile observations from satellites using infrared systems.

The Army has also backed programs to develop unmanned aerial surveillance systems. A broadside effort in this area is underway at the University of Michigan under a program known as Project Michigan. High-performance surveillance drones are also being developed for the Army.

Potential space applications for airborne reconnaissance equipment has also spurred developments.

Major industry efforts are now directed at overcoming design problems with four types of sensors—infrared, high-resolution radar, photographic, and television. There are some drawbacks to each of these, and some difficulties common to all.

Some of the common problems, pointed out by Capt. Morley W. Baker Jr., USAF, Wright Air Development Div., Dayton, Ohio, at the recent National Aeronautical Conference, include:

- High vehicle speed, requiring fast scanning.
- Excess heat generated by vehicles.
- High altitudes required to survey large areas increase resolution problems.
- True vertical and accurate heading of the vehicle is needed to interpret results.

- Wide bandwidths are needed to transmit data to the ground by data link.

There are also unique advantages and drawbacks to each sensing method.

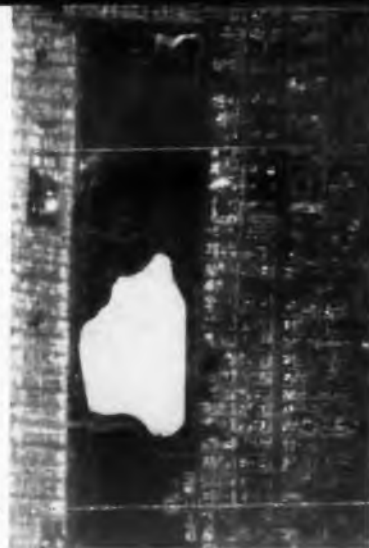
"Radar has a distinct advantage over any other sensing means because of its all-weather capability," explained Francis L. Holloway, technical director of the Avionics Div., Directorate of Advanced Systems Technology at WADD in an interview with ELECTRONIC DESIGN.

Recent developments in radar have added many advantages to this sensing technique. Side-looking systems, in which narrow fixed beams from the sides of an airplane sweep strips of terrain as the aircraft moves along, eliminate the advance warning given by former radar systems directed forward of the flight path.

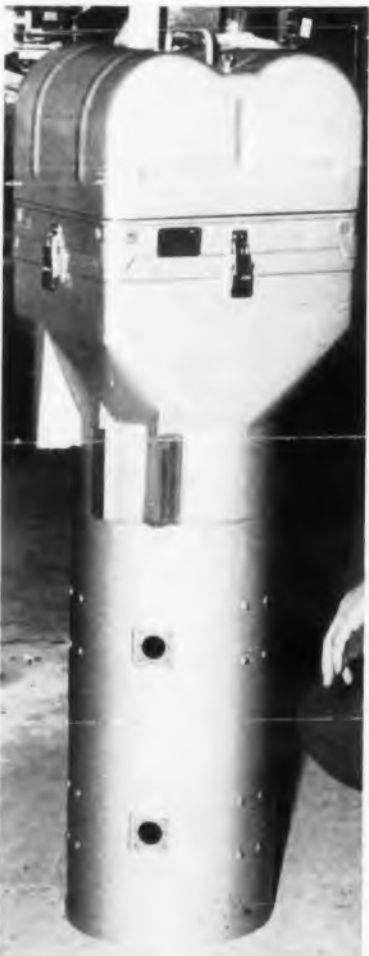
Returned echoes can be processed be-



U-2 single-jet aircraft similar to reconnaissance plane downed over Russian territory.



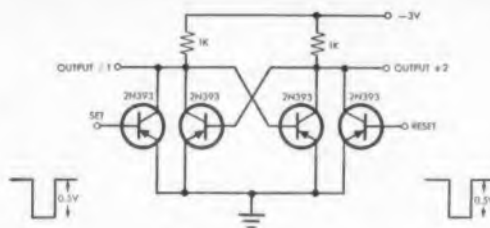
Infrared view of New York's Central Park with HRB-Singer Reconofax camera at night shows how roads are visible beneath camouflage-like overhanging trees.



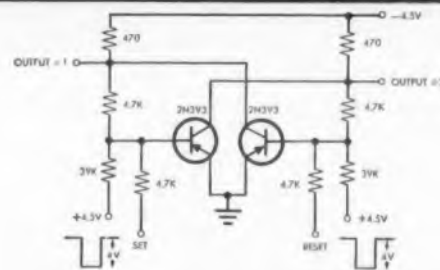
High-acuity camera delivered to Air Force this month by Fairchild Camera can resolve 2 x 2 x 2-ft object from 100,000 ft.

CIRCLE 9 ON READER-SERVICE CARD ➤

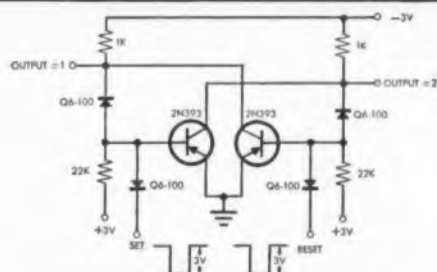
PHILCO MAT* TRANSISTORS are UNIVERSALLY APPLICABLE To All Logic Circuits Up To 5mc



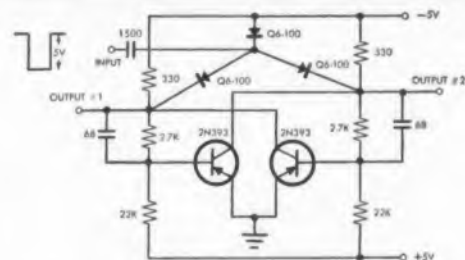
DIRECT COUPLED TRANSISTOR LOGIC FLIP-FLOP
TYPICAL SWITCHING TIMES: $t_r = 12 \mu\text{sec}$, $t_f = 15 \mu\text{sec}$.



RESISTOR COUPLED TRANSISTOR LOGIC FLIP-FLOP
TYPICAL SWITCHING TIMES: $t_r = 40 \mu\text{sec}$, $t_f = 110 \mu\text{sec}$.



DIODE COUPLED TRANSISTOR LOGIC FLIP-FLOP
TYPICAL SWITCHING TIMES: $t_r = 20 \mu\text{sec}$, $t_f = 60 \mu\text{sec}$.



RESISTOR CAPACITOR COUPLED TRANSISTOR LOGIC BINARY STAGE
TYPICAL SWITCHING TIMES: $t_r = 30 \mu\text{sec}$, $t_f = 44 \mu\text{sec}$.

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A major technological advance, the new direct drive DC Servos—with printed armatures—feature high torque to inertia ratio and greatest capability of high pulse torque in intermittent use. The new servos are low impedance devices and as such are suitable for use with semi-conductor circuits.

	MODEL PM-368	MODEL PM-488
Inertia	.005 ounce-inch-seconds ²	.018 ounce-inch-seconds ²
Running Torque (continuous)	12 ounce-inches	32 ounce-inches
Mechanical Time Constant	.025 seconds	.025 seconds
Pulse Torque (intermittent)	100 ounce-inches	220 ounce-inches
Size	1 1/4" D x 2 1/4" L	5/8" D x 2 1/4" L

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CIRCLE 10 ON READER-SERVICE CARD

NEWS

fore being displayed in the form of successive intensity-modulated traces forming a strip map. The motion of the strip film is coordinated with the speed of the airplane.

This processing can be used to display signals in ground range rather than the slant range measured by the radar. A control system receiving slant range and altitude as inputs, can provide ground range as an output. This technique permits a map scale to be set up for the measurement of distances between various points on the map.

Major efforts are being exerted toward improving resolution of airborne radar. Resolution of the system depends on the beam width and the duration of a pulse.

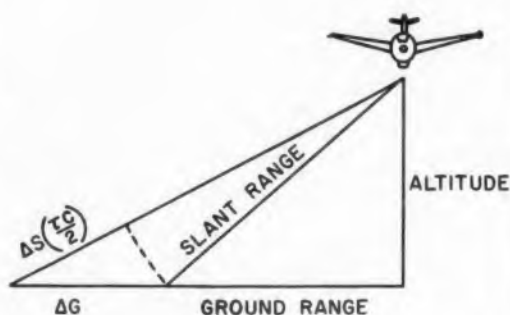
Minimum slant range resolution of the radar, or the slant range required between two objects in order to see them as two separate pips, is equal to the pulse duration times the velocity of light, divided by two (see diagram).

In order to get shorter pulses for better range resolution high frequencies are used. If the radar operates much above X-band, however, weather begins to attenuate signals, particularly rain storms.

Azimuth resolution depends on beam width. Beam width, in degrees, = $70 \lambda/D$, where λ is wavelength of the signal, and D is the length of a linear antenna or the diameter of a parabolic type, and both are in similar dimensions. There-



Side-looking radar map of Phoenix clearly shows moving vehicles along roads indicated by road map. The Motorola radar system used provides two superimposed maps—one of the terrain and the other showing moving objects.



Minimum slant range at which airborne radar can separate two targets is $\Delta S = \frac{\tau c}{2}$, where τ = pulse length and c = speed of light. The triangular relationship: $(G + \Delta G)^2 = (S + \Delta S)^2 - H^2$, (H = altitude), can be used to derive useful approximations for minimum ground range resolution, ΔG .

fore increasing azimuth resolution can be accomplished by going to higher frequencies or by lengthening the airborne linear antenna.

The attenuation problem again limits the frequency, so that lengthening the antenna is the only way to increase the theoretical resolution limit even further. Since about 50 ft is the limit for length of an antenna on an airplane, it seems that this also limits possible resolution.

Work on "synthesized" antennas as part of Project Michigan, however, is overcoming this problem. Signal-processing techniques are able to give the effect of a longer antenna although only a very short antenna is used. (*ED*, May 11, p 12.)

Velocity information is necessary in the synthesizing technique, in which returned radar signals are stored and processed by an analog computer. Therefore the accuracy of a doppler radar system, or other velocity measuring system, affects the resolution obtainable.

Many other factors complicate the airborne radar problem. Cathode-ray beams, used to display the radar information, are deflected because of the motion of the aircraft through the earth's magnetic field. In the synthesizing technique, signals are processed on the ground so that this problem is overcome.

System noise enters into the resolution problem, so that use of masers or parametric amplifiers seems logical for high-resolution systems. Project Michigan researchers have been busy with maser development along with solving the radar problems.

High-altitude operation is desirable for long range observations, however the energy returned from a target decreases with the fourth power of the slant range, so that higher altitudes greatly



For complete engineering data on Military-Grade Yellow-Jacket Film Capacitors (Type 158P) write for Engineering Bulletin 2301. Data on Sprague's Commercial and Entertainment Grade Yellow-Jacket Capacitors (Types 148P and 149P) is given in Bulletin 2063A. Both bulletins are available from Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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CIRCLE 12 ON READER-SERVICE CARD

NEWS

increase systems power requirements.

Important progress is also being made in the infrared field. High resolution is being achieved as optics and detectors improve.

The ability to penetrate darkness and camouflage to pick up radiation from below gives IR systems an advantage over optical systems in airborne applications. Clouds, fog and rainstorms again greatly attenuate signals, and atmospheric absorption by CO₂ and water vapor allow only radiation at particular wavelengths to reach the airborne sensing system.

Project Midas, for Missile Defense Alarm System, has led to much speculation about the ability of a satellite infrared system to identify missile plumes. Spectral analysis of radiation from the plumes might permit identification according to wavelength distribution.

One complication involved in this energy-distribution analysis is that incandescent gases transmit most energy at the frequencies where they are most absorbent. Since missile plumes contain large amounts of CO₂ and water vapor, much of the radiation from them is attenuated by the atmosphere. Since there are other substances present in the burning fuel, other high-radiation wavelengths may be found by spectral studies of actual missile launchings.

Another problem is that there are only small differences between the spectral



Aerojet-General SD-2 surveillance drone tested by Army Signal Corps has short-range radio command system and carries preprogrammer for longer flights.



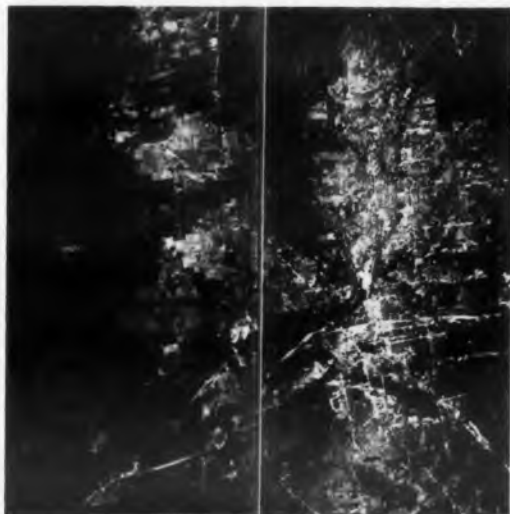
Baja California peninsula as seen by the wide-angle lens of Tiros I. Poor TV resolution provided by vidicons may be improved with ruggedized image orthicons.

signatures of various hydrocarbon fuels.

The scanning speeds of infrared systems are limited by the relatively slow time constants of detectors. Some of the fastest detectors now developed might provide scanning speeds up to 1 mc, compared to about 4.5 mc and faster for television systems. Scanning speed can be defined as the number of changes in light intensity which can be measured in a second.

Spectral measurements from satellites might be performed by a radiometer or a spectrometer. A radiometer uses filters to select the particular wavelengths to be analyzed. A spectrometer disperses the light, using a prism, before analyzing distribution of energy. The dispersed radiation can be physically scanned over a single detector, or an array of detectors can be used with constant monitoring of the energy received by each detector. Where a source of radiation varies rapidly with time, as is the case with a missile plume, the second method may be preferable because the total radiation variations would cause an error in the spectral distribution analysis. This defect might be made negligible with a scanning type system, however, if scanning rates were high enough so that very little change in total radiation occurred during a scanning cycle.

Field of view is another important consideration with an aerial system designed to survey large areas of the ground. A maximum field of view of about 1 minute of arc is possible with a spectrometer, because a wider field would enter too



Side-looking radar view of Fort Worth, Tex., lower right, shows how high buildings reflect much energy and little return is received from flat Arlington Lake, upper right. Texas Instruments¹ AN/APQ-55 system produced the map.

much extraneous radiation for accurate analyses to be made. With a radiometer, more useful for measurements of weather phenomena or similar applications where resolution is not so important, fields of view up to four or five minutes might be used.

The area of the detector used is a limiting factor in resolution achievable with infrared systems. Single element detectors down to about 0.1 sq mm in size have been produced.

Photography has not been left out in the search for suitable systems for unmanned aerial reconnaissance. Techniques for scanning a photo taken by an airborne vehicle and returning it to the ground by radio link with little resolution loss are under development.

One recently developed system suitable for this is the Photoscan system designed by CBS Laboratories, Stamford, Conn. (*ED*, March 16, p. 34). This system uses a flying spot scanner with a unique tube design to accomplish transmission with little loss of detail.

Low-light level image orthicons are under development by many companies in order to overcome one inherent defect of TV surveillance—the inability to penetrate darkness.

Integration of light received by the image orthicon tube over a period of time allows scenes at very low light levels to be received and transmitted to the ground at video frequencies. Image motion compensation becomes a difficult problem with an integrating type system.

The use of light intensifiers with the image orthicon can serve to increase signal strength. ■■



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CIRCLE 13 ON READER-SERVICE CARD

Motorola Unveils 19-In. Battery TV Set

WHILE anxious eyes looked to the Far East for the promised flow of direct-view, transistorized battery TV receivers, Motorola, Inc. of Chicago, Ill., unveiled its large-screen, 19-in set in New York City.

The 22-transistor, 12-diode receiver, resulting from an intensive research program, materially alters the import threat and its potential impact on the American market. With production deliveries scheduled within a month, the U. S. consumer may link "transistor TV" with "19-in. screen" before the first Japanese midget sets appear on dealers' shelves. The 40-lb American-made 19 in. set is priced at \$275 (less battery, which is expected to cost about \$100) compared to the \$250 tag (battery included) originally scheduled for the 8-in. Sony portable, due within the next few months. The Sony is expected to weigh in at 20 lb.

The large-screen Motorola star swam into its ken amid clouds of market-research controversy. U.S. TV makers had claimed that buyers would shy away from the small imported models; im-

porters had merely smiled and said sales figures would upset the market-research predictions.

15-Kv High-Voltage Supply

To achieve the high brightness and small spot size necessary for comfortable viewing in open areas such as patios or beaches, 15-kv sec anode voltage is applied to the picture tube; voltage regulation is within several hundred volts when changing from a bright to a dark scene. To minimize battery drain, the specially designed picture-tube heater operates from 12.6 v at 150 ma, a 50-per-cent power reduction over conventional tubes. The accelerating anode is supplied with 100 v tapped from the flyback transformer and rectified by a silicon diode. The picture tube is a type 19AEP, a standard modified 19XP4.

2,500-Hours Silver-Cadmium "Energy Cell"

The power requirements for the receiver are 120 v ac at 0.33 amp and 20 v dc at 1.5 amp with the optional "energy cell" or silver cadmium battery. An average of five to six hours viewing

is possible before recharging is necessary. A minimum of 500 recharge cycles is claimed. Other benefits include almost constant voltage delivery until end of discharge, exceptionally long shelf life and no damage due to complete discharge (possible, for example, if a set is inadvertently not turned off).

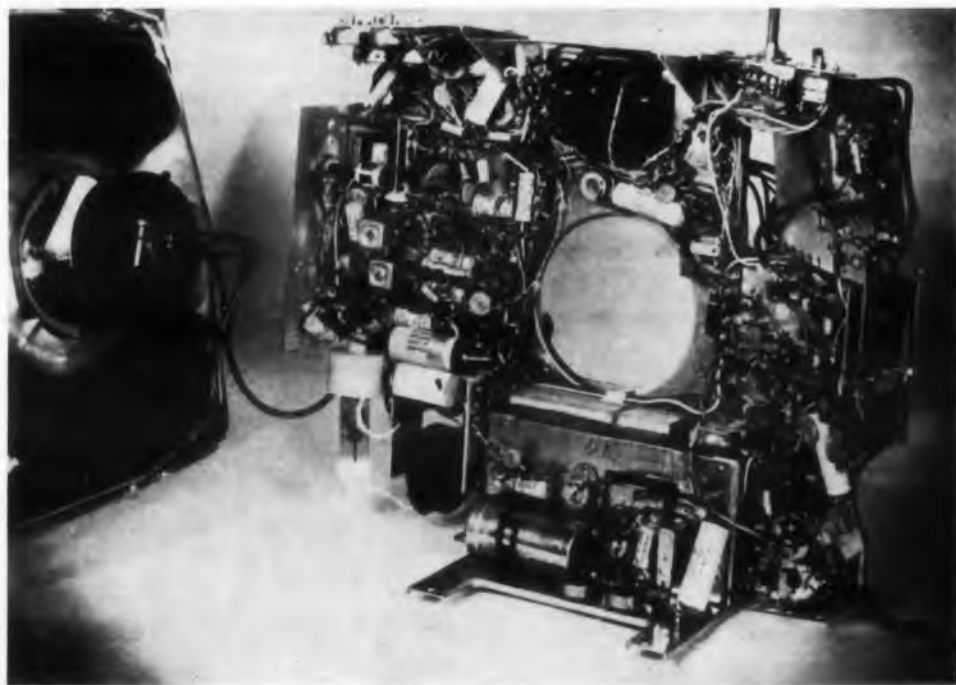
The set may be operated from 110 v ac or the energy cell. A relay-controlled battery charging circuit permits the energy cells to be recharged while the receiver is on ac. Over-charging is prevented by the relay cut-out provision.

Video Response 3.5 Mc

A three-stage video if section, at a video carrier frequency of 45.75 mc, contains a bridged-T filter to achieve greater than 70-db attenuation at the 47.25 mc lower adjacent-channel sound frequency plus two 39.75 mc traps for 50- to 60-db reduction of upper adjacent-channel video frequencies. The over-all bandpass of the if section, using two double-tuned and two single-tuned circuits, is 3.5 mc. To maintain a uniform signal



Thirty-watts (20-v, 1.5-amp) input power is supplied by the silver cadmium energy cell shown mounted in the lower center of the chassis. An average of five to six hours viewing time is claimed before recharging is necessary; a minimum of 500 recharges can be expected.



The picture tube and deflection yoke may be easily removed from the cabinet and chassis assembly when servicing is necessary.



Accessible operating controls for the 22-transistor, 12-diode 19-in. receiver include agc, volume/on-off, contrast, brightness and station selector.

level over a wide range of signal-level inputs and to minimize fading due to signal propagation and reflection from airplanes, an amplified keyed agc system is employed. A three-position ("Local," "Suburban" and "Fringe") switch is provided as a front-operating control.

The 4.5-mc intercarrier sound signal is applied to a ratio detector and then to a two-stage transformer coupled amplifier, feeds a Class-B audio output stage which drives a 3 x 5 in. oval speaker. Maximum output, at 10 per cent distortion, is greater than 650 mw.

The detected video signal is amplified in a two-stage video amplifier to obtain a 90 v p-p voltage for application to the kinescope cathode. Both horizontal and vertical blanking are applied to eliminate retrace lines or "veils."

Sensitivity is 15 μ v for 20 v Output

Approximately 15 μ v is required at the tuner input for 20 v p-p video output. Tuner noise figures vary from 8 to 10 db depending on channel frequency. The three stage tuner, consisting of an rf amplifier, oscillator and mixer, uses MADT transistors. Plug-in UHF strips simplify modification for VHF-UHF operation.

Sync signals from the video section are clipped and amplified in a two-stage sync arrangement. Horizontal afc, by means of a duo-diode detector, stabilizes the 15,750 cps blocking oscillator. The horizontal output stage, isolated from the oscillator by a buffer stage to reduce loading, supplies 13 amp p-p sawtooth current through the low-inductance (97 μ h) horizontal yoke winding. Also, 15 kv for high voltage and 100 v for kinescope accelerating grid and video amplifier supply are tapped off the flyback transformer.



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Parameter	25°C Conditions	Min.	Max. Units
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$V_{CE(sat)}$	$I_C = 20\text{ mA}, I_B = 0$	0	— V
f_{max}	$V_{CE} = 10\text{ V}, I_C = 1\text{ mA}, f = 1\text{ kc}$	40	120 —
f_{Tc1}	$V_{CE} = 10\text{ V}, I_C = 1\text{ mA}, f = 1\text{ kc}$ $T_A = -55^\circ\text{C}$	30	— —
f_{Tc2}	$V_{CE} = 10\text{ V}, I_C = 1\text{ mA}, f = 1\text{ kc}$ $T_A = 150^\circ\text{C}$	—	100 —
f_{Tc3}	$V_{CE} = 10\text{ V}, I_C = 100\text{ }\mu\text{A}, f = 1\text{ kc}$	20	— —
f_{Tc4}	$V_{CE} = 10\text{ V}, I_C = 100\text{ }\mu\text{A}, f = 1\text{ kc}$	30	— —
f_{Tc5}	$V_{CE} = 20\text{ V}, I_C = 0$ $T_A = +150^\circ\text{C}$	—	5 μH
C_{ob}	$V_{CE} = 10\text{ V}, I_C = 0, f = 1\text{ mc}$	—	5 μF
F_T	$V_{CE} = 15\text{ V}, I_C = 10\text{ mA}$	200	— mc



NEWS

Component Progress to Depend On Basically New Structures

"In the next decade we are going to see some important improvements in traditional devices, but our greatest progress will depend on development of basically new structures." Designers attending the 1960 Electronic Components Conference in Washington heard H. A. Stone, director of component development at Bell Telephone Laboratories, make this statement at the opening session of the conference, "Quo Vadis 1970."

Other points made by Mr. Stone were:

- "We are rapidly reaching a point where the great number of parts in a system will preclude any reasonable expectation of system reliability, on one hand, and any possibility of effective maintenance on the other."

- "Things that were too big to handle have become too small to handle. We're reaching the point of diminishing returns in reducing size of components."

- "There will be modification of the micro-module concept, but during the next decade the concept, or something like it, will certainly come into being as a discipline for the organization of our new components into systems."

- "Although there will be great advance in miniaturization in the next 10 years, standard components will be around."

At the conference, which was attended by some 600 registrants, miniaturization and molecular electronics received heavy emphasis. More than half the 31 papers delivered at six technical sessions covered these areas.

Following are some of the highlights of the miniaturization sessions:

- "In Britain," said G. W. A. Dummer of the Royal Radar Establishment, "maximum attention is being given to the solid-circuit approach. The microcircuit or flat-plate approach to miniaturization is being used as the medium in which to gain reliability experience. It is proposed to fit a number of subunits, each containing a stack of wafers, inside equipment containing micro-miniature assemblies. A technique for assembling the subunits using a very thin, miniature, wrapped joint is being developed. In the United Kingdom, most encouraging results have been obtained with wrapped joints as reliable connections."

- A new type of microminiature hermetically sealed transistor enclosure was reported by F. K. Clarke of the Philco Corp. Suitable for counting on a multielement wafer, the enclosure measures 0.18 by 0.13 by 0.6 in. The unit, said Mr. Clarke, can be mounted simply by insertion into a slot in a wafer. Its electrical leads emerge from the



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TO THE ENGINEER

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If you need simultaneous transfer of a large number of circuits without fail, take a look at AE's new WQA relay. It will do the work of four or more heavy-duty, general-purpose relays each with maximum spring pile-ups, and sustain 50 million or more operations without readjustment.

In the WQA relay, all moving springs pass through holes in a unique actuating "card." Moved directly by the armature, the card in turn actuates all the moving springs. This method of operation pre-establishes exact timing and sequence of all spring operations, and at the same time assures perfectly syn-

chronized "break-before-make" on all circuits. Contact capacities on WQA relays can be custom-tailored to your needs, with either one, two or three levels of contact assemblies available, each with a capacity of 17 Form C combinations. Other Forms available.

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If you'd like more information on the WQA relay, address your request for Circular 1957 to: Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

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package in the horizontal plane, greatly simplifying connections to other components. The enclosure, he reported, permits component densities of 1 million parts per cu ft, "about 16 times greater than present maximum component density."

Electronic Gimmicks From Japan Draw Crowds at World Show

Japanese consumer products stole the electronics show at the recent U.S. World Trade Fair. In addition to exhibiting the largest volume of electronic equipment, the Japanese showed their latest advances in transistor radios, tape recorders and television sets.

One of the most popular products seen at the Japanese pavilion was a portable transistorized television receiver. Its developer, the Sony Corp., expects the device to be available in the U.S. by August of this year. It will sell for about \$250. The receiver is said to be fully compatible with U.S. broadcasting standards. Sony is now producing 2,000 sets per month, and will increase production to 10,000 per month before the end of the year.

WESCON Sets Entry Rules For Industry Design Contest

Plans for the second Industrial Design Awards program of WESCON have been drawn up and entrants officially invited, according to Kenneth J. Slee, chairman of the contest.

To enter the event, entries must be the product of a WESCON member company, an exhibitor at WESCON, or the product of a company exhibiting in WESCON through an authorized exhibitor. The product must be an industrial electronic product, an electronic component, instrument or complete system. Systems too large to be transported to Los Angeles for the August show will be displayed through photographs. All entries must have been in production prior to June 15, 1960, which is the deadline for the program.

Two kinds of awards are presented for winning designs. The WESCON Award of Excellence will honor the product designs judged to be superior. The Award of Merit will be given to all products selected for display in the exhibit.

The program, originated last year, will be expanded and diversified at this year's show, Mr. Slee said. Brochures describing the program and rules for entry have been received by about 1,000 electronics companies, he added.

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SPECIFICATIONS

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10 cps to 1 Mc

RISE AND FALL TIME

Less than 10 millimicroseconds

RELATIVE PULSE DELAY

200 millimicroseconds to 50 milliseconds

JITTER (Pulse widths, relative delay, rep rate)

0.1 percent

TRIGGER OUTPUT

Positive 25 volt pulse

EXTERNAL DRIVE

3 volts rms required (0.1 volt or 2 msec equivalent jitter referenced to Pulse Output)

ELECTRONIC GATE

10 volts required

OUTPUTS

Two Pulses at one output connector, independently variable in width and relative delay

PULSE WIDTHS

100 millimicroseconds to 50 milliseconds

PULSE AMPLITUDE

0 to 50 volts maximum
0 to 500 ma maximum

POLARITY

Positive or Negative Pulses available

DUTY FACTOR

50 percent

OUTPUT IMPEDANCE

50, 93, 125, 185 or 200 ohms available (selected by front panel switch)

OUTPUT ATTENUATOR

1:1 to 200:1 coarse selector, 3 to 1 vernier control

Here at last is a pulse generator which can shoulder a broad range of applications . . . a flexible, reliable pulser whose fast rise and low jitter features make it the most advanced instrument of its kind. With its provisions for external drive and electronic gating, its enormous range in pulse widths and delays, and the arbitrary cable impedance feature, you'll find the E-H 130 indispensable for almost any pulser job. Call, write or wire E-H for more information today.



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NEWS

Rocketeers Hear Sun-Power Papers

*ARS Los Angeles Meeting
Runs Gamut of Techniques*

THE COMPLETE range of techniques for converting solar energy to useful power for space vehicles was worked over at solar-power sessions of the American Rocket Society's meeting in Los Angeles. Thermionic and thermoelectric devices, solar heat engines, photogalvanic solar batteries and solar regenerative fuel cells were among those techniques under close scrutiny.

William C. Savage, a senior research engineer at the Wright Air Development Div., described the over-all WADD Solar Program. It involves the cooperative effort of five division laboratories—covering photovoltaic conversion, photoemissive conversion, photolytic conversion and various kinds of solar thermal devices.

Conversion Means Loss

Photovoltaic conversion systems in use today are not mechanically oriented toward the sun and lose efficiency, Mr. Savage told the Rocket Society. "Explorer VI exhibited an over-all efficiency of about 1.5 per cent. If it were fully oriented it would have an efficiency of about 6.5 per cent, using 8 or 9 per cent solar cells," he said.

One system being developed for WADD will have the capability of full orientation, Mr. Savage said. "In a fully oriented system like this," he pointed out, "it is important to keep bearing friction and slip-ring friction near zero. The solar array will be rotating continually with constant velocity."

Mercury bearings are being investigated at WADD. Calculations show the frictional drag to be orders of magnitude less than that

◀ CIRCLE 17 ON READER-SERVICE CARD

for the most delicate instruments which use ball bearings. In a zero-gravity field the mercury will support the solar-paddle shaft; loads from sudden acceleration would be absorbed by a steel shaft on a Teflon collar.

"A major area for improvement of solar power systems lies in energy storage," he said. "Nickel-cadmium batteries appear to have the best cycle life time; but their storage capability is poor."

Accurate design criteria for solar batteries are currently being established at WADD, Mr. Savage said. Tests are being conducted on 50 type-F NICD batteries simultaneously, using a newly developed solar cell simulator which will assure charge conditions similar to system operation.

Research is being conducted in an effort to achieve 15 per cent efficient silicon solar cells. "These improvements can be accomplished by reduced contact and sheet resistance, accurate control of impurity diffusion, improved surface coatings and reduction of reflection losses," Mr. Savage observed.

Photoemission phenomena are also scheduled for investigation under the WADD program, he said. Work will be done in the selection of optimum materials, fabrication of three laboratory models and investigation of their characteristics.

SPACE BRIEFS

INTERPLANETARY NAVIGATION will require a clock that will tell crew members the astronomical time and, because it is calibrated in microseconds, help them make computations, says the University of Michigan in a report to the Air Force.

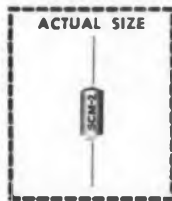
SATELLITE DIGITAL PROGRAM and storage system is to be developed by the Hermes Electronics Co., of Cambridge, Mass., under a \$75,000 contract from the Applied Physics Laboratory.

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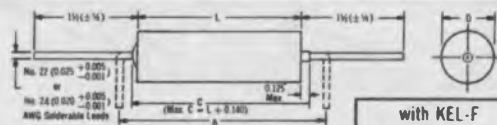
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case size	with KEL-F insulating sleeve		with Mylar insulating sleeve**		avg. wt. gms.
	D	L	D	L	
F	0.125	0.250	0.162	0.337	0.5
B	0.175	0.438	0.210	0.525	1.3
G	0.279	0.650	0.315	0.735	3.1
H	0.341	0.750	0.377	0.835	3.9

* Dimension "A" determined by suspending a one-pound weight from one lead and rotating the case from the vertical position to the horizontal position, and then repeating the procedure for the other lead.

** Meets all requirements of MIL-C-55057 and MIL-C-21720A, including dimensions.



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At light-table, Lee E. Zeunen (right) and Du Pont Technical Representative Wray Hushebeck examine a finished intermediate. States Mr. Zeunen: "We've added a number of new accounts because of better service at lower prices—made possible by CRONAFLEX."

"Durability, versatility of CRONAFLEX® helped us double production last year, while cutting costs 50%"

—Mr. Lee E. Zeunen, General Manager, Capitol Reproductions Inc., Detroit, Mich.

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Mr. Zeunen finds that CRONAFLEX saves time and money other ways as well. "For example," he explains, "what were once 15-minute exposures now take us 30 seconds with CRONAFLEX. And, because this film is so easy to handle and process, we're able to offer our customers same-day service on jobs that used to require 3 or 4 days!"

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CRONAFLEX in providing complete engineering reproduction services. "Adhering, as we must, to rigid tolerance specifications," continues Mr. Zeunen, "we depend on CRONAFLEX for consistent uniformity. In addition, better resolution and equalization of line densities have improved the quality of finished work considerably. In short, we've found that CRONAFLEX permits us to deliver precision reproductions faster and cheaper."

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NEWS

Aim For 10-Kmc

General Telephone Project Has Already Reached 4 Kmc

DEVELOPMENT of tunnel diodes with cut-off frequencies up to 10 kmc using a structure easily adapted to production is the aim of a program now in progress at General Telephone and Electronics Laboratories, Bayside, N.Y.

Germanium tunnel diodes oscillating up to 4 kmc, type D4115B, have been developed and are available in sample quantities at \$100 each from Sylvania Electric Products, Inc.'s Semiconductor Div., Woburn, Mass. Diodes with 3 kmc cut-off, type 4115A, \$75 each, and 2 kmc cut-off, D4115, \$50 each, are also available from GT&E.

The 4-kmc tunnel diodes have a peak current of about 1.5 ma at 50 mv, with valley voltage of about 310 mv.

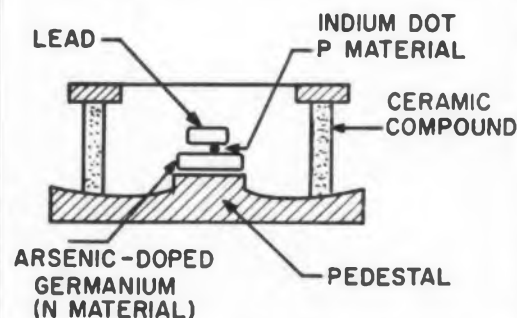
The diodes are contained in a ceramic package suitable for stripline or cavity applications. In the laboratory, they oscillate in a microwave cavity sealed by an aquadag-covered lucite washer.

The cavity acts as an inductance, and a Mylar sheet between cavity segments acts as a bypass capacitor.

GT&E researchers expect to reach about 6 to 8 kmc using germanium with the present ceramic package. Gallium arsenide will be used to reach for 10 kmc, according to George Dermitt, section head, advance device research section.

Frequency Is Inductance-Limited

The inductance of the small package being used in the GT&E program limits the frequency



Basic tunnel-diode structure used in General Telephone Labs high-frequency development program shows how ceramic ring encases the diode. Contacts at both ends are gold-plated Kovar.

Tunnel Diodes



4-kmc tunnel diode is placed in the microwave cavity used in GT&E Labs experiments. The cavity acts as an inductance and the Mylar sheet surrounding the cavity acts as a bypass capacitor.

which can be reached, according to Mr. Dermitt. Inductance is on the order of 0.2 nanohenry for the 0.057-in. high, 0.120-in. diam package.

Frequency is inductance-limited in accordance with the basic equation for oscillation:

$f = 1/2 \pi \sqrt{LC}$, which is approximately valid for a tunnel diode operated near its cut-off frequency. Inductance in the diode must be small enough so that the frequency given by this equation is lower than the resistive cut-off frequency of that particular diode. This resistive cut-off frequency can be defined as the point at which the negative resistance of the tunnel diode's equivalent circuit becomes zero when looking into the terminals of the circuit.

The ceramic diode package uses indium as *p*

Package Uses Indium Germanium

material, and heavily arsenic-doped germanium as *n* material. Contacts are gold-plated Kovar.

Measurements used in predicting cut-off frequencies are one of the primary problems in the program, according to Walter Hauer, research engineer in the systems and circuits laboratory. The very low inductances can not be measured on a conventional bridge because of the large series inductance in series with the tunnel diode on the bridge.

Present makeshift measurement techniques permit prediction of cut-off frequency only within about 20 per cent, Mr. Hauer said. ■ ■

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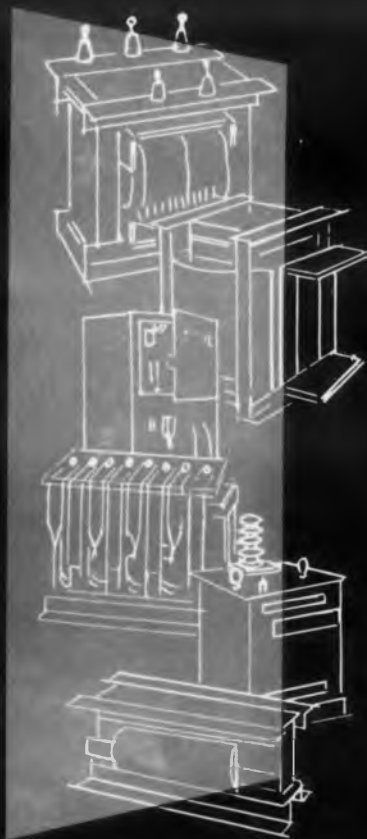
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CIRCLE 21 ON READER-SERVICE CARD

WASHINGTON REPORT



Ephraim Kahn

COMPONENTS DEVELOPMENT is a key to effective weapons system design and development, asserts Lt. Gen. Mark E. Bradley Jr., Air Force Deputy Chief of Staff, Materiel. A sense of urgency, plus a speed-up in components development obtained through taking full advantage of existing knowledge and techniques enabled the Hound Dog missile's lead-time to be cut by about 20 per cent, he noted. As to design and selection of components for missile systems: "The more nearly the advanced research aspects have been eliminated, the surer one can be of success."

GOVERNMENT BUDGETING PROCEDURES are hampering scientific research intended to help the military, according to testimony given to the Senate National Policy Machinery Subcommittee. Important developments take time. They are best accomplished under programs which are expected to last for several years, with money available so that managers can count on continuity. And the programs "must be responsive to current results and must be capable of rapid re-orientation." One annoying aspect of this problem is that the military budget accounts for R&D programs and their supporting facilities and equipment in separate categories. This has caused some delays. Congress has been asked—but probably will not agree—to provide enough R&D money for a three- to five-year period.

BASIC RESEARCH SPENDING by the Air Force is slated to be increased by \$7 million a year for the next few years. Air Force Secretary Dudley C. Sharp wants to keep the service from "falling behind" in the R&D race. "An increasing part of our money" must be devoted to exploiting promising avenues in R&D, he notes. "If we wait until our technology is ready before deciding to produce, we are destined to have an obsolete weapons system." If, on the other hand, "we have the courage to anticipate the varying states of the art . . . we have the chance of attaining the optimum in modern weapons." Stress on R&D (which will take funds away from production) will inevitably produce "more expensive weapons systems," Sharp avers. This can, however, be offset (in theory at least) by the expectation that fewer new systems will be needed to do the job.

INCENTIVE CONTRACTS have been sharply scored by Chairman Carl Vinson (D, Ga.) of the House Armed Services Committee and its special Procurement Subcommittee. He has directed the committee's staff to cooperate with the General Accounting Office to curb all negotiated defense contracts and to try to devise safeguards to the government to be

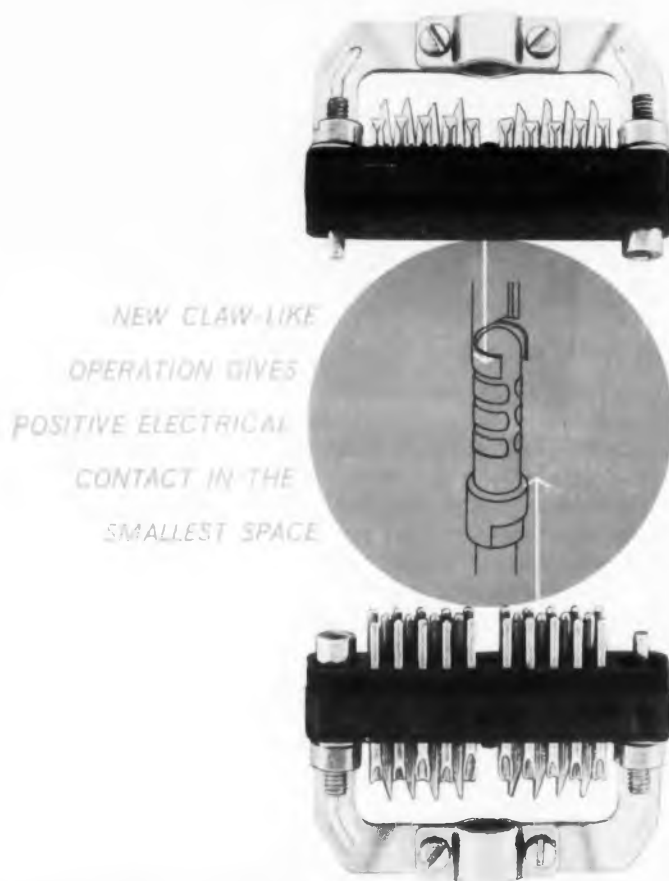
incorporated into these pacts. Congressman Vinson wants: (1) maximum competition, (2) use of the best type of contract for each purpose, and (3) complete and accurate cost information to be made available to the government before prices are set or contracts signed.

TECHNOLOGICAL BREAKTHROUGH on a grand scale seems remote, says a former (1953-56) Assistant Air Secretary for Research and Development. Seeing today's balance of power as "perhaps a temporary balance," Trevor Gardner told Sen. Philip A. Hart (D, Mich.) that he sees little hope of improving the total U.S. security position by advances in weapons technology. In fact, he observed, "most informed people in this field believe that it is highly improbable that either side or any nation can invent their way out of trouble by developing a new decisive weapons advantage through science and technology. It just doesn't seem to be in the cards for the ten- or even the 20-year cycle."

TECHNICAL PERSONNEL TURNOVER, especially in top-level jobs, is "one of the most serious problems" facing the Defense Department's scientific activities, states Dr. Herbert F. York, Director of Research and Engineering. As things stand, many people with great responsibilities occupy top spots only for the amount of time necessary to master problems, not see them through to solutions as well.

AIR FORCE EQUIPMENT TEST REPORTS made in the course of its activities will be given very restricted distribution in the future. There have apparently been complaints that competitors have obtained copies of Air Force reports in which commercial equipment is evaluated. This is specifically banned in a new regulation, which also asserts that before any reports are issued, steps will be taken to make sure that manufacturers' proprietary rights are protected. Reports will not include "any portion of test results that concern the equipment of another manufacturer. This applies at all times, even when comparative tests are made." In any case, release of the report to the maker of equipment himself is discretionary. Reports will show whether the equipment that was tested is suitable for use by the Air Force. A summary of defects will be given if it is not acceptable.

CUTTING DOWN LEAD-TIME so that only four years elapses between evolution of a new concept and finished hardware in the hands of troops is an Army objective. Its R&D chief, Lt. Gen. Arthur G. Trudeau, is trying to speed things by overlapping and telescoping some phases of the R&D cycle. It is starting production engineering as early as possible in the development cycle and doing user and engineering testing concurrently or on a combined basis. Speaking of the "quantum jump" taken by electronics in the past decade, General Trudeau comments that "a cubic foot of space which only yesterday held 7,000 parts, now holds 350,000; and even this figure can be increased by a factor of ten in certain fuse applications. Using solid circuit techniques, even this is only a beginning."



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Therlo matches such commercially hard glasses as Corning #7052 and #7040 in expansivity from 80° C to the annealing point. In every case where Therlo has been specified the resulting reduction in rejects both in fabrication and glass-sealing production have cut production costs impressively.

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CIRCLE 23 ON READER-SERVICE CARD



CHANGES IN PRICES AND AVAILABILITY

TWENTY SILICON JEDEC DIODE TYPES are available in four complete series from International Rectifier Corp. of El Segundo, Calif. All units are hermetically sealed and high current loads for each series are carried without the need for a heat sink. Designed for use in applications requiring high forward conductance and low leakage current at high temperatures are types 1N440 through 1N444; 1N440B to 1N444B; 1N1487 to 1N1492 and 1N1692 to 1N1695. Prices for the units in quantities of to 99 range from 70 cents to \$4.45 each.

NUVISTOR SMALL SIGNAL TETRODE No. A-2654 is now available to equipment manufacturers on a limited sampling basis. The new tube is one-third the size of conventional rf-amplifier tetrodes, and consumes about one-half the heater power. Radio Corp. of America's Electron Tube Division at Harrison, N.J., gives maximum ratings of 250-v plate voltage, and 2.2-w plate dissipation.

SMALL SIGNAL SILICON TRANSISTOR types 2N698 and 2N699 made by the Fairchild Semiconductor Corp. of Mountain View, Calif., will replace earlier types 2N332 through 2N341, 2N342A and 2N343.

SILICON SINGLE CRYSTALS for computer switch diodes are available in commercial quantities from E. I. DuPont de Nemours & Co., Inc. of Brevard, N.C. The crystals, which have been doped with microscopic quantities of gold, are priced at \$1,000 a pound. They are also available at \$2.20 a gram.

DRIFT-FIELD GERMANIUM TRANSISTORS of the pnp type are available at Radio Corp. of America's Semiconductor and Materials Division of Somerville, N.J. The new group includes converter types 2N1526, 2N1527, 2N1635, 2N1636 and 2N1639; if-amplifier types 2N1524, 2N1525, 2N1631, 2N1632 and 2N1638; and rf-amplifier type 2N1637. In addition to a small case and only three leads, these transistors feature uniformity of characteristics, exceptional stability, and low feedback capacitance. They offer various rf-amplifier, if-amplifier and converter transistor complements in a wide range of collector-to-base voltages, small-signal current transfer ratios, alpha-cut-off frequencies and power gains.

CIRCLE 24 ON READER SERVICE CARD ➤

ELECTRONIC DESIGN • May 25, 1960

National Communications Parley Is Scheduled by IRE Group

The Sixth National Communications Symposium sponsored by the IRE Professional Group on Communications Systems will be held Oct. 3 to 5 in Utica, N.Y.

Concurrent with the symposium, classified sessions will be held under the auspices of the Directorate of Communications, Rome Air Development Center. Participation in these sessions will be limited to United States citizens who are cleared to review secret documents and to foreign government representatives.

Sensitivity Gains Reported For Ground-Based Radar

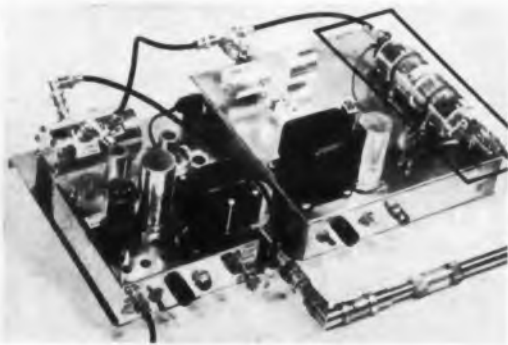
Significant improvements in the sensitivity of ground-based radars have been reported achieved by Zenith Radio Corp.

By combining a new parametric amplifier tube and a method called synchronous pumping, the company said, test results on an L-band radar showed a 50-per-cent increase in range or 125-per-cent increase in area covered.

The equipment was developed by a team of Zenith research physicists, headed by Dr. Robert Adler, associate director of research, in cooperation with Dr. Glen Wade of the Stanford Electronics Research Laboratory.

The parametric amplifier tube, Dr. Adler said, provides high-signal amplification of broad-frequency band, with very low noise and unconditional stability.

With synchronous pumping, the parametric amplifier is energized by the radio frequency of the signal transmitted by the radar. Performance impairment by the idler channel is avoided, Zenith reported.



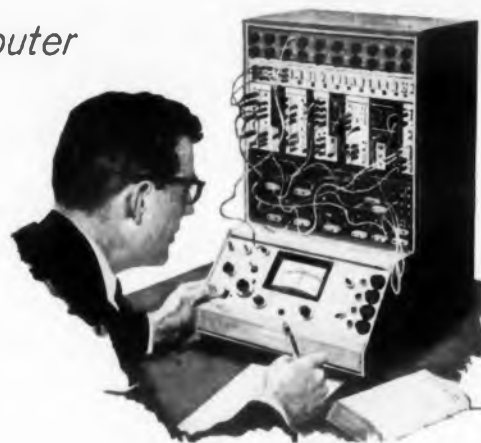
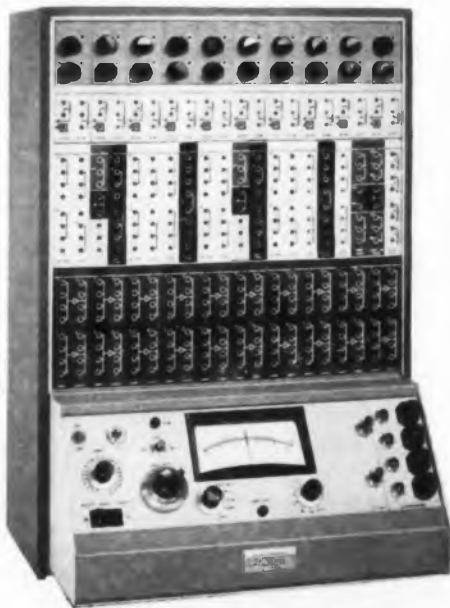
Synchronous pump generator (above) and a parametric amplifier tube (enclosed in rectangle) are combined in a Zenith L-band radar system that is said to offer significant improvements in the sensitivity of ground units.

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ELECTRONIC DESIGN • May 25, 1960

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The TR-10 is especially useful in solving problems in such diverse areas as servo-system design, heat flow, chemical reaction analyses, suspension systems studies and many other problems involving dynamic conditions. Fast answers to problems posed by new design ideas immediately determine feasibility of projects. With the TR-10, engineers can explore new ideas as they occur — concentrate valuable time on the most promising area of study.

(Applications notes are available describing typical problem solutions.)

How Do You Use The TR-10?

First—Represent in equation form the physical system to be studied.

Second—Select through a simple computer diagram the computing components required to perform the calculation (programming).

Third—Interconnect these components on the computer (problem patching) and set problem parameters with adjustable controls.

Fourth—Run the problem with results presented graphically on an accessory recorder or oscilloscope. You now have an electronic analog model of the physical system under study. You can manipulate design parameters quickly, running comparative solutions without becoming involved in repeated calculations. With the TR-10 you can rapidly develop truly optimum designs.

For complete details of TR-10, write for free copy of Bulletin AC 934-FA

PACE TR-10 Analog Computer, including components for addition, subtraction, multiplication, division, integration and generation of powers, roots, logs, antilogs and arbitrary functions.

EAI

ELECTRONIC ASSOCIATES, INC. Long Branch, New Jersey

CIRCLE 25 ON READER-SERVICE CARD

NEW



NEW BORG MICRODIALS ADD RICHNESS AND STYLE TO CONTROL PANELS AND INSTRUMENTS

Now from Borg, originator of famous Microdials, comes a fresh, new concept in turn-counting dial appearance . . . Series 1360 Microdials. These new Borg Microdials were specially developed to add style and color to electronic control panels and equipment. Available in five smart models of red, gray and black color variations. Colors are inlays of colored plastic . . . will never wear, scale or rub off. Quality

mechanical features such as smoothness of action . . . absence of noise . . . fewer ambiguities in reading and setting assure accurate, reliable performance. Contoured brake arms lock settings in place, but do not interfere with reading and setting. Catalog data sheet BED-A137 gives complete color combinations and specifications. See your Borg technical representative or distributor, or let us put him in touch with you.



BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation
Janesville, Wisconsin

Micropot Potentiometers

• Turns-Counting Microdials

• Sub-Fractional Horsepower Motors

• Frequency and Time Standards

CIRCLE 26 ON READER-SERVICE CARD

NEWS

For Spacemen's Beer



This 1-cu-ft refrigerator was designed for use in manned space vehicle. According to the developer, Westinghouse Electric Corp., refrigeration was obtained thermoelectrically, by passing a current through a semiconductor. Heating could have been obtained, the company says, by reversing the direction of current flow. No refrigerant is necessary.

Army Sponsors Development Of Automated Mapping System

A system for automating the processing of data from aerial photographs for use in mapping is being developed by Fairchild Camera and Instrument Corp., Syosset, L.I., N.Y., under a \$283,-116 Army contract.

The integrated mapping system to be developed for the Army Engineer Research and Development Laboratories map compilation branch, will automatically supply contour information, orthophotographs, and a tape-recording of profile information using the output of a standard stereo plotter.

PZT Ultrasonic Transducers Boost Cleaner Efficiency

Lead zirconate titanate transducers are being used for the first time in a commercial line of ultrasonic cleaners. Sandwiched between layers of metal, the PZT ceramic is said to boost electrical-to-acoustic conversion efficiency from the usual 70 per cent for conventional barium titanate transducers to 90 per cent.

The PZT ceramic, known for about five years, has been commercially available for about a year and a half. Branson Ultrasonic Corp. of Stamford, Conn., first to make large-scale use of the material in transducers, claims several advantages in addition to the increased efficiency.

The principal advantage: PZT can be operated at temperatures higher than 200 F, compared with 160 F for barium titanate. Hence, the transducer head can operate over a longer duty cycle; it can be driven with full-wave energy.

Further, the sandwich-type construction allows the head to be reclaimed for a cost of only 20 per cent of the initial capital investment—about a quarter of what it would cost to reclaim a barium titanate transducer.

Lower Frequencies Practical, Too

Since the acoustic velocity in PZT is somewhat greater than that in barium titanate, lower-frequency ultrasonic energy can more easily be delivered to a tank with a given-size transducer. Branson is using 25-kc energy with the PZT rather than the usual 40 kc. This gives greater dispersion of the ultrasound in a cleaning medium and reduces beaming effects.

Branson's enthusiasm for PZT is not shared by others in the ultrasonic cleaning field. A spokesman for Narda Ultrasonics Corp. in Westbury, N. Y. reports that Narda has used PZT heads where specific requirements such as high-temperature operation have called for them.

"But PZT raises problems," he notes. "It's difficult to get PZT material with consistent characteristics."

Branson's answer to this problem is extremely careful selection of transducer-head materials.

Air Force to Centralize Contract Management Setup

The Air Force has announced plans to centralize contract management into three regions—at Wright-Patterson Air Force Base, Dayton, Ohio; Olmsted Air Force Base, Pa., and Mira Loma Air Force Station, Riverside, Calif. All procurement districts and plant representative offices will fall under jurisdiction of one of these regions.

Each region will be responsible for production, quality control and other staff functions. Procurement districts will maintain their prime job of contract administration at their present locations.

Through greater control in a concentrated area, the regional setup is expected to provide more flexibility in operation and savings in costs. The Air Force expects the regions to become effective the first quarter of fiscal 1961.

Constantin LEAK-PROOF GLASS-TO-METAL SEALS

you
can

twist
the
pins



but you **CAN'T** break the seal

CONSTANTIN SEALS REMAIN LEAK-PROOF!

Specially formulated glass making and fusing techniques employed by L. L. Constantin create a seal so rugged the pins can practically be torn off a Constantin header without breaking the seal.

The special construction which locks out atmospheric influences withstands the stresses of assembly line production, prevents leakage and assures longer life for electrical and electronic components.

For positive sealing of standard, miniature or subminiature components — during the crucial assembly stage and in operation — for quality with confidence, use Constantin leak-proof glass-to-metal seals.

Write for our new catalog on Glass-to-Metal seals.



L. L. Constantin & Co.

**MANUFACTURING
ENGINEERS**

GENERAL OFFICES: ROUTE 48
LODI, NEW JERSEY

PLANTS:

ROUTE 48
LODI
NEW JERSEY

5TH AND CAPITOL STS.
SADDLE BROOK
NEW JERSEY

ENGINEERED COMPONENTS for the Electronic Industry



New Teflon* FEP Resin enables Garlock to supply electronic components of complexities never before achieved.

Now—New developments in TEFLON FEP electronic components by Garlock. With the commercial availability of Teflon FEP, Garlock can now process electronic components never before possible with Teflon TFE. The reason is this—whereas TFE must be processed like powdered metals, the new FEP has the advantage of being melt-processed in conventional extrusion and injection molding equipment.

Think of what this means to you as a designer. You can now specify Teflon for the most delicate and complex components you may design. Teflon FEP opens whole new avenues of design possibilities . . . it can be injection molded into close-tolerance feed-throughs, stand-offs, insulators, tube sockets and connectors . . . it can be heat-bonded to itself and other materials, making possible improved printed circuit design. Also available in rod form, sizes $\frac{1}{4}$ " to 3" dia.

Another important point. Developed as a supplement to Teflon TFE, the new FEP resin exhibits the same fine physical properties of chemical inertness, top thermal stability, excellent dielectric strength, and outstanding antistick characteristics. FEP is rated at a continuous service ceiling of +400°F, will resist extreme cold down to -395°F.

At low temperatures, FEP has more impact resistance than any other known plastic. It is virtually unaffected by weather and remains unchanged when subjected to ultra-violet light and ozone attack. Finally, water absorption of FEP is zero!

Turn to Garlock for more information on components of new Teflon FEP. Your Garlock Electronic Products rep-

resentative will be glad to give you complete details. Call him, or write for Catalog AD-169, Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

*Du Pont Trademark for TFE and FEP resins

NEWS

Peripheral-Data Machines Seen Boon to Management

By 1965 peripheral data-processing machines will eliminate 75 per cent of the personnel now engaged in data input, the 1960 Northeastern Divisional Data Processing and Computer Conference was told at its recent New York meeting.

Charles F. Winter, sales manager of the Data Systems Div., American Electronics, Inc., said that by automating data input at the source before it goes to the central processor, information that management needs for important decisions will be produced almost immediately. Peripheral machines are proving to be the most rapid and efficient business tools available, he added.

Highly Phase-Stable Filters Key to New Function Computer

Highly stable filters have been designed into a new cross-spectral density-and-transfer-function computer to permit fast and efficient computations based on random and periodic signals.

The manufacturer, Ortholog Div. of Gulton Industries, Inc., says use of the new filters in conjunction with spectral-analysis techniques makes possible the efficient performance. The computer has a bandwidth of 3 cps to 3 kc and a claimed amplitude error of less than 1 per cent.

The computer is said to be particularly useful in the structural analysis of equipment under vibration test on shake tables and in other testing situations.

The units are priced at \$20,000 to \$40,000.

Army Computer Method Gathers Radio-Propagation Data Rapidly

A computer technique for swift calculation of the Maximum Usable Frequency (MUF) and the Lowest Useful High Frequency (LUF) for any radio skywave path has been perfected.

Developed by the Army Radio Propagation Agency at Fort Monmouth, N.J., the new procedure reduces the time for gathering radio-propagation data to approximately four minutes. Standard mathematical calculations to obtain the same information take three hours manually. Moreover the machine method is said to be more accurate.

The computer application has been under examination for some time, but solution was complicated by the numerous propagational variations

GARLOCK

ELECTRONIC PRODUCTS

to be considered. The technique, applicable to a large-scale, general computer, represents a new step in computer application, the Army reports.

The propagation technique is only a step in the Army's objective toward development of machine radio-frequency management techniques.

Computers and Human Beings To Learn from One Another

Scientists at the California Institute of Technology are using computers to learn more about thinking. They expect the computers to learn a little also.

A new project in the university's recently opened center will merge studies of the human thought process with computer technology.

Data from research on the human nervous system will be fed into a Burroughs 220 computer that has been programed to draft a mathematical model of the human brain. According to Dr. G. D. McCann, professor of electrical engineering and director of the computer center, "The results may produce a new generation of computers that more closely parallel the human thinking process."

The project is being conducted by Cal Tech's biology and electrical engineering faculties.

RAMAC 305 Scores Car Race



Computing equipment is performing more varied jobs than ever before. Here a test report printed by the IBM RAMAC 305 data-processing system is checked by a racing driver entered in the 12-hour Sports Car Endurance Race in Sebring, Fla. According to IBM, RAMAC permitted driver, pit crews, and spectators to know the official standings of all cars while the race was still in progress. The system has a storage capacity put at 5 million digits, and it is said to recall in less than a second.

NEW DELCO 50-AMP. TRANSISTORS

HIGHER CURRENT THAN EVER BEFORE FOR MILITARY AND COMMERCIAL USE

	2N1518	2N1519	2N1520	2N1521	2N1522	2N1523
Maximum Collector Current (Amps.)	25	25	35	35	50	50
Maximum Collector to Base Volts, Emitter Open, Max I _{co} 4ma	50	80	50	80	50	80
Minimum Open Base Volts (1-Amp. Sweep Method)	40	60	40	60	40	60
Maximum Saturation Volts at Maximum Collector Current	0.7	0.7	0.6	0.6	0.5	0.5
Gain at I _c at 15 Amps.	15-40	15-40	17-35	17-35	22-45	22-45
Minimum Gain at Maximum Collector Current	12	12	12	12	12	12
Thermal Resistance Junction to Mounting Base (°C/Watt)	0.8	0.8	0.8	0.8	0.8	0.8

Characteristics at 25°C Maximum Junction Temperature 95°C

A new family of high current transistors featuring the 50-ampere 2N1522 and 2N1523. Two 25- and two 35-ampere types round out the line. All thoroughly tested and completely reliable. Available in production quantities. Call or write your nearest Delco Radio sales office for full product information and applications assistance.

