ELECTRONIC DESIGN

OCTOBER 25, 1960

SPECIALLY DESIGNED COMPONENTS CUT TRANSFORMER-RECTIFIER'S SIZE, WEIGHT...p. 42

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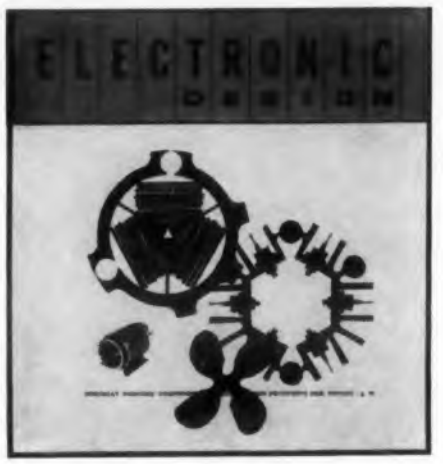

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Space Electronics:

Key Conferences in U.S. and Canada Consider Its Ups and Downs

SPACE ELECTRONICS developments—new techniques that are rocketing the art forward and old side effects that could ground it ignominiously—were on the agenda of major conferences in this country and Canada in the last month.

The sessions were:

- A communications symposium at Utica, N.Y., at which this nation's progress in space electronics equipment was weighed and found capable of meeting the challenge of the future, if industry exerted itself.
- A telemetering conference in San Francisco that disclosed, among other advances, hitherto classified information on ICBM and IRBM firings.
- Canada's largest scientific assembly, the IRE show, which stressed the vitality of the Canadian electronics industry and reported among space gains two radical developments in equipment.
- A meeting in Chicago on radio interference reduction at which speakers warned that clogged airwaves could imperil the American defense system and missile launchings.
- Another Chicago meeting, the National Electronics Conference, which had as one goal the updating of registrants on Spage Age electronics.
- A down-to-earth gathering of value engineers at Philadelphia that pointed to impressive savings resulting from value analysis and set as a goal three missiles for the price of one.

Utica

At the Fifth National IRE Communications Symposium in Utica (Oct. 5-7), Maj. Gen. Harold W. Grant, Air Force director of Communications-Electronics Headquarters, told a press conference that electronics was not holding up the nation's progress in space exploration. Present equipment,

The Atlas, this country's first ICBM, roars aloft majestically at Cape Canaveral, Fla., symbolic of space achievements that imbue the electronics industry with optimism.

Maj. Gen. Harold W. Grant, Air Force director of Communications-Electronics Headquarters, who addressed the Fifth National IRE Communications Symposium in Utica, N.Y.

he said, can handle guidance and data transmission for any space probe the country can launch at this time. The military leader expressed confidence that the electronics industry would keep ahead of developments in rocketry.

But far from complacent, General Grant balanced his optimism with stern reminders in a formal opening address to the meeting.

"The Air Force believes," he said, "that it is no longer enough—in fact it is no longer consistent with the plans for our country's survival—to put together by piecemeal methods a communications system that aims merely to catch up or keep pace with current military requirements. Rather we must anticipate further needs and future weapons.

"We must be ready for them before they have completed the journey from the drawing board to the factory and actually come into being. To meet the anticipated requirements of the future air weapons is the mission of a program known to most of you as 480-L, or the AIRCOM Modernization Program."

Referring to costs, General Grant continued:

"It is becoming more and more apparent that the communications-electronics phases of weapons systems development represent a rapidly increasing share of the total cost of national weapons. Balanced against these rising costs is the unde-

riable fact that to perform these essential functions by other than electronic means is impossible.

"I strongly feel, however, that if we are to accomplish our program objectives at a price we can afford, we must strive to obtain technological breakthroughs comparable to those that have been made in the fields of weapon yield and propulsion. It is the unfortunate fact that the communications-electronics field has notably lacked such a breakthrough.

"There is very little in the way of fundamental technique that we are using today that does not antedate World War II. The bulk of our advances have consisted of doing the same old things in a bigger and better way.

"This 'bigger and better' approach will not meet the challenge. It is too slow and vastly too expensive."

Symposium Draws 1000

More than 1,000 attended the symposium, conducted by the Rome-Utica Chapter of the Professional Group on Communications, IRE. Papers were presented, and 27 exhibits were on view. Plans were announced to expand the gathering next year to 75 exhibits.

Digital communications were explored in six unclassified sessions. One paper, by A. P. Brogle of the Army Signal Research and Development Lab, Fort Monmouth, N.J., discussed the results of a study of basic factors to be considered in selecting a system.

"A fundamental problem of recent system developments," Mr. Brogle reported, "is the selection of the method of transmission which yields best over-all performance for least total cost in required equipment. For an acceptable solution, this choice must be made within the permissible limits of these factors and under the constraints of restricted bandwidth, specified transmission media and modulations, given power outputs and transmission losses, predicted noise levels, and so forth."

The paper described a technique "for evaluating transmission distortion and the effects of noise in these systems directly in terms of the pulse error rate." A new method of transmission called biternary was cited and compared with quaternary transmission as a means of doubling the channel capacity of PCM systems without requiring increased bandwidth or transmission facilities.

"Binary transmission," the paper said, "is more tolerant to the effects of all types of interference than quaternary transmission and significantly reduces a major problem of quaternary transmission of excessive errors due to low frequency cut-off effects. The use of biternary transmission is planned in present and future military pulse code modulation systems." *(Continued on page 6)*

NEWS

F. de Jager and J. A. Greefkes of N. V. Philips' Gloeilampenfabrieken, Eindhoven, the Netherlands, discussed FRENA, a system for the transmission of speech at very low signal-to-noise ratios.

"For signal-to-noise ratios between 3 and 12 db, the intelligibility of ssb modulated speech can be increased by transmitting the amplitude and frequency information via two different channels, fulfilling different requirements as to bandwidth and signal-to-noise ratio," the paper reported. "At the receiver these two signals can be recombined to give a reconstruction of the original speech signal, which is only partly influenced by the noise.

"By choosing a special type of modulation, these two signals can be transmitted as one signal of nearly constant amplitude.

"The FRENA system combines a fairly drastic degree of clipping with two measures that are taken to diminish distortion. Firstly the clipping procedure is not performed on the audio speech signal but on a ssb modulated signal, so that many of the distortion components fall outside the wanted frequency band. Secondly, the amplitude information is not entirely discarded, the main envelope of the speech signal being transmitted via a second information channel having a narrow bandwidth of approximately 100 cps.

"In this way the 'frequency information,' as found in the zero-crossings of the clipped ssb

Teamwork News Coverage

The following ELECTRONIC DESIGN staff members furnished on-the-spot coverage of the meetings in this space report:

Lawrence D. Shergalis—Fifth National IRE Communications Symposium in Utica, N.Y.

Thomas E. Mount—1959 Space Electronics and Telemetry Show in San Francisco.

Alan Corneretto—IRE Canadian Convention and Exhibition in Toronto and National Electronics Conference in Chicago.

Howard Bierman—Fifth Conference on Radio Interference Reduction and Electronic Compatibility in Chicago.

George H. Rostky—Value Engineering Conference in Philadelphia.

signal, is separated from the 'amplitude information,' as contained in the envelope, and the mode of transmission of the two signals can now be adapted to their different demands as regards bandwidth and signal-to-noise ratio.

"At the receiving side the two signals are recombined to give an approximation of the original speech signal."

Electromagnetic Interference Problems

"Evaluation of Electromagnetic Interference Problems Using Computer Simulation Techniques" was the subject of a paper by D. R. J. White and W. G. James of the American Machine & Foundry Co., Alexandria, Va. The two described a digital computer simulation program for use by communications system and equipment designers who must consider electromagnetic interference.

Their simulation program is designed "to predict and analyze the interference experienced by an airborne receiver located in an electromagnetic environment."

"This environment," the paper said, "results from its associated transmitters, termed the 'test transmitter,' from a large deployment of discrete transmitters, and from atmospheric and cosmic noise sources.

"For each transmitter expected to contribute significantly to the signal environment, all parameters influencing its emitted signal strength are simulated and the results entered into computer storage. Among these parameters are modulation, antenna patterns, frequency signatures, and so on.

"Representations of propagation phenomena which modify emitted signals are entered into the program with tabulations of noise levels. Receiver antenna patterns, frequency response and detection characteristics also are simulated, along with signal acceptability criteria.

"All postdetector inputs from other than the test transmitter are summed, and the ratio of the test transmitter signal power level to the sum of all others is determined. The resultant ratio is modified in accordance with the postdetector characteristics to yield a receiver output channel signal-to-noise-plus-interference ratio."

One objective of the simulation program, according to the paper, "is to provide a tool for determining the effect of the interference on information transfer by the system under test." Another objective "is to make this tool sufficiently flexible that one may readily determine whether changes in the emitter environment, test transmitter or receiver characteristics, or any combination of these, will serve to reduce the interference level, and to what extent reduction will occur."

"The user," the designers said, "might evaluate changes in such factors as the test transmitter

power, frequency, polarization, location or operational doctrine, or in the antenna of the receiver, the front end noise level, or the if bandwidth."

Harold J. Pratt Jr. of Melpar, Inc., Boston, examined known factors that could conceivably influence earth-space communications.

"In most instances," he said, "accurate propagation and noise data do not exist for earth-space communications. Therefore, results already established for ground-ground or ground-low altitude systems have been extrapolated where they appear valid, or theoretical data have been calculated using mathematical models."

In his paper, "Propagation, Noise and General Systems Consideration in Earth-Space Communications," he analyzed the various propagation, noise and general system aspects and attempted to predict the optimum ranges of operating frequencies for such systems.

"The atmosphere is shown to be nearly transparent to rf transmission between 80 and 15,000 megacycles," Mr. Pratt said. "Various noise sources, both internal and external to the system, were investigated and a relative system sensitivity spectrum plotted."

Maximum available transmitter power and antenna parameters were predicted for the 1965-1970 era.

"Using the 'beacon' and 'radar' equations and considering fading effects and system weights and sizes," the paper said, "the optimum frequency range for one-way and two-way earth-space communications systems is determined to be 2 to 6 kilomegacycles."

"Use Of Optical Frequencies For Space Communication" was the subject of a paper by Cecil B. Ellis of General Precision Lab., Inc., Pleasantville, N.Y.

He reported that the spectrum from the infrared through the visible to gamma rays had been surveyed for signaling from earth or an earth satellite to a spaceship at planetary distances.

"The best region for signaling from a satellite vehicle," Mr. Ellis reported, "appears to be from —1000 to 400 angstroms.

"One information bit per second could be sent for a distance many times the diameter or the solar system. If the source is to be on the earth's surface, the best frequency region would be 4000 to 3000 angstroms. One could probably then reach the neighborhood of Mars at one bit per second when that planet is closest to the earth. Greater distances would be possible at slower information rates."

Mr. Ellis' analysis showed that neither the longer wavelength infrared region nor the short-wave X-ray and gamma ray regions were likely to prove useful for this application. For work in

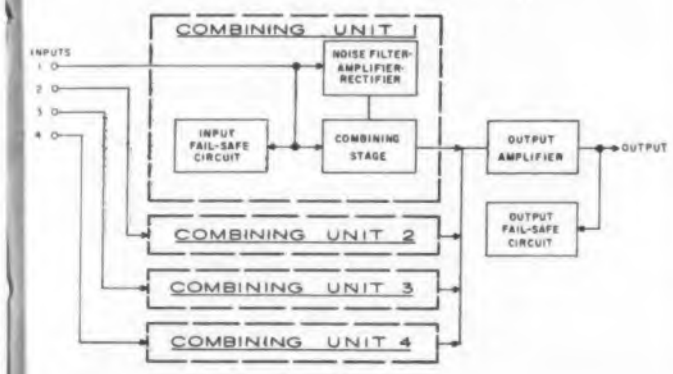
these parts of the spectrum, he noted, the photomultiplier might be replaced by a photoconductor for the infrared and by a scintillation counter for the x-rays and gamma rays.

San Francisco

The 1959 Space Electronics and Telemetry Show in San Francisco (Sept. 29-30) drew 700 registrants and 35 exhibitors. In sharp contrast to WESCON, held in the same city just a month previous, most registrants attended to hear the papers rather than to browse through a multitude of new products and services.

Noteworthy among the papers was "A Diversity Combiner for Telemetry," by Clifford Hall of Nems-Clarke. It described a combiner that accepts the outputs of four receivers and produces a single output. Since considerable effort to improve rf transmission between missiles and telemetry receiving stations has increased use of multireceiver stations, Mr. Hall's paper was considered timely.

Rf fields reaching the ground from a missile fluctuate rapidly in strength and polarization



Nems-Clarke diversity combiner for telemetry, described to San Francisco space electronics show, provides one strong output from four receivers. Signal polarization and strength from a missile fluctuate, but with right-and-left-polarized antennas and variously placed receivers, signal loss is minimized.

while the missile is in sight. When more than one antenna and receiver are connected to a combiner, the outputs result in a single signal of a quality often much higher than that of the output of any one receiver.

In Mr. Hall's diversity combiner each receiver contributes to the output in proportion to its signal-to-noise ratio. When the receiver output noises are uncorrelated, the combiner signal-to-noise ratio is equal to or higher than the best receiver signal-to-noise ratio.

A common cathode combining circuit is used in the combiner. Each receiver's contribution to

(Continued on page 11)

Tuning in at Random on the Conferences . . .

Lunik Uses PDM with Two Frequencies

The day the Soviet moon-circling satellite reached the moon, its PDM telemetering signal changed character sharply. A different type of modulation went into action at a much higher pulse frequency. Both types of telemetering signal, picked up by Western scientists, are still being analyzed by Space Technology Labs, several of the scientists told ELECTRONIC DESIGN in Chicago, but there is no real chance of learning much about Lunik's instrumentation setup from data so far recorded.

Of Engineers and Reliability

Dr. C. S. Draper of the Massachusetts Institute of Technology, recognized as this country's foremost guidance experts, told a National Electronics Conference navigation and guidance session in Chicago: "Any engineer worth his salt doesn't have to be reminded of the importance of reliability. And he understands that reliability is not quality control. Very often the grumbling feedback to parts people over failures are unjustified, because very often it is the equipment design that is just no good."

Utica Communications Symposium to be Permanent

The national administrative committee of IRE's Professional Group on Communications Systems voted to allow the Rome-Utica Chapter to hold a permanent yearly National Communications Symposium in Utica. Expanded facilities will be available when Utica's new civic auditorium is completed early in 1960.

Information Scientists Needed, OTS Chief Warns

Speaking at the opening luncheon of the National Electronics Conference, J. C. Green, director of the Office of Technical Services, told many of this country's electronic leaders that the answer to the problem of "exploding technical information" was the creation of information scientists or researchers on the same corporate levels as technical scientists and researchers. These new specialists, he asserted, would have central responsibility for seeing that all information from all sources promptly reaches the people who could use it.

GE Offering Company Value Engineering Service

General Electric, which founded the discipline of value engineering in 1947 under the leadership of Larry Miles, has organized a Value Engineering Service, ELECTRONIC DESIGN learned at Philadelphia. This month GE started selling the new service to its more than 100 departments around the country.

(Continued from page 9)

the combined output is controlled by sampling the receiver output.

Missile 'Drop Outs' Analyzed

Up to now, information concerned with ICBM and IRBM firings has been pretty well classified. It was with some interest, therefore, that those in attendance heard "Radio Frequency Propagation to and from ICBMs and IRBMs," by William Drake and Fred Howell, of Space Technology Labs. An analysis was made of a large number of missile launches to learn the whys of data "drop outs."

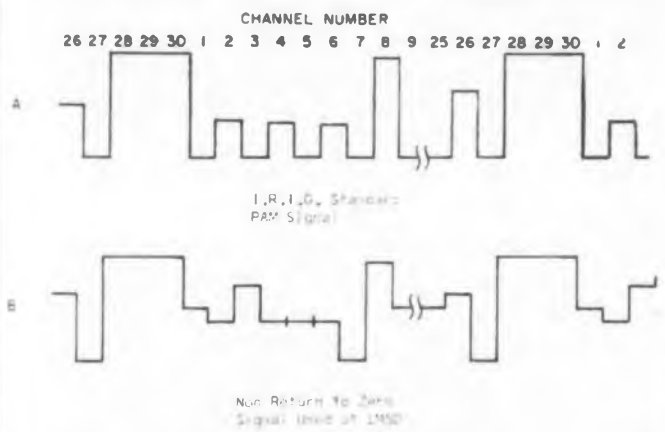
Typical difficulties were traced to antenna ionization, flame attenuation, antenna pattern (narrow beam width) and pressure shock wave. The paper presented a number of remedies:

- To stop antenna ionization, one should reduce the transmitter power to below the level that will result in sustained breakdown.
- To avoid flame attenuation, one should place airborne antennas as far as possible from the rocket exhaust. This ensures a better look angle between the antennas and the ground stations during a period of low aft aspect angle. Flame attenuation will be only slightly reduced.

In general, the authors urged that ground stations be placed for maximum aft aspect angle during powered flight—in particular not too near the launcher. A medium-gain antenna near the launch site will give adequate coverage during the first minute of flight, the paper reported, and high-gain tracking antennas placed down-range, where they have aft-aspect angles better than 90 degrees, will give excellent coverage from the time the missile appears over the horizon. This, in spite of the low transmitting power recommended in the first point.

Decom for a Wildcat System

William Kroll of the Lockheed Missiles and Space Division described "A Decommutation



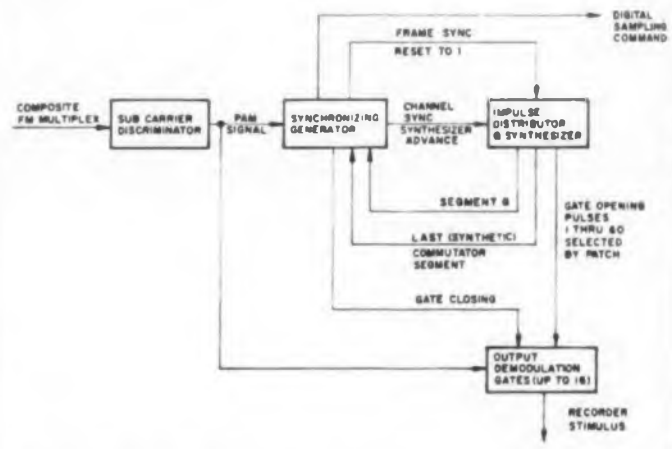
Lockheed's "wildcat" telemetry system, presented at San Francisco conference, has 100 per cent duty cycle. Upper signal is IRIG standard PAM signal with reference pulses. Lower curve is non-return to zero signal.

NEWS

System for FM/FM Telemetry" that permits doubling of the information capacity of a commutated telemetry channel. This is done, it was reported, by using a non-return to zero *PAM* signal.

Outstanding features of the decom system were given as:

- Continuous coverage of commutator speeds from below 60 to more than 600 points per second without resorting to plug in devices.
- Accommodation of 30, 45 or 60 commutators,
- Automatic synchronization when the signal first appears and sustained synchronization when commutator speed changes occur,
- Accommodation of commutator speed changes of ±30 per cent during a run,
- No effect on operation of the system should loss of frame synchronization occur for several frames.



System block diagram of Lockheed telemetry system for non-return to zero decommutation.

Deep Space Talking

Two approaches to space-to-earth communication were presented. Pasos and Heninger of the Philco Corp. described "A Reactance-Modulated FM Transmitter for Space Communications or Telemetry." A cavity oscillator using a planar power triode in a grid isolation circuit generates power in the 2 kmc region. The transmitter developed at Philco uses crystal diodes coupled into the cathode cavity to obtain a variable reactance for fm.

Jensen of Philco, however, solved some of the problems involved in using a voltage tuned magnetron. Since this tube is so efficient, it is a logical choice for space transmitting. But since it is basically a wide-band device, new techniques in high-voltage regulation and afc to maintain a stable frequency had to be developed. Jensen's paper, "A New Telemetry Transmitter Using a Voltage Tuned Magnetron for Space Environment," described some of the design solutions.

The technique uses a crystal oscillator output against the multiplied crystal frequency's mixed signal with the magnetron frequency. The frequencies from crystal and mixer are switched, amplified, detected, amplified and finally synchronously detected to provide correction to a saturable reactor regulator. With this technique, a wide band device like the voltage tuned magnetron can be used in a narrow-band application with good frequency stability, it was said.

Toronto

Two themes, the strength of the Canadian electronics industry and the importance of space electronics, dominated the fourth annual IRE Canadian Convention and Exhibition in Toronto (Oct. 7-9). Some 8000 registrants saw more than 120 exhibits. More than 100 papers were presented.

In the well-attended space meeting, R. K. Brown of Canada's Defense Research Board reported on the development of equipment for studying the ionosphere from above, using rockets and satellites. For the project, the board has designed a sounding and telemetering set that will develop a peak power of 80 watts for sounding, a 0.8-watt average power and a telemetry average power of 25 watts. A solar-cell array will supply 7 watts at a cost of $3000 per watt.

The set, which will operate between 2 and 15 mc, was designed on the basis of the following loss figures:

Thermal noise (over 30 kc bandwidth)	−159 dbw
Cosmic noise	+ 45 db
Antenna losses	+ 10 db
Space transmission losses	+103 db
Receiver signal-to-noise	+ 10 db
	+ 19 dbw

T. A. Randall of Aeronca, in a paper on lunar communications, emphasized that only a little work, relatively, has been done on space receivers and even less on transmitters and antennas for space use. Especially needed, he said, are power sources, receiver circuitry that will track doppler shifts in transmitter frequency, and space-vehicle directive antennas with high stability and coverage from broad to narrow bandwidth.

Radical Advances Reported

Two radical developments were reported in the panel discussion that followed the space electronics papers. One, a "thermo-electron converter" power source, was described by Mr. Brown as a giant diode. In the device, a cylindrical, chemically heated filament is enclosed with 0.005 inches of tolerance in another cylindrical element. The converter was said to develop 0.5 volts at 5 amperes "with very high efficiency."

The other development, described by a Crosley

notes on the life expectancy of capacitors

"At half past nine by the meet'n-house clock,—
Just at the hour of the Earthquake shock!
What do you think the parson found,
When he got up and stared around?
The poor old chaise in a heap or mound,
As if it had been to the mill and ground!
You see, of course, if you're not a dunce,
How it went to pieces all at once,—
All at once, and nothing first,—
Just as bubbles do when they burst.
End of the wonderful one-hoss shay.
Logic is logic. That's all I say."

From the "One-Hoss Shay" by Oliver Wendell Holmes

The designer and builder of the One-Hoss Shay achieved an interesting objective of some modern-day designers—a product utilizing component materials of great uniformity and well-coordinated life expectancy.

In capacitor design the One-Hoss Shay concept would result in enormously expensive units since materials normally vary in their physical and electrical characteristics. Therefore, the manufacture of capacitors with perfectly uniform characteristics from one to the next would involve a complex process of detailed selection of their component materials, and uniform assembly procedures. Economical and practical capacitors must accordingly be designed with two points in mind:

1) **They will have a finite, but should have a very low, failure rate.**
2) **They will have a finite, but should have a long, life expectancy.**

Exact determination of these levels for any capacitor design is a complex process of analysis and testing. A few of the highlights of these methods will be discussed below.

It has previously been shown (1) that the life expectancy of paper-oil dielectric capacitors is inversely proportional to the fifth power of the applied DC voltage. Further studies (2) indicate that one responsible mechanism for this exponential relationship is gassing of the oil. The life expectancy was also found to be halved for each ten degree Centigrade increase in operating temperature, over the normal range. This effect is probably analogous to the familiar chemical rule concerning the electrolytic action rate of solutions. Thus the actual measured life under a set of test conditions can be translated into expected life under another set of conditions of voltage and temperature, as follows:

$$L_2 = \left(\frac{E_1}{E_2}\right)^5 \cdot T_1 \cdot 2^{-\left(\frac{t_2 - t_1}{10}\right)}$$

where
L_2 = **expected life in hours**
E_1 = **test voltage**
E_2 = **actual working voltage**
T_1 = **time duration of test in hours**
t_1 = **test temperature in degrees Centigrade**
t_2 = **actual operating temperature in degrees Centigrade**

This relationship applies only to a failure caused by the actual degradation of the paper-oil dielectric brought about by the stresses of voltage and temperature. It would be most misleading to say that each and every failure experienced in any production lot will obey this law—some failures may be the result of manufacturing errors or material flaws.

This basic formula, although evolved for paper-oil capacitors, appears to apply to other types, such as mica and plastic film, but the fifth power law does not hold for these types since their molecular structure is significantly different. A voltage exponent of seven to ten appears to be appropriate for these types. It is also possible that the rule of halving of life expectancy with each ten degree Centigrade rise in temperature may not strictly apply to materials other than paper-oil because of their inherently different sensitivity to temperature, and due to different ranges of operating temperature. These points are the subject of much continuing investigation.

The formula shown has thrown a new light on the use of accelerated conditions as a production evaluation tool. Accelerated tests have, in certain instances, become a processing procedure, offering two major advantages:

1) **So-called "early" failures can be eliminated to a high degree by proper over-stressing.**
2) **Life expectancy can be better evaluated since measured results are available in a short time.**

Thus accelerated, or "screening," tests can serve a highly useful purpose where very high degrees of reliability are required, and must be measured or estimated quickly. This processing and evaluation, of course, involve additional expense, and are therefore not used for run-of-the-mill products. They also do not ensure a good product if the design or manufacturing controls are basically inadequate, and must never be used to sort good units from an inherently bad population.

One additional point should be made before we summarize an example: since, unlike the One-Hoss Shay, we cannot have all production capacitors fail simultaneously, some attention must be paid to the distribution of the failures with regard to time. It is important to know the shape of the failure rate curve.

Some hypothetical numbers can be used to illustrate the previous discussion. Assume that a group of 200 silvered mica button capacitors, designed for 500 WVDC and 125°C., is subjected to an accelerated test of 1000 VDC and 150°C. for 50 hours. At the end of this time, a failure level of one per cent is found, and the failures have occurred at 10 and 40 hours (we assume they are "pure" dielectric failures). Assuming a voltage exponent of 8 to apply, we may use the expected life equation as follows:

$$L_2 = \left(\frac{1000}{500}\right)^8 \cdot T_1 \cdot 2^{-\left(\frac{125 - 150}{10}\right)}$$

therefore, $L_2 = 1435\ T_1$

or, under actual conditions, these failures would have occurred at 14,350 and 57,400 hours of continuous operation. These failures then represent 0.035 and 0.009 per cent failures per 1000 hours, respectively. These times to failure correspond to over 16 and 65 years of normal, intermittent service.

References:

1) J. R. Weeks, Capacitor Life Testing, Bell Laboratories Record. Vol. XXIV, No. 8. August, 1946.
2) Harold Basseches and Mary W. Barnes, Gassing of Liquid Dielectrics Under Electrical Stress. Industrial and Engineering Chemistry. Vol. 50, No. 6. June, 1958.

SC-59-8

engineer, is a space antenna wound in an extended spiral then compressed to coil-spring form. From its 2.5-inch compressed height the antenna (weighing 1.5 ounces) springs open to a 6-foot length.

Space applications were the background for much of the discussion in the solid-state session. G. C. Sziklai of Westinghouse pointed out the advantages of molectronic equipment for space use in his paper on molecular electronics, and A. C. H. Hallet of the University of Toronto did the same for the properties of metals at very low temperatures.

In all, there were 25 technical sessions, covering nearly the whole range of the electronic art.

Among the products on display were:

- Bach-Simpson's frequency controller-indicator, which won the best-Canadian-designed-component award at the show. (Bach-Simpson won last year's inaugural contest with an oscilloscope.) The novel device uses a synchronous motor to drive an ac generator that provides a voltage varying with the frequency being measured. The unit is said to be about one-third the size of standard frequency meter-controllers.
- Raytheon's GP803 scan converter, which won the best-product-design award. The unit was developed for bright radar display of air traffic (See *ED* June 24, 1959; p. 3).
- A filament-voltage regulator designed by C. P. Clare Canada, Ltd., in which a mercury-wetted relay cuts a resistor into the filament circuit of vehicular communications equipment to limit the effective heating voltage applied to the load. The unit reduces battery-generator input surges from 40 to 5 per cent.

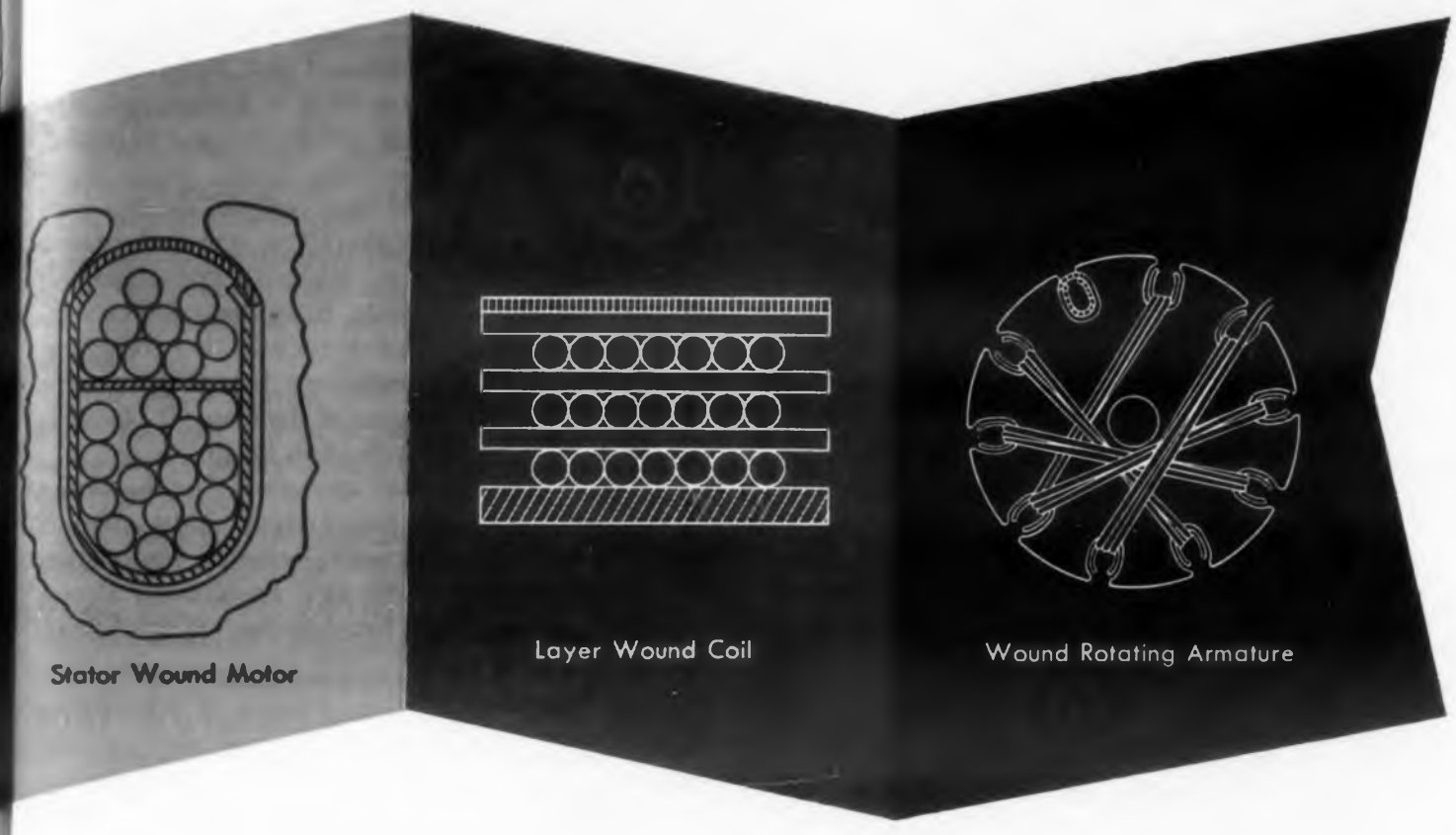
Announced at the convention dinner was the establishment of a region Gold Medal Award for technical or administrative contribution to research or development.

Chicago

The Fifth Conference on Radio Interference Reduction and Electronic Compatibility, held in Chicago (Oct. 6-8), heard this warning by G. P. Sutton, chief scientist of the Advanced Research Projects Agency in Washington:

"Failure to achieve a satisfactory and relatively interference-free environment may seriously compromise the effectiveness of our defense system. . . . Radio interference may mean the loss of lives, expensive equipment or strategic advantage."

In a keynote address to 300 engineers at the conference, Mr. Sutton urged more general consideration of problems of frequency allocation, radiated power requirements, antenna directivity and other factors to minimize interference.



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A multi-fold increase in launched space vehicles for weather observation, scientific exploration, biomedical investigations and communication repeater stations is scheduled for the near future, Mr. Sutton indicated. Unless spectrum allocation is determined in advance and undesired emission eliminated, he asserted, chaos will result. Telemetry data may be rendered useless and valuable scientific programs voided, he warned.

Three Vital Phases in RFI Reduction

In the military area, as altitudes, velocities and mobility of vehicles increase, communication-electronic (C-E) systems increase in complexity, power output and spectrum utilization, the conference was told. A. H. Sullivan Jr. of Engleman & Co., Washington, predicted that "in time, interference aspects may predominate over all other considerations in engineering C-E systems."

He presented three vital phases in planning an interference-free C-E system:

- Prediction of interference, based on known data and measurements concerning (1) system and equipment performance, (2) ambient electromagnetic environment and (3) propagation and frequency data.
- Engineering the C-E system for maximum compatibility with the electromagnetic environment, based on data furnished by prediction.
- After installation of the system, reducing existing interference not forseen during the prediction phase.

Prediction Techniques Described

Relatively small systems or individual pieces of equipment can conceivably be "cleaned up," the conference heard, by effective shielding, adequate filtering and rerouting of cables and leads. For major military installations, however, RFI headaches must be reduced to a minimum during the initial planning stage.

Site selection, equipment to be used, operating frequencies assigned—all must be evaluated for minimum interference interaction, it was stressed.

C. E. Vlakely of the Georgia Institute of Technology outlined the method of constructing Mutual Interference Charts from which a systematic selection of operating frequencies can be obtained for adjacent equipment with maximum freedom from interference.

Missile Hazards Noted

A film depicting numerous missile launchings—some successful, some failures—offered grim evidence of the potential dangers of RFI.

H. R. Austin of Motorola, Inc., Chicago and F. E. Rock of General Electronics Lab, Inc., Cambridge, Mass., presented a paper on the interference possibilities open to a satellite communications system from mutual, galactic, terrestrial and airborne sources. *(Continued on page 16)*

NEWS

H. Kilberg of RCA Service Co., Patrick Air Force Base, Fla., discussed the RFI detection system at the Atlantic Missile Range and presented slides depicting the complex and varied instrumentation in use.

Electrically ignited pyrotechnic devices are used in missiles and aircraft as one-shot energy sources for destructors, explosive bolts, ejection seats and other actuators, it was noted. The hazards of stray electromagnetic radiation triggering such devices and precautions being taken were covered by B. Weinbaum of the Convair Division, General Dynamics Corp., San Diego.

The conference was sponsored by the Army Signal Research and Development Labs and was conducted by the Armour Research Foundation in cooperation with the IRE Professional Group on Radio Frequency Interference.

Space Equipment Shown

The NEC conference in Chicago (Oct. 12-15) featured space equipment and components in many of the 260 exhibit booths.

The requirements for very long range communications equipment, for ultra reliable systems, for massive data handling and for new solutions to old problems were the bases of many of the roughly 110 papers delivered.

A highlight of the conference was a special session at which scientists of Space Technology Labs reported on the findings to date of Explorer VI and three Lunik satellites. Besides revealing new data on the earth's radiation belts and magnetic fields of the earth and moon, the scientists described the Telebit system for digitizing, storing and telemetering data collected by the sensors of Explorer VI.

Attendance at the conference, swelled by a simultaneously held AIEE fall meeting, reached the neighborhood of 10,000.

Philadelphia

The EIA-sponsored Value Engineering Conference in Philadelphia (Oct. 6-7) argued that government and industry were not getting full value for their money. Weapons and communications systems, produced at crash-program speeds, cost millions more than they should, Larry Miles, value engineering chief of General Electric, contended.

Mr. Miles, founder of the 12-year-old movement of value analysis, said that system costs could be slashed without sacrifice in performance. The target, he declared, should be three systems for the price of one.

With crusading fervor, speaker after speaker from major companies—from GE, Radio Corporation of America, Stromberg Carlson, Raytheon—

nd speakers from the military—BuShips, BuAer, Army Ordnance; Army Rocket and Guided Missile Agency—all cited outstanding records of cost savings inspired by value analysis.

Savings mounting to millions were attributed to the small but growing army of value engineers.

Conferees complained bitterly of being mistaken for mere cost reductionists. The difference, they argued, is clear:

"The cost reduction man tries to shave the cost out of a part. The value analyst wants to chop the cost out of a function."

The value engineer's golden book starts with: What does it do? What does it cost? What else can do the job? What will that cost?

The conference was hailed as a milestone in value analysis. Announcements of more and more military contracts with value-engineering incentive clauses pleased the unexpectedly large attendance of 360.

(See *ED* staff report on value engineering Nov. 12, 1958.) ■ ■

CONFERENCE QUOTES...

On Molecular Electronics . . .

"In the next ten years, materials engineers and systems engineers will no longer be separated by a component engineer. The component specialist will become either a materials or systems man, and a new type of engineer will be born, the molecular engineer." *G. C. Sziklai, Westinghouse, after delivering a paper on molecular electronics at the Canadian IRE.*

On Space Guidance . . .

"Although no radically new techniques will be required, present ones need to be improved considerably to be compatible with the severe size, weight and power limitations imposed by space operations, the rigorous reliability requirements for lengthy performance and the uncompromising accuracy demands of space navigation." *Bernard Lee, Emerson Electric, in a discussion of space guidance at NEC in Chicago.*

CIRCLE 17 ON READER-SERVICE CARD ➤

WASHINGTON REPORT

Ephraim Kahn

Electronics Subcontracting To Be Reviewed

Big electronics companies with prime contracts from the Defense Department may be visited by investigators from the House Small Business Committee. They will be asked about their subcontracting programs and what their plans are for throwing more business to smaller companies.

Underlying the committee's activity is its apparent desire to impose some sort of Congressionally approved rules that will force the Government to put more prime contracts in the hands of small firms. The committee's staff has made studies of government buying and small business. Its conclusion is that "although the Department of Defense has contended that the future for small business in Government procurement lay in the subcontracting field because of the innovation of the new complex weapons, the only protection for an equitable share of procurement for small business is still in the prime contracting field."

The group also asserts that it is only in prime contracts that legislative control exists over money spent. In the "subcontracting field, there is no legislative control over the procurement dollars and there is no method established in which Congress is able to follow and direct the procurement dollar to ascertain how much, if any, is going to small business." Efforts of prime contractors to buy from small firms vary widely, "but there is no equality for small business," as the committee's staff sees it. Despite claims of efforts to correct a situation in which the percentage of prime defense contracts going to small business continues to decline, "nothing constructive is being done to overcome this decline."

The fact that small firms are receiving only 3.4 percent of prime contracts for R&D draws heavy fire from the Committee. It says that this portends "a concentration of know-how into the hands of the larger manufacturers. The dominant position of these favored manufacturers may become entrenched if they are permitted to acquire a disproportionate share of the benefits of modern research and development."

A subcommittee of the Small Business Com-

mittee may, in effect, take its case to the country. The group, headed by Rep. Multer (D., N.Y.) "deems it important that small-business firms in the field be given an opportunity to tell their story to Congress."

The committee will, of course, continue its push for increased use of advertised, competitive bidding in military purchasing. It claims, for example, that in connection with a single purchase of radar systems, $750,000 were saved. Similarly, in a procurement of a radiac system, $158,000 were saved.

Staff studies of interest to electronics companies are now being made. They include:

(1) The protection of proprietary rights of small firms that develop items at their own expense.

(2 The continued use and increase of negotiated procurement rather than the advertised, competitive method. The group also wants to be sure that bidding procedures have been effectively improved "to guarantee that small business will receive full bid sets, including specifications, drawings, amendments, and so forth, in ample time to permit submission of responsible bids."

(3) The use of restrictive language in specifications which precludes small business from having an equal opportunity to compete.