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DEPENDABILITY
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RELIABILITY

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Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

Detroit, Michigan
57 Harper Avenue
Tel: TRinity 3-6560

CIRCLE 29 ON READER-SERVICE CARD

Announcing...

the **NEW**
Franklin Model 500A
Digital Multimeter

all-electronic operation ... 0.1% d-c accuracy

From its extra-heavy-duty case (0.090" aluminum) to its improved all-electronic circuitry... the Model 500A offers more advantages than any other digital multimeter available today. No idle boast! The effectively infinite d-c input resistance (on ranges below 1200 V) permits accurate readings across resistive loads that would be disturbed by the best conventional instrument. Then again, there's the conservative 0.1% d-c accuracy... better than some bridges. Yes—the 500A has the usual features too; like the automatic polarity indication that lets you read negative or positive d-c without reversing leads. The brief specs tell more...



MODEL 500A DIGITAL MULTIMETER
\$1850 F.O.B. BRIDGEPORT, PA.

request
data sheet 2013

brief specifications

RANGES	DC: 0.000 to 1,200, 12,000, 120.0, 1200 V positive or negative (automatic polarity indication). AC: Same as dc ranges (rms value of 30 to 10,000 cps sine wave). OHMS: 0.001 to 1,000 K ohms.
ACCURACY	DC: Better than $\pm 0.1\%$ of full scale. AC: Better than $\pm 0.2\%$ of full scale up to 120 V and 200 cps. Better than $\pm 0.5\%$ of full scale above 120 V and 200 cps. OHMS: Better than $\pm 0.2\%$ of full scale.
INPUT IMPEDANCE	DC: 20 megohms nominal. (Effective input impedance on other than 1200 V range approaches infinity.) AC: 20 megohms shunted by 400 mmf.

POWER REQUIREMENTS	105 to 125 V, 60 cps, 250 W.
DIMENSIONS	Portable model (illustrated): 11 $\frac{1}{4}$ " H x 11 $\frac{1}{4}$ " W x 18 $\frac{1}{2}$ " D. Rack mounting model 19" W.
WEIGHT	45 pounds.
FINISH	Smooth gray baked enamel. White engraved panel designations.
SPECIAL FEATURES	Printer output provisions. Static parallel; binary coded 1-2-2-4 decimal output. (Other codes optional extra.)



FRANKLIN
electronics, inc.

BRIDGEPORT
PENNSYLVANIA

VAN NUYS
CALIFORNIA

You count best when you count on FRANKLIN

CIRCLE 30 ON READER-SERVICE CARD

NEWS

Two New Financing Sources Open to Electronic Firms

Two new sources of financing are available to electronics companies—the Commercial Discount Corp. of Chicago and the Techno Fund, Inc., of Columbus, Ohio.

Commercial Discount offers loans from \$100,000 to \$1 million over a five-year period. The money may be used for such projects as plant expansion, new equipment and new-product development.

The Techno Fund offers loans to "small businesses that normally do not have access to traditional sources of capital."

Commercial says its financing program will not give it a share of ownership or a managerial voice in companies receiving loans. Techno will make loans primarily in exchange for convertible debentures of the borrowing companies.

National Electronics Acquires Industrial Tubes in Merger

The directors and stockholders of National Electronics, Inc. and Industrial Tubes, Inc., both of Geneva, Ill., have approved the merger of the two companies. The two plants will operate under the name of National Electronics, Inc.

Directors and principal officers are: J. H. Hutchings, president and director; L. J. Prevost, vice-president, treasurer and director; R. K. Soderquist, vice president, secretary and director; and R. T. Orth, director.

National Electronics, Inc. a wholly-owned subsidiary of Eitel-McCullough, Inc. of San Carlos, Calif., now claims to be the largest manufacturer of industrial control tubes in the United States.

Permanent U. S. Trade Show Planned in Brussels Center

A permanent exhibition for American industry is expected to be set up in the *Centre International Rogier* in Brussels, Belgium. According to James S. Ross, president of International Permanent Exhibits, Inc., plans for the project are now being readied.

The plans include a staff of professional and technical engineering consultants trained to discuss the products and services of exhibitors. A sizable section of the exhibition would be devoted to audio-visual presentation of exhibitors' films and recordings, Mr. Ross said. The exhibition

would serve industry and the general public throughout the year.

For information concerning display material and literature for European distribution and markets, write International Permanent Exhibits, Inc., 624 S. Michigan Ave., Chicago 5, Ill.

Delaware Leads Nation In Patents Per Capita

Delaware has the highest percentage of inventive citizens in the nation, according to a tabulation of the Patent Office of the U.S. Department of Commerce. During 1959 a total of 46,937 patents were issued to residents of the U.S.—one to every 3,808 persons. Delaware residents received one patent to every 1,205 persons, a total of 360.

New Jersey ranked second, with one patent grant to every 1,472 persons; Connecticut, third, with one to every 1,556 persons. The heavily populated states of New York and California ranked eighth and ninth, respectively.

Patents are now being issued at the rate of about 900 to 1,000 each week. Patent applications are being received by the Patent Office at the rate of about 350 each working day.

U.S. Induction Heater Shown in India



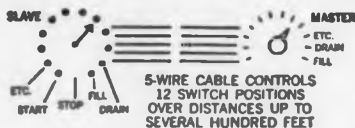
An Indian demonstrator explains an induction heater to crowds at the U.S. Small Industries Exhibit in Bombay. The equipment being demonstrated was manufactured by the Induction Heating Corp., New York.

*have you checked this
Remote Actuator for jobs
under Shock and Vibration?*

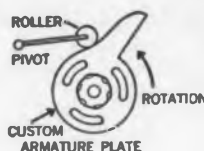
...OAK ROTARY SOLENOIDS

(Mfd. under license from G. H. LELAND, INC.)

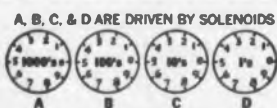
CUSTOM-BUILT FOR—



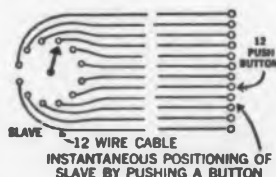
MASTER-SLAVE DEVICES
(Incremental Positioning)



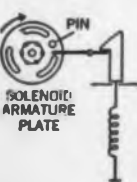
CAM LIFTS



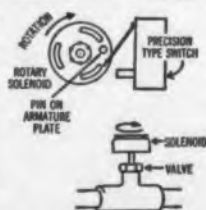
A, B, C, & D ARE DRIVEN BY SOLENOIDS
4 DECADE COUNTER
ADDED SWITCHING ALLOWS
PRESETTING A FUNCTION TO OCCUR
AT ANY COUNT SUCH AS SHUT OFF
WATER AT 397 COUNT, ETC.



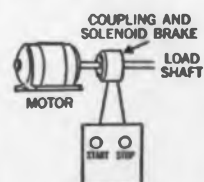
AUTOMATIC SWITCHING



TRIPPING DEVICES



ACTUATORS

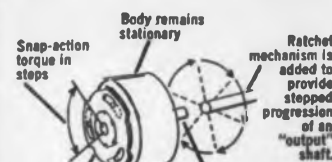


CLUTCHES and BRAKES
(When Modified for Straight Pull)

MODEL 5E
SHOWN ACTUAL SIZE

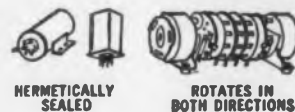


OPERATES IN ANY POSITION

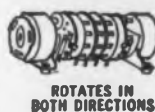


Armature plate rotates through predetermined angle then springs back to original position.
"Solenoid" shaft oscillates with armature... can be supplied at front or rear... other power take-off arrangements also possible.

EXTREMELY ADAPTABLE



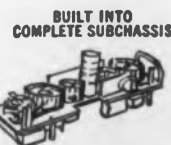
HERMETICALLY SEALED



ROTATES IN BOTH DIRECTIONS



WITH SEALED DUST CAP



BUILT INTO COMPLETE SUBCHASSIS

stepping torques from 6.4 to 64 inch-ounces

If you've been searching for an actuator that meets such specs as MIL-S-4040A, and is remarkably small for the amount of work it can do, investigate Oak Rotary Solenoids. They operate on DC and are designed for intermittent service. Standard models give steps of 25°, 35°, 45°, 67.5°, or 95° in either a left or right-hand direction. Self-stepping or externally pulsed units are also built. Oak Rotary Solenoids find wide use in both commercial and military equipment. Why not evaluate their unusual capabilities for your next project. We will be glad to help you engineer the job. Just send us a short description and sketch.

CIRCLE 31 ON READER-SERVICE CARD

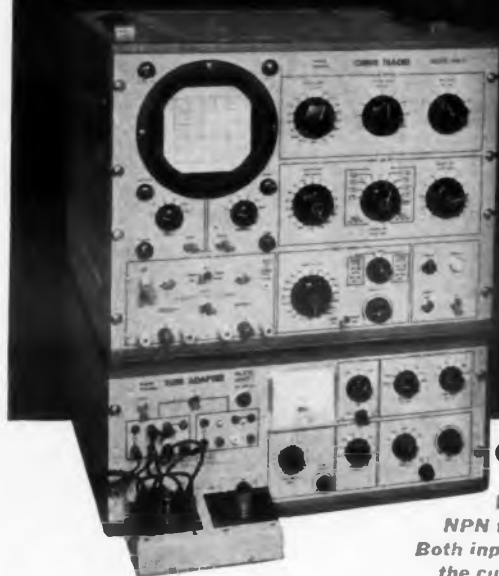
OAK MFG. CO.

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

SWITCHES • ROTARY SOLENOIDS • CHOPPERS
VIBRATORS • TUNERS
SUBASSEMBLIES

Baird-Atomic MEETS THE TEST

WITH THE
MOST COMPLETE
LINE OF
TRANSISTOR &
SEMICONDUCTOR TEST
EQUIPMENT AVAILABLE

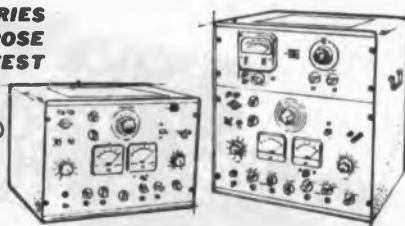


CURVE TRACER, MODEL MW-1 (Shown with tube adapter)

Baird-Atomic's Curve Tracer, Model MW-1, is the finest of its type. It is designed to display families of characteristic curves for PNP and NPN transistors in either common base or common emitter configurations. Both input and/or output current or voltage may be selected as components of the curves displayed. Its operational range includes the highest maximums (30A collector current continuous duty—50A intermittent and 450 watts maximum) and the lowest impedances (minimum observed .001 ohms to 10 megohms) presently available. Maximum input drive current is 5 amperes and the MW-1 features automatic overload protection. These features make B/A's New Curve Tracer the most versatile on the market.

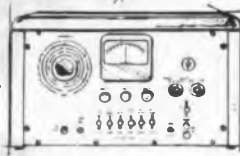
MODEL KP-2 SERIES GENERAL PURPOSE TRANSISTOR TEST SET ▶

(for medium power transistors up to 2 A)



MODEL GP-4 TRANSISTOR TEST SET ▶

(for low power transistors—h parameters)



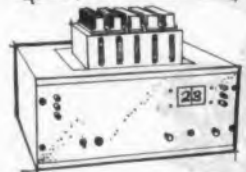
MODEL KT-1 BETA TESTER (for Beta h_{fe} and I_{c0})



MODEL JI SEMICONDUCTOR MINORITY CARRIER LIFETIME TEST SET



MODEL JN RESISTIVITY TEST SET



MODEL NA-1 COMPONENT SELECTOR (for inspection of 2 or 3-terminal components)

For more complete technical data on BA's line of transistor & semiconductor test equipment, write to:



Baird-Atomic, Inc.
33 University Road
Cambridge 38, Massachusetts

CIRCLE 32 ON READER-SERVICE CARD

NEWS

Five Are Appointed Fellows Of AIEE For Achievements

Four communications engineers and an electrical instrumentation specialist have been named Fellows in the AIEE.

The five men were honored, along with 18 power engineers, for "outstanding contributions to the electrical engineering profession."

The instrumentations specialist was Forest K. Harris, a physicist in the Electricity and Electronics Division of the National Bureau of Standards.

The communications engineers were:

Hubert L. Kertz, vice president in charge of the operating staff departments, Pacific Telephone and Telegraph Co., San Francisco.

Wesley C. Lallier, transmission and outside plant engineer, Wisconsin Telephone Co., Milwaukee.
Clarence Amos Wells, transmission and protection engineer, Pacific Telephone and Telegraph Co., Los Angeles.

Robert C. Siegal, chief engineer, Wisconsin Telephone Co., Milwaukee.

Pencil-Sized Devices Block Precipitation Static In Planes

A discharge device has been designed by Stanford Research Institute engineers to eliminate radio static caused when aircraft fly through snow or clouds of ice particles.

The device allows noise-producing corona discharges (St. Elmo's Fire) to occur but prevents them from reaching the radio antennas, the institute said.

The device incorporates a sharp tungsten pin supported by a resistively coated plastic cement for attachment at all points on the aircraft at which the discharges occur.

A typical device to counter precipitation static consists of a nylon rod about the size of a lead pencil, with the tungsten pin crosswise through it at a very carefully determined location from the outer end. The nylon rod is coated with paint having the proper electrical resistance.

2,000 Stereophonic Stations Envisioned in U.S. by 1963

A radio manufacturer predicts there will be 2,000 fm stations broadcasting full stereophonic sound in the U.S. by 1963. Today there are about 900 fm stations, broadcasting monaural sound.

The manufacturer, Henry Fogel, president of Granco Products, Inc., of Kew Gardens, Queens, N.Y., says that fm sales, which passed the million mark in 1959, will reach 4 million yearly by 1963. And he added that a million of these would be automobile radios.

Mr. Fogel made his predictions in an address at the national convention of the National Association of Broadcasters in Chicago. He said that fm offered low-cost, high-quality radio.

Noting that the Federal Communications Commission had set a July deadline for the filing of proposed standards for fm stereophonic broadcasting, Mr. Fogel said that full stereophonic programs could be expected by the end of the year.

Weather Radars Produced For Business, Commercial Aircraft

Radars that enable pilots to spot storms up to 150 mi away from their planes have been produced for commercial airlines and business aircraft.

The radars, manufactured by Radio Corp. of America, come in two sizes. One, which weighs about 125 lb, has a 150-mi range; the other, which weighs about 57 lb, has an 80-mi range.

The antenna is mounted in a radome on the nose of the aircraft. A 5-in. viewing screen is mounted between the pilot and co-pilot.

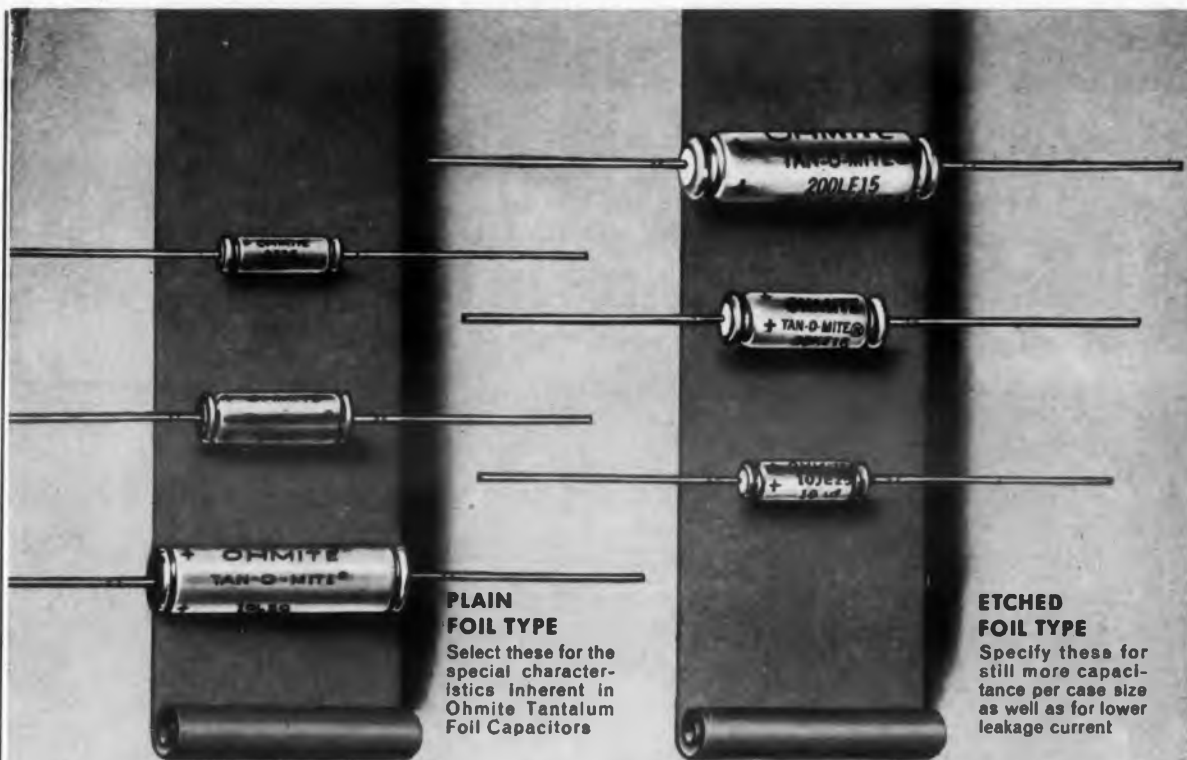
Air Force Allots \$900,000 To Study Image Recording

The Air Force has authorized a \$900,000 study of the idea of recording images on photo-sensitive material and then transferring them to thermoplastic tape.

Light from an image produces a pattern of electrostatic charges on the solid-state photo-sensitive material. The charge pattern will then be transferred to thermoplastic tape.

The pattern—which represents the image—may be made permanent by heating and then immediately cooling the tape. The heating deforms the plastic surface in accordance with the charge pattern. The cooling freezes the surface wrinkles.

In thermoplastic recording, a plastic tape is scanned by an extremely fine electron beam that is modulated by the information to be recorded. This produces on the tape's surface an electrostatic charge pattern of the type that would be obtained from the photosensitive material. The process using electron beam scanning is said to take less than a second.



PLAIN FOIL TYPE
Select these for the special characteristics inherent in Ohmite Tantalum Foil Capacitors

ETCHED FOIL TYPE
Specify these for still more capacitance per case size as well as for lower leakage current

OHMITE TAN-O-MITE[®]

TANTALUM FOIL CAPACITORS ...

BOTH PLAIN AND ETCHED FROM STOCK

- 113 Stock Values
- Polar and Non-Polar Types
- Meets MIL-C-3965B: Insulated and Uninsulated Case Styles; All Vibration Grades
- Extra High Capacitance in Small Case Size
- Great Stability in Use or Storage
- Long Life—in Operation and Storage
- Operates in Wide Temperature Extremes
- Very Low Leakage Current and Power Factor

Write for Bulletin 152F



OHMITE MANUFACTURING COMPANY
3643 Howard Street, Skokie, Illinois

RHEOSTATS • RESISTORS • TAP SWITCHES
RELAYS • R.F. CHOKES • TANTALUM CAPACITORS
VARIABLE TRANSFORMERS • GERMANIUM DIODES

CONDENSED SPECIFICATIONS—Series TF

Construction Tantalum foil in metal cases sealed against atmospheric conditions. Plastic insulating sleeves optional.

Range Plain foil units, 0.25 to 140 mfd; etched foil units, 0.5 to 200 mfd. Working voltages range up to 150 VDC depending on capacitance.

Tolerances (120 cps, +25°C) Plain foil, $\pm 20\%$. Etched foil as follows:

less than 50 volts.....	-15% +75%
50-99 volts.....	-15% +50%
100-150 volts.....	-15% +30%

At extremes of operating temperature, the capacitance change meets MIL-C-3965B requirements.

Temperature Range Operation in ambients from -55°C to +85°C.

Power Factor (120 cps, +25°C) Plain foil, 10-15% depending on voltage rating; etched foil, 15-20% depending on voltage rating.

Maximum DC Leakage Current Plain foil, 0.017 microamps/volt-mfd at 25°C; 0.10 at 85°C. Etched foil, 0.01 at 25°C and 0.06 at 85°C.

CIRCLE 33 ON READER-SERVICE CARD

2 NEW Electrostatic Deflection Tubes Highlight G-E Advances in Display Systems



NEW G-E Z-4718 for transistorized applications

NEW G-E Z-4613—Three-gun tube for improved tracking accuracy

The aim of General Electric research and development in cathode ray tubes is twofold: solve specific customer problems; advance the technology of the industry. Important progress in both areas is demonstrated by two G-E tube advances.

NEW Z-4718—custom designed for shipboard use—is a low drive electrostatic tube permitting utilization of transistorized video drive to effect required space and weight savings. In addition to providing good resolution with minimum deflection defocusing, this rugged, 12-inch G-E tube has passed the MIL-E-1 shock and vibration test to assure reliable operation under severe operating conditions. Z-4718 is an interim design, soon to be superseded by a new line of G-E tubes, which, for many applications, will provide order-of-magnitude improvement in drive requirements.

NEW Z-4613—providing multi-beam tracking accuracy exceeding anything ever produced in the industry—was custom designed by G.E.'s Cathode Ray Tube Department to (1) meet advanced radar system requirements, and (2) simultaneously provide

best state of the art deflection sensitivity for electrostatic deflection tubes within exacting space limitations. G.E.'s five-inch square, three-gun Z-4613—with tracking accuracy of $\frac{1}{2}$ to 1%—successfully met all specifications and is now in service.

WHATEVER YOUR DISPLAY TUBE REQUIREMENTS, General Electric has the personnel, facilities and design skill to provide just the tube to meet your application needs. For additional information, call or write, General Electric Company, Industrial & Military Operation, Cathode Ray Tube Department, Electronics Park, Syracuse, N. Y.

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NEWS

Instruments Gather Plane Facts



Crammed with test instruments, Boeing model aircraft gets a final checkout before being sent off for wind-tunnel experiments. Company laboratory at Wichita, Kan., handles the installation of instruments for wind tunnels throughout the country.

Three Organizations Schedule Symposium on Temperature

A symposium, "Temperature—Its Measurement and Control in Science and Industry," has been scheduled for next March 27 to 31 in Columbus, Ohio.

The papers presented will deal with the concept of temperature, analytical theory and instrumentation such as thermocouples. A reference book based on the material covered is scheduled for publication after the symposium.

Additional information about the conference may be obtained from Dr. C. M. Herzfeld, Chief of the Heat Division of the National Bureau of Standards.

It will be sponsored by the American Institute of Physics, the Instrument Society of America and the National Bureau of Standards.

Quis Custodiet Ipsos Custodes? Minitrack Uses the Stars

Minitrack stations, which keep track of artificial satellites in space, use the real heavenly bodies to keep track of Minitrack.

It works this way: On clear, cloudless nights, an aircraft carrying a blinker light flies over the station. The light is flashed by a radio signal from the ground and the aircraft is photographed against the stars. Simultaneously, a 108-mc signal from the aircraft is received by the tracker.

Two positions are then worked out—the one the station says Minitrack shows and the one the stars show. Since the stars are always right, errors in Minitrack calibration can be detected and the stations recalibrated.

The calibration is being done by the Bendix Aviation Corp for the National Aeronautics and Space Administration.

U.S., British Aim to Co-Ordinate Time-Frequency Transmissions

The United States and Britain are trying to get time and frequency transmitting stations to beep in unison.

The coordination effort was begun to provide a uniform system of transmission. This would help in the solution of problems in radio communications, geodesy, and the tracking of satellites.

It is expected that by the end of the year signals from the stations in the program will be synchronized to the thousandth of a second. The transmitting stations in the program are GBR and MSF at Rugby, England; NBA in the Canal Zone, WWV at Beltsville, Md., and WWVH in Hawaii.

The participating agencies are the Royal Greenwich Observatory, the National Physical Laboratory and the Post Office Engineering Dept. in the United Kingdom, and the U.S. Naval Observatory, the Naval Research Laboratory and the National Bureau of Standards in the United States.

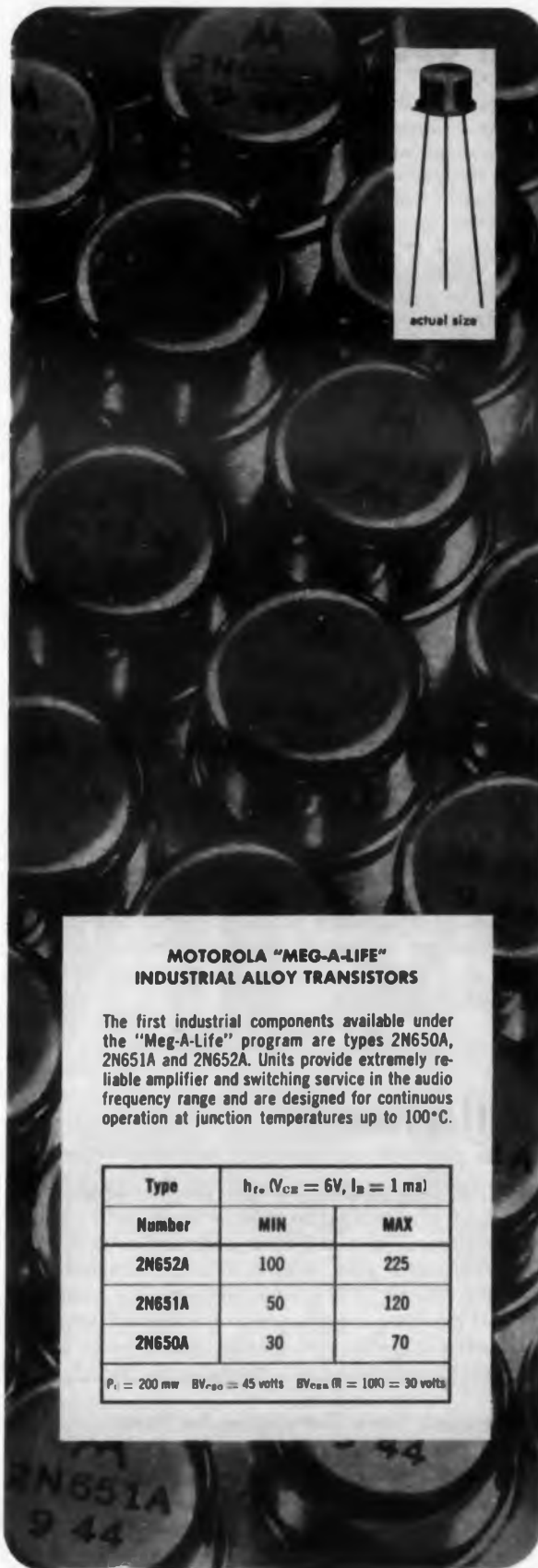
14 Advanced Students Chosen For Instrumentation Grants

Fourteen candidates for advanced electrical engineering degrees have been awarded full tuition fellowships by the Foundation for Instrumentation Education and Research.

The 14 will do research in nanosecond instrumentation systems, adaptive control system theory, medical applications of electronic instrumentation and control signal stabilization.

In addition to tuition costs, the recipients will receive a \$1,500 cost-of-living stipend. The university where he studies will be given a \$1,000 "cost-of-education" grant.

Funds for the fellowships were donated by 18 industrial firms.



MOTOROLA "MEG-A-LIFE" INDUSTRIAL ALLOY TRANSISTORS

The first industrial components available under the "Meg-A-Life" program are types 2N650A, 2N651A and 2N652A. Units provide extremely reliable amplifier and switching service in the audio frequency range and are designed for continuous operation at junction temperatures up to 100°C.

Type	h_{re} ($V_{CE} = 6V, I_B = 1 \text{ ma}$)	
Number	MIN	MAX
2N652A	100	225
2N651A	50	120
2N650A	30	70

$P_c = 200 \text{ mw}$ $BV_{EBO} = 45 \text{ volts}$ $BV_{CEO} (R = 100) = 30 \text{ volts}$

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Why MOTOROLA Introduced The MEG-A-LIFE Program

In many industrial applications, assurance of semiconductor reliability is as desirable as it is for military applications. For this reason, Motorola has introduced "Meg-A-Life" . . . a quality assurance program patterned after the procedures used for standard military-approved components.

"Meg-A-Life" tests are in accordance with MIL-S-19500 (general military specifications for transistors). Sampling is based upon MIL-STD-105. In addition to electrical, mechanical and environmental tests (including shock, centrifuge, vibration, humidity and temperature tests), 1000-hour storage tests at 100°C and 1000-hour operating life tests at maximum rated power are performed.

Approved units are stored in a bonded area. Written certification of compliance to "Meg-A-Life" reliability requirements is available. Since all tests represent the most adverse conditions for which the devices are designed, Motorola's "Meg-A-Life" program provides the industrial user an assurance of reliability previously not available.

FOR COMPLETE INFORMATION on the Motorola "Meg-A-Life" program contact your Motorola Semiconductor district office:

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CIRCLE 35 ON READER-SERVICE CARD

A New Design Specialty Has Come of Age

FOR a growing number of designers the problems of inner space—the mysteries and threats posed by the ocean—are more pressing than the much-publicized conquest of outer space. These are the designers working in anti-submarine warfare, called by the Navy ASW, an increasingly critical branch of military science that daily grows more dependent on electronic innovation. Many specialists believe the U.S. is falling behind in ASW despite the progress of a massive effort.

In the Navy, the hand of ASW now reaches so far into all major activities that most of the cost of operating the fleet is burned up by undersea operations. Outside the Navy, ASW reaches to the top levels of defense planning, where some strategists believe the missile-armed submarine has the same awesome offensive capability, and generates the same discouraging defensive problems, as land-based intercontinental missiles. The accelerating ASW program may eventually swell to the size of the ICBM program, which it resembles in many ways.

Both programs have profound strategic implications. Both

efforts are spurred by a belief that our defenses lag the Soviet offensive capability and the advantage lies inherently with the offense. In both programs private industry finances a large number of projects without official government support. At times both the ASW and ICBM efforts are characterized by undependable financing, as well as scurrying to make up for lost time.

The hundreds of companies trying to establish themselves beside the old-line ASW organizations support the view that the ASW effort may reach the proportions of the ICBM program. Direct procurement for ASW will total \$1.7 billion in the coming fiscal year. Of this total, major electronic equipment will account for about \$25 million, most of it for sonar devices. But this figure does not include the cost of a very expensive program now nearing completion.

This is big money—because the problem is big. In the special report below, **ELECTRONIC DESIGN** presents the ASW situation as it appears to the electronic systems designer.

Anti-Sub Warfare: Can Designers Meet the Challenge?

Robert N. De Floria and Alan Corneretto

Associate Editor

Assistant Editor

Designers are running fast but falling behind in the hottest race of the technical cold war—anti-submarine warfare. The special report that appears below presents the problem as an electronic designer sees it: A problem; an indicated solution—breaking the large problem into smaller ones; the four parts—surveillance, localization, classification and killing; and a sum-up of where we stand.

Problem: Atomic Needle in a Haystack

The problem anti-submarine-warfare planners face in designing an effective global system starts with the submarine, which has undergone a revolution in the past decade. The snorkel, atomic-warhead missiles, and nuclear propulsion have transformed an already formidable design challenge into a designer's nightmare.

At least 450 Soviet snorkel-equipped fleet submarines are operational. The Russians have stated an objective of 1,200 submarines. Each of these post-World-War-II boats is capable of running for weeks without fully exposing itself to surface detection. Detection of a snorkeling submarine at ranges the Navy would like is very doubtful, even in a relatively calm sea.

With a nuclear-warhead missile, which the Soviets are adding to their undersea craft, a submarine is promoted from a ship killer to a city killer. Rear Adm. John S. Thach, commander of the Atlantic ASW groups, highlights the potential of modern subs this way: "A dozen submarines, carrying possibly 20 missiles apiece, could wipe out 70 per cent of an economy in one blow."

Nuclear Power Complicates the Threat

From this, it follows that an ASW defense system 97 per cent effective in stopping an all-out attack against the U. S. mainland by a missile-armed Soviet submarine fleet, or 99 per cent effective in stopping the projected Soviet fleet,

would still be woefully inadequate. Indications are that present ASW effectiveness is nowhere near even this inadequate performance. The U. S. is vulnerable to attack.

Complicating the already discouraging picture is the prospect of nuclear power for unfriendly submarines. It must be assumed that Soviet technology, which has already produced nuclear-powered ice-breakers, also has, or will soon have, nuclear submarines roughly comparable to ours in performance. Although performance figures for U. S. nuclear submarines are classified, it is believed that current nuclear subs can cruise at twice the depth and three times the speed of present snorkel craft.

Therefore, the first step out of the ASW designer's nightmare is to design a global system to keep track of 1,000 mobile launching pads for nuclear-tipped missiles. Each of the pads will travel at 40 kt to depths of 1,000 ft through an area twice as big as all seven continents put together.

The Sea is an Enemy

The sea is no friend of the defender in this uneven contest; it quickly stops all radiation ex-

cept acoustics. Even this radiation is deflected by temperature gradients, and is scattered by reverberation from ocean bottom, surface and suspended particles.

Sound detection gear cannot discriminate well among echoes from submarines, schools of fish and the myriad noises of the not-so-silent world. Because less than one out of 10 solid contacts currently being made by ASW units is a submarine, classifying the probable contacts as submarines or as false targets multiplies the surveillance problem by more than ten. Destruction of the verified target is the final, and probably the easiest phase of this problem.

An added complication is the growing number of potentially hostile submarine fleets operated by such nations as Egypt, Albania, and Red China, now the third largest submarine builder. These factors bring the submarine into the localized war picture, and scuttle any plan for an easy way out by neutralizing the entire submarine menace via threat of retaliation against the Communist heartland itself. The submarine in the role of harasser of shipping, must be met and defeated in its own element.

One further point must be considered in designing a global ASW system. The Communist submarine fleet is a force in being. Trawlers and submarines are constantly present off both coasts, apparently mapping the ocean bottom and learning the landmarks. Under international law, they have every right to be there. But properly armed, these prowlers could mount a coordinated attack with little or no warning, and with tragic results.

An ASW system cannot exist as a mere concept or in skeleton form. There is no time for a build-up. To fulfill its role, the ASW force must be constantly at sea, on top of submarine activities and prepared for the kill.

Indicated Solution: Break Up Large Problems

Black as the problem is, designing a solution in the form of a global ASW system must be attempted—for two reasons: First, the situation may not be entirely hopeless; and second, anything less than an adequate defense against submarines imperils the nation.

The over-all ASW problem can be divided into four phases: (1) long-range surveillance, (2) localizing, (3) classifying and (4) the kill. To be successful, the ASW system designed must be feasible in all these phases. The first phase is "perhaps the most perplexing one we have," according to Frank A. Parker, assistant director of defense research and engineering for undersea warfare.

(Continued on page 38)



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SM14-30	0-14	0-30	0.1	3 mv.	0.1	1 mv.	0.001	0.01	19"	8 1/2"	13 1/2"
SM36-15	0-36	0-15	0.1	3 mv.	0.1	1 mv.	0.005	0.05	19"	8 1/2"	13 1/2"
SM75-8	0-75	0-8	0.1	3 mv.	0.1	1 mv.	0.01	0.1	19"	8 1/2"	13 1/2"
SM160-4	0-160	0-4	0.1	10 mv.	0.1	1 mv.	0.08	0.8	19"	8 1/2"	13 1/2"
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CIRCLE 36 ON READER-SERVICE CARD

ASW-DESIGNERS' CHALLENGE

1—Surveillance and Detection: Wiring Oceans for Sound

The enormous stretches of ocean that must somehow be kept under surveillance can be judged from the relief map of the Atlantic ocean floor. Under this one ocean lies a continent much larger than North and South America combined. This continent is complete with mountain ranges, canyons, and cliffs, all of which make detection more difficult.

It has been jokingly suggested that we "pull the plug and shoot 'em down with tanks." Suppose the water were drained off the continent so that BMEWS-type radars, mounted along the coast of the now-exposed continent could be employed. We would probably not be able to keep track of several hundred vehicles as they moved freely over the broken surface of this enormous continent. If radar, the near-ideal detector, cannot accomplish this surveillance task, what can?

The long-range problem must obviously be simplified by transforming it into several shorter-range problems, as is done in harbor defense, where, in effect, surveillance is maintained on a selected portion of the harbor. Applying this approach to surveillance of the Atlantic, the restricted entrances and exits to this 12-million-square-mile ocean or "harbor" must be guarded. This net-tending operation must be backed up by lines of detection devices closer to the continent, using techniques similar to Herald listening equipment now protecting harbors. Mobile hunter-killer groups must protect the nets against damage and must patrol the shipping channels. These roving task forces must keep tabs on suspicious vessels legally present in this three-di-

Giant underwater listening array of electronically scanned transducers can be "screwed to the bottom" of the ocean to aid in area surveillance, one of the most critical areas of ASW.



mensional harbor, and must move swiftly to investigate unidentified contacts. Finally, intelligence reports of potentially hostile movements, must be integrated and used to alert the defense system. This is the basic pattern of the long-range surveillance portion of the global ASW system.

How can this portion of the system be implemented? It is obviously impractical (as well as illegal) to string nets across the international waters of the Denmark Strait and between Iceland and Scotland. Can these and other entrances be "fenced" by the sonar of patrol ships? Attempts to do so have so far proven unsuccessful. In one recent exercise of the NATO fleet, the majority of infiltrating submarines got through such a picket line. Highly sensitive listening devices "screwed to the bottom" might meet with more success, however.

Fixed Detectors: A Job for Giants

The ocean is being wired for sound. A feasibility study of ocean-area surveillance, Project Atlantis, has been completed, and a program of R&D has been laid out by the Navy's Bureau of Weapons to test some of the Atlantis conclusions.

Giant transducers are reported going into use at fixed underwater locations, probably in connection with an underwater DEW-line. Also, the Atlantic cable, which intersects the path of submarines entering and leaving the ocean via the Denmark Strait, is reportedly playing an acoustic role in long-range detection. The advantages offered by permanent on-station sen-



This hydroacoustic transducer, developed by Stromberg-Carlson, may represent a breakthrough. The unit, using high-pressure fluid flow to produce high-level acoustic energy, needs no costly electronic driver. A somewhat similar unit of 10 times the power, is reported by Textron's MB Electronics.

tries are too good to pass up. Broad-area surveillance may prove feasible. Sensitive, but pressure-resistant transducers could be used to provide deep-water coverage.

There are drawbacks, however, as was exposed last year when a Soviet trawler cut one of the Atlantic cables. How can the sensing signals be securely transmitted to the data-processing center? Cables can be cut, buoyant radio links are even more vulnerable, and direct sonic telemetry, even in deep water, may be unreliable. But ultimately, an underwater sonic counterpart of the massive ICBM detection system may be activated.

The generally low frequencies and high power levels involved in surveillance dictate the use of very large transducing arrays. These use electronic scanning almost exclusively. The large size of passive listening arrays is indicated by the Edo Corp. transducer shown in an accompanying photo. This unit, designed for fixed underwater detection duty, is reported to be in use.

The use of automatic analyzers in conjunction with a bomb pattern (the Jezebel concept) is also being developed for long range detection.

Insufficient knowledge of basic science is particularly critical in long-range detection. Designers need to know more about the transmission characteristics in deep water (several thousand feet). What fatigue effects will be produced in materials by enormous sea pressures—almost 5,000 psi at 10,000 ft? How can fixed underwater sensing arrays be protected from fixed underwater jammers? How can the present linear-array hydrophones be made more sensitive?

Also needed for bottom-mounted ocean area

Target: Transducers

The search is on for wide-bandwidth, low-Q transducers of great efficiency, power and deep-submergence capability. Barium titanate devices are efficient and easy to shape, but like most ceramic transducers, do not have uniform characteristics. Barium titanates are affected by pressure and aging. The current transducer favorite, lead zirconate titanate, used in the latest high-powered sonar, is good but still new and expensive. Ammonium dihydrogen sulfate, is very stable but must be carefully protected from moisture. The zirconium titanates are noteworthy only for temperature characteristics. Magnetostrictive transducers, which are heavy and hard to shape, appear to be on the way out.

surveillance are electronic design engineers' ideas for:

- Less expensive large-scale listening arrays with sufficiently high accuracy for surveillance of large ocean areas.
- Non-acoustic sensing devices that can operate on the ocean bottom.
- Wave-powered or nuclear-powered electric generators that will power remotely located unattended floating and bottom-mounted listening arrays.
- Basic research on deep-ocean effects on materials, sound, acoustic power generating devices.

Millions of dollars have already been spent by government agencies and private industry to explore these questions. Still more answers are needed.

Mobile Detectors: How Hunters Fit In

Development of long-range surveillance systems that operate from mobile platforms has actually preceded the fixed sensors. Ships and aircraft are under United States control, not subject to "accidental" destruction under cold-war conditions as are unmanned devices in international waters.

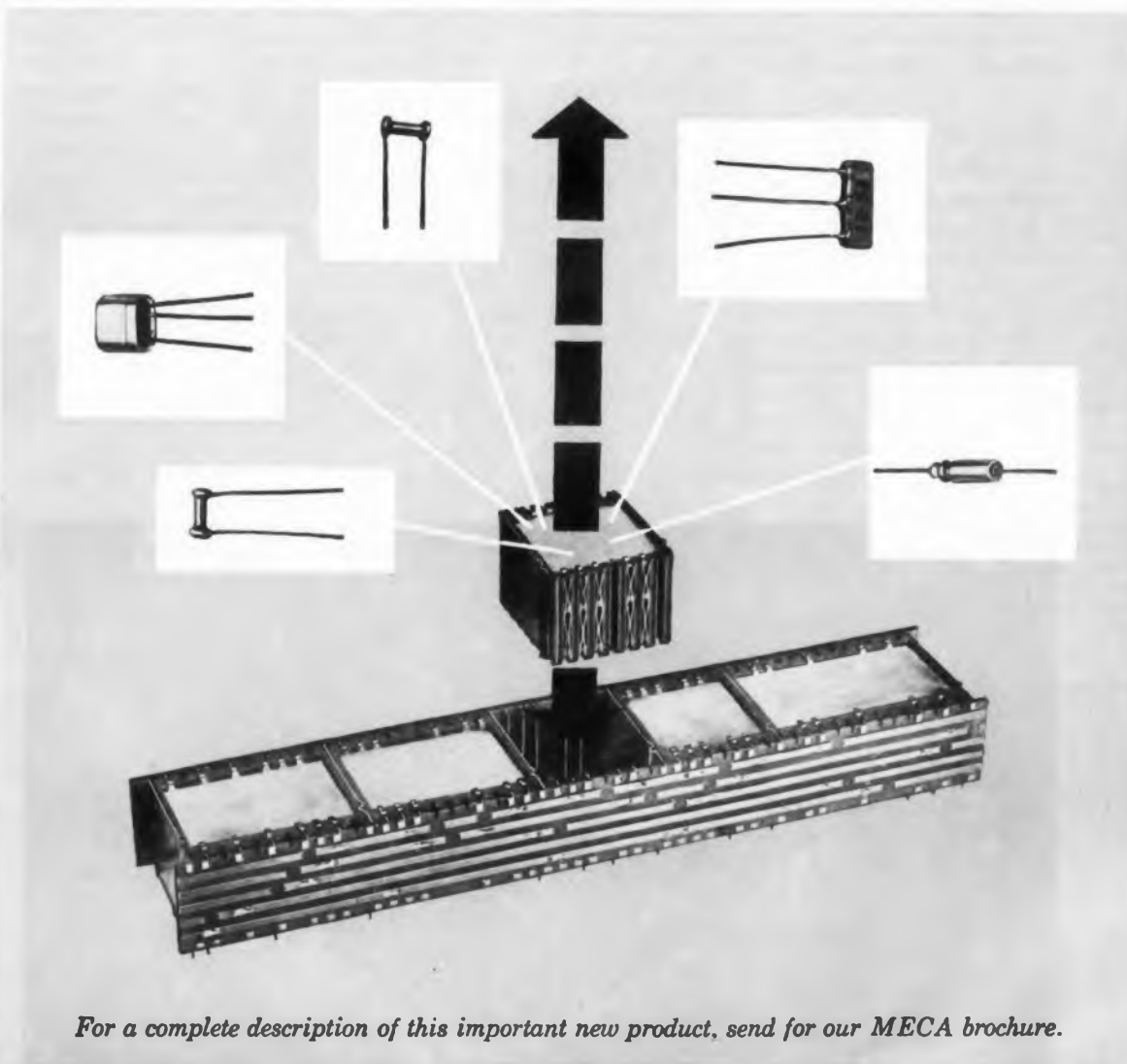
Now available as units of the surveillance network are 300 or more surface vessels, including carriers and a mixture of escort vessels that include destroyers, frigates and cruisers, supplemented by about 700 aircraft. These are primarily slow patrol craft and helicopters, which so far are sufficiently faster than the quarry. Eighty submarines, the majority of the U.S. undersea fleet, are equipped for anti-submarine duty. Blimps round out the force. Every one of these types leaves much to be desired as a long-range surveillance platform.

Their individual deficiencies are being made up by modification and by group operation. As

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CIRCLE 37 ON READER-SERVICE CARD

ASW-DESIGNERS' CHALLENGE

one part of the over-all FRAM program (Fleet Rehabilitation and Modernization), new electronic detection devices are being designed and added to each vehicle.

Submarines are superior to surface ships or aircraft as sonar platforms. Hull-mounted sonar is plagued by the noise of waves caused by the ship's passage over the ocean's surface, and the transducer may be lifted completely out of the water in heavy seas. Power put into shallow water is limited by the low water pressure near the surface. Cavitation puts a 1 w per sq cm limit on the amount of power that can be put into the water at shallow depth. Transmitted signals are attenuated by bubbles trapped in the top 100 ft of water, and are subject to severe vertical deflections by the steep and variable thermal structure near the surface. All of these problems can easily conspire to make the submarine at lower depths undetectable.

Hull-mounted surface-ship sonar has been improved by use of lower frequencies, larger arrays and higher power. Ship hulls may eventually be made part of transducing arrays.

Improvements, when translated into terms of increased detection ranges, search rates and probability of detection, must always be qualified by the condition of the sea. The limit on the amount of power that can be put into the water is not in sight. Megawatt sonars are already in trial.

One solution developed by design engineers and accepted for service this year is variable depth sonar. Originated ten years ago as a 3-ton "fish" that could be towed at a depth of 150 ft at about 5 kt, this device has now been refined into a high-power, high-speed, deep-ranging underwater ear. According to Lt. Cmdr. William F. Wicks, of BuShips' sonar branch, "under certain tactical conditions and certain oceanographic conditions, the detection capability was significantly greater than that of hull-mounted sonar."

Some idea of the character of the high-power towed sources envisioned in long-range fixed or mobile detection is given by AMF's proposed Amfar transducer concept, a new way to put power through water. This device would use a non-explosive, chemically fueled, controlled thermodynamic process to put from 1 to 1.5 megawatts of low-frequency power into the sea.

The non-electrical transducing system can be towed at depths of from 50 to 2,000 ft, and provide ranges of many miles.

Towed sonar has been tried with aircraft. But aircraft and helicopters cannot provide the lift needed to tow arrays of the size required for efficient surveillance. Blimps are better in this regard, but are difficult to maneuver with required accuracy. Aircraft-towed sonar seems to be dormant.

Submarine-mounted passive acoustic arrays

have increased target-range capability tenfold in the last decade. Circular and linear arrays have undergone considerable development at naval laboratories, notably the Underwater Sound Laboratory, New London, Conn. Work is now proceeding there to follow up pioneer research that indicates that low frequency listening (about 1 or 2 kc) detects submarines best. To take advantage of these low frequencies, very large arrays must be mounted on the submarine.

One circular array, mounted on the USS Threadfin, contained 96 barium titanate line hydrophones in a circle of approximately 15 ft diameter. An elliptical array on the USS Flying Fish measured 24 ft across the ship's beam and 48 ft fore and aft. A conformal array mounted along the full length of the Flying Fish, used more than 1,000 feet of sensitive elements. These arrays represent what is probably the most effective mobile submarine surveillance devices yet put to sea.

Infrared detection of great potential, though severely limited by range, is under investigation. It can detect the change in surface water temperature caused by warmed water rising from around a submarine.

Unconventional detecting schemes are also being considered, such as project Snifter, which detects the smell of diesel oil; radioactivity detectors to track nuclear subs; detection of the ionized water particles caused by propellers' cavitation; detection of the reduction of surface tension caused by the passage of a submerged sub; and even detectors to sense changes in sea life caused by passage of a nuclear sub. Every known effect is being exploited to "open the undersea environment and expose lurking submarines," as one admiral put it recently.

Needed for mobile long-range area surveillance are electronic design engineers' ideas for:

- Variable-depth sonar (VDS) devices that have passive listening capability while under way.
- VDS of improved design to be towed deeper and faster, able to be operated from hydrofoil craft, to be raised and lowered more quickly, and to give more accurate range and bearing.
- Underwater drones, self powered and controlled by acoustic signals, to be operated from a surface ship as self-contained variable-depth sonar devices.
- Telemetry breakthrough to allow these drones to be controlled from the air.
- Small, manned buoys to be towed to a remote station where they would maintain surveillance at any depth in critical areas as needed, and report to surface patrols any contacts detected.
- Acoustic arrays designed as part of specialized ASW submarines. The first of such systems is now going into fleet use.



SUBROC weapon, in design by Goodyear-Kearfott team, is launched from torpedo tube to break surface for a nearly 100-mi flight and to re-enter water as a homing torpedo.

The Submarine—Star of ASW

The same factors that make the submarine a threat also make it an ideal submarine killer. No small source of comfort to ASW specialists are the 80 submarines now available for such defensive duty. Many programs are in force to improve the effectiveness of these boats.

Integrated sonar like Raytheon's triple-threat system will make the submarine a more knowledgeable vessel than the surface craft. Developments coming along in underwater communication will allow submarines to operate in close cooperation with other fleet units. New, ultra-powerful vlf transmitters permit U.S. submarines to receive signals while submerged at 50-ft depths. New hull designs give speed and maneuverability exceeding that of most surface craft, and eventually of most helicopters and blimps.

Weapons like SUBROC will enable underwater vessels to destroy enemy subs at about 100-mi range without surfacing. Polaris allows attack of submarine harbors and inland areas at 1,500-mi ranges. Sperry's SINS (Ship Inertial Navigation System) corrected with American Standard's radio sextant or Sperry Gyroscope periscope star tracker allow submarines to reach any destination with minimum risk of detection.

As oceanographic data becomes more complete, piloting from the bottom, which is never more than 4 mi away, will allow even more accurate navigation.

Wrapping all these capabilities into a tightly controlled weapons system is Electric Boat's SUBIC program (Submarine Integrated Control), which will result in a submarine with fast reactions controlled by a small crew.

Because many believe the submarine to be the best weapon against its aggressive counterpart, more programs can be expected to improve it further.

Ideas are welcome.

- Long-range, secure underwater communications to allow coordination between members of submarine hunter-killer teams.
- More applied research on small high-powered transducers, more sensitive hydrophone devices, and data handling of controls from many sensors.
- More basic research on near-surface ocean transmission characteristics, marine noise sources and characteristics.
- Effective non-acoustic sensing methods.
- Electronic countermeasures programs to step up interception of enemy submarine signals.

(continued on page 42)

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Bendix Bulletin



Up-to-the-minute news about transistors and rectifiers

MIL-TYPE SEMICONDUCTORS CREATE NEW DESIGN FREEDOM



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2N1011	/67 (Sig C)	-70	-80	5	35	95	-65 to +95	55	3.0
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ASW-DESIGNERS' CHALLENGE

2—Localization: Team Effort Above, Below the Surface

Once a submarine-like contact has been localized to an area that can be conveniently combed by a hunter-killer group, more specialized ASW techniques are used to pin-point target location for classification and possible destruction. The process of localizing has been the focus of ASW development since World War I, hence techniques are more highly refined here than in most areas of ASW.

Target information is gathered from the ASW ships deployed over the suspected area. Surface ships, now equipped with hull-mounted and soon with variable-depth sonar, are primary sources of information. Signal-to-noise ratios have improved 26 to 27 db over the performance of World War II sonar. Multi-channel arrays have advanced to where as many as 1,200 channels are employed. Power put into the water has been raised from the half-kw or so of World War II to the megawatt range.

Ship-mounted radar, sometimes discounted as an ASW weapon, still performs many valuable functions, such as reducing the opportunities for snorkel-equipped submarines to use their breathers. The new side-looking radars (*ED*, April 13, p. 4) should be able to detect snorkels with extreme sensitivity.

The eyes and ears of the surface ships are extended by helicopter-borne dip sonar and air-

craft-dropped sonobuoys. After years of development, these devices have yet to reach their ultimate capabilities. Sonobuoys and dipped sonar, for example, are now employed in three ways—as passive listening arrays, active ranging devices, and in conjunction with explosive sources of noise. In this last type of system, sound from practice-type depth charges reflected by the submarine to the sonobuoys, giving away the submarine's position. This is the Julie concept developed for BuWeapons. A version of Julie, Jezebel, is being developed for area surveillance.

Aircraft-towed sonar, subject of experiments for several years, seems to suffer from noise problems as well as from maneuvering problems that are overcome by dip sonar and sonobuoys. The value of these approaches to detection rests on the speed advantage of the carrying craft over that of the submarine, and becomes increasingly important as submarine speeds overtake surface ship speeds.

Improved submarine performance makes these vehicles increasingly important for localizing enemy submarines. Consequently, considerable effort has gone into equipping submarines for pin-point detection as well as for long-range surveillance duties. One example of new detection capability is Raytheon's AN/BQQ-1 multifunction, integrated sonar. This three-way system incorpo-

rates advanced searching capabilities, electronic control of underwater weapons and communications, all of which are needed to make the submarine an effective member of the hunter-killer team. This is the first instance in which the entire system is built into the submarine as an integral part of hull design.

Among non-acoustic detection devices developed for localizing under special conditions, MAD (Magnetic Anomaly Detection) equipment is the most highly advanced. MAD, pioneered by Texas Instruments, has been in operation for some time and can detect submarines on or near the surface from an aircraft. It has the bonus feature of distinguishing submarines from the many non-metallic objects that confuse sonar. Its main drawback, short range, is being attacked in work carried out in many parts of the country.

Needed for localization are electronic design engineers' ideas for:

- A breakthrough in the size-frequency-power-directivity relationship involved in transducer operation. This would be similar to the current effort to break away from parabolic antenna design in radar.
- Drone-helicopter borne dip sonar comparable to the new DASH (Drone Anti Submarine-Gyrodyne) weapon-carrier.
- Expendable sonobuoys fired from a surface ship in the way that weapon ALFA is, to extend listening range of these vessels.
- Sonobuoys that give their exact location.
- Applied research on methods to obtain higher information-rate sonar.

THE ASW OFFICER SPEAKS:

"We Need More and Better Information"

Present detection gear and data-processing equipment are woefully inadequate, says a former ASW officer. More of his views, especially written for *ELECTRONIC DESIGN*, are set forth in this report.

AN ELECTRONIC designer would quickly appreciate the ASW problem if he could be present aboard an ASW craft attacking a submarine.

The ASW officer is flooded with information—too often inaccurate—from many sources, and his attack aids are inadequate to permit rapid, accurate evaluation of what he does receive.

He lacks a picture of the ocean around, below, and sometimes above him. What is the enemy's

bearing, range, course, speed, aspect, depth and range rate? He must know all this before he can order the ASW craft to the correct firing point. He further must decide which weapons are to be fired precisely when and precisely where.

To the ASW officer, current detection equipment is afflicted with critically short detection ranges, low information rates, inadequate information displays, poor data-handling facilities, excessive dependence upon operator skills and lack of a dependable method of identifying friendly submarines.

What the ASW officer needs is a fast, accurate and clear way to collect information from the participating 'copters, blimps, destroyers, killer submarines, fixed-wing aircraft, and sonobuoys.

Also needed is an effective data-processing system that can reduce all this incoming information to course to steer, selection of weapons, and firing information. Course to steer ought to be fed directly into steering motors, but it should also be displayed for evaluation and clear-bearing check. Although the selection of weapons may be done automatically, the facility for correcting firing time at the last minute is a necessity if the target moves too late for reevaluation by a computer.

To protect the U.S. against even present-day submarines, we must have equipment with assured ranges of at least several miles, rather than several hundred yards. ASW crews are now working with detection ranges little greater than the range of modern ASW weapons.



Official Navy Photo

Experimental array of hydrophones aboard the USS Flying Fish tests feasibility of large conformal arrays for passive detection. Work is part of massive program to extend range of listening gear.

- Active sonobuoys that operate without confusion from multiple echoes.
- Basic research to find radically new detection schemes, other than acoustic.

3—Data Handling and Target Classification

With large quantities of information gathered from many types of sensors at many locations, the problem could easily become too much information rather than not enough. A modern submarine alone may carry as many as eight sonars. The tempo of the action has increased with submarine speed and firepower. Three problems are involved—data handling, communications, and classification. All three are interwoven into one of the knottiest near-real-time data handling problems in electronics. Many specialists consider classification the most critical specialized area of ASW.

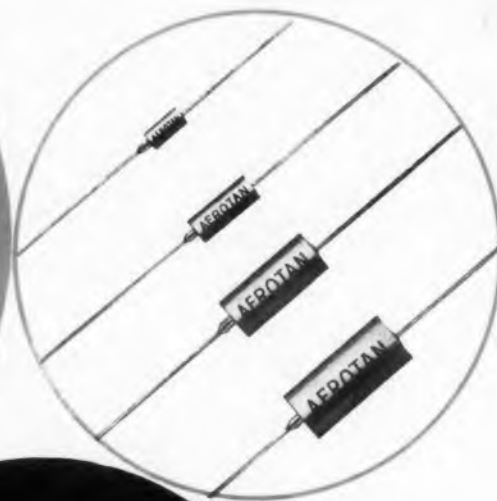
A single submarine contact will produce acoustic signals at dozens of widely separated sensors. Some will respond passively to the level of noise generated by the sub's propeller and machinery, a crude function of distance in some cases, a measure of range and bearing in others. Others will be measuring transit time of their own sonic pulse—confused by pulses from other sonar and reflections from other task force hulls. Still others will be operating with the noise reflections from bombs, a source displaced from both the target and the receivers. Source, target, sensors, and medium are all moving, usually in different directions, as is each maneuvering aircraft and ship on which the data is being plotted.

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1.5	A	A	A	A	*B
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2.2	A	A	A	A	*A
2.7	A	A	*A	B	B
3.3	A	A	*A	B	B
3.9	A	*A	B	B	B
4.7	A	*A	B	B	B
5.6	*A	B	B	B	*B
6.8	*A	B	B	B	*B
8.2	B	R	B	*B	B
10.	B	B	B	*B	B
12.	B	B	B	*B	B
15	B	B	B	*B	B
18.	B	B	*B	B	B
22.	B	B	*B	C	*C
27.	B	*B	C	*C	*C
33.	B	*B	C	*C	*C
39.	B	*B	C	*C	*C
47.	*B	C	*C	*C	*C
56.	*B	C	*C	*D	*D
68.	C	C	*C	*D	*D
82.	C	*C	C	*D	*D
100.	C	*C	D	*D	*D
120.	C	*C	D	D	D
150	*C	D	*D	D	D
180	*C	*D	D	D	D
220	D	*D	D	D	D
270	*D	D	D	D	D
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ASW-DESIGNERS' CHALLENGE

display of a Julie-type sonobuoy problem has been accomplished by the Grumman-Loral ASA-31, now going into dozens of carrier-based ASW aircraft. The bottleneck in fully automating this problem has been the necessity of a trained sonarman in the loop to interpret the echos and decide if they are real targets or interference. The JASDA (Julie Automatic Sonic Data Analyzer) is being developed by Douglas Aircraft to replace the sonarman by automatic analyzing equipment. Machine-classification of underwater echos is also the objective of Polarad's EAR program (Electronic Audio Recognition).

In this R&D program, designers are developing an analog of the human brain and ear. Stromberg-Carlson is directing considerable research attention to the problem of classifying and identifying submarine signals. The approach is to identify a submarine's signature, or that of other undersea objects, by the spectrum of frequencies they generate. Frequency patterns and doppler shift can be used to separate moving from fixed objects. Unless the signals can be translated into terms of target information useful for fire control, nearly all that has gone before is academic.

The data-handling and classifying problem is complicated by the need to coordinate the activities and signals from many fleet units in the hunter-killer force. A complex seagoing communications network is an integral part of every group. The usual communication problem of tying together fleet units is complicated further by the need to communicate with submerged units.

Design engineers are still looking for basic answers in this little-known field, which involves putting power through one of the greatest possible impedance mismatches. According to Norman D. Miller of Texas Instruments, the most

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Target: Sonar Receivers

Though sensitivity of sonar receivers has been optimum for about 20 years, over-all receiver operation is a long way from ideal. Bandwidth requirements have been widened to accommodate Doppler shift caused by increased closing speeds of multiple-beam or multiple-channel equipment. The problem of increasing the search rate of sonars has led to multiple-channel receivers and in turn to problems of phase-shift and gain-shift stability. Needed are receivers with phase stability of 0.5 deg and amplitude stability of 0.5 db.



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practical method so far developed is the single-side-band suppressed-carrier acoustic link. Using a carrier frequency of 8 kc, a 20-w signal was used successfully in communication between helicopters and submarines at ranges of 5,000 to 10,000 yd (depending on sea conditions), with a theoretical maximum of 20,000 to 30,000 yd. More basic work is in progress at naval laboratories, in which the method of communication used by sea creatures such as the porpoise are under investigation.