(4) The nature and extent of Qualified Bidders' Lists, planned procurements, and mobilization-type procurement which exclude small business from having an equal opportunity to compete for Government business.

(5) Whether the Government's buying agencies are putting enough emphasis on the joint-determination and set-aside programs to guarantee that full advantage is taken of the potential of small firms.

(6) Problems in the issuance of certificates of competency and certificates of small business, to determine whether small firms are receiving fair treatment and "to guarantee that when small business concerns are low bidders that they receive the contracts."

Senate Scores "Loose" Patent Procedures

The long-range move in Congress to impose tighter controls over patents in which the government has an interest has been pushed along another notch. The Senate Subcommittee on Patents, Trademarks, and Copyrights has sharply scored the "comparatively loose procedures" used by the Veterans Administration to make the results of its research available to the general public. The agency has not taken title to any inventions but has left this with contractors, reserving the right (which it never used) to compel issuance of royalty-free licenses for patented items.

MEETINGS

Calendar of Events

November

2-4	National Midwestern Meeting, "New Frontiers for Aviation," Hotel Lassen, Wichita, Kans.
2-5	11th Exposition of the ARI, Air-Conditioning and Refrigeration Industry, Atlantic City, N. J.
3-5*	Mid-America Electronics Conference, Kansas City Section of the IRE, Kansas City Municipal Auditorium, Kansas City, Mo.
4-6*	National Automatic Control Conference, IRE, Sheraton-Dallas Hotel, Dallas, Texas.
4-6	Eastern Analytical Symposium and Instrument Exhibit Baltimore-Washington, Delaware Valley, New York and New England Sections of the Society for Applied Spectroscopy, Analytical Groups of the N.Y. and N. J. Sections of the American Chemical Society, Metropolitan Microchemical Society, Hotel New Yorker, N. Y.
4-6	ANS Winter Meeting. American Nuclear Society, Sheraton Park Hotel, Washington, D. C.
5-6	Control Systems Components Conference, IRE, AIEE, SAE, ISA, ASME, Sheraton Hotel, Dallas, Texas.
9-11*	4th IRE Instrumentation Conference and Exhibit, IRE, Atlanta Biltmore Hotel, Atlanta, Ga.
9-11	Radio Fall Meeting, IRE, EIA, Syracuse Hotel, Syracuse, N. Y.
10-12*	12th Annual Conference on Electrical Techniques in Medicine and Biology, AIEE, IRE, ISA. Sheraton Hotel, Philadelphia, Pa.
12-13	American Society of Industrial Designers, Statler Hilton Hotel, New York, N.Y.
16-19	Conference on Magnetism and Magnetic Materials, AIEE, Office of Naval Research, American Physical Society, IRE, and the Metallurgical Society of A.I.M.E. Sheraton-Cadillac Hotel, Detroit, Mich.
16-20	14th Annual Meeting and Astronautical Exposition, American Rocket Society, Sheraton Park Hotel, Washington, D. C.
16-20	5th International Automation Congress and Exposition. New York Trade Show Building, New York, N. Y.
17-19	Northeast Electronics Research and Engineering Meeting. IRE, Boston Commonwealth Armory, Boston, Mass.
19-20	6th Annual Meeting of the Professional Group on Nuclear Science, IRE, Somerset Hotel, Boston, Mass.
23-24	Symposium on Solid State Techniques in Instrumentation, ISA, IRE, AIEE, Benjamin Franklin Hotel, Philadelphia, Pa.

*Includes meetings described herewith.

11th Annual Mid-America Electronics Conference, November 3-5

The Mid-America Electronics Conference (Maecon-1959), sponsored by the Kansas City Section of the Institute of Radio Engineers, will be held at Municipal Auditorium, Kansas City, Mo. The program will consist of 16 sessions. Papers covering various phases of professional group interests will include: Engineering Education and Management, Simulation and Computers, Technical Writing, Components and Reliability, Guidance and Communication, Trans-

mission and Control Systems, Adaptive Servos and other Nonlinear Devices, Wave Propagation, Medical Electronics, Communications and Airborne Electronics. Conference Chairman is I. J. Jones, Maecon, Bendix Aviation Corp., P.O. Box 1159, Kansas City 41, Mo.

National Automatic Control Conference, November 4-6

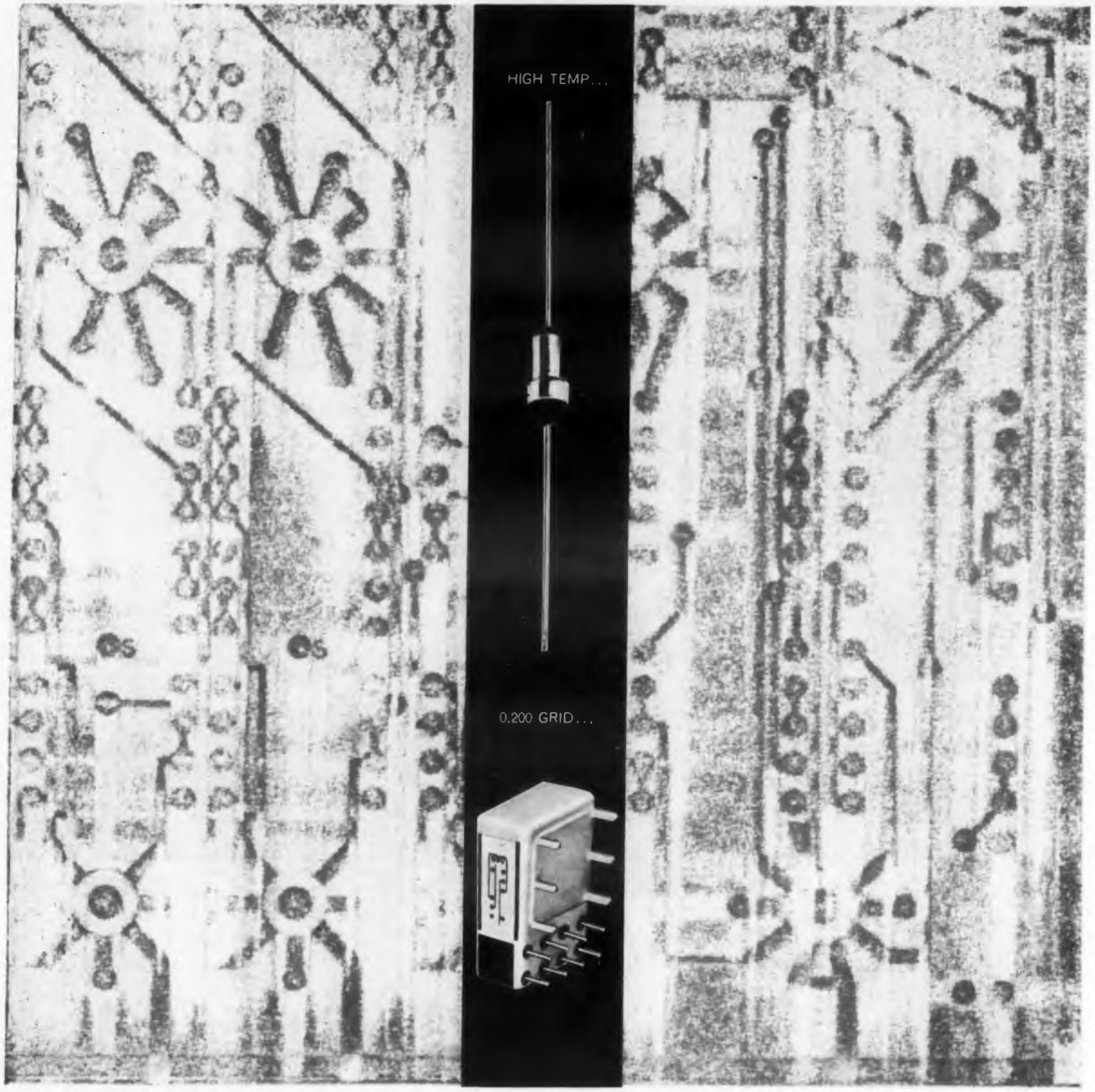
The IRE Professional Group on Automatic Control will sponsor a National Automatic Control Conference in Dallas, Tex., at the new Sheraton-Dallas Hotel. Control groups from other organizations such as the PGIE, AIEE, ASME, and ISA will participate in the activities. One of the prime purposes of the sessions is to have specifications people make their reactions known and also for industrial people to have a "sounding board." The Chairman is Denny D. Pidhayny, Ramo-Wooldridge, P. O. Box 90534 Airport Sta., Los Angeles 45, Calif.

4th IRE Instrumentation Conference, November 9-11

The Atlanta Biltmore Hotel in Atlanta, Ga., will be the site for the IRE Instrumentation Conference. Technical Sessions will include papers dealing with Reliability, Measurements, Data Gathering and Display, Nuclear Instrumentation, Semiconductor Applications, and Missile Satellite Instrumentation. The exhibit will include a wide variety of electronic equipment related to instrumentation, data gathering, and related areas. Chairman is H. N. Zeidler, Technical Program Committee, 1960 Western Joint Computer Conference, Stanford Research Institute, Menlo Park, Calif.

12th Annual Conference On Electrical Techniques In Medicine And Biology, November 10-12

The 12th Annual Conference on Electrical Techniques in Medicine and Biology will take place in the Sheraton Hotel, Philadelphia, Pa. It is sponsored by the Joint Executive Committee in Medicine and Biology, appointed by and representing the pertinent interests of the American Institute of Electrical Engineers, the Institute of Radio Engineers for its group on Medical Electronics and the Instrument Society of America. The objective of the conference is to contribute to the further advancement of the scientific area between the medical and biological sciences and electrical engineering principles, both from an applied and a basic point of view. A part of the meetings will be devoted to various forms of nonionizing radiation. This includes both biological effects and the use of radiations as a research tool. Conference Chairman is Dr. Herman P. Schwan, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.



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EDITORIAL

Overtime is Needed to Get Us Into Space

We can postulate the ideal in one step, but it takes many steps to get there. This truism is recognized in practically all fields of endeavor except, seemingly, when it comes to developing space vehicles.

In the area of rocket development we hope to close a nine-year Russian lead in as little as two years. It lately appears that we expect to accomplish this feat with a cut in funds. "It can't be done," says General John B. Medaris as he reports the slowdown of the Saturn timetable because of financial difficulties.

According to the General, if we are going to compete at all with the Russians in conquering space there has to be a solid, well-financed program. He says right now we are straddling the issue. Current predictions of the 1960 budget for defense spending show future cut-backs, which means either a reduction in operating forces or missile activity

We flounder in indecision while the Soviets efficiently proceed to put up Luniks. President Eisenhower himself may have to decide whether Saturn, for example, will be turned over to the Air Force, or NASA, continued by the Army, or canceled altogether. We seemingly have neither policy nor organization.

While our missile and space vehicle developments may be adequate for national survival, they are not at all adequate to posit us in the role of a world leader. The act that established NASA declared, in the American tradition, that our "activity in space should be devoted to peaceful purposes for the benefit of all mankind." If our free democratic society can outdo our adversary in bringing the fruits of the new frontier, space, to the people of the world we may survive with our liberty and our justice inviolate. But if we cannot tap the resources of space for man's benefit, we face the day of economic impotency. Our political liberties will then be meaningless.

Time, therefore, is a most crucial factor. We need a crash program to meet the challenge before us. We cannot be content to risk our future on the success of one or two long range space programs. The military's current resources should be kept on the job of testing out missile after missile. Until we evolve a national policy, let inter-service rivalry work for us to accumulate a continuum of data and knowledge. We need the sophisticated systems that are on paper, but the sophisticated comes generations after the simple and crude. The time span of several generations must be telescoped for us, and in this period of limited available manpower, overtime, much overtime is needed.

James C. Kyprios

Design Procedure For The Schmitt Trigger

Leonard L. Kleinberg
Senior Engineer, Guided Missile Lab.
I.T.T. Laboratories
Nutley, N. J.

Although Schmitt trigger circuit analysis is covered in various texts, the information and procedure required for its design are not well-known. Lengthy calculations and time-consuming trial-and-error setups, the usual approaches followed, can be eliminated by the design steps outlined.

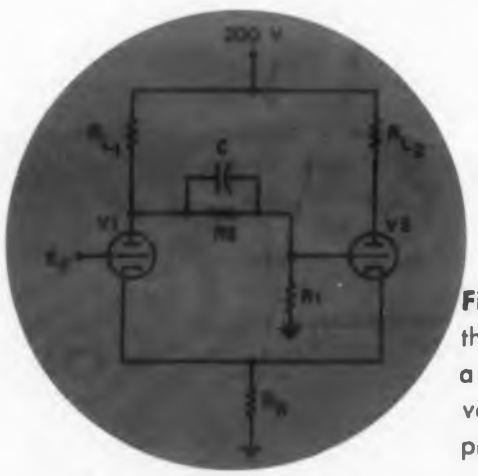

Fig. 1. Basic circuit of the Schmitt trigger using a 6922 dual triode in a voltage comparator application.

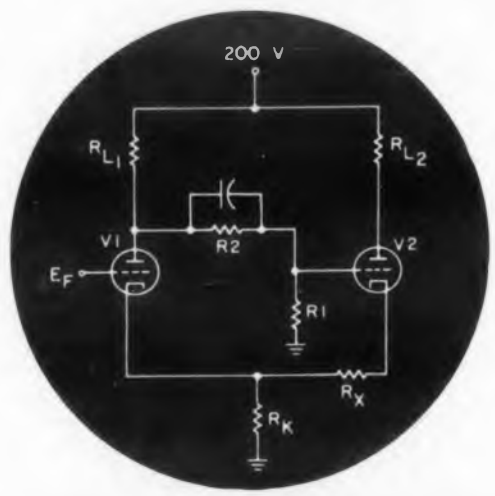

Fig. 3. Schmitt trigger circuit modified to avoid hysteresis.

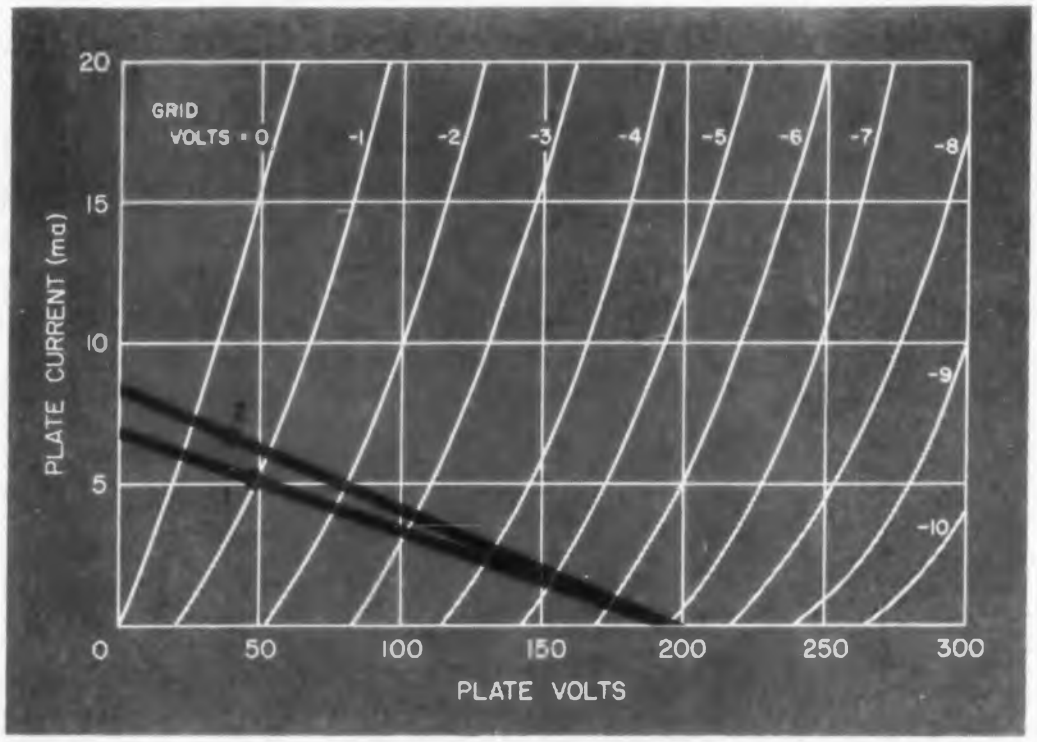

Fig. 2. Plate characteristics of the 6922 tube with load lines inserted for sample design of Fig. 1.

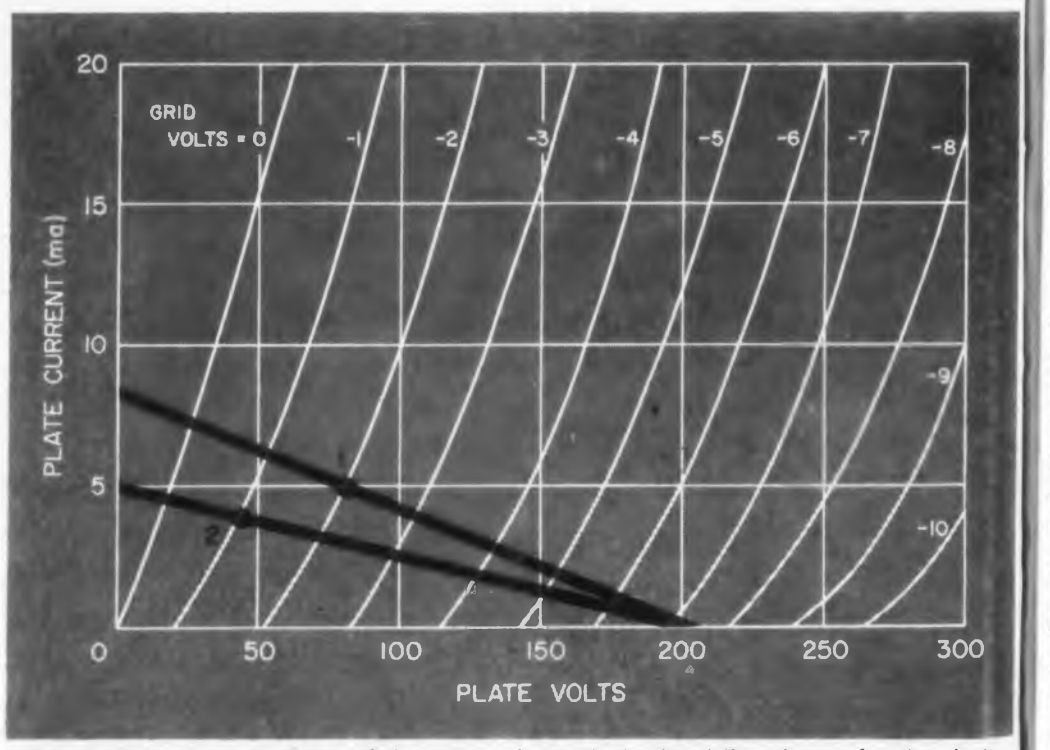

Fig. 4. Plate characteristics of the 6922 tube with the load line drawn for the design shown in Fig. 3.

LABORIOUS calculations and tedious trial-and-error procedures can be eliminated from Schmitt trigger circuit design by following the step-by-step technique presented. Since there are more variables (five) in the circuit than there are modes of operation (two), an algebraic solution is not possible; some conditions must be chosen and others solved for.

Circuit Operation

When T_2 is conducting, the voltage developed across R_k in Fig. 1 is sufficient to maintain T_1 at cut-off. When the grid of T_1 reaches firing voltage E_F, T_1 begins to conduct heavily and T_2 is cut off. The rapid transition of the circuit depends upon the regeneration of T_1 through R_k. As the plate of T_1 falls, the grid of T_2 also falls, reducing the current through R_k. The current through R_k is increased by the conduction of T_1. However, the decrease in current through R_k due to T_2 is greater than the increase in current due to T_1. This is easily obtainable through the gain of T_1 and the ratio $\frac{R_1}{R_1 + R_2}$.

The condition of regeneration is that the gain-crossover ratio product be greater than unity.

Another condition that should be imposed upon the circuit operation is that when the transition takes place, T_1 shall operate in its normal grid base region. Quite often T_1 will draw grid current and load the driving stage.

Design Procedure

The following design procedure simplifies calculations of all circuit components and is more rapid than the trial and error technique. Potentiometers may be used in the circuit for appropriate adjustments. The value of E_f is arbitrarily chosen to be 20 v and the tube is a 6922 dual triode.

Step 1. The cathode potential must maintain T_1 at cut-off. The cut-off potential, as obtained from the characteristic curves is approximately −7 v. *(Cont. on p. 26)*

The cathode potential must be:

$$e_{RK} = E_f - E_{co} = 20-(-7) = 27 \text{ v.}$$

Step 2. Values of bias and current are chosen that are compatible with the tube's characteristics:

$$i_{b2} = 5.0 \text{ ma}$$

$$e_{gk2} = -2 \text{ v} \quad \text{(Point 1 on Fig. 2)}$$

Step 3. A load line can be drawn for R_{L2} and R_k. The extended load line yields a maximum tube current of 8.3 ma. (Line 1, Fig. 2)

$$R_{L2} + R_k = \frac{200 \text{ v}}{8.3 \text{ ma}} = 24 \text{ K}$$

R_k may be determined:

$$R_k = \frac{e_{RK2}}{i_{b2}} = \frac{E_f - E_{co}}{i_{b2}} = \frac{27 \text{ v}}{5 \text{ ma}} = 5.4 \text{ K}$$

R_{L2} may now be determined:

$$R_{L2} = 24 \text{ K} - 5.4 \text{ K} = 18.6 \text{ K}$$

Step 4. Since R_{k2} is at a potential of 27 v and the bias on T_2 has been chosen as -2 v, the grid potential of T_2, e_{C2}, is known.

$$e_{C2} = e_{Rk2} + e_{gK2} = 27-2 = 25 \text{ v}$$

The ratio of $\frac{R_1}{R_1 + R_2}$, A, may now be calculated.

$$A = \frac{e_{C2}}{E_{bb}} = \frac{25}{200} = 1/8$$

Where $R_1 + R_2 \gg R_L$.

Step 5. When the grid voltage of T_1 reaches the potential of E_f (20 v), the transition should take place. A value of bias is chosen for T_1 so that T_1 goes into heavy conduction. Choose $e_{gK1} = -1$ v. The current through T_1 is immediately known.

$$e_{Rk1} = E_f - e_{gK1} = 20 - (-1) = 21 \text{ v}$$

$$i_{b1} = \frac{e_{Rk1}}{R_k} = \frac{21 \text{ v}}{5.4 \text{ K}} = 3.9 \text{ ma}$$

Step 6. Since the bias and plate current are known, the voltage across the tube is known. Plot $i_{b1} = 3.9$ ma and $e_{gK1} = -1$ v on the curves (Point 2 of Fig. 2) and draw the load line as in Step 3. The maximum tube current (T_1) is 5 ma.

$$R_{L1} + R_k = \frac{200 \text{ v}}{5 \text{ ma}} = 40 \text{ K}$$

$$R_{L1} = 40 \text{ K} - 5.4 \text{ K} = 34.6 \text{ K}$$

All components in the circuit are now known. The remaining calculation is to check and determine if T_2 is off.

$$e_{C2} = (e_{Rk1} + e_k)\, A = \frac{(21 \text{ v} + 42 \text{ v})}{8} = 7.9 \text{ v}$$

$$e_{gK2} = 7.9 \text{ v} - 21.0 \text{ v} = -13.1 \text{ v}$$

This establishes that T_2 is cut off.

To bring T_2 into conduction, the grid of T_1 must be brought below 20 v, a condition termed hysteresis. In some applications this effect is not detrimental, while in others it is of paramount importance that the circuit switch both ways at E_f.

Modification to Avoid Hysteresis

Fig. 3 illustrates a Schmitt trigger circuit in which hysteresis is avoided. The design technique is slightly different as the following steps will point out.

Step 1. Assume that T_1 is conducting and T_2 is cut-off, and that the bias on T_1 is -1 v. Assume further that the tube current i_{b1} is 5 ma. (Point 1 in Fig. 4). Draw the load line (line 1 on Fig. 4). The maximum tube current is 6.6 ma

$$R_{L1} + R_k = \frac{200 \text{ v}}{6.6 \text{ ma}} = 30 \text{ K}$$

$$R_k = \frac{e_{Rk1}}{i_{b1}} = \frac{21 \text{ v}}{5 \text{ ma}} = 4.2 \text{ K}$$

$$R_{L1} = 30 \text{ K} - 4.2 \text{ K} = 25.8 \text{ K}$$

Step 2. The potential of the plate of T_1 is 49 v + 21 v = 70 v.

The 49 v is obtained from the characteristic curves. "A" may be solved for since the grid of T_2 must be at 21 v $-$ 7 v, or 14 v in order that T_2 must be just at cut-off.

$$A = \frac{14}{70} = 0.2$$

Step 3. When T_1 is cutoff, the voltage on the grid of T_2 is 40 v.

$$e_{c2} = E_{bb}\, A = 200\ (0.2) = 40 \text{ v}$$

Step 4. In order that T_1 just be at cut-off when $E_f = 20$ v, the voltage across R_k must be 27 v. The current flowing in T_2 must be:

$$i_{b2} = \frac{e_{Rk2}}{Rk} = \frac{27 \text{ v}}{4.2 \text{ K}} = 6.4 \text{ ma}$$

Step 5. Solve for R_x. Since the grid of T_2 is at 40 v, a bias on T_2 can be specified such that the tube current is 6.4 ma. Choose $e_{gK2} = -0.5$ v. The cathode of T_2 must be at 40 v + 0.5 v, or 40.5 v. The value of R_x is equal to:

$$R_x = \frac{40.5 \text{ v} - 27 \text{ v}}{6.4 \text{ ma}} = \frac{13.5 \text{ v}}{6.4 \text{ v}} = 2.1 \text{ K}$$

Step 6. The final step yields the value of R_{L2} and completes the circuit design. Plot $e_{gK2} = -0.5$ v and $i_{b2} = 6.4$ ma and draw the load line. The maximum current is 8.0 ma.

$$R_{L2} + R_k + R_x = \frac{200 \text{ v}}{8.0 \text{ ma}} = 25 \text{ K}$$

$$R_{L2} = 25 \text{ K} - 4.2 \text{ K} - 2.1 \text{ K} = 18.7 \text{ K}$$ ■ ■

Waveguide Flange Design For Better Microwave Performance

Lou Virgile
Sperry Gyroscope Co.
Great Neck, N. Y.

Lou Virgile feels that something is lacking in existing flange designs. There are too many slightly different designs serving a single purpose. The various drawings (including the "standards") show very little consistent overall thought.

Mr. Virgile's first reaction to microwaves was "This is something for the EE's." After considerable experience as a senior product engineer responsible for mechanical development, design, shop and test follow-up of microwave components and subsystems, he has revised his estimate.

He now sees electronics responsible for a key 20 per cent of microwave performance, with 80 per cent represented by factors like structural design, heat transfer, mechanism development, materials selection, and packaging.

WAVEGUIDE flange design seldom receives the consideration it deserves. The factors presented here can help the designer minimize vswr and maximize power handling capabilities. These factors can aid in new designs and can serve as a guide in evaluating proposed standards.

Unless otherwise specified, the term "flange" is here construed as the opening of the finished waveguide component, or as the detail part that will have no further machining after assembly to a waveguide.

It is common practice to call parts "flanges" though they are actually flange blanks. Flange blanks are machined after attachment to the waveguide.

Good Alignment Is Most Significant

Perhaps the most significant factor in proper flange design is alignment. In connecting one waveguide to another, it is necessary to minimize the step that occurs at the junction due to tolerances and other factors.

High Power Breakdown. The effect of this misalignment on high power breakdown is shown in Fig. 1. The tests described by Fig. 1 were performed in X-band, but the chart is plotted as percentage misalignment. The results apply to any size waveguide. The percentages refer to dimensions of the waveguide opening.

Standing Waves. Similar misalignment in WR112 waveguide produced the vswr's shown in Fig. 2. Here, readings were taken at a 3.5 cm wavelength. This graph also represents all sizes of waveguide. It agrees with values calculated[1] for cover-to-cover flange conditions up to about 15 per cent of center frequency. Vswr increases over greater ranges.

Fig. 2 shows that it is not advisable to use chokes to reduce vswr where the misalignments are small. The choked joints have greater microwave mismatch than the cover-to-cover connections.

Angular Twist. The effects on vswr of angular twist of the connection are shown in Fig. 3. This graps shows that the choke flange is undesirable as a vswr suppressor in correcting for the small (less than 7 deg) angular twists that are normally encountered.

A more sophisticated approach to the vswr-misalignment question is available[2], wherein the offset is compared to an appropriate iris.

The amount of physical mismatch is tremendously important in determining microwave performance. This mismatch depends on the alignment of the mating flanges. It is a function of:

- Tolerances of the waveguide inside dimensions.

Table 1. Maximum Misalignment of Perfectly Centered Waveguide.

Waveguide	Inner Dimensions			Maximum Misalignment	
	a	b	Tolerance	%a	%b
WR650	6.500	3.250	±0.015	0.2%	0.5%
WR430	4.300	2.150	±0.008	0.2%	0.4%
WR187	1.872	0.872	±0.005	0.3%	0.6%
WR112	1.122	0.497	±0.004	0.4%	0.8%
WR75	0.750	0.375	±0.003	0.4%	0.8%
WR34	0.340	0.170	±0.002	0.6%	1.2%
WR15	0.148	0.074	±0.001	0.7%	1.4%

■ Tolerances of the distances of the flange bolt holes from the waveguide centerline and from each other.

The first of these factors may be described as an inherent flaw. It cannot be improved through better flange design. It is the amount of misalignment that can result from perfectly centered mating of two waveguides, one of maximum positive tolerance, and one of maximum negative tolerance. Its effects are shown in Table 1.

This table was set up for worst conditions. The tolerances are those of commercial standard waveguide, and the waveguide sizes were selected to show maximum percentage misalignment. It is obvious that even the largest error (1.4 per cent) is of little microwave significance.

Thus, it is realistic and convenient to eliminate "inherent flaw" from the discussion and to consider mislocation of the bolt holes as the only source of error.

There are several sources of misalignment due to flange design. They include:

1. Error in determining centerline of flange openings for each of a pair of flanges.

2. Error in locating the first bolt hole from these centerlines for each flange of the pair.

3. Difference in size between maximum hole diameter and minimum bolt diameter. If one flange is tapped, this difference must be averaged with the difference between maximum tap pitch diameter and minimum thread pitch diameter.

4. Difference between minimum waveguide outside dimension and maximum flange opening where the waveguide goes completely through the flange. Where one flange is finished (choke) and the other is not (cover), as in most choke-to-cover junctions, this figure should be halved.

These four factors are shown in Table 2 for various military standard flanges.

Misalignments can be quite large, according to Table 2, particularly in the smaller sizes of waveguide. The chances of maximum misalignment are quite remote, so the vswr per joint is usually less than the maximum figure. But the high power breakdown values, which can be read directly from Fig. 1, are serious. One bad connection per system can hurt the power carrying capacity. A single case of high vswr is less important.

Alignment Techniques

There are several techniques which can help minimize misalignment.

■ Where the waveguide goes entirely through the flange, do not drill the holes until after attaching the flange to the waveguide. This eliminates the slop between flange and waveguide since the bolt holes are located from the finished opening. The error eliminated represents an average (for the cases in Table 2) of more than 20

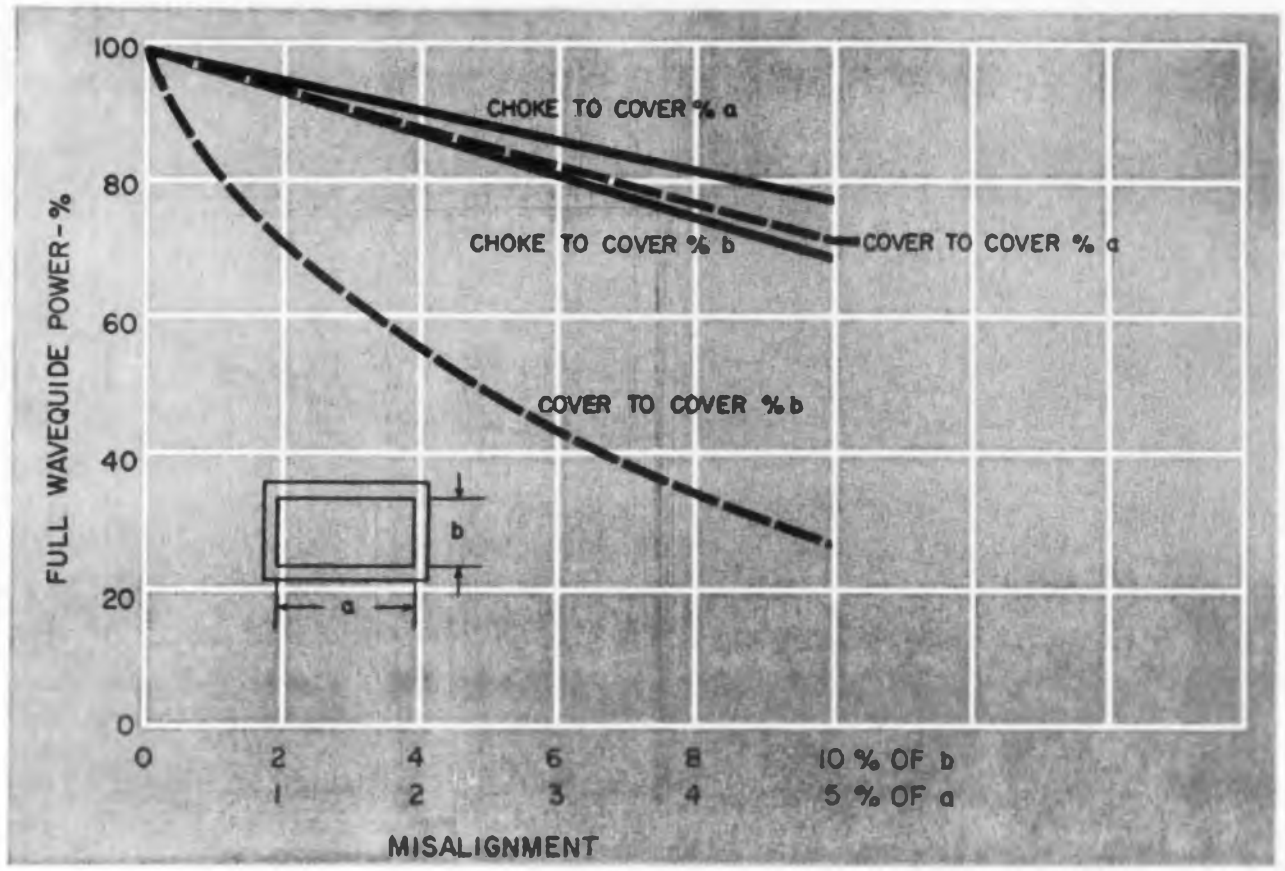

Fig. 1. The breakdown power of a waveguide decreases with increased misalignment of the flanges.

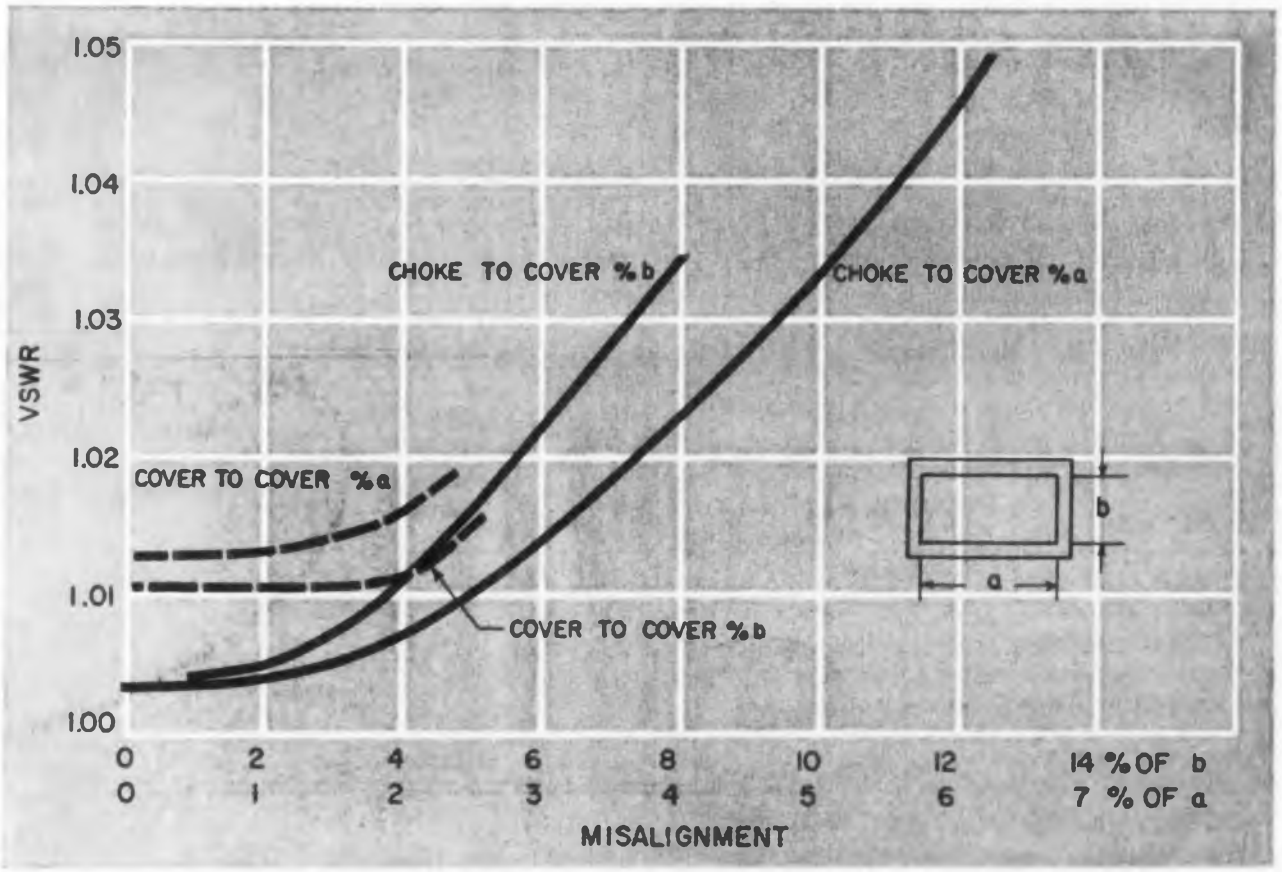

Fig. 2. Waveguide vswr gets worse as flange misalignment increases.