Needed for data handling, classification and communications in ASW are electronic designers' ideas for:

- Taking the man completely out of the data-processing loop, except for decision making.
- Completely integrated, completely automated systems for converting detection data from hunter-killer units into course-to-steer and weapon-to-use information. This would be a sea-going SAGE system.
- Autopilot control of hunter-killer vehicles, after the decision to attack.
- An IFF (Identification Friend or Foe) system for effectively protecting our own submarines without giving away position to the enemy.
- Effective communication with submarines under all sea conditions.
- Continuous display of the ocean bottom in the operating area.

4—The Kill: Last Stop For a Submarine

If all has gone well in ocean-area surveillance, localizing and classification, the submarine can be destroyed—if the submarine does not fire first. The arsenal of antisubmarine weapons has been growing in variety and complexity at an accelerating pace.

Weapon ALFA, a 12.75-in. rocket-fired depth charge that has become standard ASW main battery, is being joined by Minneapolis-Honeywell's longer-range ASROC. This weapon is a rocket-assisted torpedo and depth charge with range measured in miles.

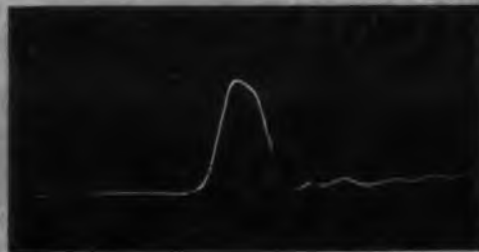
Range of more conventional torpedoes and depth charges will be given a boost in 1961 by the DASH program—drone helicopters that will operate from decks of destroyers. Extended range places a greater burden of precision on the weapon control system. Use of nuclear depth charges such as Betty, anti-submarine mines such as the new MK-57, and homing torpedoes such as those developed by GE and Aerojet-General, reduce the pre-launch fire-control problem.

In planning weapon-systems complement for the hunter-killer task force, the ASW designer

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BANDWIDTH



▲ Photograph, actual size, of high frequency sine wave display.

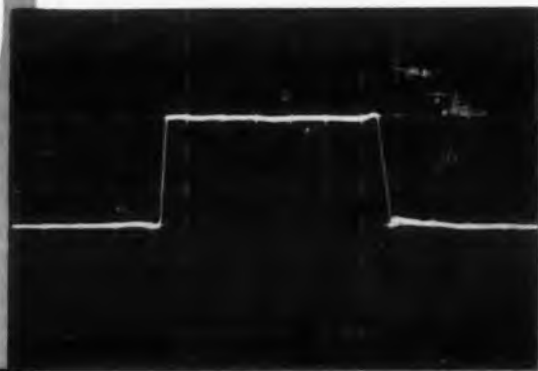


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▲ Pulse display on illuminated reticle photographed with ordinary camera.

◀ Photograph of one milli-microsecond single transient display.

For full details, write for Data Sheet 7070.

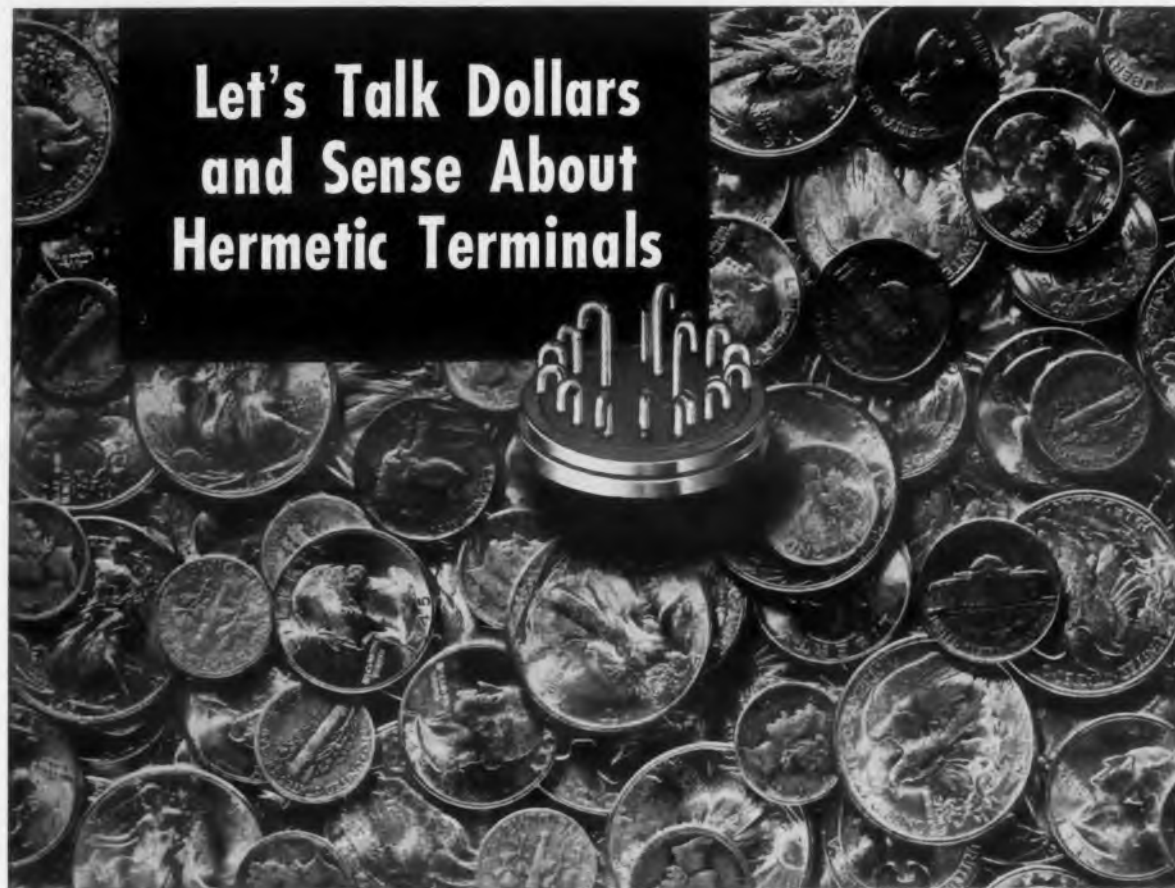


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ASW-DESIGNERS' CHALLENGE

cannot neglect defenses. Longer range, more powerful weapons, similar to Polaris and SUBROC, must be presumed soon available to hostile submarines.

Counter weapons must be provided to protect the ASW task force, which, itself makes an excellent target.

Needed for the kill are electronic designers' ideas for:

- Guidance systems with more accuracy and faster reaction time for the delivery of weapons to target submarines.
- Acoustic control of submerged weapons.
- Longer-range, more reliable tracking capability for homing weapons.

Where Do We Stand?

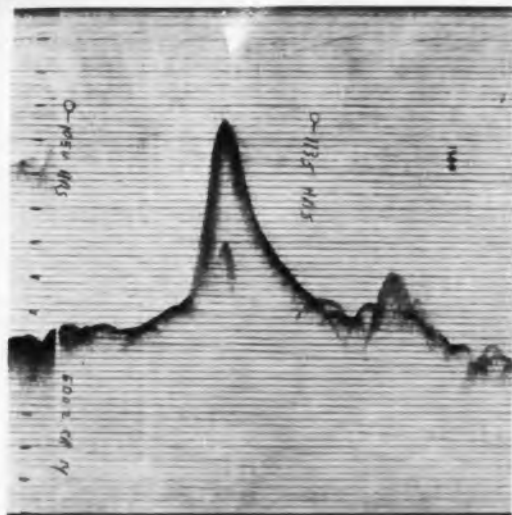
The total design effort constitutes a three-pronged attack on the submarine menace:

- The ocean that protects the submarines it hides is being made more transparent by massive transducing arrays on surveillance vessels and by ocean-bottom megawatt sonars. A huge oceanographic program, Tenoc, and other basic research efforts are under way to discover the secrets of piercing the green veil with sonic and non-sonic techniques.

Black Sky Thinking

What lies 10 years ahead? If today's snorkel submarines can slip through today's defensive systems, and if faster, deeper-diving nuclear submarines with significantly greater endurance will prove, as expected, superior to the ASW systems now in development, what will stop tomorrow's nuclear undersea craft? Some specialists think nothing will, at least nothing under optimistic development at this time. They point out that 100-kt nuclear submarines capable of reaching all but the deepest parts of the ocean, are now in the works.

Skippers of such boats will not have to worry greatly about blimps, 200-mph 'copters, destroyers, hydrofoils or any conventional surface craft. We can only hope that undersea missile subs, darting in near silence through 100-mile-long undersea canyons, will be confronted with detection devices substantially better than sonars with ranges barely measured in miles, or magnetic anomaly detectors with ranges in yards.



Ocean-bottom profiles like this one, made on special paper with a Woods Hole Oceanographic Institute precision recorder, are high on the Navy's wanted list. This profile was made with Alden recording techniques.

- The weapon itself is being matched by fast, versatile task forces that are being automated and provided with new ears and eyes and with the ultimate in powerful weapons.
- The source of the problem, a system of nations with a record of aggression, is being confronted with the fast, powerful Polaris weapon system, capable of retaliating against either weapons or nations. ■ ■

What might frighten tomorrow's submariner? Perhaps pursuers in killer subs equipped with radically improved detection and attack systems and working in concert with radical non-submarine systems. The killer subs would need really long-range detectors, which might have to function through an efficient radiation window. For weapons, these subs might have 500-kt cavitation-tracking torpedos or missiles that would home on what little nuclear radiation is grown off below the surface. The killer groups would be backed by an efficient, permanent grid of passive detection stations and by task forces of giant ocean-skimming surface ships. Each skimmer would mother a fleet of supersonic VTOL aircraft of extended range and endurance.

Combinations of these ASW methods might shift the balance to defense, but skimmers, windows and cavitation-tracking torpedos are beyond the horizon and perhaps not even headed in our direction.

Tomorrow's sky looks black. In undersea warfare the offense is widening its lead.



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TP-15-10	0-10	15	10mV	5mV	0.5	15"
TP-15	0-32	15	10mV	5mV	0.4	20"
TP-1-60	0-60	1	20mV	6mV	0.5	10"
TP-2-75	0-75	2	20mV	10mV	1.0	13"

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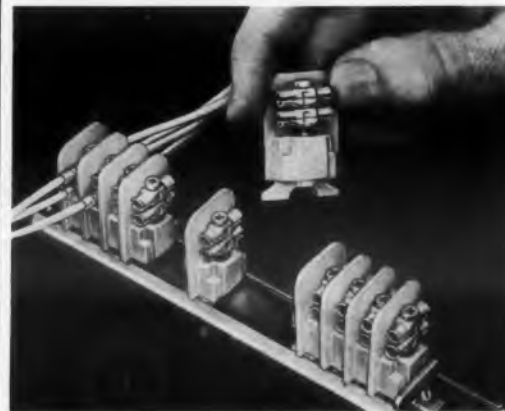
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The Burndy Corporation, Omaton Division, has available for immediate delivery its terminal block development, MODULOK,[®] which employs the principle of crimp-type, snap-in contacts, combined with the convenience and versatility of modular design. Individual modules, molded of Zytel 31, a nylon compound having extremely low water absorption characteristics, can be snapped together or apart. These modules are inserted into separate steel tracks up to 32 inches in length, and are secured in place by end locks. MODULOK has found wide application in early warning systems, missile ground control systems, and associated fields.

Modules are available with either 2- or 4-tier spring-loaded sockets which may be set for quick-disconnect for rapid ring-out, bussing, or circuit changes. A twist of a screwdriver transforms the quick-disconnect into a permanent connection. Up to 30 modules per foot of track can be accommodated. The unique spring-loaded, cup-shaped sockets exert continuous, uniform pressure in either position. Contact tips are the solderless crimp-type applied to wire ends.

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Burndy Corporation, Norwalk, Connect.

CIRCLE 45 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 25, 1960

EDITORIAL

The Navy Needs Your Ideas

If you can electronically tell the difference between a fish and a submarine at a few thousand yards, the Navy wants to hear from you.

A highly accurate sound-velocity meter and a device for determining the amount of self-noise generated are two other problems that face planners in anti-submarine warfare, commonly called ASW. Airborne multi-frequency scanning receivers, which now have up to 1,200 channels, need better gain and phase stability circuits to do the job expected of them. Better servos with 25-watt radiance are needed. Development of a reliable automatic range-tracking gear to free human operators will also help the Navy. All these problems beg for solutions.

The adequacy of our defenses against missile-bearing submarines all depend on solid engineering effort in many areas—no breakthroughs are envisioned. The retaliatory ability of our Navy's Polaris-bearing atomic submarines will depend on accurate navigation, fix determination, underwater communications, and myriad other problems that could mar a successful missile firing from below the surface. *ED's* special report, which begins on page 36 of this issue, clearly spells out the magnitude and seriousness of the problem.

Many specifics are heavily classified, but fortunately the Navy is equipped to keep channels of information open. Companies which are members of the National Security Industrial Association can attend symposia sponsored jointly by the Navy and the anti-submarine warfare committee of NSIA. At these meetings, the Navy spells out its problems and needs. The Navy co-sponsors similar meetings with professional organizations such as the Institute of Aeronautical Sciences. If you have clearance and a bona fide interest you can attend. If a solution to any ASW problem occurs to you, the Navy wants you to make a proposal. Once you become active in ASW, the Navy will send you classified information about those areas in which you would be likely to make a contribution.

The Navy, however, cautiously overclassifies information and it is difficult for industry to get a complete picture of the ASW challenge. Because of overclassification, magazines like *ELECTRONIC DESIGN* are unable to give the coverage to this subject which they feel would benefit the nation as a whole.

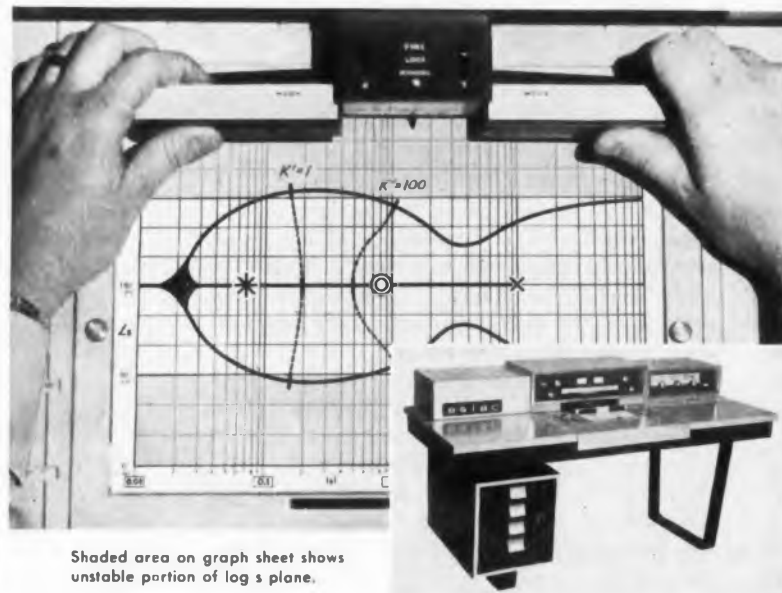
But the Navy does have much information available and, because it wants companies to invest their own R&D funds in ASW, will make such information available. If you think you can be of use, write now for BuShips Form 550.5. The Navy needs your ideas.

James G. Lippert

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CIRCLE 46 ON READER-SERVICE CARD

Determine Plate Dissipation From Current and Voltage Waveforms

Karl W. Angel, Electron Tube Div.,
Radio Corp. of America, Harrison, N. J.



In this article, engineer Karl Angel describes a method for determining plate dissipation in horizontal deflection amplifier tubes and damper tubes from straight-line approximations of plate-current and plate-voltage waveforms. The method requires only a calibrated cathode-ray oscilloscope, a simple rectifier probe, and a current-sensing resistor. When used with care, the method helps evaluate circuit performance, and can indicate where designs can be improved. The method can be adapted for any application in which a periodic waveform exists.

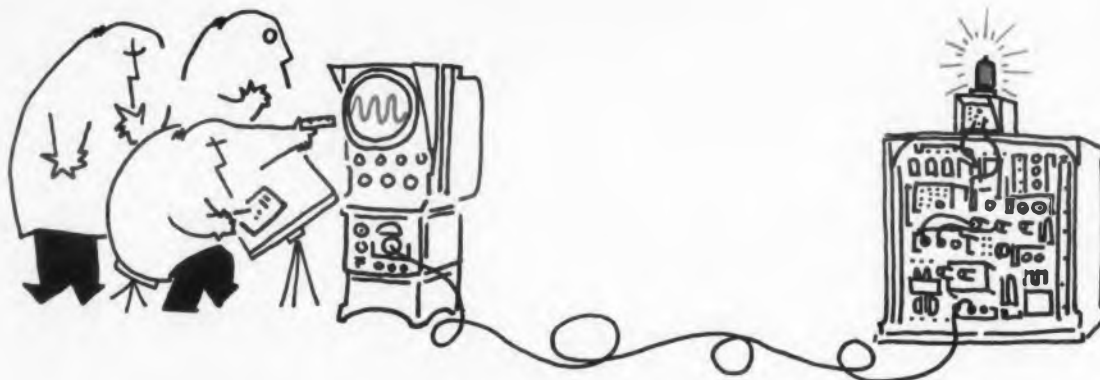


PLATE voltages and currents which are periodic and predominantly linear time variants lend themselves to graphical analysis. They can be evaluated with good accuracy by straight-line approximations. Plate dissipation is easily determined as the time-integral of the product of the linearized current and voltage, divided by the period of the waveform. If the straight-line approximations are carefully made with the aid of a straight-edge, and the oscilloscope is accurately calibrated, it is not necessary to know the characteristics of the load, the regulation of *B Boost*, or other parameters of the circuit. The approach described in this article was used in designing horizontal deflections systems. It can be adapted to any system involving similar wave forms.

Amplifier-Tube Plate Dissipation Derived from Plate Voltage and Cathode Current Waveforms

Fig. 1 shows a typical cathode-current and plate-voltage waveform for a horizontal-deflection-output amplifier tube, with their straight line approximations. The linearized current and voltage waveforms are analyzed in Fig. 2.

Note that the cathode-current waveform is used in making the initial straight-line approximation of plate current. To determine the maximum plate current i_1 for use in calculations, the screen grid current, i_p (screen) must be subtracted from the total cathode current i_k . When operation includes the "knee" region of the tube characteristic, the value of i_p (screen) which is subtracted from i_k should actually be a straight-line approximation of i_p (screen). When operation is entirely above the

knee, the peak value of i_p (screen) may be subtracted from i_k to determine i_1 .

The total period of the sweep trace and fly-back is represented by the period T . The time of the forward trace, T_s is divided into three fractions, aT_s , bT_s , and cT_s , for determining linearized values of i and e .

The time intervals aT_s , bT_s , and cT_s , and the subscripts 0, 1, and 2 for voltage and current in the waveforms and calculations for output-tube and damper-tube dissipation are not related and should not be confused. For example, aT_s for an output tube is not necessarily the same as aT_s for a damper tube, even in the same circuit. In each case the factors a , b , and c simply represent the first, second, and third fractions of T_s , and the subscripts 0, 1, and 2 represent the initial, second, and third values of current or voltage.

The plate dissipation

$$P_b \text{ (amp)} = \frac{1}{T} \int_0^T iedt$$

This can be expanded to the expression

$$P_b \text{ (amp)} = \frac{T_s}{T} i_1 \left[E_0 \left(1 - \frac{a+b}{2} \right) + e_1 \left(1 - b + \frac{b-a}{3} \right) + \Delta e_1 \left(\frac{1-b}{2} \right) \right] \quad (1)$$

where

$$i_1 = \text{maximum plate current} = i_k - i_p \text{ (screen)}$$

In the plate voltage waveform, voltage rise e_1 is measured with respect to a reference level E_0 ,

the lowest point which the waveform reaches. Voltage rise Δe_1 is measured from e_1 . The sign of e_1 in Eq. 1 must correspond to the slope of the plate-voltage waveform between the end of aT_s and the end of bT_s . If the plate voltage increases during this interval, the sign of e_1 is positive; if it decreases during this interval the sign of e_1 is negative.

A sample calculation of plate dissipation for a 6DQ6-A in a 110-degree deflection system using a 6AU4-GTA damper illustrates the method.

$$\begin{aligned} \frac{T_s}{T} &= 0.87 & a &= 0.32 & b &= 0.87 \\ E_0 &= 48 \text{ v} & e_1 &= 26 \text{ v} \\ i_k &= 400 \text{ ma} & i_p \text{ (screen)} &= 40 \text{ ma} & \Delta e_1 &= 14 \text{ v} \\ i_1 &= 360 \text{ ma} \end{aligned}$$

$$\begin{aligned} P_b \text{ (amp)} &= \frac{T_s}{T} i_1 \left[E_0 \left(1 - \frac{a+b}{2} \right) + e_1 \left(1 - b + \frac{b-a}{3} \right) + \Delta e_1 \left(\frac{1-b}{2} \right) \right] \\ &= 0.87 \times 0.36 \left[48 \left(1 - \frac{0.32 + 0.87}{2} \right) + 26 \left(1 - 0.87 + \frac{0.87 - 0.32}{3} \right) + 14 \left(\frac{1 - 0.87}{2} \right) \right] \\ &= 0.313 [48 (0.405) + 26 (0.313) + 0.91] \\ P_b \text{ (amp)} &= 0.313 (19.5 + 8.15 + 0.91) = 8.94 \text{ w} \end{aligned}$$

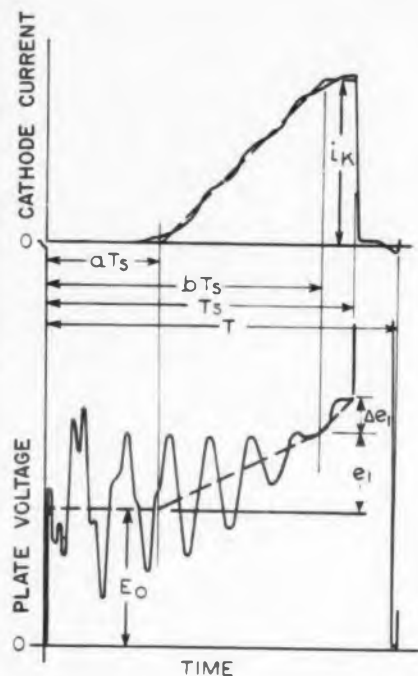


Fig. 1. These typical cathode-current and plate-voltage waveforms, when properly analyzed, yield the plate dissipation of a horizontal-deflection-amplifier tube. Straight-line approximations are shown.

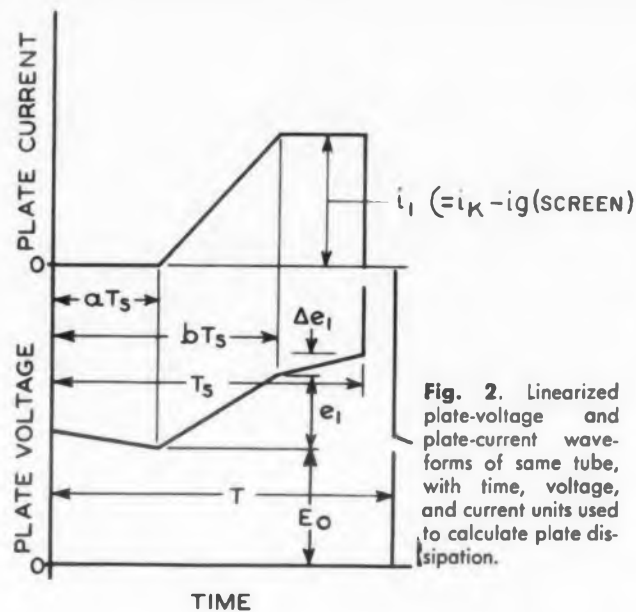


Fig. 2. Linearized plate-voltage and plate-current waveforms of same tube, with time, voltage, and current units used to calculate plate dissipation.

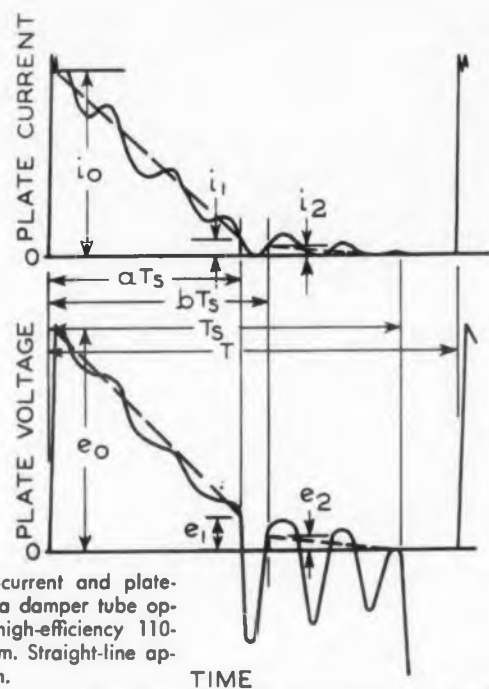


Fig. 3. Typical plate-current and plate-voltage waveforms of a damper tube operating in the same high-efficiency 110-degree deflection system. Straight-line approximations are shown.

Damper Tube Plate Dissipation Determined By A Similar Process

A similar procedure will determine plate dissipation for the damper tube. Typical damper-tube plate-current and plate-voltage waveforms, with straight line approximations are shown in Fig. 3. The linearized versions of these waveforms are analyzed in Fig. 4. Note that the straight-line plots of Fig. 4 are generalized, and do not correspond specifically to the waveforms of Fig. 3. The signs of Δi_2 and Δe_2 in the equations may be either positive or negative, depending upon the slope of the current and voltage waveforms between cT_s and T_s . The equation used for determining the plate dissipation depends on the actual shape of the waveforms. For the general case, the equation is:

$$P_b(\text{damper}) = \frac{T_s}{T} \left\{ ai_0 \left[\frac{e_0}{3} + \frac{e_1}{6} \right] + ai_1 \left[\frac{e_0}{6} + \frac{e_1}{3} \right] + i_2 \left[e_2 \left(1 - c + \frac{c-b}{3} \right) + \Delta e_2 \left(\frac{1-c}{2} \right) + \Delta i_2 \left[e_2 \left(\frac{1-c}{2} \right) + \Delta e_2 \left(\frac{1-c}{3} \right) \right] \right] \right\} \quad (2)$$

Inspection of the waveforms can allow simplification of the mathematics. Three simplifications are possible when the waveforms between bT_s and T_s are triangular. If $i_2 = \Delta i_2$, and $e_2 = \Delta e_2$, we have the general triangular case, where the simplified equation form becomes

$$P_b(\text{damper}) = \frac{T_s}{T} \left[ai_0 \left(\frac{e_0}{3} + \frac{e_1}{6} \right) + ai_1 \left(\frac{e_0}{6} + \frac{e_1}{3} \right) + i_2 e_2 \left(\frac{c-b}{3} + \frac{1-b}{3} \right) \right] \quad (3)$$

If $i_2 = \Delta i_2$, $e_2 = -\Delta e_2$, $b = c$,
or if $i_1 = \Delta i_2$, $e_2 = -\Delta e_2$ and $C = 1$,

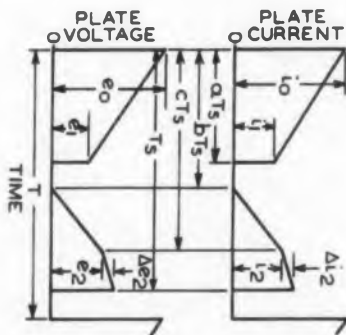


Fig. 4. Linearized plate-voltage and plate-current waveforms of damper tube, with time, voltage, and current units used to calculate plate dissipation.

we have the right triangular case, where the equation simplifies to:

$$P_b(\text{damper}) = \frac{T_s}{T} \left[ai_0 \left(\frac{e_0}{3} + \frac{e_1}{6} \right) + ai_1 \left(\frac{e_0}{6} + \frac{e_1}{3} \right) + i_2 e_2 \left(\frac{1-b}{3} \right) \right] \quad (4)$$

Finally, if $C = \frac{1-b}{2}$ and $b = \frac{1+b}{2}$, we have the isosceles triangular case, where the equation becomes:

$$P_b(\text{damper}) = \frac{T_s}{T} \left[ai_0 \left(\frac{e_0}{3} + \frac{e_1}{6} \right) + ai_1 \left(\frac{e_0}{6} + \frac{e_1}{3} \right) + i_2 e_2 \left(\frac{1-b}{2} \right) \right] \quad (5)$$

The final terms in Eqs. 4 and 5 are often less than one per cent of the total dissipation.

A sample calculation of plate dissipation for a 6AU4-GTA in the 110-degree deflection system used in the preceding example is given below.

$$\frac{T_s}{T} = 0.87 \quad a = 0.62 \quad b = 0.65$$

$$i_0 = 524 \text{ ma} \quad e_0 = 34 \text{ v}$$

$$i_1 = 33 \text{ ma} \quad e_1 = 7 \text{ v}$$

$$i_2 = 26 \text{ ma} \quad e_2 = 4 \text{ v}$$

(continued on page 52)

$$\begin{aligned}
 P_b(\text{damper}) &= \frac{T_s}{T} \left[ai_0 \left(\frac{e_0}{3} + \frac{e_1}{6} \right) + ai_1 \left(\frac{e_0}{6} + \frac{e_1}{3} \right) \right. \\
 &\quad \left. + i_2 e_2 \left(\frac{1-b}{3} \right) \right] \quad (4) \\
 &= 0.87 \left[0.62 \times 0.524 \left(\frac{34}{3} + \frac{7}{6} \right) \right. \\
 &\quad \left. + 0.62 \times 0.033 \left(\frac{34}{6} + \frac{7}{3} \right) \right. \\
 &\quad \left. + 0.026 \times 4 \left(\frac{1-0.65}{3} \right) \right] \\
 &= 0.87 [0.325 (12.57) + 0.0205 (8.01) \\
 &\quad + 0.104 (0.117)]
 \end{aligned}$$

$$\begin{aligned}
 P_b(\text{damper}) &= 0.87 (4.07 + 0.164 + 0.0121) \\
 &= 0.87 (4.34) = 3.68 \text{ w}
 \end{aligned}$$

Measurement Technique

Time values should be determined from the current waveforms, and the same external scope trigger used for both current and voltage measurements. For observation of current waveforms, the oscilloscope should be connected directly across a 2-to-3-ohm, 2-w sensing resistor which should be accurately determined on a bridge. For voltage waveform measurements the oscilloscope should be connected to the appropriate circuit point through the rectifier probe shown schematically in Fig. 5. This probe should be housed in a plastic cylinder to minimize capacitive loading effects.

In this probe the input voltage is applied to a reverse-connected 6V3-A diode in series with an adjustable positive bias voltage. Because positive signal voltages greater than the bias voltage do not appear at the probe output, the probe does not load the circuit under test during retrace. The 6AL5 shunt rectifier clips off negative peaks and provides a ground reference point for the voltages applied to the oscilloscope. The output waveform can be clipped at any point desired by adjustment of the bias voltage.

For measurements of damper voltage the bias voltage should be set at maximum to avoid compression of the waveform. From the current waveform, the time value for zero current must be determined. This time value on the voltage curve will establish zero voltage from damper cathode to plate. The ground side of the probe input may need to be connected to E_{bb} to minimize the distorting effects of pickup in the probe leads. This is necessary if E_{bb} is not well filtered, and is to be avoided when possible by adding filtering to the E_{bb} supply. Extreme care should be used when this connection is employed, because the oscilloscope case is at a high dc potential with respect to ground.



Waveform Interpretation—A Guide To Improved Efficiency, Lower Dissipation

A considerable amount of information can be extracted from the waveforms through analysis that will help correct conditions causing high plate dissipation.

The following approximation is useful in analysis of output-tube plate-voltage waveforms:

$$E_0 + e_1 \approx E_{bb} \left(2 - \frac{N_1}{N_2} \right) - E_{bb} \left(1 - \frac{N_1}{N_2} \right) \quad (6)$$

where E_{bb} = supply voltage
 E_{bb} = boost voltage

$\frac{N_1}{N_2}$ = flyback-transformer turns ratio,
output tube tap to damper tap

This approximation is based on the fact that the voltage $E_0 + e_1$ is reached approximately at the end of the damper conduction period aT_s at which time the damper cathode is clamped at E_{bb} . The voltage $E_0 + e_1$ is thus the equivalent voltage referred to the output-tube plate. The total change in damper voltage is approximately equal to the total change in output-tube plate voltage times the turns ratio N_1/N_2 .

The change in output-tube plate voltage be-

tween aT_s and T_s will have a positive slope (as in Figs. 3 and 4) if the boost-ripple voltage is larger than the resistive drop in plate voltage, and a negative slope if the opposite is true. The boost ripple voltage, therefore, can be used to keep the output-tube load line away from the diode line and to reduce the length of the damper conduction period. Only the rising portion of the ripple voltage can be used for this purpose because of the clamping action of the damper near the end of its conduction period. The use of the boost ripple voltage for this purpose does not degrade linearity because this voltage does not appear across the yoke.

Eq. 6 shows that an increase in E_{bb} will increase $E_0 + e_1$, and thereby increase the output-tube plate dissipation P_b (amp). An increase in boost voltage, however, will reduce P_b (amp), except if the increase in boost is brought about by an increase in peak plate current, in which case no change in P_b (amp) will occur.

An increase in the turns ratio N_1/N_2 will increase $E_0 + e_1$ to a limit of E_{bb} at $N_1/N_2 = 1$, and will produce a corresponding increase in P_b (amp). Similarly, a decrease in N_1/N_2 will reduce $E_0 + e_1$ to a limit of zero at $N_1/N_2 = 0$. The turns ratio, however, cannot be changed indiscriminately because its value is determined by circuit-loss and linearity considerations. For a given peak-to-peak yoke current and total circuit loss, N_1/N_2 is fixed. Any substantial change in the optimum value of N_1/N_2 will result in reduced scan and degraded linearity. Small changes can be made provided the conduction period for the output tube is shifted to correct for the resulting linearity changes.

Fig. 1 and Eq. 1 show that for P_b (amp) to be as small as possible two requirements must be met: (1) E_0 should be as close as possible to zero; (2) under minimum-line-voltage conditions

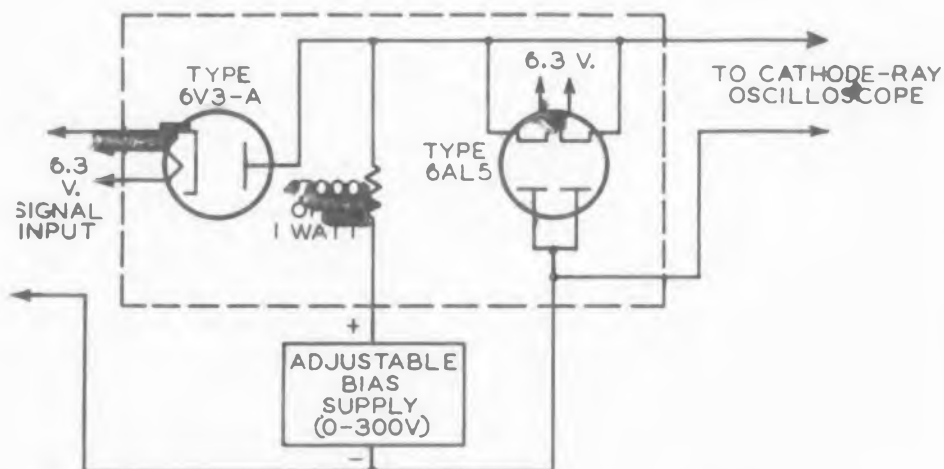


Fig. 5. Circuit of rectifier probe used for observation of voltage waveforms.

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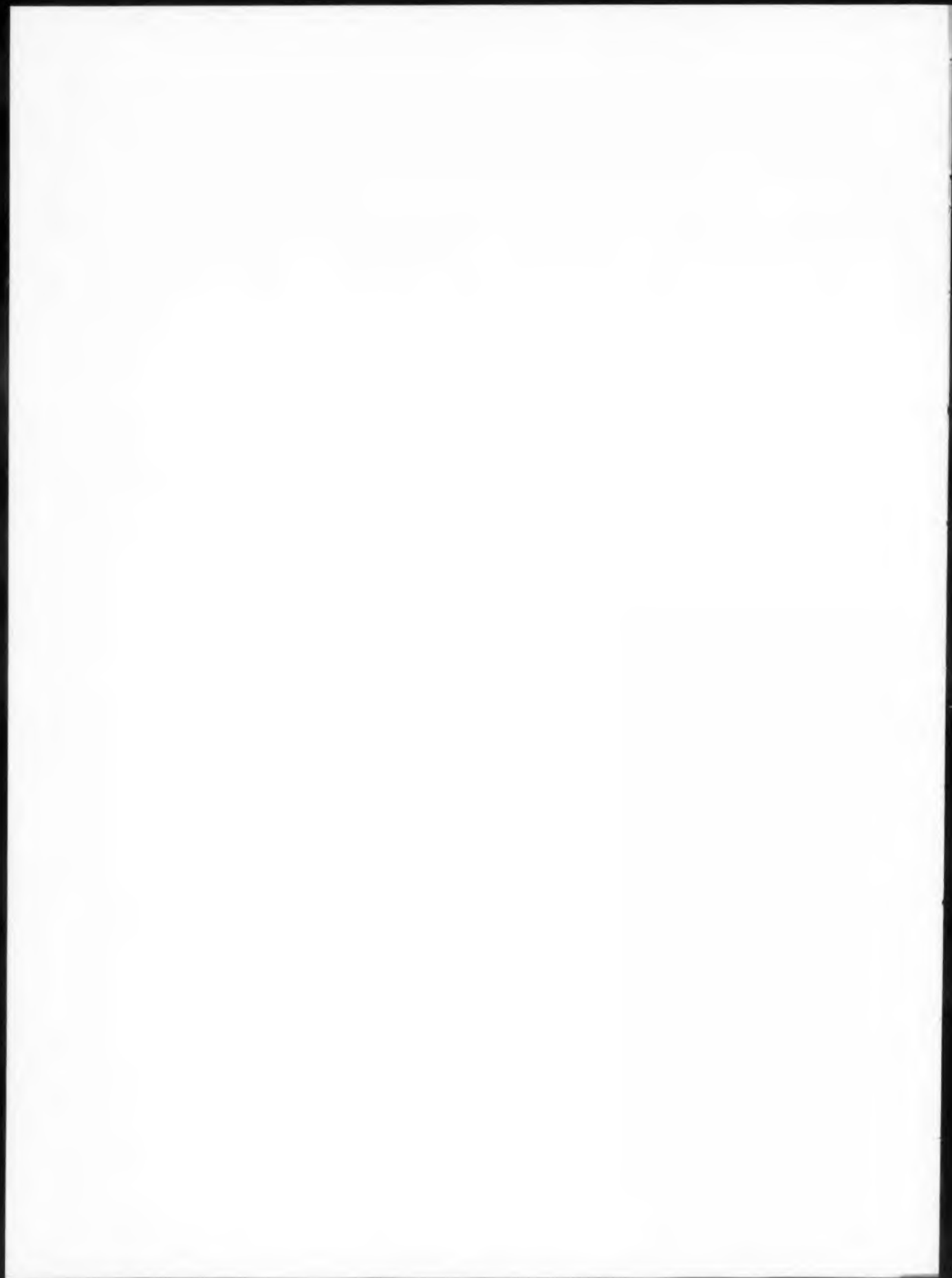
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At 00^h00^m01^s GMT, May 1, 1960, Martin logged its 523,692,000th mile of space flight



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the slope of the increase in plate voltage from aT , to bT , for a tube having a high-limit knee voltage should be as close as possible to the tube diode line without actually touching it. To determine these conditions, the cathode-current waveform of the output tube should be applied to the vertical input of the oscilloscope, and the plate voltage used as the oscilloscope sweep voltage. The resulting Lissajous figure in the dynamic load line. The negative peaks of voltage should not be allowed to touch the diode line (as indicated by clipping of these peaks), because the resulting rapid rise in screen grid current can cause radiation of energy to the tuner, by either Barkhausen oscillations or "snivets." Barkhausen oscillations produce a vertical bar on the left-hand side of the screen; "snivets" produce serrated vertical lines on the right of the screen.

Boost Ripple Aids Linearity

The slope of the dynamic load line may be made to conform to that of the diode line by adjustment of the boost capacitor to provide more or less boost ripple. The position of the point for $E_0 + e_1$ on the load line however, is fixed by E_{bb} , E_{bbb} , and N_1/N_2 , Eq. 6, and cannot be changed by a change in ripple amplitude.

The output-tube plate dissipation P_b (amp) can be reduced also by an increase in aT , and bT , to the limiting condition of center raster compression (white "over-drive" line) resulting from a too rapid transition from damper-tube conduction to output-tube conduction. The period aT , may be increased by an increase in output-tube bias. The period bT , may be increased by a reduction in peak-to-peak driving voltage. Because a reduction in driving voltage reduces grid-resistor bias, such reduction must be accompanied by an increase in the time constant of the control grid resistor and coupling capacitor to maintain the desired bias.

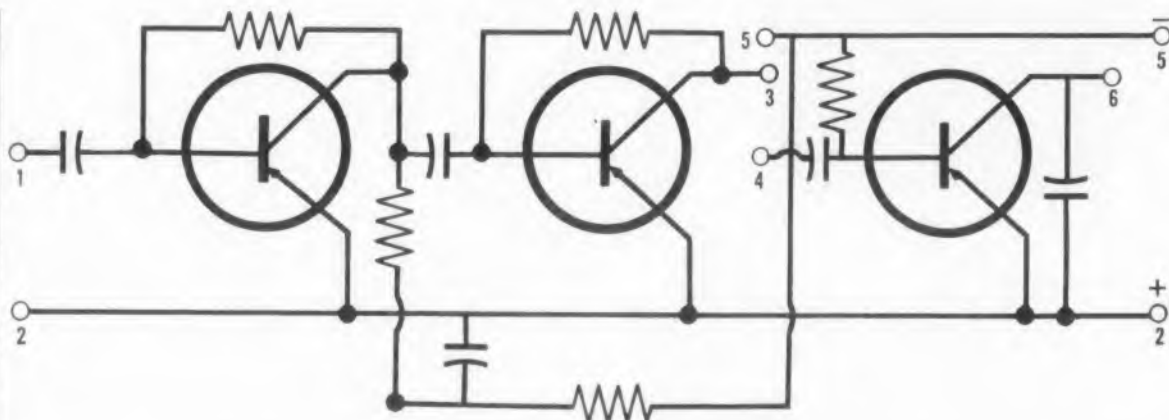
Little can be done to reduce damper-tube plate dissipation P_b (damper), except to use a tube type having lower internal resistance, or by decreasing the damper conduction period aT , by an increase in boost-ripple amplitude. Such a change will also reduce the tendency of the damper tube to conduct at the end of the trace period. The damper conduction period, however, must be sufficiently long to make up for trace-period losses and maintain good linearity.

Output-tube and damper-tube plate-dissipation values obtained by the method described have been checked against those obtained by the thermocouple method, and have shown good correlation. It is important to emphasize the necessity for care in making the straight-line approximations of the voltage and current waveforms, and for the use of accurately calibrated meters. ■ ■

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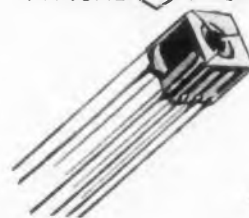


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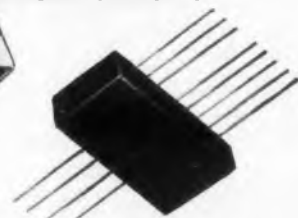
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William R. Cuming
Emerson & Cuming, Inc.
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CONSIDERATION of ceramic encapsulents should start with bonding systems which are available and practical to use. The next consideration is the fillers which can be incorporated in the compound. With respect to the bonding agents, those indicated in Table I are the most important.

Alkali Silicates and Silica Sols

Alkali silicates and silica aquasols are essentially colloidal suspensions in water. On drying at temperatures ranging from room temperature to 250 F, a material is produced which has excellent bonding characteristics. Sodium silicate solution (water glass) has been the most popular. Many of the commercially available inorganic cements are merely two components, a liquid and a powder. The liquid is sodium silicate of about 40 per cent solid content; the powder may be finely divided silica.

On mixing in the proper proportions a mortar is produced which can be poured or troweled into a cavity. If drying is slow, a material of sufficient strength for many embedment applications is produced. Flexural strength is about 500 psi. Strength is maintained at about this level to about 1000 F. Glass formation then begins to occur. Upon cooling, a somewhat stronger material than the original is produced.

Ceramic Encapsulents

Ceramic encapsulents become increasingly important as temperature requirements of electronic equipment go up. About 600 F is the highest temperature for the best epoxides; about 800 F is the top limit of the very best silicones. Certain inorganic encapsulating compounds, however, can be used well in excess of 2500 F.

Alkali silicate cements are porous and somewhat hygroscopic. Impregnation is necessary for moisture protection. The bond is rigid and brittle. Prior to drying, the mortar is strongly alkaline and is corrosive to many electronic components. Despite all of these negative factors, the material is effectively used in many encapsulating applications where high temperature performance is a necessity.

Silica aquasol is an improvement over sodium silicate in that it is a neutral system. Corrosive effects are minimized. Resultant encapsulents are



Fig. 1. Electronic circuits before and after embedment in Eccoceram SM-25. These components do not have temperature capability equivalent to that of the ceramic. This, however, does illustrate the feasibility of producing embedments when suitable components are available.

superior in electrical properties. Organic silicates such as ethyl silicate, will hydrolyze to produce the alcohol and silica. The latter is then available for bonding.

Silicates and Aluminates of Calcium

Calcium silicate (Portland) and calcium aluminate cements are widely used in a variety of construction applications. The former is, of course, the familiar constituent of concrete for roads and reinforced structures. The latter is a less strong but higher temperature material. Both are hydraulic cements, i.e., they take on water of hydration during the setting reaction. Both are strongly alkaline in nature. They have limited electronic usefulness. However, calcium aluminate cements will withstand 3000 F and may, therefore, be considered in certain heat barrier applications.

Table 1
Inorganic Bonding Agents

Alkali Silicates—Sodium, Potassium
Silica Aquasols
Organic Silicates—Ethyl Silicate
Calcium Silicate—Portland Cement
Calcium Aluminate—Lumnite Cement
Calcium Sulfate—Plaster of Paris
Clay
Glass
Oxychloride Cement
Oxyphosphate Cement—Aluminum Phosphate
Inorganic Polymers



Fig. 2. High temperature wirewound resistor is shown before and after embedment in Eccoceram SM-25. In use, the imbedded unit melted internally without any adverse effect on the ceramic encapsulant.

Calcium Sulfate

Calcium sulfate (plaster of Paris) is not of much value for encapsulation systems since it loses all strength at 250 F.

Clay

Clay may be considered an encapsulant, but probably only for components, in particular, resistors. To produce a true ceramic bond, it is necessary to raise the temperature to at least 1500 F. Resultant materials can be strong, non-porous and of relatively good electrical properties.

Glass

Glasses also are important as inorganic bonding agents. Solder glasses of high lead content have softening temperatures as low as 800 F. Dissipation factors are below 0.03. Several other glasses range upwards in softening point. High silica glass has a softening temperature about 3000 F and a dissipation factor below 0.0009. Dielectric constants of the usable glasses range from 4.0 to 7.0.

In general, the glasses are used in powdered form. Fillers may be added. The entire mass is compressed and then heated to establish the bond. Alternatively, successive powdered glass coatings can be applied and fired. Certain glasses will crystallize during the heating cycle and will then

Table 2
Inorganic Fillers

Flake Type Mica	Natural and Synthetic
Fibers	Glass, Silica, Asbestos, Alum, Silicate
Expanded Types	Vermiculite, Perlite
Bubble Types	Hollow Glass Microspheres, Hollow Clay Spheres, Alumina Spheres
Massive Types	Silica, Alumina, Titania

be capable of still higher temperature usage. Encapsulations produced from glass compositions can be completely non-porous.

Other Bonding Agents

Other inorganic bonding systems at present appear to have limited electronic usefulness. This is primarily due to the corrosive nature of the materials. However, there may be instances where this is permissible, particularly with respect to components. There are also a number of proprietary systems which may have merit. Inorganic polymers are under investigation, primarily on government research and development contracts. To date, there are no materials which are of practical interest, although several worthwhile leads are being pursued.

Fillers

Only a listing of fillers which are useful in inorganic encapsulation is presented here (Table II). The filler has a role similar to that in the resinous encapsulant case. It reduces shrinkage and modifies thermal expansion coefficient. It may re-enforce the material and relieve strains. In systems which are heated to develop a glassy state, the filler may enter into the elevated temperature reactions.

A typical ceramic encapsulant (Ecco-ceram SM 25) is usable from -70 F to +2000 F as a ceramic encapsulant for electronic circuits (Fig. 1) and components (Fig. 2). The material is used in a manner similar to that of a conventional casting resin. Its properties, fully cured, are:

Specific Gravity	1.8
Flexural Strength, psi	1000
Dielectric Constant (10^2 to 10^{10} cps)	Approx. 4.2
Dissipation Factor (10^2 to 10^{10} cps)	Below 0.004
Volume Resistivity (ohm-cm) 70 F	10^{11}
	1000 F
	10^7
After 120 hrs. at 90% R.H., 70 F.	10^8
After 120 hrs. at 90% R.H. on impregnated sample	10^{12}
Dielectric Strength (Volts/mil-100 mil sample)	100

It is supplied in two components; a powder and a liquid. These are mixed to produce a flowable material which can be poured into a cavity. Vibration and/or vacuum may be used for improved filling.

After curing, it can be immediately subjected to 2000 F. In most instances, thermal shock of embedments between +2000 F and -70 F will not cause cracking. It will not burn and is highly resistant to nuclear radiation. ■ ■

Acknowledgment

Ceramic encapsulents have been investigated under sponsorship of the Bureau of Ships, Dept. of the Navy. Mr. L. E. Seiffert has acted as technical monitor for the Navy. His aid is most appreciated.

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Current Range (Amps)	0-1	0-1	0-1.5	0-1.5
Regulation Against 20% Line change 0 to full load	0.1% 0.1%	0.1% 0.1%	0.1% 0.1%	0.1% 0.1%
Impedance (Ohms) DC to 100KC	.4	.4	.2	.2
Ripple (RMS) in Millivolts	2	3	2	3
Panel Height	5 1/4"	5 1/4"	5 1/4"	5 1/4"
Price: (See Notes)	\$555	\$620	\$580	\$645

Note 1: If meters not desired deduct \$30 and drop "M" from model number.
Note 2: If fixed output desired (± 5 volts) deduct \$40 and add "F" to model number followed by nominal output voltage desired.

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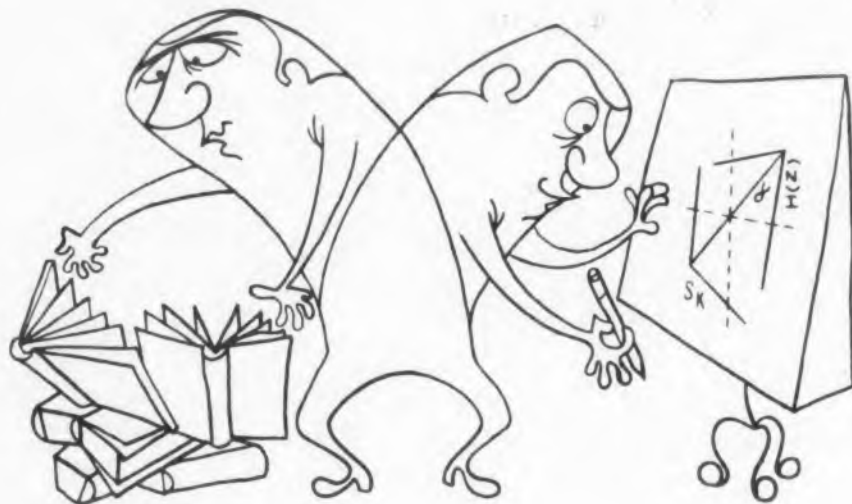
CIRCLE 171 ON READER-SERVICE CARD

Make Your Own Basic Line Nomograms

Part 2

Burrell R. Hatcher

Convair
Division of General Dynamics Corp.
San Diego, Calif.



It's often easier to make your own nomogram than it is to search for one. Here, in the conclusion of a two-part article, author Burrell Hatcher, shows how to make nomograms for proportions and for recurrent variables such as are found in quadratic equations.

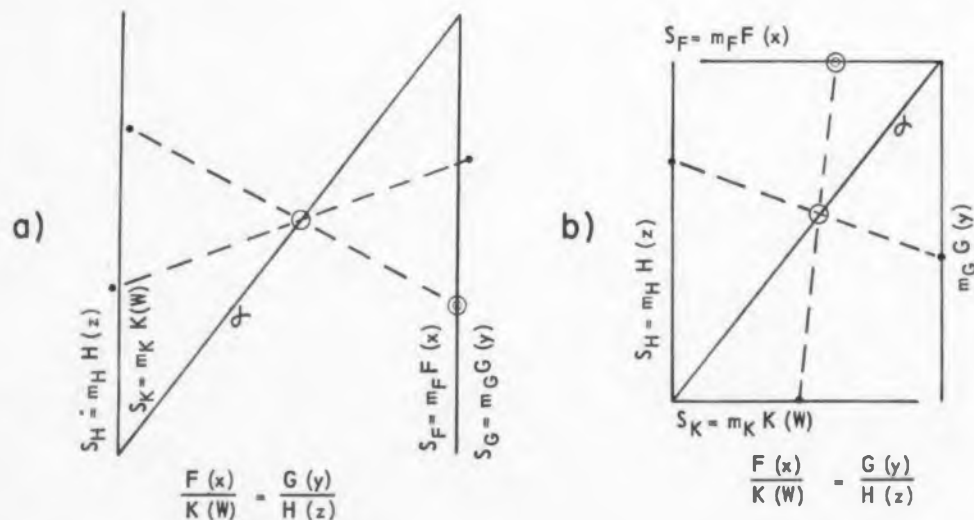


Fig. 9. Two forms for presenting proportions.

FACED with a given equation, the designer often has more than one choice of nomogram he may construct. The transformer equation, $Z_o = Z_p (n_s/n_p)^2$, can serve as such an example. In Part 1 of this article, one type of nomogram was shown for this equation.

A more general case of this equation is given by

$$\frac{F(x)}{K(w)} = \frac{G(y)}{H(z)}$$

In this case, it is convenient to set each side of the equation equal to α , and to construct two charts, each having the α -axis as a diagonal, and each having scale factors such that

$$\frac{m_F}{m_K} = \frac{m_G}{m_H}$$

The charts may be oriented in either of two ways, as illustrated in Fig. 9a and 9b. The method shown in Fig. 9a involves putting two scales on a line, one scale on each side. While this scheme looks somewhat neater and offers the advantage of compactness, it might also be confusing.

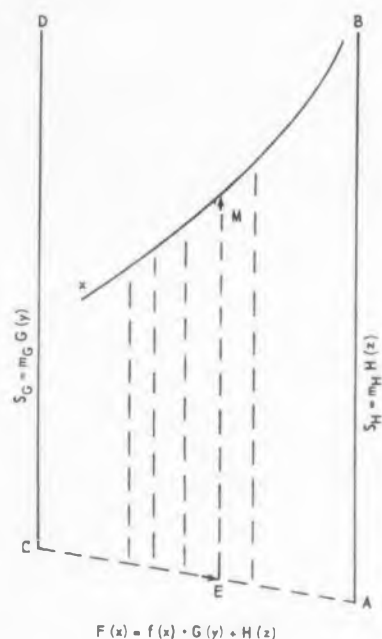


Fig. 10. Basic form of the recurrent variable nomogram.

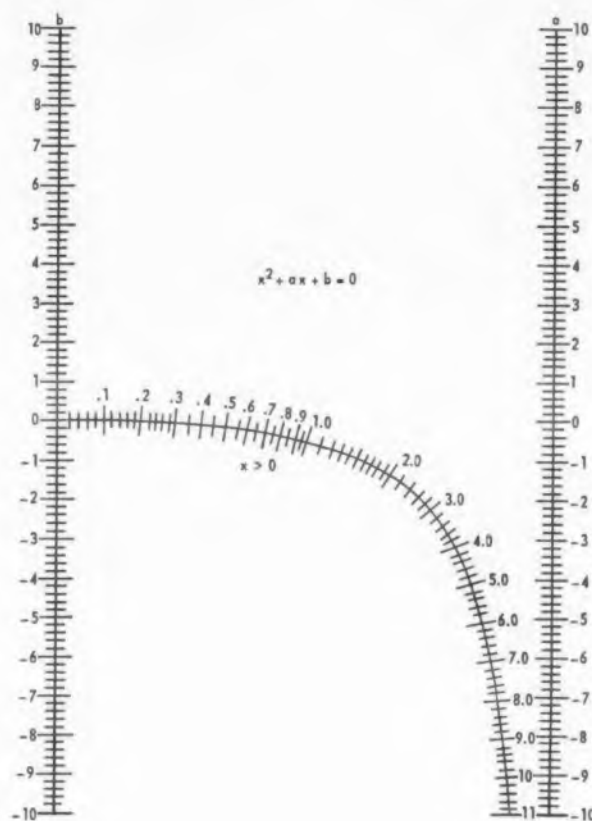


Fig. 11. A nomogram form of the general quadratic equation. Details are in Chart 3.

$$x^2 + ax + b = 0 \quad \begin{array}{l} L = 8 \\ W = 5 \\ -10 \leq a \leq 10 \\ -10 \leq b \leq 10 \end{array}$$

$$-x^2 = ax + b$$

$$m_a = m_b = \frac{8}{10+10} = .4 \text{ IN.}$$

$$\overline{CE} = \left[\frac{(.4) 5}{(.4)x + (.4)} \right] x = \frac{5x}{x+1}$$

$$\overline{EM} = \left[\frac{(.4) (.4)}{(.4)x + (.4)} \right] -x^2 = \frac{-.4x^2}{x+1}$$

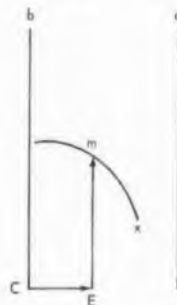


Chart 3. Details for Preparing Nomogram of Fig. 11.

Recurrent Variable

$$F(x) = (x) \cdot G(y) + H(z) \quad (\text{Fig. 10})$$

What distinguishes this equation is the appearance of two functions of x , one in a term alone, and one as a multiplier of a function of another variable.

On parallel axes, and in the same direction, one constructs the scales of $S_G = m_G G(y)$ and $S_H = m_H H(z)$. On \overline{CA} , the line connecting the zero points of S_G and S_H , one lays off

$$\overline{CE} = \left[\frac{m_H \overline{CA}}{m_H f(x) + m_G} \right] f(x).$$

From the point E , one lays off \overline{EM} parallel to the y - and z -axes. It should have a length which may be calculated as

$$\overline{EM} = \left[\frac{m_G m_H}{m_H f(x) + m_G} \right] f(x).$$

The directions C to A and E to M are both taken to be positive. The equation of the x -axis, is given by the locus of the point M as x is varied. It is generally not a straight line. When the terms containing y and z bear opposite signs, the $G(y)$ and $H(z)$ scales in Fig. 10 should increase in opposite directions.

Fig. 11 and Chart 3 illustrate a form of the general quadratic equation, which exemplifies the recurrent variables.

Scale Graduations

In general, scale graduations should seldom be closer than 1/10 in., or farther apart than 1/4 in. Although decimal graduations are preferred, when the 0.1-unit marks come too close together, 0.2-unit or 0.5-unit graduations should be used.

The use of any other subdivisions should be avoided except in special cases. For example when the quantity is inches, 1/4-, 1/8-, and 1/16-unit graduations may be used.

The unit graduation marks themselves should be about twice the length of the 0.5-unit graduation marks, and about three times the length of the 0.1- or 0.2-unit marks. The marks should be long enough so the shortest mark is easy to distinguish.

The thickness of the lines should be held to a minimum for accuracy, but should be thick enough to be readily visible. When more than three axes appear in a single chart, a simple key showing the order of use should appear on the chart.

On nonlinear scales, a transition from one scale pattern to another may become necessary. A transition point should be a point where:

- There is a calibrated, major value of the nonlinear variable.
 - The fine graduations are not too close.
 - The coarse graduations are not too far apart.
- Scales on slide rules illustrate transition points very well. ■ ■

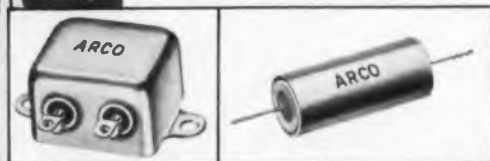


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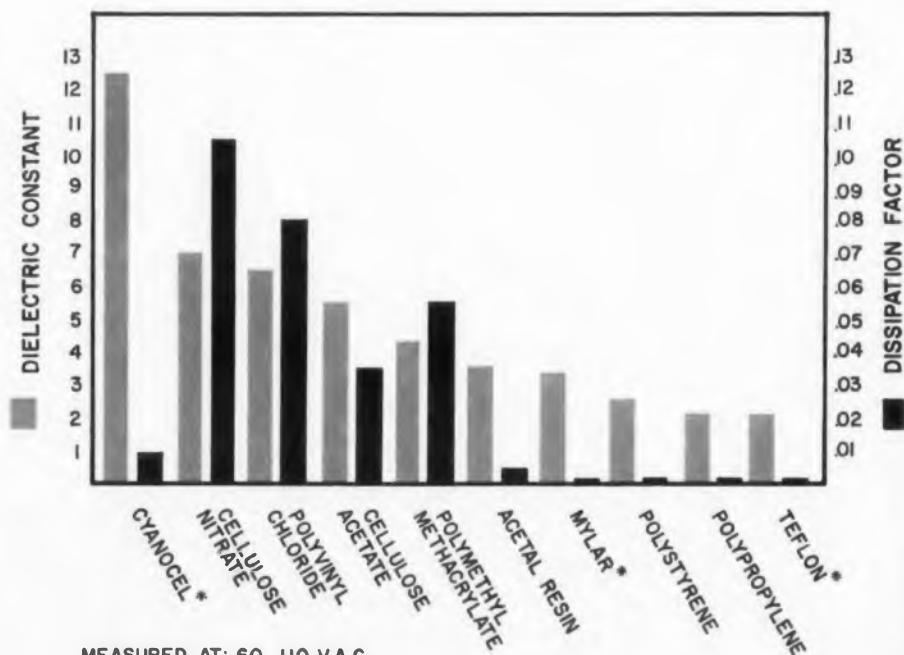
THE COMBINED properties of high dielectric constant and low dissipation make Cyanocel, a chemically modified cellulose, an attractive new addition to the electronic materials field. Capable of being cast into films and thermally molded, it is a white and fibrous material in its bulk form. It is also available as a 10-per-cent liquid solution.

Electroluminescent lighting is one field where the unique electrical properties of Cyanocel are claimed to be advantageous by its manufacturer, American Cyanamid Co., 30 Rockefeller Plaza, New York City. The material's first commercial appearance will be in a new electro-

luminescent lamp made by General Electric. The product is cast as a film on the conducting glass of the lamp.

This application, according to Dr. L. G. Tompkins, a technical manager at Cyanamid, is only the beginning. He believes the material will eventually find applications in the microminiaturization of electronic components such as capacitors and transformers. In capacitor applications, he said, the material would be cast as a film on metal foils.

Inasmuch as Cyanocel is a new material, he said in an interview, it is difficult to predict all the uses that might be found for it. "But we're ready to work



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The electrical properties of Cyanocel, a chemically modified cellulose, are illustrated in this graph, which charts the dielectric constant and dissipation factor for organic film-forming materials.

Electrical Properties Determined at 25 C

Frequency	Dielectric Constant	Dissipation Factor
100 cycles	13	less than 0.02
1 kc	12.8	less than 0.02
10 kc	12.3	0.02
100 kc	11.7	0.04
1 mc	10.0	0.12

with all companies that would like to investigate and explore its possibilities and uses," he said.

Cyanocel is priced at about \$30 per pound in its bulk form. Anticipating a growing demand for the material and resulting increased production rates, Cyanamid expects the price to decrease eventually. Sample quantities of the material are now available.

Clear solutions of Cyanocel are formed in a number of organic solvents and solvent mixtures in which no trace of the original fibrous structure remains. Some of the solvents are acetone, acetonitrile, acrylonitrile, and dimethylformamide. Its solubility is 5 per cent or greater.

Films of the material can be prepared by "doctoring" solutions onto any flat, smooth surface and then drying it in cabinets through which warm, dust-free air is passed. Films can also be placed on objects by spraying or by dipping them into a Cyanocel solution.

Thermal molding at 200 C and 6,000 psi will produce articles that retain the electrical properties of the material.

After a dosage of 10^8 roentgens from Cobalt⁶⁰, the dissipation factor of Cyanocel went up to 0.03 and the dielectric constant went down to about 6.3. The results were determined by tests made at 110 v and 60 cps. Although transparent after subjected to radiation, the material had turned brown.

The bulk density of Cyanocel is 5 to 6 lb per cu ft. Cast film density is 1.2 gm per cc.

Under ordinary conditions of industrial handling, this highly cyanoethylated cellulose is not expected to present any hazards to health.

For more information on this insulation material, turn to the Reader-Service card and circle number 250.



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Relay Transfers up to 51 Circuits

BY REPLACING the conventional leaf spring with spring wire, a new compact relay can transfer up to 51 circuits simultaneously. It is designed to perform more than 50 million operations without readjustment.

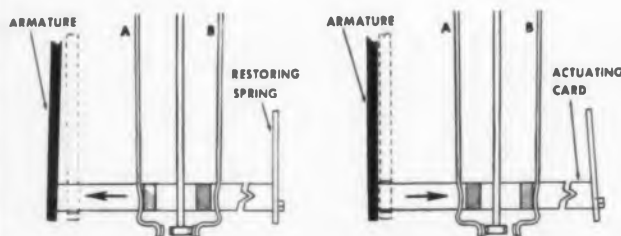
Developed by Automatic Electronic Laboratories, Northlake, Ill., the Series WQA is the first compact relay which can handle this many simultaneous switching operations.

An actuating card activated by armature movement operates all moving wire-spring contacts simultaneously and independently. The movable springs are aligned and anchored in a molded as-

sembly, while a plastic comb aligns the relay's stationary springs. Cumulative buffer wear is avoided.

The WQA relay is available in one, two, or three levels of contact assemblies with up to 17 Form C combinations each. Other forms, such as A or B, may also be obtained on special order. Operating voltages range from 6 to 220 v dc. Rectified ac is also accommodated. The maximum contact pile-up—51—requires less than 4 w of operating power.

The relays are principally made on order and can be delivered no later than 60 days after the order has been received. By the end of 1960, the relays are ex-



When the relay is energized, movement of the armature to the right causes the actuating card to move to the right. This forces the moveable contacts ("B") to break from the stationary springs (shown between "A" and "B"), and permits moveable contacts ("A") to make with stationary contacts.

CIRCLE 52 ON READER-SERVICE CARD

pected to be available from stock. A three-level relay is priced at about \$50; breakdowns for quantity orders have not been established.

Twin Independent Contacts Used

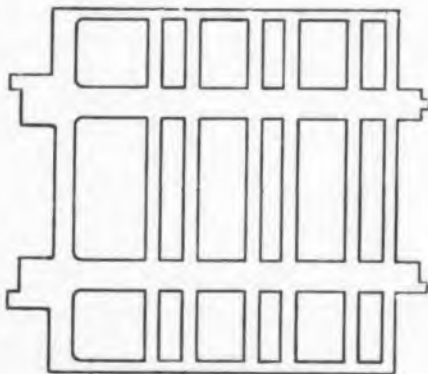
To insure positive contacting, Automatic Electric, a subsidiary of General Telephone and Electronics, is manufacturing the relay with twin, independent contacts of Code O (palladium-silver). The self-equalizing contacts are coined after welding to a dome configuration for proper mating and will carry 3-amp, 150-w, non-inductive load. Contacts are protected from dust by a transparent plastic cover.

Individual adjustment of spring contacts is not necessary on the WQA relay. The entire level of stationary springs may be controlled by simple adjustment of their supporting arm.

Solderless-wrap terminals are used; they eliminate soldering defects and provide gas-tight, corrosion-resistant connections. The insulation resistance of the relay is a minimum of 1500 meg at 80 F, 88 per cent relative humidity.

Dimensions of the WQA relay are: one level, 4.06 x 3.14 x 2.19 in.; two levels, 4.06 x 3.14 x 2.97 in.; three levels, 4.06 x 3.14 x 3.78 in. The relay's net weight is 2.25 lb, approximately.

For more information on this relay, turn to the Reader-Service card and circle number 251.



"Secret" of accurate timing of the relay lies in the actuating card that controls all the moving springs. This is a sheet of rigid plastic that is moved directly by the armature and in turn actuates the moving springs, which pass through holes in the card. The time and sequence of all spring operation is thus pre-established exactly by the size and spacing of these holes.



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Capacitor	Capacitance (uuf)	Volume (approx.)
W, WL-5	1 to 560	0.00204 in. ³
W, WL-4	561 to 1000	0.00327
W, WL-3	1001 to 2700	0.00702
W, WL-2	2701 to 4300	0.01951
W, WL-1	4301 to 10,000	0.02106



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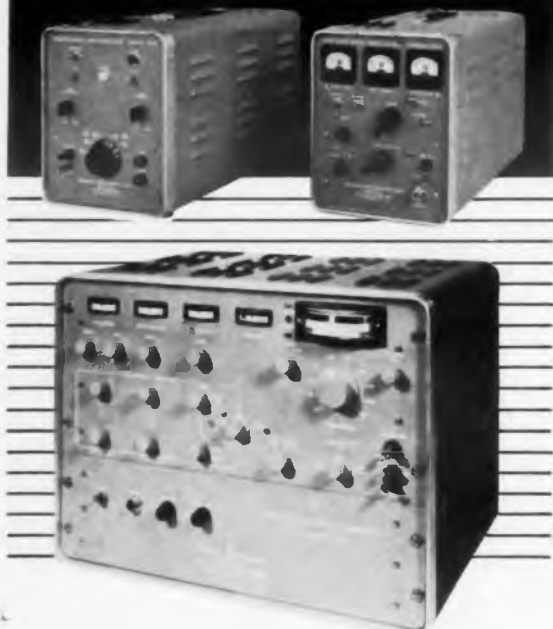
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Employers' Rights in Employees' Inventions

Albert Woodruff Gray

Rules governing ownership of employees' patents have been laid down by the courts. This article discusses several situations which illustrate how these rules are applied.

WHO OWNS your patents? If you worked on an invention as part of your regular job, your company may be able to compel you to assign it to them. If you did the work at home, not in line with your regular duties, you probably have prior rights to it. There is no ready answer. It depends upon circumstances.

Cases of "who has the shop rights" in employees' inventions go way back. One interesting case involved a manufacturer of capacitors. He decided to develop a line of magneto capacitors and hired engineers specifically for this purpose.

When later one of these engineers joined a competitor, the magneto manufacturer sued to compel the engineer to assign the patents that had been granted him to his former employer.

Assignment of the patents to the magneto manufacturer was granted. In denying the claim of the engineer to these inventions and their patents, the Massachusetts court pointed out that not only was this work performed in the employer's shop and with its facilities but under the direction of its chief engineer.

Here the court referred to a previous case when claims had been made by a government employe against the assertion of ownership of an invention by the United States. When an invention is discovered by an employe, even in the course of his employment and at the employer's expense, the United States Supreme Court had ruled in that instance, it is nevertheless the invention and property of the employe. The invention and the essential idea are his irrespective of the facilities of the employer that have been used.

But, in the case of the engineer employed by the magneto manufacturer, there was an exception.

By the terms of his employment, the engineer had agreed to assign these inventions to his employer. In that previous decision of the Supreme Court, it had been said, "If one is employed to devise or perfect an instrument or a means for accomplishing a prescribed result, he cannot after successfully accomplishing the work for which he

was employed, plead title thereto against his employer. That which he has been employed and paid to accomplish becomes, when accomplished, the property of his employer."¹ An important point is the nature of the employment. When the employe has been entrusted with the confidence of his employer, this factor deprives him of any claim that he might otherwise make to inventions which were the sole object of his employment.

Homework That Accrues to Employer

Recently an experienced mechanical engineer had been assigned to the work of developing a loop antenna assembly according to a model supplied by the Signal Corps.

Later the employe had been granted a patent on the invention he had perfected. In a suit brought by this employer a decree was asked from the court that the employe be compelled to assign the patent to the employer and be restrained either from using or disclosing to others any manner of information relating to the antenna.

In his defense the employe insisted that he had made and developed this invention at his home at night and had received no instructions relating to improvements from his employer relating to this loop antenna.

Granting the relief asked for by the employer, the Federal Court pointed out that the employe had been hired and paid to make specific improvements to this assembly to meet certain specifications. The court ruled that if an employe is hired to invent or is assigned the duty of devoting his efforts to a particular problem, the resulting invention belongs to the employer.²

Homework That Belongs To Inventor

Two National Bureau of Standards research workers became interested in the possibility of substituting alternating current for the direct battery current then employed in different electronic circuits. The research work to which they had been

assigned was entirely different from this subject which had enlisted their scientific curiosity. When a method for so using alternating current for this purpose had been perfected and patents issued to these scientific engineers, the invention and its patents were claimed by the United States.

In its claim to these inventions, the government contended before the Federal Court that where an employe was a member of a research bureau and made an invention wholly outside of the work to which he had been assigned, that invention is the property of the government.

Uniformly unsuccessful in establishing this claim in the lower courts the government brought the controversy before the United States Supreme Court for a final determination. There in holding these inventions and patents to be the property of these two employes and not the property of the United States, that court said,

"One employed to make an invention who succeeds during his term of service in accomplishing that task, is bound to assign to his employer any patent obtained. The reason is that he has only produced that which he was employed to invent. His invention is the subject of his contract of employment. Necessarily that which he is paid to produce belongs to his paymaster."

In contrast to this situation, the court pointed out, if the employment is general, even though it may cover a field of labor or research in which such an employe conceived the invention and for which he was granted a patent, the law does not require an assignment from him of the patent. ■ ■

References

1. Wireless Specialty Apparatus Co. v. Mica Condenser Co., 131 N. E. 307, Mass., June 3, 1921
2. Marshall v. Colgate-Palmolive-Peet Co., 175 Fed. 2d 215 Delaware, June 2, 1949



VARIAN presents the VA-839

KLYSTRON WITH 5% BANDWIDTH RIVALS TWT'S

5 megawatts peak power

10 kw average • 40 db gain • No tuning

Coherent radar systems with frequency agility and of exotic concept can be designed around the VA-839 amplifier klystron. You can use programmed frequencies, pulse-to-pulse frequency changes, phase coding or frequency variations within the pulse—all with the stability and freedom from spurious noise that is characteristic of Varian Klystrons.

Varian Associates also builds pulse power klystrons of 12% bandwidth and pulse power traveling wave tubes for even greater bandwidths. These demonstrate Varian's unmatched capability in advanced microwave tube development and manufacture. May we supply further data or an answer to a particular microwave need of yours?

Representatives throuout the world



VARIAN associates
PALO ALTO 21, CALIFORNIA

KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MAGNETRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR & EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES
CIRCLE 55 ON READER-SERVICE CARD

NEW PRODUCTS

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



Silicon Controlled Rectifiers Made For Low Current Use

254

These eight, low-current, silicon-controlled rectifiers can be used in circuits for pulse and phase controlling dc output as well as power inversion. The units—types C10U, C10F, C10A, C10G, C10B, C10H, C10C, C10D—differ by repetitive piv ratings, which range from 25 to 400 v. Average forward current ratings are 1.7 amp at a stud temperature of 125 C, and 4.2 amp at 75 C. They have a maximum forward voltage of 1.2 v at 3 amp, dc, or 2 v at 20 amp.

General Electric Co., Dept. ED, Charles Building, Liverpool, N.Y.

Price & Availability: In medium size quantities, prices range from \$4.50 to \$40 each. Immediately available from stock.



Cathode-Ray Tube Has High Signal Sensitivity

256

Type K1736 cathode-ray tube is a 5.25-in. diam unit with a single beam and electrostatic focus and deflection. Deflection voltages are: D_1D_2 , less than 60 v per in.; D_3D_4 , less than 22 v per in. All screens of the high-frequency tube are provided with highly reflective metal backings for maximum brightness. A gradual voltage gradient is allowed by the spiral resistance winding. Typical operating voltages are: post accelerator, 10,000 v; accelerator, 1,400; pattern adjustment electrode, 1,400. Line width is 0.03 in. max.

Allen B. Du Mont Laboratories, Inc., Dept. ED, Clifton, N.J.

Price & Availability: \$150 per tubes with P1 or P2 phosphors; delivered 6 to 8 weeks after order received on small quantities.



Instrument Tests All Commercially Available Computing Resolvers

257

Model MST-8QSA measures the electrical characteristics of all commercially available computing resolvers. Each test result is directly read from panel-mounted indicators without the use of charts or graphs. A complete set of measurements takes less than 10 min per unit. The instrument measures function error, inter-axis and null spacing error, fundamental and total null, electrical zero, winding phase, T/R, T/R difference, and phase shift.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

Delivery: In 10 weeks.



Tuner Combines Shorted Stub And Line Stretcher 258

This coaxial tuner, known as a stub stretcher, combines in a single unit an adjustable shorted stub and a line stretcher. This combination permits the stub position to be continuously varied with respect to the load and thus, any load impedance can be matched to the line. Two models are available, one for use from 300 to 10,000 mc and the other from 1000 to 10,000 mc. They are available with Type N, BNC, C, or HN connectors and have a power rating of 100 w.

Microlab, Dept. ED, 570 W. Mount Pleasant Ave., Livingston, N.J.

Price & Availability: Priced from \$120 to \$160, depending on frequency range and connectors. Immediate delivery from stock.



Traveling Wave Tube Covers 2 to 4 Kmc Band 259

Type WJ-211 travelling wave tube covers the 2- to 4-kmc band with spot noise figures in the order of 2.7 db and fixed voltage noise figures below 4.8 db across the band. Anticipated applications of the tube are radiometry, telemetry, and radar. Externally, the tube is compatible in size, weight, and power supply requirements with present solenoid-focused low noise tubes. Cathode operating temperature is, typically, 650 C; this low temperature is expected to contribute to a long tube life.

Watkins-Johnson Co., Dept. ED, 3333 Hillview Ave., Palo Alto, Calif.

Price & Availability: Tubes are priced at \$1,950; delivery is 4 to 8 weeks.

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 4

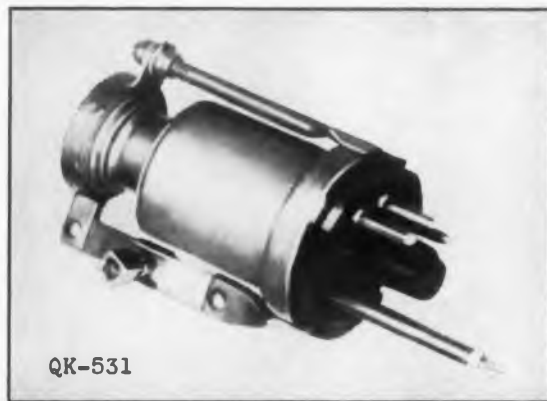
RAYTHEON KLYSTRON CLOCKS 62,000 HOURS OF SERVICE

--tube retired after seven years of continuous operation

We don't send out 62,000-hour warranties; however, you can expect unusual performance from Raytheon klystrons. Take the tube cited above -- the QK-531 -- a 6,575-6,875 mc reflex klystron which we conservatively warrant for 7,500 hours. As the local oscillator in the Houstonia, Missouri, link of the Panhandle Eastern Pipeline Company's 400-mile microwave system, the tube performed a major function in relaying up to ten channels of information between the Odessa and Boonville stations.

How is this kind of performance built into a tube? Advanced manufacturing techniques and rigorous quality control is the answer.

If you need low-power coverage of government, studio link and common carrier frequency bands, look into the characteristics of Raytheon's complete line of klystrons.



QK-531

The QK-531 is particularly suited for local oscillator service in microwave receivers. It is useful, also, as a local oscillator in microwave spectrum analyzers, as a pulse generator for testing circuit response and as a frequency modulated source in microwave relay links.



Homer Marrs of Motorola presents gold-plated klystron trophy to F. J. McElhatton, Panhandle Eastern Pipeline Co. J. A. Fowler, Supervisor of Communications for Panhandle, is at the left. Prized klystron, the Raytheon QK-531, performed for 62,000 hours.



Close control of product quality and costs at every state of production is responsible, in part, for Raytheon's success in meeting industry and government specifications. Every step of assembly is spot checked by inspectors, each with 10 years or more experience in microwave tube production.

Excellence in Electronics



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: E. Waterloo, Ontario.

NEW PRODUCTS

High-Level, Low-Level Switch 473

For PDM systems



This three-pole, high-level, low-level switch is for use in PDM systems. Two of the poles are for differentially scanning 10 or more low-level signals such as thermo-couple and strain-gage outputs. The third pole is for scanning 43 channels of 0-to-5-v dc, high-level output signals. A magnetic pulser triggers the keyer. Timing and phasing of the data poles operate with transmitter and de-commutation equipment designed in accordance with IRIG standards.

Instrument Development Laboratories, Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.
Availability: Delivery requires 120 days.

VU Meters 703

Complete line available



This complete line of VU meters conforms to industry standards. The instruments can be furnished with A or B scale plates and are offered in sizes of 2.5, 3.5, and 4.5 in., round or rectangular, and in acrylic or phenolic cases. They are for use in broadcast monitoring panels, tape recorders, sound level indicators, and in other applications. They have a double-bridge d'Arsonval movement with wide-band, full-bridge rectifiers.

Pace Electrical Instruments Co., Dept. ED, 70-31 84th St., Glendale, L.I., N.Y.

Availability: Production quantities are available to equipment manufacturers. Units are also sold by distributors for in-plant, prototype, and laboratory purposes.

Palladium Diffusion Purifier removes all impurities from commercial cylinder hydrogen

The Engelhard Palladium Diffusion Purifier is used to remove all impurities from commercial cylinder hydrogen. This includes such impurities as oxygen, nitrogen, argon, water vapor, hydrocarbons and any others found in commercially bottled hydrogen.

The hydrogen purity achieved is, without question, the highest obtainable—no trace of impurities are detectable in the purified gas, by any known method.

Electrical circuit interlocks prevent palladium and hydrogen contacting at 150°C to form beta phase Pd-H₂ system which is brittle and impervious. Impurities are not permitted to accumulate within the palladium tubes. Impurities are bled off continuously with a small hydrogen stream which is vented to a hood or a small burner. A check valve located in the pure product line prevents back flow into the tubes.

The Engelhard Hydrogen Palladium Diffusion Purifier is now manufactured in standard sizes for flowrates from 5 scfh up to 1000 scfh. Larger sizes are custom built to meet customer's requirement. Write for literature and price list.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.

CIRCLE 57 ON READER-SERVICE CARD



CHEMICAL
DIVISION

These platinum precision resistance spirals measure temperature

by change in electrical resistance.

Here are ideal components for both accuracy and reliability in temperature measuring or controlling equipment. They have an accuracy of $\pm 0.1^\circ\text{C}$.

Three types are available in a full range of sizes. A glass enclosed series affords high precision for temperatures between -220°C and $+500^\circ\text{C}$. Spirals are obtainable as standard products having a resistance of 25, 50 or 100 ohms. The variation in diameters, lengths, etc., are numerous.

High temperature spirals in which suitable ceramic replaces the glass are also available. These are used for measuring temperatures up to 750°C . The accuracy of the ceramic spirals is only slightly less than that obtainable from the glass spiral, but still superior to thermocouples in stability. For extremely precise temperature measurements, a laboratory standard resistance thermometer is available.

Although most spirals are supplied directly to the user as components, we also provide a fabrication service and supply spirals in metal sleeves or other constructions as required. Send for complete literature.

INSTRUMENTS AND SYSTEMS DIVISION • 850 PASSAIC AVENUE
EAST NEWARK, NEW JERSEY

CIRCLE 58 ON READER-SERVICE CARD

DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION • AMERSIL QUARTZ DIVISION • BAKER CONTACT DIVISION • BAKER DENTAL DIVISION • BAKER PLATINUM DIVISION • BAKER SETTING DIVISION • CHEMICAL DIVISION • HANOVIA LIQUID GOLD DIVISION • INSTRUMENTS & SYSTEMS DIVISION • IRVINGTON-BAKER REFINING DIVISION • D. E. MAKEPEACE DIVISION • RESEARCH & DEVELOPMENT DIVISION • H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD., TORONTO • ENGELHARD INDUSTRIES LTD., BAKER PLATINUM DIVISION, HANOVIA PRODUCTS DIVISION, LONDON • SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S.A., BO-

PROMPT PRECIOUS METAL SCRAP RECOVERY SERVICE • ENGELHARD PROCEDURES RECOVER

ELECTRONIC DESIGN • May 25, 1960

CHEMICAL
DIVISION



gold plating for electrical and electronic components

Recently, the use of gold electroplates have been extended to many new functional applications especially in the field of electronics where the tarnish resistance and low electrical resistivity of gold are most useful. A complete line of precious metal plating solutions for both decorative and functional purposes are available from stock.

ATOMEX is a 24K gold immersion solution that permits the deposition of a thin, dense, uniform layer of 24K gold on printed circuits and metallized plastics by means of a simple bath. Atomex deposits gold by ionic displacement—it is the first practical gold immersion solution containing no free cyanide. The Atomex deposit is more permanent and less expensive than electroplating of comparable thickness. Costly analytical control is unnecessary. Write for literature.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.

CIRCLE 59 ON READER-SERVICE CARD

Atomic Number	79
Atomic Wgt.	197.20
Crystal Structure	Face center cubic 4.07A°
Density	20°C = 19.3 G/CM ³
Melting Point	1063°C
Specific Resistance	13.2 OHMS/MILL/FOOT
Thermal Conductivity	0.71 c g s UNITS (20°C)
Coef. Linear Expansion	14.2 Micro Inches /°C (20°C)
Hardness	Rockwell 15 T Scale = 24
Tensile Strength	P.S.1 x 1000 = 18
Magnetic Susceptibility	.15 x 10 ⁻⁴ C.G.S. Units (18°C)



BAKER
CONTACT
DIVISION

precious metal contacts for high-reliability

For high-reliability and long operating life, precious metal contacts in pure or alloyed forms of silver, platinum, palladium and gold are very definitely indicated. These contacts provide unmatched high resistance to atmospheric corrosion, deformation, arc erosion, binding and metal transfer. Baker precious metal contacts are supplied as wire, rod, sheet and in a complete line of fabricated forms. Facilities are also available for manufacture to your specifications. Write for Baker Contact catalog.

BAKER CONTACT DIVISION • 207 GRANT AVE., E. NEWARK
HARRISON P. O., N. J.

CIRCLE 60 ON READER-SERVICE CARD

DOTA • ENGELHARD INDUSTRIES S.A.R.L., PARIS • ENGELHARD INDUSTRIES A/S, COPENHAGEN • GLOVER & GODDE PTY., LTD., MELBOURNE • ENGELHARD INDUSTRIES, K.K., TOKYO • ENGELHARD INDUSTRIES, PTY., LTD., MELBOURNE • ENGELHARD INDUSTRIES, LTD., ZURICH • INDUSTRIE ENGELHARD S.P.A., ROME • GIULIANO STACCIOLI-METALLI PREZIOSO S.P.A., ROME • INVERSIONES EN INDUSTRIAS NACIONALES, S.A., BOGOTA. ASSOCIATED COMPANIES: KALIE-CHEMIE-ENGELHARD KATALYSATOREN G.M.B.H., HANOVER

100% OF ASSAYED PRECIOUS METAL CONTENT • IRVINGTON-BAKER REFINING DIVISION

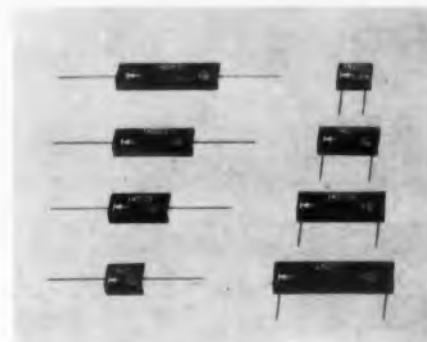
CIRCLE 57, 58, 59, 60 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960

Silicon Diode Stacks

471

For power supplies



For use in high-voltage power supplies for radar and communications applications, types 1N2878 through 1N2925 silicon diode stacks provide from 700 to 6500 v. The units have a piv of 24 v. They provide 250-ma average rectified forward current at 25 C, 0.5 μ a reverse current at piv, and 30- μ a leakage at 100 C. Forward voltage drop is low. The environmental requirements of Mil specs are met.

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

Price & Availability: Units are in stock. Price ranges from \$11 to \$29.65 ea for orders of 1 to 99.

Variable Resistor

704

Can have 500 ohms to 10 meg resistance



Model 6 variable resistor, a miniature 10-w composition control with a rotational torque of 1 oz-in. min, is available in resistances of 500 ohms to 10 meg. Mechanical rotation is 250 deg and effective electrical rotation is 220 deg. Change in resistance is less than 1% under vibration test per MIL-STD 202, less than 0.3% under shock test per MIL-202A, and less than 0.5% under acceleration test per MIL-R-94B.

Centralab, Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Price & Availability: Available to the OEM market exclusively, units are priced between \$1 and \$1.50 ea.



ENGINEERING
REPORT
ON BENDIX COMPONENTS



ONE-MINUTE SYNCHRO SYSTEM ACCURACY

Electrical two-speed Autosyn[®] synchro features—

- ACCURACY UNAFFECTED BY THERMAL AND MECHANICAL STRESS
- HIGH SIGNAL-TO-NULL RATIO
- ELIMINATION OF GEAR ERROR FOUND IN MECHANICAL TWO-SPEED SYSTEM
- ADAPTABILITY TO GYRO PICKOFF

Developed to meet need for accurate data transmission with maximum system simplicity. Produces two electrical outputs from single shaft, thereby eliminating inaccuracies of two-speed gear system as well as installation and maintenance costs of additional unit.

The synchro contains two separate sets of windings. One set pro-

duces the normal signal pattern of one cycle of output voltage, while the other produces eleven cycles, for each rotation of the synchro shaft. Increase in accuracy is very close to the 11-to-1 theoretical maximum, resulting in a system error of ± 1 minute when used back-to-back with similar units.

*REG. U. S. PAT. OFF.

ADDITIONAL CHARACTERISTICS:

Input voltage (to rotor)	26 volts, 400 cycles, single phase
Input current	200 ma max.
Input power	2.5 watts max.
Signal-to-null ratio	350:1
Sensitivity (mv/degree)	3500

For more detailed information on specific applications, write—

Eclipse-Pioneer Division

Teterboro, N. J.



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

CIRCLE 61 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Standards

699

Range is 1200 to 6400 cps



Type SFK frequency standards can be supplied with any output frequency between 1200 and 6400 cps. Designed for missile and airborne use, the units are transistorized, tuning-fork controlled, and occupy 1-5/8 cu in. Frequency tolerance is up to 50 ppm. Ambient temperature is to 125 C. Requiring a 10- to 14-v dc input or a 24- to 32-v dc input, the units deliver a 7-v peak-to-peak square wave into 10,000 ohms.

Accurate Instrument Co., Dept. ED, 2418 W. Alabama, P.O. Box 6373, Houston 6, Tex.

Vibration Transmissibility Recorder

472



Records directly

This vibration transmissibility recorder is able to record transmissibility or other two-signal ratios directly as a function of frequency, giving a ready-to-use curve. It simultaneously accepts two synchronous signals in the range of 10 to 5000 cps, measures their frequency, computes the average amplitude values, and plots the ratio as a function of frequency. The instrument can be used to determine: input voltages vs frequency, time-integral input voltages vs frequency, and time-derivative of input voltages vs frequency.

Lord Manufacturing Co., Dept. ED, Erie, Pa.
Availability: Units are made on order.



BAROMETRIC ALTITUDE CONTROL

Maintains aircraft altitude in automatic flight systems.



This Eclipse-Pioneer pressure-sensing instrument helps maintain aircraft at a selected altitude in automatic flight. Sensing barometric altitude, it generates electrical control signals whenever the aircraft is displaced from the reference. These signals, proportional to the deviation, are power amplified and provide a control signal to restore correct altitude. Write for details.

VERTICAL SENSOR

Indicates true vertical positioning within ± 3 minutes of arc.



Eclipse-Pioneer's Vertical Sensor is a small (4 7/8" high), lightweight instrument for highly accurate determination of vertical positioning. An iron pendulum is suspended in a tube of damping fluid. Two magnetic pickups, 90° apart at the bottom of the tube, detect deviation from vertical by sensing movement of the pendulum from center. Output increases linearly as the unit tilts from vertical, and cross coupling is minimal. Ask for further information.

Manufacturers of
GYROS • ROTATING COMPONENTS
RADAR DEVICES • INSTRUMENTATION
PACKAGED COMPONENTS

Eclipse-Pioneer Division



Teterboro, N. J.

CIRCLE 62 ON READER-SERVICE CARD

Voltage-to-Frequency Converters 700

Produce 10,000 and 100,000 pps



These voltage-to-frequency converters enable dc and analog voltages to be measured accurately with an electronic counter. Model 2211A produces 10,000 pps for a full scale input of 1 v and model 2211B produces 100,000 pps. Accuracy of the 2211A is 0.03% and of the 2211B, 0.04%.

Dymec, Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

High-Temperature Coating 682

For tuned circuits

For use with tuned circuits, type 338-D high-Q, temperature-resistant coating has only a negligible effect on the frequency response of the assembled units. It is particularly suitable for use in the manufacture of miniature in-line, rf filters. It is supplied as a solvent solution that can be brushed, dipped, or sprayed. After a brief drying period, the coating is cured in an oven at 275 to 300 F for 2 hr. The cured coating is clear, tough, resistant to water, oils, solvents, and high temperature.

Plastic Associates, Dept. ED, 185 Mountain Road, Laguna Beach, Calif.

Power Supply 701

Provides 155 v dc at 150 ma

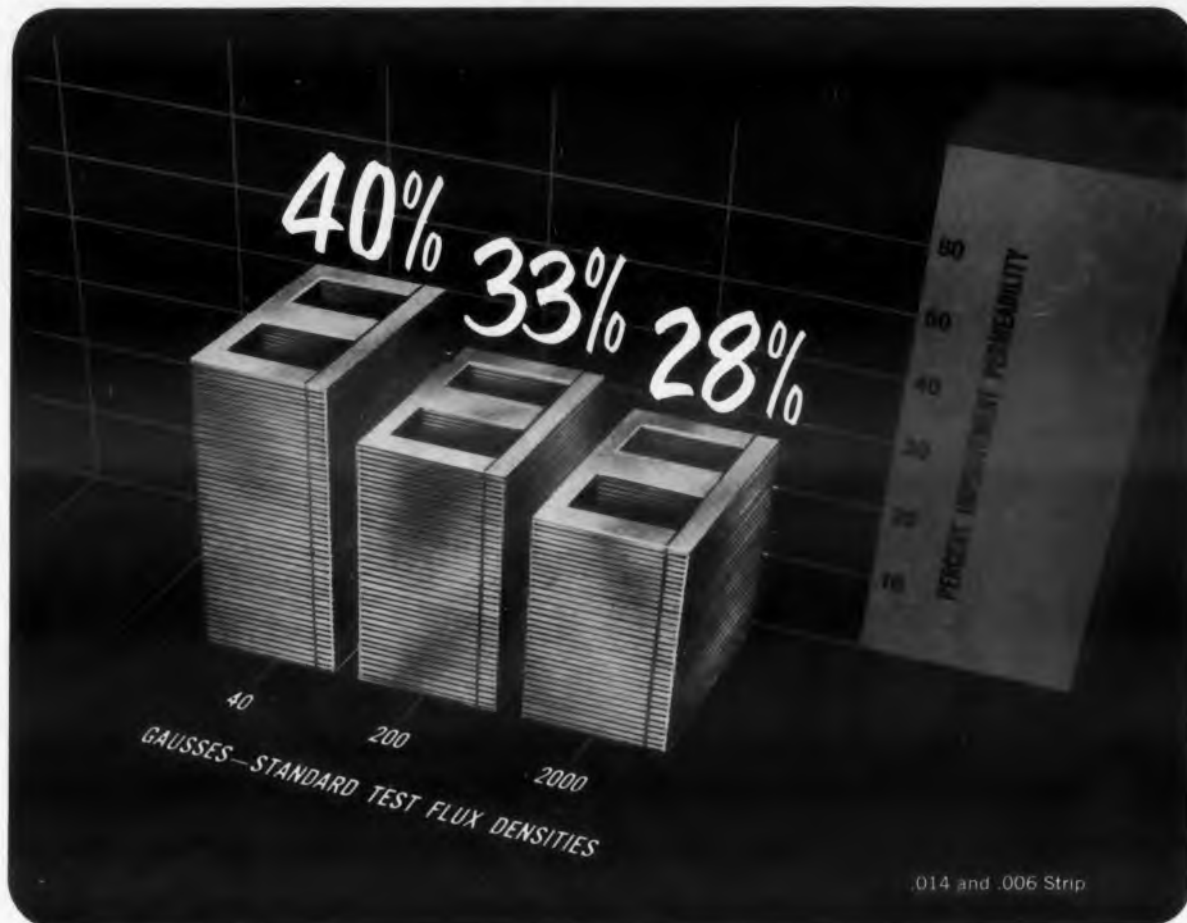


Able to provide 155 v dc at 150 ma regulated to $\pm 1\%$, this power supply contains a reactor and a hermetically sealed constant voltage transformer. The time delay relay is adjustable from 30 sec to 3 min. Input is 95 to 130 v ac at 60 cps. Ripple is less than 10 mv. A 6.3-v, 60-cps supply is built into the unit.

Freed Transformer Co., Inc., Dept. ED, 1718 Weirfield St., Brooklyn 27, N.Y.

Price: The unit is competitively priced.

Experience—the added alloy in A-L Electrical Steels



Higher permeability values now guaranteed for Allegheny Ludlum's Moly Permalloy

Means new, consistent and predictable magnetic core performance

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum, with higher guaranteed permeability values than former typical values. For the buyer, this new high quality means greater uniformity . . . more consistent and predictable magnetic core performance.

This higher permeability is the result of Allegheny Ludlum's intensive research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. A-L continues its research on silicon steels,

including Silectron, well-known grain-oriented silicon steel, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available from Allegheny Ludlum. In addition, you can be assured of close gage tolerance, uniformity of gage throughout the coil, and minimum spread of gage across the coil-width.

If you have a problem relating to electrical steels, laminations or magnetic materials, call A-L. Prompt technical assistance will be yours. And write for more information on Moly Permalloy. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

Address Dept. ED-5.

ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

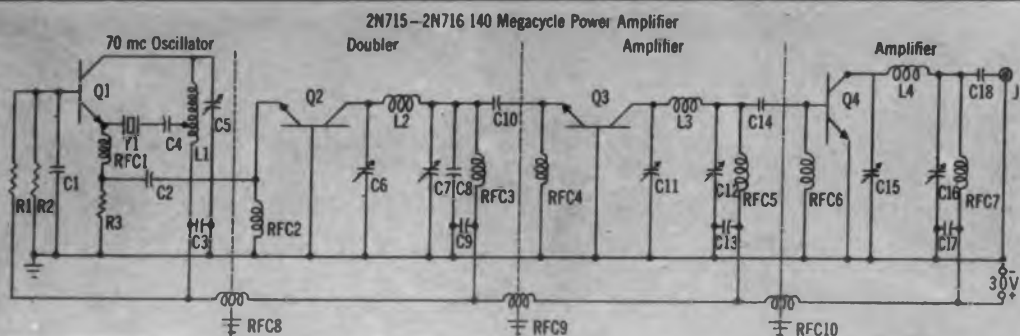
Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17

Export distribution, Laminations: AD. AURIEMA, NYC 4

CIRCLE 63 ON READER-SERVICE CARD



How to design 250mw at 140mc transistorized power amplifiers



C1, C2, C3--.001 μ f disc ceramic
 C4--20 μ f tubular ceramic
 C5, C6, C7, C11, C15--1.8-13 μ f
 C8--47 μ f silver mica
 C9, C10, C13, C14, C17, C18--500 μ f disc ceramic
 C12--7-45 μ f mica trimmer
 C16--3.2-50 μ f
 L1--8 turns #18 Airdux, tapped 2 turns from ground
 L2--4 turns #12 magnet wire, $\frac{1}{2}$ " D, $\frac{1}{4}$ " L
 L3--3 turns #12 magnet wire, $\frac{1}{2}$ " D, $\frac{1}{4}$ " L
 L4--3 turns #12 magnet wire $\frac{1}{2}$ " D, $\frac{1}{4}$ " L
 Q1, Q2, Q3, Q4--TI 2N716
 R1--5100 ohms, $\frac{1}{2}$ watt
 R2--680 ohms, $\frac{1}{2}$ watt
 R3--200 ohms, $\frac{1}{2}$ watt
 RFC1--.47 μ h
 RFC2--4.7 μ h
 RFC3 through RFC10
 1.2 μ h
 Y1--70 mc crystal

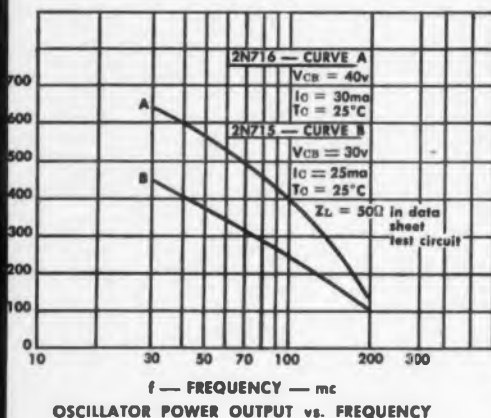
..with NEW TI 2N716 silicon mesa transistors

Now . . . silicon high frequency transistors *specifically* designed for your VHF power circuits . . . another addition to the industry's broadest line of silicon mesa transistors (now 16 TI types!).

TI 2N715 and TI 2N716 *guarantee 500-mw amplifier output at 70 mc* and provide *100-mw typical power output at 200 mc*.

These subminiature (TO-18) silicon units feature . . . 1.2-w dissipation at 25°C case temperature . . . 10-50 beta spread . . . collector reverse voltages of 50 and 70v . . . maximum collector reverse currents of 1.0 μ a (25°C) and 100 μ a (150°C).

Check the guaranteed specs below and take immediate advantage of advanced performance in your designs. Both units are ready for your orders in every TI distributor's stocks today, and in quantities of 1,000 and up from your nearest TI sales office.



This power rating for 1000 hours expected life at a case temperature of 25°C derated linearly to +175° case temperature at the rate of 1.25°C per mw.

Maximum voltage ratings at an ambient temperature of +25°C. BV_{CEO}: This is the voltage at which h_{FE} approaches one when the emitter-base diode is open circuited. This value may be exceeded in applications where the dc circuit resistance (R_{BC}) between base and emitter is a finite value.

When the emitter-base diode has a reverse voltage applied, peak collector to emitter voltage equal to BV_{CEO} minus V_{EB} may be allowed. Such conditions may be encountered in class B or C amplifiers and oscillators.

Specify I_{EB0} on commercial data sheet
 Specify I_{CB0} on commercial data sheet

Tentative Specifications 2N715-2N716										
Parameter	Test Condition	1 P _C = 25°C T _C = 25°C			2 V _{CB}			3 V _{EB}		
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
**BVEBO	I _{EB0} = 100 μ a I _C = 0	5			5					
***BV _{CEO}	I _{CB0} = 10 μ a dc I _E = 0	50			70					
*h _{FE}	V _{CE} = 10 v dc I _C = 15ma dc	10		50	10		50			
*V _{CE(sat)}	I _C = 15ma I _B = 3ma	1.2			1.2					
C _{ob}	V _{CB} = 5 v dc I _E = 0 F = 1 mc		3	6		3	6			μ f
Amplifier Power Output and Transducer gain	(V _{CB} = 40 v dc I _C = 30 ma dc P _{AC} = 500 mw F = 70 mc)				500	600	7.5			mw db
	(V _{CB} = 30 v dc I _C = 25 ma dc P _{AC} = 300 mw F = 70 mc)	300	400							mw db

TEXAS INSTRUMENTS
 INCORPORATED
 SEMICONDUCTOR-COMPONENTS DIVISION
 13500 N. CENTRAL EXPRESSWAY
 POST OFFICE BOX 312 • DALLAS, TEXAS

the first silicon transistor manufacturer

NEW PRODUCTS

Power Transformers 713 and Reactors

For circuits rated up to 250 kv

Pulse-viewing transformers, mono and bifilary types, and transformers for magnetron and klystron applications can be furnished for circuits rated up to 250 kv. Charging reactors are also offered. A typical unit is a bifilar pulse transformer with recessed bellows providing a wide temperature tolerance, 30-kv rated output, and step-up ratio of 1:5. All components meet Mil specs when required.

Manson Laboratories, Inc., Dept. ED, 375 Fairfield Ave., Stamford, Conn.

X-Band Dummy Loads 711

Outside dimensions are 5/8 x 1-1/4 in.

Designed to operate with a RG51/U waveguide, model 890379 X-band dummy load has outside dimensions of 5/8 x 1-1/4 in. and can be used in any radar operating from 7050 to 10,000 mc. Up to 600 w of average power and 460 kw of peak power can be dissipated without liquid cooling. The maximum vswr is 1.1. Requirements of MIL-D-14454 and MIL-E-5272 are met.

Litton Industries, Airtron Div., Dept. ED, 5873 Rodeo Road, Los Angeles 16, Calif.

Ceramic Vibration 715 Pick-Up

Operates in temperatures to 200 F

Model 61C ceramic vibration pick-up operates in temperatures to 200 F and in high humidities. The unit is used for locating and measuring vibration and for checking surface smoothness. The sensitive element is polarized polycrystalline barium titanate. The unit has an internal impedance of 10,000 pf at 80 F. Recommended load is 1 meg. Shure Brothers, Inc., Dept. ED, 222 Hartrey Ave., Evanston, Ill.

◀ CIRCLE 64 ON READER-SERVICE CARD

IMMEDIATE DELIVERY OF ELMENCO

capacitors

IN QUANTITIES UP TO
500 Per Item
CONTACT THESE AUTHORIZED
ELMENCO INDUSTRIAL DISTRIBUTORS

The authorized distributors listed below carry a full stock of all Elmenco Capacitors and can give you immediate delivery from stock.

ARIZONA: Radio Specialties & Appl. Corp., 917 N. 7th St., Phoenix; Standard Radio Parts Inc., 218 N. First Ave., Tucson

CALIFORNIA: Brill Elect., 610 E. 10th St., Oakland; Elect. Supply Corp., 2085 E. Foothill Blvd., Pasadena; Federated Purchaser Inc., 11275 W. Olympic Blvd., L. A. 64; Hollywood Radio Supply Inc., 5606 Hollywood Blvd., Hollywood 28; Pacific Wholesale Co., 1850 Mission St., San Francisco 3; Peninsula Elect., 656 S. 1st St., San Jose; Shanks & Wright Inc., 2045 Kettner Blvd., San Diego; Shelley Radio Co. Inc., 2008 Westwood Blvd., L. A. 25; R. V. Weatherford Co., 6921 San Fernando Rd., Glendale 1; Zack Electronics, 654 High St., Palo Alto

COLORADO: Denver Electronics Supply Co., 1254 Arapahoe St., Denver 4

DISTRICT OF COLUMBIA: Capital Radio Wholesalers Inc., 2120 14 St., N.W., Wash., D. C.

FLORIDA: Elect. Supply, 909 Morningside Dr., Melbourne; Elect. Supply, 61 N. E. 9th St., Miami

ILLINOIS: Newark Electronics Corp., 223 W. Madison St., Chicago 6

MARYLAND: Kann-Ellert Electronics Inc., Howard & Redwood Sts., Balt. 1; Wholesale Radio Parts Co. Inc., 308 W. Redwood St., Baltimore 1

MASSACHUSETTS: Cramer Electronics Inc., 811 Boylston St., Boston 16; Radio Shack Corp., 730 Commonwealth Ave., Boston 17

NEW JERSEY: Federated Purchaser Inc., 1021 U. S. Rte. 22, Mountainside; Radio Elec. Service Co., Inc., 513 Cooper St., Camden 2

NEW MEXICO: Midland Specialty Co., 1712 Lomas Bl. N.E., Albuquerque; Radio Specialties Co., Inc., 209 Penn Ave., Alamogordo

NEW YORK: Arrow Elect. Inc., 525 Jericho Turnpike, Mineola, L. I.; Elect. Center Inc., 211 W. 19th St., N. Y. 11; Harvey Radio Co., Inc., 103 W. 43rd St., N. Y. 36; Lafayette Radio, 100 Sixth Ave., N. Y. 13; Terminal Elect. Inc., 236 W. 17 St., N. Y. 17

PENNSYLVANIA: Almo Radio Co., 412 N. 6th St., Phila 23; George D. Barbey Co. Inc., 622 Columbia Ave., Lancaster; George D. Barbey Co. Inc., 2nd & Penn Sts., Reading; D. & M. Distributing Co., Inc., 2535 N. 7th St., Harrisburg; Phila. Elect. Inc., 1225 Vine St., Phila. 7; Radio Elec. Service Co., Inc., 701 Arch St., Phila. 6; A. Steinberg & Co., 2520 N. Broad St., Phila.; Wholesale Radio Parts Co., Inc., 1650 Whiteford Rd., York

TEXAS: All-State Dist. Co., 2411 Ross Ave., Dallas 1; Busacker Elect. Equip. Co. Inc., 1216 W. Clay, Houston 19; Engineering Supply Co., 6000 Denton Dr., Dallas 35; Midland Specialty Co., 500 W. Paisano Dr., El Paso; The Perry Shankle Co., 1801 S. Flores St., San Antonio

WASHINGTON: C & G Radio Supply Co., 2221 Third Ave., Seattle

CANADA: Electro Sonic Supply Co., Ltd., 543 Yonge Street, Toronto 5, Ont.

ARCO ELECTRONICS, INC.
NEW YORK • DALLAS • LOS ANGELES
Exclusive Supplier of ELMENCO Capacitors to Distributors and Jobbers in U.S.A. and Canada

It could
happen...

with

El-Menco
CAPACITORS!

NEW

Mylar-Paper Dipped

CAPACITORS

TYPE
MPD

INSURE FAILURE-PROOF PERFORMANCE!

Only 1 Failure in 7,168,000 Unit-Hours for 0.1 MFD Capacitors

Setting a new standard of reliability!

*Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 100°C with rated voltage applied — have yielded a failure rate of only 1 per 7,168,000 unit-hours for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 7,168,000 UNIT-HOURS.

SUPERIOR FEATURES!

• Five case sizes in working voltages and ranges:

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MFD
1600 WVDC —	.001 to .05 MFD

Write for Technical Brochure Giving Complete Information on the El-Menco Tubular Dur-Paper Line.

THESE CAPACITORS WILL EXCEED ALL THE ELECTRICAL REQUIREMENTS OF E.I.A. SPECIFICATION RS-164 AND MILITARY SPECIFICATIONS MIL-C-91A AND MIL-C-25A.

FOR FAILURE-PROOF PERFORMANCE... COUNT ON ELMENCO MYLAR-PAPER DIPPED CAPACITORS FROM MISSILE GUIDANCE SYSTEMS TO DATA PROCESSING EQUIPMENT!

*Registered Trade Mark of DuPont Co.

SPECIFICATIONS

- TOLERANCES: $\pm 10\%$ and $\pm 20\%$. Closer tolerances available on request.
- INSULATION: Durez phenolic resin impregnated.
- LEADS: No. 20 B & S (.032") annealed copper-weld crimped leads for printed circuit application.
- DIELECTRIC STRENGTH: 2 or 2½ times rated voltage, depending upon working voltage.
- INSULATION RESISTANCE AT 25°C: For .05MFD or less, 100,000 megohms minimum. Greater than .05 MFD, 5000 megohm-microfarads.
- INSULATION RESISTANCE AT 100°C: For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- POWER FACTOR AT 25°C: 1.0% maximum at 1 KC.



El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.
WILLIMANTIC CONNECTICUT

Manufacturers of El-Menco Capacitors

- molded mica • dipped mica • mica trimmer • dipped paper
- tubular paper • ceramic • silvered mica films • ceramic discs

NEW PRODUCTS

Power Relays 716

Handle 17.5 amp at 16.6 v

Able to handle 17.5 amp at 16.6 v, type RX-1307 power relay is capable of 100,000 operations under full load at 100 C. It meets the requirements of GS-4176-1, including shock resistance to 75 g and a temperature range of -55 to +100 C. Dimensions are 1-5/8 x 1-5/8 x 2-1/8 in. Uses are in checking out aircraft or rackmounted circuitry, and in modulators, power supplies, amplifiers and process control equipment.

Wheelock Signals, Inc., Dept. ED, Long Branch, N.J.

Crystal-Detector Analyzer 710

Voltage gain is 10 to 20,000 db

This crystal-detector analyzer, a broadband, low-noise, video amplifier, has calibrated voltage gain from 10 to 20,000 db in 20-db steps, and a gain stability of 0.05 db per day. The calibrated bandwidth is 50 kc to 10 mc, over-all sensitivity is -102 dbm for a 10-mc bandwidth, and maximum noise figure is 1.8 db. Crystal loads can be selected from 100 ohms to 100 K; biasing is 0 to 1 ma.

ITT Laboratories, Electronic Defense Laboratory, Dept. ED, 3702 E. Pontiac St., Fort Wayne, Ind.

Instrument Bearings 712

Made to ABEC class 7 tolerances

Made to ABEC class 7 tolerances, these thin-width instrument bearings are for use in synchros, gear trains, potentiometers, servos and small motors. The OD measures from 0.275 to 0.5 in. and the bores, 0.0937 to 0.1875 in. Standard material is 440C stainless steel. Open, single and double-shielded bearings are offered.

Miniature Precision Bearings, Inc., Dept. ED, Precision Park, Keene, N.H.

Availability: From stock.



THIS IS WHY

Beam-X^{*} SWITCH



• SIZE —
1.1" x 3"



• LOWEST COST



• WEIGHT —
1.8 OUNCES



• ELIMINATES
90 TRANSISTORS,
DIODES AND
RESISTORS



• RUGGED SHOCK
AND VIBRATION

FIRST OF A FAMILY
MULTIPOSITION SWITCHES

BEAM-X APPLICATIONS: COUNTING • CODING • DISTRIBUTION • CONVERTING • MULTIPLEXING • SWITCHING • TIMING
• SAMPLING • PRESETTING • MATRIXING • DECODING • DIVIDING • GATING • MEMORY • OSCILLATING

OUTPERFORMS ALL ELECTRONIC SWITCHES

and

- 10 CONSTANT CURRENT OUTPUTS
- MEMORY AND AUTOMATIC LOCKING
- TOTAL POWER — 1.2 WATTS
- HIGH TEMPERATURE
- LONG LIFE
- SPEEDS FROM DC TO 10 MEGACYCLES
- ANY NUMBER OF POSITIONS
- OPERATING VOLTAGE FROM 12 V TO 200 V
- PRESETTABLE TO ANY POSITION
- OPERATES NIXIE® TUBES AND PRINTERS
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Detailed theory, circuit design and application data contained in Brochure BX-535 . . . Write for your copy today.



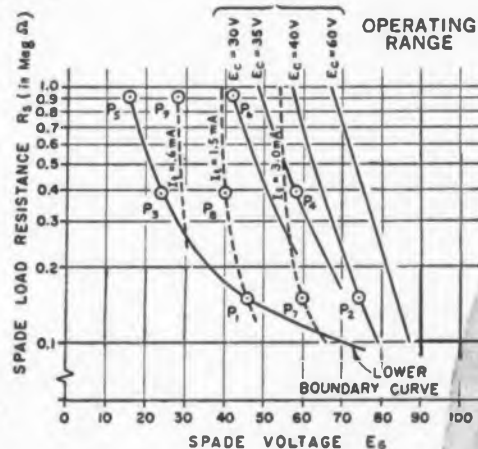
*Trademark of Burroughs Corporation

ANOTHER ELECTRONIC CONTRIBUTION BY
Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

and



BX-1000 IMPROVED CHARACTERISTICS

Gyros

708

Rotor speed is 36,000 rpm

These gyros have a rotor speed of 36,000 rpm. The rotor reaches top speed within 0.1 sec after the charge of ignition and provides effective performances for longer than 1 min. Both rate and free gyro types have a maximum rotor angular momentum of 3.5×10^5 gm cm^2 per sec. The drift rate of the free gyro is 3.5 deg max during the first minute. The rate gyro has a full scale range of 75 deg per sec after ignition and rises to 130 deg per sec after 1 min of operation. Its undamped frequency is 33 cps and damping factor is from 0.4 to 0.6 at 20 C. Units weigh 0.5 lb.

Giannini Controls Corp., Dept. ED, 918 E. Green St., Pasadena, Calif.

Resistors

714

Carbon film type

These carbon film resistors meet the environmental requirements of MIL-R-10509C, characteristic B. Due to a dry air space between the epoxy tube and the resistive element, moisture is prevented from being transmitted to the carbon film. Military sizes offered are: RN60, 65, 70, 75, and 80.

Mepco, Inc., Dept. ED, Morristown, N.J.

Indicator Lamps

718

Low-voltage type

These high-impedance, low-voltage, transistorized, incandescent indicator lamps provide a 180-deg light output. A second impedance eliminates the need of an external driver and the possibility of loading system circuitry. A self-contained bias eliminates the need for a second voltage source. The assembly measures 0.5 in. in diameter and 2 in. in length. Indicators are available for positive or negative 6, 8, or 10-v supply sources at 50 ma.

C & K Components, Inc., Dept. ED, 101-103 Morse St., Newton 58, Mass.

◀ CIRCLE 67 ON READER-SERVICE CARD



With proven performance four section flanged guided female contacts



Hooded



Draw Pull



Hoodless Knob-type



Hooded Screw Lock

SUBMINIATURE CONNECTORS

...the complete line

Only U.S. Components offers you a standard line of Draw Pull, Hooded, Hoodless Screw Lock, and Hoodless Knob-type Screw Lock connectors, each available in nine different contact configurations.

- Connector bodies supplied in glass and orlon-filled diallyl phthalates, alkyd, asbestos and glass-filled melamines
- Wire solder terminals
- Silver or nickel plated contacts with 24 carat or antimony gold flash
- Meets or surpasses all applicable MIL specs.

SPECIFICATIONS

Contacts 5-7-11-14-20-26-34-42-50;
other configurations upon request

Wire size #20AWG wire

Voltage breakdown between contacts—
sea level 1950 V.A.C. RMS

Current rating 7.5 amps

U.S. Pat. No. 2,761,108 Additional Patents Pending

Write today for quotation or specific information.



U. S. COMPONENTS, INC.

Associated with U.S. Tool & Mfg. Co., Inc.

454-462 East 148th St., New York 55, N. Y. CYPRESS 2-6525

CIRCLE 68 ON READER-SERVICE CARD

NEW PRODUCTS

Magnetic Counter

698

Weighs 3-5 oz



Weighing 3 oz, this additive, four-digit counter records pulses at a rate of 1800 counts per min. It can be reset by a single stroke. Dimensions are 15/16 x 1-1/4 x 2 in. Units stand vibration, shock, and temperature extremes, are available for 6, 12, 24, and 110 v dc, and can be used in statistical applications, airborne recording, and camera data chambers.

Abrams Instrument Corp., Dept. ED, 606 E. Shiawassee St., Lansing, Mich.

Coaxial Waveguide Adapter

702

In-line type



Model 849 in-line adaptor connects a type N coaxial connector to a UG-149/U waveguide flange. The vswr is less than 1.25 from 4400 to 6000 mc.

Radar Design Corp., Dept. ED, P.O. Box 38, Syracuse 11, N.Y.

Price & Availability: \$296 ea with discounts provided on quantity orders. Delivery time is five weeks.

Pulse Transformer

430

Operates at 6 μ sec pulse width

Designed to operate at a pulse width of 6 μ sec at 833 pps, type PT 120 pulse transformer has an input of 9.6 kv peak pulse at 426 amp. The output characteristics are 54.5 kv peak pulse at 75 amp,

extreme sensitivity

10 mc to 44,000 mc



PANORAMIC'S SPA-4 SPECTRUM ANALYZER

MORE USEABLE SENSITIVITY

BAND	RF SENSITIVITY*
10 — 420 MC	—95 to —105 dbm
350 — 1000 MC	—90 to —100 dbm
910 — 2200 MC	—90 to —100 dbm
1980 — 4500 MC	—80 to —90 dbm
4.5 — 10.88 KMC	—80 to —95 dbm
10.88 — 18.0 KMC	—70 to —90 dbm
18.0 — 26.4 KMC	—60 to —85 dbm
26.4 — 44.0 KMC	—55 to —85 dbm

*measured when signal and noise equal 2X noise
Using one tuning head which contains one triode and two Klystron oscillators, Model SPA-4 offers more exclusive advantages for applications demanding extreme sensitivity, stability, versatility, accuracy.

- Three precisely calibrated amplitude scales—40 db log, 20 db linear, 10 db power.
- Two independent frequency dispersion ranges—continuously adjustable—0-70 mc and 0-5 mc. Negligible internal frequency modulation permits narrow band analysis of FM problems.
- Variable I.F. bandwidth from 1 kc to 80 kc.
- Push-button frequency selector.
- Synchronoscope output with 40 db gain.
- Accurate measurement of small frequency differences. A self-contained marker generator, modulated by a calibrated external generator, provides accurate differential marker pipes as close as 10 kc.

Tremendous flexibility and many unique advances of Panoramix's compact SPA-4 make it unsurpassed for visually analyzing FM, AM and pulsed signal systems; instabilities of oscillators; noise spectra; detection of parasitics; studies of harmonic outputs; radar systems and other signal sources.

Write, wire or phone today for detailed SPA-4 bulletin.



OWens 9-4600
Cable: Panoramix, Mt. Vernon, N.Y. State
524 So. Fulton Ave., Mount Vernon, N.Y.

CIRCLE 69 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960

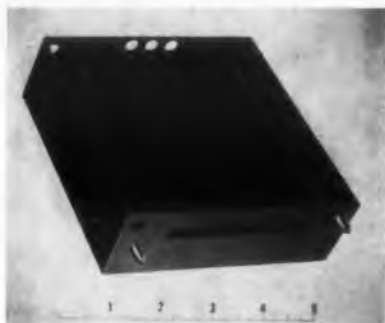
bifilar wound, capable of 3 amp filament current at 230 v ac. The primary is tapped to give a varying output from 52 to 58 kv peak pulse. The oil-filled transformer measures 7-3/8 x 5-7/8 x 10 in. Overall dimensions, including terminals, are 14-1/2 x 7-1/4 v 10 in.