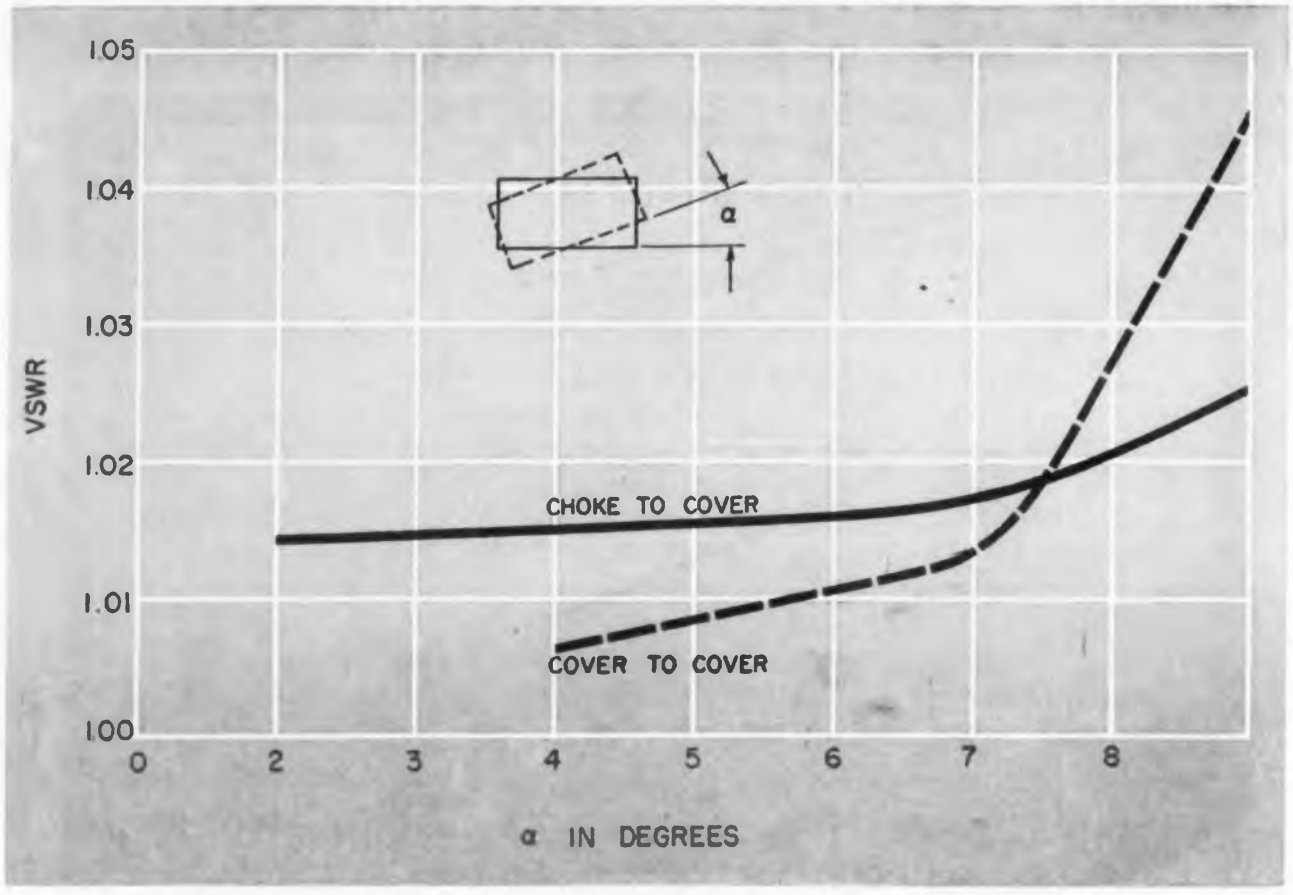

Fig. 3. Vswr increases as the angular twist of the connection increases.

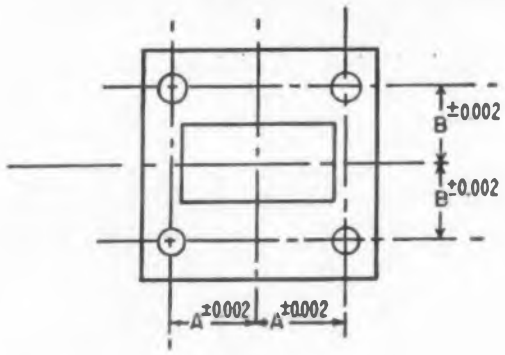

Fig. 4. Distances between bolt holes can be 0.004 in. off when all dimensions are taken from a hard-to-find centerline.

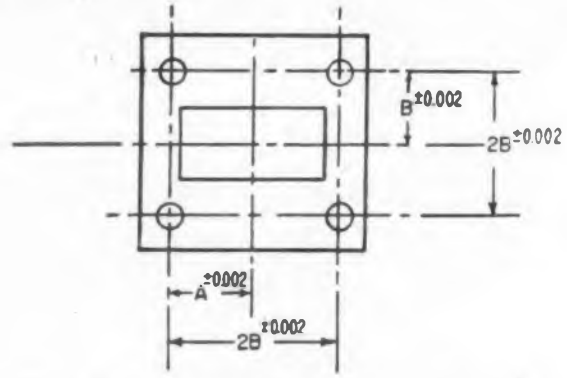

Fig. 5. Improved tolerances result when position of one bolt hole is measured from another.

Table 2. Misalignment Error Due to Four Separate Factors.

Waveguide	Flange	1. c/l Error	2. First Hole Error	Minimum Bolt Diam.	Hole Diam.	3. Max. Hole Less Min. Bolt	3. Max. Diff. in Pitch Diam.	4. Max. Slop	Max. Total Mis-Alignment
WR650	MS90052	0.0025	0.0025	0.3042	0.330±.005	0.0308	—	0.025	0.066 (2.0%b)
WR187	MS90046	0.004	0.005	—	—	—	0.008	—	0.044 (5.1%b)
	MS90047	0.0015	0.005	0.1831	0.219+.003	0.0389	—	0.010	
WR90	MS90058	0.003	0.002	—	—	—	0.007	—	0.025 (6.3%b)
	MS90059	0.0015	0.002	0.1571	0.169+.005	0.0169	—	0.009	
WR28	MS90055	0.0015	0.001	—	—	—	0.006	—	0.017 (12.1%b)
	MS90057	0.001	0.001	0.1061	0.116+.003	0.0129	—	0.006	

(1) Centerline error. (2) First hole error. (3) Error due to differences in hole and bolt sizes. (4) Error due to slop between flange and waveguide.

per cent of the maximum total misalignment, a substantial improvement.

■ Use smaller clearance holes and evaluate tolerances on a statistical rather than a 100 per cent basis. "Degree of interchangeability" considerations are an important source of misalignment. Theoretically, 100 per cent interchangeability is obtained when the clearance holes are large enough to permit assembly of two flanges though the tolerances on the various parts may be completely unfavorable.

From this viewpoint, most of the flange combinations in the smaller sizes should show many instances of failure to assemble. However, examination of the tolerances on a statistical basis, assuming normal distribution and specification limits of 3.5 times standard deviation of each parameter, shows that the unsuccessful trials would be less than five in ten thousand[3].

Actual experience at the Sperry Gyroscope Company has borne this out. In making thousands of X-band assemblies, no complaints of inability to bolt flanges together have been received to the author's knowledge.

■ Dimension parts functionally. Poor dimensioning is best illustrated by an X-band flange which is partially dimensioned in Fig. 4. Here, the bolt holes are *2A* (or *2B*) inches apart ±0.004 in. More functional dimensioning, at no increase in manufacturing cost, is illustrated in Fig. 5.

Dimensioning as in Fig. 5 reduces the tolerances between holes from ±0.004 in. to ±0.002 in. This reduces the difference (for 100 per cent interchangeability) between maximum bolt diameter and minimum clearance hole diameter from 0.016 in. to 0.008 in. Thus a smaller clearance hole can be used.

More Expensive Alignment Techniques

There are other techniques which can be used to reduce misalignment. But they represent considerably higher cost, so they should be used sparingly.

■ Use tighter tolerances. Obviously, tighter tolerances can reduce misalignment. By and large, existing flange and waveguide design represent a satisfactory compromise between precision and cost. Closer tolerances generally result in costly secondary manufacturing operations.

■ Use pre-doweling. Provide each flange with an accurately located dowel pin and a reamed hole. These serve to register the flanges. The bolts serve only to make a tight connection. This technique is extremely expensive.

■ Use post-doweling. The most accurate (and most costly) method involves centering the inside walls of matching waveguides at assembly and then post-doweling to maintain this alignment. This technique should be restricted to the most critical applications.

Other Flange Considerations

Degree of Contact. Of extreme importance in waveguide connections is the degree of contact. This is primarily a function of the flatness of the mating surfaces. Screwing the flanges tightly together can correct for minor deformations.

While insufficient contact can cause high vswr, the major objections are to the arcing and breakdown that occur in high power applications. Remedies include use of chokes and special gaskets to improve the contact.

Quick Disconnects. It is often desirable to use quick disconnects, in place of bolts, for frequently removed parts. They generally apply pressure to the flange joint at a maximum of four points (replacing eight or more bolts in larger flanges), and thus increase the likelihood of high power breakdown. They should be used only with extreme care.

Gaskets. Requirements for pressurizing waveguides make it necessary to use gaskets at the flange connections. Sometimes the seal is a combination rf and pressure gasket, but more often, it is a simple rubber (or similar material) seal, which fits into a machined groove in one flange. Good design allows a 10 to 30 per cent gasket compression, considering both tolerance extremes.

Materials and Finishes. The choice of materials for flanges is dictated by the material used for the waveguide itself. However, the application of finishes to flanges (as part of the waveguide assembly) is an important factor in their design.

Care must be taken to apply coatings which will withstand both erosion and galvanic corrosion. In general, anodic coatings (Anodize, Alodine, Iridite, etc.) are applied to aluminum units, and electroplates (gold, rhodium, etc.) to brass. Special requirements, such as mating of dissimilar metals, sometimes require the use of other finishes that do not react unfavorably with either base metal.

Objections to the use of Anodize as a finish have been raised because it is dielectric in character, and prevents dc contact between flanges. To the author's knowledge, this insulating coating does not degrade microwave performance, except in items like crystal mounts, where dc contact is necessary.

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Automatic Circuit Tolerance Tester

for checking reliability and failure trends

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Automatic switching of extreme limit values of components in electronic circuits permit rapid evaluation of reliability and failure.

RELIABILITY and failure trends of electronic circuits can be rapidly and accurately determined by automatic insertion of extreme limit values of component parts. If satisfactory operation is achieved under these conditions, a high degree of reliability can then be assumed for the circuit under test.

It would be possible to test the reliability of a circuit by successively wiring into it all the desired combinations of the high and low "end point" limit values. Proper operation of the circuit under all these combinations of parts limits would indicate a reliable circuit.

The use of this method in testing 16 parameters would require that 2^{16} or approx. 70,000 combinations be investigated. Using the normal methods of soldering or plugging this number of combinations into the circuit would take far too much time for the method to be practical.

A device called an "Automatic Circuit Tolerance Tester" has been developed to make this search rapidly and antomatically. Fig. 1 is a block diagram of the instrument, and it illustrates the principle on which it operates.

Binary Counter Operates Relay

In the tester, a binary counter is triggered at a rate that is variable between 0.25 and 20 cps. Each stage of the counter controls a relay which switches the value of one component part in the circuit under test. One characteristic of a binary counter is that it will run through all possible combinations of its high and low states; this is the requirement of the test procedure.

The prototype tester, shown in Fig. 2, uses a 16-stage counter, each stage of which controls one part-switching relay. If any stage of the counter contains a "one," the relay controlled by that

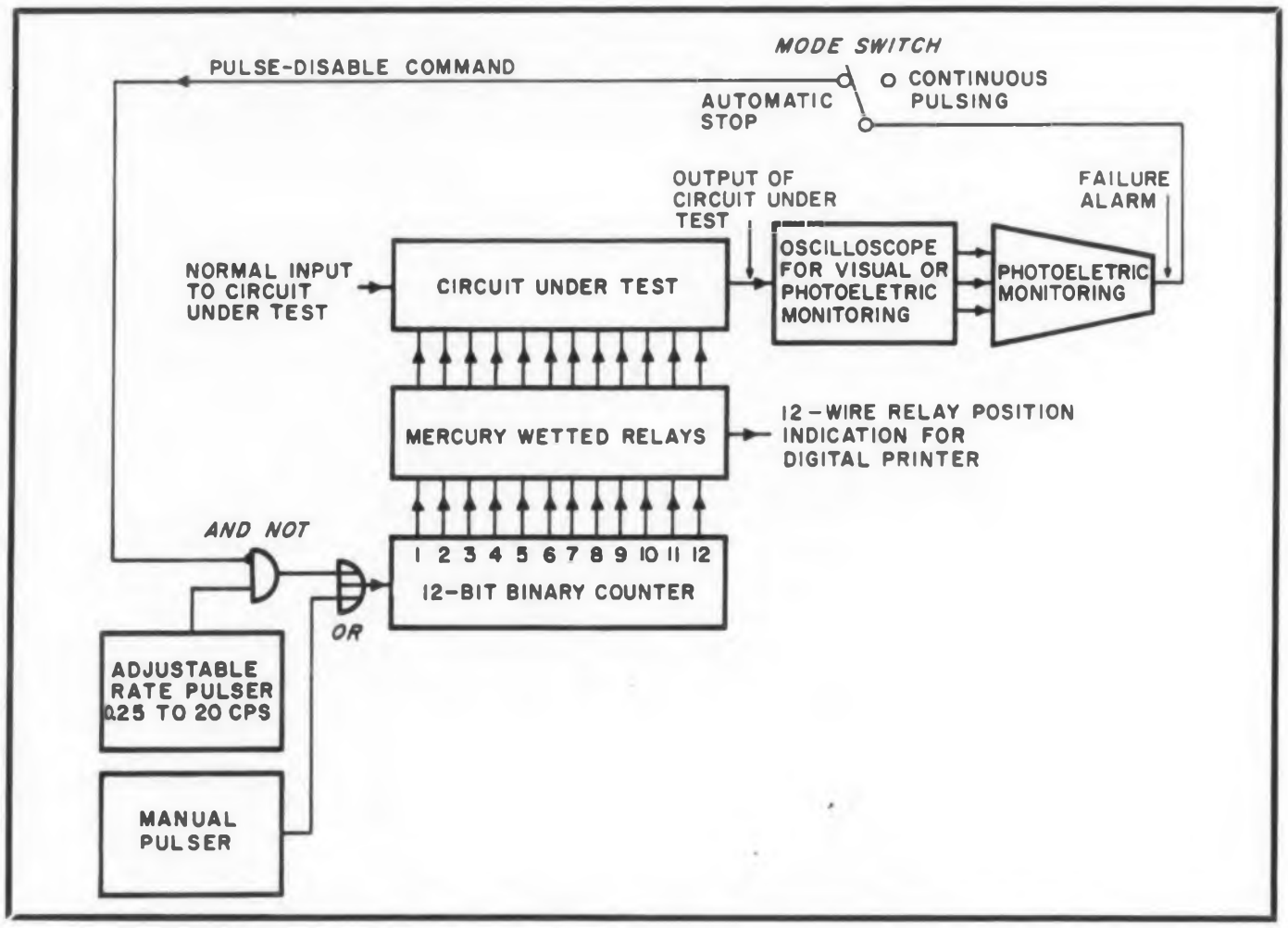


Fig. 1. Block diagrams of automatic circuit tolerance tester.

Karle S. Packard has been engaged in research and development of cathode ray stereoscopy, magnetic survey equipment, and microwave relay links, systems, and components during his 13 years at AIL. In his present capacity as Reliability Group Manager for Project STAR, he has been instrumental in the development of the automatic tester described.

stage is energized. The relay contacts are wired so that if the relay is not energized, the low-limit part value is in the circuit; when the relay is energized, a short circuit is removed, producing the high-limit part value. The use of a low-limit part plus a part corresponding to the range reduces the transient effects of switching, since removal or insertion of a short circuit across the range part is the only actual switching done.

The 16 relays are mounted about one inch from the components being switched and are mercury-wetted relays of low contact-capacitance (less than 5 μμf) and low contact-resistance. Thus, the instrument can be used at any frequency for

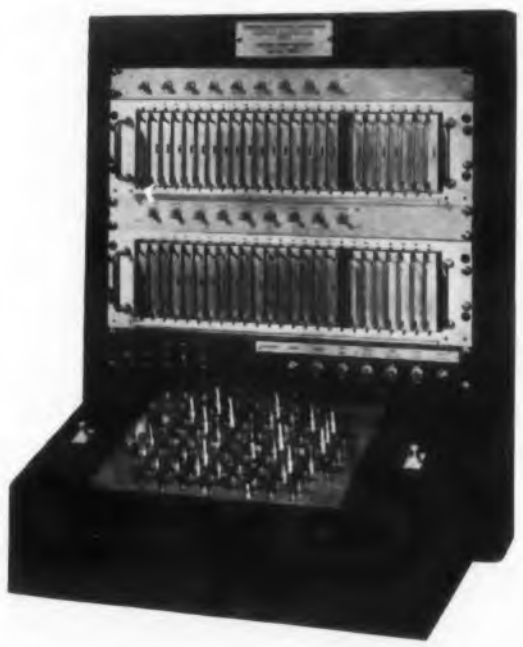


Fig. 2. Automatic circuit tolerance tester with circuit in position.

which these capacitances can be regarded as very small. The relays have a life of at least 10^8 operations, which is important in a circuit being operated at a high switching rate.

To obtain optimum relay life, the relays, which are an octal plug-in type, are each occasionally advanced one position in the counter, except for the number 1 stage relay, which is shifted to number 16 stage. Because the first stage relay operates at about 4000 times the rate of the 12th stage relay, this occasional change prevents uneven wearing out of relays.

Precision Parts Used

The circuit to be tested is wired into a plug board that is on the top of the instrument. Switched component parts can include resistors, capacitors, transistors of different betas, etc. Precision parts are used for building the test circuit. Resistors are metal-film type and capacitors are ceramic or glass. They have the stability necessary to prevent changes in value with age, humidity, and other performance degrading factors. Such instability could invalidate the test.

Because the circuits under tests are largely transistorized digital types, transistor beta variations and excessive I_{CBO} are important contributors to circuit unreliability. "Libraries" of transistors have been accumulated with high- and low-limit values of beta by selection from incoming units and special orders from manufacturers. These are treated as high- and low-limit parts and are also switched in and out of the circuit under test. Transistor I_{CBO} is permanently maintained at its maximum predicted value during the test by adjustment of a variable potentiometer between the collector and base of each transistor.

Three Operating Modes

Controls on the front of the instrument provide for either one-step-at-a-time manual advance of the count, continuously variable automatic advance at rates from 0.25 to 20 cps, or manual setting of any combination without going through a complete counting cycle. A switch provides for automatic "stop" in case of failure of the tested circuit, or, if a digital printer is used to automatically record failures, the switch can be set to a "no-stop" position.

A unijunction transistor relaxation oscillator provides a variable-rate trigger for the 16 standard flip-flops that make up the relay-drive counter. The normal signal-input is applied to the circuit under test.

The output of the circuit under test is viewed on an oscilloscope; since the normal circuit-output waveshape is known, failures are easily detected by observation. When a particular combination of part values causes circuit failure, stepping of the counter can be stopped manually and the

combination that caused failure is read as a binary number from lamp indicators on the fronts of the flip-flops. A lighted lamp or "one" in a stage indicates that the component controlled by that stage is at its high-limit value. A zero or unlit lamp indicates low-limit value.

Automatic Failure Indicator

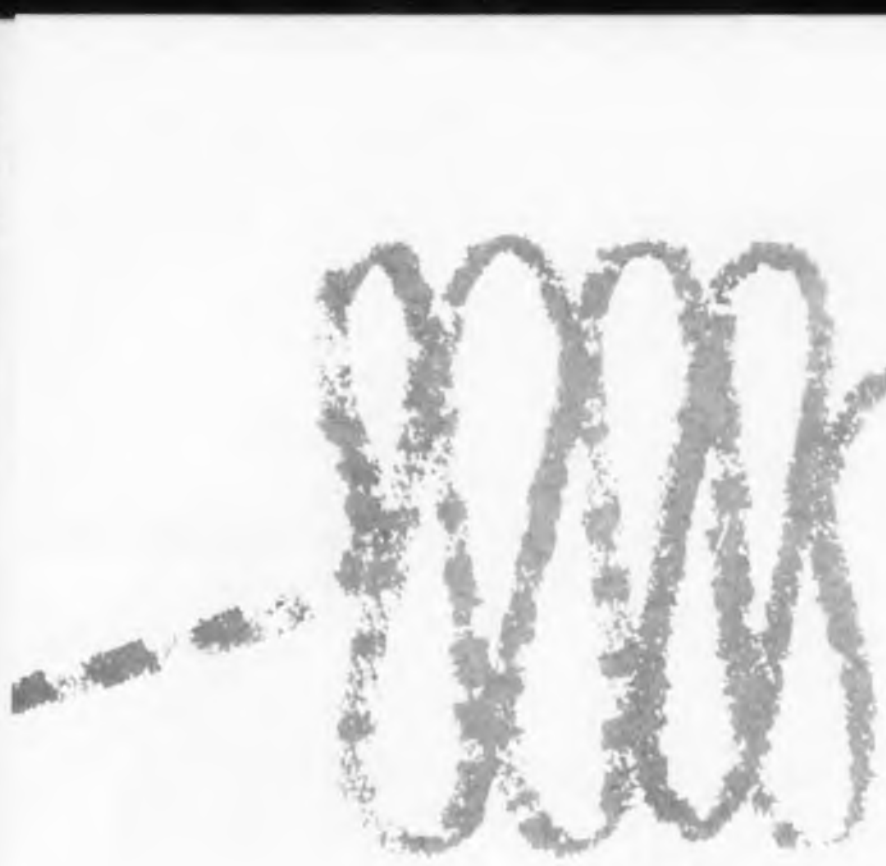
An automatic failure indication device has also been developed. The allowable circuit output is premarked on the face of an oscilloscope as an opaque trace whose line width represents allowable output voltage and time tolerances. The normal output will thus always be hidden behind the opaque line (black masking tape is used). A failure will appear as a visible trace on the face of the oscilloscope and is detected by a photocell mounted in a hood. The photocell signal disables the part-switching pulse drive line and the part switching stops. Faster switching rates can be used with this automatic system than with manual operation. A digital printer can be commanded to print on paper tape the number of each failure step without stopping the switching. This provides rapid, unattended testing. Any failure trend can be noted by observing the tape and comparing the status of the various parts on the failed steps.

It is also possible to make a less sophisticated automatic failure indicator without the use of an oscilloscope. One way is to compare the output of the circuit under test with that of an identical circuit containing the nominal values. The two circuits are triggered or otherwise fed inputs in parallel and the difference in outputs is detected. The system can be designed so that a difference in output waveforms of more than a certain amount will cause failure indication.

Another method is to integrate the output of the tested circuit in such a way that a dc voltage is maintained as long as the circuit output is active. The absence, increase, or decrease of this dc voltage would be an indication of circuit failure and would produce a failure alarm. Both these methods have been tried with moderate success.

Design Application

Perhaps of as great significance as the use of the instrument in determining reliability of previously designed circuits is its use as an aid to the circuit designer during the development of new circuits. Several new circuits have been optimized by placing the preliminary design in the tolerance tester, noting failure trends, and then changing nominal part values in the indicated direction. This procedure has not yet become routine, but has been sufficiently useful to gain significant acceptance among design engineers. In this manner, the circuit is designed and tested at the same stage of development. ■ ■



Making The Most of Flat Cables

***Part 2:** This last of two articles describes some of the connectors and terminals that can be used with flat cables. Also covered are methods of shaping flat cables.*

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FLAT CABLES can be shaped for a variety of purposes. And they can be terminated to many of the standard terminals and connectors now available.

When some AMP terminals are connected to some flat cables, the conductors are separated by a punch and die that removes U-shaped pieces of insulation from between the conductors. It leaves a radius at the end of the slot in the insulation to absorb large stresses that might tear the insulation. Conductors are stripped at the end either before or after slotting. A double crimp holds both the insulation and the stripped conductor end. (See Fig. 1.)

Some terminals can be attached at any position along the conductor without the need for stripping. (Fig. 2.)

Conventional connectors are attached easily by stripping, soldering and encapsulating the flat cable. (Figs. 3, 4 and 5.) Scotchcast #4 (Minnesota Mining & Mfg. Co.) is a convenient resin to use for encapsulating.

Some connectors have been especially designed for flat conductor cables. Like the cable, they are thin, flat and light. When used with an Industrial Hardware connector, the cable's conductors are first stripped simultaneously, then folded around the ends of the terminals and dip-soldered. A mechanical strain relief is applied. Variations are available for bulkhead mounting, for printed wiring, wire wrap and for soldering conventional wires. (Figs. 6 and 7.)

Elco's Varicon terminals may be staked into a board after a flat cable's stripped conductors have been "combed" through the terminal holes. The staked side of the board is then dip-soldered, adding to the reliability of the pressure connection. Molded receptacles for the Elco plug are available for wire wrap, taper tab, printed wiring and soldered wires. These are illustrated in Figs. 8a and 8b.

AMP's printed wiring connector is designed to accept flat conductor cable or conventional wire. Terminals are crimped on stripped conductors and inserted as a group in the connector block. Individual terminals may be removed as desired for circuit checking. (Fig. 9.)

The Advantgaes of Book Packaging

Printed wiring can be hinged for serviceability while the circuits are energized. "Book packaging" permits greater packaging density, reduces package weight and cost, eliminates board connectors and increases the reliability of the system by eliminating half of the series terminations required for a board connector system. (See Fig. 10.) Most of the advantages of a pluggable package may be retained by equipping each book of many pages with a single connector.

How Retractile Cables Are Made

Flat cables with thermoplastic insulations may be formed by the use of heat and stresses. An S-shaped retractile cable is shown in Fig. 11. Retractile cables used for connecting sliding chassis to a rack are formed by winding standard cables on a suitable fixture that holds the cable in a final desired shape. Bend radii should be kept as large as practicable to maintain the high flex life characteristics of the cable. The forming fixture should be made of a material having low thermal inertia. A heat forming fixture for retractile cable is shown in Fig. 12.

The recommended forming temperature for insulation material made of Polyester, type M, is 130 C.

Processing time need be only long enough to raise all parts of the cable to processing temperature. A circulating air oven is preferred, although almost any other type of oven is suitable.

The need for an S-shaped retractile cable, such as described above, may be eliminated in some applications by the use of flat cables laid out in the shape of a U. This eliminates the necessity for heat-forming the cable, and it may be used in its natural, straight form.

In some application it is desirable to capture the cable in a channel or raceway approximately a half-inch deep and a little wider than the cable. The channel may be lined with pressure-sensitive Teflon tape to minimize abrasion damage to the cable under severe conditions. The cable loop is driven back and forth by the motion of the chassis to which it is attached, and no spring retractile is necessary.

(Continued on page 39)

Fig. 2. (above) Some terminals, like these, made by AMP Inc., can be attached at any position along the conductor without the need for stripping.

Fig. 1. (left) Some AMP terminals can be crimped to a flat cable.

Fig. 3. (above) Many familiar connectors may be connected by encapsulation. Conductors are first stripped, then the cable is slit between conductors and soldered in place as with conventiona! cable.

Fig. 4. (above) Encapsulating resin acts as a strain relief.

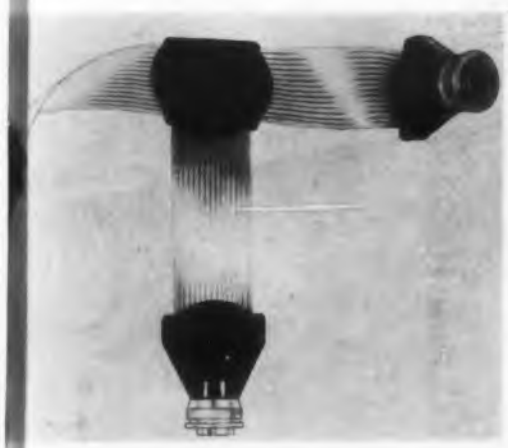


Fig. 5. This Bendix-Scintilla harness has Pygmy connectors attached by encapsulation.

Fig. 6. (left) This Industrial Hardware connector is connected by dip soldering and can be stacked in multiple.

Fig. 7. This Bendix-Scintilla connector is designed for environmental extremes.

Figs. 8a (left) and b (below). An Elco Varicon can connect a flat cable to conventional wires or printed wiring.

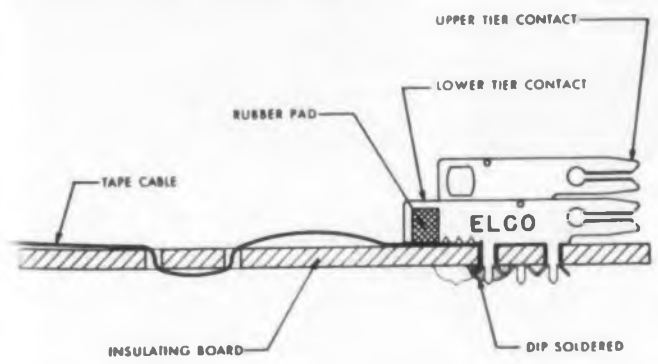


Fig. 9. (left) AMP printed wiring connector.

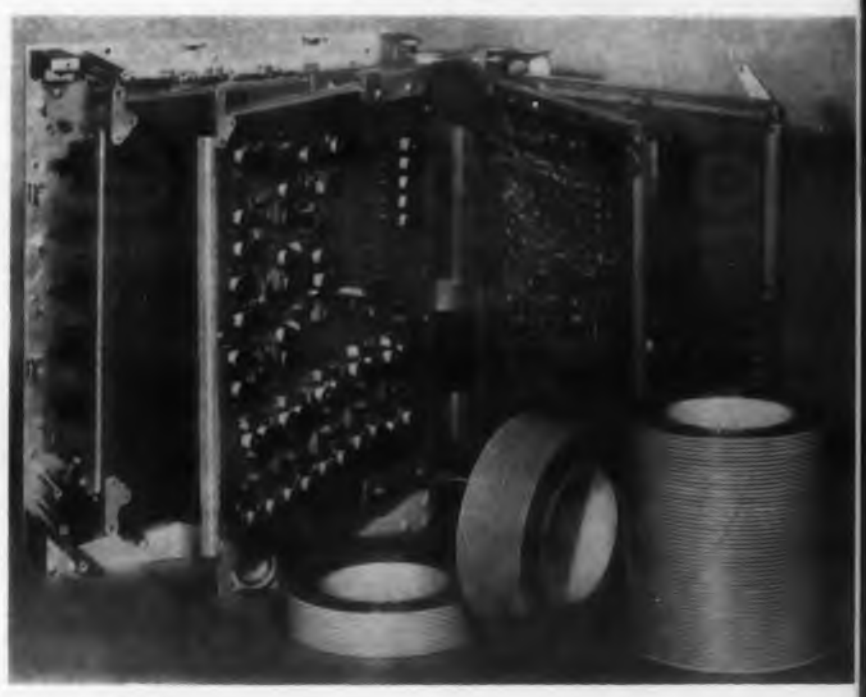


Fig. 10. (right) "Book Packaging" in Stromberg-Carlson airborne equipment uses hinged printed wiring boards interconnected by a flat cable.

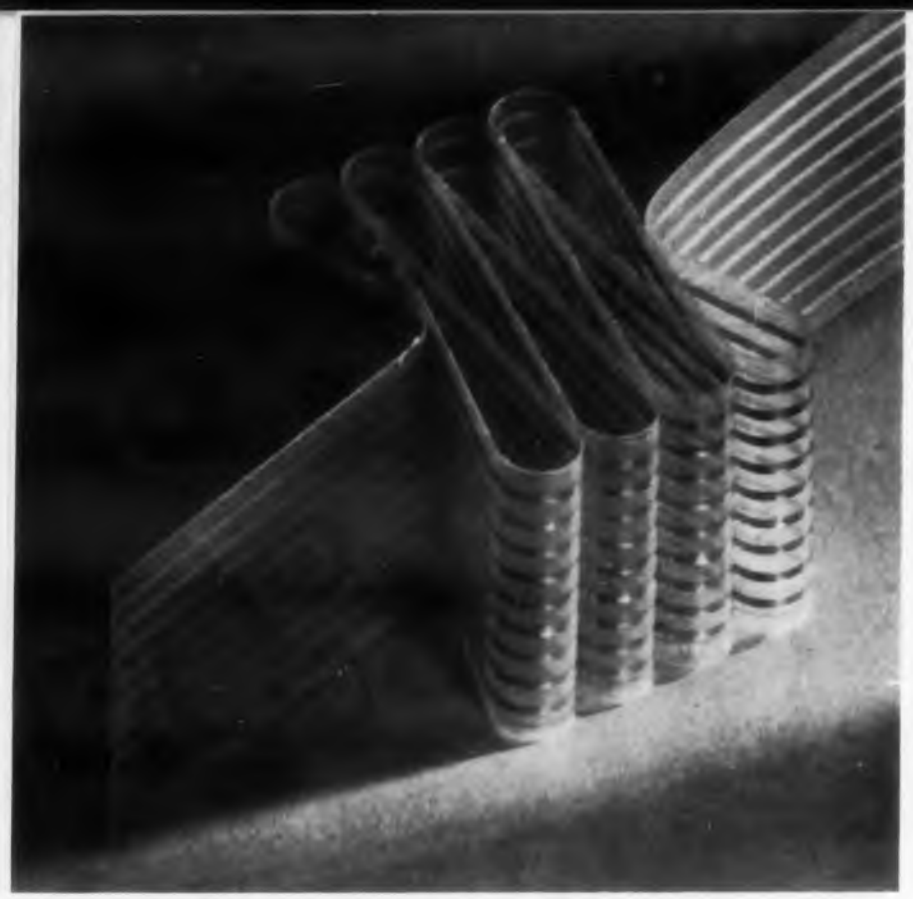


Fig. 11. (left) An "S" shaped retractile cable can be used for connecting a sliding chassis to a rack.

Fig. 12. (above) Heat forming fixture for retractile cable.

Fig. 13. (right) A curved cross-section makes a flat cable self-supporting.

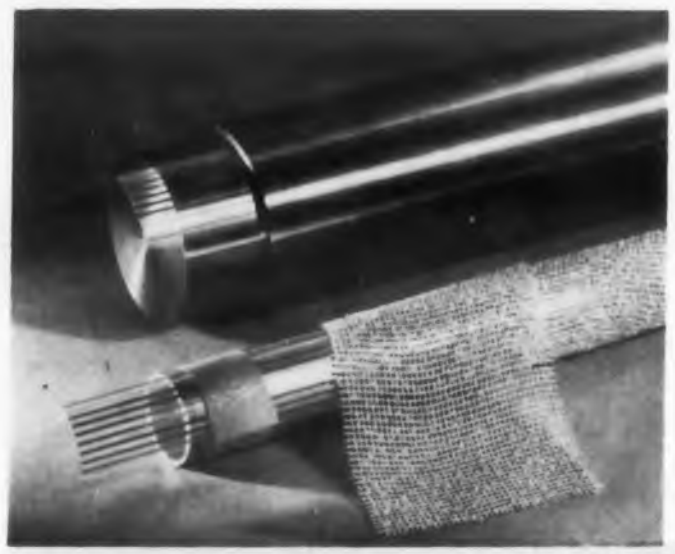


Fig. 14. Simple heat forming tools used for making a curved cross-section.

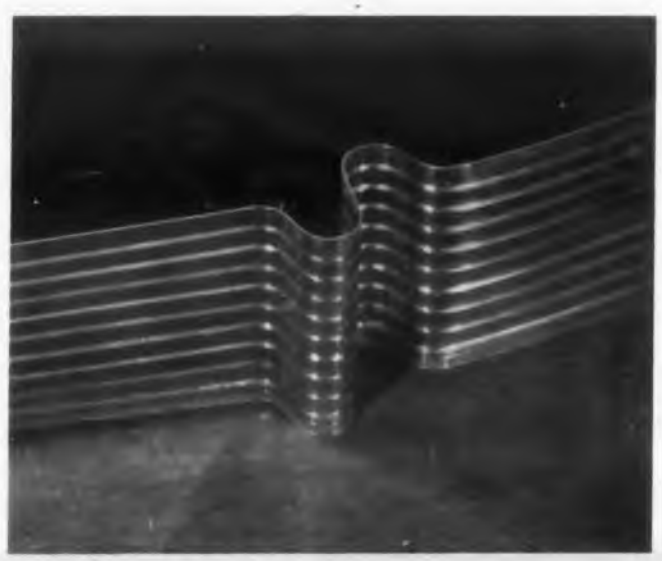


Fig. 15. A corrugation compensates for the variation in dimensions between fixed points and absorbs longitudinal stresses.

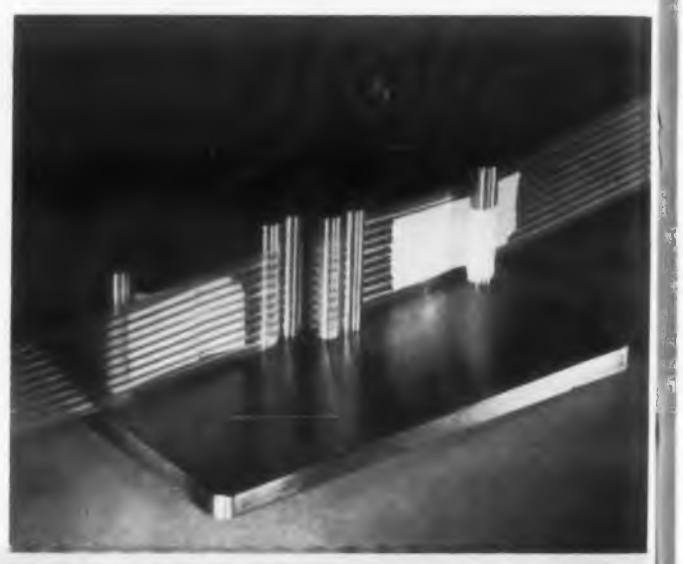


Fig. 16. The fixture for heat forming a corrugation.

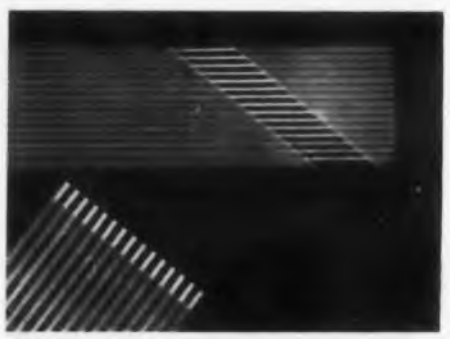


Fig. 17. Narrower cable is stripped at an angle when changing conductor centers.

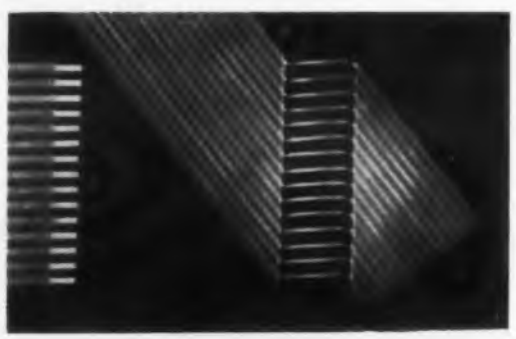


Fig. 18. Narrower cable conductors are staggered to make conductor centers match larger cable.

Fig. 19. Conductors are held in position with masking tape and dip soldered.

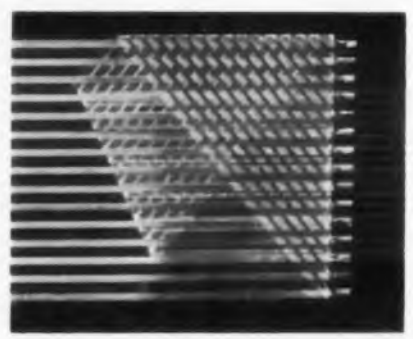


Fig. 20. The cable is folded to restore in-line configuration. Insulation may then be replaced with electrical tape or encapsulation.

Fig. 21. Changing conductor centers with grid wiring technique.

Uses of Curved Cross-Section Cable

Applications requiring extremely low mass for interconnecting multiple-conductor cable, such as oscillating or high-speed recording or reading heads, are ideally suited for a flat cable formed with a curved cross-section. (See Fig. 13.)

Acting much like a doubled-up steel tape rule, this cable shape is used where minimum mass and friction are desired. In some applications it can be completely self-supporting, with no channel or raceway necessary.

In the application, the ends of the cable should be mounted or potted in such a way that the cross-section curve of the cable is maintained to prevent buckling of the cable at the terminal ends. U-shaped cables have the advantage of less length, resulting in lower cable cost and lower voltage drop. However, they are not self-retracting, and space requirements are usually quite different. Mechanical resonant frequency problems are usually easier to solve with the U configuration. Simple heat-forming tools for flat cables with a curved cross section are shown in Fig. 14.

Corrugated Cable Helps

When it is desirable to have the cable follow a straight line between two fixed points, it is often difficult to cut the cable to the exact dimensions required, since cutting and stripping tolerances are usually necessary. Sometimes it is necessary to allow for minor variations in the mounting of a termination, or longitudinal vibrations must be absorbed. Such variations can be compensated by the use of an adjustment corrugation. (See Fig. 15.)

Corrugations may be formed on a fixture in an oven (Fig. 16). It is desirable to control forming temperature within a few degrees to produce uniform controlled corrugations. Care should be taken to prevent heavy compression or other high stresses on the cable during the forming operation.

Changing Conductor Centers

Angle splicing may be used to change conductor centers. (See Figs. 17 through 20.)

The Selectacon grid-wiring technique is a versatile method for changing conductor centers. A cable with any given conductor spacing is laid at a right angle on top of a cable with any other conductor spacing, and selected conductor intersections are simply soldered through the insulation (*ED*, Oct. 15, 1958). This method is shown in Fig. 21.

Separating the conductors, by slitting at the end of the cable, makes it possible to connect the cable to a connector or cable with any spacing between terminals or conductors. ■ ■

Get Higher Torque from Multipole Hysteresis Motor

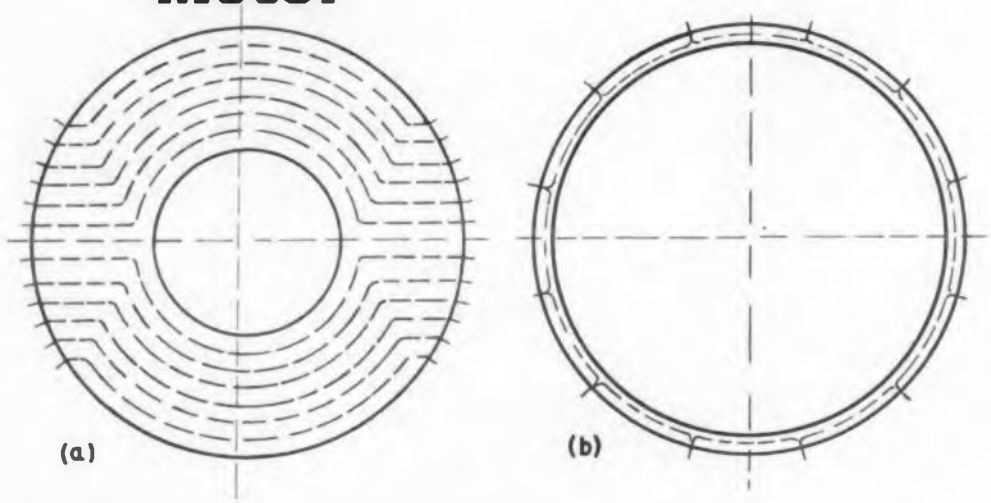


Fig. 1. Density of magnetic lines in rotor must remain constant; (a) shows a two-pole rotor and (b) a 12-pole rotor. In both cases density is the same, but useable volume of magnetic material is greatly reduced with 12 poles.

Fig. 2. Supersyn rotor design. This four pole rotor has the optimum magnetic density, but many times the effective volume of conventional rotors. Magnetic lines of force traverse several long, narrow paths.

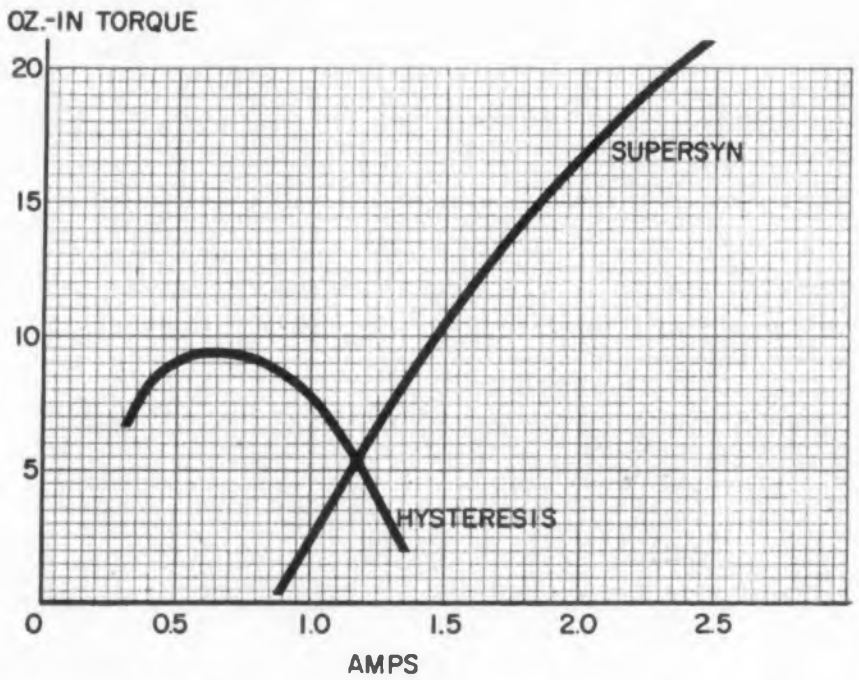


Fig. 3. Torque (in-oz) per ampere relationship of conventional hysteresis synchronous motors and new Supersyn. Both motors the same size.

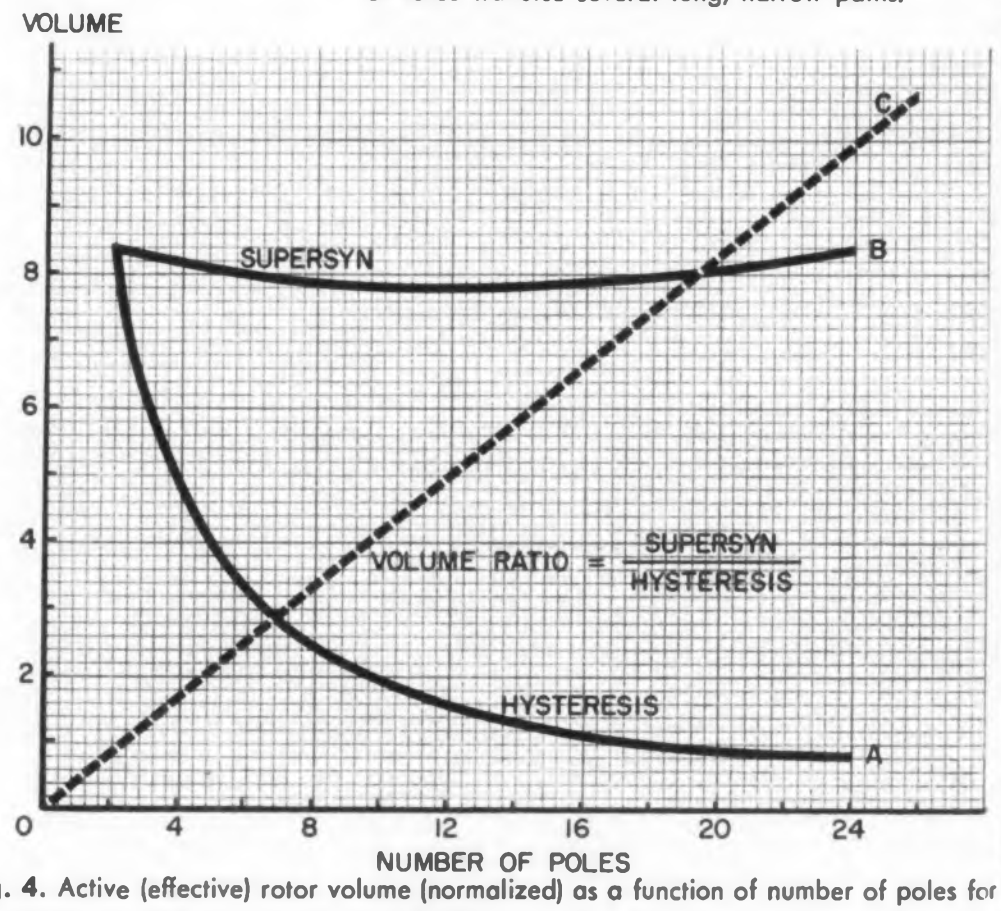


Fig. 4. Active (effective) rotor volume (normalized) as a function of number of poles for conventional and Supersyn motors. As both volume and poles increase, torque increases.

TEN TIMES smaller than conventional multipole hysteresis synchronous motors, a new design eliminates wasted rotor volume without sacrificing optimum flux density.

Designed by Andrew Bekey of Bekey Electric Div. of Genisco, 2233 Federal Ave., Los Angeles 64, Calif., the Supersyn will find application in electronic and aircraft power supplies.

Its fast acceleration and good damping along with high power in a small package will make it particularly valuable in applications where size and weight are at a premium.

Design

A new rotor design is the heart of the Supersyn –the stator and package are similar to standard motors. Conventional hysteresis synchronous motors contain a cylindrical rotor built of permanent magnetic material. Since the motor's torque is proportional to a constant (representing the quality of the hysteresis material) times the usable volume of material times the number of poles, it seems reasonable to expect the torque to increase with number of poles.

But since the total magnetic flux through the rotor is divided in as many parts as there are poles, and since to achieve best rotor operation an optimum density of magnetic lines is needed, the rotor volume must be decreased as poles are added. See Fig. 1. As magnetic flux is divided into more parts the rotor section must be decreased to keep the magnetic density constant.

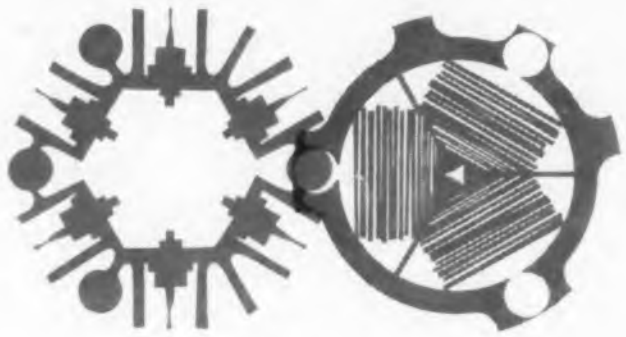
With the usable rotor volume reduced in the same ratio as the increase in poles, the torque is virtually constant. Horsepower output varies with speed.

If a rotor is designed as in Fig. 2, so that the lines of force traverse several long paths, the usable rotor volume is enormously increased. Each path being individually narrow, the magnetic density remains optimum.

Result of this design is shown in the curves of Figs. 3 and 4. A Supersyn with 24 poles has ten times the usable rotor volume of the conventional hysteresis synchronous motor. Practically, this means that for the same horsepower a Supersyn is one tenth the size of a conventional motor. A 12-pole Supersyn of the same size as a conventional motor would have five times more power.

For hysteresis synchronous motors with more than 24 poles, the Supersyn is virtually a necessity; and in terms of torque per ampere (Fig. 4) Supersyn's almost linear increase makes it a sure bet–it becomes a constant horsepower device, rather than a conventional constant torque device.

For further information on this new high power hysteresis synchronous motor turn to the Reader-Service Card and circle **101.**



Specially Designed Components Cut Transformer-Rectifier's Size, Weight

TRANSFORMER-RECTIFIERS that are more compact and lighter than others on the market are now being made available for airborne applications. They were trimmed in size and weight by specially designed circular components.

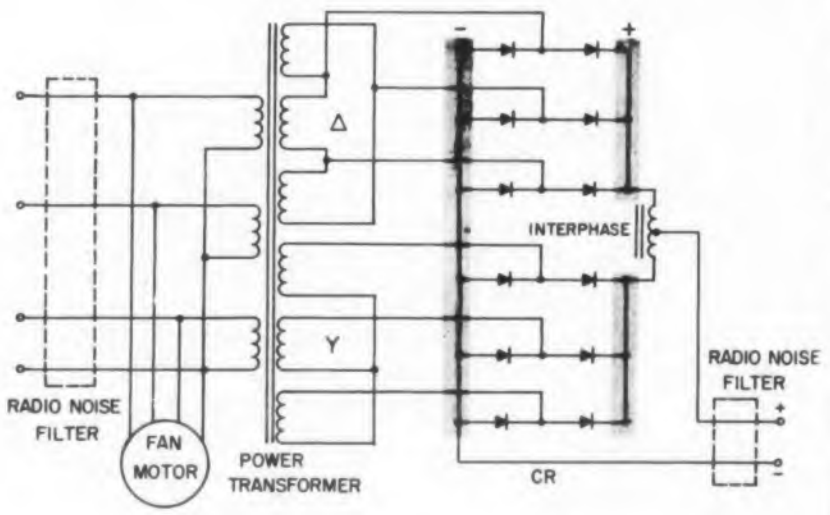
The most distinctive component in the T-R's is a three-phase transformer constructed with a symmetrical Y configuration—claimed to be a first. The transformer consists of three single-phase structures mounted into the Y configuration. It is symmetrical magnetically, electrically and physically. The structures consist of a coil assembly and core.

Each core is made from wedge-shaped sections of wound, grain-oriented steel tape. Three of these sections are placed adjacent to each other so that each occupies one-third of the circular configuration. They are then cut at the periphery so that the three-coil assemblies can be placed over the three adjacent and matching parts of the sections. A tension band clamps the cut sections together to provide uniformity of flux patterns.

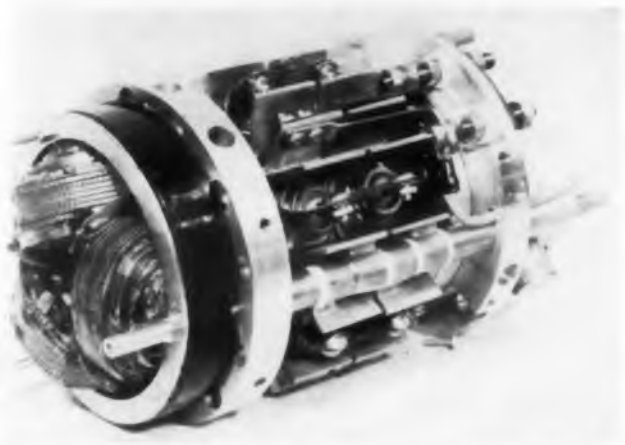
The secondary of each coil is made of two separate wires that are connected in wye and delta, respectively, to the other coils. The three-phase, wye-connected primary is thus split into a six-phase output at the secondary with a nominal output of about 20 v. The wye and delta outputs are 30 electrical degrees out of phase with each other and each is tied to its own rectification circuit.

The wye-delta secondary doubles the fundamental ripple frequency and cuts the magnitude of the ripple voltage in half—to about 2.5%. And the interphase transformer cuts this in half again—to about 1.5%, and eliminates the need for any further ripple refinement.

Made by Chatham Electronics, a division of Tung-Sol Inc., 630 W. Mt. Pleasant Ave., Livingston, N. J., all four



The wye-delta secondary of the transformer doubles the fundamental ripple frequency and cuts the magnitude of the ripple voltage in half—to about 2.5%.



Visible, from left to right, are the transformer, and the silicon diodes mounted in heat sinks.

T-R's in the "Y" series work off 200 v ac and deliver 28 v dc. The output of models 28VS20Y, 28VS50Y, 28VS100Y and 28VS200Y, is, respectively, 20, 50, 100 and 200 amp. The 200-amp unit weighs under 17 lb (compared to about 30 lb for other units with comparable ratings) and measures 11 in. in length. By comparison, the same unit occupies about one quarter of the volume of competitive units.

Twelve silicon diodes are in the rectification system—six for each full-wave bridge. They are also specially designed and are claimed to have higher current ratings than competitive units in this application.

Each delta and wye section is fed into its own bridge network. The bridges rectify independently of each other and their outputs are combined electrically with an interphase transformer.

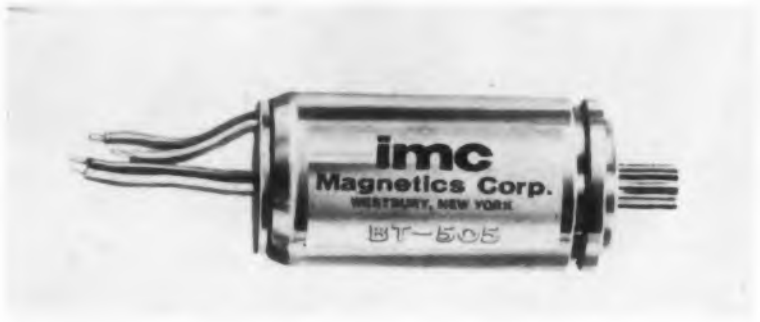
The diodes are mounted on extruded aluminum heat sinks which are arranged in semi-circular sections with recesses to accommodate the diodes and radial fins to dissipate heat. Two of the semi-circular sections are electrically tied together to form the negative bus for the diodes. The other two sections are isolated from the first ring and each other. Between these two rings lies the interphase transformer, which equalizes any difference between the two bridges, limits peak current in the diodes, and reduces ripple in the dc output by about 50%.

The fan, an axial flow type, has a three-phase induction motor. It operates at 6500 rpm at sea level and at 18,000 rpm at 60,000 ft. thus displacing a nearly-constant volume of air.

For more information on these units, turn to the Reader-Service Card and circle number **102.**

NEW PRODUCTS

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



Servomotor Has 1 in. Length

This size 5 servomotor has a 1-in. overall length and delivers a no load speed of 9500 rpm. The unit has a stall torque of 0.09 oz-in. and a theoretical acceleration of 45,000 rad per sec^2. Total power input is 3.5 w. Operating in a temperature range of −55 to +150 C, it is a 400 cycle unit. Completely encapsulated in epoxy, the servomotor weighs 0.68 oz and has a diameter of 0.5 in.

IMC Magnetics Corp., Dept. ED, 570 Main St., Westbury, N. Y.

CIRCLE 33 ON READER-SERVICE CARD

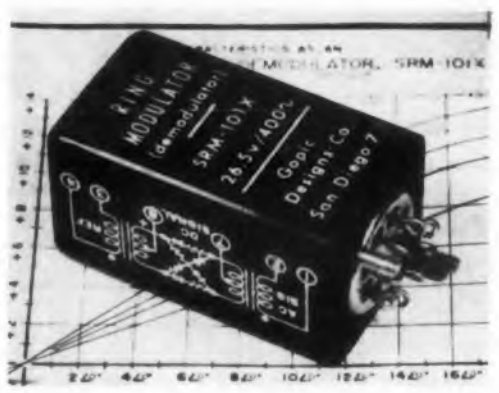
Center Screwlock Connector Contains 152 Contacts

The series 1900 miniature rectangular power connectors come with a center screwlock, closed entry contacts, and up to 152 contacts. These pin and socket connectors can be had with terminals for solderless wire wrap, solderless taper pin or solder cup. The series can also be supplied with 104, 78 and 34 contacts. Body dimensions are 1.72 x 3.59 in. Current rating is 10 amp continuous, 13 amp max. Voltage breakdown at sea level is 1800 v rms and 2500 v dc.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

CIRCLE 34 ON READER-SERVICE CARD

Ring Modulator-Demodulator Stable from −54 to +85 C



Type SRM-101X ring modulator-demodulator is stable between −54 and +85 C when operating as a phase-sensitive demodulator. No adjustment or external circuit compensation is required to maintain a 60-db dynamic range, a maximum phase error of 20 min, and a gain variation of less than 0.03% per deg C. The two transistors, four silicon diodes, and four wirewound resistors are preassembled on an etched circuit board which is potted and sealed in a steel case. The unit is suitable for both industrial and military applications.

Gopic Designs Co., Dept. ED, P.O. Box 7534, San Diego 7, Calif.

CIRCLE 35 ON READER-SERVICE CARD

Transistorized Generator Provides Simulated and Flexible Pulse Pattern

This transistorized pulse pattern generator provides a simulated and flexible time division pulse pattern and can be used for testing both slow and high speed electronic systems such as: guidance systems, computers, communication systems, and telemetry systems. It is especially useful working with equipment having a time division multiplex principle. The unit generates a pulse pattern any length from 1 to 100 pulses. The pulse rate is continuously variable from 10 to 100,000 pulses per sec using an internal oscillator, and it can be driven by an external oscillator at a pulse rate as low as desired. Each pulse can assume either a mark or space condition and is controlled by an individual switch.

Data Products Company, Inc., Dept. ED, 7320 Westmore Rd., Rockville, Md.

CIRCLE 36 ON READER-SERVICE CARD

Tunnel Diode Samples Available

The ZJ56, an experimental germanium semiconductor tunnel diode, is designed for low level switching and small signal applications with frequency capabilities extending to 1000 mc. Its operating temperature range is —55 to +100 C. The unit has a rated dissipation of 50 mw and is derated 0.66 mw per deg C in the ambient temperature range of +25 to +100 C. Peak tunnel current is: 0.9 ma, min; 1 ma, typical; 1.1 ma, max. There is a waiting list for these units which are available in sample quantities.

General Electric Co., Semiconductor Products Dept., Dept. ED, Liverpool, N. Y.

CIRCLE 37 ON READER-SERVICE CARD

CIRCLE 38 ON READER-SERVICE CARD ➤

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 8

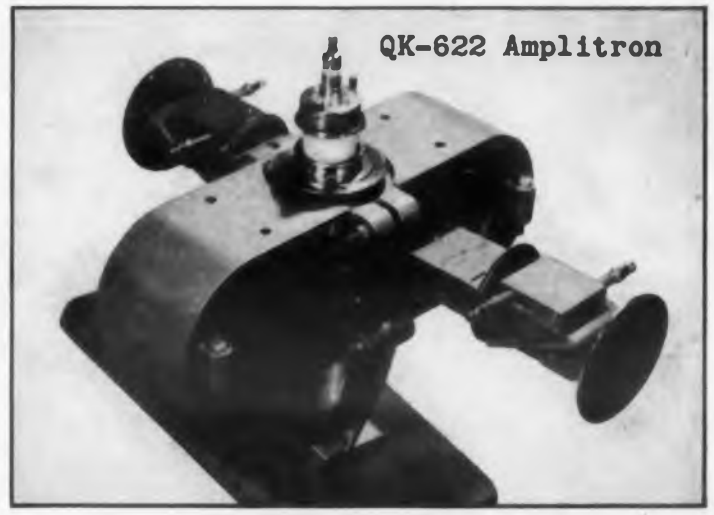
NEW RAYTHEON HEATERLESS AMPLITRONS EXCEED 1,000 HOURS AT RATED POWER OUTPUT

Two new 3-megawatt, S-band Amplitrons have demonstrated an operating life of more than 1,000 hours at rated power output. The QK-622 covers the 2,900 to 3,100 Mc band; the QK-783, the 2,700 to 2,900 Mc band. Both tubes supply full power with low phase pushing characteristics over their entire operating bands at efficiencies greater than 70%--making them unquestionably the most highly efficient microwave tubes thus far developed.

Tubes may be operated at reduced peak power levels to serve as driver stages. High efficiencies are retained at peak power of 600 Kw and gain of 10 db.

Exceptionally long tube life is made possible by the fact that no cathode warmup is required. Starting takes place whenever RF input is present prior to application of modulating pulse. Heater supplies may be omitted entirely from the equipment.

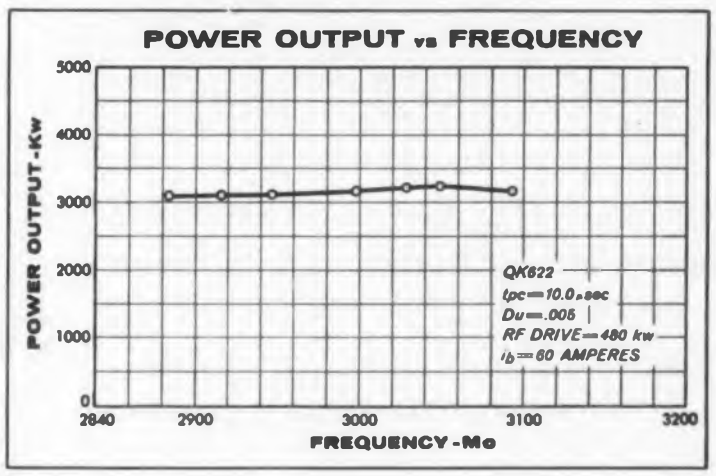
Applications include power-amplifier stages for long-range radars. The tube has been used successfully as an RF power source for linear accelerators.

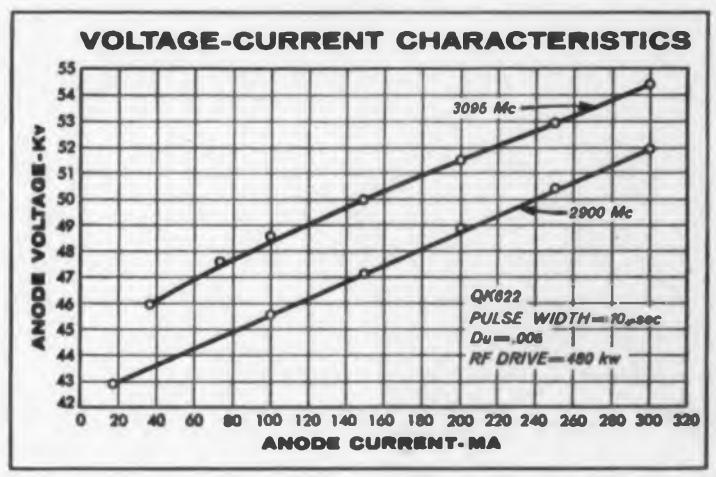


QK-622 Amplitron

Typical Operating Characteristics
(QK622 and QK783 Amplitrons)

Peak Power Output (min.)	3 Mw
Average Power Output	15 Kw
Pulse Duration	10 μ sec
Band Width	200 Mc
Duty Cycle	.005
Pulse Voltage	50-55 Kv
Peak Anode Current	65 amps
Efficiency	70%
RF Input	475 Kw
Weight (with permanent magnet)	125 lbs.





Excellence in Electronics

RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

NEW PRODUCTS

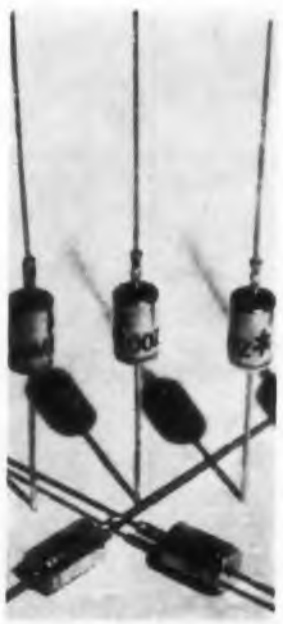
Interval Timer

Resolving time is 20 mμsec

Having a resolving time of 20 mμsec, the designated model LFQ-20 quantizer is accurate to one part in 10^7 per day. Compatible with a variety of digital data handling equipment, the unit accepts time-varying input signals and reads out the time of each interval in digital code. The unit is transistorized and meets Mil specs. It is designed to fit a standard relay rack.

Computer Equipment Corp., Dept. ED, 1931 Pontius Ave., Los Angeles 25, Calif.

CIRCLE 40 ON READER-SERVICE CARD



Zener Diodes

Are rated at 13.2, 22, and 29.7 v

Designed to meet MIL-E-1/1236, these three 10-w Zener diodes have the following ratings: type 1N1353, 13.2 v; type 1N1358, 22 v, and 1N1361, 29.7 v. Their uses include the regulation of vacuum tube filaments, protection of transistors against voltage surges, and to provide voltage regulation despite variations in input voltage. For use in both ac and dc circuits, these Zener diodes are compact in design and are suitable for miniature equipment.

Motorola, Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell, Phoenix, Ariz.

CIRCLE 41 ON READER-SERVICE CARD

IF Amplifier

Center frequency is 200 mc

Type 39 if amplifier has a center frequency of 200 mc, a gain of 120 db, and a 3 mc bandwidth. The unit provides detector output and gain control. A matched input noise figure of 6.5 db is standard; lower noise figure input circuitry can be supplied when required.

Lel, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

CIRCLE 42 ON READER-SERVICE CARD

Binary Decade Counter

Transistorized

Model BD-101 binary decade counter consists of four transistor flip-flops that may be externally connected as a binary counter, as a binary coded decimal counter, or as any multistage counter that requires feedback. The power required is +20 v at 20 ma and −90 v at 1 ma. The maximum input rate is 100 kc.

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

CIRCLE 43 ON READER-SERVICE CARD

Circuit Modules

Perform varied functions

Types 24 through 27 flip-flops and binary dividers come in speeds to 1.2 mc. They are epoxy resin filled and can be furnished with either soft wire in-line leads or soft hook terminals. All units operate to 60 C and meet the requirements of MIL-T-21038, grade 5, class Q, life expectancy X.

MF Electronics Co., Dept. ED, 122 E. 25th St., New York 10, N.Y.

CIRCLE 44 ON READER-SERVICE CARD

NEW PRODUCTS

Synchro Data Switch

For two-speed systems

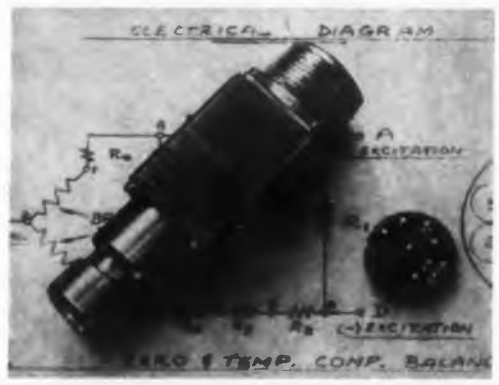
Model DS-3 synchro data switch operates automatically between fine and coarse synchros in two-speed systems. For use with all common synchro ratios and sensitivities, it operates on 60 or 400 cps or any other synchro excitation frequency. For small errors, it sums the fine and coarse synchro signals so that the coarse signal is blocked. For large errors, the coarse signal overrides the fine to prevent false nulls. The unit consists of solid state components, potted and hermetically-sealed in a metal case.

Feedback Controls, Inc., Dept. ED, 8 Erie Drive, Natick, Mass.

CIRCLE 47 ON READER-SERVICE CARD

Pressure Transducers

Have ranges of 0 to 50 through 0 to 5000 psig



The SP2-518 series of pressure transducers come in pressure ranges of 0 to 50 through 0 to 5000 psig. Bridge impedances can be specified from 50 to 2000 ohms. The sensitivity is ±0.015 mv per v with total errors of less than 1% of full scale. Nonlinearity and hysteresis errors combined are less than ±0.5% of full scale. The thermal zero shift is less than ±0.01% full scale per deg F; the thermal coefficient of sensitivity is ±0.005% of full scale per deg F over the range of −65 to +275 F. The unit has an easily accessible recalibrating terminal board with bobbin wound resistors.

Standard Controls, Inc., Dept. ED, 1130 Poplar Place, Seattle 44, Wash.

CIRCLE 48 ON READER-SERVICE CARD

NEW PRODUCTS

Signal Generator

Range is 100 cps to 100 kc

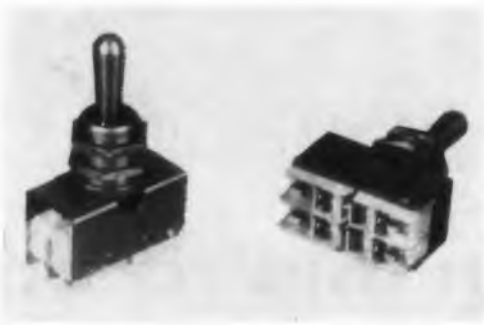
Designed for use with fm telemetry discriminator systems, model 320 signal generator has a frequency range of 100 cps to 100 kc with 0.02% accuracy at all frequencies. Maximum settling time to stabilize to a new preset frequency is 1 sec. The unit is crystal referenced. Suitable for standard rack or instrument case mounting, the chassis with power supplies is 8-3/4 in. high. Other applications are as a laboratory frequency standard and as an accurate frequency source for use in calibrating complex electronic systems.

Digital Instrument Labs., Dept. ED, 5115 Via Corona, Los Angeles, Calif.

CIRCLE 51 ON READER-SERVICE CARD

Toggle Switch

Has four poles



Made for aircraft and military use as well as for compact control panels on electrical and electronic equipment, this four-pole toggle switch occupies less than 1 cu in. The bat handle of the switch is kept in one of three positions with the center position off. Each pole is rated at 6 amp from 125 to 250 v ac, 30 v dc resistive, and 3 amp at 30 v dc inductive. All exposed metal parts are either stainless steel or are treated to resist corrosion. The operating force required to move the bat handle is set above the point where vibration or accidental jarring will actuate the switches. The weight is about 1 oz.

Electrosnap Corp., Dept. ED, 4218 W. Lake St., Chicago 24, Ill.

CIRCLE 52 ON READER-SERVICE CARD

Transformers

Isolation type

These three hermetically-sealed, isolation type transformers use an electrostatic shield brought out to a terminal to eliminate noise. Made to exceed MIL-T-27A, they operate from a 115 or 230 v, 60 cps, single-phase line to a 105, 115, or 125-v line. Model HSM-270 is Mil type TF4RXO1JB and has a 50-va rating, model HSM-271 is Mil type TF1RXO1KA and has a 125-va rating, and model HSM-272 is Mil type TF1RXO1NB and has a 250-va rating.

Triad Transformer Corp., Dept. ED, 4055 Redwood Ave., Venice, Calif.

CIRCLE 53 ON READER-SERVICE CARD

Miniature Connectors

Provide 25 lb retention

These miniature electrical connectors have insertable contacts which provide a minimum retention of 25 lb. The contact retention spring, is designed to accurately fit into the retaining angle of the hard insert and hold under compression. The connectors have hard plastic center inserts.

The Deutsch Co., Electronic Components Div., Dept. ED, Municipal Airport, Banning, Calif.

CIRCLE 54 ON READER-SERVICE CARD

DC Power Supply

Delivers 60 v at 1000 amp

Made to produce a high magnetic field inside a high compression molding dye for manufacturing magnetic ceramics, this power supply delivers 60 v dc at 1000 amp. Ripple is less than 5%. Sequence timers and reversing switches, located internally, make the output positive or negative as required. The output is varied over a wide range by a saturable core reactor. The intensities of the magnetizing and demagnetizing fields are controlled independently by manual adjustments.

Nothelfer Winding Labs., Inc., Dept. ED, P.O. Box 455, Trenton, N.J.

CIRCLE 55 ON READER-SERVICE CARD

CIRCLE 922 ON CAREER INQUIRY FORM ON PG 129 ➤

...ES.

Electronic Daily

PUBLISHED DAILY DURING THE RADIO ENGINEERING SHOW · AND WESCON

. 8, No. 1 — Tuesday, August 18, 1959 — Copyrighted 1959 Hayden Publishing Co., Inc.

NEW SHOCKLEY DIODE APPROACHES IDEAL

Page 4

Few Delays Due To Strike

Page 2

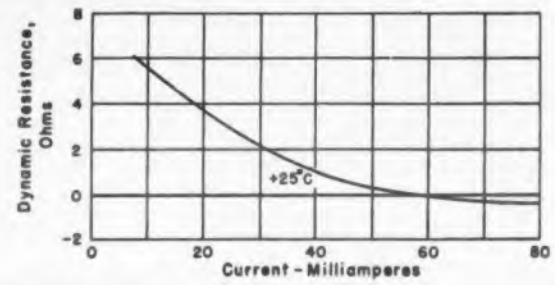
MEMO:
This is a reproduction of an announcement of major importance to users of Zener diodes.

Drs. Horsley (l.) and Shockley (r.) check out new compensated avalanche diode which approaches concept of ideal di

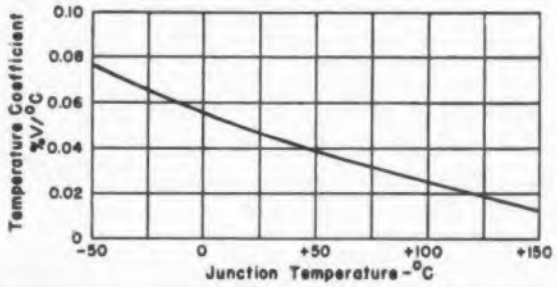
THE SHOCKLEY COMPENSATED AVALANCHE DIODE...

A new silicon voltage regulator for more precise voltage control under varying loads and changing temperature.

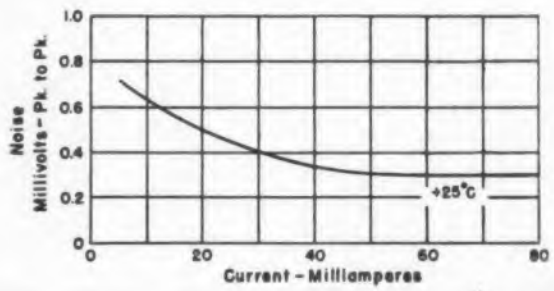
Reproduced at the left is the first issue of the ELECTRONIC DAILY distributed at the recent WESCON Show. The lead story describes the new Shockley Compensated Avalanche Diode which had just been announced. The immediate interest that followed was due to a major breakthrough in Zener design, enabling us to approach the ideal in operating characteristics. The result has been significant improvement in three areas:



1. Dynamic resistance—Drops to zero and is actually slightly negative at the higher currents of the operating range. Therefore, changes in the current flowing in the diode cause less shift in regulated voltage.



2. Temperature coefficient—Reduced to half that of conventional Zener regulator diodes. (Note: This is still somewhat greater than that of Zener reference diodes.)



3. Noise—Reduced to less than half that of conventional Zeners.

The curves shown are typical of those in our Data Sheet ADC-1. A copy is available from your Shockley representative or from our Palo Alto headquarters. But "the proof is in the pudding"—try one in a circuit and be convinced.

Shockley TRANSISTOR CORPORATION
A SUBSIDIARY OF BECKMAN INSTRUMENTS, INC.
STANFORD INDUSTRIAL PARK, PALO ALTO, CALIFORNIA

Differentials

Shaft sizes are 5/64, 3/32, 1/8 in.

Designed to meet Mil specs, type V15 miniature differentials have shaft sizes of 5/64, 3/32, and 1/8 in., and are available in ball and oilless bearing units. A variety of stainless steel and aluminum end gears can be supplied in 96, 120, and 200 pitches with 100 to 600 teeth. Static friction under load is not more than 5%, lost motion between any two end gears is not more than 10 min of arc, and load rating is 10 oz-in. The ball bearing units have a maximum operating speed of 1000 rpm.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., E. Rockaway, L.I., N.Y.

CIRCLE 57 ON READER-SERVICE CARD

Ohmmeter

For automatic production testing

Model 8516 ohmmeter, for automatic production testing of components and assemblies, covers a range of 3.75 to 4 ohms and may be supplied to cover any specified resistance range between 0.1 and 1,000,000 ohms. Accuracy of the standard instrument is better than 0.05 ohms. Three pilot lights are used to indicate if the resistance is below the lower limit, within limits, or above the upper limit. The unit operates from a 115 v, 50 to 60 cps line, and has a very low voltage at test terminals.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

CIRCLE 58 ON READER-SERVICE CARD

NEW PRODUCTS

Magnetic Tape Transport

Transfer rate is 400,000 characters per sec

The model 908, Mark II, Magnetic tape transport has a transfer rate of 400,000 characters per sec. It has complete program freedom at 120 in. per sec with 10-1/2 in. reels of tape 1 in. wide and a 16-channel system. The transport has a redundant guide system, fully interchangeable head mounting, and loading with almost instant reel hub release. Solid state electronics supported by logically arranged plug-in boards provide the servo drive and control.

Potter Instrument Co., Inc., Dept. ED, Plainview, L.I., N.Y.

CIRCLE 61 ON READER-SERVICE CARD

Environmental Chamber

Measures 7 x 3 x 3 ft

Measuring 7 x 3 x 3 ft, model FH-63-705-705 environmental chamber provides temperatures from —100 to +300 F and simulates altitudes to 200,000 ft. The temperature recording controller provides for programming and automatic proportioning of heating and cooling. Temperature and altitude changes are rapid. The unit includes a manometer and a radiation gauge. Designed for testing complete assemblies of electronic equipment, the chamber will accommodate an entire relay rack assembly at one time.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

CIRCLE 62 ON READER-SERVICE CARD

We are pleased to announce that

Schweber
ELECTRONICS
60 HERRICKS ROAD, MINEOLA, L. I., N. Y.
TWX G-CY-NY 580 PIONEER 8-6520

has been selected as the first direct factory source for Fairchild transistors and devices. A complete inventory is now available at Schweber's facilities for same day shipment. Factory price protection up to 1000 pieces per type.

FAIRCHILD
SEMICONDUCTOR CORPORATION

CIRCLE 63 ON READER-SERVICE CARD

NEW

HIGH-VOLTAGE SILICON MESA TRANSISTORS

FAIRCHILD'S 2N699
OFFERS ANOTHER UNIQUE COMBINATION

120 VOLTS collector to base voltage, permits greater voltage swings in amplifier and oscillator circuits and more protection in inductive switching circuits. Maximum base-emitter turn-on voltage is only 1.3 volts for I_C=150 mA and I_B=15 mA.

120 MEGACYCLES typical gain-bandwidth product means excellent broad-band video performance. In addition the units will provide typically 18 db neutralized gain at 30 mc and 30% efficiency in a 70 mc oscillator circuit.

300° C SURVIVAL has been assured. Every transistor produced at Fairchild has been preaged a minimum of 60 hours at 300° C before test. This provides extra reliability at their recommended maximum operating junction temperature of 175° C.