Burmac Electronics Co. Inc., Dept. ED, 142 S. Long Beach Road, Rockville Centre, N.Y.

Price & Availability: Delivery made in about 4 weeks. Price is \$635 ea when ordered in small quantities.

Magnetostrictive Delay Line 705

Delays are from 50 to 500 μ sec



Type 5802 torsional-mode delay line conforms to environmental requirements specified by MIL-T-5422K and Air Force packaging requirements WCLN 58-18. Delays are from 50 to 500 μ sec and digit rates extend to 1 mc. A limited number of taps can be provided. Input and output impedances are provided to suit individual requirements.

Ferranti Electric Inc., Dept. ED, 95 Madison Ave., Hempstead, L.I., N.Y.

Availability: Delivery time is 60 days.

Ultrasonic Cleaner 428

Provides high and low frequencies

Model V-100 ultrasonic cleaner operates at 400 kc with overtones of other frequencies ranging from 20 kc. The higher frequencies remove dirt particles down to 1 micron; the lower frequencies provide cleaning action for larger dirt particles. The unit produces uniform concentration of ultrasonic power throughout the cleaning chamber. It is useful for cleaning metal filters for jet aircraft. Other cleaning applications are: etched circuit boards, precision electromechanical parts, semiconductor slices and dice, and potentiometer parts.

McKenna Laboratories, Dept. ED, 2503 Main St., Santa Monica, Calif.

Price & Availability: \$490 fob Santa Monica; one to three-week delivery.

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers •

ESC EXTRA

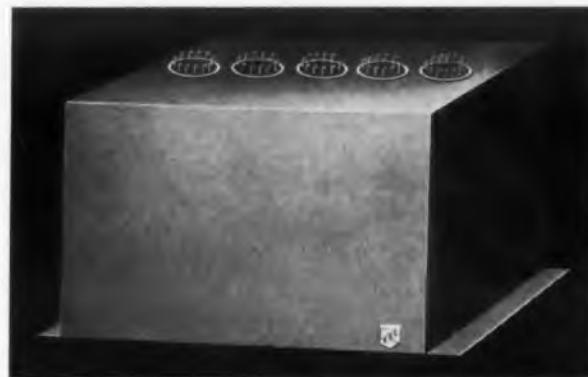
Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

ESC DEVELOPS DELAY LINE WITH 170 to 1 DELAY TIME/ RISE TIME RATIO

**Model 61-34 Perfected
For Specialized
Communications Application**

PALISADES PARK, N. J.—An entirely new Lumped-Constant Delay Line, with a proven 170 to 1 delay time/rise time ratio, has been announced by the ESC Corporation, Palisades Park, N. J. The new delay line, known as Model 61-34, was specifically designed for a specialized communications application calling for the exceptionally high delay time/rise time ratio.

ESC, the world's leading manufacturer of custom built and stock delay lines, is already widely recognized in the electronics industry for its exceptional engineering advances. In October, 1958, ESC broke through an existing design barrier and produced a delay line with a 145 to 1 delay time/rise time ratio. It had been thought, prior to the announcement of the Model 61-34, that ESC had reached the ultimate in this type of delay line.



SPECIFICATIONS OF NEW DELAY LINE MODEL 61-34

Delay time/rise time ratio: 170/1

Delay: 200 usec.

Rise time: 1.16 usec.

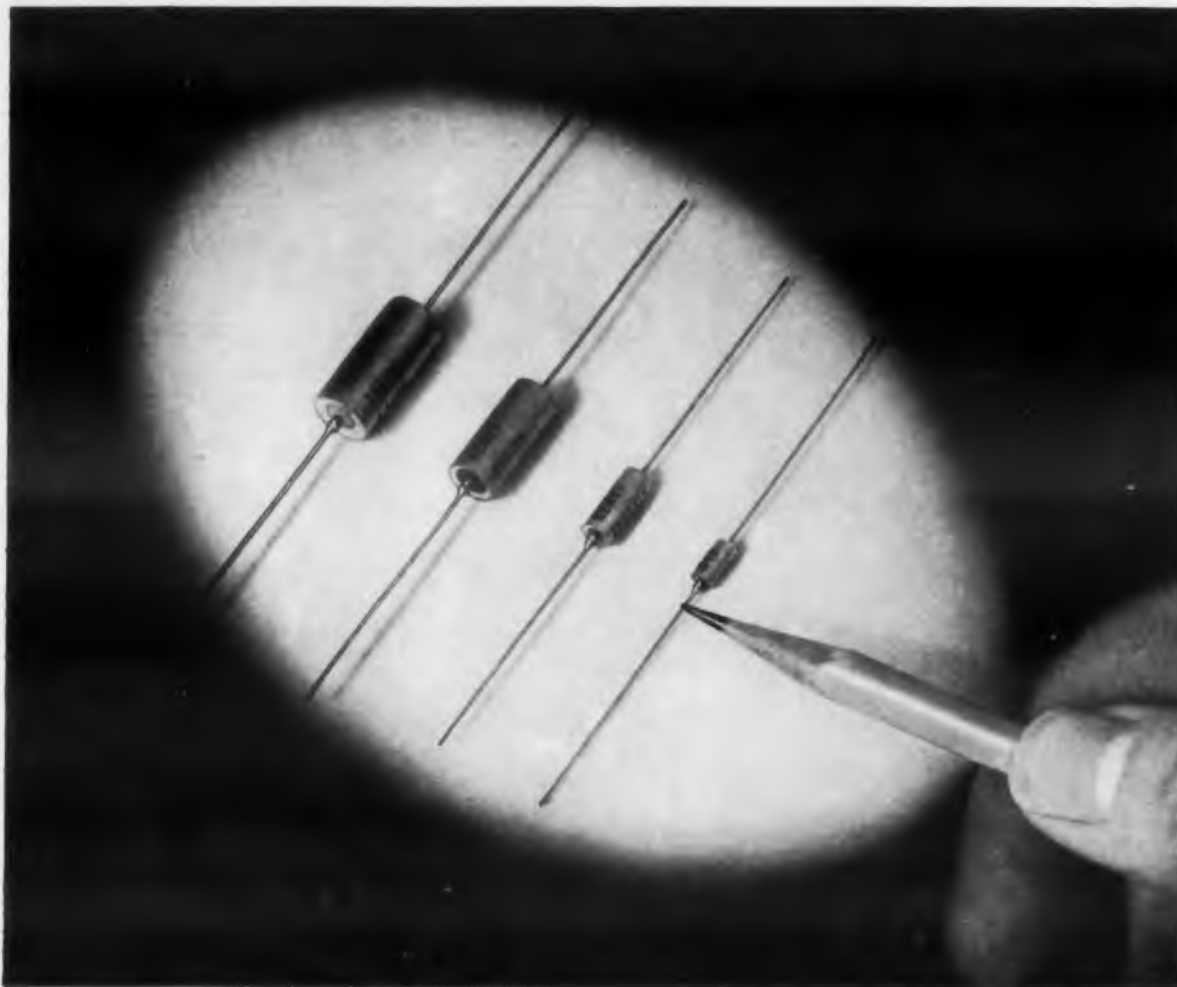
Attenuation: less than 2 db

Frequency response: 3 db = 325 KC

50 taps with an accuracy of ± 0.2 usec. at each tap.

Complete technical data on the new unit can be obtained by writing to
ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

CIRCLE 70 ON READER-SERVICE CARD



KEMET COMPANY EXPANDS ITS SOLID TANTALUM CAPACITOR LINE!

These new, smaller sized J-series capacitors — an addition to the proved and accepted H-series solid tantalum line—comply with and in many instances exceed the requirements of MIL-C-26655 (USAF).

For example, these capacitors are available in capacitances up to 22 microfarads at working voltages of 50 volts at 85 degrees C. At 125 degrees C., they operate at two-thirds of the 85 degree C. working voltage. Available with or without insulating sleeves, the new J-series capacitors maintain the excellent low

leakage current characteristics associated with the H-series line, even though they occupy about $\frac{1}{3}$ of the space of the earlier types.

These new capacitor designs are made possible by the advanced research facilities available at Union Carbide Corporation, plus the fact that "Kemet" is not dependent on other suppliers for the mining or processing of tantalum.

For literature, write Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

**UNION
CARBIDE**

CIRCLE 71 ON READER-SERVICE CARD

NEW PRODUCTS

Toroidal Cores

420

Are rated at 200 mu

The Genalex toroidal cores are rated at 200 mu. Type G59Q has an OD of 0.8 in. and type G60Q has an OD of 0.5 in. For frequencies of less than 2500 cps, the Q-value is better than that of 125 or 140-mu cores of equal size. The cores are color-coded and pre-graded with the inductance marked on each core.

Wallace E. Connolly & Co., Dept. ED, P. O. Box 295, Menlo Park, Calif.

Price & Availability: Units are in stock and are priced between \$0.71 and \$0.80 ea in quantities of 1 to 5000.

Power Supply

706

Has three outputs



Type 50-121 transistorized power supply provides 28 v dc at 2.5 amp, 120 v dc at 250 ma, and 250 v dc at 500 ma. Voltage regulation is $\pm 0.1\%$. Ripple is 2.5 mv rms. Weighing 70 lb, the unit operates from -10 to $+125$ F, requires 110 to 130 v ac, and meets MIL-E-5272 and MIL-E-4970. It can be rack mounted.

Hydro Aire Co., Dept. ED, 3000 Winona Ave., Burbank, Calif.

Audio Signal Generator

424

Dual-function type

Model 50 sine and square wave signal generator measures distortion in hi-fi amplifiers and frequency response of test equipment, hi-fi amplifiers, and tone controls. It provides precise measurement of amplifier input, output impedances, and loudspeaker resonant frequencies. Tuning range is continuous from 21 to 250 cps.

Packard Bell Electronics, Industrial Products Dept. ED, 1920 S. Figueroa St., Los Angeles, Calif.

Price & Availability: \$274.50; 10-day delivery time.

Electron Tube News

...from **SYLVANIA**

NOW AVAILABLE!



FIRST TV DAMPER TUBE WITH SARONG CATHODE

...Sylvania-6AU4-GTA

Sylvania has "beefed up" the heart of 6AU4-GTA — added life to its service, increased its stability and improved its over-all performance. 6AU4-GTA's bright future results directly from the use of the new concept in cathode coating for electron tubes—Sylvania *Sarong Cathode*.

An exclusive Sylvania development, *Sarong Cathode*

is a thin film of cathode material made to precise measurements for uniformity and *wrapped* on an ultrasonically cleaned cathode sleeve. This provides greater control of density and smoothness of the cathode emissive material, greater control of the coating process, and provides high uniformity of electrical characteristics from tube to tube.

Sarong Cathode significantly minimizes plate-to-cathode arcing. Surface of Sarong is virtually free of "peaks and valleys," provides uniform spacing between cathode and plate.

Sarong Cathode eliminates "hot spots." Control of density of Sarong coating assures uniform temperature and emission over the entire cathode surface.

Sarong Cathode reduces heater-to-cathode arcing. Wrap-around cathode eliminates possibility of cathode emissive particles adhering to the inside of the cathode sleeve during the coating process.



SARONG ADDS LIFE TO TV DAMPER TUBE

Sylvania-6AU4-GTA illustrates the advantages attainable with the use of *Sarong Cathode*. It is the first TV damper tube to receive this specialized treatment. Other Sylvania types soon to utilize *Sarong* include 6AX4-GTA and 6DE4. This vital development plus several individual tube-type improvements combine to produce highly reliable TV damper tubes deserving of a place in your designs. Your Sylvania Sales Engineer will gladly give you complete technical data and delivery information. Ask him.

NEW! TWO HIGH-VOLTAGE RECTIFIERS FOR TV PROVIDE "COOL" OPERATION, IMPROVED RELIABILITY



ELECTRICAL CHARACTERISTICS	1N2	1A3
Filament Voltage	1.25V ± 0.2V	1.25V ± 0.2V
Filament Current	200mA	200mA
Tube Drop for Ib = 7mA	100V	225V

RATINGS (Design Max. System)	1N2	1A3
Inverse Plate Voltage	28,000V	30,000V
Total DC and Peak DC	24,000V	26,000V
Peak Plate Current	50mA	50mA
Average Plate Current	0.5mA	0.5mA

Sylvania-1N2 and -1A3 feature improved structural design for greater reliability, longer life expectancy. Utilizing a large anode within a T-12 bulb, 1N2 and 1A3 offer improved heat dissipation for "cool" operation and a reduced voltage gradient. Too, increased anode-to-filament spacing reduces electrostatic field forces that cause filament pulling and resultant plate-to-filament arcing.

Sylvania-1N2 has a tube drop of 100V @ 7mA Ib and a DC inverse plate voltage of 24KV. Sylvania-1A3 has a tube drop of 225V @ 7mA Ib and a DC voltage of 26KV. Further, 1A3 incorporates a helical shield as an additional safeguard against electrostatic charges. For complete technical data, see your Sylvania Sales Engineer.

For further information, contact the Sylvania Field Office nearest you. Or, write Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS** 

Encapsulated Yoke

For 70-deg crt



Type Y59 epoxy-encapsulated ferrite core, deflection yoke is for 70-deg cathode ray tubes having a 7/8 in. neck diameter. Designed for transistorized military and industrial TV raster applications, the yoke has single-ended coils with high inductance-to-resistance ratio. Flat face crt pincushion distortion is corrected by four anti-pincushion magnets without linearity deterioration. The magnets are preadjusted and prealigned. Impedance range is from 110 μ h.

Syntronic Instruments, Inc., Dept. ED, 100 Industrial Road, Addison, Ill.

Availability: 4 to 6 weeks from receipt of order.

Impedance and Phase Comparator

741

For production testing



Model 1503 deviation test bridge, using a test frequency of 100 cps, is suitable for production testing of electrolytic and other large capacitors, transformers, chokes, motors, inductors, and resistors with ratings from 1 ohm to 30 meg. Testing rates of up to 4000 pieces per hr are possible with accessory test jigs. The accuracy for measurements of zero deviation in either phase or impedance is 0.03%. Three interchangeable scales in a 6-in. illuminated meter are provided. The instrument is made by Buruel & Kjaer of Denmark.

B & K Instruments, Inc., Dept. ED, 3044 W. 106th St., Cleveland 11, Ohio.

Price & Availability: \$395; 15-day delivery time.

For unmatched reliability... BOMAC BEACON MAGNETRONS

Life — up to 500 hours guaranteed — over 3000 hours reported
Frequency stability — less than 2 Mc drift per 100 hours (C band)
Power stability — drop of less than 1 db per 1000 hours of constant voltage input
Duty cycle stability — less than 3 Mc frequency shift for a change in duty cycle of 0.00005 to 0.002 (C band)
Vibration — less than 2.5 Mc frequency shift from 55 to 2000 cps
Shock — withstands 100 g's (6 millisecond duration)
Lightweight — 7 to 10 oz.
Miniaturized
Tunable over a broad band



Band	Tube Type	Fixed Freq. or Tunable	Frequency Range Mc	Watt. Peak Power	Output Modulation With
C	BL-212	Tunable	5400-5900	100	UG699/U
C	BL-243	Tunable	5400-5900	200	UG699/U
C	BL-242	Tunable	5400-5900	400	N
C	BLM-022	Tunable	5400-5900	500	TNC
C	BLM-026	Tunable	5400-4900	500	TNC
C	BLM-020	Tunable	5400-5900	700	TNC
C	BL-245	Tunable	5400-5900	900	TNC
C	BL-250	Tunable	5400-5900	150	TNC
X	BLM-003	Tunable	9000-9600	150	TNC
X	BLM-014	Tunable	8500-9000	150	TNC
X	BLM-012	Tunable	8900-9400	1000	TNC
X	BLM-021	Tunable	8500-9000	1000	3000A/U
X	BLM-024	Tunable	9300-9200	150	TNC

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SALEM ROAD, BEVERLY, MASSACHUSETTS

Official in their field — A subsidiary of Varian Associates

Leaders in the design, development and manufacture of TR, ATR, Pro-TR tubes; shutters; reference cavities; crystal protectors, silicon diodes; magnetrons; Nystroms; duplexers; pressurizing windows; noise source tubes, high frequency tube oscillators; surge protectors

FOR A TIGHT CLOSURE
OR TO COMPRESS A GASKET

SOUTHCO

Adjustable Pawl FASTENERS

1/4 turn closes—additional turning tightens



Just slip the knob through a hole in the door (any door thickness—it doesn't matter). Fasten with two rivets, bolts, or welds. The Southco Adjustable Pawl Fastener will fit your door frame, even when material gauge varies between units.

Turn the knob. The first quarter turn latches the door. Now keep turning. You're pulling the door tightly against its frame. You can compress a gasket, form a dust or moisture seal, overcome vibration.

You'll save installation time and satisfy your customers with these rugged, attractive, pre-assembled fasteners. Ideal for heavy machines, electronic consoles, miniaturized units, cabinets, missiles, slide-mounted modules, etc.



SOUTHCO FASTENERS

LION

CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS Receptacle and Plug Adapters 733

Double-plug, BNC type



Model 2B-1270 molded, double-plug, BNC plug adapter permits connections from a 3/4-in. banana jack to a BNC receptacle. Also offered, model 2B-1269 receptacle adapter makes connections between a 3/4-in. banana jack to a BNC male plug. The banana plug has a one-piece beryllium copper spring; the plug body is molded of unbreakable plastic.

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

Price & Availability: Price is \$2.85 per unit, \$2.50 ea in quantities of 7 to 12. Delivery time is two days after receipt of order.

Clutch-Brake 365

Magnetically set



Both the clutch and brake of the 2.2 SMCB clutch-brake combination are magnetically set. The unit is available in any dc voltage to 90 v, has a current rating of 1.55 amp, and 8 lb-in. torque on both the clutch and the brake. It is supplied with bearing-mounted drive and driven shafts.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

Availability: Units will be in stock in 6 months.



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Semiconductors

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DeMambo Radio Supply Co., Inc.
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PLeasant 7-5626

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C & G Radio Supply Co.
BRoadway 2-3181

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CLEVELAND 14625 Detroit Avenue, Lakewood, Ohio..... ACademy 1-9191
DALLAS 511 Braniff Airways Bldg..... FLanwood 7-9408
DAYTON 375 W. First Street..... BAIdmen 4-9651
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electronic corporation **T**
wakefield, massachusetts

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CIRCLE 74 ON READER-SERVICE CARD

FROM **Transitron**...INDUSTRY'S BROADEST LINE OF

CONTROLLED RECTIFIERS & SWITCHES



(11/16)



(7/16)



TSW30
TSW60

SILICON CONTROLLED RECTIFIERS are now available in both the $\frac{11}{16}$ " hex and $\frac{7}{16}$ " hex base packages. Replacing thyratrons and magnetic amplifiers in many applications these rugged devices offer greater reliability and increased efficiency. Some typical applications are:

- industrial control
- lighting control
- solid state inverters
- overvoltage protection
- short circuit protection

Write for Bulletin **TE-1356**

TYPE	PIV	Max. average amps Forward current		Max size of Package
		at 25°C case	at 100°C case	
TCR 520	50	20	10	1 1/2"
TCR 1020	100	20	10	1 1/2"
TCR 1520	150	20	10	1 1/2"
TCR 2020	200	20	10	1 1/2"
TCR 2520	250	20	10	1 1/2"
TCR 3020	300	20	10	1 1/2"
TCR 3520	350	20	10	1 1/2"
TCR 4020	400	20	10	1 1/2"
TCR 510	50	10	5	1 1/2"
TCR 1010	100	10	5	1 1/2"
TCR 1510	150	10	5	1 1/2"
TCR 2010	200	10	5	1 1/2"
TCR 2510	250	10	5	1 1/2"
TCR 3010	300	10	5	1 1/2"
TCR 3510	350	10	5	1 1/2"
TCR 4010	400	10	5	1 1/2"
TCR 503	50	5	2	3/8"
TCR 1003	100	5	2	3/8"
TCR 1503	150	5	2	3/8"
TCR 2003	200	5	2	3/8"
TCR 2503	250	5	2	3/8"
TCR 3003	300	5	2	3/8"
TCR 3503	350	5	2	3/8"
TCR 4003	400	5	2	3/8"

THE TRANSWITCH is a new bi-stable silicon computer element that can be turned **OFF** with a gate current. Extremely uniform electrical characteristics over a wide current range (2-50 ma) permit the device to fulfill low level logic and medium power needs. The device is designed for:

- miniaturized memory circuit
- ring counters
- shift registers
- controlled rectifier driver
- flip-flop equivalent

Write for Bulletin **TE-1357A**

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

	Typical	Maximum	Test Conditions
Saturation Voltage V_S	1.0	1.5	Volts $I_C = 50$ mA
Forward Leakage Current I_F	0.1	10	μ A } AT RATED VOLTAGE
Reverse Leakage Current I_R	0.1	10	μ A }
Forward Leakage Current I_{F2}	20	50	μ A at 125°C
Gate Voltage to Switch "ON"	$V_{G\ on}$	0.7	1.0 Volts $R_L = 1$ K
Gate Current to Switch "ON"	$I_{G\ on}$	0.1	1.0 mA $R_L = 1$ K
Gate Voltage to Switch "OFF"	$V_{G\ off}$	1.2	4.0 Volts $I_C = 50$ mA
Gate Current to Switch "OFF"	$I_{G\ off}$	7.0	10 mA $I_C = 50$ mA
Holding Current I_H	2.0	5.0	mA $R_L = 1$ K

See Transitron at the AFCEA Show, Booths 157 - 158

Transitron

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CIRCLE 75 ON READER-SERVICE CARD

NEW PRODUCTS

Test Switch

750

With connected lamp



Type 6AR push-to-test switch-light has a lamp connected internally to the arms of the dpdt switch, enabling two separate circuits to be monitored without a common connection. The device is suited for fail-safe circuit applications where isolation is needed between the monitored circuit voltage and the test voltage. Contacts are rated at 1 amp dc, resistive load. Life expectancy is better than 100,000 operations. The lens-encapsulated lamp is replaceable.

Eldema Corp., Dept. ED, 1805 Belcroft Ave., El Monte, Calif.

Environmental Chamber

681

Provides from +70 to -130 F

For special testing, model A-120-5 environmental chamber provides temperatures from +70 to -130 F. Chamber dimensions are 30 x 18 x 16 in. and exterior dimensions are 40 x 32 x 44 in. For production chilling, a convection fluid can be used in the chamber. An air circulator provides mechanical air convection to minimize temperature variation and maintain close temperature control.

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

Range Time Decoder

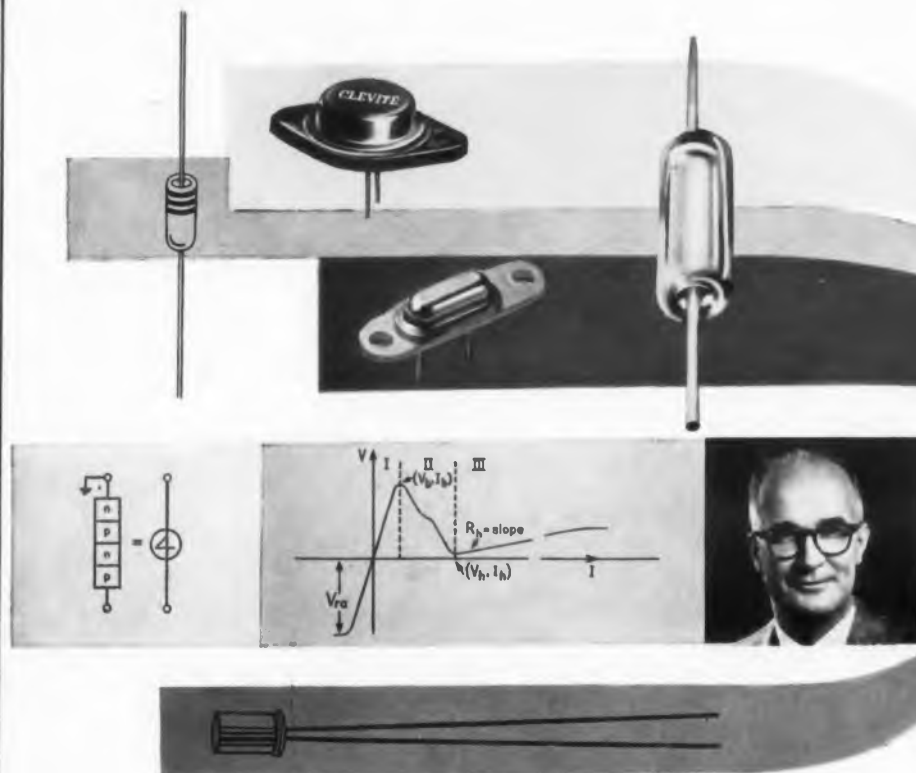
593

Has self-contained power supply

Model TRD 1501 range time decoder, a search and control device for automatic utilization of time range signals, is furnished with a self-contained power supply. When a range time pulse is received, the sequential counter generates an output pulse summed with binary one-detectors.



a new pattern



SHOCKLEY TRANSISTOR UNIT - STANFORD INDUSTRIAL PARK, PALO ALTO, CALIFORNIA

A DIVISION OF

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n semiconductor progress . . .

SHOCKLEY TRANSISTOR JOINS CLEVITE

In keeping with its program of advancement in semiconductors, Clevite has acquired the Shockley Transistor Corporation of Palo Alto, California.

Dr. William Shockley, noted solid state physicist and co-winner of the 1956 Nobel Prize for his work in the development of the transistor joins Clevite, together with his research and development organization.

NEW PRODUCTS

In addition to Clevite Transistor's broad line of diodes and transistors, the corporation now offers to the industry Shockley devices which represent new advances in the semiconductor art. The Shockley 4-layer diode is a nearly ideal switch for pulse generation, pulse counting and high power switching in such applications as computers, telephone and control circuits. A new plant in Palo Alto, California, is underway to fill the growing demand for these new devices.

NEW PLANTS

Besides the new plant for the Shockley organization in California, Clevite Transistor is nearing completion of its new \$4,000,000 Waltham, Massachusetts facility which will employ 2,000 people. The present Waltham plant will continue as a supplementary operation. Clevite's overseas operation, Intermetall G.m.b.H., now employs 1,000 people in a new plant at Freiburg, West Germany to serve the European market.

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254 Crescent Street Waltham 54, Mass. Tel: TWinbrook 4-9330



CIRCLE 76 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960

Provision is made for storing coincidence. When preselected pulses are present, a signal is generated during frame identification and applied to a second memory circuit. Reset is accomplished when the preselected pulse is generated. This pulse is used to start recorders or as any start signal. Power requirement is 105 to 125 v ac at 59 to 61 cps. Suitable for mounting in a 10-in. relay rack, the unit measures 13 in. in depth and 7 in. in height.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

Price & Availability: \$4500; 30-day delivery.

Channel Analyzer

737

Linearity is 0.5% of full scale



Model 34-12 400-channel analyzer may be used as a pulse-height analyzer or as a multi-channel scaler. Completely transistorized, the basic unit includes a crystal-controlled live timer and a 5-in. crt with live data display. Capacity is 10^5 counts per channel and linearity is 0.5% of full scale. The unit incorporates memory sub-grouping, external programing, add-subtract logic, coded-decimal storage, spectrum transfer circuit, coincidence-anticoincidence circuits, auto-print, auto-record, and automatic background subtraction.

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

Availability: Units can be delivered in 45 to 60 days.

Alloy for Microwave Cavities 684

Temperature coefficient is 0.3 ppm per deg C

For use in microwave cavities, optical structures, and other temperature sensitive components, this alloy has a maximum temperature coefficient of 0.3 ppm per deg C. Specific applications include in wavemeter cavities such as X-band frequency meter cavities, and missile-borne radar-beacon cavities.

General Communication Co., Dept. ED, 677 Beacon St., Boston 15, Mass.

NEW PRODUCTS

Test Chambers

360

Temperature range is -100 to $+400$ F



For environmental production testing of electronic components, these test chambers provide temperatures from -100 to $+400$ F. The liquid coolant provides a temperature drop of from $+107$ to -70 F in less than 1 min. The high-velocity fan insures rapid disposal of the coolant. The thermostat selector switch provides control to within ± 1 F.

The Electric Hotpack Co., Inc., Dept. ED, 5065 Cottman St., Philadelphia 35, Pa.

Price & Availability: Price ranges from \$600 to \$2450. Delivery time is 45 to 60 days.

Purging Machine

686

For airborne electronic equipments

For on-the-spot moisture evacuation and dry-nitrogen pressurization, this 20-lb purging machine can automatically evacuate, pressure, re-evacuate, and finally re-pressure as many as four airborne electronic equipments simultaneously. Operating time cycle is 34 min. The unit meets MIL-E-4158A requirements.

General Electric Co., Light Military Electronics Dept., Dept. ED, French Road, Utica, N.Y.

DC Power Supply

747

Dual-output type



This dual-output, transistorized dc power supply is rated at 1 amp for 15 to 200 v and at 100

<p>85C WET-SLUG TANTALYTIC CAPACITORS</p> <p>Completely sealed porous anode provides lowest impedance, per unit volume, of any capacitor. From -55C to $+85$C operation. Bulletin—GEA-7008A</p>	<p>125C KSR* TANTALYTIC CAPACITORS</p> <p>Offer voltage ratings to 150 volts d-c from -55C to $+85$C; to 100 volts for 125C operation. Up to 50% lighter, and 30% smaller. Bulletin—GEA-6766A</p>	<p>85C TANTALYTIC CAPACITORS</p> <p>Dependable operation over a temperature range of -55C to $+85$C. Polarized, non-polarized, etched, or plain foil units with improved shelf life characteristics. Bulletin—GEC-808D</p>
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General Electric offers a complete line

Application versatility and performance reliability highlight General Electric's complete line of Tantalytic* capacitors. Wherever small size, light weight, and superior performance are required—in computer, missile, ground support equipment and airborne electronic applications—there's a General Electric Tantalytic capacitor with optimum characteristics and reliability. High capacitance, stable operation, low capacitance loss, and low impedance—at maximum voltage over wide temperature ranges—are available for your particular electronic circuit applications. And the recent addition of a new high-voltage Tantalytic

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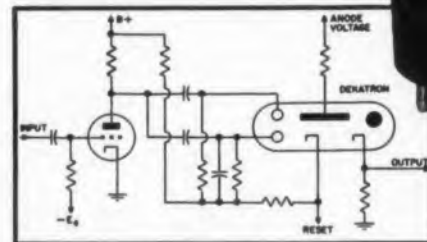
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CIRCLE 78 ON READER-SERVICE CARD

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Electronic Counting Tubes
(up to 20,000 counts/sec.)



Typical Drive Circuit

Now available—only complete "Hand Book of Counting Tubes" in print. Tube specifications, applications, sample circuits, design criteria are included. Available at \$1.00 a copy through Dekatron Tube Section, Baird-Atomic, Inc.

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Instrumentation for Better Analysis

CIRCLE 79 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960

SOLID TANTALYTIC CAPACITORS

Small size, to .003 cu. in., stable operating characteristics, long shelf life, and operating temperatures from -55C to +85C; ratings to 50 volts d-c, capacities to 22 mfd.
Bulletin—GEZ-2796A



HIGH-VOLTAGE TANTALYTIC CAPACITORS

Ratings to 300 volts at 85C; to 250 volts at 125C. Capacitance: from 0.15 mfd. to 35 mfd., both polar and non-polar. Maximum stability, low capacitance change.
Bulletin—GEA-7065



125C CYLINDRICAL TANTALYTIC CAPACITORS

Smaller, lighter single-case design for 125C operation. 10 to 150 volts, polar or non-polar; ratings to 7750 vaf. Special units available for 30G 2000 cps.
Bulletin—GEA-7085



of TANTALYTIC CAPACITORS

capacitor has expanded the application versatility of General Electric's Tantalum line, representing G-E efforts to meet the electronic industry's need for constantly improved ratings and performance from smaller, lighter capacitors.

For complete application and specifying information, contact your G-E sales representative, or write for the bulletins indicated above to General Electric Co., Section 449-17, Schenectady 5, N. Y.

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CIRCLE 77 ON READER-SERVICE CARD

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LABORATORY PERFORMANCE AT 1/2 THE COST!

HEATHKIT OP-1
\$184⁹⁵

PROFESSIONAL 5" DC OSCILLOSCOPE KIT (OP-1)
Distinguished quality, coupled with traditional Heathkit savings, highlight the OP-1 as one of the most unusual values in the test equipment field! Designed as a professional caliber research tool, the OP-1 meets critical quality standards demanded in industrial, educational or medical applications. Features include; 5ADP2 CRT; DC coupled amplifiers and CR tube unblanking. Triggered sweep circuit operates on int. or ext. signals, AC or DC coupled. Send for FREE Heathkit catalog today describing this and many other money saving kits or see your nearest Heathkit dealer.



NOTE: Prices and spec. subject to change without notice. Dealer and Export prices slightly higher.

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CIRCLE 81 ON READER-SERVICE CARD

ma for 0 to 50 v. The outputs have separate current and voltage meters and may be used simultaneously. Regulation is 0.05% for line variations and 0.1% for load changes. Ripple is 1 mv rms, recovery is within 50 μ sec, and overshoot is 1% at full current and voltage.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.
Price: \$1185 fob Springfield.

Tubing

363

Made of glass phenolic material



This encapsulation tubing is made of glass phenolic Plaskon material. Thickness is from 0.2 in. with a tolerance of ± 0.005 in.; for the ID, tolerance is ± 0.005 in. and -0.000 in. Angles, channels and covers can be cut from standard lengths of tubing.

Stevens Tubing Corp., Dept. ED, 86-88 Main St., East Orange, N.J.
Availability: Delivery time is 7 to 10 days.

Vibration Monitor

732

Indicates 0 to 5 mils



This transistorized vibration monitor detects excess vibration signals from a magnetic pickup. A vibration level of 0 to 5 mils is directly indicated on a front-panel meter. The monitor operates a relay. Higher ranges can be obtained. The input is from an ac line or from 48 v dc.

The Indikon Co., Inc., Dept. ED, 76 Coolidge Hill Rd., Watertown 72, Mass.
Availability: Delivery time is 90 days.

83

NEW PRODUCTS

Heat Exchangers

736

For cooling power transistors



The LF line of forced-air heat exchangers is for cooling power transistors. Designed to operate from a ducted source of air, flowing at rates from 1 to 15 cfm, these exchangers enable a 50-w transistor to produce the full 50 w, instead of the usual 15 to 20 w. Several models can be furnished.

Gasket Manufacturing Co., Inc., Dept. ED, 319 W. 17th St., Los Angeles 15, Calif.

Price & Availability: Price is \$9.75 ea for 1 to 50 units. They are furnished from stock.

Metallized-Paper Capacitor 687

Capacitance range is 0.1 to 20 μ f

These 50-v, metallized-paper capacitors can be supplied in 0.1 to 20 μ f with phenolic-coated or hermetically-sealed construction. A 4- μ f unit measures 15/32 x 9/16 x 1-1/8 in. Units are impregnated in a high-K, thermosetting resin. Their shape is rectangular.

Hopkins Engineering Co., Dept. ED, 12900 Foothill Blvd., San Fernando, Calif.

Recording Readout Oscillograph 665

Speeds are 0.05 to 170 in. per sec



Able to provide for the recording of up to 50 channels of test data on a record 12 in. wide, model 607 direct-recording, readout oscillograph offers speeds of 0.05 to 170 in. per sec. Record storage and take-up spools are self-contained. The

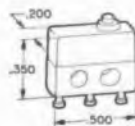


MICRO SWITCH Precision Switches

Basic Switches with Gold Contacts



... absolute



New Sub-Subminiature "1SX" Switch with Gold Contact

The new "1SX" switch is the smallest single-pole double-throw snap-action switch available with enclosed gold contacts. It weighs only 1/28 of an ounce and is so small it can hide behind a dime. Designed for use on dry circuits, the "1SX" can be specified for computers, missile applications and other installations involving low energy circuits. A number of different actuators are available. Turret-type terminals are used to permit easy wiring and strong wrap-around lead wire connections. The gold contacts operate with the exclusive MICRO SWITCH snap-action spring, fabricated from beryllium copper. Write for Data Sheet No. 175 on the new sub-miniature "1SX," with MICRO SWITCH precision and the absolute maximum in reliability.

75 YEARS HONEYWELL
ENGINEERING THE FUTURE



maximum in reliability!

MICRO SWITCH offers three important series of ultra-small basic switches with corrosion-proof gold contacts which provide long shelf life in applications involving low electrical loads. They are available with many different integral and auxiliary actuators.

Subminiature "SM" Series—These gold contact models have single-pole double-throw contact arrangement. A choice of terminals includes: "T" type turret design, solder terminals, double-turret terminals, and "quick-connect" terminals for fast, solderless wiring.

"V3" Basic Switches—Postage stamp size gold contact designs, can be used singly or gang-mounted in assemblies. "V3" Basics are available with many different types of auxiliary actuators.

For engineering help on highly reliable gold contact basic switches for low energy circuits, see the Yellow Pages for the name of the nearby MICRO SWITCH branch office. Ask for Data Sheet 175. MICRO SWITCH has wide experience in electronic applications requiring the advantages of switches with gold contacts.



"SM" Series



"V3" Series

MICRO SWITCH . . . FREEPORT, ILLINOIS

A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario

CIRCLE 82 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960



Honeywell
MICRO SWITCH Precision Switches

record does not require dark-room handling. The record drive system operates in both forward and reverse directions, allowing a fast record run during a test with reversing after completion for reviewing and analysis at slow speeds.

Midwestern Instruments, Dept. ED, P. O. Box 7186, Tulsa, Okla.

Component Ovens

364

Warm-up time is 5 to 15 min



Having a warm-up time of 5 to 15 min, these component ovens may be regulated to ± 1 C for ambient changes of 120 C or 0.2 C differential with a thermostat control. Sizes of the component cavity are designed to meet customer requirements.

Waltham Electronics Corp., Component Oven Dept., Dept. ED, 751 Main St., Waltham, Mass.
Price & Availability: \$25 to \$100; 10 to 30 days.

DC Signal Amplifiers

419

For telemetering, instrumentation and recording



Designed to accept an input signal in the mv range, these dc signal amplifiers produce an output signal ranging from 0 to 5 v dc for use in telemetering, instrumentation, and recording systems. Model 10-108-2 operates from 115 v, 400 cps; model 12-105-0, from 28 v dc. Both units are suitable for temperature and strain measurements in industrial and military applications. Transformer type magnetic elements are used. Requirements of MIL-E-5272A are met.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.
Availability: Delivery is in 4 to 6 weeks.

0.5 to 5 Mc
5 to 50 Mc
Type 1211-B, \$295

50 to 250 Mc
Type 1215-B, \$210

180 to 600 Mc
Type 1209-BL, \$260

900 to 2000 Mc
Type 1218-A, \$465
(for use at sweep speeds
to 1 cps)

Type 1263-A
Regulated Power Supply
\$305

Type 874-VQ
(r-f rectifier)
\$30

250 to 920 Mc
Type 1209-B, \$260

Type 1750-A Sweep Drive, \$470

Sweep Oscillator System

with Plenty of
Frequency
Coverage

By merely substituting basic oscillator units in this system, you can cover, in narrow or wide sweeps, segments of the frequency range from 500 kc to 2000 Mc. More than this, you can control sweep speed, center frequency and frequency span over wide ranges by simple knob adjustments.

The Type 1263-A Regulated Power Supply is designed to power the Unit Oscillator as well as to keep the oscillator's output constant over wide ranges of frequency. It does this by comparing the rectified r-f output of the oscillator against an internal reference voltage, and applying any necessary corrections to the oscillator through its plate voltage supply. With this setup output is maintained within 2% over the oscillator's entire frequency range.

Write For Complete Information

- * Sweep Drive's claw-like arm attaches to knobs and dials up to 4 inches in diameter, and to 1/4- and 1/2-inch shafts to convert oscillators, signal generators, and receivers to sweep operation.
- * Sweep-speed, sweep-arc, and sweep-center frequency are completely adjustable even while the Drive is in motion.
- * Wide range of sweep speeds... reciprocating motion, adjustable from 0.5 to 5 cps.
- * Sweep arc adjustable from 30° to 300°. At sweep speeds below 1 cps, arc can be increased by coupling Drive directly to Oscillator dial rather than to control Knob attached to vernier reduction-drive.
- * Rated maximum torque is 24 ounce-inches. Limit-switch circuit disconnects and brakes motor should limits of shaft travel be accidentally exceeded.
- * Generates a horizontal deflection voltage proportional to shaft angle for scope displays and x-y recorders.
- * Blanking circuit shorts out CRO trace during return portion of cycle and produces a reference base line.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722
District Office in Ridgefield, N. J.
WHimey 3-3140

CHICAGO
Oak Park
Village 8-9400

PHILADELPHIA
Abington
HAncock 4-7419

WASHINGTON, D.C.
Silver Spring
Jumper 5-1088

SAN FRANCISCO
Los Altos
WHitecliff 8-8233

LOS ANGELES
Los Angeles
HOLlywood 9-6201

IN CANADA
Toronto
CHerry 6-2171

NEW PRODUCTS

Switching Amplifier 377

Has modular construction

Designed for industrial control where a small input signal is needed to actuate a relay or control device, model 2001-4 modular type, transistorized amplifier requires a signal of 2.5 mv rms at 60 cps for contact closure. The contacts are rated at 2.5 amp at 115 v ac or 24 v dc. The power supply requirement is 10 v at 0.1 amp, 60 cps. Input impedance is 10,000—j2500 at 60 cps. The time constant of the relay plus amplifier for pull-in is 11 msec; for dropout, 14 msec. Width of the unit is 3 in. and over-all depth is 11.5 in.

Gemco Electric Co., Dept. ED, 25685 W. Eight Mile, Detroit 40, Mich.

DC Power Supplies 372

Current ratings are 100 to 1500 amp

These silicon-regulated dc power supplies come in eight standard models with current ratings of 100 to 1500 amp and a voltage range of 14 to 36 v. Units have transistor-magnetic control; silicon power diode rectifiers and transistors are used. Overloads of 400% can exist for 1 sec without harming the units. Drift is 0.05%, ripple is 0.1% rms for up to 500 amp and 0.5% for 500 to 1500 amp.

Sprague Engineering Corp., Dept. ED, 19300 S. Vermont Ave., Gardena, Calif.

Price & Availability: Price range is \$1440 to \$7520. Delivery time is 90 to 120 days.

RF Phase and Ratio Meter 368

Frequency response is from 150 kc to 100 mc

Type 305 rf phase and ratio meter is used for simultaneous reading of the phase angle and amplitude ratio between two rf voltages and for automatic plotting of the transfer characteristics. Frequency response

is from 150 kc to 100 mc. The device is sensitive to 50 mv. Consisting of a frequency converter and a phase meter, the instrument is suitable for plotting phase characteristics of crystal filters, transmission systems, and if amplifiers.

Ad-Yu Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

Price & Availability: \$575; six-week delivery time.

Alumina Polishing Crystals

375

For semiconductors

For the final preparation of highly polished semiconductor surfaces, these alumina crystals come in graded uniform particles of 0.05 microns gamma aluminum oxide (Al_2O_3) and 0.25 microns alpha aluminum oxide. They are laboratory-certified to be 99.99% activated aluminum oxide.

Geoscience Instruments Corp., Dept. ED, 425 Park Ave., New York 22, N.Y.

Power Supplies

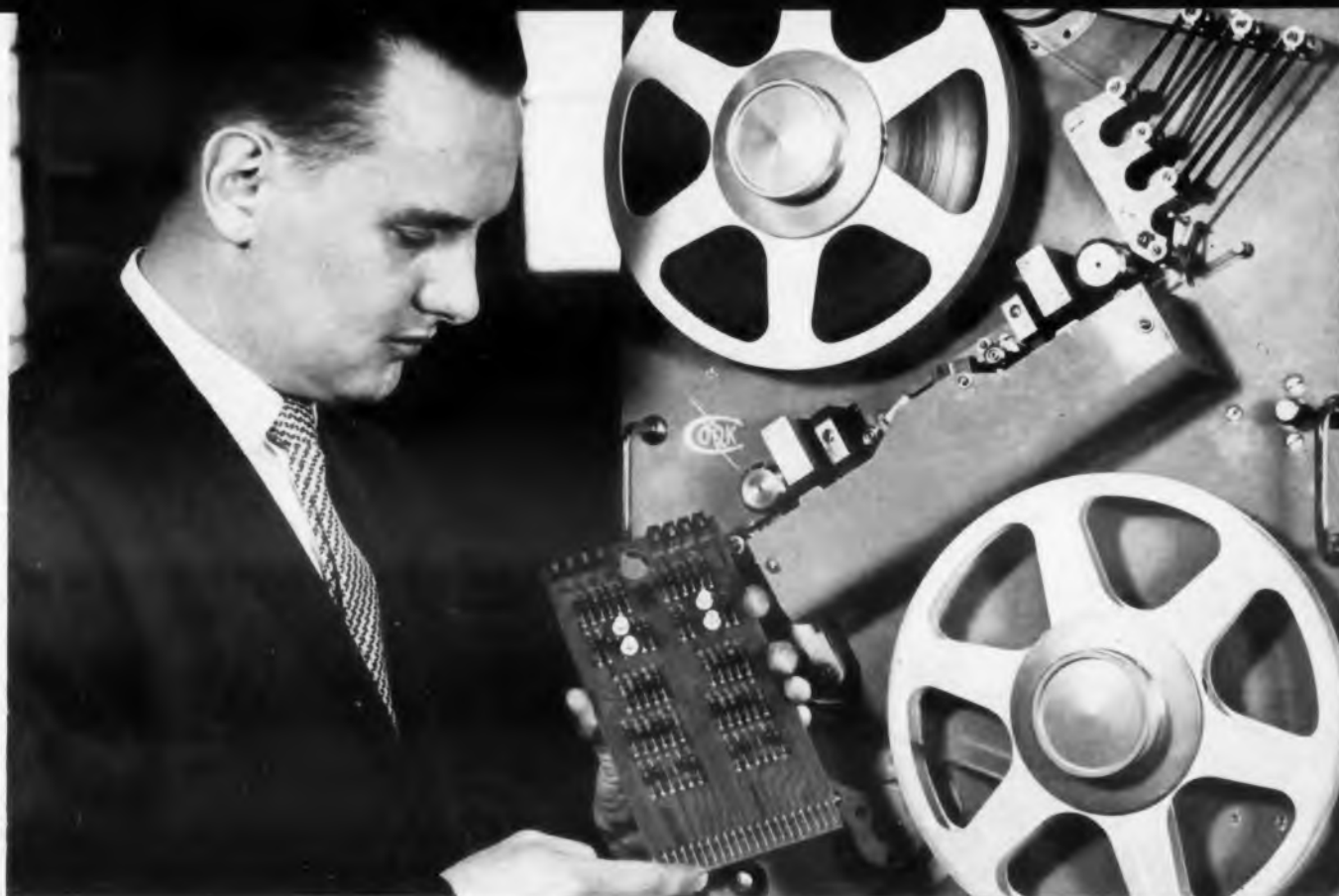
614

Outputs are 11 to 260 v



This line of power supplies, including 36 different units, offers a range in output power from 3 to 25 kw and a voltage range of 11 to 260 v. The units are designed for such applications as in missile ground systems, aircraft ground supplies, and in computer and automation equipment. Several dc generators may be coupled to the same motor for multiple output. Static, solid-state regulators are used.

Electric Specialty Co., Dept. ED, 211 South St., Stamford, Conn.



Tung-Sol transistors handle critical switching in high speed tape transport

Cook Electric's Model 59 Digital Tape Transport embodies the design know-how gathered by Cook during its 12 years of active participation in missile programs which include the Atlas, Polaris and Titan missiles. It was built to fulfill the demands of modern industry for reliable, high-speed data processing and storage equipment. This tape transport is a direct adaptation of the equipment originally developed to provide unattended, 45-day documentation of the Polaris Missile system.

Gratified with the superior performance demonstrated by Tung-Sol switching transistors in the Polaris version, Cook assigned Tung-Sol units to these critical tasks in the industrial model. Tung-Sol's 2N414 germanium high-speed switching transistors serve in the flip-flop and logic circuits. Here's how Cook engineers evaluated the Tung-Sol semiconductors: "Tung-Sol transistors meet our exacting demands for performance and reliability"

There are many reasons for the superlative performance of all Tung-Sol components. Consider just three: Tung-Sol's exclusive concentration on the technology of component manufacture . . . strict adherence to the highest manufacturing standards . . . a quality control network that's unsurpassed.

If your design requires tubes or semiconductors, or both, specify Tung-Sol. There are many Tung-Sol components for virtually every military and industrial requirement ready to perform with full-life reliability. Our applications engineers will be glad to help you select the components that'll do the best job for you. Tung-Sol Electric Inc., Newark 4, N. J. TWX: NK193.

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ont.



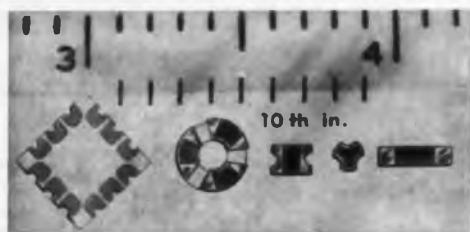
TUNG-SOL®

NEW PRODUCTS

Microminiature Resistors

409

Come as small as 0.01 in. thick



These microminiature module resistors can be supplied on substrates to most three-dimensional configurations. Common forms include rods, plates and semi-circular elements. Substrates may be of mica, glass, ceramic or quartz. Thicknesses down to 0.01 in. are possible. Fired silver or soft solder tinned terminals eliminate the necessity for lead wires. A final hard, impervious coating of a specially prepared silicone resin can be added, if required.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.

Availability: Made on order only.

Beam Switching Tube

410

For transistor circuits

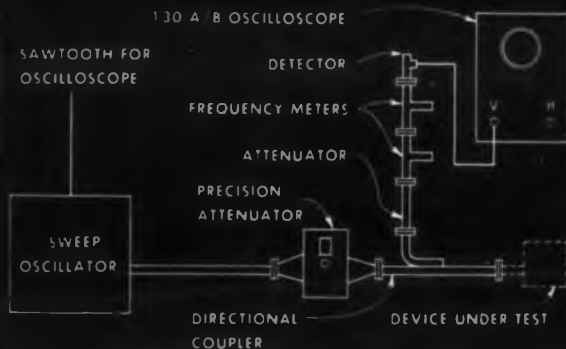


The Trochotron beam switching tube, for transistor circuits, can replace up to 20 transistors or tubes and other circuit components. A single cathode provides an electron beam for any one of 10 constant current outputs. Supply voltages can be utilized from 300 v for operation in conventional tube circuits to below 28 v for transistor circuits.

Baird-Atomic, Inc., Dept. ED, 33 University Road, Cambridge 38, Mass.

Price & Availability: Prices range from \$70.25 to \$92.95. Sample quantities are immediately available. Large quantities can be supplied in 60 days.

4 new microwave sweep oscillators



*speed, simplify
measurements
2.0 to 18.0 KMC*

Covers full band, or any part
Use with 'scope or recorder
All electronic; no mechanical sweep
Direct reading, independently
adjustable sweep range
and rate controls

◀ Figure 1. Arrangement for high speed microwave measurement to provide rapid visual display with 130A/B oscilloscope.

hp Dependable, quality

Hewlett-Packard Electronic Sweep Oscillators are new measuring tools deliberately designed to give you simpler, faster microwave measurements. Four models are provided, covering frequencies 2.0 to 18.0 KMC as follows: Model 683A, 2.0 to 4.0 KMC; Model 684B, 4.0 to 8.1 KMC; Model 686A, 8.2 to 12.4 KMC and Model 687A, 12.4 to 18.0 KMC.

These instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. These oscillators provide a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the new oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the sweep oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the new oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as 130A/B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your field engineer. Detailed discussions of these methods are also contained in the Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

TYPICAL SPECIFICATIONS

Below are specifications for -hp- 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for -hp- 683A, 684B, and 687A (P band) are similar except for frequency range and other minor variations.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variation less than 3 db over any 250 MC range; less than 6 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.014 to 140 seconds over full-band.

Sweep Output: +20 to +30-volt-peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level ± 1 db.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: +10 volts or more, 5 millisecond maximum duration.

External FM: Approx. 350 v peak to modulate full frequency range.

General

Input Connectors, Impedances: BNC; above 100,000 ohms.

Output Connector: Waveguide cover flange (686A, 687A); Type N, female (683A, 684B).

Power Requirements: 115/230 volts $\pm 10\%$, 50/60 cps; approximately 540 watts.

Price: 683A (2.0 to 4.0 KMC) \$3,000.00.

684B (4.0 to 8.1 KMC) \$2,900.00.

686A (8.20 to 12.40 KMC) \$2,900.00.

687A (12.40 to 18.00 KMC) \$3,400.00.

(Prices above are f.o.b. factory for cabinet models. Rack mount instruments \$15.00 less.)

Data subject to change without notice.

HEWLETT-PACKARD COMPANY

4478A Page Mill Rd. • Palo Alto, California, U.S.A.

Field Representatives in All Principal Areas

Cable "HEWPACK" Davenport 6-7000

4478-P

Regulation Monitor

417

Measures from $\pm 0.001\%$ to $\pm 10\%$ regulation



Model RM-2A transistorized regulation monitor measures from $\pm 0.001\%$ to 10% regulation. Sensitivity ranges are $\pm 0.1\%$, $\pm 1\%$, and $\pm 10\%$ full scale. Stability drift is less than 0.005% for 8 hr on the high-sensitivity range. On other ranges there is less than 1 scale division. Long term stability is less than 0.01%. The instrument is designed to measure the stability of any dc voltage from 2 to 500 v. Transistors, Zener diodes, and mylar and tantalum capacitors are used. The unit is compact.

Calibration Standards Corp., Dept. ED, 1130 W. Fifth Ave., Pomona, Calif.

Timing Modules

412

Both fixed and adjustable delay types



Offered in both fixed and adjustable time delay types, these timing modules consist of an RC timing network, a resistance divider biasing network, and a solid-state gate circuit. In fixed-time types, the delay period may be 0.00005 to 300 sec. The adjustable-time units provide a delay that may be adjusted to any point within a 20:1 range. The accuracy may be 10%, 5%, or 3% in fixed-time units and 10% or 5% in adjustable units. Input is 28 v dc. All units can stand shock, acceleration, vibration, and temperatures from -55 to $+125$ C. A typical module is housed in a case measuring 1 cu in.

Tempo Instrument Inc., Dept. ED, P.O. Box 338, Hicksville, N.Y.

Price & Availability: Price ranges from \$100 to \$400. Delivery time is two to four weeks.

instruments that speed and simplify your work

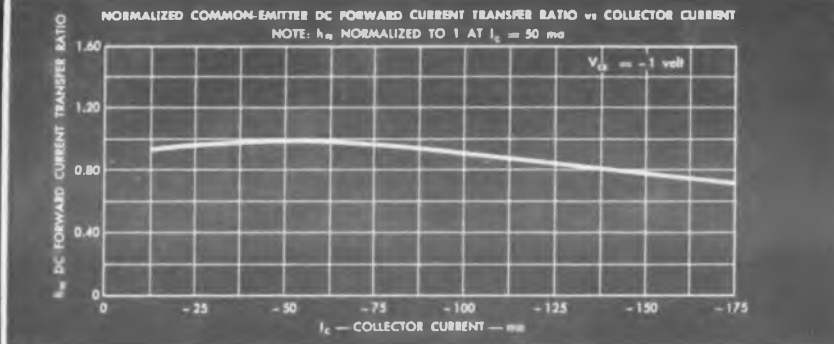
CIRCLE 85 ON READER-SERVICE CARD

Low cost germanium general purpose transistors give you 250 mw dissipation

...with
beta spreads
as low as 2:1

Available in commercial production quantities, TI 2N1372 series germanium P-N-P alloy transistors make possible low-cost applications that provide linear beta, high power gain and low distortion characteristics. These general purpose economy transistors are especially suited for your medium frequency switching circuits, audio amplifiers and motor control applications.

Fully automatic testing and classification by CAT (Centralized Automatic Testing) completely eliminates human error and assures uniformity and reliability... ideal for your production assembly and testing requirements. Evaluate the specifications below and contact your nearby TI distributor or TI sales office for the devices most suited to your particular requirements.

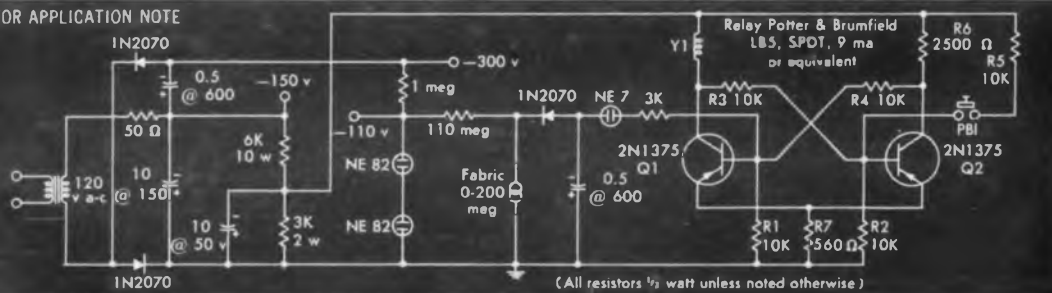


maximum ratings at 25° C ambient	2N1372	2N1373	2N1374	2N1375	2N1376	2N1377	2N1378	2N1379	2N1380	2N1381	Unit
Collector-Base Voltage	-25	-45	-25	-45	-25	-45	-12	-25	-12	-25	v
Collector Current	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	ma
Total Device Dissipation	250	250	250	250	250	250	250	250	250	250	mw
Storage Temperature Range	-55 to +100										°C
electrical characteristics at 25° C ambient											
I_{CBO} Collector Reverse Current											μ a
($V_{CB} = -12v$ $I_E = 0$)	(max)										-7
($V_{CB} = -20v$ $I_E = 0$)	(max)										-7
($V_{CB} = -1.5v$ $I_E = 0$)	(typ)										-3
h_{FE} dc Forward Current Transfer Ratio*											μ a
($V_{CE} = -1v$ $I_C = -50$ ma)	(min)										30
	(typ)										45
	(max)										95
$f_{\alpha b}$ Common-Base Alpha-Cutoff Frequency											mc
($V_{CB} = -5v$ $I_C = -1$ ma)	(typ)										1.5
Noise Figure 1000 cps†											db
	(typ)										7.0

*Tolerance on all values $\pm 10\%$ for test set correlation. †Conventional noise compared to 1000 cps and 1 cycle bandwidth.

GERMANIUM TRANSISTOR APPLICATION NOTE

High
Resistance
Sensing
Unit



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IN QUALITY
GERMANIUM TRANSISTORS

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SEMICONDUCTOR-COMPONENTS DIVISION
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NEW PRODUCTS

Elapsed Time Indicator

627

Has 1/8-in. characters



Having numerals 1/8 in. high, model 1440 elapsed time indicator provides readings from 000 to 999 hr. Nominal input requirement is 115 v at 400 cps, single-phase. The unit meets the environmental requirements of MIL-E-5272. It weighs about 1.8 oz, has an over-all diameter of 0.67 in. and a height of 1-7/8 in.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.

Availability: The unit is made on order.

Abrasive Crystals 575

These ruby and sapphire abrasive crystals meet the requirements of the electronic and semiconductor manufacturing. They produce high-polished surfaces needed in advanced device fabrication. Homogeneity is certified by laboratory analysis of each batch.

Geoscience Instruments Corp., Dept. ED, 425 Park Ave., New York 22, N.Y.

Price: The ruby is priced at \$4.74 for 5 oz; the sapphire, \$5.

Broadband Circulators 573

Range is 1 to 2 kmc

Model X-101 broadband circulator is designed for use with radiometers, masars and parametric amplifiers operating in the range of 1 to 2 kmc. The isolation between the output arms exceeds 20 db. Insertion loss is less than 0.5 db.

◀ CIRCLE 86 ON READER-SERVICE CARD

tion loss is less than 1 db over a 200-mc bandwidth with a maximum vswr of 1.3 v. The vswr is less than 1.2 within a bandwidth of 100 mc. The unit can be supplied with an electromagnet for use as an electronically-actuated switch. It weighs less than 1 lb and measures 3.75 in. in diam and 1.5 in. in height.

Melabs, Dept. ED, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Germanium Transistors 592

Switch to 400 ma

Offered in four types, these germanium, diffused-base transistors are capable of switching 400 ma. Types 2N1495 and 2N1496 have switching rates of better than 10 mc. Types 2N1204 and 2N1494 switch at rates in excess of 5 mc. Types 2N1494 and 2N1496 are used with a heat sink and have dissipation ratings of 500 mw; types 2N1495 and 2N1204, free-air mounted, provide dissipation ratings of 250 mw. In all units the collector is silver-stud mounted to the case. Cadmium electrodes are used. Applications include data processing systems, such as memory drivers and transmission line drivers, oscillators, and communications equipment.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

Oven 369

Stability is 0.0033 C per deg C

The PM series of ovens offers a stability of 0.0033 C per deg C. The ambient temperature range is from -20 C to within 10 C of the operating temperature. Standard cavity temperatures are 65, 75, and 85 C; other temperatures can be furnished on request. The frequency stability with a 1-mc monitor crystal is ± 3 parts in 10^8 . Dimensions are 1-7/16 x 1-7/8 x 4 in.

Monitor Products Co., Dept. ED, 815 Fremont, South Pasadena, Calif.

Price & Availability: Price is about \$125 ea in prototype quantities. Delivery time is 30 days.