2 WATTS dissipation at 25° C – the combination of power with high frequency that is available only in double diffused silicon transistors.

In Fairchild's recent succession of new transistor announcements, each has offered some exceptional combination of characteristics previously unattainable. The 2N699 combines high collector voltage rating with high-frequency performance, medium power capabilities and low saturation resistance. Its applications range from low-current high-frequency I-F circuits to high-current, low-frequency relay drivers. Other products nearing production at Fairchild promise even greater advances in the state of the art.

2N699 — ELECTRICAL CHARACTERISTICS (25° C)

Symbol	Characteristic	Min.	Typ.	Max.	Test Conditions	
h_{FE}	D.C. pulse current gain	40		120	I_C = 150ma	V_C = 10v
$V_{BE(sat)}$	Base saturation voltage		1.0	1.3	I_C = 150ma	I_B = 15ma
$V_{CE(sat)}$	Collector saturation voltage			5v	I_C = 150ma	I_B = 15ma
h_{fe}	Small signal current gain at f = 20 mc	2.5	5.0		I_C = 50ma	V_C = 10v
C_{ob}	Collector capacitance		14$\mu\mu$f	20$\mu\mu$f	I_E = 10ma	V_C = 10v
I_{CBO}	Collector cutoff current			2μa	V_C = 60v	T = 25°C
				200μa	V_C = 60v	T = 150°C

A new plant of nearly ten-times increased capacity opened in June 1959 to fill demand created by new products introduced in less than a 12-month period.

For full information, write Dept. B-10-28.

FAIRCHILD
SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD • MOUNTAIN VIEW, CALIF. • YOrkshire 8-8161
Regional sales offices in Los Angeles and Philadelphia

CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Rectifiers

Have piv range of 700 to 1600 v

Type BR/1N2772-2781 silicon rectifiers, called the Siamese series, have a piv range of 700 to 1600 v with a maximum dc output of 750 ma at 25 C. Maximum forward voltage drop is 1.8, reverse leakage factor is 4 μa, and recovery time is 5 μsec. All units are hermetically-sealed to meet Mil specs. Dimensions are 19/32 in. in length and 3/8 in. in diameter.

Bradley Semiconductor Corp., Dept. ED, 275 Welton St., New Haven 11, Conn.

CIRCLE 66 ON READER-SERVICE CARD

Time Delay Relay

Uses miniature potentiometer

Incorporating a miniature potentiometer, this time delay relay has a time range of 50 msec to 2 sec or of 2 to 50 sec. The delay times are set by means of an external screw adjustment. The units may be delayed pull-in type or delayed drop-out. The control circuit is transistorized and a relay contact is the only moving part. The relays are hermetically sealed, use printed circuit construction and weighs 5-1/2 oz. Mil specs for ground support equipment are met.

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

CIRCLE 67 ON READER-SERVICE CARD

Insulating Felts

Have wide range of densities

This line of insulating felts that come in rigid or semi-rigid boards are composed of inorganic mineral fibers mill-formed to specific densities and thicknesses with a durable, thermo-setting resin. Thermal conductivity range is from 0.27 for low density felts to 0.24 for the high density felts, based on a test mean temperature of 70 F. Densities range from 3 lb per cubic foot to 12 lb per cubic ft.

United States Mineral Wool Co., Dept. ED, Stanhope, N.J.

CIRCLE 69 ON READER-SERVICE CARD

DC Power Supply

Has two regulated outputs

Operating from a source of 105 to 125 v, 60 cps, single-phase, model P36-.20 power supply provides two dc outputs which are regulated to within 0.25% for line and load changes. The unit is transistorized and has an output current cutoff which provides external circuit protection. The outputs are completely floating with either positive or negative ground. Recovery time is less than 50 μsec, ripple is 0.01%, and overshoot is less than 1% of voltage setting. The unit is portable and measures 11-1/4 x 13-9/16 x 10 in.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

CIRCLE 70 ON READER-SERVICE CARD

Cathode Ray Tube

Frequency range is 2 to 10 kmc

Capable of presenting microwave frequency information directly on its screen this cathode ray tube, called Wamoscope, operates over the range of 2 to 10 kmc. The spot size is 160 lines per in. at the center of the 10-in. screen. Made for use in advanced electronic systems, the tube does not require a solenoid. It is particularly suitable for high-resolution radar applications.

Sylvania Electric Products, Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

CIRCLE 71 ON READER-SERVICE CARD

CIRCLE 72 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Subcarrier Discriminator

Output is ±10 v

Made for telemetry used, type GFD-3 subcarrier discriminator has an output of ±10 v max at 500 ma, continuously adjustable. The dynamic input range is 10 mv to 10 v. The unit has phase-lock circuitry and replaceable plugboard features. The power drain is less than 27 w. The unit is completely solid state, weighs 12 lb, and measures 8 x 16-1/2 x 3-1/2 in.

Data-Control Systems, Inc., Dept. ED, Danbury, Conn.

CIRCLE 74 ON READER-SERVICE CARD

Voltmeter

Peak responding type

Model 305A voltmeter measures peak or peak-to-peak values of any repetitive wave forms. The operating mode can be selected to respond to peak-to-peak and positive or negative peak of the waveform. The dc component of the waveform is not measured by the instrument. The frequency range for sine waves is 5 cps to 500 kc; distorted waveforms with harmonics to 2 mc, and pulses with duration from 0.5 μsec to 5 msec having repetition rates from 5 pps to 500,000 pps can also be measured. The 5-in. mirror scale is a suppressed-zero indication type. The accuracy of the meter is 2% to 5% and the precision of the reading is better than 0.5% at any part of the scale. The instrument can be used as a wideband amplifier with a gain of 86 db and a source of impedance of about 3 ohms in series with 0.22 μf.

Ballantine Labs., Dept. ED, Boonton, N.J.

CIRCLE 75 ON READER-SERVICE CARD

CHECK YOUR RCA SEMICONDUCTOR DISTRIBUTOR

For...

- ✓ A comprehensive line of superior-quality RCA Transistors and Silicon Rectifiers.
- ✓ RCA Semiconductors for special projects or preproduction-run requirements from local stock—at factory prices.
- ✓ Prompt delivery of the latest RCA types for your evaluation.
- ✓ Orders filled from factory-fresh stock.
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- ✓ Valuable RCA technical assistance when it is needed.
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- ✓ Specialists who understand your problems and your electronic needs.

RADIO CORPORATION OF AMERICA
Semiconductor Products-Distributor Sales
Harrison, N. J.

RCA SILICON RECTIFIERS

DIFFUSED-JUNCTION TYPES

Another Way RCA Serves You Through Electronics

RCA TYPES FOR INDUSTRIAL and MILITARY POWER SUPPLIES

RCA TYPE NUMBERS	MAXIMUM RATINGS Absolute-maximum values: For supply frequency at 60 cycles and with resistive or inductive load.									CHARACTERISTICS		
				FORWARD CURRENT, DC				AMBIENT TEMPERATURE		At Ambient Temp. of 25°C		At Ambient Temp. of 150°C
	Peak Inverse Voltage (VOLTS)	RMS Supply Voltage (VOLTS)	DC Reverse Voltage (VOLTS)	50°C Ambient (MA)	100°C Ambient (MA)	150°C Ambient (MA)	Surge One-Cycle (AMP)	Operating (°C)	Storage (°C)	Max. Forward Voltage Drop (DC) at indicated DC Forward Current (VOLTS)	Max. Reverse Current (DC) at Max. Peak Inverse Voltage (μa)	Max. Reverse Current (averaged over one complete cycle) at Max. Peak Inverse Voltage (μa)
IN536	50	35	50	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	400
IN537	100	70	100	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	400
IN538	200	140	200	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	300
IN539	300	210	300	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	300
IN540	400	280	400	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	300
IN1095	500	350	500	750	500	250	15	−65 to +165	−65 to +175	1.2 at 500 ma	5	300
IN547	600	420	600	750	500	250	15	−65 to +165	−65 to +175	1.2 at 500 ma	5	350
RCA TYPES FOR MAGNETIC AMPLIFIERS and BLOCKING CIRCUITS												
IN440-B	100	70	100	750	500	250	15	165	−65 to +175	1.5 at 750 ma	0.3	100
IN441-B	200	140	200	750	500	250	15	165	−65 to +175	1.5 at 750 ma	0.75	100
IN442-B	300	210	300	750	500	250	15	165	−65 to +175	1.5 at 750 ma	1.0	200
IN443-B	400	280	400	750	500	250	15	165	−65 to +175	1.5 at 750 ma	1.5	200
IN444-B	500	350	500	650	425	0	15	150	−65 to +175	1.5 at 750 ma	1.75	200
IN445-B	600	420	600	650	400	0	15	150	−65 to +175	1.5 at 750 ma	2.0	200

RCA TYPES FOR TV and RADIO RECEIVERS and GENERAL PURPOSE

RCA TYPE	MAXIMUM RATINGS Absolute-Maximum Values: for supply frequency of 60 cps and with capacitor input to filter							CHARACTERISTICS				
			FORWARD CURRENT (UP TO 75°C)			AMBIENT TEMPERATURE		At Ambient Temperature of 25°C			At Ambient Temperature of 100°C	
								Max. Instantaneous Forward Voltage at Instantaneous Forward Current = 15 amps (VOLTS)	Max. Reverse Current (μa)		Max. Reverse Current (ma)	
	Peak Inverse Voltage (VOLTS)	RMS Supply Voltage (VOLTS)	DC (AMP)	Peak, Recurrent (AMP)	Surge for a "turn-on" transient = 2 milliscs (AMP)	Operating (°C)	Storage (°C)		Peak Inverse Volts = 400	Peak Inverse Volts = 500	Peak Inverse Volts = 400	Peak Inverse Volts = 500
1N1763	400	140	0.5	5	35	100	−65 to +150	3	100	—	1	—
1N1764	500	175	0.5	5	35	100	−65 to +150	3	—	100	—	1

...immediately available from your local

RCA SEMICONDUCTOR DISTRIBUTOR!

QUALITY is the reason designers of high-reliability equipment specify RCA Silicon Rectifiers. FAST SERVICE is the reason they order through their local RCA SEMICONDUCTOR DISTRIBUTOR.

All RCA Silicon Rectifiers are Welded and Hermetically Sealed. Entertainment types are subjected to rigid quality control procedures to provide top quality and performance. In addition, RCA types for Industrial Power Supplies and Magnetic Amplifiers undergo these extensive tests to assure reliability and long life.

- **100% high-temperature dynamic test at full load current and rated voltage**
- **100% reverse leakage current test**
- **100% forward characteristic test**
- **100% pressure-seal test**
- **100% temperature cycling test**

So, whatever your requirements for Silicon Rectifiers—or transistors—for *fast service* check with your local RCA SEMICONDUCTOR DISTRIBUTOR. For quality products, specify RCA. *You benefit from this combination!*

RADIO CORPORATION OF AMERICA
Semiconductor Products—Distributor Sales • Harrison, New Jersey

NEW PRODUCTS

Inverter

Transistorized

This 2 kw dc-ac inverter will supply a 2-kva output or two l-kva outputs of 120 v, 60 or 400 cps, single-phase, from a source of 11 to 14 v dc or 22 to 32 v dc. Frequency stability is ±0.01% and efficiency at full load is about 85%. It can be used as a replacement for rotary inverters in microwave, telemetry, and automatic control installations. The standard rack panel unit measures 24-1/2 x 19 x 12 in.

Electrodynamic Instrument Corp., Dept. ED, 2508 Tangley Rd., Houston 5, Tex.

CIRCLE 77 ON READER-SERVICE CARD

Ratio Transformer

Measures deviation in per cent

For use in testing transformers, transducers and resolvers, type PDR 1100 ratio transformer measures ratio deviation in per cent. The unit consists of seven-decade ratio transformer combined with a four-place, per cent deviation ratio transformer. Ratio settings to 3.11111 are possible, measuring deviations to 9.999%. The maximum input voltage is 350 v at 0.35 cps or 140 v at 400 cps. Also available, type PDR 1101 has a maximum input voltage of 350 v at 2.5 cps or 150 v at 60 cps. Per cent deviation ratio transformers can be obtained alone for use with standard ratio transformers. Type PDR 1102 accepts the same input voltage as the PDR 1100; input to the PDR 1103 is the same as to the PDR 1101. All units have built-in switching transient suppression and an accuracy of 0.001%.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 15, Calif.

CIRCLE 78 ON READER-SERVICE CARD

CIRCLE 825 ON READER-SERVICE CARD

Wirewound Potentiometer

Non-contaminative type

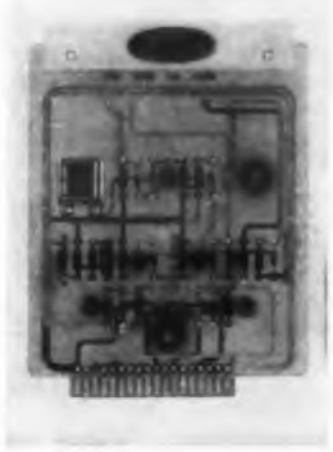
Encased in phenolic housing, series 61 wirewound potentiometer is for use in chemical production, laboratory testing, and other applications where safeguarding from foreign factors is important. The terminal lug spacing on the rear plate of the casing provides for a 10,000-v dc rating, or a safety factor in dust filled atmospheres. Rated at 2.5 w, the unit measures 2 in. in diam and 5/8 in. in depth.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

CIRCLE 88 ON READER-SERVICE CARD

Pulse Generator

Transistorized



Model 300X transistorized pulse generator provides accurately timed clock pulses at crystal-controlled frequencies. A standardized 2.5-v pulse of both polarities is generated by the oscillator. The output stage is transformer-coupled and has a constant voltage. The pulse remains undeteriorated when loaded at an output current between 0 and 100 ma. Mounted on a 5 x 6-in. glass-epoxy printed circuit card 1/16 in. thick, the unit is for use with an 18-pin PC receptacle. Accuracy is to 0.01% of crystal frequency and the operating temperature is from 0 to 135 F. Available models and operating frequencies are: 300X-1, 100 kc; 300X-2, 200 kc; and 300X-3, at 300 kc.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 89 ON READER-SERVICE CARD

CIRCLE 825 ON READER-SERVICE CARD

NEW PRODUCTS

DC Power Supply

Regulation is 0.25%

Type 157 transistorized power supply provides three simultaneous outputs: 22.5 v dc at 1 amp, —12 v dc at 1 amp, and —6 v dc at 0.5 amp, all adjustable and all regulated to within 0.25% for line and load changes. The input power is 115 v, 400 cps, three-phase. The ripple is 0.01%, recovery time is less than 50 μsec, and the overshoot will not exceed 1% of voltage setting. Designed for a standard 19 in. relay rack and panel, the unit measures 5-1/4 in. high.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

CIRCLE 92 ON READER-SERVICE CARD

Potentiometer

Has 3/4-in. diam

The series 450 10-turn potentiometer, called Multipot, is 3/4 in. in diam and 1-1/4 in. long. Units are available in resistance ranges from 1 to 250 K. They provide a 2-1/2 w power rating, operate from —65 to +100 C, and withstand 20 g shock for 11 μsec. They exceed MIL-E-5272A, procedure II for vibration, 5 g to 2000 cps, and meet MIL-STD 202, Method 102, for temperature cycling. Designed for use in general test equipment and computers, they have rear-mounted terminals.

Daystrom Pacific, Div. of Daystrom Inc., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

CIRCLE 93 ON READER-SERVICE CARD

Accelerometer

Gas-damped

For aircraft and missile control applications, this accelerometer is equipped with a gas-damped seismic system. The range of the instrument is ±1 to ±25 g, the damping is 0.65 of critical at 75 F, and the temperature range is −65 to +250 F. The zero and sensitivity drift from −25 to +180 F is less than 2% of range per 100 deg F. The linearity is less than 1% of acceleration span and the hysteresis is less than 1% of acceleration.

Wiancko Engineering Co., Dept. ED, 225 N. Halstead, Pasadena, Calif.

CIRCLE 95 ON READER-SERVICE CARD

Photoconductive Cell

Made of indium antimonide

Made of indium antimonide, this photoconductive cell, called the Mullard Orpio, has a sensitivity to 7.5 microns at room temperature. The spectral response range is from the visible to 8 microns; the peak response is 6 to 6.5 microns. The sensitivity is measured with 2 μw of radiation falling on the sensitive area and 50 ma dc applied to the cell. With this condition, the signal-to-noise ratio at 6 microns is more than 72 and the noise equivalent power is 4 x 10-9 w. The impedance of the cell is about 75 ohms. The maximum dc value is 100 ma and the maximum case temperature is 70 C. The unit is readily attached to a heat sink.

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

CIRCLE 96 ON READER-SERVICE CARD

DECISION MAKER

for simplified monitoring, controlling, high-precision switching

Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of ±1 microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

Performance stability is inherent; reliability is exceptional due to the A.P.I. locking-coil design. On "make", contact is firm with substantial contact pressure; contact resistance is low. On "break", separation is clean and quick without contact teasing.

10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.

ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

CIRCLE 98 ON READER-SERVICE CARD

NEW PRODUCTS

Motor-Generator

Miniature

Type RBG-2407 miniature motor-generator unit combines a low inertia control motor with an ac drag-cup rate generator. The rate generator has an output of 10 v, 1000 rpm with a linearity of about 1%. The motor gear ratio can be from 2.5:1 to 3600:1. The standard control winding impedance is 5400 ohms locked rotor; other impedances can be supplied. All units are 2-17/32 x 2-17/32 in. in cross section and have a maximum length of 4-1/8 in. for direct-drive motors and 5 in. for gear motors.

National Pneumatic Co., Inc., Holtzer-Cabot Motor Div., Dept. ED, 125 Amory St., Boston, Mass.

CIRCLE 99 ON READER-SERVICE CARD

Receptacles

For plug-in components

These receptacles use crimp type, snap-locked contacts for use with plug-in relays and other plug-in components. Closed-entry sockets are crimped to wire ends and snap-locked into the relay receptacle. Suitable for use in missile guidance and control equipment, these receptacles meet or exceed Mil specs for voltage drop, dielectric strength, contact engaging and retention forces, corrosion resistance, and mechanical strength.

Burndy Corp., Dept. ED, Norwalk, Conn.

CIRCLE 105 ON READER-SERVICE CARD

BIG news in electronics for vibration testing

One of the world's largest vibration test systems was recently shipped by MB to the Sperry Gyroscope Company. It featured an electrodynamic exciter of 25,000 pounds force output, a 100 KW high fidelity power amplifier of advanced design, and fully integrated, electronic controls for complex motion tests.

What makes one company a preferred source of supply in its field? Reliability, of course. But among other things, a record of "firsts." Look at MB's record in electronics alone, as applied to vibration:

- first KVA amplifier design for shaker drive
- first automatic sequencing with interlocks
- first completely remote operation
- first amplifier with full current capacity down to 5 cps
- first use of active analog computers
- first application of XY recording technique
- first to achieve low distortion in big-output amplifiers
- first displacement limiter providing protection without complete system shutdown
- first use of high-degree negative feedback around output tubes
- first use of regulated tube filaments

When you need vibration test equipment, make *your* investment in MB quality and capabilities.

MB ELECTRONICS
A DIVISION OF TEXTRON ELECTRONICS, INC.
1058 State Street, New Haven 11, Conn.

Pioneer and leader in the field of vibration

CIRCLE 106 ON READER-SERVICE CARD

Magnetic Shielding Kits

For on-the-spot evaluation

These magnetic shielding kits are for on-the-spot evaluation of non-shock sensitive, non-retentive Netic and Co-Netic shielding materials. The kits assist in finding out how many layers of material are needed and what configuration is best. Five types of kits are available. A variety of configuration as well as sheet stock and foils are provided. Kit No. 1, the largest in the series, has a magnetic and electrostatically shielded calibrated probe with standard shielded plug connector for ac field intensity evaluation.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

CIRCLE 107 ON READER-SERVICE CARD

Vacuum Oven

Provides to 500 F

This vacuum oven provides temperatures to 500 F and a vacuum to 29.5 in. mercury. A rotary vane type water cooled pump with forced feed lubrication is used. Vacuum break is through a filtered inlet. A recirculating blower increases speed in work load heating before and during vacuum pumping. The 45 kw input required for heat-up is reduced to 15 kw when the heaters have reached the maximum surface temperature. The unit has doors at each end of the 48 x 72 in. work chamber; the doors are sealed with double silicone rubber gaskets and locked with spinner handle clamps.

Grieve-Hendry Co., Inc., Dept. ED, 1330 N. Elston Ave., Chicago 22, Ill.

CIRCLE 108 ON READER-SERVICE CARD

◀ CIRCLE 109 ON READER-SERVICE CARD

NEW PRODUCTS

IF Amplifier
Transistorized

Type 83 transistorized if amplifier is a hybrid unit combining the low-noise properties of a tube input circuit with the low-power requirements of transistors. A type 7077 miniature ceramic triode with five silicon tetrode transistors helps the unit stand high shock and vibration. The noise figure is better than 2.5 db.

Lel, Inc., Dept. ED, 380 Oak St., Copiague, L.I., N.Y.

CIRCLE 111 ON READER-SERVICE CARD

Oscillator
Transistorized

This transistorized oscillator makes it possible to use the output of low-level transducers such as thermocouples or accelerators without dc amplification. The unit is made to IRIG specs of frequencies and deviations for channels 5 through 18 and A through E. The output signal amplitude is 0 to 2.2 v rms. The output impedance is 24 K direct. The harmonic distortion is less than 1% of center frequency, the linearity is within 1.5% of bandwidth and the output amplitude stability is within 1.35 db for full bandwidth. The power requirements are 26 v dc ±15% at a nominal 15 ma. The dc common mode rejection is rated at 10^7 within ±20 v of ground. The unit weighs 10 oz and measures 63/64 x 1-57/64 x 3-19/32 in.

Hoover Electronics Co., Dept. ED, 110 W. Timonium Rd., Timonium, Md.

CIRCLE 112 ON READER-SERVICE CARD

DC Voltage Regulators

Transistorized

These transistorized voltage regulators provide fixed and variable outputs of 6 to 20 v dc and 15 to 35 v dc at 0.5 amp from unregulated sources of 24 to 32 v dc and 35 to 45 v dc. Typical ripple reduction is 500:1, line regulation is ±0.1% or 10 mv, and load regulation is 50 mv for 0 to 0.5 amp load change. Typical residual noise is 1 mv. The maximum output impedance is 0.1 ohms for 5 kc to dc. Applications include airborne equipment, missiles, telemetry, and computers. The unit measures 3 x 3 x 5 in. and weighs 16 oz.

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

CIRCLE 113 ON READER-SERVICE CARD

Insulated Tubing

Multichannel type

For use on cables between bulkheads, under floors, and in other tight areas, this multichannel Zippertubing permits large diameter cables to be broken down into two or more smaller cables. The cables may be of the same or different diameters, can be sealed together, and branched off into desired locations. The tubing is made of vinyl plastic for general use. For airborne applications, type 74 polyvinylchloride can be subjected to temperatures from −90 to +185 F and meets the chemical and physical requirements of MIL-I-7444A. Type 63 polyvinylchloride is also available and conforms to the chemical and physical requirements of MIL-I-631C, grade C, class I, category I.

The Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

CIRCLE 114 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supply

Provides 0 to 2000 v dc

Model 2000VPS-100 power supply has double and triple filament regulation to provide a stability of 0.0004 per day. In addition to its use in nuclear reactor instrumentation and scintillation counter spectrometry, it provides precise regulation of line voltages from 105 to 125, 60 cps, for all types of circuits requiring negative polarity in the 0 to 2000 v range. A one-volt change in line voltage changes the output 500 μv. Power consumption is 60 w, output current is 5 ma, output impedance is less than 0.1 ohm, and ripple is less than 5 mv rms. The unit has dual switches, each with its own pilot light, and a precision potentiometer mounted at the front panel. It measures 3-1/2 x 19 x 10 in. and weighs 12 lb.

Gyra Electronics Corp., Dept. ED, Washington and Elm Sts., P.O. Box 184, La Grange, Ill.

CIRCLE 117 ON READER-SERVICE CARD

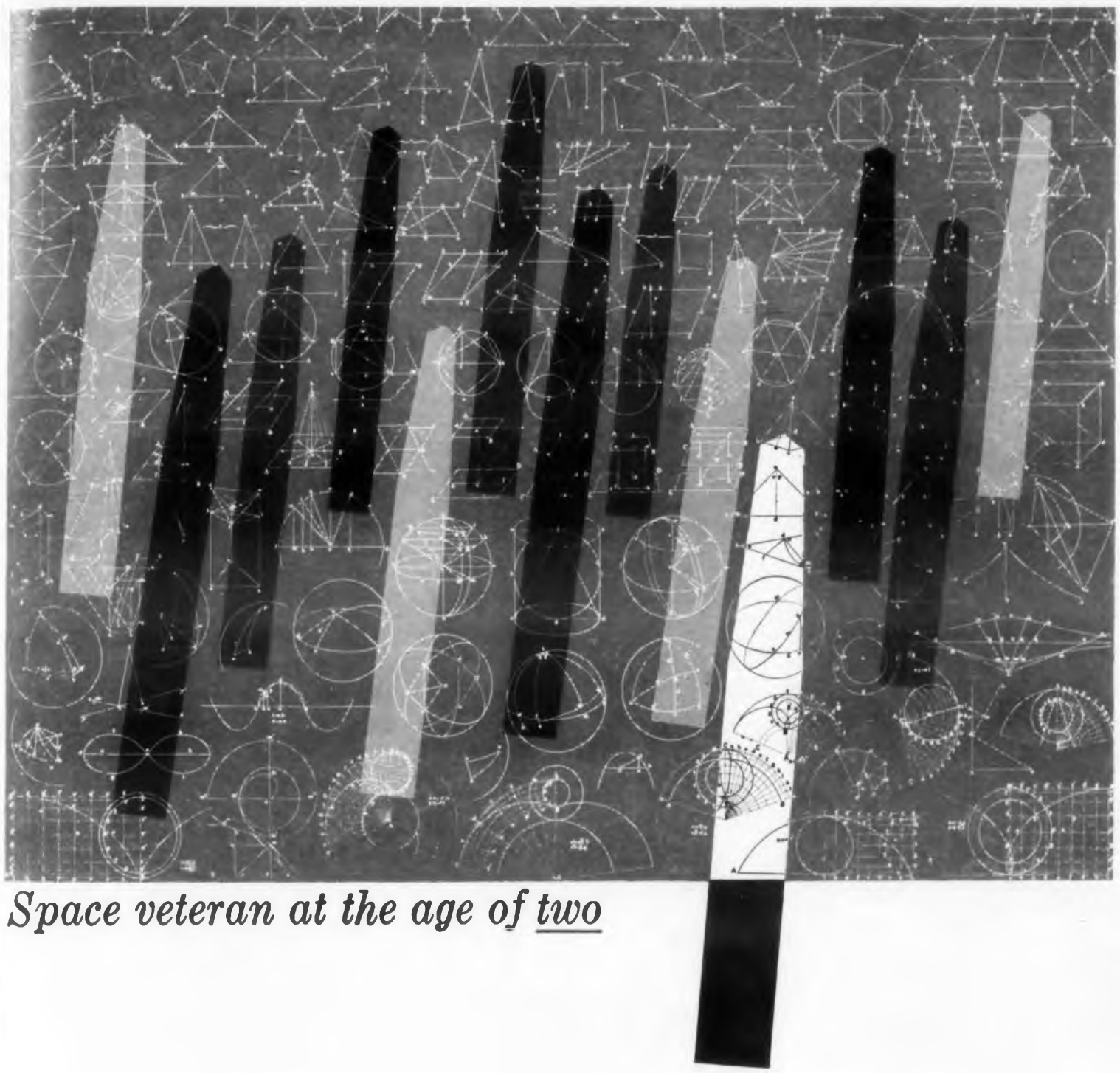
Current Governor

Provides 0.1 μa to 10 ma

Designed especially for transistor testing, CS-112 current governor furnishes currents from 0.1 μa to 10 ma in steps of 0.1 μa at load voltages from 0 to ±100 v. The current is set by decade knobs arranged to provide a digital inline readout. Accuracy at any current setting is 1% +0.1 μa; short term stability is 0.05%; line regulation is better than 0.1%; and load regulation is better than 0.1%. The unit measures 19 x 8-3/4 x 15 in. and weighs 35 lb. Its applications include calibration, measurements of Zener diodes, potentiometers, solenoids, and other devices.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

CIRCLE 118 ON READER-SERVICE CARD



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Santa Monica, Calif.

The Air Force THOR, built by Douglas and three associate prime contractors, shows how well a down-to-earth approach to outer space can work. Since its first shoot early in 1957, it has had more than *forty* successful launchings...at a variety of jobs from re-entry vehicle testing at ICBM ranges to placing satellites in orbit. Initial planning for THOR included volume production tooling, ground handling equipment and operational systems. This typical Douglas approach made the giant IRBM available in quantity in record time, and THOR has performed with such reliability that it has truly become the workhorse of the space age. Douglas is now seeking qualified engineers and scientists for new projects with even more exciting prospects.

Robert Johnson, Missile and Space Systems Chief Engineer, reviews results of a THOR-boosted 5000 mile flight with Donald W. Douglas, Jr., president of DOUGLAS

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NEW PRODUCTS

Capacitors

Range from 3.5 to 18 μμf and 7.5 to 138 μμf

Series MCA capacitors have straight-line capacity characteristics and come in six standard sizes ranging from 3.5 to 18 μμf and 7.5 and 138 μμf. They have silver-plated phosphor bronze wiping contact, silicon-treated steatite insulation, and soldered nickel-plated brass rotors and stators.

Hammarlund Manufacturing Co., Inc., Dept. ED, 460 W. 34th St., New York 1, N.Y.

CIRCLE 122 ON READER-SERVICE CARD

Miniature Choke Coil

Inductance is 1.5 to 18 mh

Measuring 0.16 in. in diameter and 0.375 in. long, this choke coil has a range of inductance from 1.5 to 18 mh. Sealed in epoxy resin for protection against climatic and mechanical conditions, the unit is designed to meet MIL-C-15305A.

Essex Electronics, Div. of Nytronics, Inc., Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J.

CIRCLE 123 ON READER-SERVICE CARD

Capacitors

Use polystyrene film

These capacitors use polystyrene film for both

the dielectric and the encasement. Metal or plastic shells and the use of glass seal terminals are eliminated. A complete range of capacity ratings is available with working voltages of 200, 400, and 600 v dc.

The Potter Co., Dept. ED, 1950 Sheridan Road., N. Chicago, Ill.

CIRCLE 124 ON READER-SERVICE CARD

Multicoder

Samples to 90 channels

Measuring 4 in. sq, this solid state telemetering multicoder samples to 90 channels of information at an input level of 0 to 5 v dc. Simultaneous outputs are available in PAM, PDM, and magnetic tape recording format. The units are supplied for multiple speeds and selectable channel configurations; the speed and number of channels is selected by insertion of programming plugs. The unit operates in typical missile environments to 100 C and requires less than 4 w of power from an unregulated 28-v source. It weighs less than 3 lb.

General Devices, Inc., Dept. ED, P.O. Box 253, Princeton, N.J.

CIRCLE 125 ON READER-SERVICE CARD

Ceramic Transducers

Curie temperature is 750 F

Having a Curie temperature of 750 F, the Glennite Hi-T transducer elements are made of lead zirconate and lead titanate compounds. The standard frequency tolerance is ±10%; tolerances to ±1% can be obtained. They can be used in ordinance systems, high temperature electromechanical sensors, missile and underwater sound applications, and ultrasonic industrial equipment. Square plates and rods, circular discs and rods, thin walled cylinders and rings, focusing cylindrical sections, and hemispheres are available.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.

CIRCLE 126 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Standard

Provides 0.1, 1, and 5 mc

Using a transistorized crystal oscillator, model NC-1200 frequency standard provides outputs of 0.1, 1, and 5 mc. The outputs are stable to 1 ppb per day and may be used simultaneously. Each output can furnish 200 mv across a 50-ohm load. The frequency is adjustable permitting calibration to one part in 10^{10}. The required input is 115 v ac, 60 cps; special power requirements can be provided for including battery and 400 cps operation. The oscillator meets MIL-E-16400 shock and vibration specifications. The components can be repackaged to meet Mil specs. Designed for relay rack installation, the unit measures 6 x 7 x 11 in.

National Company, Inc., Dept. ED, Malden, Mass.

CIRCLE 129 ON READER-SERVICE CARD

VHF-FM Receiver

For 30 to 15,000 cps

Type ESB vhf fm receiver provides distortion-free transmission of the band from 30 to 15,000 cps and eliminates cross-modulation. The unit is available in these three versions: a relay receiver for broadcasting; a long-distance link receiver for cf systems or radio transmission over wide areas, and a short-distance link receiver for cf or radio relay links. For all standard types, the frequency ranges are 87.5 to 100 mc, 41 to 68 mc, 60 to 88 mc, 156 to 174 mc, 174 to 220 mc, and 50 to 80 mc. The maximum swing specifications are 50, 75, 150 kc. Modulation frequency ranges are 30 to 15,000 cps, 300 cps to 60 kc, 300 cps to 120 kc.

Rohde & Schwarz Sales Co., Dept. ED, P.O. Box 257, 111 Lexington Ave., Passaic, N.J.

CIRCLE 130 ON READER-SERVICE CARD

Component Bending Block

For components to 1-3/4 in. long

For bending leads on resistors, diodes, and capacitors, model 700 bending block can be adjusted to any component up to 1-3/4 in. long. Leads can be bent as close as 0.07 in from the ends of the component. Finger pressure is used. The bends can be made for panel holes as far as 3 in. apart and for any lead up to 0.045 in. in diameter.

By-Buk Co., Dept. ED, 4314 W. Pico Blvd., Los Angeles 19, Calif.

CIRCLE 132 ON READER-SERVICE CARD

Phase-Splitting Transformer

Operates 3-phase devices

Type P-4674 phase-splitting transformer operates 3-phase devices where only single-phase is available. It provides 115 v, 400 cps, to a 90-va gyro power supply. The input is 115 v, 400 cps, single-phase. The requirements of MIL-T-27A are met. The unit measures 2-3/4 x 3-1/2 x 3 in. and weighs 3-1/4 lb.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N.Y.

CIRCLE 133 ON READER-SERVICE CARD

Magnet Wire

For operation to 250 C

For use in transformers, solenoids, miniature relays, and motors, this silicone-Teflon magnet wire is for continuous operation at temperatures to 250 C. It has nickel-plated copper conductors. Round sizes 15 through 36 AWG, with single or heavy film thicknesses, are available.

Anaconda Wire and Cable Co., Dept. ED, 25 Broadway, New York 4, N.Y.

CIRCLE 134 ON READER-SERVICE CARD

CIRCLE 135 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Sensitive Tape

Used over range of −50 to +400 F

This pressure sensitive tape is composed of a 3-mil Teflon backing and a fluoropolymer adhesive and has a total thickness of 6 mils. Called Temp-R-Tape FR, it can be used over the temperature range of −50 to +400 F.

The Connecticut Hard Rubber Co., Dept. ED, 407 E. St., New Haven 9, Conn.

CIRCLE 136 ON READER-SERVICE CARD

Stampings

For electronic applications

Included in the applications of these precious metal stampings are electrical contacts, protective rupture discs, and solder preforms for semiconductor devices. A variety of alloys are available including 99% gold and 1% arsenic, 99.99% fine gold, 99.5% silver and 0.5% antimony, and 99.99% fine silver. Components may have 0.025 to 2 in. OD with less than ±0.00025 in. variation. Thicknesses of the parts are held to ±0.0002 in., and flatness to within 0.0002 in.

Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

CIRCLE 137 ON READER-SERVICE CARD

High-Purity Gold Preforms

For semiconductors

For use in the production of semiconductor devices, the gold is about 99.999% pure. It can be alloyed with high-purity antimony, gallium aluminum, tin, cadmium, tellurium, zinc, and silicon. It is available in spheres from 0.001 to 0.1 in. in diam, discs from 0.005 to 1 in. OD with thicknesses down to 0.0004 ±0.0001 in. prior to stamping, pellets with diameters down to 0.001 in., and washers of any size. Doping can be either positive or negative.

Alloys Unlimited, Inc., Dept. ED, 21-01 43rd Ave., Long Island City 1, N.Y.

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2N697 MULTI-PURPOSE SILICON 'MESAS' NOW MASS-PRODUCED BY WORLD'S LARGEST TRANSISTOR MANUFACTURER

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electrical characteristics at 25°C ambient

(unless otherwise noted)

	PARAMETERS	TEST CONDITIONS		min.	max.	unit
I_{CBO}	Collector Reverse Current	V_{CB} = 30v	I_E = 0	—	1.0	μa
	at 150°C	V_{CB} = 30v	I_E = 0	—	100	μa
BV_{CBO}	Collector-Base Breakdown Voltage	I_{CBO} = 100μa	I_E = 0	60	—	v
BV_{CER}	Collector-Emitter Breakdown Voltage	I_{CER} = 100ma	R_{BE} = 10 ohms	40	—	v
BV_{EBO}	Emitter-Base Breakdown Voltage	I_{EBO} = 100μa	I_C = 0	5	—	v
h_{FE}*	D-C Forward Current Transfer Ratio	I_C = 150ma	V_{CE} = 10 v (2N696)	20	60	—
			(2N697)	40	120	—
$V_{BE(sat)}$*	Base-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma	—	1.3	v
$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma	—	1.5	v
h_{fe}	A-C Common Emitter Forward Current Transfer Ratio	I_C = 50ma	V_C = 10v f = 20mc	2.5	—	—
C_{ob}	Collector Capacitance	I_E = 0ma	V_C = 10v	—	35	μμf

*Pulse conditions: length = 300μs; duty cycle < 2%.

maximum ratings at 25°C ambient

Collector-Base Voltage	60v
Collector-Emitter Voltage (R_{BE} = 10 Ω)	40v
Emitter-Base Voltage	5v
Total Device Dissipation	0.6w
Total Device Dissipation at case temperature 25°C	2w
Storage Temperature Range	−65°C to +175°C

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SERVICES FOR DESIGNERS

Computing Services

A four-page, two-colored brochure, titled Computing Services, gives an account of mathematical services for scientific, industrial and business applications provided by a firm specializing in the digital computer and industrial control fields. Types of mathematical and organizational services are listed, as are typical problems solved by this company. Featured is a check list enabling the reader to determine if mathematical services are needed by his firm, plus notations on the benefits of a computing service.

Computer Control Company, Inc., Mathematical Services, Dept. ED, 2251 Barry Avenue, Los Angeles 64, Calif.

CIRCLE 142 ON READER-SERVICE CARD

Field Service Capabilities

A new eight-page, illustrated brochure describing the field service capabilities of Hoffman Electronics Corp.'s Laboratories Division is now available. The booklet outlines the field services Hoffman offers on a world-wide basis in the areas of field engineering, overhaul and repair, test equipment, standards, training and medical electronics.

Under the direction of William R. Barnes, Hoffman's field service department offers a complete package of the services, or any combination of them, to both military and industrial customers.

Hoffman Electronics Corp., Field Services, Laboratories Div., Dept. ED, 3740 S. Grand Ave., Los Angeles, Calif.

CIRCLE 143 ON READER-SERVICE CARD

Construction Services

Complete installation through start-up service for automation and instrumentation systems is being offered by the Panellit Service Corp. Services include a contract organization furnishing installation drawings and installation of the panels, field instruments, the field interconnections, commissioning, operator orientation and providing supplementary instrumentation personnel where needed. The services are described and illustrated in two-color, 16-page brochure, No. 107.

Panellit Service Corp., Dept. ED, 7401 N. Hamlin Ave., Skokie, Ill.

CIRCLE 144 ON READER-SERVICE CARD

Environmental Test Facilities

The environmental test facilities, located at the firm's plant in Philadelphia, are primarily intended for making reliability and performance checks of TDI telemetry equipment. But these test facilities are available to other organizations. Products are subjected to applicable vibration, temperature, humidity and altitude tests in simulated adverse conditions. Facilities also provide for acoustical noise and shock tests, radio interference and susceptibility measurements, and simulation of static acceleration encountered in missile launchings. Bulletin 859, eight pages, describes the facilities. It contains charts and tables that list equipment capabilities. Photographs show the equipment in operation in the laboratory.

Tele-Dynamics Inc., Dept. ED, 5000 Parkside Ave., Philadelphia 31, Pa.

CIRCLE 145 ON READER-SERVICE CARD

Nuclear Irradiation

Services of this firm include the handling of complete radiation effects programs, from planning through irradiation and post-irradiation and reporting. At its San Jose and Vallecitos facilities, GE's Atomic Power Equipment Dept. has what it claimed to be "the most complete privately owned nuclear research facilities in the world." Its integrated irradiation services range from basic and applied nuclear research programs to specific testing and development operations requiring specialized experience and equipment. They are available to private industry and government research. A variety of other technical services are available to meet specialized customer requirements. A bulletin, No. GEA-6934, eight pages, includes photographs and detailed descriptions of the irradiation services.

General Electric Apparatus Sales Div., Dept. ED, Schenectady 5, N. Y.

CIRCLE 146 ON READER-SERVICE CARD

Environmental Test Facilities

A "one stop" test facility laboratory, capable of simulating accurately the environments in which missiles and aircraft function, is being offered by Itemlab, Inc. In the laboratory, components can be subjected to combined environmental exposures, such as acoustic noise, vibration and elevated temperatures, simulated blast-off, rapid changes in pressure and temperature and all other conditions that might influence their operational reliability.

Itemlab, Inc., Dept. ED, Port Washington, N.Y.

CIRCLE 147 ON READER-SERVICE CARD

NEW LITERATURE

Meter-Relay 150

The successive circuit stages involved in operation of a continuous reading meter-relay are shown in bulletin S-2, four pages. Diagrams, photos and specifications are included. Assembly Products, Inc., 75 Wilson Mills Rd., Chesterland, Ohio.

Semiconductor Alloys 151

The physical properties of lead-antimony, tin-antimony, tin-gold and other semiconductor alloys are discussed in a series of technical data sheets. Each of these sheets contains a phase diagram of a particular alloy combination and a description of the phase relationship and crystal structure, alloy properties and fabricating possibilities of those alloys. Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.

Nuclear Instrumentation 152

Over 50 nuclear instruments and monitoring systems are covered in 12-page bulletin C. Brief text outlines design, uses and performance data. Among the group classifications are: amplifiers, scalers, power supplies, electrometers, spectrometers, radiation monitoring systems, medical and survey instruments. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Crossbar Scanner 153

Driving circuitry and electrical and mechanical specifications for a self-stepping crossbar scanner appear in illustrated bulletin 58-217, two pages. Standard and optional features available with the unit are also included. James Cunningham, Son & Co., Inc., 100 Litchfield St., Rochester 8, N.Y.

Amplifiers and Preamplifiers 154

Wideband, if, and transistorized amplifiers and preamplifiers are treated in this four-page brochure. Illustrations, specifications, descriptions, unit price and quantity discounts are given for each model. Instruments for Industry, Inc., 101 New South Rd., Hicksville, N.Y.

Equipment Control Connectors 155

This 12-page, illustrated brochure, No. 372, covers connectors designed for applications up to 600 v. Dimensions, specifications, and examples of typical applications are included. Joy Manufacturing Co., 1201 Macklind Ave., St. Louis 10, Mo.

Circular Slide Rule

For those who must perform simple calculations in multiplication, division and proportion, this pocket-size calculator is available. Instructions will be included with each slide rule. *Write on company letterhead to General Industrial Co., 1788J Montrose Ave., Chicago 13, Ill.*

Data Translators 158

This eight-page, illustrated catalog covers special purpose record readers, which are used to convert information recorded in pictorial or graphic form into either digital or proportional analog resistance form. Also included are various types of automatic plotting machines used for graphing business, military, and scientific data. Benson-Lehner Corp., 11930 W. Olympic Blvd., Los Angeles 64, Calif.

Variable Resistors 159

Data sheet 175 contains dimensional drawings, tabular comparative data, and an illustration of the 1/2 in. diam high temperature variable resistors. Electrical and mechanical specifications appear. Chicago Telephone Supply Corp., Elkhart, Ind.

Motor Tach Generators 160

Catalog 6000, 16 pages, describes basic models of the firm's line of precision made motor tach generators, sizes 8 to 18, for scientific, military and industrial applications. Definitions, performance curves, dimensional drawings, and physical, electrical and mechanical characteristics are included. John Oster Manufacturing Co., Avionic Div., 1 Main St., Racine, Wis.

Test and Industrial Instrumentation 161

Bulletin C706, 15 pages, describes and illustrates such de vices as time interval meters, EPUT meters, preset counter-controllers, transducers, general and special purpose test instruments and electronic counters. Specifications and applications are given. Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond 3, Calif.

Semiconductors

Revised and expanded to 40 pages, booklet SCD-108B covers germanium and silicon transistors and silicon rectifiers. Maximum ratings, typical operation, characteristics, and dimensional outlines are given for each type. Schematic diagrams and tables also appear. *Send 30 cents to Radio Corp. of America, Semiconductor and Materials Div., Somerville, N.J.*

NEW LITERATURE

Transistors 165

"Understanding Transistors," a 64-page handbook with over 50 diagrams and illustrations, explains transistor theory and applications. Junction transistors, drift transistors, tetrode transistors, alloy-junction transistors, surface barrier transistors, transistor oscillators, and silicon transistors are among the subjects covered. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Linear Actuators 166

Three data sheets describe various models of three linear actuators. Load, stroke, speed, performance, and other elements are listed in table form. Performance curves are given for each series. Lear, Inc., 110 Ionia Ave., N.W., Grand Rapids 2, Mich.

Meters 167

Expanded scale ac and dc voltmeters, expanded scale frequency meters, and linear scale ammeters are discussed in this 20-page catalog. Operating principles and specifications are given for each. Various meter case styles and sizes are illustrated in photographs and drawings. Helipot Div. of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Precision Potentiometers 168

Six data sheets present electrical and mechanical specifications for six types of precision potentiometers. Diagrams, resolution and power dissipation graphs, environmental test data, and parameters for custom designs also appear. Guidance Controls Corp., 110 Duffy Ave., Hicksville, N.Y.

Cables 169

The firm's line of cables for data transmission and processing requirements is discussed in this four-page bulletin. Miniaturized low-capacitance coaxial cables, low-loss coaxial cables and shielded twisted pair cables are covered. Times Wire and Cable Co., Inc., 358 Hall Ave., Wallingford, Conn.

DC Power Supplies 170

This four-page bulletin describes 63 high-voltage dc power supply models. Illustrations, tabular specifications, and protective and optional features are included. Sorensen & Co., Richard Ave., S. Norwalk, Conn.

Relays 171

Catalog A-101MM describes microminiature crystal-case relays. Features, specifications, a photo and a schematic diagram appear on this sheet. The Amerelay Corp., 130 County Courthouse Rd., New Hyde Park, N.Y.

Traveling-Wave Amplifiers 172

This catalog sheet lists principal electrical characteristics as well as physical dimensions and weights for 15 types of traveling-wave amplifiers and three types of backward-wave oscillators. Four of the traveling-wave amplifiers described employ permanent-magnet focusing; the other 11 and the three backward-wave oscillators are solenoid focused. Sylvania Electric Products, Inc., 730 Third Ave., New York 17, N.Y.

Components 173

Neon and incandescent indicators, both conventional and transistorized, push button switches, combination indicators-switches, decimal readout devices and other display panel components are described in this 30-page catalog. Also described is a transistor-diode tester. Photographs and technical data are provided. Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn.

Analog Computer 174

"Analog Computer CM-2," a two-page brochure, describes and illustrates a solid-state computing device for mathematical calculations. It lists all technical data and specifications, including special amplifiers and networks which are available. Pictorial material is included. Southwestern Industrial Electronics Co., a division of Dresser Industries, 10201 Westheimer Rd., P.O. Box 22187, Houston 27, Tex.

Transducer 175

The Hi-Ac-Tran model 106 transducer, designed especially to connect control computers to pneumatic equipment, is described in Bulletin No. E-106. The bulletin describes the principle of operation and outlines the transducer's pneumatic and electrical rating specifications, performance data and special features in two pages. Associated Control Equipment, Inc., P.O. Box 136, 853 Fourth Ave., Coraopolis, Pa.

Power Transistors 176

This two-page engineering bulletin describes the type 2N1069 and 2N1070 npn high-power silicon transistors. Temperature range for the units is −65 to +175 C. Form 1953 contains a dimensional outline, a graph and tabular data. Silicon Transistor Corp., Carle Place, N.Y.

NEW LITERATURE

Silicon Semiconductor Devices

Called SPAN (Semiconductor Product Application News), this publication will be published bimonthly and contains technical data and application information on silicon semiconductor devices. This first issue covers, among other subjects, silicon photo-voltaic detection cells. *Write to SPAN editor, Semiconductor Div., Hoffman Electronics Corp., Dept. ED, 1001 Arden Drive, El Monte, Calif.*

Automatic Checkout Equipment 178

"Demon," the firm's universal digital automatic checkout equipment, is described in this illustrated catalog sheet. The equipment, when used with appropriate signal sources, can handle a wide variety of checkout problems of varying degree and complexity. General specifications are included. Curtiss-Wright Corp., 6767 Hollister Ave., Goleta, Calif.

Semiconductor Directory

This directory, No. 5, provides pricing data on transistors, diodes and rectifiers produced by 16 leading U. S. manufacturers. Over 2100 types are in the directory, including the latest high speed switching, high current power, Zener and diffused junction mesa types. Also included are microdiodes, variable capacitors and photosensitive devices. *Write on company letterhead to Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.*

Connectors 179

This two-color, four-page brochure is designed to aid in the selection of Amphenol AN/MS connectors (MIL-C-5015C and MIL-C-5015D). The reference shows available AN/MS insert contact arrangements and contains a quick reference for insert specifications. Schweber Electronics, 60 Herrington Rd., Mineola, L.I., N.Y.

Socket Screw Products 180

This eight-page bulletin describes the complete line of Unbrako standard socket screw products. It covers socket head cap screws, set screws, button heads, flat heads, shoulder screws and socket screw keys, as well as dowel pins, pressure plugs, and square head set screws. Configurations, sizes, materials, design features, and proper installation are charted for reference and comparison. Photographs, line drawings, cutaway views and microphotographs are included. Standard Pressed Steel Co., Box 202, Jenkintown, Pa.

3M FLUOROCHEMICAL FC-75 has a useful liquid range of —150°F. to 212°F. at atmospheric pressure, with a viscosity of 16 Centistokes at —90°F. In addition, it offers these other useful properties: High dielectric strength in both liquid and vapor state (37 KV 0.1" gap for liquid) . . . self-healing in high voltage electrical equipment . . . excellent wetting power . . . compatible with materials commonly used in the construction of high temperature equipment . . . thermally stable to temperatures in excess of 750°F. and, even under extreme use conditions, does not form sludge or corrosive products. Heat capacities in liquid and vapor state are approximately equal.

Frequency Meter 182

In one page this data sheet covers a heterodyne frequency meter designed to measure 100 to over 10,000 mc. The unit generates 500 to 900 mc and harmonics. A photograph and technical specifications are given. Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

Magnetic Rectifier Controls 183

Bulletin MRC 658 describes a line of small and light magnetic rectifier controls for power and servo control applications. The units are applicable in systems ranging in power from a few watts to many kilowatts. Included in the bulletin are schematic diagrams and a description of the operation of many magnetic rectifier control applications. These include: half-wave rectified power supply, full-wave power supply, ac motor speed control system, ac servo drive, dc motor speed control, and three-phase ac to dc power control system. Fairfield Engineering Corp., 934 Hope St., Springdale, Conn.

Semiconductor Journal

The Lattice, a new semiconductor technical journal, is being published principally for use by design engineers interested in solid state devices. Issue No. 1 covers the Army's Micro-Module Program. The Lattice will be devoted entirely to the theory and practice of the semiconductor art. Within this broad field, various timely subjects will be presented in the future. Microelectronics and miniaturization is the topic for the first series of three issues. *Write on company letterhead to: Tung-Sol Electric Inc., Dept. ED, Summer Ave., Newark 4, N.J.*

Two-Circuit Journal 184

This two-page data sheet, No. 164, describes the 3MN series of 2-circuit switches for use on machine tool limit and control mechanisms. The snap-action switches have a median mechanical life of over 10 million operations at full overtravel. Three switches have a combined stacking width of only 2.03 in. Contact arrangement is single-pole two-circuit double-break. The data sheet has photographs, mounting dimension information, characteristics, complete electrical data and prices. Micro-Switch, A Division of Honeywell, Freeport, Ill.

Power Supply 185

Data sheet 3070, two pages, describes the Regatron model 2-212A power supply, a dual unit designed for transistor applications. Photographs, a graph, electrical specifications, dimensions, and prices are included. Electronic Measurements Co., Inc., Eatontown, N.J.

NEW LITERATURE

Data Reduction 188

Data reduction and digital control systems are the subjects discussed in this 76-page handbook. The handbook covers the theory behind the firm's Digitizer, a shaft position encoder; Digitizer systems; input, processing and output components; accessories; and case histories of representative systems now in use in varied industries throughout the United States. Photographs, schematics and block diagrams are included. Coleman Electronics, Inc., 133 E. 162nd St., Gardena, Calif.

Pull-Push Switches 189

This data sheet, one-page, contains a dimensional drawing and complete technical data on two new 13/16-in. diameter pull-push switches for electronic and electrical applications. The type SK-1 unit has a 3 amp, 125 v rating with the operating force of 8 to 17 oz. Type SMK has a 1-amp, 125-v rating with a maximum operating force of 6 oz. Both switches are available in spst switching sequence only. Chicago Telephone Supply Corp., Elkhart, Ind.

Instrumentation Recorder 190

The firm's FR-600 instrumentation recorder which offers a frequency response of 250 kc in direct recording and to 20 kc in fm work, is described in this four-color, 10-page brochure. Full specifications and descriptions of accessories, optional equipment, and human engineering are included. Also provided are photographs. Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.

Shock Mounting 191

Data sheet 149 explains and gives suggested approaches for low cost shock mounting of cathode ray, memory or data storage tubes within non-shock sensitive and non-retentive Netic Co-Netic magnetic shields. Photographs are included in this two-page data sheet. Magnetic Shield Division, Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

Silver-Zinc Batteries 192

Design details for over 20 manual and automatically activated silver-zinc primary batteries are given in this six-page illustrated brochure. The batteries are for one-shot single use installations in operational weapons systems. There are specification tables showing electrical performance, environmental capabilities, physical specifications, energy-to-weight ratios, and automatic activation times. Cook Batteries, Subsidiary of Telecomputing Corp., 3850 Olive St., Denver 7, Colo.

CIRCLE 193 ON READER-SERVICE CARD

Capacitors 221

The six-page illustrated brochure contains listings of the company's commercial capacitors. Included are over 500 listings of twist-prong electrolytics in single, dual, triple and quadruple styles. Other capacitors include molded tubular and metal and cardboard case electrolytics for various applications. Astron Sales Corp., E. Newark, N.J.

Wiring Harnesses 222

"Key Points in the Design, Manufacture and Use of Wiring Harnesses," a 14-page booklet, offers practical hints for improving, stripping, tinning and soldering of cable wires. It suggests design procedures for facilitating in-the-instrument connecting operations and ways for the harness user to improve cable installations. Line drawings illustrate techniques. Methods, Inc., 12 Bland Ave., Emerson, N.J.

Vibration Interferometer 223

Designed for precise checking and calibration of accelerometers, the vibration interferometer is the subject of two-page bulletin 204-59. Applications, product features, description and specifications are given. Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

Voltage-Tunable Magnetrons 224

Bulletin PT-1, 26 pages, describes the firm's four new S-band packaged voltage-tunable magnetrons. Illustrated with photos, diagrams and charts, the manual includes data on design, typical applications, operation and manufacturing. General Electric Co., Schenectady 5, N.Y.

Pressure Pickup 225

Bulletin 1620, two pages, describes a pressure pickup capable of absolute and gage measurements to 10,000 psi. In addition to sections on design features and specifications, a schematic drawing and a wiring diagram are included. Consolidated Electrodynamics, 360 Sierra Madre Villa, Pasadena, Calif.

Synchros 226

This illustrated 170-page catalog of synchros, servo motors, servo amplifiers, resolvers, rate gyros, and potentiometers contains specifications and outline drawings of 200 units. Included are details on synchros manufactured to the latest MIL specifications. United Aircraft Corp., Norden Div., Commack, L.I., N.Y.

CIRCLE 193 ON READER-SERVICE CARD

NEW LITERATURE

Filters 228

A line of high, low, bandpass and telemetering filters in custom or standard designs are described in two-page sheet 601. Dimensions, electrical characteristics, and special features are provided. Control Electronics Co., Inc., 10 Stepar Place, Huntington Sta., N.Y.

Transistor Amplifiers 229

Miniature transistor amplifiers are illustrated and described in six-page bulletin 59 25M. Electrical, physical, and dimensional specifications are given on 13 types of amplifiers as well as a miniature pressure transducer. Taber Instrument Corp., Electronics Div., 107 Goundry St., N. Tonawanda, N.Y.

Magnetic Amplifier 230

Bulletin M-62, two pages, describes a high-sensitivity dc magnetic amplifier. Illustrations of the unit, transfer characteristics, a schematic diagram, and electrical, mechanical, and dimensional specifications are given. Airpax Electronics Inc., Seminole Div., Fort Lauderdale, Fla.

Silicon Transistors 231

Five new silicon transistors are described in this two-page bulletin. Electrical and physical specifications, illustrations and a table of operating characteristics of the firm's silicon transistors are provided. Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass.

Semiconductor Directory 232

Over 2100 types of transistors, diodes and rectifiers produced by 16 manufacturers are listed in this semiconductor directory. Stock numbers, manufacturers and prices are given. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Analog Computer 233

A transistorized, desk-top analog computer is illustrated and described in 10-page bulletin AC934. Problem illustrations, component specifications, and a physical description are given. Electronic Associates, Inc., Long Branch, N.J.

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This is a partial listing only. Names of other Raytheon Industrial Distributors on request from John Hickey, Raytheon Distributor Products Division, Westwood, Mass.

RAYTHEON

CIRCLE 234 ON READER-SERVICE CARD

Stored Program Educational Computer 235

Catalog S 1, 14 pages, describes a general purpose stored program digital computer and digital differential analyzer plus a logical design implementer. Specifications, operation codes, a block diagram, and physical components are included. Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif.

Selenium Rectifiers 236

This 27-page booklet, ECG-402, contains basic information on junction rectifiers, capacitive loading, purposes of capacitance in the load, how to boost the output voltage, and the effect of capacitance on voltage regulation. Included are test specifications for selenium rectifiers, frequency characteristics, and protective finishes. General Electric Co., Semiconductor Products Dept., Liverpool, N.Y.

Ferrites 237

The "Ferrite Selector," 20 pages, contains characteristics, physical properties, and applications for over 37 types of ferrites distributed by the firm. Technical information includes saturation magnetization, Curie temperature, resistivity, dielectric coefficient, and line width. The key features of each material are described in relation to microwave applications. Ferromagnetic Distributors, 15015 Ventura Blvd., Sherman Oaks, Calif.

Pulse Height Analyzer 238

A 100-channel pulse height analyzer with 20-channel storage, model PHA-120 is discussed in bulletin 3021-9. The four-page brochure illustrates the equipment, gives a block schematic diagram, and describes such applications as fallout studies, whole-body counting, and background studies. Specification data and performance figures also appear. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Coaxial Attenuators 239

Four-page illustrated bulletin 17R describes 1 to 12.4 kmc fixed coaxial attenuators. Electrical, physical, and dimensional specifications are given, as well as vswr vs. frequency, and frequency sensitivity of insertion loss graphs. These attenuators are used in all applications requiring isolation between rf component and in the extension of the ranges of power meters. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

NEW LITERATURE

Selenium Rectifiers 243

Brochure EGG-344, 24 pages, describes a step-by-step method for selecting specific selenium rectifiers for circuit applications. Its three sections cover basic selenium rectifier information, a product description of the rectifiers, and the method used in selection of the right rectifier. Work sheets, charts, graphs and nomographs are also included. General Electric Co., Semiconductor Products Dept., Syracuse, N.Y.

Code Bar Switches 244

Four-page bulletin CBS 1 describes features and specifications of code bar switches designed to meet the need for keyboard switches featuring direct binary-coded outputs. A cutaway drawing shows the operating principle. Three models are covered. Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif.

Printed Circuit Boards

"Quality Control Manual for Printed Circuit Boards and Board Assemblies," a U. S. Air Force approved publication, deals with various phases of standardization, purchasing, government inspection, in process inspection, final inspection, and other allied material. Prepared in outline form, the 36-page manual contains the requirements for the establishment and maintenance of an inspection system. *Write on company letterhead to the Bureau of Engraving, Inc., Industrial Div., Dept. ED, 500 S. Fourth St., Minneapolis 15, Minn.*

Transformers 245

Catalog TR-60 lists the firm's line of transformers. Over 1000 items and several new lines, including microminiature transformers and transformers for transistor applications appear in the book. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Speed Changers 246

Bulletin 96 discusses applications and benefits of miniature adjustable ratio speed changers, which are continuously adjustable over a 25:1 range. Torque, speed, hp, and ratio ratings in addition to five different speed controls are also described in the two-page illustrated bulletin. Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

Magnetic Recording Heads 249

This illustrated four-page brochure and its data sheets give specifications, outline dimensions and general information on the firm's magnetic tape and drum heads. Also included are design sheets with spaces for electrical and mechanical parameters to aid in the design of a tape or drum head to customer specifications. General Transistor Western Corp., Magne-Head Div., 2660-64 S. La Cienega Blvd., Los Angeles 34, Calif.

Molded Plastic Fasteners 250

Screws, nuts, washers, insulators and bushings are discussed in this six-page bulletin on nylon products. The full range of sizes by types and quantity prices for easy ordering are given. Richco Plastic Co., 4445 W. Fullerton Ave., Chicago 39, Ill.

Transistor Plug-ins 251

Detailed physical and electrical specifications of transistorized plug-in units for digital systems appear in catalog PI-79. The flip-flop, amplifier, gating, buffing and other packages are described in this illustrated brochure. Core memory selection, signal circuits, and encoding and decoding networks are also discussed. A five-page addendum describes design criteria and systems applications. Digitronics Corp., Dykor Components Div., Albertson, L.I., N.Y.

Analog Computer 252

Tech Notes No. 1 explains "How to Simulate a Non-Linear Control System with an Analog Computer." Diagrams of a typical control system and plots showing response of the system at various points with different parameters are included in the four-page publication. Donner Scientific Co., 888 Galindo Rd., Concord, Calif.

Video Switching System 253

This system, used in industrial closed-circuit television circuits to switch a number of television cameras to any of a number of viewing monitors, is described in data sheet 6-99. Detailed specifications of each of the individual modular sections of the system are given. To facilitate application of the AVS-X system, a typical installation consisting of two cameras and five monitors is shown in simplified form. Also diagrammed in the bulletin is the schematic layout of the AVS-X for the same system, showing number and location of modules, relays, and amplifiers. Cohu Electronics, Kin Tel Div., 5725 Kearny Villa Rd., San Diego 12, Calif.

NEW LITERATURE

Panel Switches 256

Switches for computers, office machinery, machine tool control and instrument panels are covered in bulletin 55. Characteristics, dimensional details and ordering information are included in the illustrated brochure. Electrosnap Corp., 4218 W. Lake St., Chicago 24, Ill.

Flow Regulators 257

Bulletin A-200, two pages, covers the inline type pressure compensated hydraulic flow regulator valves. Operation, performance standards, and ordering information are given. Waterman Engineering Co., P.O. Box 391, Evanston, Ill.

Special Purpose Tubes 258

High vacuum relays, vidicon camera tubes, and the firm's research and production facilities are described and illustrated in this four-page bulletin. Resitron Labs, Inc., 2908 Nebraska Ave., Santa Monica, Calif.

Heavy-Duty Counters 259

A line of heavy-duty counters for indication, recording, and automatic regulation of material flow is described in four-page bulletin O159. Illustrated with 13 photographs, the bulletin covers mechanically actuated counters, electrically impulsed counters for remote indication and control, and solenoid-operated models. Richardson Scale Co., Clifton, N.J.

DC Amplifier 260

This two-page data sheet describes the firm's high performance dc operational amplifier for military applications. Illustrated with a photo and dimensional diagrams, the data sheet discusses such characteristics as power requirements, dimensions, weight, and output capability. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.

Computers 261

Research in thin magnetic films, data recording and storage, and cryogenic electronics is discussed in this 20-page, illustrated bulletin on aircraft, missile, and space vehicle computers. Polaris computers, hybrid digital computers for AEW systems, and the firm's variable increment computer are covered. Automated production processes involved are shown in photos. General Electric Co., 600 Main St., Johnson City, N.Y.

Tantalum Capacitors 264

The 15 types of solid, foil and sintered anode tantalum capacitors are discussed in catalog 9-169, 16 pages. A table with over 600 listings arranged by microfarad and voltage ratings is included. Mallory Capacitor Co., Indianapolis 6, Ind.

Krypton Isotope 265

Krypton 85, a radioactive isotope of the rare, inert gas krypton, is discussed in four-page catalog 345A. The firm uses trace quantities of this radioisotope in gas-filled electronic tubes requiring free electrons. Catalog 345A answers such questions as: What is Krypton 85? Where is it used? How can it be obtained? Why are free electrons necessary to start gas-filled tubes? Air Reduction Sales Co., 150 E. 42 St., New York 17, N.Y.

Sealed Relays 266

Bulletin GEA-6628, 24 pages, describes hermetically sealed microminiature, subminiature, miniature, and high-speed relays for military and general purpose applications. Photographs, circuit diagrams, coil data, and specifications are provided. General Electric Co., Schenectady 5, N.Y.

Toroidal Signal Transformer 267

This data sheet discusses a miniature, toroidal signal transformer designed for low-level applications. Dimensional drawings, specifications and ordering information are given, in addition to a description of toroidal design. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Print and Plot Scaler 268

Two-page bulletin 3027-9 outlines the features of the firm's print and plot scaler, which is designed for accurate digital and analog readout of spectrographic equipment. Applications, specifications and performance data are included in the illustrated bulletin. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Autographic Plotters 269

Multichannel autographic plotters are featured in bulletin PG-100. Application data and specifications on the modular plotter, the segmental recorder and scanner plotter, and the standard, high speed, and extra high speed strain gage plotters are included. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

NEW LITERATURE

Solderless Wiring Devices 273

Solderless wiring terminals are illustrated and described in this four-page brochure. Five barrel styles are given, including insulated, non-insulated and vibrationproof styles. ETC Inc., 990 E. 67 St., Cleveland 3, Ohio.

Tantalum Capacitors 274

The firm's complete line of tantalum capacitors is described in 15-page brochure 9-169. Included are electrical and dimensional specifications on components having capacitances from 0.25 to 1300 μf. Dimensional and cut-away diagrams are also provided. Mallory Capacitor Co., Indianapolis 6, Ind.

Ultrasonic Cleaning 275

The "Ultrasonic Cleaning Primer," 12 pages, describes ultrasonic cleaning, how it works, areas in which it can be used, and various solvents and detergents available for use with this type of equipment. National Ultrasonic Corp., 111 Montgomery Ave., Irvington 11, N.J.

Linear Transformers 276

Eight-page bulletin 1201-A provides notes on basic design of control systems using linear differential transformers as ac transducers with ac or dc outputs. Topics covered include simple circuits, mountings, and shielding. Minatron Corp., One Cliveden St., Belle Mead, N.J.

Centrifugal Blowers 277

This 12-page catalog describes and illustrates the firm's line of centrifugal blowers. Included are 54 flow charts, electrical specs and dimensions on blowers with free air ratings from 18 to 270 cfm. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, N.Y.

Brazing Alloys 278

Vacuum-tube grade brazing alloys are described in four-page bulletin 25. Included is information on temperature and composition of these brazing alloys, their brazing characteristics and their impurity values. These alloys are used in klystron and magnetron tubes. Handy & Harmon, 82 Fulton St., New York 38, N.Y.

Solder Joint Reliability 280

This brochure is a four-page illustrated comprehensive report on a method of improving electronic equipment reliability through planned solder joint checks. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Relays

Catalog No. 259, 20 pages, illustrates and describes a complete line of hermetically sealed balanced rotary-type relays. Electrical, physical, and mechanical specifications are provided, as well as dimensional diagrams. *Write on company letterhead to Hi-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.*

Galvanometer 281

Electrical and physical specifications and a complete description of an electronic galvanometer are given in two-page bulletin 14-10. Applications, a circuit diagram, and illustrations of the unit are also provided. Kin Tel Div. of Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 12, Calif.

Control Instrumentation 282

Bulletin A-913, eight pages, serves as a guide to electronic control instrumentation. The firm's Autronic control equipment is illustrated and described. A chart illustrates the major system components. Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Encoders 283

Four-page bulletin 312-A illustrates and describes the firm's shaft position encoders. Basic design, mechanical and electrical design considerations, scanning rates, and coding are discussed in detail. A scanning circuit and a translator circuit are also given. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Microwave Power Supply 284

A universal power supply which powers and modulates backward wave oscillators, backward wave amplifiers, voltage tuned magnetrons, and traveling wave amplifiers is described in this two-page bulletin. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

PC Peg Boards Speed Breadboard Layout

TEMPORARY circuits on "breadboards" have become a standard means of checking and adjusting new devices using conventional components. Miniaturization of components has reduced many breadboards to the appearance of a collection of terminals. In view of this trend, a "peg board" array of terminals and connections has been devised to provide an easy and flexible method of inter-connecting standard circuit elements.

The board for this model was constructed of 10" x 15" x 1/4" thick copper clad epoxy glass laminate mounted on an enclosed base. Modular type construction was used.

Three types of modules have been built: a left end, a right end, and a center module. The left-end module is shown in Fig. 1. The right-end module is the mirror image of the left-end module, and the center module is similar except it has no connectors along the left edge but has a greater number of pegs.

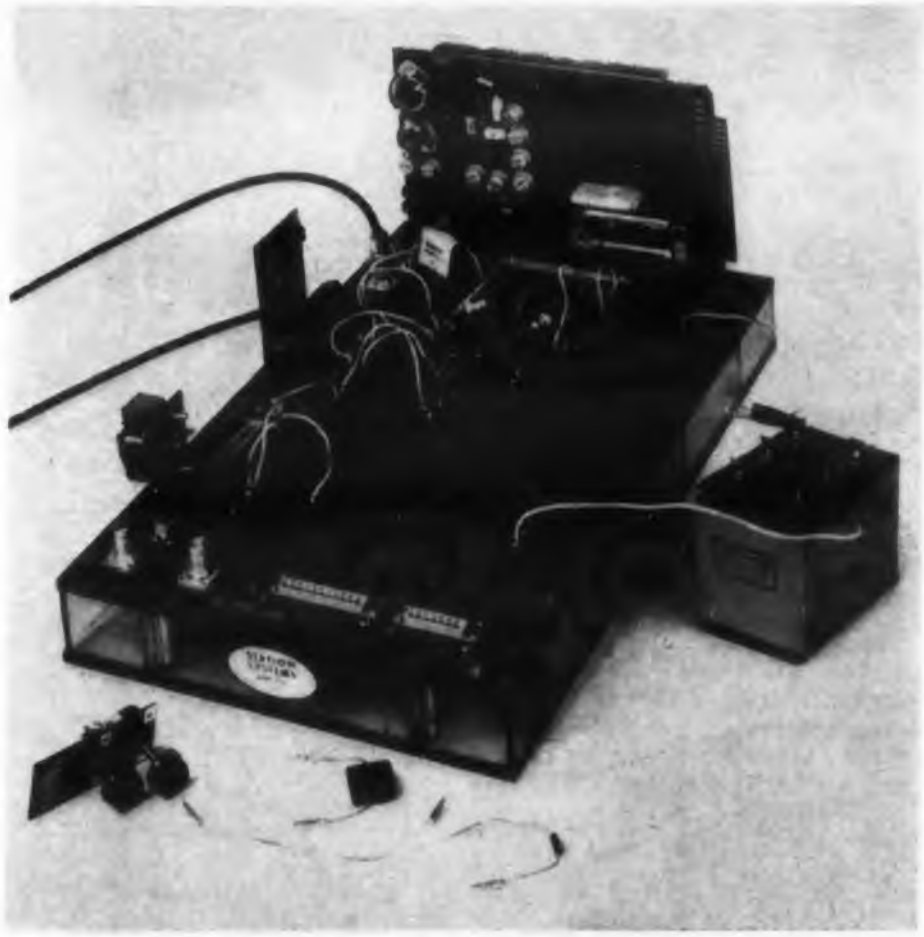


Fig. 1. PC peg board cuts hook-up time down to seconds.

When a circuit grows too large for one board, another module may be placed alongside and the circuit continued on the second unit.

Printed circuits are used to connect the page and the connectors. This has the advantage of providing a permanent visual indication of all connections on the face of the board. A numbering system, Fig. 2, is used whereby each multiple group and connector terminal is identified. A circuit can be rebuilt at some future time, if component locations are recorded before dismantling.

The reverse side of the board, Fig. 3, shows the pegs soldered into place and the method of mounting the connectors. The pegs are simply mounted in holes that are drilled through the board to provide a snug fit. After the pegs have been positioned in place they are soldered either by dipping or manually.

Continental connectors are mounted in slots and are flush with the board. The first row of connector terminals are bent over and soldered directly to the board. An overlay card is then dropped into place and the second row of terminals is bent over and soldered to the card. The row of pegs marked "*B*" are made slightly longer than the rest and only the overlay card is soldered to these pegs. The pegs are made of brass in the shape of blunt brads and are gold plated. Plating provides a low resistance connection that is nontarnishing.

A sleeve must be provided on each component lead to allow connection to the pegs. The center terminals of UG-22/U type "*N*" rf connectors are suitable for this purpose. A supply of components can be quickly made up, used, and stored for future use.

Building a circuit merely involves selecting the desired components and pushing them into place on the pegs. If a change is necessary, a component may be removed and a new one inserted in a matter of seconds. Since all wiring is done on one side, the circuit may easily be checked.

Meters, oscilloscopes, oscillators, etc. can be connected to the coaxial connectors, pin jacks and banana jacks provided along the edge of the board.

Fig. 1 also shows the use of the auxiliary plug-in cards. These cards are made of etched copper clad phenolic to provide a means for mounting switches, transistors and potentiometers. The cards illustrated show the mounting of two miniature potentiometers, four toggle switches, and four transistors. The transistors are mounted on the cards by means of flea clips and can easily be changed.

A layout board which is useful in determining the proper layout of a circuit on a P-C card is shown inserted into the larger connector.

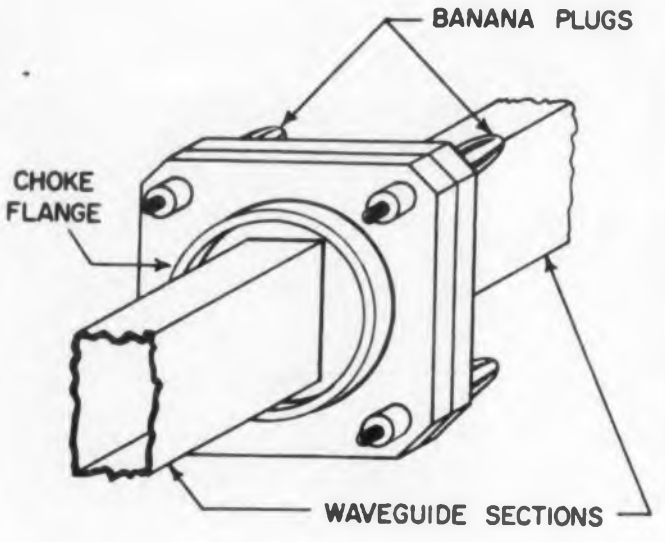
R. Morley, Bell Telephone Laboratories, Murray Hill, N.J.

Fig. 2. Numbering system allows recording of temporary circuit for duplication later.

Fig. 3. Reverse side of peg board shows how pegs and second row connector terminals are soldered in place.

IDEAS FOR DESIGN

Banana Plugs Cut Microwave Breadboarding Time



Setting up a microwave breadboard and making frequent circuit changes can consume a major portion of an experimenter's time. The lowly banana plug is made to order as a quick disconnect fastener for waveguide.

The use of these plugs for holding a waveguide properly aligned is seen in the figure. Note that one of the flanges is a choke. While the spring tension of the plug is sufficient to hold the joint together, some leakage will occur if both flanges are flat faced. This is particularly true at the higher frequencies above about 9 kmc.

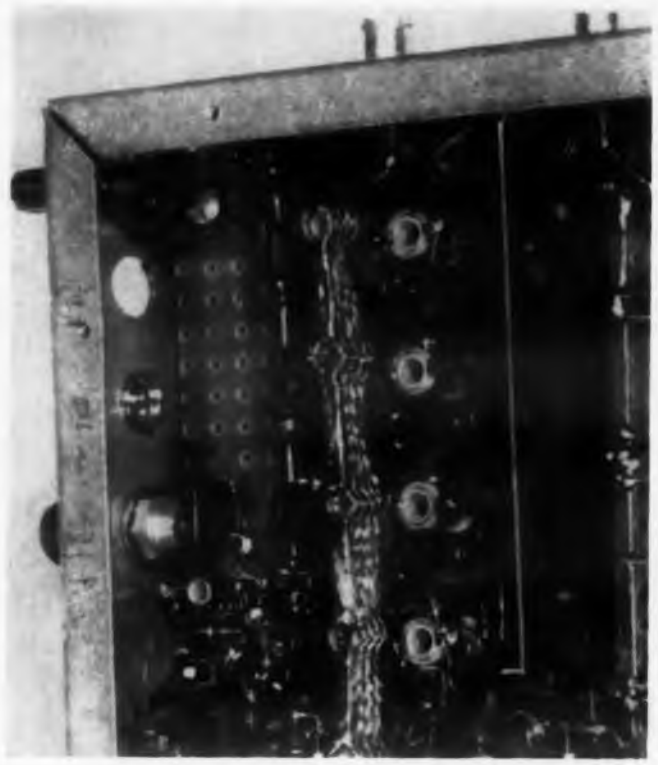
Vincent J. Kaneski, Senior Engineer, Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va.

Braided Shield Doubles for Transistor Heat Sink

It is sometimes necessary during the breadboard stage of designing transistorized circuitry to stabilize the temperature of transistors. At other times it's necessary to match temperature drifts in groups of transistors. These precautions prevent transistor parameter variation from affecting circuit performance.

A simple solution to the problem is to form a heat sink from braided shield as shown. The shielding is doubled back on itself to enclose the transistors. Strips of shield may be inserted in the space between transistors. Solder is applied while the transistors are temporarily replaced by metal rods of the same diameter.

The resilience of the braid permits the heat sink to snugly grip the transistors provided care is taken to prevent solder from flowing to the portions of the braid alongside the transistor positions. This scheme has the following advantages:



Transistor heat problems are neatly licked by a braided shield heat sink.

This arrangement provides excellent thermal conductivity and large thermal capacity. Assembly requires only a soldering iron and pliers. It is unnecessary to construct metal bars with mounting provisions as might be required using other methods.

R. L. Forgacs, Sr. Research Engineer, Scientific Laboratory, Ford Motor Co., Dearborn, Michigan.

Boosted Heater Voltage Ups Thyratron Reliability

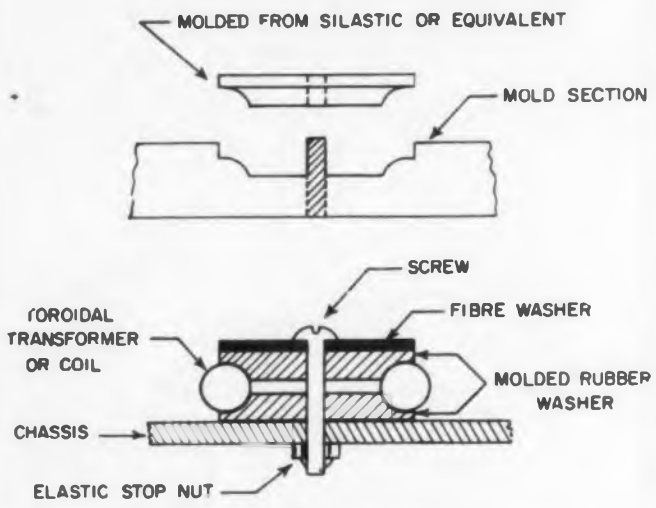
A 2D21 thyratron was required to conduct a peak current near its peak rating, from 30 to 60 seconds after turning on the heater. As soon as fired the heater was turned off for 20 minutes to an hour. The tubes failed after only 10 or 20 operations at normal heater voltage, (6.3 v). The cathodes were observed to be severely pitted. Each operating cycle had dislodged a bit of the oxide coating. Spaces would not permit a larger thyratron.