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*Another new Hydro-Aire product
for the aircraft, missile support,
missile and electronics industries*



Ready Now! A Reliable Family of
Transistorized Time Delay Devices
—available on time from Hydro-Aire

These fully-transistorized time delay devices are but nine of a widely diversified family including relays, sequence timers, computer timing modules and time-programmed, system supervising units—all custom-designed, built and on-time delivered by Hydro-Aire. Perhaps one of these proven designs meets your specifications. If not, we will custom-design to your requirement. All of our time delay devices are compactly designed, available for AC or DC operation, and conform to applicable Mil Specs. These devices typify the many reliable electronic products being designed, developed, produced and on-time delivered by Hydro-Aire.

CHARACTERISTICS: TIME DELAY RELAY MODEL 50-085

Size—2 $\frac{3}{8}$ " x 1 $\frac{1}{2}$ " x 1 $\frac{1}{2}$ "

Weight—4 oz.

Time delay range—adjustable over one decade; 6 to 60 seconds with $\pm 5\%$ accuracy

Life: 100,000 operations at rated contact load

Maximum power required: 50 ma at 24-31 VDC

Temperature range: -55°C to +71°C as standard; to +125°C available on special request

WRITE FOR ELECTRONICS CATALOG. A note on your letterhead brings a free copy, containing detailed facts and specifications. If you have a time delay device requirement, include your specifications for a prompt quote.

HYDRO-AIRE

BURBANK, CALIFORNIA
DIVISION OF CRANE CO.

Solid state devices include
time delay devices, voltage
regulators, power supplies,
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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.

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.

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120 K**

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Need fast delivery?**

NEW PRODUCTS

Recorder-Reproducer

415

Frequency response is 125 kc at 15 ips



Model CM-100 video-band recorder-reproducer records both analog and pulse signals. It is capable of the following frequency responses: 1 mc at 120 ips, 500 kc at 60 ips, 250 kc at 30 ips, and 125 kc at 15 ips. The over-all bandwidth is 400 cps to 1 mc per track. A 7-track system, the unit is packaged in a single, standard size rack. Six speeds are possible ranging from 7.5 to 120 ips. Tape used is 1/2 in.

Mincom Div., Minnesota Mining & Manufacturing Co., Dept. ED, 2049 S. Barrington Ave., Los Angeles 25, Calif.

Availability: Delivery time is 90 days.

Pulsed Oscillator

407

Covers the C-band range



Designed specifically for transmitter service in missile and drone type radar beacons, this C-band, triode, pulsed oscillator uses a replaceable planar triode tube which has the capability of operating into highly mismatched loads. The designated C-band range is covered with two units: one has a tuning range of 5400 to 5700 mc, the other from 5700 to 5900 mc. Output peak power is 100 w min with a maximum duty cycle of 0.002.

ACF Industries, Inc., ACF Electronics Div., Dept. ED, 11 Park Place, Paramus, N.J.

Components

418

Can be stacked



This line of components includes saturable reactors, pulse transformers, dc-dc converters, and 400-cps power transformers. They can be stacked as poker chips. Miniature units can be furnished. Terminals can be supplied to meet individual requirements.

Communication Accessories Co., Dept. ED, Lee's Summit, Mo.

Silicon Rectifiers

688

Peak voltage is to 1000 v

These pre-assembled, silicon, full-wave bridge rectifier units are suited for such applications as dc filament supplies for audio amplifiers and instruments, relay power supplies, and plate supplies. They provide forward currents to 2 amp and peak voltages to 1000 v.

Semicon, Inc., Dept. ED, P.O. Box 328, Bedford, Mass.

Connector Collet

413

For use with solder and crimped terminals



Designed for use with both solder and crimped terminals, the TOTCO connector collet eliminates wire breakage at terminals and serves as a complete shield against rf radiation interference at plugs. When used with a crimp-type terminal, the collet provides a mechanical connection. Models available have 4, 19, and 55 pins.

Technical Oil Tool Corp., Dept. ED, 1057 N. La Brea Ave., Los Angeles, Calif.

Availability: Delivery time is 30 days.

HERE'S WHY CENTRICORES ARE PROBABLY THE MOST CONSISTENTLY UNIFORM CORES YOU CAN BUY:

The exceptional uniformity you get in tape-wound Centricores is not easy to come by. It's the result of painstaking precision at every stage of the manufacturing process—and, in fact, *before* manufacturing. Three principal factors help produce Centricore uniformity:

Careful classification of materials—Raw alloys are first "pedigreed"—meticulously selected, then tested for some 14 parameters, and classified by magnetic properties. We're the largest buyer of nickel alloy magnetic materials in the world... which permits us to choose material for Centricores from an unusually wide distribution of magnetic properties.

Special winding machines—We build our own machines, to die-making tolerances, for winding magnetic alloy tape into cores. We also build our own machines for applying insulating coating to the tape. These machines give us far greater uniformity in dimensions, insulation and ultimate performance of Centricores.

Closely-controlled annealing—Annealing—perhaps the most critical phase of the core-making process—is done under precisely regulated atmospheric and temperature stabilized conditions to hold Centricore magnetic performance to uniformly high levels.

Exceptional uniformity from core to core and lot to lot is further assured with Super Squaremu "79", a new high-performance alloy we've developed. It has outstanding magnetic qualities and is remarkably uniform in squareness, thermal stability and gain. Super Squaremu "79" offers an effective solution to problems of variation in magnetic performance.

WRITE FOR BULLETIN C-3

SIZE	MATERIAL	THICKNESS
1	HIGH NICKEL Hymu 89 Squaremu 79 Super Squaremu 79	.001**
THRU	LOW NICKEL Squaremu 49 Carpenter 49	THRU
225	GRAIN-ORIENTED SILICON Crystalligned Microsil	.004*

*Special sizes, shapes and thicknesses quoted on request.

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powdered molybdenum permalloy cores • electromagnetic shields

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50 VA
Power Supply



Model MK-150

Ultra-stable, fine line characteristics — the kind you need and can depend on, are in ELIN's latest 3-phase 50 VA Power Source! Voltage and current sensing on each leg provide super-regulated output. Delta and Wye connections are at rear panel. Input Voltage, 105-125V, single phase. Input Power 225W. Output Voltage $\pm 0.1\%$. Output Frequency $\pm 0.1\%$. Output Regulation 0.1% Line to Line. Output Distortion 0.2%. Load Power Factor up to 0.3 inductive. Write for ELIN Technical Data — today!

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CIRCLE 90 ON READER-SERVICE CARD

NEW PRODUCTS

High-Vacuum Relay

414

Switch up to 35 peak kv



Model 35 high-vacuum relay is capable of switching up to 35 peak kv ac or dc in air. The unit is suited for switching high-powered radar pulse networks, dielectric testers, high-voltage power supplies, X-ray apparatus, and other devices. The standard unit is supplied with a 24-v dc actuating coil. Actuating coils with other voltage requirements can be furnished.

Resistron Laboratories, Inc., Dept. ED, 2908 Nebraska Ave., Santa Monica, Calif.

Price & Availability: Units are in stock and can be delivered in 10 days. Price is \$85.

Silicon Diodes

408

Cover the range from 100 to 600 piv



Designed to operate at temperatures up to 200 C, silicon diode-rectifiers MP100 through MP600 cover a range from 100 to 600 v, peak inverse. At 200 C and 225 peak inverse voltage, maximum average rectified current is 50 ma. The fused junction components are hermetically sealed in a glass case. Applications for the subminiature devices include gating, and limiting and magnetic amplification.

General Instrument Corp., Semiconductor Div., Dept. ED, 65 Gouverneur St., Newark 4, N.J.

ANALYZE NOISE

WITH AN
ALLISON FILTER



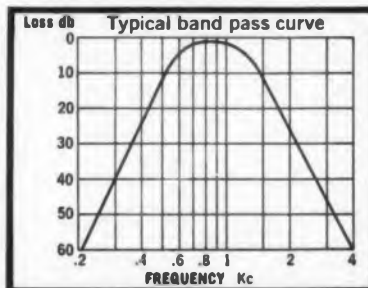
Allison 2B Filter

You can evaluate the amount of a noise and its frequency characteristics with an Allison Filter. You can make this evaluation regardless of whether the noise is continuous or intermittent, or whether it has sharp peaks. *Allison Filters do not ring on transient noises.* This analysis can be very important in testing equipment, preventing hearing loss, and controlling harmful or irritating industrial noises.

Allison Filters have been in constant use for a wide range of laboratory and industrial applications for nearly a decade.

ALLISON SERIES 2 FILTER SPECIFICATIONS

- Continuously variable passive network — no power supply
- Frequency range: 2A, 15 to 10,080 cycles; 2B, 60 to 20,160 cycles; 2C, 9 KC to 670 KC
- Designed for use in 600 OHM circuit and with transformers for other impedances
- Low loss — approximately 2db in pass band
- Attenuation rate — 30 db per octave
- Size: 14" high, 7" deep, 5/8" wide
- Portable and rack models available



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Newark Electronics Co., Inc.
Inglewood
Pacific Wholesale Co.
San Francisco
San Delco
San Diego
Valley Electronic Supply Co.
Burbank

CONNECTICUT

Sun Radio & Electronics Co., Inc.
Stamford
The Bond Radio Supply, Inc.
Waterbury

FLORIDA

Electronic Supply
Melbourne; branches in
Miami, Orlando, St. Petersburg

ILLINOIS

Marquip Company
Chicago
Newark Electronics Corp.
Chicago

INDIANA

Brown Electronics, Inc.
Fort Wayne
Graham Electronics Supply, Inc.
Indianapolis

IOWA

Deeco, Inc.
Cedar Rapids

MARYLAND

Radio Electric Service Co.
Baltimore

MASSACHUSETTS

The Greene-Shaw Co., Inc.
Newton

NEW YORK

Delburn Electronics, Inc.
New York City
Hudson Radio & Television Corp.
New York City
Sun Radio & Electronics Co., Inc.
New York City
Standard Electronics, Inc.
Buffalo, N.Y.

OHIO

Buckeye Electronics Distributors
Columbus
The Mytronic Co.
Cincinnati
Pioneer Electronic Supply Co.
Cleveland

OKLAHOMA

Oil Capital Electronics
Tulsa

PENNSYLVANIA

D & H Distributing Co.
Harrisburg
Herbach & Rademan, Inc.
Philadelphia

TEXAS

Scooter's Radio & Supply Co.
Fort Worth

WASHINGTON

Seattle Radio Supply Co.
Seattle

WISCONSIN

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Milwaukee



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**GENERAL INSTRUMENT
CORPORATION**
240 Wythe Avenue
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Depend on the best from **GENERAL INSTRUMENT**

SILICON VOLTAGE REGULATOR DIODES

- Low zener impedance
- Low reverse leakage up to the point of breakdown

PLUS the highest degree of reliability
proved by controlled life tests
and outstanding performance
in actual circuitry.



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**AXIAL
LEAD
TYPES**



**STUD
TYPES**

1N1589

1N1590

1N1591

1N1592

1N1593

1N1594

1N1595

1N1596

1N1597

1N1598

**GLASS
ENCASED**



1N704

1N708

1N713

1N718

1N725

1N730

1N735

1N738

1N745

1N761

1N1765

1N1767

1N1770

1N1771

1N1773

1N1776

1N1780

1N1788

1N1795

1N1802

Hermetically sealed, ruggedly constructed and small in size and weight. General Instrument voltage regulator diodes are produced in volume quantities under rigid quality control. Their excellence is recognized by leading manufacturers and they are specified in an increasingly wide variety of circuits now in production. The types listed here are just a sampling of the complete line. Detailed technical information is available upon request.

CIRCLE 92 ON READER-SERVICE CARD

CIRCLE 93 ON READER-SERVICE CARD

UNPRECEDENTED EFFICIENCIES IN HARMONIC GENERATION...

11 kMc
input @
500 mw



33 kMc
output @
5 to 20 mw

Nine new examples of Microwave Associates' capabilities in the design of harmonic generators are available now. These models feature exceptionally high output power with conversion losses well below existing devices.

New designs incorporating solid state elements can be used to eliminate costly klystrons, DC bias supplies and high voltage power supplies. All units feature broadband fixed-tuned operation, filters eliminating unwanted harmonics, and versatile coaxial, waveguide and

strip-line packaging. These models are typical examples of our progress to date... presently we are working for even greater efficiencies and performance. Additional models in development converting 1 watt at 2000 Mc to 100 mw or more, at 4000 and 6000 Mc, to be announced soon.

Your specific application problems are of prime interest to us. Our Applications Engineers would welcome the opportunity to design harmonic generators to meet your specifications.

SPECIFICATIONS

Model	INPUT				OUTPUT				Output mW
	Connector Type UG	Frequency Input kMc/s	Band	mw input	Connector Type UG	Frequency Output kMc/s	Band	Conversion Loss (max.)	
MA796	23/U	0.26 — 0.28	P	20	23/U	1.30 — 1.43	L	13db	1
MA797	23/U	1.30 — 1.43	L	100	23/U	5.22 — 5.72	C	15db	3
MA798A	39/U	9.0 ± 150Mc	X	500	596/U	18.0 ± 300Mc	K	17db	10
MA798B	39/U	10.0 ± 150Mc	X	500	596/U	20.0 ± 300Mc	K	17db	10
MA798C	39/U	11.0 ± 150Mc	X	500	596/U	22.0 ± 300Mc	K	17db	10
MA798D	39/U	12.0 ± 150Mc	X	500	596/U	24.0 ± 300Mc	K	17db	10
MA799A	39/U	9.0 ± 100Mc	X	500	600/U	27.0 ± 300Mc	Ka	20db	5
MA799B	39/U	10.0 ± 100Mc	X	500	600/U	30.0 ± 300Mc	Ka	20db	5
MA799C	39/U	11.0 ± 100Mc	X	500	600/U	33.0 ± 300Mc	Ka	20db	5



Write or call:

MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS

Western Union FAX-TWX: Burlington, Mass., 942 • BRowning 2-3000

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Bonder

426

For microassembly techniques

Model 400 transistor wire bonder is for bonding contact wires between the semiconductor material and the header terminal post in transistors. The instrument can be adapted to other micro-assembly techniques. It can be furnished with a continuous wire feed.

Kulicke and Soffa Manufacturing Co., Dept. ED, 1234 Callowhill St., Philadelphia 23, Pa.
Availability: The unit is in stock.



Gaussmeter

411

Reads from 0.1 to 30,000 gauss



Model 120 direct-reading gaussmeter measures the direction and magnitude of magnetic flux density and reads from 0.1 gauss, full scale, to 30,000 gauss, full scale, in 12 ranges. The instrument includes a built-in means of calibration. The sensing element is a thin wafer of indium arsenide having a temperature coefficient of 0.1% per deg C. Applications of the instrument include: readout of magnetic ink and magnetic tape, vibration pick-ups, dc motors, magnets, tachometers, relay testing and polarized relays. Input is 115 or 230 v at 50 or 60 cps.

F. W. Bell Inc., Dept. ED, 1356 Norton Ave., Columbus 12, Ohio.

Price & Availability: \$490; from stock.

Filter Fan

421

Provides 75 cfm of air

The Muffin filter fan provides 75 cfm of filtered air for equipment cooling and ventilating. The filter box locks in place between the frame and the fan, adding about 3/4 in. to the depth of the unit. Mounting is easily performed with clips.

Rotron Manufacturing Co., Inc., Dept. ED, Woodstock, N.Y.

Price & Availability: Small quantities can be furnished from stock; larger quantities, in 3 to 6 weeks. Price is \$15.85 ea for 1 to 9 units.

• ENCAPSULATED UNDER VACUUM,
STONITE COILS LOCK OUT
CORRODING MOISTURE... END
SHORT CIRCUITING HAZARDS

Stonite
CUSTOM-MADE
COILS

Designed and engineered to specifications, Stonite coils meet precise requirements in today's burgeoning industry.

SPECIFY

Stonite

These influential tell why:

- BOUNDLESS EXPERIENCE, QUALITY CONTROL
- WIDEST, MOST VERSATILE RANGE OF APPLICATIONS
- CONTINUOUS PROCESSING CHECKS, RIGID INSPECTIONS
- FINEST MATERIALS, WINDING SERVICES, ADVANCED TOOLING
- WIDEST SIZE RANGE, ANY QUANTITY

PAPER SECTION • FORM WOUND • LAYER ROBIN
PRECISION WINDING • HIGH TEMPERATURE COILS
COPPER AND ALUMINUM CONDUCTORS
Round—Square—Rectangular
Also Round, Square, Rectangular Tubing

Write, describing your requirements and request a representative call. Ask for latest Stonite illustrated brochure.

Stonite
COIL CORP.
YARDVILLE 4, NEW JERSEY
JUniper 7-7323

CIRCLE 95 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 25, 1960

Slicing and Dicing Machines 373

For semiconductor materials

Type 618 slicing and dicing machine automatically cuts wafers from semiconductor materials such as germanium, silicon and quartz crystals with a parallel accuracy of 0.0001 in. Size can be consistently repeated to ± 0.0002 in. The table driving mechanism provides a smooth feed which is adjustable from 0.1 to 144 in. per min; table positioning is adjustable to 25 ft per min.

Brown & Sharpe Manufacturing Co., Dept. ED, Providence 1, R.I.
Availability: Delivery time is 45 days.

Stepping Switches 378

Produce up to 2400 steps per min

Series 18400 stepping switches produce up to 2400 steps per min at 24 v dc. Able to perform sequencing, pulse control, and switching functions, the units are suitable for military and commercial applications. Stepping action is magnetic. The units have solder terminal headers, AN connectors, and hermetic sealing.

The A. W. Haydon Co., Dept. ED, 232 N. Elm St., Waterbury, Conn.

Cabinets and Consoles 675

Precision made

These cabinets and consoles are precision made for housing electronic equipment in missile systems, radar systems, and ground support equipment. They are made as arc-welded assemblies. Materials used are magnesium and aluminum. Each cabinet is stress-relieved after welding. They are strong and light-weight.

Brooks & Perkins, Inc., Dept. ED, 1950 W. Fort St., Detroit 16, Mich.
Availability: Cabinets can be built to customer specifications. Many types are supplied from off-the-shelf extrusions and hardware.

CIRCLE 96 ON READER-SERVICE CARD >

...and here's another

Amperex® AMPLIFRAME*

for improved
TV tuner
performance

Amperex
AMPLIFRAME
triode
type 6FY5

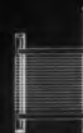


One year ago, Amperex made the AMPLIFRAME type 6ES8 available to the TV industry for their highest quality cascode tuners. By virtue of its high transconductance, low noise and exceptional reliability, the type 6ES8 is now generally accepted as the standard of the industry.

NOW, to establish another new industry standard—in this case for less expensive tuners—Amperex presents the AMPLIFRAME triode Type 6FY5, an improved version of the now famous AMPLIFRAME type 6ER5, offering 1 db lower noise and 2 db higher gain. The extraordinary uniformity of this tube is the result of the special Amperex techniques utilized in its mass production.

Here are some of the outstanding features of the new type 6FY5:

- extremely high transconductance and input impedance provide very high gain-bandwidth factor.
- internal screening-shields reduce plate-to-grid capacitance.
- newly designed tongue-mica clamp on cathode eliminates microphonics.
- remote characteristics insure low intermodulation distortion.
- operational at lower supply voltage for greater design flexibility.
- extreme tube-to-tube uniformity.



*AMPLIFRAME, a new concept in electron tubes, designed and mass produced exclusively by Amperex, incorporates the unique FRAME GRID...the closest approach to the ideal "Physicists' grid"—electrical characteristics but no physical dimensions. The FRAME GRID results in:
• higher transconductance per milliamperes • tighter G_m and plate current tolerance • low transit time • low capacitances • lower microphonics • rugged construction

ask Amperex



for Ampliframe applications assistance on RF and IF TV circuitry

specifications

AMPLIFRAME TYPE 6FY5

remote cut-off triode for TV tuners
transconductance 13,000 micromhos at 11 mA
amplification factor 70
capacitances input: 4.75 μf
output: 3.3 μf
plate to grid: 0.50 μf
plate voltage, typical 135V
heater current & heater voltage 200 mA, 6.3V

AMPLIFRAME TYPE 2FY5

controlled heater warm-up version
heater current & heater voltage 600 mA, 2.4V

AMPLIFRAME TYPE 3FY5

controlled heater warm-up version
heater current & heater voltage 450 mA, 3.1V

Amperex Electronic Corp.
230 Duffy Avenue
Hicksville, L.I., N.Y.

NEW PRODUCTS

Digital Multiplexing Synchronizer 578

For missile tracking systems

Model DH-14 digital multiplexing synchronizer accepts up to six simultaneous inputs supplied by model DH-10 digital distribution unit. Each input sample contains 30 characters of four binary bits each. The unit checks all data for accuracy and arranges it for entry into the IBM 709/7090 DPM or the Univac 1103A.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price & Availability: \$50,000; 90 to 120 days.

Multiplexer 376

Has a 10-mv resolution

The Radiplex 89 multiplexer, having a 10-mv resolution, eliminates the need for dc channel amplifiers ahead of the multiplexer and can directly acquire and multiplex outputs of low-level strain gages, thermocouples or other transducers. The system handles 48 channels and is made up of three sections. At a 24-kc word rate, each section is independently driven at 4000 cps. Read-out is in Nixie form. Isolation of transformer windings and placement of the input gates result in common mode rejection of 10^6 and crosstalk of less than 0.05%.

Radiation Inc., Dept. ED, Melbourne, Fla.

Power Supply 579

Provides ac and dc

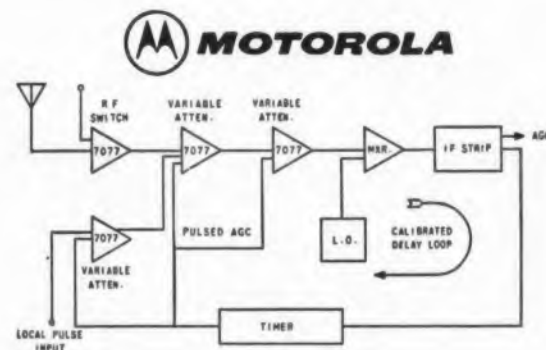
Designed to operate from an input of 85 to 250 v ac at 50 or 60 cps, model PSI power supply provides 117 v of 400-cps ac and 28 v dc. Regulation is $\pm 2\%$ from no load to full load. Either section of the dual output supply can be furnished as a separate unit. The 400-cps output is rated at 600 va and the dc output is rated at 10 amp at 28 v. The ac frequency control standard

Good electronic design you limit compromise by PROOF: G-E 7077 over a wide spectrum of



WIDE-BAND TAPE RECORDER.

For Lockheed, California Division, 28 General Electric 7077's serve as pre-amplifiers in a 14-channel 500-kc 60"-per-second tape recorder that stores wide-band information from an air defense exercise five times as rapidly as before. Extreme requirements of frequency, timing accuracy, and reproducibility are met by the 7077's low noise, high impedance, and high G_m . Also, the tube's small size matches the miniaturization needs of the Lockheed tape-recorder equipment.



GROUND-SURVEYING RADAR.

Motorola's Western Military Electronics Center in Phoenix uses four General Electric ceramic 7077's for high-speed RF switching and pulse attenuation in a 440-mc distance measuring circuit where timing to one billionth of a second is needed for pulse delay measurement. Minimum plate-to-cathode capacitance, high gain, low noise, and a configuration that makes the tube ideal for grounded-grid service, were reasons back of Motorola's choice of the G-E 7077.

involves trade-offs... but
 using ceramic tubes.
 meets designers' targets
 frequency and function.



is accurate to $\pm 0.01\%$. Both outputs are adjusted by means of a switch. Maximum distortion of the ac output is 9%; maximum peak-to-peak ripple of the dc output is 0.03 v. The unit meets MIL-1-16910A. It is furnished in a rack cabinet and can be mounted in a carrying case.

Stancil-Hoffman Corp., Dept. ED, 921 N. Highland Ave., Hollywood 38, Calif.

Price & Availability: The dual supply is available for early delivery at \$2700.

Silicon Transistors 574

Power dissipation is 125 w at 25 C

Types PT900 and PT901 diffused, mesa, silicon transistors have 125 w power dissipation at a case temperature of 25 C. The alpha cut-off frequency is 50 mc, continuous collector current is 10 amp, and saturation resistance is 0.2 ohm. The units are designed for use as power converters and inverters operating at frequencies up to 1 mc. Other applications are fast-response power supply regulation, aircraft radio transmitters, ultrasonic generators, compact rf generators for induction heating, computer core-drivers, high-speed switches, radar pulse generators, and high-power video amplifiers.

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

Price & Availability: Type PT900 is priced at \$155; type PT901, \$195. Small quantities can be furnished immediately.

Projector-Printer 374

Reproduces engineering drawings

The Kecofax electrophotographic projector-printer reproduces engineering drawings having dimensions up to 34 x 48 in. Loading film into the holder and setting the exposure time are manual operations; the rest is automatic. A finished print can be made in 40 sec.

Keuffel & Esser Co., Dept. ED, Third and Adams Sts., Hoboken, N.J.
Availability: Units are currently available.



MISS-DISTANCE INDICATOR.

Ralph M. Parsons Company uses seven General Electric ceramic 7077's in tuned stages as high-gain, low-noise RF amplifiers in its PARAMI system for determining air-intercept missile accuracy. A 324-mc circuit, the Parsons PARAMI system has a gain-bandwidth product approaching the limit of the state of the art.



UHF DISTRIBUTED AMPLIFIER.

Many receivers—one antenna, with Temco Electronics' broadband distributed amplifier. Arranged in six five-stage units, 30 G-E 7077's are used as RF amplifiers, operating over a 750 mc bandwidth, between 250 and 1000-mc. Fills the frequency gap between TWT's and existing distributed amplifiers.

Phone your nearest General Electric Receiving Tube Department Office:

New York: Wisconsin 7-4066, 6, 7, 8

Chicago: Spring 7-1600

Los Angeles: Orange 9-7765

Progress Is Our Most Important Product

GENERAL  ELECTRIC

431-202

$$1. z = f(x, y) \quad 2. z = f[g(x), h(y)] \quad 3. z = f(u, x, v, y)$$

$$4. y_1 = f_1(x), y_2 = f_1(x), \dots, y_{20} = f_{20}(x)$$

$$5. z_1 = f_1(x, y), \dots, z_4 = f_4(x, y) \quad 6. u = z \cdot f(x, y)$$

$$7. z = f(x_1 + x_2 + \dots, y_1 + y_2 + \dots)$$

NOW... A NEW APPROACH TO FUNCTION GENERATION

The Link Analog Function Generator

Link's analog function generator offers a new level of performance for analog computation and simulation. Key to this outstanding performance... a Link-developed *rectilinear servo motor* with solid-state servo-amplifiers and a *ceramic-film resistance element*.

This new function generator eliminates the high drift and complex design of diodes generators, provides high-speed operation without the limited flexibility of optical techniques and the inherent backlash, friction and inertia problems of existing servo generators.

IT PROVIDES:

RELIABILITY—Modular design • Automatic failure protection • Simplified maintenance

ECONOMY—Standardized components • Printed circuits

FLEXIBILITY—Plug board programming • Rack mounted or table top use

VERSATILITY—Numerous functions or function groups can be generated with minor modification, or by connecting one or more generators in series.

The analog function generator, first of a line of **DIALOG*** components and system building blocks to be introduced by Link, is another example of Link's unique computer capability. Thoroughly experienced in analog and digital techniques, Link can provide the most objective, economic solution to computation, simulation and control problems. For additional information on Link's new Function Generator or its broad computer capabilities — and your copy of Link's **DIALOG*** catalog — write to Industrial Sales Department.

DIALOG* (Link *Digital-Analog* System Components and Building Blocks)



*DIALOG is a Trademark of Link Division, General Precision, Inc.

LINK DIVISION



GENERAL PRECISION INC.

BINGHAMTON, NEW YORK

CIRCLE 98 ON READER-SERVICE CARD

NEW PRODUCTS

Buffer Amplifier

425

Dual-channel type

Type S3105-01 transistorized dual-channel buffer amplifier is designed to drive any resolver with a tuned primary impedance greater than 2000 ohms and a primary resistance of less than 1000 ohms. The amplifier-resolver combination has stable gain and phase shift characteristics from -55 to $+75$ C. Voltage gain is $1 \pm 0.15\%$. Input is 60 ± 2 v dc at 20 ma. Phase shift is less than 30 min.

Kearfott Div., General Precision Inc., Dept. ED, 1150 McBride Ave., Little Falls N.J.

Trimming Potentiometer

416

Weights less than 6 g



Measuring 1/2 in. in diameter, model WEE-50 trimming potentiometer weighs less than 6 g and is designed for panel mounting. It operates in temperatures from -55 to $+200$ C and withstands shock to 20 g, altitude of 50,000 ft, and vibration from 30 g, 10 to 2000 cps. The requirements of MIL-E-5272A are met.

Handley, Inc., Dept. ED, 12960 Panama St., Los Angeles 66, Calif.

Availability: Standard units can be supplied from stock.

Watt Meter

427

Measures gyros, synchros and servomotors

Designed for measuring gyros, synchros and servomotors, this wattmeter has ranges of 1.2, 3, 12, and 30 w with a 26-v input and 1.2, 3, 12, 30, and 120 w for a 115-v input. Accuracy is 1% of full scale. Frequency range is 50 to 2000 cps. The meter consists of a d'Arsonval type dc milliammeter and an ac-dc transducer for each phase. The unit is portable and weighs 15 lb.

Voltron Products, Dept. ED, 1010 Mission St., S. Pasadena, Calif.

Price & Availability: Price ranges from \$385 to \$585. Delivery is from stock.



new **DYKOR*** all-solid state photoelectric reader offers optimum reliability, faster stops and higher reading speeds...

For applications such as digital computers, machine tool control and tape conversion, the *fastest, most accurate* Tape Reader available is the unique **DYKOR 3500**. Built by pioneers in data processing technology, the 3500 provides *high reliability* at high tape speeds.

FEATURES...

- **STOPS FASTER**—Before the next character at 1,000 char./sec.
- **READS FASTER**—From 50 to 1,500 char./sec. (or faster if required).
- **RELIABILITY ASSURED**—By use of silicon photo-diodes, completely transistorized circuitry on etched circuit boards, simple integrated optical system with regulated lamp current.
- **VERSATILITY**—5, 6, 7 or 8-channel tapes handled interchangeably. Reads any standard tape material including oiled yellow Teletype paper.
- **SIMPLE HANDLING**—In-line load and unload.
- **CHOICE OF SINGLE OR DUAL SPEEDS.**
- **SPOOLER UNIT AVAILABLE** for take-up and re-wind of tape.



DIGITRONICS CORPORATION

103 Albertson Ave. • Albertson, L. I., N. Y. • PI 7-5090

CIRCLE 99 ON READER-SERVICE CARD
CIRCLE 100 ON READER-SERVICE CARD

A guide for predicting resistor performance

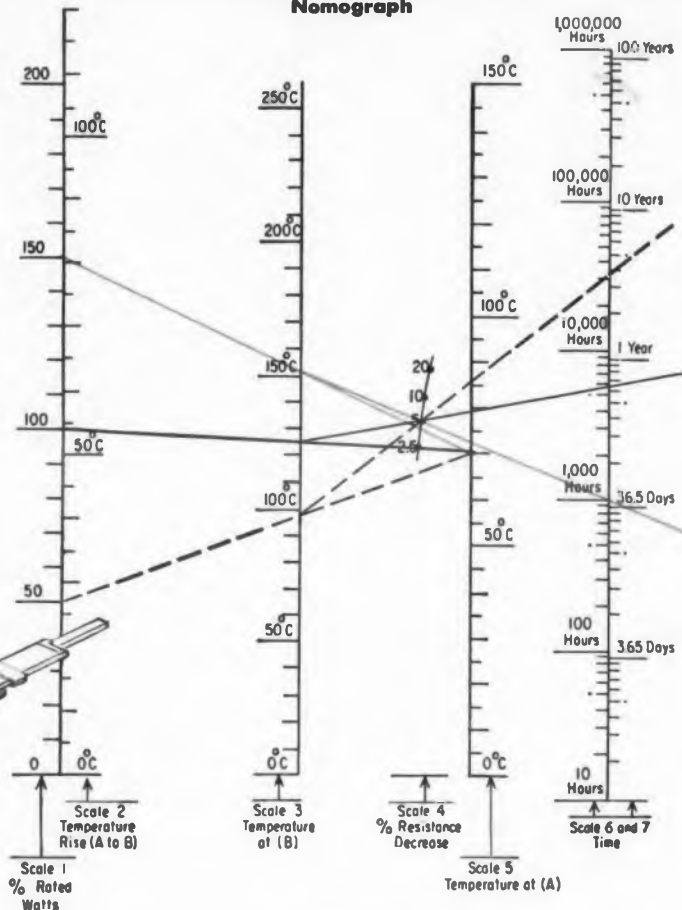


NOMOGRAPHS PREDICT LIFE PERFORMANCE OVER LONG PERIODS OF TIME FOR ALLEN-BRADLEY HOT MOLDED COMPOSITION UNITS

Allen-Bradley's exclusive hot molding process produces resistors with such uniform characteristics that their performance can be predicted with a high degree of certainty. Test data produced in the last 20 years not only in the Allen-Bradley environmental laboratories but also in independent laboratories have been carefully compared and analyzed and have served as a basis for developing the above power nomographs.

3-60-E

Type EB (1/2 Watt) Nomograph

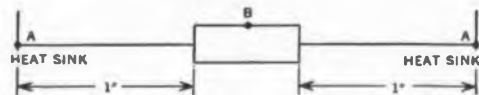


An Example of Predicting Resistor Performance

Illustration shows use of nomograph to predict the rate of resistance change with life for standard Allen-Bradley resistors. This example is based on a maximum of 5% resistance change with 70°C temperature at points "A" (see drawing below) when operated at

- 50% LOAD
- 100% LOAD
- 150% LOAD

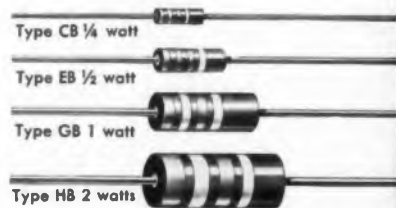
RESISTOR TEST CONDITIONS



And Allen-Bradley has been conservative in projecting test data. Inasmuch as catastrophic failure has yet to occur, the design engineer can develop circuitry with predictable performance.

WRITE TODAY—Power nomographs for standard Allen-Bradley composition resistors are published in Technical Bulletin 5000E. You'll find this information of genuine help and value to you.

A-B HOT MOLDED COMPOSITION RESISTORS



ACTUAL SIZE

ALLEN-BRADLEY

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY ELECTRONIC COMPONENTS

17 FACTS



about

ALLEN-BRADLEY

Hot Molded Composition

RESISTORS

... to assist you in the design of more stable, more reliable circuits

Circuit reliability is determined by the quality of the components and the understanding with which they are applied. A-B hot molded resistors are universally recognized for their quality and reliability. Here are 17 facts that will assist you with your design and development work.

1 Resistance changes due to humidity are temporary, but Allen-Bradley resistors can be returned to their original value by proper conditioning or "loading."

2 Resistance changes due to increase in moisture content are always positive.

3 Resistance change due to humidity varies with the resistance value and is less in the lower values.

4 Resistance change which has occurred due to humidity may be returned to the original value by conditioning the resistor at 100°C for 48 hours.

5 Resistors operating at 1/10 rated wattage load are hardly—if at all—affected by humidity.

6 Hermetically sealed resistors do not change because of humidity.

7 Resistance change due to "load life" is permanent and ultimately negative.

8 Resistance change due to "load life" can be minimized—on the order of 1% to 2% in many thousands of hours of service by derating the resistor approximately 50%.

9 This same result can be attained by limiting the maximum operating surface temperature of the resistor under load to 100°C.

10 Resistance change due to soldering is positive; but if the resistor is dry, it will return to its original value in a matter of hours.

11 The temperature characteristic of the Allen-Bradley resistor is positive above and below room temperatures between +10°C and +80°C ambient.

12 The temperature characteristic of the Allen-Bradley resistor is negligible from +10°C to +80°C ambient.

13 The voltage characteristic of the Allen-Bradley resistor is negative. It is less at elevated temperatures than at room ambient (+10°C to +80°C).

14 The voltage characteristic is less in low-value resistors than in high-value units—it is linear.

15 The voltage characteristic and the temperature characteristic tend to cancel one another in an Allen-Bradley resistor under average operating conditions where both voltage and temperature are present.

16 The "heat sink" to which a resistor is connected affects its rating. Resistors operated in parallel should be derated unless an adequate "heat sink" is provided.

17 The quality and reliability of Allen-Bradley resistors are exactly the same regardless of the "tolerances" for which the resistor is listed.

3-60-E

ALLEN-BRADLEY

Quality
Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



PRECISION FILM POTS

**AVAILABLE
FROM STOCK!**

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
7/8"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
1-3/32"	1K.....	± .25%
	10K.....	± .25%
	50K.....	± .25%
2"	5K.....	± .25%
	20K.....	± .25%
	50K.....	± .25%
3"	5K.....	± .1%
	20K.....	± .1%
	50K.....	± .1%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K.....	± .75%
	20K.....	± .75%
2"	10K.....	± .25%
	20K.....	± .25%
3"	10K.....	± .15%
	20K.....	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K.....	1" Stroke	± .5%
		2" Stroke	± .5%
	20K.....	1" Stroke	± .25%
		2" Stroke	± .25%
	10K.....	3" Stroke	± .1%
		20K.....	3" Stroke

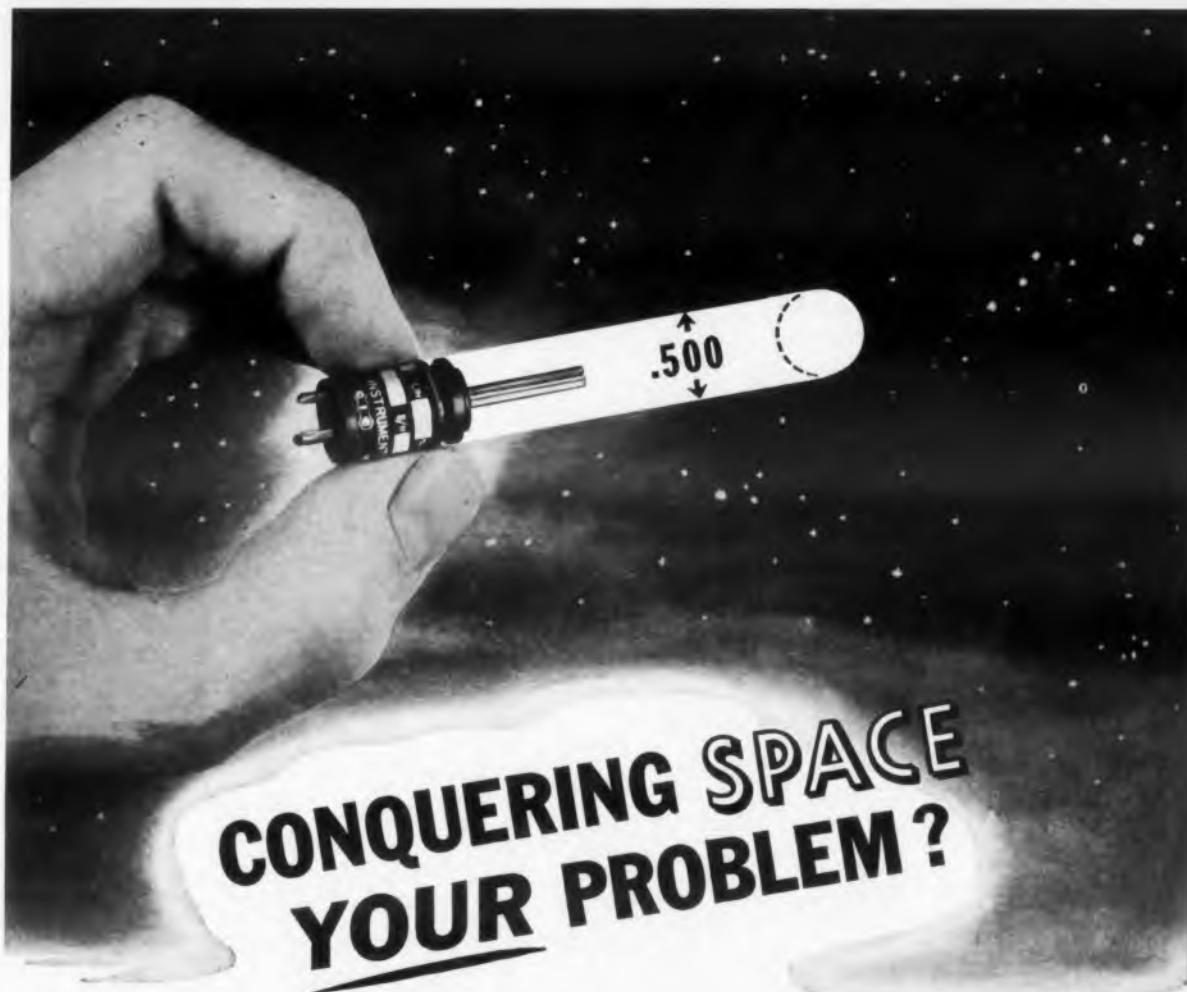
Write or call in your order! Potentiometers will be in your plant within 24 hours.



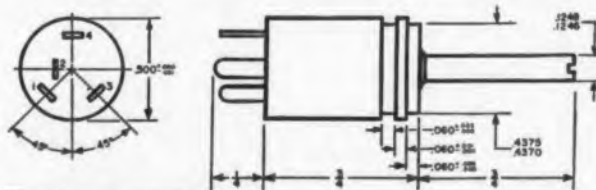
90 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 101 ON READER-SERVICE CARD

← CIRCLE 100 ON READER-SERVICE CARD



The NEW 1/2" **CIC** FILM POT IS THE ANSWER LINEARITY 0.2% • INFINITE RESOLUTION • LONG LIFE



SPECIFICATIONS:

MODEL	50
RESISTANCE RANGE	500Ω TO 150K
BEST LINEARITY OR CONFORMITY	0.2%
WATTAGE	1
GUARANTEED LIFE, REVS.	TO 30x10 ⁴

92 Madison Avenue, Hempstead, L. I., N. Y.

This subminiature film pot has much greater accuracy than comparable wire-wound types and features the reliability inherent in film pots. Now you can meet tight space requirements without sacrificing accuracy. Send us your specifications.

TERRITORIES OPEN FOR QUALIFIED SALES REPRESENTATIVES

FIRST IN FILM POTS



CIRCLE 102 ON READER-SERVICE CARD



from copper and steel . . .

from wire, strip, and bar stock . . . to . . .

COMPLETE SERVO ASSEMBLIES

We are not an assembly station. We are a manufacturer!

Steel and copper come into our factory. Housings are turned and gears are hobbled from the solid stock. Laminations are stamped from strip steel. Copper is wound right off the reel.

Every operation between raw stock and servo assembly is performed in our own plant, under our own supervision. And because we exercise this complete control over manufacture, we can honestly vouch for the quality and reliability of every motor, generator, synchro, and gear train carrying our name.

Undivided responsibility isn't a new idea by any means, but it is increasingly difficult to find in this age of overspecialization. If you'd care to sample the benefits of this integrated approach, why not call on us now?



SERVO ASSEMBLY - Type 9 motor generator driving two Type 11 CT synchros through a slip clutch and a gear train having ratio of 1500 to 1.

DAYSTROM, INCORPORATED

TRANSICOIL DIVISION

WORCESTER • MONTGOMERY COUNTY • PENNSYLVANIA

NEW PRODUCTS

Ultrasonic Cleaner 680

Has a 0.5-gal tank

Model LGT-40 transistorized, ultrasonic cleaner has a 0.5-gal tank that is completely removable. The unit is 14 in. deep, 7 in. wide, and 13 in. high. It is suitable for cleaning precision parts, electronic components, small sub-assemblies, dies, and molds. An on-off switch is the only generator control required. A second switch controls the integral heating elements. Generator output is 40 w avg, 80 w peak. Power input is 120 w at 115 v, 50 to 60 cps.

Branson Ultrasonic Corp., Dept. ED, 40 Brown House Road, Stamford, Conn.

Price & Availability: Price is \$225 without heating elements and \$245 with heating elements. Delivery time is four weeks.

Tracking Antenna 371

Range is 215 to 260 mc

The bifilar helical tracking antenna has a range of 215 to 260 mc. Two interlaced 8-turn elements are employed. Gain is 14 db for 240 to 260 mc and 13 db for 215 to 240 mc. The vswr is less than 1.8:1.

Andrew California Corp., Dept. ED, 941 E. Maryland Ave., Claremont, Calif.

Transmitter Tester 361

Has a dummy antenna of 52 ohms

This test instrument is designed for permanent connection into 50-ohm coaxial lines such as RG-8/U. The self-contained unit has a built-in dummy antenna of 52 ohms that provides a fixed load for the transmitter during adjustment. This prevents the development of excessive voltages in pi-network output circuits during tuning or mistuning. The instrument, model 52-500, also includes standing-wave-ratio indicators and an rf power meter.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

Availability: Made on order only.

◀ **CIRCLE 103 ON READER-SERVICE CARD**

Computer-Indicator 362

For airborne use

Capable of computing ground speed and drift angle of aircraft and displaying this information on an integrally lighted dial, model T8605-22N computer-indicator has a scale factor of 0.03 v per knot. The system contains servo amplifiers, transistorized buffer amplifiers, and individual power supplies. It operates on 115 or 26 v, 400 cps, single phase, or on 28 v dc. The environmental specifications of MIL-E-5272C, MIL-E-5422CE, and MIL-I-6181B are met. The unit weighs 5.5 lb.

Kearfott Co., Dept. ED, 1500 Main Ave., Clifton, N.J.

Magnetic Proximity Switch 370

For use in automatic or semi-automatic production

This magnetic proximity switch is for use in automatic or semi-automatic production machinery. It enables central supervision of production in an entire plant from one control board. It can be installed so that it is held actuated while the other machinery is at rest.

Jo-Bell Products, Inc., Dept. ED, Oak Lawn, Ill.

Environmental Chamber 683

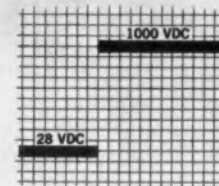
Heats up to 2300 F

The Dyna-Trol environmental chambers are able to heat to 2000 F in 1 hr and to the maximum temperature of 2300 F in 1.5 hr. A constant temperature level is maintained by input controllers. Zone gradient control operates by multiple circuits, with each circuit having an input controller. The gradients are indicated by a pyrometer. Six sizes are offered, ranging from 18 x 18 x 18 in. to 24 x 24 x 72 in.

L & L Manufacturing Co., Dept. ED, 804 Mulberry St., Upland, Chester, Pa.

Availability: Units can be delivered two or three days after receipt of order.

Convert Invert — Change



Daven solves your solid-state power supply problems!

Take advantage of Daven's experience in designing extremely compact, light-weight, high temperature units, which can withstand the most severe altitude, shock, and vibration environments. Let us engineer solid-state supplies for your missile-borne, airborne, shipborne, underwater or ground support equipment.

Converters

- DC input voltage from 6 volts to 230 volts
- DC output voltage from 1 volt to 15 kilovolts
- DC output current from microamperes to 100 amps
- Dynamic regulation, ripple, stability as required

Inverters

- DC input voltage from 6 volts to 230 volts
- AC output from 20 VA to 2500 VA
- 60-400-800-1600-2000 cycles per second
- One, two or three phase, any voltage level
- Voltage and frequency regulation 0.1% to 10% as required
- Output waveform — sine or square wave

Frequency Changers

- 20 VA to 2500 VA
- Change to or from any of these frequencies: 60-400-800-1600-2000 cycles per second
- Voltage and frequency regulation 0.1% to 10% as required

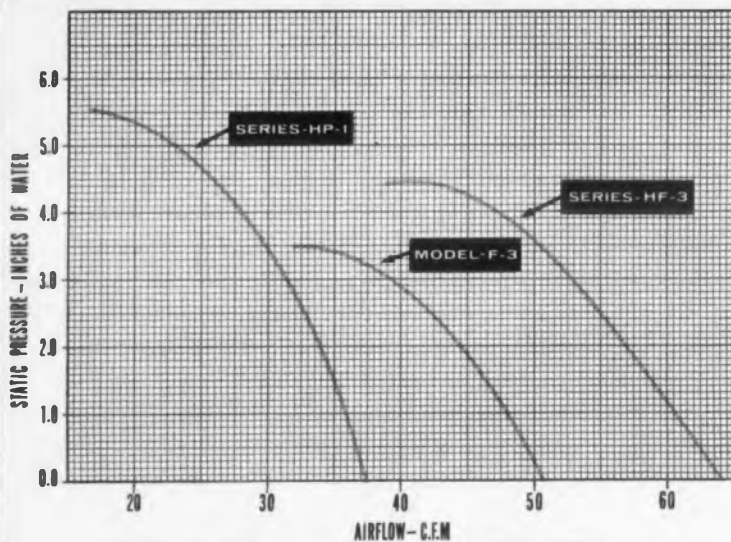
Write for complete information, including your application and requirement data.



THE **DAVEN** CO.  LIVINGSTON, NEW JERSEY

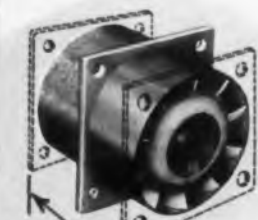
TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

NEW STANDARD 2" BLOWER POWAIR



2,000 HOUR LIFE OUTPERFORMS ALL OTHERS

Available with 28 volt DC-400 Cycle Single Phase or 3 Phase power. The D & B Powair Series offers a pressure, flow, size combination never before obtained. A completely new design approach can be taken to your electronic cooling problems, resulting in weight and size reductions. For additional information on performance and other models write us today.



Flange location anywhere at no additional cost.

CONSTRUCTION VERSATILITY

- Low sound level
- Square or round flange.
- Optional flange location over entire length of housing.
- AC or DC motors.
- Speeds from 8,000 to 22,000 RPM.

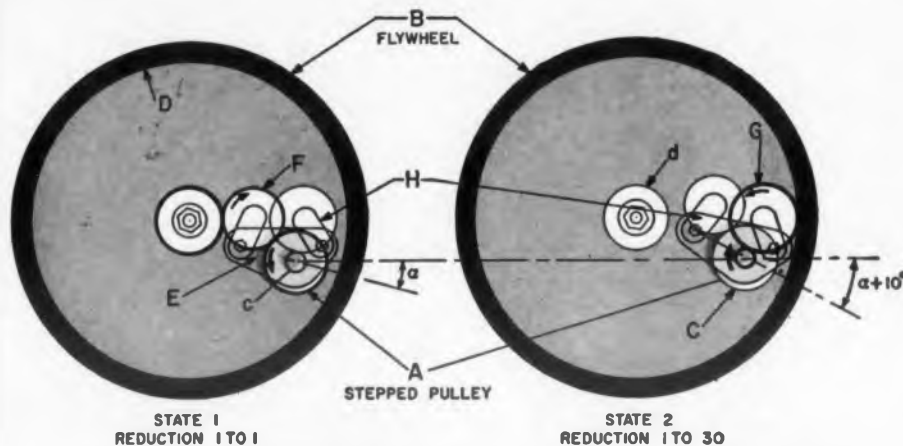
DEAN & BENSON
RESEARCH

Division of Benson Manufacturing Co., Kansas City 1, Mo.

Consult our Sales Engineering Staff for full information.

CIRCLE 105 ON READER-SERVICE CARD

DESIGN DECISIONS



Idle carriage E and stepped pulleys make for easy speed change in this tape deck made by E. M. I. Electronics. In state 1 at left, with a 1:1 speed reduction, drive shaft A rotates counterclockwise. In state 2 at right, with a 30:1 reduction, A rotates clockwise. Output of the double-rimmed flywheel B is always counterclockwise.

Stepped Pulley Gives Simple Speed Change For Tape Decks

WITH THE growing requirements for tape recorders which record at one speed and play back at another, the need becomes apparent for simple means to change speeds over a wide range of speed ratios.

The stepped-pulley approach, used by engineers of E. M. I. Electronics in England, is one of the simplest methods of tackling this problem.

As shown in the diagram, power is applied to one shaft carrying a stepped pulley A. The output drive is taken from another shaft carrying a flywheel B which has two working surfaces—an external surface *d* of its hub and an internal surface *D* of its rim.

An idler carriage E is mounted on a bearing on the input shaft so friction can drag it as far as it is free to move in whichever direction the input shaft is turning.

If the drive shaft is turned counterclockwise, the counterclockwise motion of the idler carriage will draw the idler wheel F (supported on E by swinging arm H) into engagement with the larger diameter *C* of pulley A and the smaller diameter *d* of flywheel B. B will move counterclockwise, and, since *C* and *d* are about equal in size, there will be no change in angular velocity.

If the rotation of the drive shaft is reversed, the carriage E will move clockwise till the alternate idler G engages between the smaller diameter *c* of A and the larger diameter *D* of B. Then, flywheel B will move counterclockwise as before, but with a speed reduction determined by the ratio of *D* to *c*.

In the case shown in the drawing, the ratio is about 30 to 1.

Thus, by reversing the direction of the input shaft, a large speed reduction results, while the output shaft always rotates in the same direction.

A large number of speed ratios can be obtained by suitable selection of diameters and by suitable positioning of components. ■ ■

Ferrite Beads Filter Power Supply

The technique of using a large capacitor across a dc motor to reduce hash is rather well known. Less well known, but equally effective, is the technique used by the German manufacturer Grundig in its 1960 version of the Niki portable tape-recorder.

Niki uses ferrite beads, threaded along the motor input leads. Together with the shunting capacitor, they make for excellent hash rejection.

Dr. A. V. J. Martin, Paris, France.

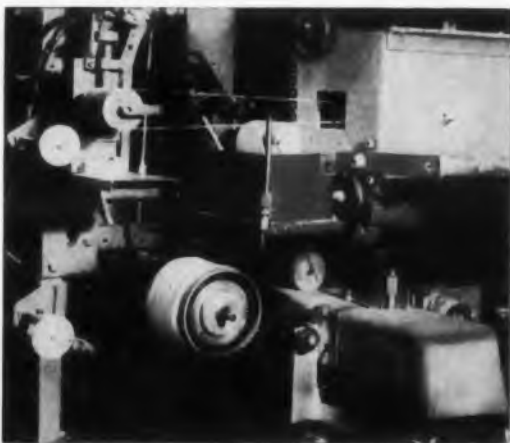
Light Beams Control Diameter Of Vacuum Tube Filaments

By using photoelectric gages to measure as well as control the diameter of vacuum tube filaments, Sylvania Electric Products of Emporium, Pa., realized many advantages. Foremost, of course, is uniformity. Tolerance on the diameter of the coated heater is easily held to within a mil.

Beyond that, Sylvania has been able to run wire for longer periods without interruption. Coating stands can run continuously using the photoelectric monitors and controllers. Previously it was necessary to stop each machine about once every five minutes to check coating thickness with a micrometer.

The light-beam gages, manufactured by Weston Instruments Div. of Daystrom, Inc., use double beams of light to cast shadows of wire on a photo-tube detector. Signals from the detector are amplified, translated, and displayed in mils on a wide-scale dial calibrated from -2 mils to $+2$ mils.

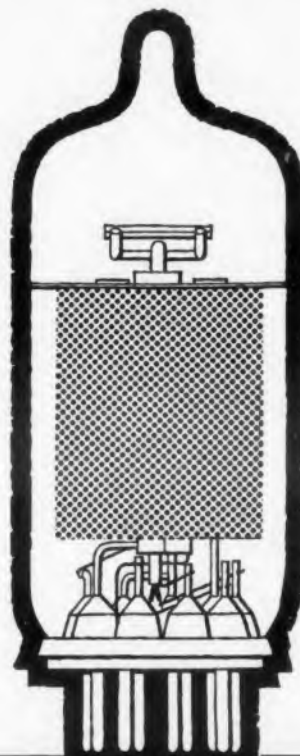
The detector signals also activate solenoids which add thinning water to the aluminum-oxide coating mixture when required. The signals can also be used to control a dye-marker which can be used to mark out-of-tolerance lengths of wire.



Thickness of filament coating is continuously measured and controlled by Weston photoelectric gage in right foreground.

EF86

6267



low
noise
pentode

High gain AF input pentode with exceptionally low noise, low hum and low microphony.

characteristics

V_a	250	V
V_{g3}	0	V
V_{g2}	140	V
I_a	3.0	mA
I_{g2}	0.6	mA
V_{g1}	-2.0	V
g_m	2.0	mA/V
r_a	2.5	M Ω
μ_{g1-g2}	38	

SUPPLIES AVAILABLE FROM

IN THE U.S.A.

International Electronics Corporation,
81 Spring Street, New York 12, N.Y.,
U.S.A. Worth 6-0790

IN CANADA

Rogers Electronic Tubes &
Components, 118 Vanderhoof
Avenue, Toronto 17, Ontario,
Canada. Hudson 5-8621

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BRITAIN'S FIRST CHOICE FOR FIRST EQUIPMENTS



MULLARD OVERSEAS LIMITED, MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND
CIRCLE 106 ON READER-SERVICE CARD

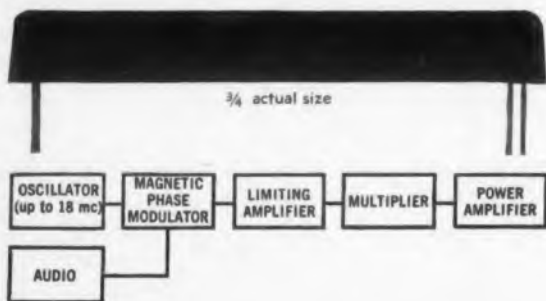
HEVIDP

mpm

magnetic phase modulators for defense application

Transmitter circuitry can be simplified

MPM'S compact design does it—with fewer multiplier stages



Block diagram shows how MPM replaces the reactance tube in a basic transmitter circuit to permit higher frequency operation. De-emphasis network and unnecessary multiplier stages are now eliminated.

The Magnetic Phase Modulator, an innovation in G.E.'s Electrically Variable Delay Line family, now combines small size with increased time delay, linearity and reliability. Improved phase shift capability permits use of oscillators operating to a frequency of 18 mc. By eliminating one or more transmitter multiplier stages, both circuit complexity—and total cost—are greatly reduced. Designed to withstand extreme conditions of humidity, shock and vibration, this magnetically stable device finds ready application in portable and semi-portable military equipment, with particular use in FM communications.

Magnetic Phase Modulators, developed to defense specifications, are available for high and low frequency transmitters, and are suitable for printed wire board mounting, transistorized circuitry and chassis miniaturization. For complete specifications write to: *Defense Industries Programs, Section 176-51.*

GENERAL ELECTRIC



DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT, SYRACUSE, NEW YORK

CIRCLE 107 ON READER-SERVICE CARD

easier NEW PRODUCT selection

Whenever you see the caption, "Price & Availability Data" below a new product item in **ELECTRONIC DESIGN**, you know that it means e-a-s-i-e-r s-c-h-e-d-u-l-i-n-g for you. Easier—because it gives you more information to work with, information that tells you how soon you can get a product, in what quantity, and at what price.

P&A helps you decide which components you can design into a product right now, and which ones to keep in mind for future projects. It reduces delays, and gives you a price picture that provides an insight into your costs and budgeting.

ELECTRONIC DESIGN began its Price & Availability policy in January, 1960. Since then, 54% of our new product releases have contained the Price & Availability Data we automatically request from manufacturers every time we receive a release. Some manufacturers now include this information in all their releases; an increasing number realize its value to you and fill out the forms we send them. Our goal—to give you a comprehensive product picture, and to lighten your work-load whenever we can.

Look to **ELECTRONIC DESIGN** for the most complete new product coverage—complete because all the products of interest to electronic engineers are included . . . complete because all the information you need is concisely supplied.

SERVICES FOR DESIGNERS

Specifications for Sale

260

Full-size standards and specifications in all fields of the aeronautical, electronic, missile and publications areas are now being made available. Government standards MS, AN and AND, in addition to others, are offered.

The price is based on the number of standards contained in the particular classification as of the date of the price list. There is a maintenance charge of \$1 per month, payable one year in advance, plus the costs of the standards received at \$0.10 per page, payable quarterly. Purchase of a complete classification includes a subject divider.

Barden Enterprises, Dept. ED, 13718 Burbank Blvd., Van Nuys, Calif.

Computer For Lease

261

A new high-speed data-processing system for scientific and industrial use will soon be ready for leasing. Called the G-20, the system is said to be capable of 45,000 floating point operations per second, and has a maximum input-output rate of 300,000 digits per second.

The complete line of input-output equipment includes magnetic tape units that read and write at 120,000 digits per second and 600 to 1250 nine-per-minute printers. The central processor is 66 in. wide, 60 in. high and 28 in. deep. Built of solid-state components, 5000 transistors and 30,000 diodes, it has an expandable random access magnetic core memory which may consist of one to eight modules of 4096 words each.

Production of the system is now under way and installation for orders already on hand will begin late this year. It is expected to lease for less than \$10,000 per month.

Bendix Aviation Corp., Computer Div., Dept. ED, 5630 Arbor Vitae St., Los Angeles 45, Calif.

Waveguide Terminations

262

Installation-by-molding of high-power terminations is available to customers furnishing their own waveguide and coaxial assemblies. Utilizing Radamic, a ceramic base microwave power absorber, the process is said to result in high power capacity without the use of artificial cooling.

Typical ratings given are: 6 w per linear in. for 1 x 5 in. waveguide to 30 w per linear in. for 6.66 x 3.41 in. waveguide. Typical price and delivery ranges from \$70 to \$200, depending on size and approximately 72 hours, respectively, for small lots.

Radar Design Corp., Dept. ED, Picard Drive, Syracuse, N.Y.

Precision Rotor Balancing 263

Quantity production balancing of all types of rotors is now made available to customers in the East Coast area. Balancing is done on equipment capable of measuring rotor displacements less than a millionth of an inch at any speed from 1000 to 200,000 rpm. Rotors as small as 0.5 grams and up to 100 lb are handled in the standard vibration mounts. Facilities are also available for special fixturing or experimental design.

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

Lab Calibrates Instruments to Government Standards 264

A commercial standardizing laboratory, devoted to measurements of length, time and mass, is prepared to calibrate precision measuring instruments to the primary standards set up by the National Bureau of Standards.

The laboratory uses more than 50 types of equipment including: an automated electronic interferometer for measuring gage blocks to 1/10 millionth of an inch by absolute measurement; an interference microscope for measuring surfaces to less than 1/10 millionth of an inch; optical universal measuring equipment for evaluating size, roundness and shape of components without removing them from their position, and comparative optical instruments that can measure angularity to 1/10 second of an arc.

The laboratory is the first complete division of a larger laboratory that is expected to provide wide services in the electronics, microwave, optics and infra red areas.


Metrologics, Inc., Dept. ED, 2201 N. Hollywood Way, Burbank, Calif.

Miniaturized Alumina Ceramic Parts Made to Order 265

The company's product development staff will work with the customer in engineering the particular requirements for miniaturized alumina ceramic parts and components. Prototype models can be made to provide testing opportunities before going into full scale production.

With new processing facilities, it is said to be possible to offer improved physical and dielectric strengths and low-loss factors in a material that is easily metallized and vacuum tight. Research and development for the complete fabrication of even the most intricate requirements in high alumina ceramic miniature is underway.

Diamonite Products Manufacturing Co., Dept. ED, Shreve, Ohio.



DU MONT ANNOUNCES TWO RADICALLY NEW CATHODE-RAY TUBES

The first cathode-ray tubes ever available with this combination of important features

—linear post-accelerator—a spiral resistance winding from tube face to deflection plate for more precise, incremental acceleration; pattern adjustment electrode—to minimize pattern distortion; astigmatism electrode—for optimum spot shape adjustment; new deflection plate construction—minimizing plate splash for more accurate displays. These, plus tighter specifications with higher deflection sensitivity—establish new standards for modern equipment design.

TYPICAL OPERATING CHARACTERISTICS

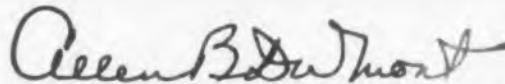
Parameter	Low-Frequency	High-Frequency
Post Accelerator Voltage	5000	> 10,000
Accelerator Voltage	1400	1400
Pattern Adjustment Electrode Voltage	1400	1400
Astigmatism Electrode	1400	1400
Focusing Electrode Voltage	180-580	180-580
Spot Size (single layer screen)	0.024	
D.D. less than	35 V	60 V
D.D. less than	35 V	22 V
Useful Scan		
D.D.	4½	3.94
D.D.	4½	> 1.96

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ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U. S. A.

INTERNATIONAL DIVISION • 818 MADISON AVENUE, NEW YORK 22, N. Y. • CABLES: ALBEEDU, NEW YORK
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WHO MAKES FINE MOTORS THIS SMALL?

Globe Industries makes motors this small to make your design more compact, reliable and salable. If you make miniature instrument packages for space exploration — if you build airborne and ground support equipment — if you want to design smaller typewriters, computers, recorders or other products, look at these 3 motors:

TYPE VS—The smallest, most powerful precision miniature d.c. motor for its size. Only $\frac{3}{16}$ " flat, four VS motors fit in a regular cigarette pack with room to spare. It has the power to lift its own weight to the top of the Empire State Building in 1 minute! Typical continuous torque—.25 oz. in.; typical intermittent torque—.5 oz. ins. We can design gear units, governors and brakes to meet MIL specs also.

TYPE SS — Only $\frac{3}{8}$ " in diameter, Type SS d.c. motors typically produce continuous duty torques of .3 oz. in.; intermittent torques to .6 oz. ins. With the basic Type SS motor you can specify any of 21 planetary gear speed reducers or 28 spur gear speed reducers. Governors and brakes are available also. Designed to meet MIL specs.

TYPE MM — The most widely used precision $\frac{1}{4}$ " d.c. motor in the world, MM motors typically produce .5 oz. in. in continuous duty applications — 1.0 oz. in. intermittent duty. Choose from 101 ratios of planetary gear speed reductions. Brakes, governors and clutches can be included. MIL specs are invited.

For details about these motors request Bulletin VSM. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A.C. & D.C. MOTORS, ACTUATORS,
TIMERS, GYROS, STEPPERS, BLOWERS, MOTORIZED DEVICES

GLOBE

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NEW LITERATURE

Welding Machines 266

This 12-page brochure, No. 8-413, describes 32 multispot and projection resistance welding machines. Data include: end product, type of operation, production rate, welding machine specifications and material handling equipment. The bulletin also describes automatic loading, special welding techniques, and automatic forming operations. Taylor-Winfield Corp., Warren, Ohio.

Crystal Filters 267

These data sheets list specifications and applications for several custom-made crystal filters. They also describe engineering and manufacturing facilities available for producing the filters. Hughes Aircraft Co., Industrial Systems Div., International Airport Station, Los Angeles 45, Calif.

Pressure Instrumentation 268

Pressure instrumentation of the variable reluctance and dc-dc types is shown and described in this four-page brochure. General specifications are given for dual coil transducers, pressure to voltage systems and single coil transducers. Ultradyne, Inc., Box 3308, Albuquerque, N. Mex.

Metal Processing 269

This metal processing bulletin, No. 57-108, eight pages, two colors, gives full information on infrared ovens and components for metal processing applications. The illustrated bulletin shows typical installations. Fostoria Corp., Infrared Div., Dept. 42, Fostoria, Ohio.

Measuring Instruments 270

Catalog No. A-28, four pages, describes and illustrates measurements instruments and Deka-Line components, including new units added since March, 1959. Information includes short-form specifications and prices for the company's complete line. Electro Scientific Industries, Inc., 7524 S.W. Macadam St., Portland 19, Ore.

Ferrite Cores and Memory Planes 271

This 11-page booklet briefly reviews and defines the basic parameters of magnetic circuits, and the special parameters used to express the performance capabilities of magnetic cores in co-current-current or switching applications. It also

gives technical data for the company's ferrite cores and memory circuit components. Radio Corp. of America, Semiconductor and Materials Div., Somerville, N.J.

Size 18 Servomotors 272

The full line of size 18 servomotors is described in this 16-page catalog. Complete with typical unit characteristics, specifications, dimensions and torque-speed curves, the catalog covers components for 115-v, 60-or 400-cps operation. Beckman Instruments Inc., Helipot Div., 2500 Fullerton Road, Fullerton, Calif.

Electronic Buying Guide 273

Containing listings of manufacturers, representatives, products and services related to the electronic industry, Electronic Sources 1960 serves as a buying guide to purchasing agents, buyers and engineers. A roster of the U.S. missile and rocket program, giving the current status of each project, is included. Directories of Industry, Inc., Dept. M-1, 2225 Southwest Drive, Los Angeles 43, Calif.

Winding Principles Brochure 274

This edition of the handbook, "Principles and Practices of Modern Winding," describes various winding techniques, and winding machines and accessories. The illustrated booklet also contains a checklist with which individual winding problems may be analyzed. Hobbs Manufacturing Co., 26 Salisbury St., Worcester 5, Mass.

Storage Monitor 275

This specification sheet describes a storage monitor that may be used in TV tape editing, closed-circuit TV investigation and stop-motion examination. Several instruments together may be used to capture a sequence of frames for specific frame selection. Hughes Aircraft Co., Industrial Systems Div., Los Angeles International Airport Station, Los Angeles 45, Calif.

Capacitors 276

Bulletin No. 2C describes stable low temperature coefficient capacitors designed to meet critical requirements. The capacitors operate from -55 to 125 C with no voltage derating and will maintain their low dissipation factor, dielectric absorption and high insulation resistance. Component Research Co., Inc., 3019 S. Orange Drive, Los Angeles 16, Calif.

Look at the maximum,
low over-all receiver
noise figures
they make possible:

8.0 db in "L" band . . . 1N25B, 1N25RB
6.0 db in "S" band . . . 1N21F, 1N21RF
7.0 db in "X" band . . . 1N23F, 1N23RF
7.5 db in "Ku" band . . . 1N78D, 1N78RD
9.5 db in "K" band . . . 1N26C, 1N26RC
9.0 db in "Ka" band . . . 1N53C, 1N53RC

ELECTRICAL CHARACTERISTICS (25°C)

SYLVANIA DIODE	ONF (Max. db for $N_{1f} = 1.5$ db)	I_c (Max. db)	N_r (Max. ratio)
1N25B, 1N25RB	8.0	5.5	1.5
1N21F, 1N21RF	6.0	—	—
1N23F, 1N23RF	7.0	—	—
1N78D, 1N78RD	7.5	5.7	1.3
1N26C, 1N26RC	9.5	7.5	1.5
1N53C, 1N53RC	9.0	6.5	2.0



Cat's-paw
quiet...

Sylvania Microwave Low-noise Mixer Diodes

for radar, relay, and
communications systems

Sylvania Low-Noise Diodes are manufactured to conform to Mil specs. All are immediately available. Design around Sylvania Microwave Diodes. You'll shout about the low-noise figures of your equipment. Contact your local Sylvania Field Office for sales information. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. "185" Woburn, Massachusetts.



SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**





NOW AVAILABLE
Rugged New Eimac X778
Traveling Wave Tube ...
One Watt Output, 55-60 db Gain

Purchase orders are now being accepted on Eimac's pioneering new high gain traveling wave tube, the X778.

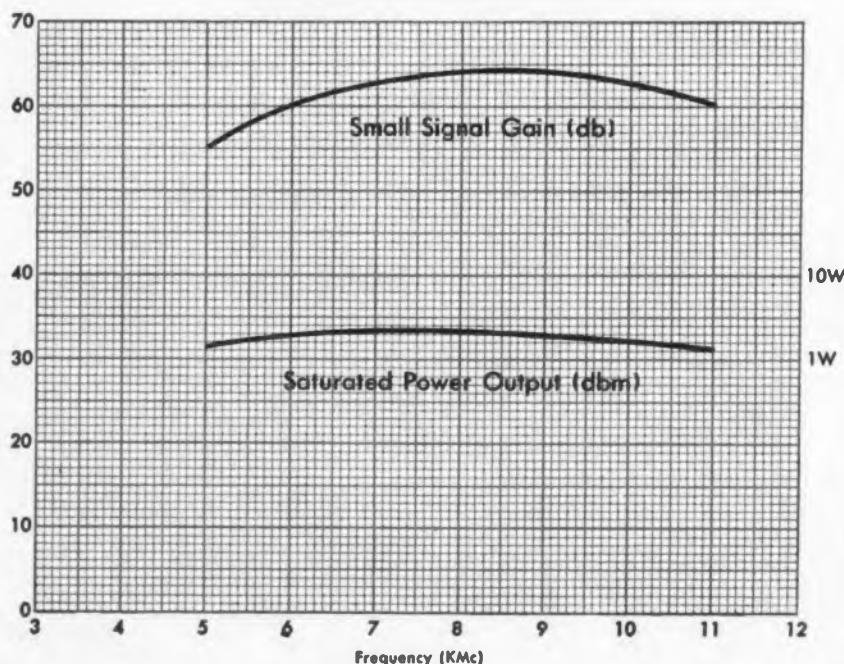
Unique features of this advanced one watt CW traveling wave tube include its exceptionally wide frequency range—5.0 to 11.0 KMc., small signal power gain of 55-60 db, and light weight permanent magnet focusing.

Like all other Eimac ceramic-metal tubes, this TWT "can take it." The X778 was especially designed to operate under severe environmental conditions of shock, vibration, temperature variation and high altitude. Breakage is a thing of the past, resulting in greatly reduced tube replacement costs.

The Eimac X778 finds wide usage in electronic counter-measures, radar augmentors, data links—in any application where more than one tube would normally be required to cover the C and X bands. This means significant cost reduction and increased system reliability.

Contact R & D Marketing Department for additional details and information on how this tube type may be modified for your requirements.

General Performance Characteristics
Eimac X778 Traveling Wave Tube



EITEL-McCULLOUGH, INC. • San Carlos, California

CIRCLE 113 ON READER-SERVICE CARD

NEW LITERATURE

Connector Slide Film 277

This technical sound-slide film describes the complete line of advanced miniature electrical connectors, how they operate and how they are installed. The film also covers rack and panel connector performance, high temperature inserts, snap-in contacts with crimp-type terminations and tools for crimping, inserting and removing contacts. Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Delay Lines 278

This two-page data sheet describes five bulletins available from the company. The bulletins cover: Q-Lines; High-Impedance Delay Lines with Magnetic Core; MiniLines-Miniaturized Delay Lines; Audio Delay Lines and Delay-Line Flats. Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N.Y.

Ceramic Magnets 279

Index I, V and VI are described in two catalogs. Catalog No. 18A describes the properties, uses and characteristics of Index I and V. It also contains a list of stock magnets and a derating curve for low temperature operation. Bulletin No. 353 gives data on Index VI. Magnetic, material and temperature characteristics are covered. Indiana General Corp., Indiana Steel Products Div., Valparaiso, Ind.

Transformer Winders 280

This one-page data sheet illustrates and describes two medium range multiple transformer winders, model 650-AM, which winds 7 to 31 AWG. and model 500-AM, which winds 10 to 31 AWG. Complete specifications are given for both models. George Stevens Manufacturing Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill.

Microwave Catalog 281

This 26-page catalog covers the company's line of microwave products, including microwave switches, coaxial and waveguide; power dividers, directional couplers and other components; and multiplex antenna systems. Also included is a data section devoted to a series of practical charts and graphs. Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif.

Motors 282

Bulletin No. MU-244, four pages, describes polyphase squirrel-cage motors 1 hp and larger, with NEMA "C" faceplates for close-coupled centrifugal pump applications. The bulletin contains photographs and outline drawings. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 33, Mo.

Ultrasonic Cleaning 283

Five bulletins describing ultrasonic cleaning and rust-proofing compounds appear in this seven-page folder. The bulletins cover ultrasonic liquid cleaning concentrate 660-J, rust preventative 606, 906-S and A-974. Applications of rust preventatives are also covered. Rust-Lick Inc., 755 Boylston St., Boston 16, Mass.

Technical News 284

"Technews" is a new periodical that will emphasize articles illustrating electron tubes and semiconductor applications. The company plans to publish the technical booklet at regular intervals. Volume I, No. 1 is now available. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N.Y.

Pressure Measurement 285

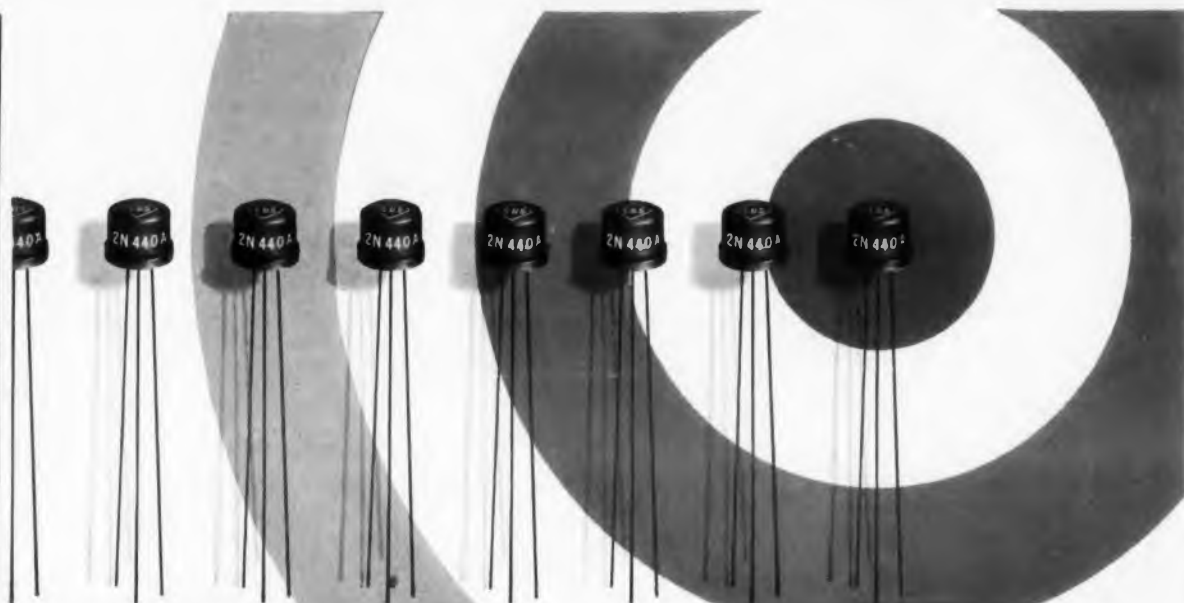
The Electromanometer system for precision pressure measurement is described in this four-page brochure. A pressure transducer and a servo-amplifier comprise the system, which is available in standard, high-speed and miniature models. Photographs, schematics and specifications explain its operation. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Phase Meter 286

Model 200 AB phase meter is described in this one-page data sheet. In addition to complete specifications, information is given on applications and principle of operation. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N.Y.

Plastic and Fibre Kit

Specimens of plastic and fibre materials, plus graphic and descriptive data, are included in this kit. All samples are selected in contrasting categories to afford a complete, detailed study of each material and its manufacturing potentialities. Packed with the samples is a printed supplement describing other materials in various applications. Write on company letterhead to The Iten Fibre Co., Dept. ED, Iten Ave., Ashtabula, Ohio.



TARGET... better than 99.99% switching transistor survival

CBS NPN germanium switching transistors are being delivered to a military project specification with an objective of 99.99% survival in 1000 hours. This means that only one transistor in 10,000 can fail due to parameter changes . . . and catastrophic failure rate is even lower.

CHECK THESE SPECIAL RELIABILITY CONTROLS

100% PRODUCTION

- Every crystal identified throughout production
- Die thickness maintained within ± 0.00005 inch
- Contamination eliminated by "dry-box" assembly
- Microscopic inspection of all critical operations
- Aging at 100°C for 200 hours
- Temperature cycling from -65° to 85°C
- Detergent bomb testing at 100 psi
- Radflo testing to 10⁻¹² standard cc/sec

RELIABILITY

- Voltage-biased, 55°C on 1000 hour life
- Storage, 85°C on 1000 hour life
- Intermittent operation, 150 mw for 1000 hour life
- Samplings 100 times larger than MIL-T-19500A
- Product identified with crystal for field survival analysis

ENVIRONMENTAL TESTING

- Shock, 500 G for 1 millisecond
- Vibration, 20 G for 20,000 cps for 10 sec
- Fatigue of leads, 16 oz. pull, three 90° arcs

YOUR INQUIRIES INVITED

Inquiries regarding *your* special reliability requirements for NPN germanium switching transistors are invited. Please call direct . . . or your local sales office.



semiconductors

CBS ELECTRONICS, Semiconductor Operations • A Division of Columbia Broadcasting System, Inc.

Sales Offices: Lowell, Mass., 900 Chelmsford St., Glenview 4-0446 • Newark, N.J., 281 Johnson Ave., TAlbert 4-2450 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 8-9081 • Atlanta, Ga., Cary Chapman & Co., 672 Whitehall St., JAckson 4-7388 • Minneapolis, Minn., The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • Toronto, Ont., Canadian General Electric Co., Ltd., LEnox 4-6311

CIRCLE 114 ON READER-SERVICE CARD

BUILD ON . . .

Eastern

CLIMATE CONTROL EXPERIENCE:

PRESSURIZATION and DEHYDRATION

Look to Eastern Industries for the advanced pressurization/dehydration packs required by the avionic and ground support systems of tomorrow. Whenever a precisely controlled flow of dehydrated air is required, Eastern design and production experience team up to create compact, lightweight, reliable subsystems. Characteristics and performance range of existing units:

Characteristics and performance range of existing units:

capacities: up to 1.5 FT³/Min. free air
operating temperatures: from -87°F to +150°F, 100% R.H.

operating altitudes: from 10,000 ft. to 50,000 ft.

weights: from 8 lbs. to 115 lbs. complete

Smaller packs feature replaceable chemical dehydrator elements—the larger subsystems are available with automatic reactivating dehydrators.

Let us quote on your next pressurization/dehydration requirement. In the meantime, write for full information on the entire line of Eastern aviation products. Send for Bulletin 360.



a wide range of units for specialized air control

**EASTERN
INDUSTRIES
INCORPORATED**
100 SKIFF STREET
HAMDEN 14, CONN.



NEW LITERATURE

Pilot Lights and Lamps

287

This 24-page digest is designed to aid in the selection of pilot lights and lamps. Categories described include: subminiature indicator lights; pilot lights with built-in resistors for neon lamps; press-to-test and press-to-switch indicator assemblies, and open-type assemblies. Charts and circuit diagrams are given for some groups. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y.

Recorder-Reproducer

288

Extended capabilities of the CM-100 video band recorder-reproducer are detailed in this 12-page, four-color brochure. Illustrated curves show the unit's increase in bandwidth at lower speeds; for example, frequency response up to 1.0 mc at 120 ips and 500 kc at 60 ips. Minnesota Mining & Manufacturing Co., Mincom Div., 2049 S. Barrington Ave., Los Angeles 25, Calif.

Time Interval Measurements

289

This 14-page data file, No. 112, describes methods of making precise time measurements with digital electronic apparatus. Examples include measuring the period of a signal, measuring pulse interval, measuring phase difference, timing relay action and determining velocity. Techniques for coping with noise and improving accuracy are also described. Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif.

Remote Area Monitoring

290

Bulletin No. 3105-9 outlines and describes applications and performance of the basic components comprising various remote area monitoring systems. Auxiliary units such as sensing elements, remote alarms and others are also covered. The eight-page bulletin is illustrated. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Resistors and Rheostats

291

Resistors, rheostats and potentiometers are described in this eight-page bulletin, No. 280. All electrical ratings are given in table form. Outline drawings are included for various rheostat models and they illustrate standard resistor terminals and mounting brackets. Hardwick, Hindle Inc., Newark 5, N.J.

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choice
FOR
critical
applications*



ADJUSTABLE PRECISION POLYSTYRENE CAPACITORS



**.01% accuracy
hermetically sealed**

SOUTHERN ELECTRONICS hermetically sealed precision adjustable capacitors are finding many applications in analog computers, network tuning circuits, differential analyzers and similar electronic circuitry that requires the utmost in accuracy and reliability.

SEC has pioneered in the design and manufacture of hermetically sealed adjustable capacitors, and this experience has resulted in a .01% accuracy standard, and a degree of in-circuit-reliability not previously available at any price. SEC adjustable capacitors incorporate features proven to be years ahead of any comparable product now available.

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Available from .01 mfd. to 10 mfd.

Accuracy: .01%

Long Term Stability: 0.03%

Temperature Coefficient: -100 PPM per °C

Temperature Range: -40°F to +140°F

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Corporation

150 WEST CYPRESS AVENUE
RURBANK, CALIFORNIA

CIRCLE 130 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960



EASY-TO-READ panel meter scale is nearly 4 inches long.

BIG LOOK panel meters

**NOW INCLUDE
NEW
4½-INCH
DESIGN**

Designed with modern BIG LOOK styling, this new General Electric 4½-inch panel meter features a snap-on, snap-off cover for easy access to the scale face.

Improved readability, even at extreme distances, results from its expanded scale length . . . ideal for multi-scale applications on portable test instruments and panelboards. DC models of this new meter feature the same self-shielded mechanism available on 2½- and 3½-inch designs.

For the complete AC and DC BIG LOOK panel meter story just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-10, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 112 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 25, 1960

Aircraft Instruments

292

Bulletin No. 05-100-B, 48 pages, describes a complete line of aviation instruments and components. The illustrated manual, using dimensional drawings and wiring diagrams, gives specifications, mounting data and installation details of ammeters, voltmeters, volt-ammeters, shunts, current transformers, resistance and thermocouple thermometers, resistance bulbs, ILS cross-pointer, trim-tab, frequency and course indicators, and luminescent materials for dials and pointers of instruments. Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N.J.

Solenoids

293

This 12-page booklet, No. GEA-6215B, discusses the complete line of solenoids, including ac and dc forms, which are available in nine different sizes providing 24 basic ratings. The bulletin describes the uses of solenoids, their flexibility, and how to select them. Complete ordering data are given for both push and pull type solenoids with force and current curves shown. General Electric Co., Schenectady 5, N.Y.

Socket Head Screws

294

Complete specifications, dimensions and data on the 1960 socket head Cap Screw series appear in this bulletin. Also contained are full particulars as to when the change will be made to the new series and suggestions for users about the change. Set Screw & Manufacturing Co., Bartlett, Ill.

Reliability of Plated-Through Holes

The reliability of plated-through holes employed in printed wiring boards is the subject of this 59-page report. It contains a number of independent studies made by major suppliers of military electronics, as well as findings of the company's test laboratories. Included in the report are listings of large military programs and their prime contractors now using and planning to use plated-through holes. About 40 charts and illustrations are shown to illustrate the results of comparison and laboratory studies. Copies of "Plated-Thru Holes for Thru Connections on Printed Wiring Boards" are available for \$1 from Photocircuits Corp., Dept. ED, 31 Sea Cliff Ave., Glen Cove, Long Island, N.Y.

Plastic Laminates

332

Basic considerations for specifying laminated plastics and vulcanized fibers are discussed in this eight-page article reprint. Taylor Fibre Co., Norristown, Pa.



plan ahead!

To be *really* sure of getting your pot deliveries on time, you *could* assemble your own! But just when you're counting on sub-contractors to deliver the necessary parts — you *might* find they're tied-up on someone *else's* job! So if you *must* be sure, lay in a good supply of raw materials in quantity lots — metals, glass, wire, plastics, bearings — the works!

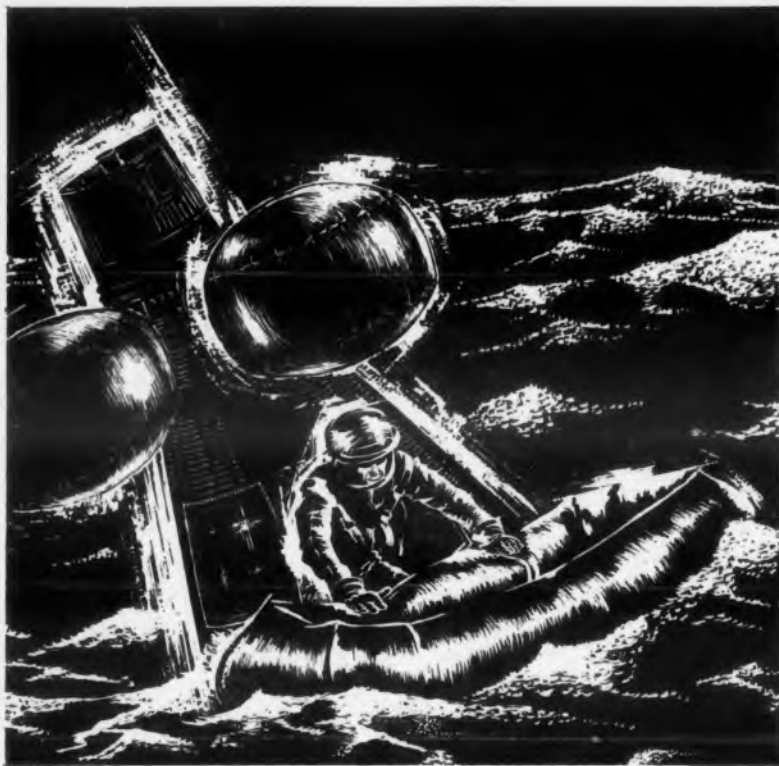
But before you load up the living-room with bar stock, check with Ace. You'll find, to your relief, that Ace abundantly warehouses all their own raw materials — just for the express purpose of being able to *make* everything they need — when it's needed, for controlled delivery! So if *delivery* of precision pots is a prime consideration, talk to the company that does its own sub-assembly manufacture — see your Acerep!



From raw materials to completed pot — within the plant — our servo-mount A.I.A. size ⅞" ACEPOT®. As with all the others, from ½" to 6".

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

Acepot® Aceirim® Aceset® Aceohm® *Reg. Appl. for
CIRCLE 132 ON READER-SERVICE CARD



space-age assignment: TOTAL RELIABILITY

The incredible complex of electronic instruments and equipment required to assure the safe return of early voyagers in space presents a great challenge to the electronics industry.

The Gudeman Company maintains a comprehensive components research and development program, dedicated to an ultimate goal of *total reliability*. The success of this and similar programs of progressive manufacturers throughout the nation can assure continuing progress for America's conquest of space.



A new Gudeman Development! The new Gudeman MR463 MEGA-REL capacitors (25% smaller than MIL-C-14157A & MIL-C-26244 (USAF) requirements, yet equivalent electrically and environmentally) reflect the creative engineering and constant design improvements that mark all Gudeman products.

CAPACITORS BY GUDEMAN

THE GUDEMAN COMPANY
MAIN OFFICE—340 W. Huron St., Chicago 10, Ill.
MFG. BRANCHES: Terryville, Conn.; Visalia, Calif.
CIRCLE 115 ON READER-SERVICE CARD

NEW LITERATURE

Alloys for Semiconductors 295

The physical properties of alloys used in the manufacture of semiconductor devices are described in these data sheets. The alloys covered are aluminum-silicon, lead-silver and indium-gallium. Each sheet contains a phase diagram of one of the alloys, a description of its phase relationship and crystal structure, properties and fabrication possibilities. Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.

Rectifiers 296

This literature describes the series 80 instrument rectifiers. The units are designed for use with dc meters of 20 to 200 μ a full-scale current. They are available in five standard types. Conant Laboratories, Box 3997 Bethany Station, Lincoln 2, Nebr.

Variable Voltage Adjustor 297

This four-page catalog contains complete specifications of manual voltage adjustors in capacities from 150 w to 10 kva in various primary and secondary voltage ranges. It also covers in detail the subject of voltage variations and fluctuations. Acme Electric Corp., Cuba, N.Y.

Laboratory Equipment 298

This 16-page catalog lists various items of laboratory equipment including: high vacuum pumps; laboratory clamps; utility oven; low temperature systems; ultrasonic equipment; tensiometers, and storage bins, steel cabinets and plastic stacking shelves. Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

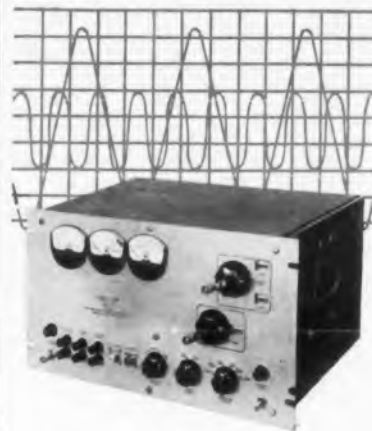
Gray-Binary Translator 299

Model TR-702 transistorized gray-binary translator is described in this technical bulletin, No. 122, two pages. In addition to a logic diagram, outline drawings and complete specifications are given. Data appear for a companion power supply, model No. PS-701. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Rotary Solenoids 314

This illustrated data sheet, two pages, covers torque, speed of stroke, type of stroke, power take-off and sizes of the company's rotary sole-

WIDE RANGE POWER OSCILLATOR



a reliable
signal source
for microwave
measurement

The AIL Type 124C Power Oscillator is applicable as a signal source over the wide range of 200 to 2500 Mc. Its range, power and stability make it an essential element of microwave component test systems. It is often used in measurements relating to antenna design. Facilities for both internal and external modulation are provided. Relative power output is indicated directly on panel meter.

Detailed literature is available on request.



CIRCLE 116 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 25, 1960



NOT AFFECTED by magnetic fields.

BIG LOOK panel meters

SELF-SHIELDED DC MECHANISMS FOR GREATER RELIABILITY

SELF-SHIELDED DC MECHANISM is one of the big built-in features you get with General Electric d-c BIG LOOK panel meters. Self-shielding eliminates special calibration problems . . . allows more flexibility in locating meters on panelboards through minimizing interaction.

Here's why: Unlike many other designs, the BIG LOOK's core is around the magnet . . . where it belongs . . . and shields the entire d-c mechanism. This means that interaction is eliminated, even when meters are cluster-mounted. Also, stray magnetic effect is minimized!

For the complete AC and DC BIG LOOK panel meter story, just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-02, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL  ELECTRIC

CIRCLE 117 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 25, 1960

noids. The line is available in eight sizes, with operating voltages from 3 to 300 v dc. Ledex, Inc., 123 Webster St., Dayton 2, Ohio.

Piezoelectricity 300

This five-page booklet is entitled "Elements of Piezoelectricity." It covers the fundamental properties of piezoelectric transducers, basic modes of operation and evaluation measurements. The booklet illustrates electrical field and mechanical strain of various shaped ceramics, such as bars or plates, plates used in shear, discs and cylinders. U.S. Sonics Corp., 625 McGrath Highway, Somerville, Mass.

Mercury Switches 301

This technical catalog, 21 pages, gives complete specifications on 21 special-purpose mercury switches. The illustrated catalog shows the switches as well as a variety of terminals and mounting clips designed for use with them. Gordos Corp., 250 Glenwood Ave., Bloomfield, N.J.

Microwave Components 302

This 16-page catalog lists a wide range of coaxial and waveguide attenuators and terminations. The terminations are available in medium power as well as low power models. Also described are reference mismatches, power dividers, stub tuners and directional couplers. Mechanical and electrical properties of Radite 75, a microwave absorber, are included. Radar Design Corp., Pickard Drive, Box 38, Syracuse 11, N.Y.

Tantalum Capacitors 303

Data on tantalum capacitors for high temperature applications are given in this eight-page bulletin, No. 6.111-2. Information includes expanded and complete detailed specifications, physical dimensions, ratings, curves, performance characteristics and application suggestions. Fansteel metallurgical Corp., Dept. EI-2, N. Chicago, Ill.

Instruments and Power Supplies 304

The ST series of power supplies with replaceable plug-in modules and various other power supplies for high current and high voltage applications are described in this short form catalog, two pages. Also described are the UHR standard bridge, a megatrometer and resistor standards. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N.J.

CAN YOU FIND THE SPLICES
IN THESE RUBBER PARTS?



8924-SR

PRECISION SPLICING BY **STALWART** ASSURES HIGH-STRENGTH BOND PLUS UNIFORM APPEARANCE

Don't worry if you can't see these splices! Stalwart's exclusive "Hi-Tensile Bonding" technique makes them almost imperceptible . . . assures fail-safe performance plus a smooth, neat joint! Using the most advanced automatic splicing equipment, Stalwart extrudes, cuts and splices seals and gaskets from all types of natural and synthetic compounds. Typical applications include critical components for aircraft/missile and ground support equipment as well as bumpers, guards, range door gaskets and similar parts. Produced to meet customer specifications, extruded parts are spliced with cross-sectional diameters ranging from 1/16" to 2 1/2". Write today for complete information.

Send for your copy of the new
Stalwart Catalog today!



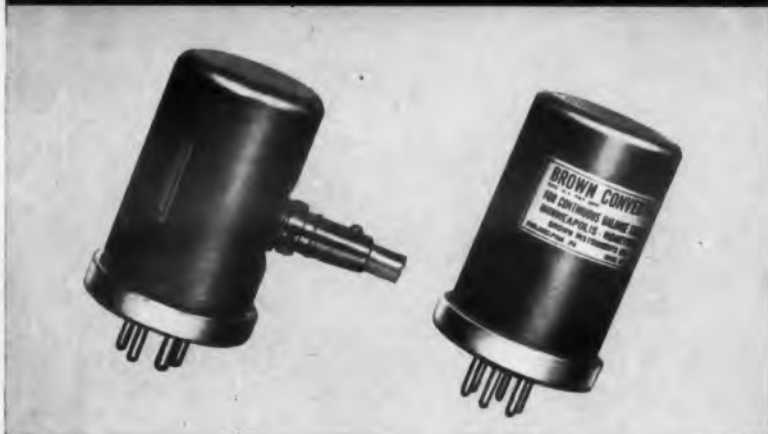
THE WORLD'S LARGEST PRODUCER OF
SILICONE CUSTOM RUBBER PARTS
STALWART
RUBBER COMPANY

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Bedford, Ohio
Stalwart subsidiaries are:
Jesper Rubber Company
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Inc.

CIRCLE 118 ON READER-SERVICE CARD

HONEYWELL CONVERTERS

put stable performance
in your measuring and servo loops



These synchronously-driven choppers handle d-c signals as small as 10^{-8} volt. SPDT switching action. Sensitive, stable performance. Ideal for computers, servomechanisms, balancing circuits. Available with special features such as fungus proofing, grounded housing, mica-filled base, various contact percentages. Weight: 10 ounces. Prices from \$36.

Driving coils in 60-50, 40 and 25-cycle converters are energized by 6.3 volt a-c; 400-cycle converters use 18 volts. Other specifications on chart below.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

ELECTRICAL CHARACTERISTICS					
Part No.	354210-2	354210-3	354210-1	354210-4	355081
Modulation Frequency	20-30 cycles	40-45 cycles	50-65 cycles	50-65 cycles	360-440 cycles
Switching Action (SPDT)	(Make-before-break) Each contact closed 55% of each cycle ($\pm 2\%$) Other actions, as specified		(Break-before-make) Each contact closed 47% of each cycle	(Break-before-make) Each contact closed 57% of each cycle ($\pm 7\%$)	Each contact closed 57% of each cycle ($\pm 7\%$)
Driving Coil Requirements	6.3 v, 60 ma at rated frequency			18 v, 98 ma at rated frequency	
Contact Rating	100 microwatts at 6 v max. 1.0 ma max.				
Electrostatic Stray Pickup	2×10^{-10} volts per ohm of input circuit impedance				
Electromagnetic Stray Pickup	Less than 2×10^{-6} volts, constant to within 2×10^{-7}			2×10^{-5} volts constant to 2×10^{-6}	
Phase Shift	Output voltage lags driving phase by $17^\circ \pm 5^\circ$			Lags driving phase by 45° to 50°	
Symmetry	Within 2%			Within 7%	
Shielding	Frame and coil shield, grounded through pin No. 2			Shell and coil shield, grounded through pin No. 2	
Load Characteristics	Resistive or Inductive				
Vibration Resistance	Output voltage varies less than 2% with rates of vibration from 0 to 10g				
Weight	10 oz.			8.5 oz.	
Special Features	Specify 354210-10 for anti-fungus treated, vibration resistant wiring, hermetically sealed case. Also available with side plug for exciter coil connection.			All 400-cycle converters are treated as shown at left	

Honeywell

75th
PIONEERING THE FUTURE
YEAR



First in Control
SINCE 1885

CIRCLE 119 ON READER-SERVICE CARD

NEW LITERATURE

Switch-Circuit Assemblies 305

This four-page data sheet describes the 1PB700 series of switch-circuit assemblies for use in pulse and digital systems. Included are photographs, schematic diagram of circuit, graphs of typical output pulses, mounting dimensions, detailed application information and prices. Micro Switch, Freeport, Ill.

Ferrite Devices 306

This four-page catalog on ferrite devices lists electrical characteristics and over-all length for more than 60 models of coaxial isolators, broadband and special-purpose waveguide isolators, compact "Tee" circulators, and phase-shift circulators. Sylvania Electric Products Inc., Central Advertising Distribution Dept., 1100 Main St., Buffalo, N.Y.

Miniature Electric-Eyes 307

Bulletin No. 590, entitled "Miniaturized Electric-Eyes—Why and How," contains complete descriptions of typical installations. Miniature electric-eyes are said to have solved a wide range of problems of inspecting, sorting, counting, web control, and level control from high speed automatic machines to final product monitoring. Photomation, Inc., 96 S. Washington Ave., Bergenfield, N.J.

Test and Measurement Instruments 308

Included in this 12-page catalog are data on: insulation testers; ohmmeters; earth resistance testers; dielectric test sets; cable fault finding equipment; transformer turn ratio test set; motor testers; corona test equipment; resonant reed frequency meters; tachometers, and other instruments. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

Magnetic Components 309

Among the magnetic components described in this illustrated 15-page catalog are: unit rectifiers, filter reactors, charging reactors, modulation transformers and reactors, and various transformers. A section of the catalog is devoted to describing the proper procedure for specifying magnetic components. Moloney Electric Co., St. Louis 20, Mo.



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Just pick up the 'phone and tell him how many and what type you need for your special project or pre-production requirements. He will deliver from local stock—and he also offers these extra advantages:

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Remember when you want fast delivery, reliable service, always check first with your local RCA Semiconductor Distributor. For the name and address of your nearest RCA Semiconductor Distributor, write RCA, Distributor Products Sales, Harrison, N. J.

For details on RCA Thyristors
see back cover!



RADIO CORPORATION
OF AMERICA

Semiconductor Products-Distributor Sales
Harrison, N. J.



COMPLETE PROTECTION of internal mechanism assured.

BIG LOOK panel meters

SEAL Reliability in — LOCK Contaminants Out

Only General Electric offers sealed cases as standard equipment on commercial 2½- and 3½-inch panel meters. Best of all, the sealing of the cases lengthens BIG LOOK operating life by protecting internal mechanisms against contaminants such as fibers, dirt, dust and chemicals.

Sealed cases on 2½- and 3½-inch BIG LOOK meters are made possible by a tough gasket and zero-set seal.

For the complete AC-DC BIG LOOK panel meter story, just contact your nearby General Electric Apparatus Sales Office or distributor, or write for Bulletin GEA-7034 direct to General Electric Company, Section 597-03, Schenectady 5, N. Y.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 120 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 25, 1960

Resistors and Coil Forms 310

A complete line of 1/2-, 1- and 2-w fixed composition resistors is described in this four-page catalog. Descriptive data include dimensions, a derating curve, color code and a table of standard resistance values and tolerances. Other sections of the catalog deal with phenolic coil forms and special resistors in nonstandard shapes and material combinations. Speer Carbon Co., St. Mary's, Pa.

Fluorinated Chemical Compounds 311

"Benzotrifluoride and Its Ortho-, Meta-, and Parachloro Isomers" is the title of bulletin No. 12-A, which presents physical and chemical properties of four fluorinated chemical compounds and their suggested applications, including uses as insulating media and transformer fluids. In addition to properties, the 12-page bulletin gives 13 typical chemical reactions for the compounds. Booker Chemical Corp., Box 344, Niagara Falls, N.Y.

Shaft Position Encoders 312

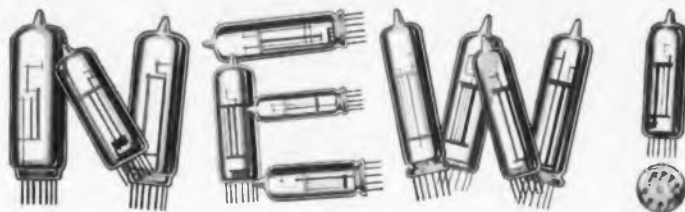
Entitled "Shaft Position Digital Encoders with Magnetic Readout," this 12-page brochure gives data for the company's 13-bit, 8-bit and incremental encoders. It describes operating principle, transistor circuitry, and includes a conversion table for binary code to decimal or gray code conversion. Electro-Mechanical Research, Inc., ASCOP Div., Box 44, Princeton, N.J.

Printed Circuits 313

Entitled "Value Analysis of Printed Circuits," this 16-page illustrated booklet outlines the several functions that may be performed by the printed wiring board and describes the types of circuitry best adapted to this method of packaging as well as those where it shows up less favorably. Constructions and design details are discussed from a value engineering viewpoint. Suggestions are offered for reducing cost without affecting function or reliability. Arthur Ansley Manufacturing Co., New Hope, Pa.

Amplifiers 328

Series USA-4 and K2 operational amplifiers are described in this short-form data sheet, one page. The data sheet contains brief technical data photographs of the units and price information. George A. Philbrick Researches, Inc., 127 Clarendon St., Boston 16, Mass.



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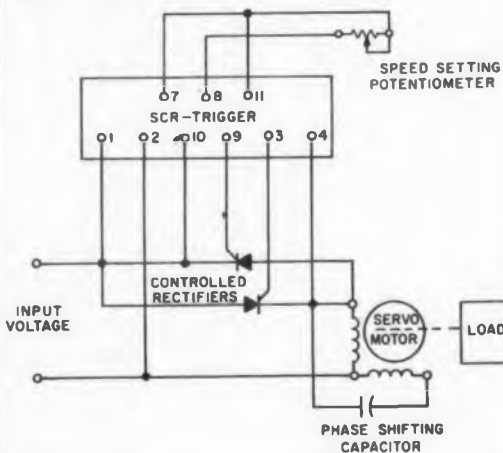
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IDEAS FOR DESIGN

Silicon-Controlled Rectifiers Vary Servo Motor Speed, Reduce Input Power

Usually a two-phase servo motor has its reference winding permanently connected to the line through a phase shifting capacitor, and its control winding driven by a control amplifier. In this way, the reference supply is constantly delivering power to its winding. This causes the motor to heat and makes it difficult to control the motor at low speed.

A circuit which eliminates the heating problem and allows stable operation at very low speeds is shown. The silicon-controlled rectifiers are in series with the motor and both the control and reference windings are controlled by them. When the firing angle of the rectifiers is retarded by the speed setting potentiometer acting on the trigger, the total motor input is reduced and the motor slows down.



The two silicon controlled rectifiers control the speed of the two-phase servo motor by controlling the power input. When the motor is rotating, input power is zero.

Baruch Berman, Chief Engineer, Avion, Div. ACF, Paramus, N. J.

Common-Emitter Circuit Has Emitter-Follower Characteristics

The emitter-follower circuit is most often used when a transistor amplifier with low output impedance is needed. However, a simple common-emitter circuit with a large amount of negative feedback can be used instead. The circuit shown has an output resistance of well under 1 K and a voltage gain of about 10, (depending upon the resistance of the external load).

In one application, this stage was used to drive the input transformer of a power amplifier,

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INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

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ELECTRONIC DESIGN • May 25, 1960

a case where its low output resistance was necessary. The total equivalent load resistance was 5 K and the total equivalent source resistance was approximately equal to the 2.2 K isolating resistor. The output resistance was measured as 625 ohms and the voltage gain as measured from the input capacitor to the collector, was 14.

In a second application the total load was 875 ohms and the source resistance was 5.5 K. The output resistance was 500 ohms with a voltage gain of 7.

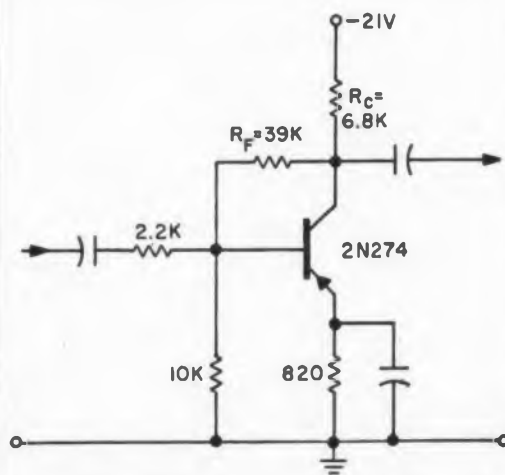
The isolating resistor in series with the base is necessary only when the driving stage has a low output resistance; for example, where a feedback gain-control pot is also driven from that stage.

The output resistance, R_{out} , and voltage gain, VG, may be expressed as follows:

$$R_{out} = \frac{1}{\frac{1}{R_c} + \frac{R_g + r_{bb'} + 1/g_{b'e} + g_m R_g / g_{b'e}}{R_f R_g + (R_f + R_g)(r_{bb'} + 1/g_{b'e})}}$$

$$VG = \left[\frac{1 + \frac{g_{b'e} R_F}{r_{bb'} g_{b'e} + 1} + \frac{R_F}{R_g} \left(\frac{1}{R_F} + \frac{1}{R_L} \right)}{1 + \frac{g_m}{r_{bb'} g_{b'e} + 1} - \frac{1}{R_F}} \right]$$

The symbols are those of the hybrid $-\pi$ equivalent circuit defined in the RCA data sheet for the 2N274. The equations apply to the low-frequency case. R_c is the collector resistor, R_g is the total equivalent source resistance composed of the isolating resistor in series with the previous-stage output resistance, plus the parallel resistance of the external base-to-ground resistor. R_f is the feedback resistor and R_L is the parallel combination of the collector and load resistances.



A common-emitter amplifier stage with negative feedback can have the low-output impedance of an emitter-follower configuration.

W. R. Finley, Design Engineer, ARF Products, Inc., Raton, N. Mex.

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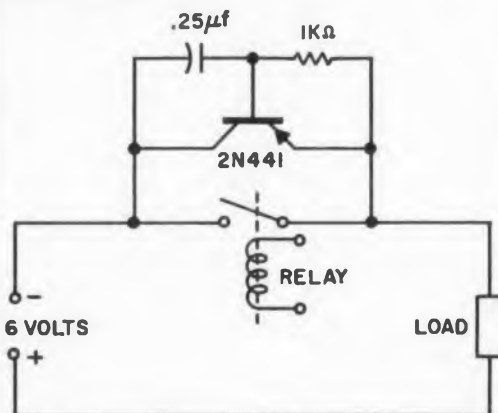
IDEAS FOR DESIGN

Amplified Capacitor Suppresses Arc More Completely

A capacitor is often placed across the contacts of a relay to suppress the arc that occurs when the contacts open. This prevents pitting of the contacts and the generation of radio frequency noise.

The effect of the capacitor may be increased by connecting it in the collector circuit of a transistor. In the circuit shown, before any capacitor was added, the pulse-voltage peak generated when the contacts opened was 640 v. After a 0.25 μ f capacitor was added, the voltage amplified by the transistor as shown in the figure, the pulse voltage dropped to about 12 v.

This arrangement requires that the transistor's current rating equal the circuit current and that its peak voltage rating equal the pulse amplitude. Also, the load must be insensitive to any transistor leakage current.



The transistor-capacitor combination helps to more completely suppress arcing when the relay contacts are opened.

Marriott Dickey, Orinda, Calif.

Q-Meter Measures IF Chassis' Resistivity

In designing an if chassis it was necessary to compare the rf resistivity of several metals and platings. This was simply done by connecting sample strips of metal in series with a series-resonant circuit and noting their effect on "Q". The resistance value for each strip was then calculated at the intended operating frequency. For best accuracy the series coil should have a high Q to cause a near maximum deflection of the Q-meter.

In our laboratory set-up, measurements were made at 11.5 mc. A solenoid coil 1 in. in diameter was wound with 4 turns of #10 AWG. Its in-

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INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

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ELECTRONIC DESIGN • May 25, 1960

ductance was 0.5 μ h. The metals to be compared were cut into strips 1-1/2 by 3/8 in. Three holes were drilled into each strip: one 1/4 in. hole to fit the Q-meter terminal, and two holes spaced 3/4 in. to fit the coil wire (#37 drill). The first strip, made of brass, was fastened to the Q-meter "Low" terminal. One end of the coil was soldered into the first wire hole, and the other end connected to the "High" terminal. The "Q" was found to be 233 at 11.5 mc. The coil was then soldered into the second wire hole in the strip, and the "Q" now measured 225. Since $R = X_L/Q$, and $X_L = 37$ ohms, the two values of R are 0.159 and 0.164 ohm respectively. The difference between the two values is 0.005 ohm. The process was then repeated with other materials, and the results compared.

Herbert H. Lenk, Cincinnati, Ohio.

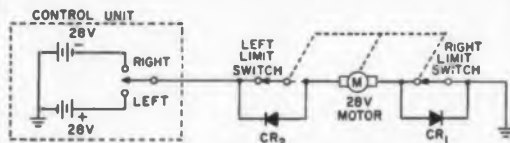
Diodes Allow Two-Wire Control Of Limit-Switched Motor

We wanted to control a dc, permanent-magnet motor in a system containing limit switches to prevent overtravel. The control had to be accomplished using only one "hot" wire and the common ground lead which were available in the existing cable design.

The figure shows our solution to the problem. Two sources of power were provided, one of each polarity. When the CONTROL switch is held in the RIGHT position the motor runs until the RIGHT limit switch opens. Since diode CR1 will not conduct with a negative potential across it, the motor will stop.

With the switch in the LEFT position a positive potential is applied and CR1 conducts. Since the LEFT limit switch is still closed, the motor will run in the opposite direction until the LEFT limit switch opens.

For the small 28-v, 100-ma motor used in this application there are many satisfactory types of diodes. 1N91 was used in our case. For larger motors, diodes must be selected to handle the starting current of the motor. Their inverse volt-

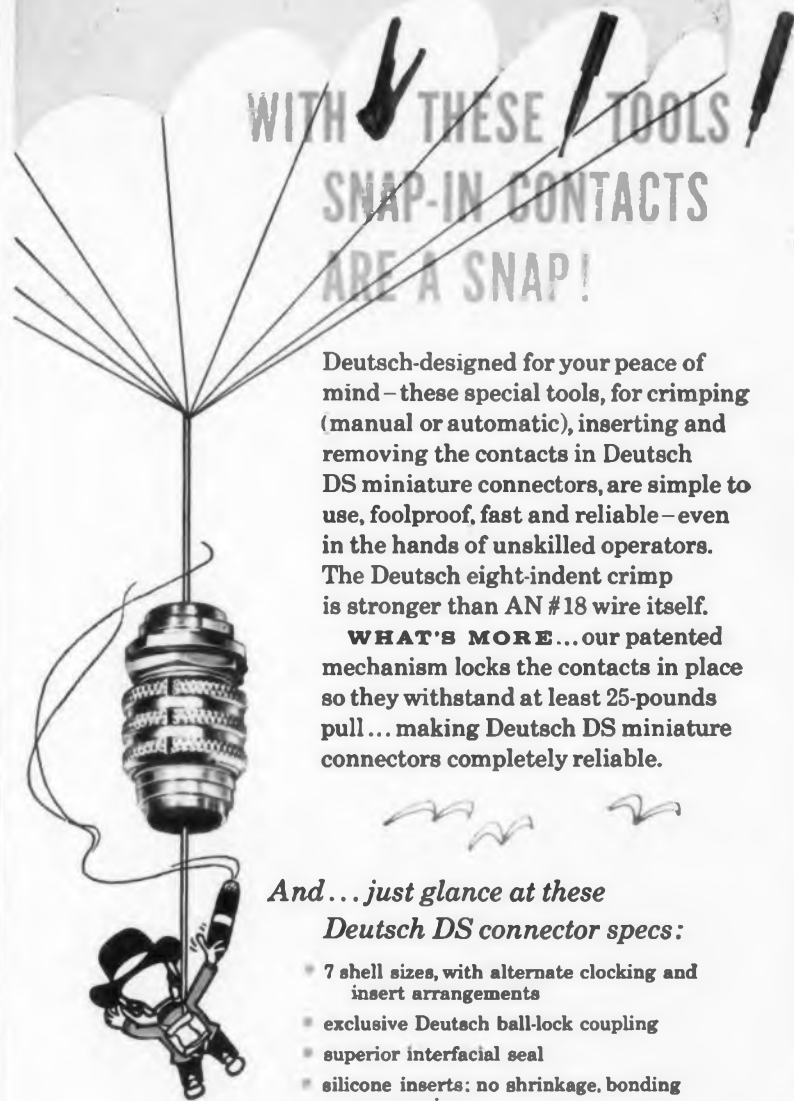


Two-wire control of the dc motor is obtained by placing a diode across each of the limit switches.

age rating must be greater than the sum of the supply potential and the voltage transient which occurs when a limit switch opens.

Charles C. DeFir, Senior Engineer, Hallamore Electronics Co., Anaheim, Calif.

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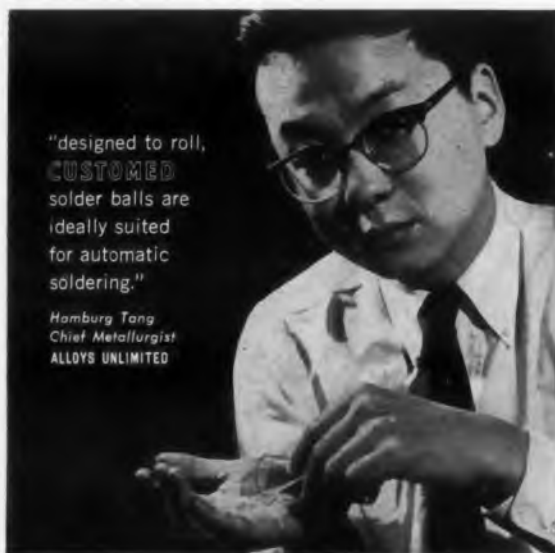
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ELECTRONIC
 DESIGN

ENGINEERING DATA

Overall Noise-Figure Nomogram

Murray Falkowitz
 Sylvania Electronic Systems
 Waltham Laboratories
 Waltham, Mass.

Murray Falkowitz designed this noise-figure nomogram to save himself time. It can save time for anyone designing receivers or amplifiers where noise is a consideration. It solves the kind of problem that can't be solved by slide rule alone.

THE NOMOGRAM shown here can be used to compute the over-all noise figure of two cascaded active networks, given the noise figure of each network and the power-gain of the first. The nomogram solves the well-known equation:

$$F_{1-2} = F_1 + \frac{F_2 - 1}{G_1}$$

where F_{1-2} is the overall noise figure, F_1 and F_2 are the noise figures of the first and second networks respectively, and G_1 is the power gain of the first network. All parameters are expressed as power ratios.

The nomogram can be used to solve for any one parameter in the equation, given the other three. The technique can be generalized to include any number of cascaded networks.

Useful for N-Stage Networks

For example, for an n -stage network, one starts with the last two stages, $n-1$, and n . By writing G_{n-1} as G_1 , and by writing F_{n-1} and F_n as F_1 and F_2 respectively, one can determine the over-all noise figure F_{1-2} of the combination. Then, using this F_{1-2} as a new F_2 and writing the gain and noise figure of the previous stage, $n-2$, as G_1 and F_1 , respectively, one determines a new F_{1-2} . This is now the over-all noise figure of the last three stages. This process is repeated until the first stage is included.

Two Procedures For Using Nomogram

There are two procedures for using the nomogram: one when the first network gain, G_1 , is less than 10 db, and one when G_1 is between 10 and 20 db. G_1 , F_2 , and F_1 are expressed in ratio form or in db.

■ For $G_1 \leq 10$ db:

1. Draw line A between second stage noise figure on F_2 scale and first-stage gain on G scale.
2. Draw line B between first stage noise figure on

the F_1 scale and the point where line A intersects the Q scale.

3. Read over-all noise figure on the F_{1-2} scale at intersection of line B.

Example: $F_1 = 5$ db, $F_2 = 10.6$ db, $G_1 = 8.2$ db. (See dashed lines on nomogram.)

1. Draw line A between $F_2 = 10.6$ db and $G_1 = 8.2$ db and note intersection at $Q = 1.6$.
2. Draw line B between $Q = 1.6$ and $F_1 = 5$ db
3. Read $F_{1-2} = 6.8$ db

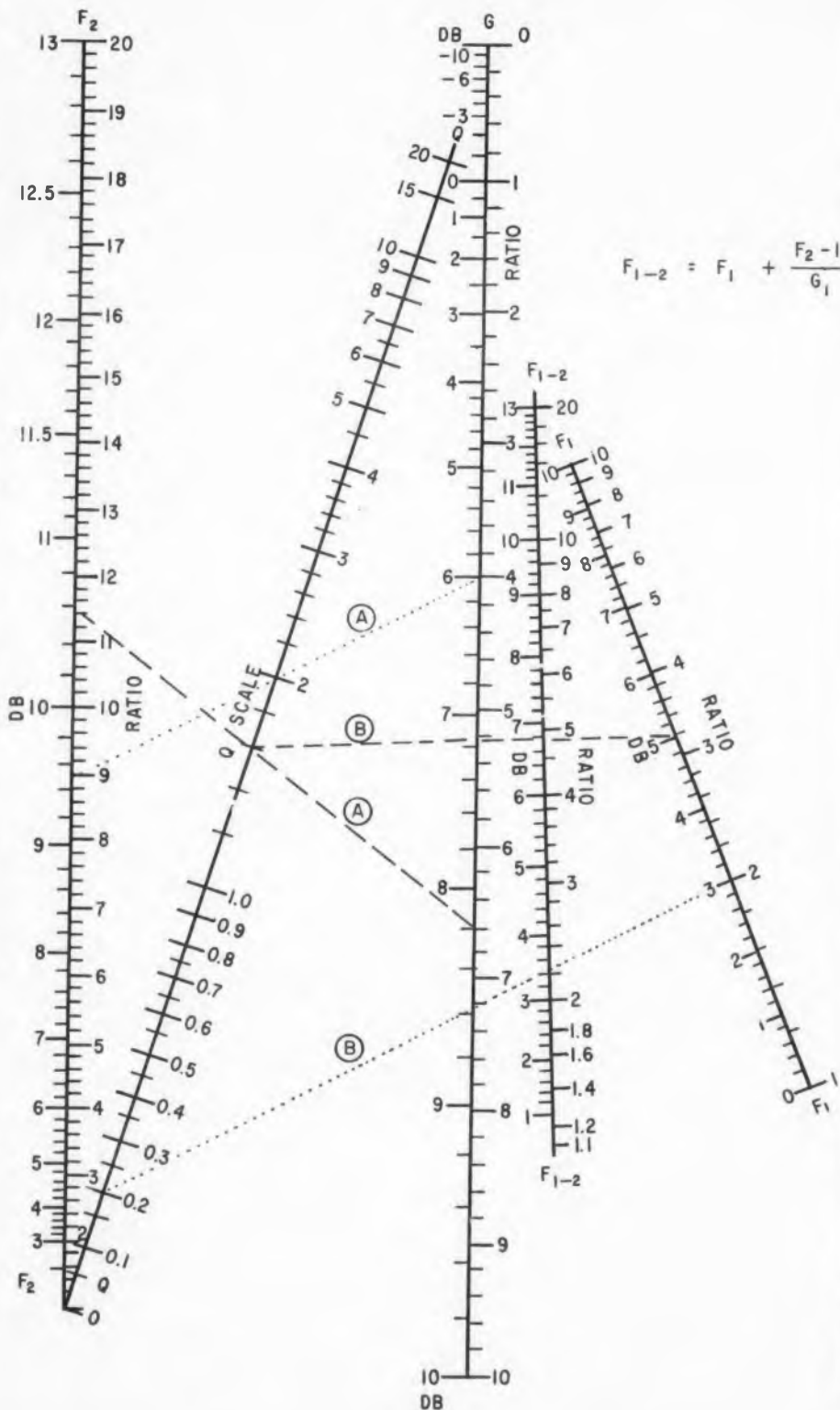
■ For $10 \text{ db} < G_1 \leq 20$ db:

1. Locate G_1 on G scale using the relation $G = G_1 - 10$ for (G_1 in db) or $G = G_1/10$ for (G_1 a ratio).
2. Draw line A between G as determined in (1) and second stage noise figure on F_2 scale.
3. Read Q scale at intersection with line A and multiply reading by 0.1.
4. Locate Q value as determined in (3) on Q scale.
5. Draw line B between Q value located in (4) and first stage noise figure on F_1 scale.
6. Read over-all noise figure on F_{1-2} scale at intersection of line B.