Knowing that thyratrons operate at a high temperature in normal continuous operation, the heater voltage was raised to 10 v. The thyratron now gives very little trouble and usually operates for several hundred cycles—sometimes many more. The excess heater voltage brings the tube up to normal temperature and permits rated peak current loads after the short heating time.

Laurence G. Cowles, The Superior Oil Co., Bellaire, Tex.

IDEAS FOR DESIGN

Toroidal Mount Made From Molded Rubber Washers



Mounting a toroidal choke or transformer to a chassis can consume a good deal of time. No special hardware is available to simplify the job. With a wide range of sizes and cross-sections, what is needed is a method of quickly making up a mount to secure the toroid snugly onto the chassis.

The solution involved developing a simple rubber washer. The washer is approximately the size of the wound inner diameter of the toroid. The mold is easily made in a model shop. A rubber composition such as Corning's "Silastic" is ideal. As can be seen in the illustration, the toroid is sandwiched between two rubber washers. These in turn fit between an additional washer and the nut head on one side and the chassis on the other. Use of locking-type nuts is recommended because of the limited holding force that can be applied to the assembly.

Harry Star, Research Engineer, Applied Science Corp. of Princeton, Box 44, Princeton, N.J.

Solder Spots Nuts in Tight Spots

Placing a small machine nut in a relatively inaccessible location to mate with a free screw is always a problem. Sometimes a special flexible gripping tool is not available. Even these will not work in really tight corners. What is really needed is a low cost device that is always available and universally applicable. A coil of ordinary wire solder does the job every time.

Place the solder so that it lays over the diameter of the nut and its end just laps beyond the flat of the nut. Then using a medium grip on pliers, (too strong a pressure will shear the solder) crimp the solder against the face of the nut. This will force the solder into the first one or two nut

Ordinary wire solder crimps onto the nut face with a simple press of pliers.

threads, firmly supporting the nut.

Use as long a piece of solder as needed, and put compound bends in the length to fit the application. Then you can spot the nut at just the right location for pick-up by the screw. After starting, you can easily pull the solder from the nut, or wait for the screw to force the solder from the nut. Most any improvised tool (or a finger) will then block the nut for tightening.

Chester B. Shapero, Research Engineer, Cupertino, Calif.

Drill Makes Handy Cable Twist Jig

Occasionally it is necessary to twist two or more insulated conductors together to form interconnection of filament cabling. If the twisting is attempted by hand, it becomes a long tedious process. Here's a handy method that's often overlooked.

Merely clamp the insulated conductors into the drill chuck. Secure the other ends of the conductors together in a vise or clamp. Then pull the conductors taut and operate the drill. The tightness of the finished cabling can be adjusted as desired by controlling the number of turns of the drill.

Leland Hogue, Staff Assistant, Sandia Corp., Albuquerque, New Mexico.

IDEAS FOR DESIGN

Power-Saving Shutoff for Mobile Radiotelephone

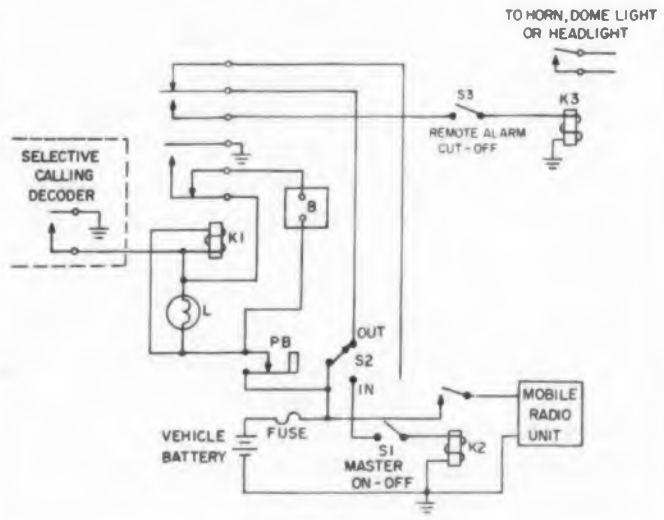
Mobile radiotelephones are used in private systems with selective signaling or in common carrier service, when selective calling is employed. They are usually left on at all times in order to intercept calls. This is true even when the vehicle is unattended. Hence, the vehicle battery must supply power whenever the receiver is turned on.

However, when an unattended vehicle has been called, a call indicator lamp is lighted. It remains on until turned off by operation of an indicator-release switch or removal of a hand-set from its hanger. The receiver is ordinarily left turned on after a call has been received. It continues to draw current even if further unanswered calls cannot relight the lighted lamp.

As shown in the figure, means can be provided for automatic shutoff of the receiver after a call has been intercepted by the receiver in an unattended vehicle.

When the contacts of the selective calling decoder or of a carrier operated relay close momentarily, relay *K1* and buzzer *B* are energized. As soon as relay *K1* pulls in, the buzzer is disconnected. Relay *K1* is held closed by a pair of electrically latched contacts; it is not released until the indicator release pushbutton *PB* is opened momentarily. Lamp *L* also lights when relay *K1* is first energized and remains lighted until *PB* is opened.

In many mobile systems, the battery is connected to the equipment through a relay, such as *K2*, so that the full current does not have to flow through the contacts of on-off switch *S1*. When the vehicle is unattended, switch *S2* is set to the "out" position. When relay *K1* is energized, a pair of relay contacts opens, de-energizing the normally energized relay *K2*.



Simple relay circuit conserves battery power for mobile radio units.

At the same time, another pair of contacts closes, actuating the horn, a dome light or headlights of the vehicle. This occurs only if switch *S3* is closed. When the vehicle is attended, switch *S2* is set to the "on" position to disable the automatic shutoff feature. When set to "off" relay *K2* is released and cuts off power to the receiver whenever relay *K1* is energized.

Leo G. Sands, Technical Director, Graf-Tek, Inc., Ridgewood, N. J.

Three Measurements Determine Mechanical Time Constant

It is often necessary to experimentally determine the mechanical time constant of a motor and load combination which satisfies the following differential equation:

$$T\,(dw/dt) + w = K$$

Where:

T = system time constant or inertia divided by viscous damping
w = velocity
K = driving function

An easy method for determining T involves three simple laboratory steps.

First, apply a minus K_1 driving source to the system; second, when the system has attained a constant velocity corresponding to the minus K_1, switch the driving source with a fast acting relay to plus K_2; and third, note the increment of time between the switching of the relay and the reversal of the motor.

If the motor has a tachometer attachment, the last step can be accomplished by triggering the sweep of a scope with the relay and by noting the increment of time corresponding to zero tachometer voltage at the vertical input of the scope.

The solution of the differential equation of the system with the initial conditions introduced by this procedure is

$$w(t) = K_2 - (K_2 + K_1)e^{-t}/T$$

where t equals increment of time from the instant of relay switching. At time t_o, the increment of time measured experimentally, $w(t)$ equals zero. Therefore, letting "a" equal K_1/K_2,

$$0 = 1 - (1 + a)\,e^{-t_o}/T$$

or

$$T = t_o/1n(1 + a)$$

In order to achieve maximum accuracy when measuring t_o, "a" should be made as large as possible. The magnitude of "a" is restricted, however, in that both K_1 and K_2 must be in the linear range of the system.

Donald A. Pierre, Hughes Aircraft, Los Angeles 45, Calif.

IDEAS FOR DESIGN

RC Network Exaggerates Distortion for Easy Spotting

Qualitative measurements of harmonic distortion are often made with an oscilloscope during the design of amplifiers and oscillators. Adjustments are made to the circuit until the waveform as viewed on the oscilloscope looks as close to a pure sinusoid as the eye can tell. Unfortunately, the eye can tell a minimum distortion of approximately five per cent.

By coupling the signal to the scope through a simple RC differentiating network, small amounts of distortion are made much more discernible. The signal emerging from the differentiator will be much more distorted than is the signal applied to it, providing, of course, that the applied signal contains distortion. On the other hand, if the applied signal is a pure sinusoid, then the differentiator will have no effect on the waveform.

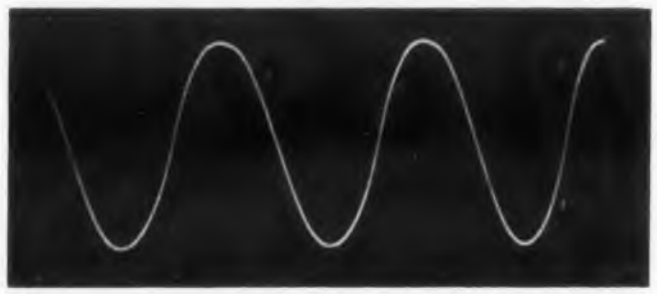


Fig. 1. Directly-coupled waveform exhibits very little distortion.

Fig. 1 is the slightly distorted signal applied directly to the scope. Fig. 2 shows the same signal after passing through the differentiating network ($RC = T/30$). Where the distortion was only slightly visible in Fig. 1, it has become quite distinct in Fig. 2.

Care must be taken to ensure that the differentiating circuit does not excessivly load the amplifier or oscillator to which it is attached, thus further distorting the signal *applied* to it. It may be desirable, when working in high impedance circuits, to interpose a cathode-follower

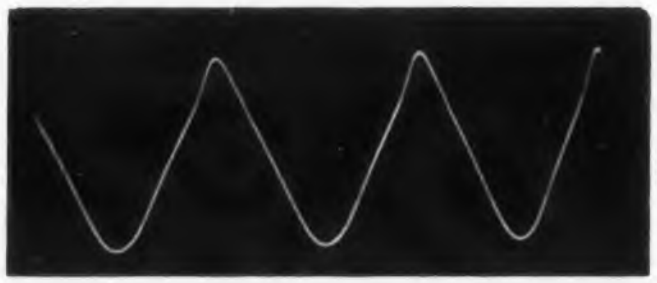


Fig. 2. When passed through RC coupling network, distortion is easy to spot.

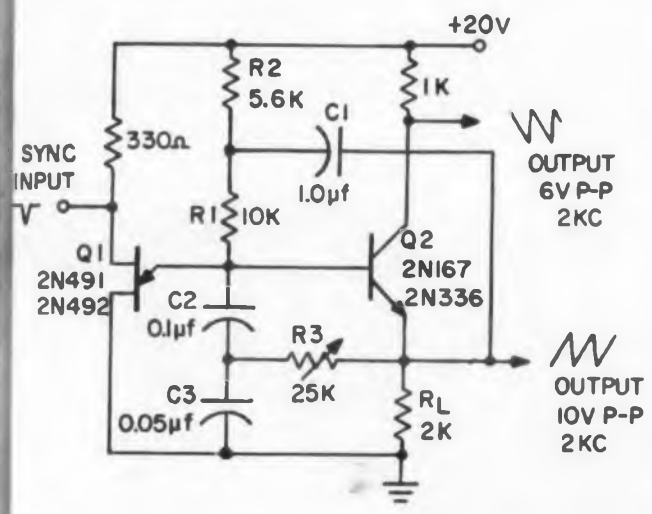
between the source and the differentiator.

Horace T. Jones, Atlantic Research Corp., Alexandria, Va.

Sawtooth Generator Displays High Linearity

Two major problems are involved in the design of linear sawtooth generators using transistors: (a) a constant charging current must be supplied to the capacitor, (b) the waveform must be compensated for the loading of the transistor output stage. The circuit shown provides both of these features with the use of only two extra capacitors and two extra resistors.

In the circuit shown, the unijunction transistor forms a simple relaxation oscillator with R_1, R_2, C_2 and C_3. The npn transistor Q_2 serves as an emitter follower output stage to the load R_L. Capacitor C_1 serves as a bootstrap circuit, maintaining a constant voltage across R_1 and thus furnishing a constant charging current to C_2 and C_3. Resistor R_3 and capacitor C_3 serve as an integrating network which compensates for the loading of the transistor output stage. Resistor R_3 is adjusted to give the optimum linearity. Linearity is improved by using transistor Q_2 with high beta.



Two-transistor sawtooth generator includes several linearity compensation provisions.

Test results with a transistor having beta of 40 at 6 ma were:

(1) linearity of circuit as shown = 0.3%

(2) linearity with integrator compensation only (C_1 removed) = 1.0%.

(3) linearity with boostrap compensation only (R_3 removed) = 2.5%

(4) linearity with no compensation (C_1 and R_3 removed) = 11%

T. P. Sylvan, Application Engineer, General Electric Co., 1224 W. Genesee St., Syracuse, N.Y.

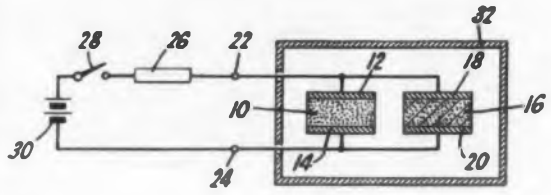
PATENTS

Oscillator

Patent No. 2,898,556. John Matarese. (Assigned to Sylvania Electric Products, Inc.)

Electroluminescence and photoconduction are combined in a system to generate an oscillating voltage waveform.

In a practical embodiment, the electroluminescent layer *10* is in shunt with the photoconductive layer *16*, the combination in series with the load *26*. Closing switch *28* causes layer *10* to emit light to illuminate layer *16*. Photoconduction increases and thereby the overall shunt resistance decreases until the voltage across layer *10* is insufficient for electroluminescence. The light source extinguishes, the resistance of the photoconduction layer increases until useful light again is emitted.

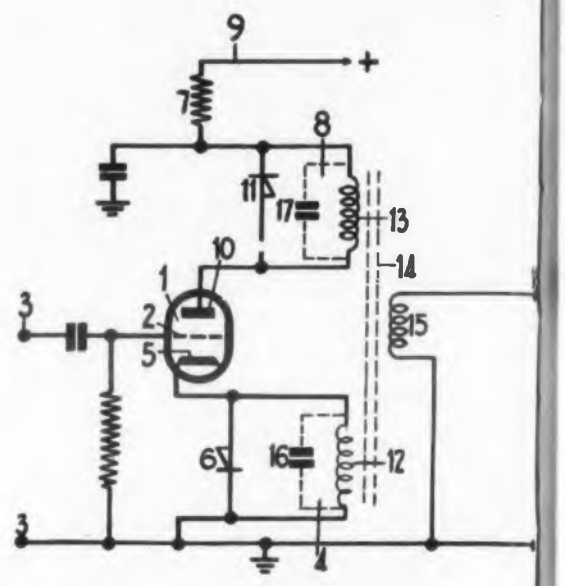


The output voltage is substantially sinusoidal.

Electric Pulse Generating Apparatus

Patent No. 2,899,552. Gordon P. French (Assigned to the General Electric Co. Ltd.)

In response to a triggering pulse, the circuit shown in the figure generates [wa



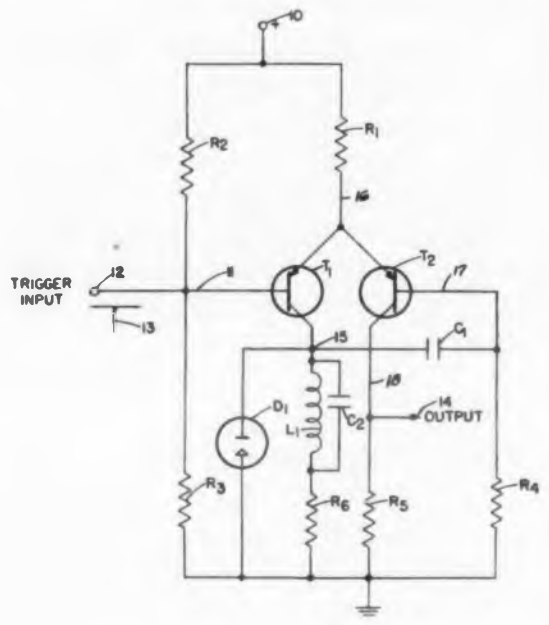
pulses of the same polarity which are separated in time equal to the duration of the triggering pulse. Diodes in shunt with the ringing networks allow the tuned circuits to respond alternately to the leading and lagging edges of the control pulse.

A negative voltage waveform applied to the control grid *2* causes inductance *12* to ring for one half cycle and a positive output is induced in coil *15*. When the applied pulse goes positive, inductance *13* rings for one half cycle so that a second positive pulse couples to the output.

Reduction of Multivibrator Recovery Time

Patent No. 2,898,478. Glenn L. Haugen. (Assigned to Bendix Aviation Corp.)

In the quiescent state of a monostable multivibrator, T_1 is cut off while T_2 is conducting to saturation. A negative impulse to terminal *12* causes the circuit to flip. Capacitor C_1 charges in series with resistor R_6 but the resistor is effectively bypassed by inductance L_1 which rapidly charges capacitor C_1. The recovery time is effectively reduced and the circuit rapidly flops back to the initial condition having T_1 cutoff. Typical components are specified in the original patent paper.



BOOKS

Safe Handling of Radioisotopes

International Publications, Inc., 801 Third Ave., New York 22, N.Y., 99 pp., $1.00

An essential guide to safety standards for all who deal with radioactive materials: exposure levels, medical supervision, monitoring, storage, transportation, decontamination, waste disposal. Available in English, French, Spanish and Russian language editions.

Effects of Nuclear Radiation on Men and Materials

T. Charles Helvey, John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y., 64 pp., soft cover, $1.80

Nuclear power for propulsion of military and civilian vehicles has become a reality. However, the application of nuclear energy in mobile units has presented a great many unexpected and unheard of technological and biological problems. This book discusses the basic nature of nuclear radiation and its physiochemical and biochemical effects. The author has gathered from the huge field of nuclear physics and radiation biophysics as well as from his own research work all pertinent information which is necessary as a background for basic understanding of nuclear radiation. The book is written for persons who are directly or indirectly involved in the numerous aspects of nuclear propulsion and powered vehicles or who have a general

interest in this topic.

The prime motive of the author in writing this book is to bring to all who are concerned with nuclear-powered vehicles and those who have an interest in nuclear propulsion the most modern data as well as recent research results in the field called Radiobiology and the effects of nuclear radiation on men and materials. All of this is done without the application of mathematics.

Radar Meteorology

Louis J. Battan, University of Chicago Press, Chicago 32, Ill., 161 pp., $6.00.

For practicing meteorologists who must keep abreast of radar theory and technique, for teachers who must recommend reading matter to their students, for electronic engineers interested in the effects of weather on microwave propagation, and for researchers who must know what has already been accomplished by their colleagues—here are the advances of the last 15 years summed up and systematized for the first time in book form.

Louis J. Battan, directly acquainted with the needs of teachers and researchers, provides a concise, well-organized, scientifically sound book to meet those needs. He covers the meteorological use of radar instruments, the meteorological quantities measured by radar, and the relationship of such measurements to more conventional meteorological parameters. The usefulness of the book is enhanced by 76 illustrations.

Printed Circuits

Morris Moses, Gernsback Library Book No. 81, Gernsback Library, Inc., 154 W. 14th St., New York 11, N.Y., 224 pp, $2.90.

This latest Gernsback Library Book is a virtual encyclopedia on the subject of printed circuits. It traces the development of printed circuits, tells how they are made commercially, how the reader can make them, how they are used in modern electronic equipment, what tubes, transistors, resistors, capacitors and other components are used with them, and how to repair, maintain and apply them in home entertainment, industrial and test equipment.

BOOKS

Shortwave Propagation

Stanley Leinwoll, John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y., 160 pp, soft cover, $3.90

All present-day radio communication is accomplished by the propagation of radio waves from a transmitter to a receiver. In general, long distance radio communication is carried on almost exclusively in the short wave bands, at frequencies ranging from 3 to 30 mc sec, or wavelengths from 100 to 10 meters.

The purpose of this book is to present in the most useful manner the basic principles of short wave radio propagation, and the way in which they can best be applied in solving the problems of long distance transmission of radio, television, in general the transmission of intelligence. Every subject considered pertinent to an understanding of short-wave propagation is treated in the book, with emphasis on those significant items which the author, in his many years of experience, has found to be of great concern.

The practical approach is used throughout the book. In particular the chapters on circuit analysis, (a circuit being the communication link between widely separated transmitter and receiver); MUF curves, and forecast ionospheric conditions are highlights of practical usefulness.

Directory of Nuclear Reactors

International Publications, Inc., 801 Third Ave., New York 22, N.Y. 214 pp., $3.50

The first publication anywhere with detailed, concise, authentic information on the 36 power reactors that will be in operation by 1962: 15 in the U.S.A.; 8 in the U.K.; 4 each in the U.S.S.R. and in France; one each in Belgium, Canada, Czechoslovakia and Sweden. Dimensions and data; fuel elements; flow diagrams; controls.

Inventions, Patents, and Their Management

Alf K. Berle and L. Sprague de Camp, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J., 616 pp, $12.50

The authors discuss principles and procedures that apply to working with patents in all fields of technology—electrical, mechanical, chemical, nuclear—from hearing aids, can openers and meters to trains, from printing presses, welders and photographic processes to solid fuels.

The theme of this work is that inventing is a business, and he who would work in this field must, to succeed, know its rules and conditions, as in any other business. The inventor who knows the right procedure to follow, and the mistakes to avoid, saves himself much expense, grief, and time.

Non-technical but covering a highly technical subject, this book accurately teaches the language of the business of inventing as used by attorneys, engineers and executives working extensively in this field. By giving a logical grasp of the legal, technical and commercial terms having to do with the subject, it enables the inventor to understand the people he must work with and to make himself understood by them.

Kaiser Aluminum Forging

Kaiser Aluminum & Chemical Sales Inc., Kaiser Center, Oakland 12, Calif., 322 pp.

The outline of this book is similar to others in the library of Kaiser Aluminum technical volumes. This forging book is designed to provide the reader with the advantages of both a textbook and a manual. For example, the production of a typical aluminum forging is traced and described in detail from original design, sinking of the die, progressive forging steps, finishing and through final inspection.

Forging engineering data presented includes alloy selection, mechanical and physical properties under various conditions, die and forging design recommendations, types of forging and availability and metallurgical quality control. The book also contains a section on forging magnetism and titanium. An extensive glossary of forging terms, to aid the reader in gaining a more comprehensive understanding of the subject, is included.

J. George Adashko

Photomultipliers may be cooled using semiconductor thermocouple piles. In this translation such cooling devices are described and test results using an FEU-11 photomultiplier are given. The noise amplitude was reduced by a factor of 2.5 as the temperature was reduced from +24 to —5 C.

Thermoelectric Cooling of Photomultipliers

E. A. Kolenko, Kh. V. Protopopov, D. G. Fleyshman, and V. G. Yur'yev

THE MOST effective means of reducing photomultiplier dark current is to suppress the thermionic emission from the cathode and the first dynodes. When a photomultiplier with an antimony-cesium cathode is cooled to 0 C, —10 C, and —30 C, the dark current is reduced by a factor of 3, 5, and 30 respectively. Further cooling leads to an even more substantial reduction in the dark current. Cooling a photomultiplier also reduces noticeably the leakage current; this is due to the migration of the cesium atoms from the interelectrode gaps into the cooled portion of the tube.

Various methods, such as liquid air, cryostatic mixture, air blast, dry ice, etc., are used to cool photomultipliers. These are cumbersome. An attractive possibility is the use of semiconductor thermocouple piles for small and simple cooling devices.

Several types of such devices have been developed and produced at the Institute of Semiconductors of the USSR Academy of Sciences.

A cross-section of a thermoelectric cooler with an FEU-19M photomultiplier is shown in Fig. 1. The thermoelectric pile *11* consists of 80 series-connected thermocouples, which are potted in epoxide tar to form a single block. The cold junctions of the pile are in contact with part 3, which touches the glass bulb of the photomultiplier near the photocathode through a system of spring contacts 2. Between the outer case of the cooler, *10*, and the inner vessel 8 is a layer of thermal insulation 9 made of foam plastic. The upper removable cover 5 has a panel *6* in which the photomultiplier and socket *1* are placed. Heat from the hot junctions of the thermopile is carried away by the chassis *4*. The light reaches the photocathode through a hole in the chassis and in the thermopile. The device described is intended for use in automatic servomechanisms used in astronomic observation.

To cool photomultipliers used in scintillation counting (crystal or liquid types), another thermocouple cooler was developed and produced. Particular attention was paid to the cooling of the FEU-11 multiplier. In this device the heat from the hot junction is removed with running water. There is provision in the cooling chamber, which differs little in its principal details from those shown in Fig. 1, for the placement of cells with the liquid scintillator.

The coolers consume 20 or 25 w of dc power. A temperature drop below room temperature of 30 to 35 deg C was obtained in a volume of 800 cc. Steady state is established in the chamber after 40 or 50 minutes; the photocathode reaches a temperature of —10 or —12 C, while the volume temperature is 5 to 6 degrees higher.

Preliminary tests were conducted using the system described above. It was found that the dark current hardly diminished upon cooling. However, an investigation of the operation of the FEU-11 in a scintillation detector with semiconductor cooling revealed certain necessary conditions for noise reduction. It was found that the noise amplitude of the photomultiplier increased greatly (in the ratio of 55 to 32) when the cooler was brought in contact with the upper part of the photomultiplier bulb. This is due to the high potential difference between the grounded cooler and the photocathode, to which a negative potential of 1 kv was applied. After applying 1 kv to

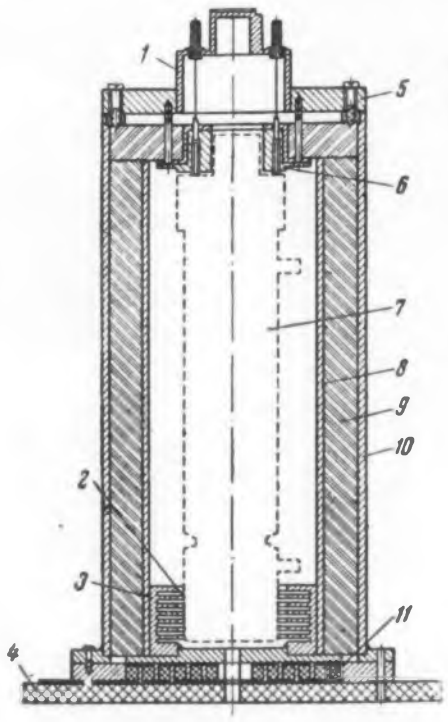


Fig. 1. Cross-section of a thermoelectric cooler with an FEU-19M photomultiplier.

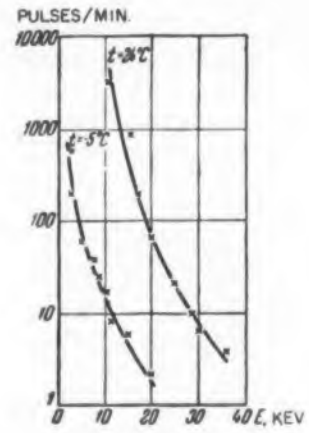


Fig. 2. Effect of cooling on the amplitude distribution of noise pulses of the FEU-11 photomultiplier.

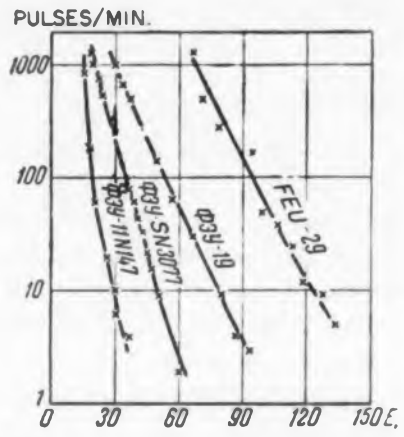


Fig. 3. Integral energy distribution of noise pulses of photomultipliers relative to a standard scintillator.

the anode and grounding the photocathode lead to the cooler, the noise level of the photomultiplier was no longer increased when the cooler was used.

As was to be expected, the condensation of moisture on the bulb of the photomultiplier increased the noise count considerably. To eliminate this, the bulb was thoroughly washed with alcohol, dried, and coated with a thin layer of paraffin. The air in the cooled space was kept dry with a dessicant such as silica gel or phosphorous pentoxide. It was found that the use of the semiconductor cooler reduced the noise of the FEU-11 multiplier from 29 kev at +24 C to 12 kev at −5 C—almost a factor of 2.5 (see Fig. 2). The failure of the FEU-19 multiplier in the setup for the measurement of weak illumination may be due to the negative potential applied to the cathode and to the fact that the FEU-19 has a higher intrinsic noise level than the FEU-11 and the FEU-S (Fig. 3). Another contributing factor is that the thermionic emission does not furnish the principal component of noise and dark current—a decisive role in the production of the noise pulses is played by phenonema that occur in the residual gas in the tube. It has also been pointed out (see I. Pelchowich, *Rev. Scien. Instruments*, 1955, 26, 470) that noise pulses are also produced by the radioactive K^{40} in the glass of the bulb. Thus, a successful application of the dark current in the photomultiplier is closely related to the improvements in the technology of photomultiplier production. The major problem is to improve the vacuum and to eliminate radioactive contaminations in the materials used in the photomultiplier.

At the present time, a new cooler has been developed at the Institute of Semiconductors of the Academy of Sciences, by which a temperature of −25 C can be produced on the mirror of a photocathode.

This article was translated from the Soviet Journal Instrument and Measurement Engineering, *No. 3, May-June, 1959.*

REPORT BRIEFS

Simulation Study

The research program conducted under this contract has centered on problems related to radar system analysis, synthesis and design in the broad sense. The program has considered problems in search radar stimulation, search radar angular accuracy, continuous and sampled control system theory, hypothesis testing and estimation. *Simulation Study, H. Dern, Electronics Research Laboratory, Columbia University, New York, Sept. 1958, 20 pp, Microfilm $2.40, Photocopy $3.30. Order PB 140412 from Library of Congress, Washington 25, D.C.*

Backward-Wave Amplifier

Results of investigations of the Hughes low noise gun have been published. The noise performance of four tubes constructed during the past quarter is discussed. The construction and performance of the first coupled helix tube are described. Initial work on ruggedization of the tube and studies of possible focusing schemes are presented. *S-Band Low-Noise Backward-Wave Amplifier, W. M. Mueller, Hughes Aircraft Co., Culver City, Calif., Apr.-June 1958, 20 pp, Microfilm $2.40, Photocopy $3.30. Order PB 140247 from Library of Congress, Washington 25, D.C.*

Microwave Electronics

Two rectangular waveguide circulators are being constructed in order to test the feasibility of several circulator-filter partition arrays. Each circulator consists of a short-slot hybrid junction and a folded magic T junction separated by a double 90 deg differential phase shift section. The analysis of the operation of this device leads to the conclusion that of all the circulators employing standard components this arrangement offers the most broadband operation. A maximally flat strip line filter having a 2 per cent bandwidth centered at 5 kmc has been constructed. By the use of a simple tuning adjustment the performance of this filter has been optimized. The present model exhibits the desired passband but presents a midband insertion loss of 10 db. Other designs for narrow band filters in the vicinity of 5 kmc presented a lower insertion loss, but did not approach the design performance as closely. Methods of reducing the insertion loss of the maximally flat filter are being investigated. *Microwave Electronics, Microwave Research Institute, Polytechnic Institute of Brooklyn, N. Y., July 1956, 43 pp, Microfilm $3.30, Photocopy $7.80. Order PB 136600 from Library of Congress, Washington 25, D. C.*

Helitron Oscillator

This study is concerned with a new type of electron beam injection for the helitron oscillator. The helitron, which was invented in 1954 by D. A. Watkins, is a voltage-tuned, backward-wave oscillator in which focusing of the electron beam depends upon a balance between centrifugal force of helical motion and a radial electrostatic field. The new injection mechanism is called slalom injection since the beam is first launched into a path like that of Slalom-Focusing and then injected from the slalom path into the concentric-cylinder geometry of the helitron. The design of a new electron gun to produce a convergent strip beam is discussed in some detail. *Slalom Injection For the Helitron Oscillator, J. L. Jones, Stanford Electronics Laboratory, Stanford University, Calif., July 1958, 79 pp, Microfilm $4.50, Photocopy $12.30. Order PB 140678 from Library of Congress, Washington 25, D.C.*

Traveling Wave Tubes

Existing slow-wave circuits which are suitable for use in high peak or average power traveling-wave amplifiers tend to have considerably less bandwidth than that exhibited by low-power traveling-wave tubes. This study relates to two new circuit configurations which are suitable for use at high power levels and which have bandwidths greater than those exhibited by existing high-power circuits. *High Power Applications of the Connected Ring Structure In Traveling-Wave Tubes, Walter Revis Ayers, Microwave Laboratory, Stanford University, Calif., Dec. 1958, 183 pp, Microfilm $8.40, Photocopy $28.80. Order PB 140614 from Library of Congress, Washington 25, D.C.*

Variable Capacitor Diodes

The design theory for the afc and fm modulator type variable capacitance diode is presented in detail while the design theory for the electronic tuning type is deferred for later discussion. Processes have been developed and units have been successfully fabricated that have capacitance in the range of 7 to 70 μμf, and Q at 50 mc of 50 or greater. The characterization has proceeded based on capacitance and internal series resistance measurements. These measurements are difficult and cumbersome, since no single instrument will measure the variable capacitance diodes over the required capacitance and Q range. The program for the next interval is based on the investigation of a lower internal series resistance unit coupled with a larger breakdown voltage. *Variable Capacitor Diodes, L. S. Chase and H. D. Frazier, Pacific Semiconductors, Inc., Culver City, Calif., Apr.-June 1958, 45 pp, Microfilm $3.30, Photocopy $7.80. Order PB 140253 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Cathode Materials For Pulse Modulators

During the program both cold cathodes and hot or thermionic cathodes were investigated. The cold cathode phase of the work included experiments with fine wire ignition, sponge cathodes, ion starting devices, gallium cathodes, dielectric starters, excitrons, semiconductor, ignitors and arc track studies. The hot cathode phase included studies of conventional oxide cathodes in basic thyratron structures and in large and small test diodes. Several sample tubes employing the more promising cold cathode designs were built and the test results are reported. *Investigation of Cathode Materials for Pulse Modulators, Donald L. Schaefer and James A. Murphy, General Electric Co., Schenectady, N.Y., Sept. 1956, 72 pp. Microfilm $4.50, Photocopy $12.30. Order PB 140435 from Library of Congress, Washington 25, D.C.*

Semiconductor Comparator Circuits

An actual circuit will possess errors in its measurement of amplitude and/or its indication of time because of noise and drift effects. Comparison can only be defined for a finite field of measurement consisting of a prescribed range of time and amplitudes. A certain minimum power is required to meet given specifications on the field and accuracy of comparison; the circuit requiring no greater power is an optimum comparator and is the best realizable circuit.

Comparison is a nonlinear operation and a criterion is presented to indicate the degree of nonlinearity, or sharpness, of comparators. This sharpness criterion reveals definite advantages in the use of semiconductor circuits. The same criterion indicates that regenerative circuits should perform comparison better than non-regenerative circuits. *Semiconductor Comparator Circuits, G. L. Hoehn, Jr., Stanford Electronics Laboratory, Stanford University, Calif., July 1958, 94 pp, Microfilm $5.40, Photocopy $15.30. Order PB 140683 from Library of Congress, Washington 25, D.C.*

Pacore Antenna

As part of the program for developing lightweight antennas for air search radars, four scale models and one full-sized version of the PACORE antenna were constructed and tested. The full-size antenna was designed for the uhf range and has side and back radiation more than 24 db down over the 400-to-450 mc band. It does not meet the air search radar requirements for low secondary lobe levels, but may be useful for wide-band directional communication. The antenna and pedestal weigh less than 500 lbs., and are rugged and compact. *Development of Pacore (Parabolic*

(Corner Reflector) Antenna, J. H. Jensen, Navy Electronics Laboratory, San Diego, Calif., Jan. 1955-July 1958, 31 pp, Microfilm $3.00, Photocopy $6.30. Order PB 140554 from Library of Congress, Washington 25, D.C.

Y-Type Circulator

It is well known that the field distribution in a rectangular waveguide containing a magnetized ferrite can be asymmetrical even though the physical configuration is symmetrical. By properly choosing the ferrite, its shape, and location, it is possible to concentrate the energy on one side of the waveguide. Reversing the field or changing the direction of propagation will cause the energy to concentrate on the other side of the waveguide. This phenomenon has been utilized to construct a new type of circulator. *The Y- Or Junction-Type Circulator, H. N. Chait and T. R. Curry, Naval Research Laboratory, Washington, D.C., May 1959, 9 pp, $0.50. Order PB 140554 from OTS, Washington 25, D.C.*

Pulse-Doppler Radar

While conventional pulsed radar effectively accomplishes the functions of range measurement and range resolution, it is unable to separate targets that occur within the same space element but have different velocities (e.g., it cannot distinguish between moving targets and fixed clutter). The cw radar, which was developed to allow velocity discrimination, does not give range information, although various schemes such as amplitude or frequency modulation have been devised to allow useful range determination. Of course, either scheme has angular resolution determined by its antenna array.

A pulse-Doppler radar combines the range measuring and resolving advantages of the pulsed radar with the velocity discrimination capabilities of the cw radar. The combination of the two principles leads to an increase in equipment complexity over that which would be required for either system alone, but the advantages of the pulse-Doppler system often justify the added complexity.

The range-measuring and velocity-measuring capabilities of a pulse-Doppler system are interrelated, and one purpose of this report is to discuss their relationship. The information presented herein was collected in conjunction with the development of a tracking radar. The same general considerations also apply to search radars, however, and some of the dissimilarities are noted. *Some Pulse-Doppler Radar Design Considerations, Robert E. Richardson, Lincoln Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., Aug. 1957, 33 pp, Microfilm $3.00, Photocopy $6.30. Order PB 140422 from Library of Congress, Washington 25, D.C.*

REPORT BRIEFS

Iterative Network Synthesis

This report is intended to introduce and dem onstrate some properties of the iterative metho of zero-pole network synthesis in the frequenc domain, as well as to extend its applications Maximally flat or equal ripple frequency respons approximation is used in illustrations and applica tions. The philosophy of the iterative method con sists of the choice of reasonable starting poles o zeros of a network function corresponding to designated circuit configuration, and the repeate computation of zeros from poles, and vice vers through the use of the realization and frequenc response constraints, alternately, until it con verges within the desired accuracy. *A Study of th Iterative Method of Network Synthesis, C. Chang, Stanford Electronics Laboratory, Sta ford University, Calif., July 1958, 98 pp, Micr film $5.40, Photocopy $15.30. Order PB 1406 from Library of Congress, Washington 25, D.*

Traveling Wave Tubes

Two sample low-noise traveling wave tub were studied to determine their performan suitability and limitations as microwave amplifier Noise figure as a function of electrode voltage solenoid current and frequency were measured well as the cold vswr gain-frequency and gai helix voltage characteristics of the tubes. We regulated voltage and current supplies we found to be needed for stable operation of the narrow band tubes. Measurement techniqu were laborious, and automated procedures a clearly called for. *Investigation of Low Noi Traveling Wave Tubes, Bernard Kilimnik Ma rial Laboratory, New York Naval Shipyard, Broo lyn, N.Y., Mar. 1959, 43 pp, Microfilm $3.30, Ph tocopy $7.80. Order PB 140498 from Library Congress, Washington 25, D.C.*

Meteor-Burst Communications

A meteor-burst communications system h been established between Stanford, Calif., an Bozeman, Mont. In one typical three-day stu of errors in teletype transmitted over this bu system, 73 percent of the errors occurred in t last character of bursts of usable signal. A tec nique for identifying and measuring the end-o burst errors is briefly described. Erasing the l character of each burst and retransmitting it the start of the next burst is suggested as o remedy for these end-of-burst errors. *End Burst Errors In Meteor-Burst Communicatio*

B. M. Sifford and Irwin Roth, Stanford Research Institute, Menlo Park, Calif., Feb. 1959, 10 pp, Microfilm $1.80, Photocopy $1.80. Order PB 140408 from Library of Congress, Washington 25, D.C.