Example: $F_1 = 3$ db, $F_2 = 9$ (ratio), $G_1 = 16$ db (See dotted lines on nomogram.)

1. Locate $G = G_1 - 10 = 6$ db.
2. Draw line between $G = 6$ db and $F_2 = 9$
3. Read $Q = 2$ and multiply, $0.1 \times 2 = 0.2$
4. Locate $Q = 0.2$.
5. Draw line between $Q = 0.2$ and $F_1 = 3$ db.
6. Read $F_{1-2} = 3.4$ db. ■ ■

Overall Noise-Figure Nomogram



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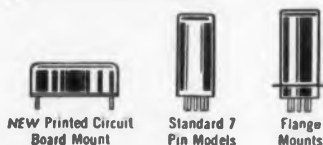
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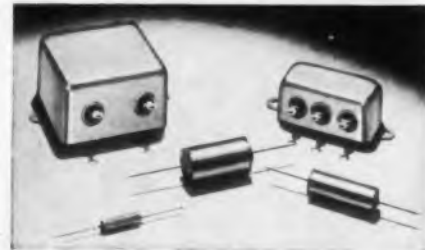


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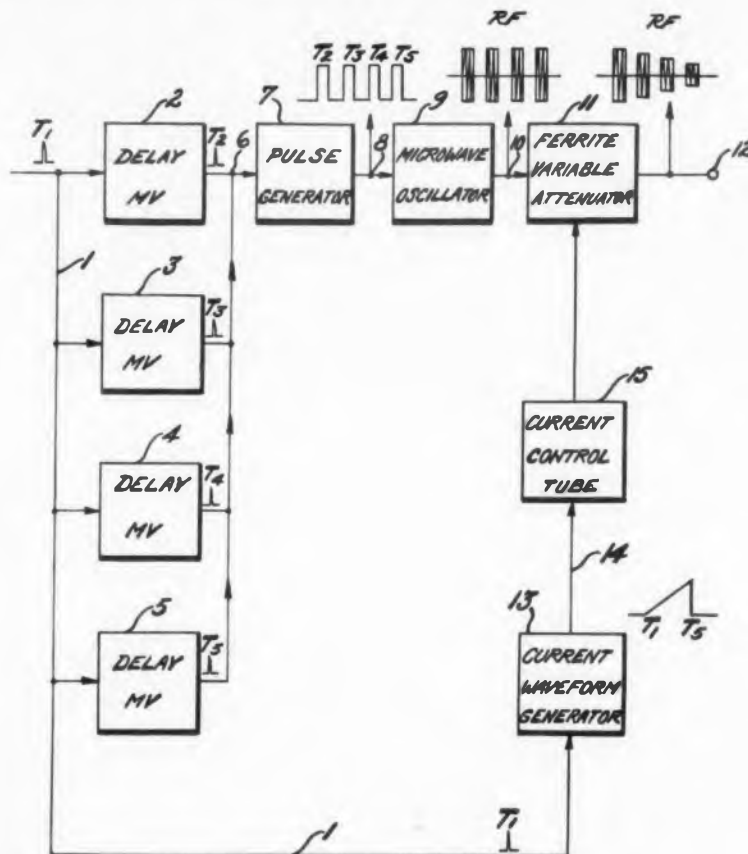
PATENTS

Pulse Generator

Patent No. 2,917,716. P. H. DalleMura and A. W. Meyer. (Assigned to United States of America)

The device produces microwave pulses of adjustable phase and amplitude. Phase is set by a bank of delay multivibrators

which trigger the pulse generator at prescribed intervals. A variable-phase square wave couples from oscillator 9 to a variable ferrite attenuator, 11. A saw-tooth waveform modulates the oscillator output to produce amplitude changes in the output signal.

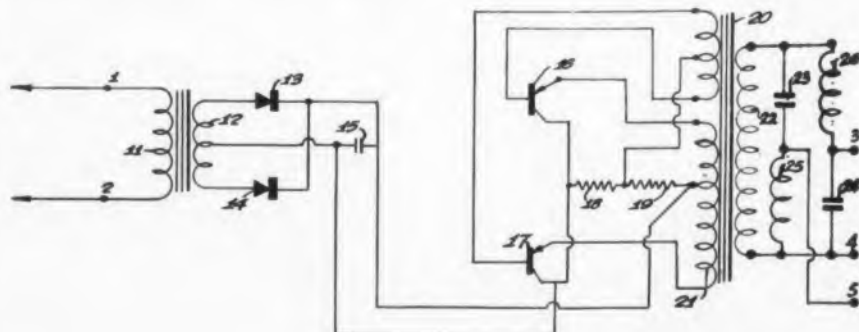


High-Frequency Ballast Unit

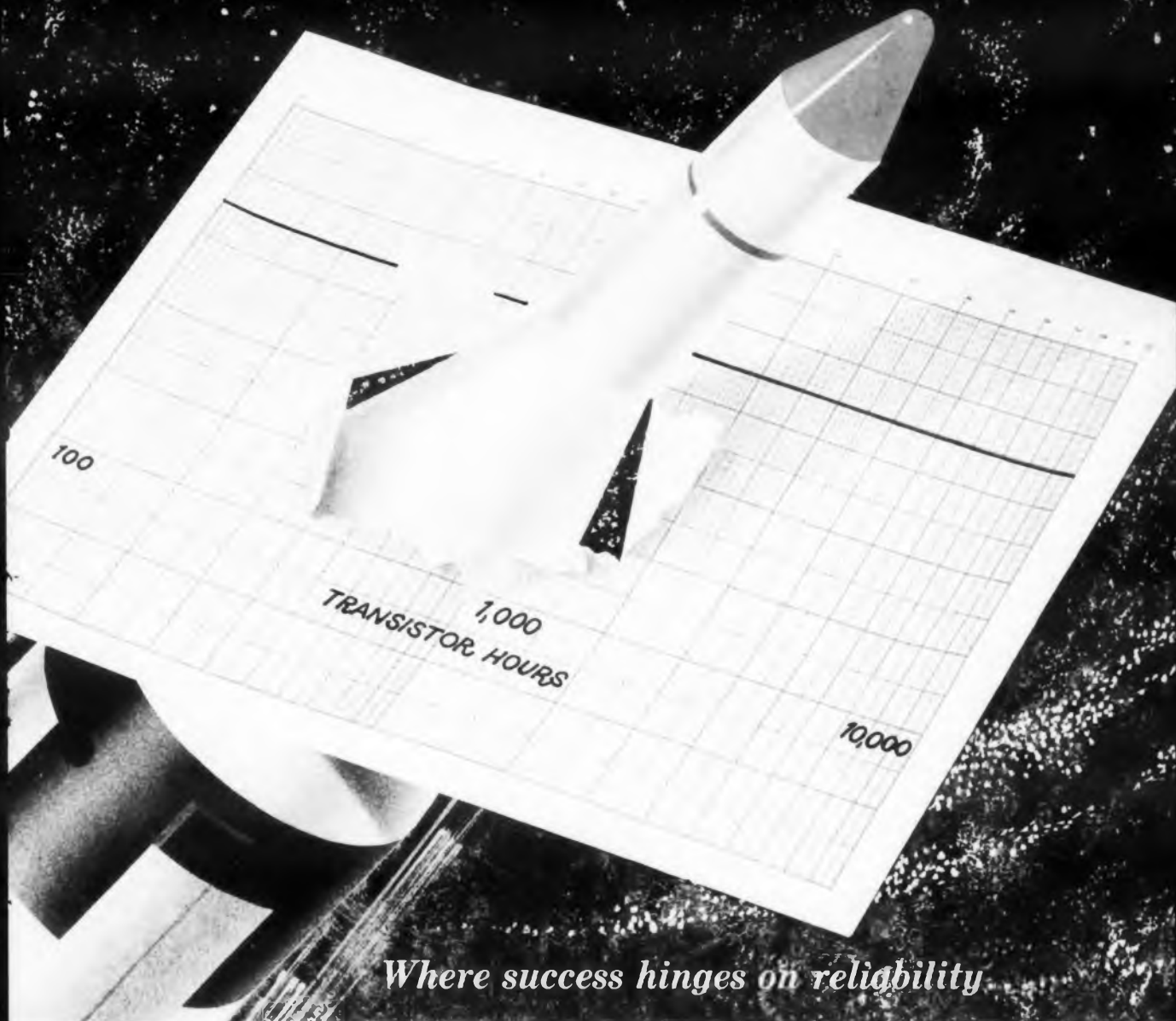
Patent No. 2,923,856. D. L. Greene and Arthur H. Philips (Assigned to Gilbert Associates, Inc.)

The ballast unit is a transistor circuit

which converts the 60-cycle line voltage to about 20 kilocycles. At this higher frequency the fluorescent lamp operates at higher efficiency, does not flicker, and starts instantly. The ballast should be



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ELECTRONIC DESIGN • May 25, 1960



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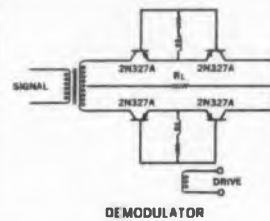
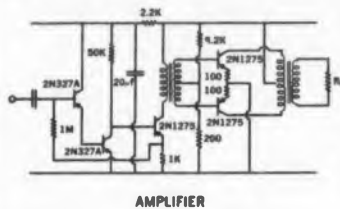
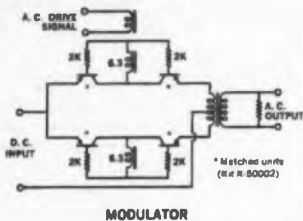
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can design your own choppers to fit your specific circuit requirements. Or, if you prefer, you can obtain these circuits encapsulated in the famous Raytheon Circuit-Pak for maximum protection against heat and shock.

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Type	I_{EO} or I_{CO} at 20 Vdc Average μamps	V_{CE} max. Volts	M_{FE} ave.	r_b ohms	Noise Figure max. db	C_{ob} $f=100\text{Kc}$ ave. $\mu\mu\text{f}$	f_{β} ave. Kc
2N327A	0.005	-40	15*	1200	30	65	200
2N328A	0.005	-35	30*	1400	30	65	300
2N329A	0.005	-30	60*	1500	30	65	400
2N1034	0.005	-40	15**	3000	30	65	200
2N1035	0.005	-35	30**	3000	30	65	300
2N1036	0.005	-30	60**	3000	30	65	400
2N1037	0.005	-35	30**	3000	15	65	250
2N1275	0.005†	-80	15**	3000	30	65	200
2N1623/ CK942	0.005	-20	25**	3000	30	65	200
2N1654	0.005†	-80	30**	3000	30	65	300
2N1655	0.005††	125	15**	3000	30	65	200
2N1656	0.005††	125	30**	3000	30	65	300

* $I_C = -3.0 \text{ mA}; V_{CE} = -0.5 \text{ V}$

†At 60 Vdc.

** $I_C = -1 \text{ mA}; V_{CE} = -8 \text{ V}$

††At 80 Vdc.

A-6760



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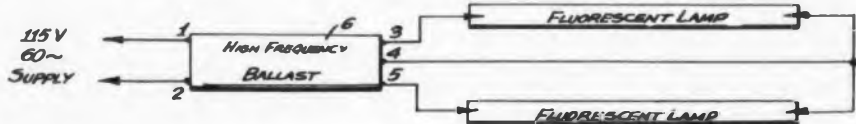
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dimensioned to replace the lamp ballast.

In the schematic, copper oxide rectifiers 13 and 14 pass dc to the electronic switch consisting of transistors 16 and 17. Initially, one transistor conducts to saturation and, for the next half period, the

second transistor conducts. A high-frequency square wave drives the fluorescent lamps connected across the secondary. Since the high-frequency voltage is generated at the lamp, the radio frequency interference is kept very small.



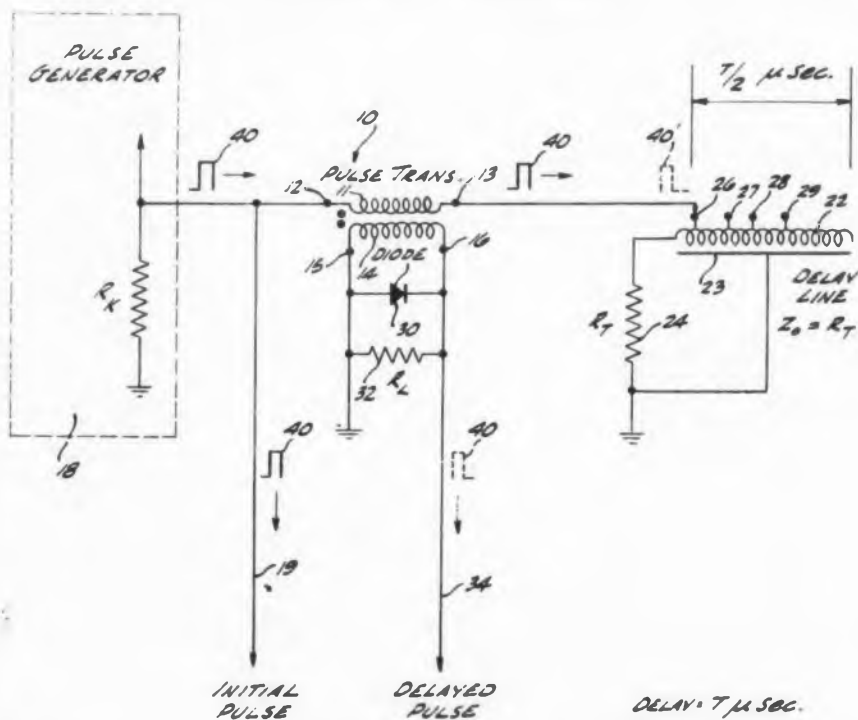
Pulse Delay Apparatus

Patent No. 2,923,898. R. J. Goad (Assigned to Hughes Aircraft Co.)

Multiple reflections of a delayed pulse are eliminated by automatically increasing the pulse generator impedance.

Pulse transformer 11 has its primary winding in series with the pulse generator and the open-circuited half-period delay line 23. The secondary 14 is loaded by

diode 30 and load resistors 32. A positive pulse from the generator passes through the transformer primary (since diode 30 conducts heavily) and is reflected from the open-circuited end of the delay line. Diode 30 is now non-conducting and the high resistance R_L is coupled into the primary winding. Resistor R_T matches the characteristic impedance of the delay line to reduce further the reflection of the delayed pulses.

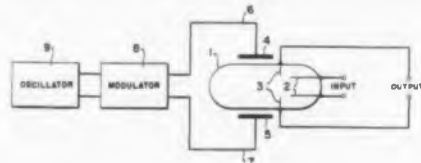


Apparatus for Modulating an Ionized Beam

Patent No. 2,925,564. R. A. Shakhbender (Assigned to Minneapolis-Honeywell Regulator Co.)

An enclosure, 1, contains a gas which is ionized by an external rf field applied across plates 4 and 5. The output electrodes meter a dc current according to the dissymmetry of the array. However,

the electrodes are positioned so that the output voltage is zero. A voltage applied to input electrodes 2 establishes dissymmetry so that the amplified output current will follow the changes in the input.



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BOOKS

Instrumentation in Scientific Research— Electrical Input Transducers

Kurt S. Lion, McGraw-Hill Book Co., Inc.,
330 W. 42nd St., New York 36, N. Y., 324
pp, \$9.50.

The author presents a comparative study and analysis of the basic systems and methods used as input transducers in electrical instrumentation. Almost all electrical sensing elements for mechanical input (linear dimensions, displacement, force, velocity, acceleration, liquid level, pressure, vacuum, flow velocity, and humidity), temperature, magnetic field strength, electrical input (free charges, space charge, space potential, surface charge, surface potential, field strength), optical and nuclear radiation are covered.

The physical mechanisms involved in

the operation of each transducer are described, as are the quantitative relationships between input and output, the range of application and the limitations, the errors, and the responses to environmental influences. Principal literature references are also given.

Materials and Techniques for Electron Tubes

Walter H. Kohl, Reinhold Publishing
Corp., 430 Park Ave., New York 22, N. Y.,
638 pp, \$16.50.

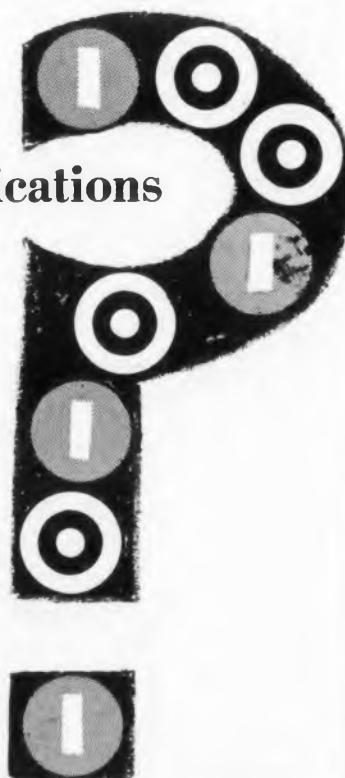
The principal subjects here are the composition, properties, and behavior of the materials used in electron tubes and the techniques for assembling these materials. All the material components of electron tubes—glass, ceramics, mica, tungsten,

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molybdenum, etc., are covered, as well as the fabricating techniques required to put the tubes together—brazing, glass-to-metal sealing, and ceramic-to-metal sealing. Chapters dealing with specific materials contain extensive tabulations of physical characteristics, chemical reactions with various reagents, and processes used in application.

This is the first volume in a new technical series to be written by scientists and engineers of General Telephone & Electronics, covering various aspects of science and technology. Subsequent volumes will deal with communications, electronics, lighting, and others.

Fast-Neutron Spectroscopy

B. V. Rybakov and V. A. Sidorov, Edited by N. A. Vlasov, Consultants Bureau, Inc., 227 W. 17th St., New York 11, N. Y., 121 pp, \$17.50.

The authors, Soviet pioneers in the development of spectroscopy methods for fast neutrons based on the time-of-flight principle, have been working with a special spectrometer of their own design. This volume surveys the work which has

been done in this field, and describes the authors' own experiments and results.

The English text has been recently translated from the Russian. It originally appeared as a supplement to the 1958 edition of the Soviet Journal of Atomic Energy.

Electrical and Electronic Drawing

Charles J. Baer, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y., 218 pp, \$6.00.

The purpose of this book is to give an over-all picture of the electrical and electronic drawing field including the latest symbology and practices. Intended for the electrical draftsman, it is also valuable to persons supervising the preparation of electrical drawings.

The author deals with the preparation of a great variety of electrical and electronic drawings, including transistor, etched, and industrial electronic circuits. Attention is given to pictorial drawings, connection drawings, block diagrams, and schematic diagrams. The material is based on the current ASA, IRE, and military standards.

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BOOKS

Electron Tube Life Factors

Edited by Craig Walsh and T. C. Tsao, Engineering Publishers, Elizabeth, N. J., 173 pp, \$9.50.

Collected here, in highly condensed form, is information regarding the changes in electron tube properties for periods of time up to 5,000 hours of life, under various environmental conditions. A series of charts and tables are given containing the information digested from the data of more than six million electrical measurements.

The tubes tested included 11 JAN-type miniature tubes and one commercial computer tube (Type 5963). The environmental conditions were set at several different levels of severity. Other environmental conditions investigated included heater cycling, plate power dissipation, plate voltage, plate current, mechanical excitation, and pulse operation.

The properties measured and presented in the book include transconductance, power output, operation current, heater current, heater-cathode leakage, grid cur-

rent, grid emission, interface resistance, and interelectrode insulation. Where it is appropriate, the results are given for both the test and MIL standard conditions. The percentages of failure at various times throughout the test are also given.

The information in this book should be of material assistance in the design and maintenance of electronic equipment for many different kinds of application. At one extreme is the ground-based equipment operating at optimum environmental conditions where long-term reliability is required. At the other extreme is guided missile equipment where one-shot reliability for a relatively short time is of paramount importance.

Classics in Management

Edited by Harwood F. Merrill, American Management Association Inc., 1515 Broadway, New York 36, N. Y., 446 pp, \$9.00.

Until now, many of the classics of management have been hidden in private collections or scattered in reference libraries. As a result, these timeless ideas have



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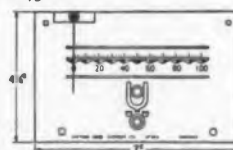
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Biological and Medical Electronics

Ralph W. Stacy, Ph.D., McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 308 pp, \$9.50.

This text and reference is written for students, laboratory workers, and clinicians using modern electronic apparatus for biological or medical research, or for clinical purposes. All recent advances in the field are covered, included special

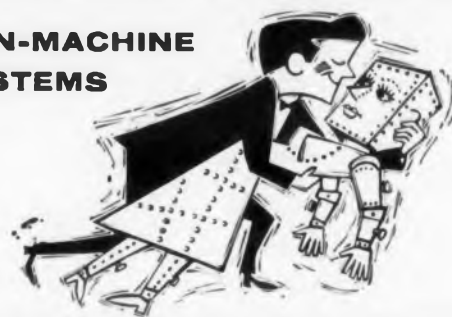
chapters on transistors and computers in the laboratory.

The book begins with a discussion of the theoretical concepts of instruments, including frequency response characteristics. These concepts are then applied to discussions of actual instruments and their use.

The level and coverage of this text are such that a background in electronics is not required. It will, however, also serve as a reference for people who have had experience in using electronic equipment.

The book's primary aim is to develop the knowledge of medical electronics to the point where the student can intelligently select and use various types of apparatus. The criteria used to determine the adequacy of an instrument for a particular job are also presented. It describes currently available equipment in standard use for biological and medical purposes, and provides a list of references for each chapter which show where additional information about the subject may be obtained. Also included are practical sections on shielding, troubleshooting, and assembly of instrument schemes.

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REPORT BRIEFS

Single Frequency Filters

Design procedures are shown for filters formed by a number of identical resonant circuits loosely coupled together. They are required to accept one narrow band of frequencies and reject another narrow band somewhat removed in frequency, without special requirements on the shape of the attenuation curve between these designs. *Design of Single Frequency Filters*, F. F. Fulton, Jr., NBS Technical Note 23, Aug. 1959, 10 pp, \$0.50. Order PB 151382 from OTS, Washington 25, D. C.

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Instantaneous correction for ac line voltage changes is obtained with a ferroresonant regulator. The regulator has controllable output voltage with degenerative feedback to produce a constant output voltage for changes in line voltage, frequency, and load conditions. Design procedures and actual construction details of a 1000-v ferroresonant circuit are given. *A Ferroresonant Regulator With Controllable Output*, George Schohan, Naval Ordnance Laboratory, White Oak, Md. Oct. 1957, 29 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 143308 from Library of Congress, Washington 25, D. C.

Aircraft Antennas

The characteristics of the tropospheric forward-scatter and meteor-burst modes of propagation are discussed as they affect the design of aircraft antennas. Considered are the antenna design limitations, the existing frequency allocations, the propagation characteristics, and the cosmic and thermal noise spectra. It was found that the best frequency for air-ground or ground-air forward-scatter communication is about 225 mc. The best frequency for air-ground or ground-air meteor-burst communication is about 50 mc. Frequencies up to somewhat above 100 mc may be satisfactory for transmission in the ground-air direction. General types of aircraft antenna arrays are suggested for fore-and-aft or omnidirectional coverage and estimates are given for the obtainable values of directive gain. Flush-mounted or slightly protruding antenna elements are recommended. Slot, patch, loop, and monopole elements are discussed in regard to size, location and orientation. *Feasibility Study of Aircraft Antennas For Forward-Scatter And Meteor-Burst Communication*, J. F. Cline, Stanford Research Institute, Menlo Park, Calif., July 1959, 63 pp, Microfilm \$3.90, Photocopy \$10.80. Order PB 143398 from Library of Congress, Washington 25, D. C.

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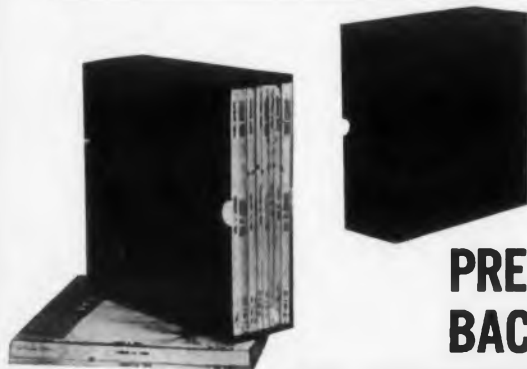
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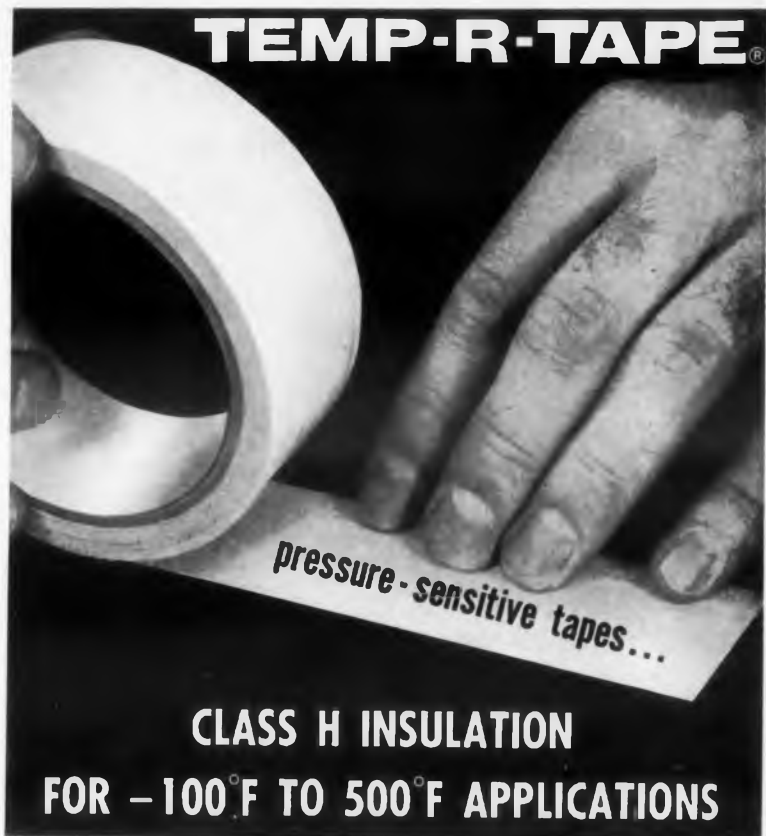
A servomechanism was designed using two independent servo loops with a photoelectric cell as the error detecting device. If the angle of rotation of the mirror which reflects light to the photocell does not exceed 20 min, the two servo loops are mutually independent. The photocell voltage output will then be a linear function of the error angle for each servo. The servomechanism has been designed by means of the "decibel-log-frequency" type of synthesis and a detailed mathematical analysis shows that the design specifications are satisfied. *The Design Of An Electro-mechanical Servomechanism With Photo-Electric Error Detection*, Ralph C. Liebowitz and Seymour Kant, Naval Weapons Plant, Washington, D. C., Jan. 1958, 89 pp, Microfilm \$4.80, Photocopy \$13.80. Order PB 138596 from Library of Congress Washington 25, D. C.

Frequency Standard

A preliminary analysis has been made of the behavior of quartz crystal units over a wide range of frequencies at very low ambient temperatures. Some experimental results are given for the temperature coefficient and Q as a function of temperature. An analysis is made of the effects on frequency resulting from variations in circuit reactances and tube-gain characteristics for two kinds of oscillators, with a comparison of the theoretical stability limitations of both types. *An Ultra-Precise Standard Of Frequency*, R. A. Sykes, Bell Telephone Laboratories, Inc., Whippany, N. J. Nov. 1956, 39 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 143348 from Library of Congress, Washington 25, D. C.

Cryogenic Materials

This handbook of data on solid materials at low temperature deals with physical properties of certain metals and non-metals over the temperature range minus 423 F to plus 500 F. The materials selected for inclusion in the handbook are limited to aluminum, cobalt, copper, iron, nickel, titanium, carbides, non-metals, and miscellaneous metals and alloys. The materials are mostly those in current use for missile applications at cryogenic temperatures, but a few have been included because of their potential for such uses. This compilation of some of the mechanical properties of materials should assist the designer by making available in one publication reliable data which have appeared in the literature or which have not yet been published. *Cryogenic Materials Data Handbook*, Cryogenic Engineering Laboratory, National Bureau of Standards, Boulder, Colo., Jan. 1960, 22 pp, \$0.75. Order PB 161093 from OTS, Washington 25, D.C.



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REPORT BRIEFS

Space Research Instrumentation

The development of various accessory circuits for use in space research instrumentation is described. The circuits include dc current detectors, voltage-controlled oscillators, voltage generators, timers and dc-dc converters. *Transistorized Circuits For Use In Space-Research Instrumentation*, L. H. Brace, Michigan University Research Institute, Ann Arbor, Mich., Oct. 1959, 31 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 144196 from Library of Congress, Washington 25, D.C.

Millimeter-Wave Generation

A millimeter-wave generator using a waveguide filled with a plasma of uniform cross-sectional density, but with an axial density variation of the form $\rho_0 (1 + a \sin \gamma z)$, is discussed. It is shown, by solving the wave equation for the system, that slow-wave space harmonics, although usually of small amplitude, can have their electric fields maximum at the center of the guide and minimum at its walls. The design of a possible 1-mm backward-wave oscillator operating at 2.5 kv with approximately 12 ma starting current is dealt with. This design is postulated on the assumption that the so-called Langmuir "electrostatic sound waves," or similar modes, may be used to set up the necessary density variation in the plasma. *A Proposed Millimeter-Wave Generator*, G. S. Kino, Microwave Laboratory, Stanford University, Calif., Sept. 1959, 20 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 143995 from Library of Congress, Washington 25, D.C.

Magnetohydrodynamics

The design of a magnetohydrodynamic generator was considered, including its length, pressure, magnetic field strength and losses. The geometry chosen was a straight channel of variable cross-section. Only dc power generation is considered, using temperatures which may be obtained from conventional thermal sources. Losses due to high exhaust temperature, ohmic heating, wall cooling, magnet power and end effects can be controlled. As far as magnet power is concerned, indications are that these losses are approximately constant. The implication is that the mhd generator should be large, and formulas are given to determine the various losses for different size units. *Design Considerations Of A Steady DC Magnetohydrodynamic Electrical Power Generator*, George W. Sutton, Aerosciences Laboratory, General Electric Co., Philadelphia, Pa., Sept. 1959, 50 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 144200 from Library of Congress, Washington 25, D.C.



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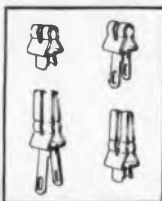
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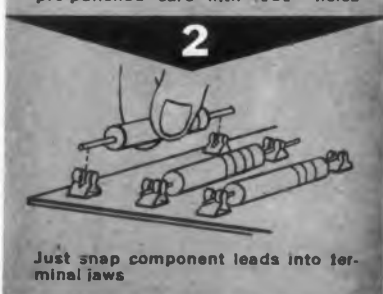
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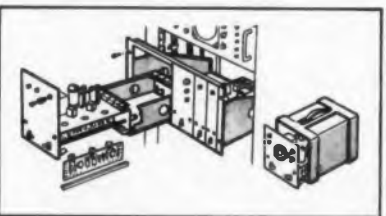
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Radio Noise Data

Radio noise measurements made during IGY by a world-wide network supervised by NBS are tabulated. Months in which usable data were obtained are shown, and results of the measurements are summarized. Month-hour data for each station and seasonal-time-block values are given. *Radio Noise Data for the International Geophysical Year July 1, 1957-Dec. 31, 1958*, W. Q. Chrichlow, C. A. Samson, R. T. Disney, and M. A. Jenkins, NBS Technical Note 18, July 1959, 239 pp., \$2.50. Order PB 151277 from OTS, Washington 25, D. C.

Ferroelectrics For Digital Storage And Switching

Materials have recently been discovered in which exist domains of permanent electric dipoles. These materials, ferroelectrics, can be used to advantage in many electronic applications where ferromagnetic materials are currently used. These circuits are the duals of their ferromagnetic counterparts. Ferroelectrics can be made in the form of single crystals or rugged ceramics. Digital information can be stored in a matrix of ferroelectric condensers, and an efficient method of storage-element selection is available in the form of a two-coordinate, coincident-voltage scheme. The matrix can be made on a thin ferroelectric sheet by painting the coordinate rows on one side and the coordinate columns on the other. The information can be taken from the matrix via a simple mixing transformer. *Ferroelectrics For Digital Information Storage And Switching*, Dudley Allen Buck, Digital Computer Laboratory, Massachusetts Institute of Technology, Cambridge, June 1952, 72 pp., Microfilm \$4.50, Photocopy \$12.30. Order PB 144326 from the Library of Congress, Washington 25, D. C.

Infrared Background Radiation

Investigation of the spectral distribution of infrared background radiation, showed that there was ready distinguishability between various objects at any one time. It was found, however, that at certain times, this distinguishability disappeared. This effect is called washout. It has also been reported by various other investigators in the field, whose work is classified. This report presents the results of efforts to determine the time and weather condition in which the washout effect might become apparent. *Washout Effect In Infrared Background Studies*, W. R. Fredrickson, N. Ginsburg, and R. Paulson, Syracuse University, N.Y., June 1959, 18 pp., Microfilm \$2.40, Photocopy \$3.30. Order PB 143193 from Library of Congress, Washington 25, D. C.

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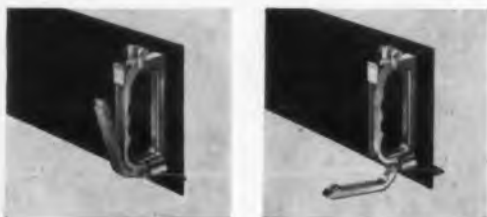
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Loop Antenna Theory

A complete mathematical solution for the thin wire loop antenna, and the subsequent development of the principle of "mode selection and suppression," using inserted distributed and/or lumped internal impedances, have been previously reported in DOFL Reports TR-462 and TR-600. The original solution was expressed in the form of wave families, consisting of one TE family and two TM families. In the present report, the two TM families are consolidated into one, and the general solutions for currents, impedances and fields revised accordingly. The solutions are then extended to incorporate the effect of multiple feed points with or without arbitrary phase delays. The problem of a loop with a solid dielectric core is reformulated, and extended to the case of a hollow spherical dielectric core enclosing a spherical conducting core. It is shown that the basic loop element theory can be used to form the solution to an array of parallel, coaxial, unequally spaced, and unequal-size loops, driven or parasitic. The results lead to



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a high degree of control over radiation coverage, and indicate further possible advantages, such as electronic beam scanning. The use of the theory developed can aid in antenna design to a great extent. *Further Extensions of Loop Antenna Theory*, J. Herman, Diamond Ordnance Fuze Laboratories, Washington, D.C., July 1959, 52 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 144226 from Library of Congress, Washington 25, D.C.

Linear Antenna Arrays

The radiation field of dipoles is usually expressed in the form of a product of a field factor and one or more array factors. Actually, such a formulation depends on the implicit assumption that the distributions of current along all elements are the same regardless of the location in the array, or differences in driving conditions. Since this is a satisfactory approximation only when the elements are near a half-wavelength long, a study of the fields of longer elements in terms of the actual distributions of current is indicated. *Linear Arrays: Currents, Impedance And Fields*, Ronald King, Cruft Laboratory, Harvard University, Cambridge, Mass., May 1959 55 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 143397 from Library of Congress, Washington 25, D. C.

Electron And Plasma Beam Dynamics

The studies described here cover the following: vacuum tubes, crossfield gaseous tubes, parallel-field gaseous tubes, semiconductor properties of ionized gas, and plasma as a means of microwave amplification. *Electron And Plasma Beam Dynamics*, A. J. Litchenberg, D. H. Sloan and others, Electronics Research Laboratory, University of California, Berkeley, Calif., June 1959, 57 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 144498 from Library of Congress, Washington 25, D.C.

Zero-Crossing Detector

A transistor detector is described which generates a pulse whenever the input waveform passes through zero. This device uses a combination of two grounded-emitter amplifiers, fed by input signals of opposite phase. Although specifically designed for use in a synchro shaft position encoder, this zero-crossing detector also has application as a composite pulse generator and as a frequency doubler. *A Transistor Zero-Crossing Detector*, John S. Denelsbeck, Naval Air Development Center, Johnville, Pa. Oct. 1958, 13 pp, Microfilm \$2.40 Photocopy \$3.30. Order PB 144108 from Library of Congress, Washington 25, D. C.

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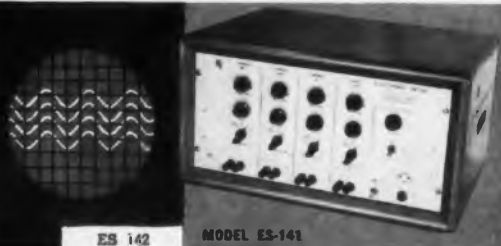
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Surface Wave Antennas

The basic array parameter useful to the antenna designer were investigated during this study. These included relative slot excitation, ground plane current distribution, control of phase, a study of the normalized impedance of the slots, the radiation efficiency of the antenna, and the development of production techniques. The various methods for launching the wave onto the ground plane were not covered in the study. Instead, a horn launcher was used to couple to the mode, and its characteristics were taken into account in the analysis. *Surface Wave Antenna Study*, Murray Hoffman, Litton Industries, College Park, Md., 1959, 95 pp, Microfilm \$5.50, Photocopy \$15.30. Order PB 138427 from Library of Congress, Washington 25, D.C.

Improving Communication Accuracy

This report summarizes a study of the role of redundancy in communication. The investigation was carried out principally in terms of an *n*-dimension model of message space. An intuitively clear method was determined for comparing the significance of redundancy in reducing error rates in a communication link with the contribution realized through the use of long messages and delay. The study clearly indicates that the cost of communications, including the cost of terminal coding and decoding equipment, is not necessarily optimized when the channel capacity is used at highest efficiency. A trade of channel capacity (in the use of redundancy) for improved reliability, or accuracy, may often be justified. *Redundancy For Improving Accuracy In Communications*, B. L. Bascore, Dikewood Corp., Albuquerque, N. Mex., June 1959 46 pp Microfilm \$3.30, Photocopy \$7.50. Order PB 143507 from Library of Congress, Washington 25, D. C.

Designing For Maintenance

The problems associated with the maintenance of electronic equipment are discussed to indicate some of the difficulties correctable by proper design. Design for ease of maintenance is concerned with keeping the equipment in operation with a minimum down-time allotted per malfunction. Discussions are included on the designer's responsibility, specifying and designing for maintainability, and the principles of design for ease of maintenance. *Design For Ease Of Maintenance*, Samuel J. Lanzalotti, Army Signal Research and Development Laboratory, Fort Monmouth, N.J., July 1957, 25 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 138095 from Library of Congress, Washington 25, D.C.

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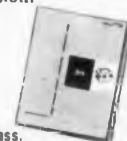
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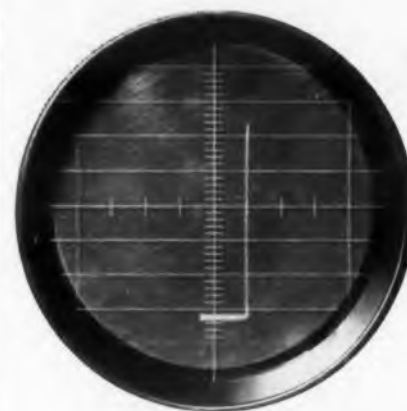
A multi-position switch, capable of handling pulses shorter than one microsecond, can be made from magnetic cores. Windings on the magnetic cores, when matrix-connected, control selection of the switch output. These windings can be excited with either direct current or pulses. The switch is capable of transmitting power efficiently, and the magnetic cores from which it is made are inexpensive and rugged. Two such switches pulse the 16 coordinate rows and the 16 coordinate columns of coincident-current magnetic-core memory. *A Magnetic Matrix Switch And Its Incorporation Into A Coincident Current Memory, Kenneth H. Olsen, Digital Computer Laboratory, Massachusetts Institute of Technology, Cambridge, June 1952, 104 pp, Microfilm \$5.70, Photocopy \$16.80. Order PB 144069 from Library of Congress, Washington 25, D. C.*

Solid Angle Antenna Patterns

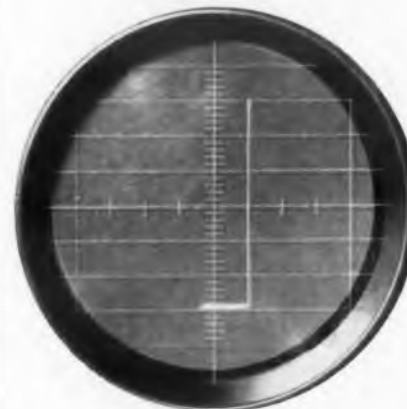
This paper discusses synthesis of solid angle antenna patterns with planar aperture or array distributions. The available techniques for one dimensional pattern synthesis (in particular that based on Fourier analysis, and methods due to Woodward and to Ruze) are applied to the two dimensional case. A discussion of antenna Q and its evaluation is given for an aperture with uniform source polarization. *Solid Angle Synthesis, Robert Plonsey, Case Institute of Technology, Cleveland, Ohio, Aug. 1959, 61 pp, Microfilm \$3.90, Photocopy \$10.80. Order PB 143661 from Library of Congress, Washington 25, D. C.*

Filter Design

A technique for the design of high-pass and band-pass transmission line filters, by transformations from low-pass prototype transmission line filter was investigated. Dealing with networks comprised of commensurate sections of line, a change of variable $\lambda = j \tan \theta$ was introduced. The new variable λ may be regarded as a frequency variable. Theorems and synthesis procedures for lumped element networks can be adopted and applied directly to the distributed case. A general proof for the validity of the transformation technique for filter design in the lumped element case is worked out. The physical realizability of the transformed functions is demonstrated. *Frequency Transformation And Transmission Line Filters, Yosef Shalev and Eugene N. Torgov, Microwave Research Institute, Polytechnic Institute of Brooklyn, N. Y., Apr. 1959, 86 pp, Microfilm \$4.80, Photocopy \$13.80. Order PB 143769 from Library of Congress, Washington 25, D. C.*



(before)
Reverse leakage
tracing before
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in H₂O₂.



(after)
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in H₂O₂,
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washing
(virtually no
change).

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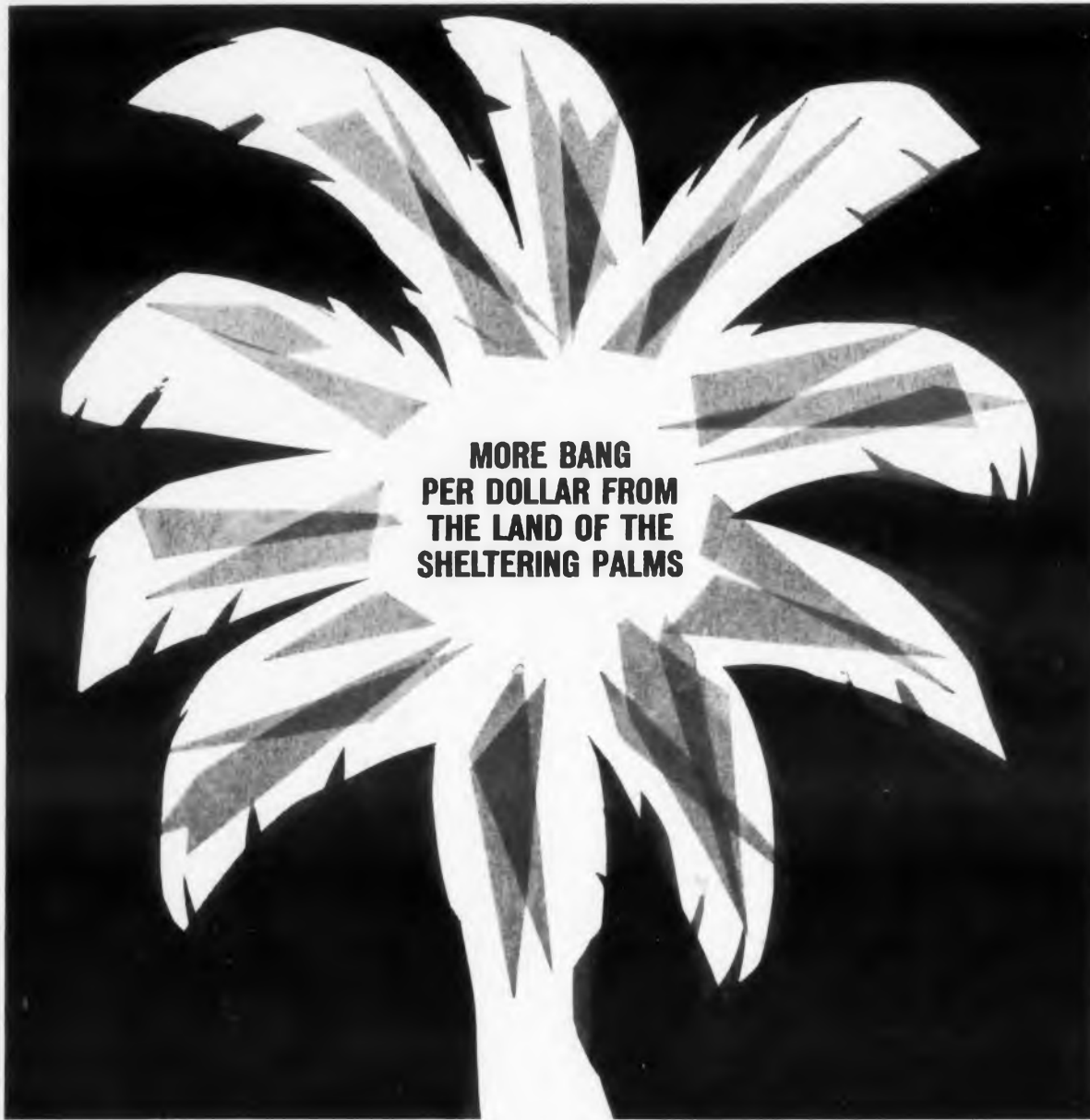


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YOUR CAREER NEWS AND NOTES

Stymied in the same old job? Don't see how you can get ahead in the company? Reader Charles D. McIntosh of Beverly Hills, Calif., suggests filing "extracurricular engineering reports as a means of rising above the crowd." Topics, he notes, can include interesting side effects observed while developing a device; methods for improving further research into the device; suggestions for improving administrative organization or engineering procedures—"in fact, almost every interesting facet you discuss with your friends at lunch, as well as the gripes you air in the washroom, are potential subjects for a report to management." The result? Notice to management that you have initiative and are discerning of more sides of your job than just the one assigned to you.

Caution: "Be sure to report on areas where you have enough facts and background knowledge to justify your opinions. Be careful not to intrude in the fields of your associates. Take care to determine the proper supervisor through whom to channel your efforts."

World leaders would do well to add a measure of science to their knowledge of politics, an engineering educator argues. He says it might help prevent many a costly error in national policy.

As support for his argument, the educator, C. S. Draper of Massachusetts Institute of Technology, points to what he terms the mistake made by the U.S. in the middle Forties in neglecting ballistic missiles in favor of pilotless aircraft.

Mr. Draper, who is director of instrumentation laboratories in MIT's Dept. of Aeronautical Engineering, says decisions of far-reaching importance are often made by leaders deficient in scientific learning.

The educator, who made his views known in an address at the 12th annual conference of the American Society of Engineering Education, urges that engineering colleges stress the humanities more and so prepare their students for potential roles of world leadership as well as scientific prominence.

Engineering teaching and research are combined in a new fellowship program under way at the Newark College of Engineering in New Jersey. Recent engineering graduates study free for Master of Science degrees in five categories, gain teaching experience as paid assistant instructors and take part in nineteen faculty research projects.

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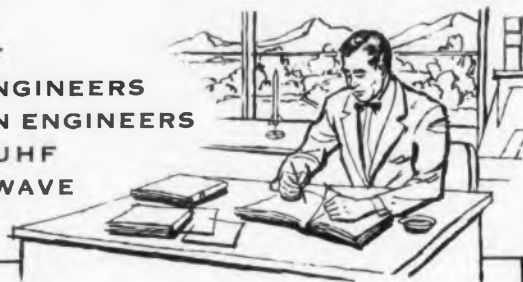
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CAREER NEWS

More and more engineering graduates can pursue diverse careers because engineering curricula no longer emphasize specialization, according to an educator.

The new concept of engineering education is due to "an ever widening spectrum of problems that make it increasingly difficult and unwise to equip graduates with specialized know-how skills," said the educator, Dr. Gordon S. Brown, dean of engineering at the Massachusetts Institute of Technology.

Dr. Brown addressed his remarks to the American Institute of Electrical Engineers in New York.

The educator said engineers should gain specialized skills in graduate school and in industry training courses. He suggested that refresher courses be given to engineers about every five years.

He called upon industry "to appreciate the vital role of on-campus research and graduate study in keeping our educational institutions places of learning rather than merely places of teaching."

The need for engineering executives in industry is second to the need for sales executives, according to a recent survey of 145 companies by the Executive Manpower Corp., New York.

This is the second consecutive year that engineering executives are second in demand, the survey found. Last year industry's top executive needs were in the manufacturing and production fields.

The companies that responded to the questionnaire indicated they would fill a total of 82 engineering management positions in the next six months. Most of the positions will pay between \$10,000 and \$15,000 a year. A few jobs will pay from \$15,000 to \$25,000. Only one engineering executive job paying between \$50,000 and \$75,000 a year will be filled, the companies indicated.

"Human factors" trouble mechanical engineers, too. The American Society of Mechanical Engineers' annual report for 1959 tells of the founding of a Human Factors Group to "maximize man-machine system performance and minimize problems arising from improper man-machine interactions."

The report also tells of the success of ASME's translation of the Russian *Journal of Applied Mathematics and Mechanics*. This prompted the society to translate two additional Russian books in 1960.



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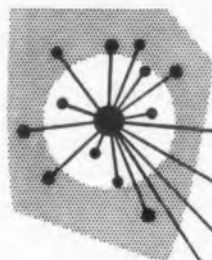
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IN

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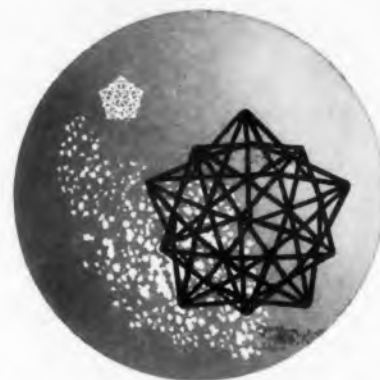
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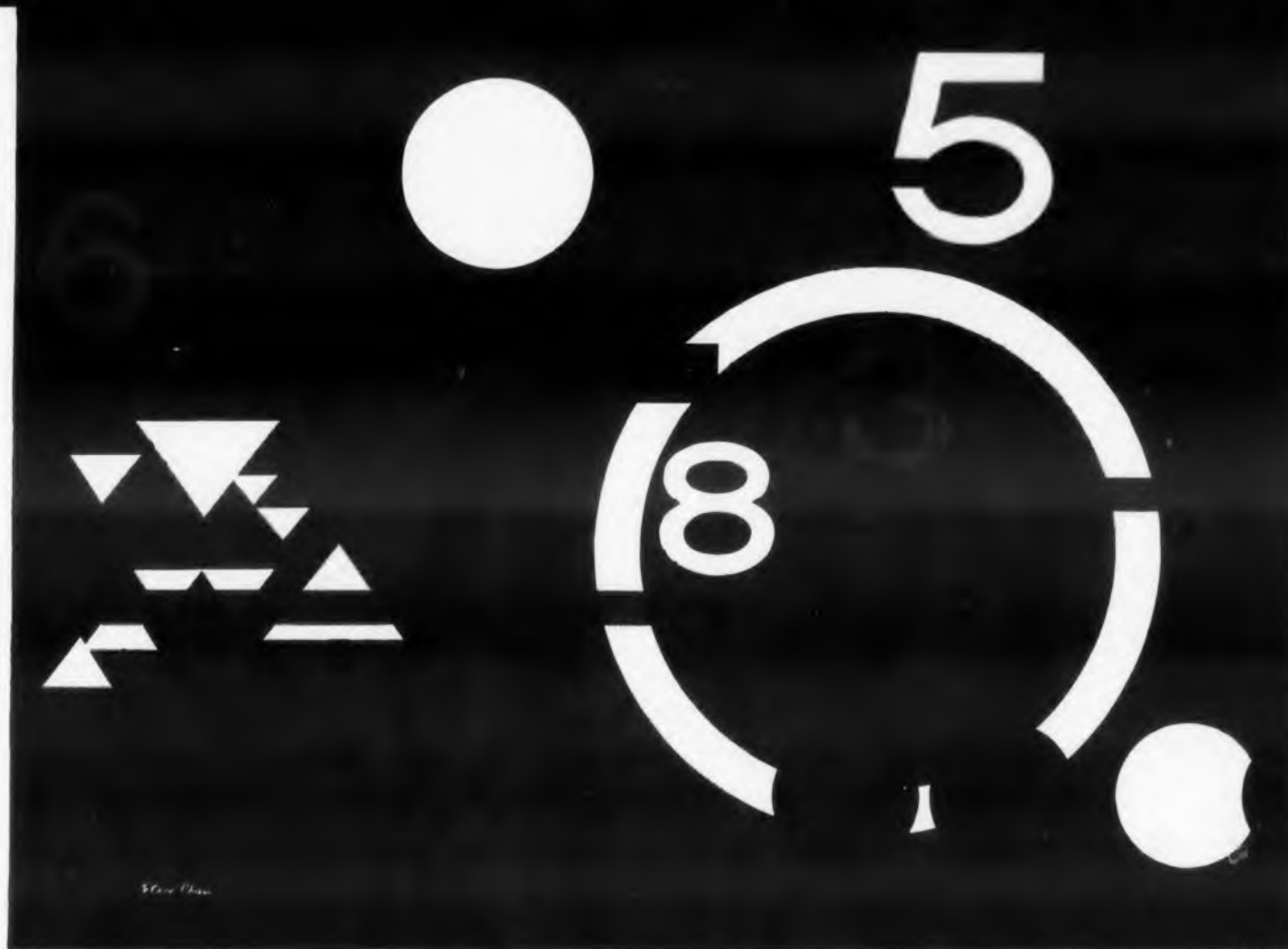
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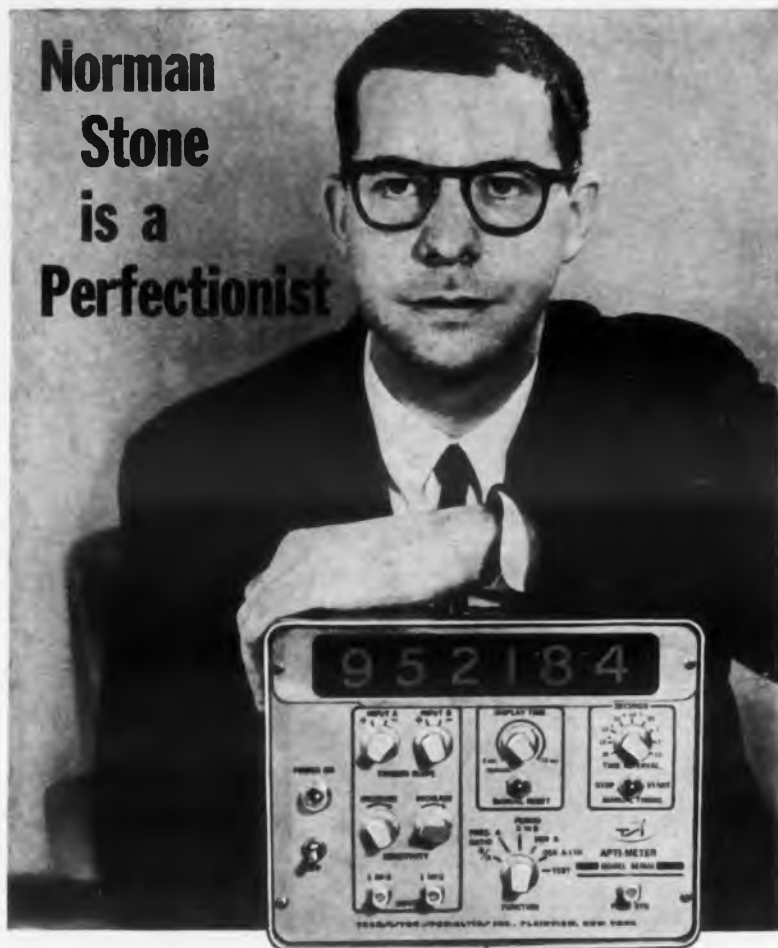
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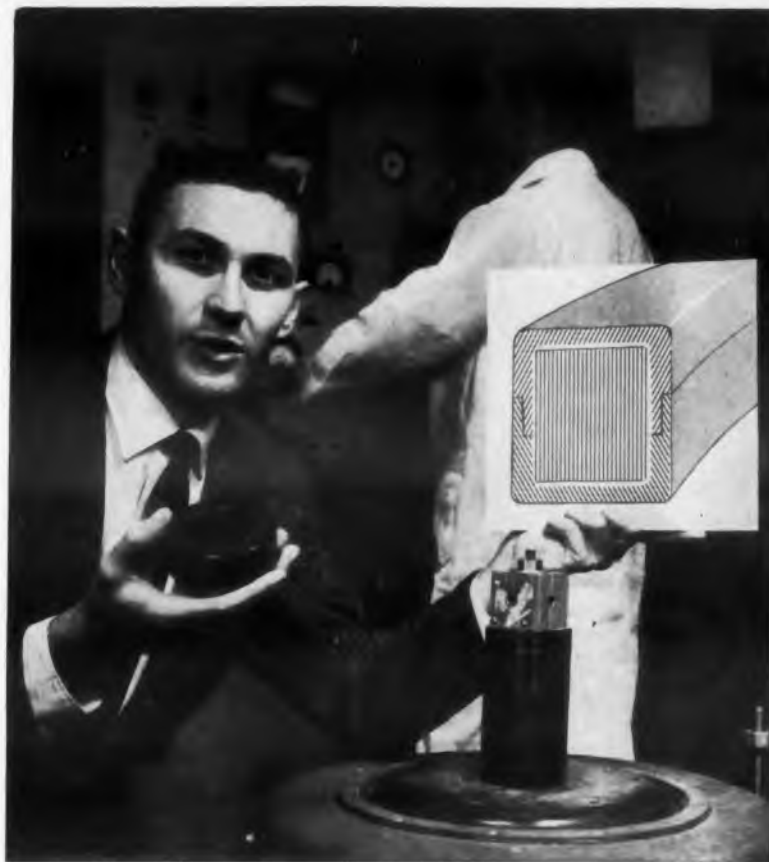
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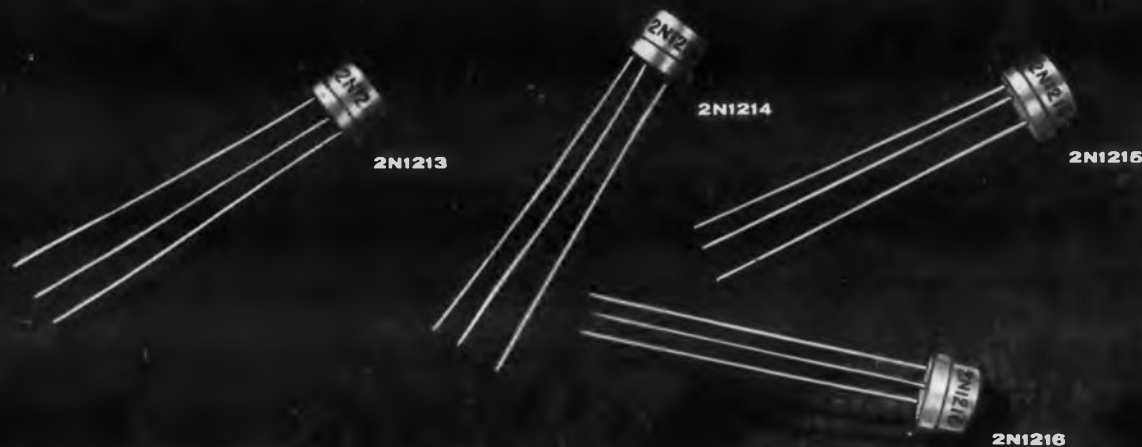
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