Power Sources

The theoretical and practical limitations and capabilities of generating electrical power by means other than rotating machinery and conventional batteries are discussed. Data and theory on the oscillating generator utilizing permanent magnet excitation, the variable reluctance oscillating generator, metal thermopiles, semiconductor thermopiles, thin film thermopiles, the fuel cell, pn junction silicon solar cell, and nuclear converters are presented.

Results of laboratory experimentation are presented on the permanent magnet oscillating generator, the variable reluctance generator, metal thermopiles, and the silicon solar cell. Objectives of the study and experimentation included the determination of efficiency of energy conversion, weight and size per unit power output, range of voltage and current, life and reliability. *Unconventional Electrical Power Sources, Paul A. McCollum, Oklahoma A and M College School of Electrical Engineering, Stillwater, Okla., Sept. 1956, 112 pp, $2.50. Order PB 151726 from OTS, Washington 25, D.C.*

Design of A Summing Circuit

After an introduction and an outline of the ionization chamber as a source of input to the proposed circuit, the design approach is explained. The functions to be performed by the circuit are defined and components to perform them are selected. This leads to a derivation of generalized transfer functions for high frequency transistors, an investigation of 2N384 unit capabilities, and to a determination of the requirements for a linear pulse amplifier.

A series AND-gate circuit employing saturated transistors has been chosen as coincidence circuit. To control this gate a mono-stable multivibrator is designed. After an integration of the design components, capabilities of passive peak-summing circuit and of diode shunt-gate are experimentally demonstrated. *Design of a Triple-Coincidence-Gated Summing Circuit, D. B. Harris, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, Mar. 1959, 86 pp, Microfilm $4.80, Photocopy $13.80. Order PB 140730 from Library of Congress, Washington 25, D.C.*

REPORT BRIEFS

Strip Transmission Lines and Components

In the introduction to this report, the background of strip-line techniques is presented briefly, and the advantages and disadvantages of strip line compared to waveguide and coaxial line are discussed. The two major types of strip line, the shielded type and the unshielded type, are described, and it is explained why the Stanford Research Institute program was devoted solely to the first of these.

Formulas and design graphs are given for the characteristic impedance, attenuation, and Q of shielded-strip transmission line. A theoretical analysis is given of the coupling between coplanar strips. Formulas and nomogram charts are presented for the characteristic impedances of the basic even and odd modes of propagation on the strips. The information on coupled strips is applied to the design of strip-line directional couplers. Formulas are derived for the design of coupled-transmission-line directional couplers that are rigorous for any value of coupling. A general analysis is given for flat-plate resonators between parallel ground planes.

A standing-wave meter for shielded strip line was designed and constructed. An experimental study of strip-line T-junctions was begun during this program, and experimental data are presented for a series of symmetrical junctions having a through-arm characteristic impedance of about 50 ohms and stub-arm characteristic impedances ranging from about 35 to 100 ohms. A typical strip-line network containing a number of different strip-line components was constructed, and is described in this report. A low-power oscillator was developed using strip-line elements and a pencil-type triode. *Strip Transmission Lines and Components, S. J. Cohn, P. M. Sherk and others, Stanford Research Institute, Menlo Park, Calif., Feb. 1957, 217 pp, Microfilm $9.60, Photocopy $33.30. Order PB 137860 from Library of Congress, Washington 25, D.C.*

Microwave Measurement Techniques

Fundamental methods relating to the measurement of basic microwave quantities such as vswr, impedance, power, attenuation, frequency, and noise are described as well as multimode measuring techniques. Following a brief introduction to the evolution of microwave theory with stress on modal representations and reflection coefficient concepts, slotted-line techniques involving crystal diode detectors are evaluated for measuring vswr, wavelength, and impedance under cw and pulse excitations. Sources of errors are considered

well as techniques for realizing precision data. Power measuring methods involving thermal and electronic elements known as calorimeters, baretters, thermistors, film bolometers, thermocouples, and crystals are discussed and evaluated. An analysis is made of errors present in measuring pulse power with thermal elements. Coaxial and waveguide cavity resonators for measuring wavelength are described with emphasis on constructional details. Additional topics include direct and indirect procedures for measuring attenuation, calibration of noise sources, multimode measuring techniques, and measurement of network parameters. *A Survey of Microwave Measurement Techniques, Anthony B. Giordane, Microwave Research Institute, Polytechnic Institute of Brooklyn, N.Y., May 1956, 58 pp, Microfilm $3.60, Photocopy $9.30. Order PB 140920 from Library of Congress, Washington 25, D.C.*

Fixed, Power, Wirewound Resistors

Studies were conducted to determine the effects of hf (55 to 2000 c with a 10-g constant-peak acceleration) and lf vibration (10 to 55 c with a 0.03-in. amplitude), mechanical shock (30 impacts at a 100-g peak acceleration), and constant acceleration (50 g for 5 sec) on the mechanical and electrical properties of fixed-power wirewound resistors. The following categories of specimens were studied: (1) cylindrical body with lug terminals and brackets for mounting; (2) elliptical body with lug terminals and brackets; (3) cylindrical body with axial terminal leads; (4) cylindrical body with axial lug terminals and a band at each end; and (5) cylindrical body with axial terminal leads and one band at the center. Results showed that only 1 mechanical and 3 electrical failures occurred in 147 specimens as a result of lf vibration. Mechanical-shock forces caused 2 electrical and no mechanical failures in 137 specimens. Constant-acceleration forces caused 1 mechanical and 4 electrical failures in 140 specimens. No transient electrical conditions were observed during stressing of the specimens. Measured electrical-resistance changes were less than 0.2%. Hf vibration was the most damaging of the stresses. *Component Evaluation and Specification Engineering Final Report on Task XVIII. High-Frequency Vibration and Shock Testing on Fixed, Power, Wire-Wound Resistors, E. G. Lebre, Jr. and P. G. Perry, Battelle Memorial Institute, Columbus, Ohio, Feb. 1955, 71 pp, Microfilm $4.50, Photocopy $12.30. Order PB 137080 from Library of Congress, Washington 25, D.C.*

STANDARDS AND SPECS

Sherman H. Hubelbank

Tube Capacitance Measurements

IEC No. 100, RECOMMENDED METHODS FOR THE MEASUREMENT OF DIRECT ELECTRODE CAPACITANCES OF ELECTRONIC TUBES AND VALVES

Covered in this publication are receiving tubes and valves; phototubes, photocells, and multiplier types; and high-power vacuum tubes and valves. The measurements and descriptions of methods of measurements of electrode connections are included. Standard sockets, shields, and cap connections to be used are specified. Copies of this publication may be purchased from ASA.

Fittings

MIL-F-3922, FLANGES, WAVEGUIDE, AND ASSOCIATED FITTINGS, AMENDMENT 1, 24 APRIL 1959

Quality assurance provisions have been modified to incorporate the standard paragraphs on responsibility for inspection.

Capacitors

MIL-C-18312A(NAVY), CAPACITORS, FIXED, PAPER (OR MYLAR) DIELECTRIC METALLIZED D-C HERMETICALLY SEALED, AMENDMENT 1, 6 MARCH 1959

It is now possible to produce all capacitors meeting this spec that are impregnated with wax or oil. The qualification submission requirements have been modified.

MIL-C-19321(SHIPS), CAPACITORS, FIXED, CERAMIC DIELECTRIC STANDOFF, AMENDMENT 3, 11 MARCH 1959

The power factor has been corrected to read 2.5% at 25 C, 1 kc per sec. The list of referenced publications has been completely changed. Two new styles for type CK81 capacitors have been added. The packaging requirements have also been changed.

Receptacles

CSA C22.2 No. 42-1959, RECEPTACLES, PLUGS AND SIMILAR WIRING DEVICES

The spec applies to attachment plugs (caps and adaptors), receptacles, cord connectors, motor-attachment plugs, and current taps of the general-use types. These items are rated at 60 amp or less and 250 v and less. For industrial types the rating is 200 amp or less and 600 v and less. Copies of this standard are available from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada, for $1.75 per copy.

Waveguides

MIL-W-85C, WAVEGUIDE, RIGID, RECTANGULAR, AMENDMENT 4, 12 JUNE 1959

Quality assurance provisions have been modified to include the standard paragraphs on responsibility for inspection.

Resistors

MIL-R-10509C, RESISTORS, FIXED, FILM (HIGH STABILITY), AMENDMENT 2, 26 JUNE 1959

The supersession data is corrected to reflect that MIL-R-10509B is superseded in its entirety, but that MIL-R-19074B(SHIPS) is only superseded in part.

Power Supplies

MIL-STD-7, POWER SUPPLY VOLTAGES FOR ELECTRONIC EQUIPMENT, 22 DECEMBER 1958

Nominal values for regulated dc power supply voltages within the range of 100 to 500 v are established by this standard. Of particular importance is the requirement that the nominal values of all regulated dc voltages within the range of 100 to 500 v, positive or negative shall be selected from the following list: 100, 150, 250, 300, and 450 v. These values shall be used for internal power supplies used in subassemblies, assemblies, major units, or accessories.

Drawings

MIL-STD-7, TYPES AND DEFINITIONS OF ENGINEERING DRAWINGS, 18 FEBRUARY 1959

This standard defines types of engineering drawings prepared by the Departments of the Army, the Navy, and the Air Force, and by contractors. The following major types of drawings are covered: arrangement, assembly, book form, construction, detail, diagram, standards, elevation, envelope, erection, installation, plan, and tabulation, to name a few. Examples of the drawing are also shown.

Education For Education's Sake Not Enough

Dear Sir:

I agree with your editorial (*ED*, June 24, p. 21,), that an engineering education is a good education for today's world, but isn't salary also important? It seems to me a case of the laws of supply and demand at work. Apparently college freshmen have balanced the "years of hard study" against salary prospects and have decided not to buy.

Remember that in a free economy, a shortage is only relative. You can buy any quantity of a commodity if you pay enough!

Jerome Mendel, Sr. Engineer
Stavid Engineering Inc.
Plainfield, N.J.

Answer to Problem Needed

Dear Sir:

There is a widespread need for a way to control the gain of a transistor amplifier. We would like an 80 db reduction in gain in which the db reduction is proportional to the avc voltage or current. A 40 db reduction that is logarithmic would be a great help. Simplicity is important so the circuit should require only 2 or 3 transistors.

Laurence G. Cowles
Electronic Design Engineer
The Superior Oil Co.
Bellaire, Tex.

Let's Try These Again!

The equations of the article "New Approach to Transistor DC Bias," which appeared in the July 22 issue, seemed to have lost a few pieces in transcription. The author, Mr. J. P. White of Leeds & Northrup Co., Philadelphia, Pa. was kind enough to call our attention to our errata.

LETTERS

Eq. (1) lost a multiplier β, and should read $I_C = \beta (I_{CBO} + I_B)$.

Closing brackets were omitted in Eqs. (5) and (7).

In the denominator of equation (5), the quantities of U_{k2}, L_{k1} and U_m should read Uk_2, Lk_1 and Um, respectively

With these few changes and with the symbol V restored to the battery in Fig. 2, the article is as good as new.

Beware of Agencies

Dear Sir:

I read with interest your article "Can An Employment Agency Help You Find the Right Job?" The presentation, however, is rather one-sided. The views of Messrs. Davis and Duffy present the brighter side of job placements. I believe that you owe it to your readers to emphasize the other side as well.

Many engineers are lured into contracts with these agencies by advertisements of well-defined "fee-paid" jobs. These jobs, however, do not materialize. Poorly placed referrals are made to any and all employers that might hire the applicant with the hope that when the applicant does change positions, he will select one of the companies to which he was referred.

In my own case, I was referred to a so-called "job shop" engineering firm by a reputable employment agency. Here I was offered a nonexistent position on a fee paid basis. The job and written contract never did materialize. Subsequently, I was offered a position in another state through another agent for the same job shop firm. Before starting work, I asked all parties involved for a clarification of the fee issue of the old referral. I was assured that it was not applicable in this instance, that it was also illegal, and that no claim would be made for same. A week later I received a bill from the first agency for securing me a "permanent" position with the job shop firm. I'm now embroiled in a lawsuit that has yet to see a

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LETTERS

(Continued from p. 123)

courtroom but have already spent more time and money on the case than any job is worth.

I hope to enter as many of the "shyster" activities used against me into the proceedings so that all of the details will be available for publication without any danger of libel to publishers. Until then, this sketchy outline is all that I can submit.

Gus Kandaris
Cincinnati, Ohio

▶ Although most employment agencies dealing with engineers are reputable in so far as we know, it is certainly true some engage in questionable practices. We have an article in the works on how to select an employment agency. This article is being written by an authoritative personnel manager in the field of engineering recruitment.

Wanted: More and Better Output, Less Work in Engineering

In "Wanted: Fewer Dreamers, More Doers in Engineering," in a recent issue of ELECTRONIC DESIGN, Mr. Bernard Gordon argued that through full responsibility over a project our engineering shortage would be reduced. He states that a "back to engineering" movement is necessary to balance out the heavy drain of manpower now devoted to theoretical or "systems thinking" as he calls it.

Mr. Gordon, president of Epsco Inc., states that the highly departmentalized-service type group organization kills both the will to create and to succeed.

The success of Epsco has made it possible for him to advance these concepts with a justifiable degree of authority. However, we must examine this success and see whether it can qualify for the extensive conclusions he has reached.

In a project involving up to four or five engineers, it is conceivable that the project engineer will understand each problem encountered, and, being the most capable of his group, will have supplied a large proportion of the answers. As the organization expands and many such engineers are performing similar functions, the situation becomes confused, with many individuals trying to accomplish the job that should have been the function of one man.

In his discussion, Mr. Gordon has dealt with the small product line where a man can see all

the facts of the job and where he can do the work. However, much or most of today's work involves much larger systems than can be handled by one, 10, or even 100 engineers. It is the organization with this type of project which cannot afford to design the smaller pieces of hardware, and thus is the best, and probably the major customer of the smaller, specialized firms like Epsco.

The "systems" thinking which Mr. Gordon deplores is responsible for the bulk of today's electronic projects. Without it, the large computers, communication nets, etc., would not exist. Try to conceive of the Bell Telephone System organized along the lines suggested by Mr. Gordon.

However, we should recognize that Mr. Gordon was trying to emphasize the point that larger responsibility can result in more work output per engineer. In doing so he has greatly exaggerated the faults of the departmentalized service groups.

Milton Collins
(Company name withheld by request)

► Mr. Gordon declines to comment.

Meet Foreign Competition with Creative Sales

Dear Sir:

It was interesting reading your editorial "We need a Radio to Export to Japan" in the July 8 issue 1959. In concurring with the requirement of men, brain power, engineering and automation, I think creative sales, advertising and astute merchandising should also be added.

The Canadian editor of Electronics and Communications in the July 1959 issue suggests remedial tax relief, legislative action and interest-free loans to reduce the sale of Japanese radios in Canada. . . .

Thank goodness our electronics industry does not subscribe to a completely controlled government protection program to maintain sales and reduce the democratic right of all of us to freely compete on the open market by using engineering, automation and creative sales to bridge the gap of competition.

Fred Kluhsman, Manager
Sales Promotion and Merchandising
W. H. Brady Co.
Milwaukee 9, Wis.

► Ed. Note: Had our editorial been directed to salesmen and merchandising men, we most certainly would have remembered to stress the role of sales!

'How to Invent'

A review of a new book by Forrest E. Gilmore.

Avoid a negative attitude toward new things.

There is no magical way to become an inventor . . .

YOU DON'T have to be born an inventor. Forrest E. Gilmore, author of a new book, "How to Invent," discusses the mental processes necessary to put you into the inventing frame-of-mind.

Most engineers, he claims, would welcome some magical way by which they might become inventors. There is no magical way. But what Gilmore discloses here are the fundamentals of the inventive processes and some of the techniques used by successful inventors. If engineers can understand these, they can, with diligent practice, become inventors.

One of the pitfalls in the path of a potential inventor is the trial and error method of inventing. This tends to produce the "crackpots" and give the inventor a reputation for being untrustworthy. Thus management tends to be unwilling to place such a person in a position of authority. For this reason many engineers shy away from being classed as inventors.

Management is also reluctant to take chances on anything that isn't proven. If a new idea doesn't work, the engineer is often charged with creating a costly "folly." And if it does work, the engineer often doesn't get the special recognition he feels that he deserves.

Some of the common mental blocks that retard the creative process include:

"There are no problems in my work."

"I tried submitting a few patent ideas but they were turned down, so I guess I don't have any inventive ability."

"I tried to improve a piece of machinery but the engineers up above laughed at me."

"I do not feel that I am paid for inventing."

"I think science fiction and speculation are a waste of time."

On the management side are comments like these:

"I am always suspicious that any engineer under me who turns in patent ideas is neglecting his regular duties."

"Some of these fellows are always trying to fig-

ure out some way of getting out of work, making some contraption to do the work for them; I think they are just plain lazy and they shouldn't be paid for it."

Obviously the road to invention isn't easy. Intelligent, creative engineers have no difficulty in surmounting the previously mentioned pitfalls. They generally appreciate the need for inventing and realize the benefits to be derived from patentable ideas.

Preparation is the first practical step toward invention. Gilmore lists a number of steps that must be observed. He recommends that the engineer:

- Be highly skillful in at least one field of industry.
- Be skillful in more than one field.
- Understand the inventive process.
- Think his own thoughts.
- Avoid a negative attitude toward new things.
- State the problem in writing.
- Master accumulated knowledge on the subject.
- Gather new facts and keep a written record.

Following preparation, there is an incubation period in which the inventor discontinues conscious work on the thing to be invented. He waits patiently for inspiration and illumination. If illumination does not come within a definite time, he should then return to more intense concentration, reviewing all the knowledge he has thus accumulated.

The engineer is cautioned to be on the alert for any ideas on the subject. Often an idea that seems unusual or ridiculous may be worth consideration. Usually ideas revealed by illumination are incomplete and need more conscious revision and experimentation.

Even though most inventions come from the subconscious, it is the conscious mind that supplies the materials. Intense thought and observation produce greater impressions in the subconscious, so they are easier to recall.

Knowledge of the patent laws is advantageous to the would-be inventor. This is the last link in putting his invention into the hands of the public with proper protection. After all, Gilmore points out, there is no point in inventing something that is not patentable. Certainly a knowledge of the procedure is necessary to obtain a patent. A knowledge of legal proof, requirements for invention, selling and licensing, and how to deal with your own company are essential.

Gilmore closes his book with a short quiz to determine your "Ingenuity Quotient." It gives a very general indication of your interest in invention, your keeness of perception and other factors that might determine your inventive skill.

"How to Invent" by Forrest E. Gilmore, is published by the Gulf Publishing Co., P.O. Box 2608, Houston 1, Texas, 89 pp, $2.50 ■ ■

YOUR CAREER

NEWS, NOTES, NOTIONS

Watch those adjectives is the title of a short article originally published in the Chicago "Scanfax" and reprinted in the current issue of the *PGEWS Newsletter*. The article by the Chicago PGEWS Chapter Chairman Robert B. MacAskill says:

"In technical writing, as in life, where we try to add strength we often betray weakness. The man who tells of his accomplishments in glowing terms makes you suspect that he is not really as good as he claims.

"Likewise, the technical writer who builds up his nouns with adjectives makes you suspect that his nouns are not good enough to stand by themselves. Instead of fortifying nouns, an excessive display of adjectives usually produces an effect opposite to that intended.

"For example, the words prerequisite and essential are often used by the inexperienced writer to describe a condition. We then doubt whether a condition without an adjective is really a condition at all.

"We make a habit of saying we will take this under active consideration, we shall feel cheated when promised under bare consideration.

"If a part is always an integral part, there is nothing left for a mere part to be except a spare part.

"The word sufficient often precedes the word improvement. An improvement, which is an honest word by itself, pales in comparison.

"Adjectives are popular because they appeal to the glib idea of our nature. We use them more for emphasis than for the precision of meaning for which they are intended. They should not be used in a haphazard fashion. They don't always measure up to the noun they precede . . .

"You may report that a piece of equipment is extremely reliable. Convincing evidence of its reliability would be the fact that it has operated continuously for a year with no repairs."

• • •

Better use of uniformed engineers and scientists by the Army is expected. The Army has announced a new program "Scientific and Engineering Assistants' (S&E) Programs" which will make better in-service use of enlisted engineers and scientists. Although the Army has operated such a program since 1948 results have not been entirely satisfactory. The new program will "clearly require professional level performance in a scientific or engineering specialty" and frequency of interruption of professional-type duties will be reduced.

(Continued on page 132)

Advancement Your Goal? Use New Form To Speed Action

ELECTRONIC DESIGN's new Career Inquiry Service form is designed to help engineers advertise themselves. This new service speeds applicants to the jobs they seek. It is the first such service offered in the electronics field and is receiving high praise from personnel managers.

To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will act as your private secretary and type neat, duplicate copies of your standardized resume and send them to all companies you may select . . . *the same day the resume is received.* (ELECTRONIC DESIGN will detach the circle number portion of the form, so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personnel-manager requests for resumes from applicants who proved ineligible.

Mail Career Inquiry Service form to Reader Service, ELECTRONIC DESIGN, 830 Third Ave., New York 22, N. Y.

ELECTRONIC DESIGN CAREER INQUIRY SERVICE

USE BEFORE DEC. 9, 1959

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below. (22)

(Please print with a soft pencil or type.)

Name _____ *Telephone* _____

Home Address _____ *City* _____ *Zone* _____ *State* _____

Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924

925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

Put Yourself in this "Growth" Picture!

grow faster with a growing company . . .

utilize advanced facilities available

for research, development

and manufacturing projects of the highest technical nature

. . . where your work and talents are recognized

as extremely vital . . . enjoy year-round living

and recreation in the pleasant Southwestern climate

To date, almost 14,000 people at Texas Instruments are in this "Growth" picture. In addition, they are enjoying many other benefits from TI's enlightened personnel policy — company-sponsored profit sharing plan*, periodic advancement and salary reviews, educational assistance, insurance, and retirement programs.

TI offers a stimulating challenge in research, development and manufacture in geosciences, military and industrial instruments and systems, semiconductors and other electronic components. To keep its position as a leader in these fields, and to stay ahead of the ever-increasing demands of Space Age technology, more new permanent positions have been created for qualified Engineers.

Come grow with us . . . work and live in an environment of professional, social and recreational freedom. Write to your area of interest on the right.

*Which, in 1958, was 15% of base salary!

you'll grow faster with a growing company!

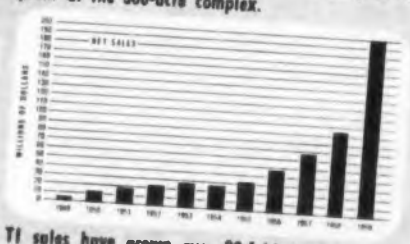
TEXAS INSTRUMENTS
INCORPORATED
DALLAS 9, TEXAS

Over the past decade, TI personnel increased over 15-fold from 800 to almost 14,000. Will be 15,000 by end of 1959.

Semiconductor-Components plant . . . world's largest semiconductor manufacturing facility. Construction underway will more than double its size.

Typical of all TI plants and offices, the Apparatus division assembly area is well-lighted and air-conditioned.

TI Central Research Laboratory's new building, located adjacent to the Semiconductor-Components plant at the 300-acre complex.



TI sales have grown over 20-fold over the past ten years . . . from under $5,000,000 to $200,000,000 for 1959.

Typical of Dallas and Houston: modern buildings and facilities, new multi-lane freeways that bring downtown within minutes of suburbia.

Many lakes, within minutes of Dallas, provide excellent recreation. Houston is "next door" to Galveston, nationally known seaside resort.

specific career opportunities now open at Texas Instruments

SEMICONDUCTOR-COMPONENTS DIVISION

DEVICE DEVELOPMENT—Develop new semiconductor devices; conduct experimental and theoretical studies on the effects of nuclear radiation on semiconductor materials and devices; evaluate experiments in the analysis of gases and electro-chemistry; conduct physical measurements on semiconductor surfaces; determine the effects of chemical reaction on semiconductor surfaces; studies in device stability, reliability and characterization; materials research and development including crystal growth and crystallography.
CIRCUIT DEVELOPMENT—Transistor circuit design and application; design automatic and semi-automatic test equipment.
MECHANIZATION—Design and develop high speed automatic machinery.
Please write to C. A. BESIO, Dept. 1104, P. O. Box 312, Dallas, Texas

CIRCLE 904 ON CAREER INQUIRY FORM

APPARATUS DIVISION

MANUFACTURING ENGINEER—To perform the planning and coordination of the manufacture of electro-mechanical/electronic systems and components on an assigned project basis; to determine action to be taken; follow-up and report successful operation of the course of action selected. BS in EE, ME or IE, with minimum 3 years experience in manufacturing processes, tooling, scheduling, and costs.
QUALITY CONTROL ENGINEER—To establish and maintain standards of quality and inspection methods for all raw materials, work in process and finished products. BS in EE, ME or IE with minimum 3 years experience in working to customer requirements, procedures, quality reports plus prevention and detection of defects in electro-mechanical apparatus.
SENIOR MICROWAVE ENGINEER—To perform applied research and development in the field of microwave and high-powered transmitter equipment including ASR transmitter and automatic performance monitoring. MS in Physics or EE with minimum 5 years experience in the field of microwave and high-powered transmitting equipment.
SENIOR ELECTRONIC ENGINEER—To conduct engineering analysis of techniques that will be incorporated into various product lines. Electronic design experience associated with the missile field involving circuit (transistor), computers, telemetry, and guidance systems design essential. MS in EE, ME or Physics with minimum 7 years experience in field of missile electronic design and systems planning and analysis.
CIRCUIT DESIGN ENGINEER—With strong instrumentation background with emphasis on circuit design. Experience in application of transistor circuits to instrumentation highly desirable although not essential. BS or MS in EE or Physics with minimum 5 years experience.
RESEARCH ANALYST—To perform industrial marketing research in the field of military and industrial electronics; requires analytical ability with imagination to foresee variables and recognize limitations and data; ability to present ideas clearly in verbal and written form. Must also be able to interpret and point out use and conclusion of statistical studies to division management. BS in ME, EE or MBA or MA in Economics.
SENIOR GUIDANCE ENGINEER—To design microwave antennas and circuit components; supervise engineering personnel in design and development of complete missile antenna and microwave systems; contribute original advancements in missile microwave and antenna concepts for proposals and system development. BS in EE or Physics with minimum of 5 years experience in stripline microwave design. Also thoroughly familiar with radiation and propagation theory.
MATHEMATICAL STATISTICIAN—To specialize in the study of noise applications; to perform systems analysis of sonar and radar product lines; to provide consulting service to other technical personnel. MS or PhD in Mathematics with minimum of 6 years experience in applied analysis of advanced mathematics.
MATHEMATICIAN—To specialize in transform calculus as applied to servo mechanisms and network analysis and continued fraction work; provide consulting services to other technical personnel. MS or PhD in Mathematics with minimum of 6 years experience in applied analysis of advanced mathematics.
Please write to JOHN PINKSTON, Professional Placement, Dept. 1104, 6000 Lemmon Avenue, Dallas 9, Texas

CIRCLE 905

GEOSCIENCES AND INSTRUMENTATION DIVISION

MECHANICAL DESIGN ENGINEERS—BS or MS in ME to design small electro-mechanical mechanisms.
ELECTRICAL DESIGN ENGINEERS—BS in EE or Physics to design and construct supervisory control systems of electro-mechanical and electronic design; transistor test equipment, requiring heavy experience on electronic circuit design, preferably with transistors; digital computers with experience in detailed logical design.
MANUFACTURING ENGINEER—BS in ME or IE with experience in production, planning, production control, methods and tooling in the electronics industry.
SALES ENGINEER—BS in EE, Physics or ME with sales experience in electro-mechanical instruments.
Please write to DAVE TURNER, Dept. 1104, 3609 Buffalo Speedway, Houston, Texas

CIRCLE 906 ON CAREER INQUIRY FORM

CENTRAL RESEARCH LABORATORY

HEAD—PHYSICS SECTION—4 to 5 years experience in semiconductor physics and proven ability to direct a variety of technical projects. Responsible for directing work on the measurement and understanding of electrical, thermal, magnetic, optical, and transport properties of semiconductors. Educational requirement is PhD in Physics.
HEAD—DEVICE SECTION—4 to 5 years experience in semiconductors plus experience in group leadership and proven ability to supervise a variety of technical projects. Will be responsible for directing work on design, fabrication and evaluation of new solid state devices. Educational requirement is MS or PhD in either Physics or EE.
SOLID STATE THEORIST—Responsible for the understanding and interpretation of the physical properties of semiconductors and other solid state materials. Educational requirements: PhD in Physics with concentration in quantum mechanics. Solid state experience desirable but not necessary.
DEVICE THEORIST—Responsible for the design of new solid state devices and interpretation of their characteristics in terms of physical and fabrication parameters. Educational requirement is PhD in Physics or EE, or MS with 2 to 3 years experience in solid state device theory.
SEMICONDUCTOR TECHNOLOGY—Responsible for the design and interpretation of experiments on the technology of semiconductors, including impurity diffusion and alloying. Educational requirement is PhD in Physical Chemistry or Metallurgy. Experience requirement: 3 to 4 years experience in semiconductor technology.
THEORETICAL PHYSICIST—2 to 3 years experience in electron or nuclear magnetic resonance with interest and background to perform theoretical analysis of EMR and NMR to develop possible new types of magnetometers or to make significant improvement in present types. Sufficient experimental background and interest to assist in translating theoretical results into experimental projects.
PHYSICISTS—Either MS or PhD with 1 year minimum experience in the fields of superconductivity and low temperature physics. Should be acquainted with conventional techniques of transferring and handling liquid helium and designing circuits and instrumentation for studies in this area.
Please write to A. E. PRESCOTT, Dept. 1104, P. O. Box 1079, Dallas, Texas

CIRCLE 907 ON CAREER INQUIRY FORM

CIRCLE 904 THROUGH 907 ON CAREER INQUIRY FORM

CAREER NEWS

(Continued from p. 128)

Over 30,000 have served in technical positions during the past ten years.

In general, engineers and scientists have been vocal about poor assignments and misused while in the armed services. Few kicks have come from men in the Air Force, where, in the Research and Development Command at least, an earnest effort is made to place highly skilled personnel in the right slots. The task of getting officer personnel into the proper job, Operation Square Peg, has been evolved into a science. According to the September 8 issue of *Engineering and Scientific Manpower Newsletter*, "Headquarters ARDC has embarked upon a project aimed at developing and implementing a new, highly mechanized system of job-man matching. . . . The system will employ a procedure for the matching of job profiles (job specifications) against the personal profiles of research and development officers. Such a matching procedure will be mechanized within the limits of the statistical reporting system; but in addition, available personnel records will be utilized to a considerable extent.

"A mechanical processing procedure has been devised which will produce a tabulated listing of officers and their qualifications who possess the necessary codifiable mandatory and desirable qualifications for successful accomplishment of the job in question. . . . This listing will be utilized as a basis for eventual personnel action. . . . The square peg program does not create a situation where officers become 'sprinkled perforations on a punchcard.' The mechanical phase of job-man matching merely speeds up a screening process which formerly was accomplished manually.

"ARDC does not claim perfection for the system, but it believes it is making as close an approach to perfection as the job potential in the Research and Development Command will permit. It is justifiably proud of the fact that other military units are considering adopting or adapting it to their specific needs. It is to be hoped that the method will spread to other units in the three services where engineers and scientists are utilized as such."

• • •

Women entering the engineering field are almost nil according to a recent survey made by the Women's Bureau of the Department of Labor. Highlights of the survey reported by the Engineering and Scientific Manpower Newsletter didn't even show up electronics as a possible classification. Of 88,000 women college graduates only 586 women had jobs as chemists, and 703 as mathematicians and statisticians, or 1.8 per cent of employed graduates, biological technicians represented 2.8 per cent. Graduates for the most part went into teaching.

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EXCEPTIONAL OPPORTUNITIES FOR

SENIOR ELECTRONICS ENGINEERS

LIVE AND WORK IN FLORIDA!

Our tremendous expansion program calls for immediate employment of 200 Senior Electronics Engineers in our new facilities at Palm Bay, Florida. Top salaries. Generous profit sharing plan. Excellent housing available close to your work.

WHERE YOU WILL WORK

Radiation, Inc. was incorporated in 1950 as an engineering organization devoted to the design and development of advanced electronic equipment. More than half the entire personnel are engineers, scientists, and other technically trained people — many with advanced degrees and extensive records of original work. The company is primarily concerned with research and development, with limited production volume. It has pioneered in the development of radar, telemetry, data processing, instrumentation, and test equipment for use by industry and the various branches of the military services.

New office and Administration Building at Palm Bay.

Radiation, Inc. has achieved an enviable position in the field of electronics by continually seeking and employing the most competent engineers and encouraging them to take a creative approach to the problems they encounter. It can offer you great personal satisfaction if you welcome the many challenges. Here your work will take you to unexplored horizons. Here are the facilities and talent to create new equipment when projects require them. Here is association with acknowledged authorities in their various fields . . . men whose everyday thinking is newer than the newest texts. And here you'll find not only satifaction in your work, but fair reward as well. Liberal compensation. More - than - liberal employee benefits. Unique profit sharing plan. An opportunity for you and your family to live *right now* where others only dream of living.

Radiation, Inc. has opportunities at all levels for research, design, administrative and sales engineers with experience in digital and analogue equipment, logic circuitry, transistor applications, servo mechanisms, antennas, radar, ECM., microwave, electronic packaging, missile systems, weapons and warfare system analysis, space technology, guidance systems, communications systems, and infra-red studies. Opportunities exist to perform "state of the art" hardware development and basic research in all of the above fields.

Send resume and complete information to: *A. J. Wilson, Engineering Employment Manager, Radiation, Inc., Melbourne, Florida*

RADIATION, INC.
RESEARCH DEVELOPMENT PRODUCTION
IN ADVANCED ELECTRONICS

CIRCLE 910 ON CAREER INQUIRY FORM

Miles of broad, sandy beach for family fun.

WHERE YOU WILL LIVE

In order to make sure that comfortable housing will be available for new personnel and their families at reasonable prices, Radiation, Inc. has entered into an agreement with the Mackle Company to give Radiation, Inc. employees top priority on the purchase and construction of new homes in Port Malabar.

This outstanding new community is being built by the Mackle Company, largest community planners and builders in the nation, through General Development Corporation, one of Florida's largest land owners. The new home section lies within the city limits of Palm Bay—adjacent to the Radiation plant—and has paved streets, city fire and police protection, municipal water and sewer system.

Excellent schools, churches of all denominations, a fine public library, a large new shopping area, and a long established down town business section are all conveniently near.

The area is one of the finest in Florida for enjoyable year-round living, with swimming from safe, uncrowded ocean beaches — boating and fishing in the Indian River and Atlantic Ocean—golf, tennis, and water skiing.

This 3 bedroom home only $900 down, $117 a month.

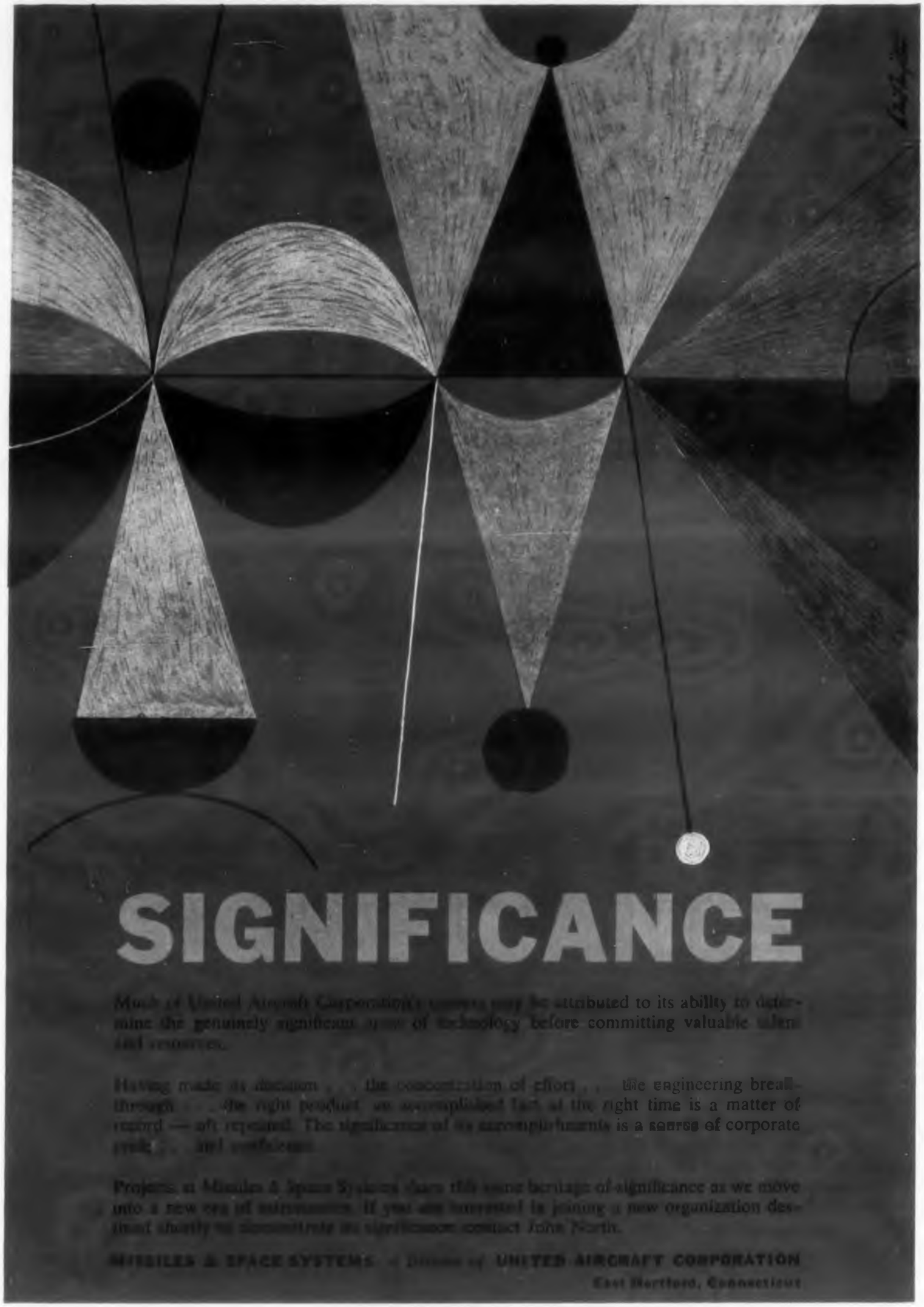
If you qualify for one of these positions at Radiation, Inc. you will have your choice of 12 beautiful Mackle-built homes, ranging in price from $10,725 to $20,300. FHA terms are available, with down payments from $325 and monthly payments from $70.

A brochure showing pictures of the homes, floor plans, prices, and terms will be sent you upon receipt of your job application. This is a rare combination—the opportunity to secure an excellent, well-paying job and live nearby in a Florida community in a well-designed, well-built home at reasonable cost.

Outstanding MACKLE-BUILT COMMUNITIES
Through
GENERAL DEVELOPMENT CORPORATION

AD 59056 (1)

CIRCLE 335 ON READER-SERVICE CARD



CIRCLE 913 ON CAREER INQUIRY FORM

CAREER OPPORTUNITIES BROCHURES

Lead

Through this illustrated brochure—Lead, the new Lockheed Electronics and Avionics Division is introduced.

Lead is intended to serve the broad field of electronics: the military, the non-military, government, and industry. Generally, the company is interested in the design, development, and production of electronic devices, subsystems, and systems.

Lockheed Electronics and Avionics Div., Dept. ED, 6201 E. Randolph St., Los Angeles 22, Calif.

CIRCLE 870 ON READER-SERVICE CARD

Packard Bell Electronics Corp.

Programs now in progress at Packard Bell Electronics Corp. are briefly discussed in the brochure entitled, "A Challenge To Engineers."

Areas covered are: Communications, Beaconry, Automatic Checkout, Digital Technology, Anti-Submarine Warfare, ECM and ECCM. Company facilities and benefits are listed.

Packard Bell Electronics Corp., Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 871 ON READER-SERVICE CARD

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