Flux Controls Resistance of Magnetoresistor

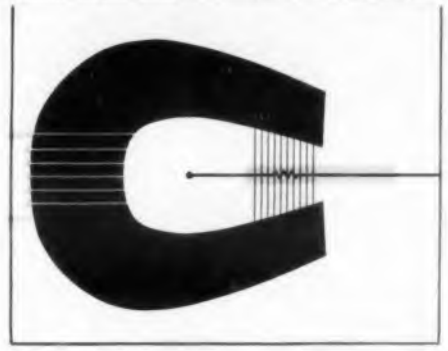
VALUE ENGINEERING REPORT . . . page 98

ELECTRONIC DESIGN

October 29, 1958

HIGHLIGHTS OF ISSUE

ELECTRONIC DESIGN



Magnetoresistors (cover) . . . 28

Magnetoresistors are solid state devices that act like rheostats. Except magnetoresistors have no moving parts. Their resistance is a function of the magnetic field passing through them. The unit features fast response time and low noise.

November 12, 1958 Vol. 6
Number
23

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DESIGN

BEHIND THE NEWS

This is Frescanar master control. The two scopes receive target information from radome-encased antenna of Frescanar (frequency scan radar). Scope on left displays target range and bearing, that on right, altitude. Data is instantaneously transmitted to missile anti-aircraft batteries which automatically track down targets. "3-D" system requires only one antenna and one master console as compared with conventional types which require two or more.

"Three-D" Radar Makes Its Debut

Hughes Aircraft and the Army Signal Corps have teamed together to develop a radar that scans electronically and obviates the need for physical-scan radar.

Simultaneously, the Hughes AN MPS-23 provides azimuth, altitude, and range information of multiple targets on a pair of PPI 'scopes. The visual data are converted into digital pulses that are carried over land lines to the command center of the Army's Missile Monitor System—an air defense system for mobile use with a field army. This field system is designed to supply command intelligence for directing fire of Nike and Hawk batteries against air-breathing vehicles—aircraft or missile.

Idea Born in '48

Frescanar (frequency scan radar), as Hughes dubs the radar set, is the hardware version of an idea developed by Dr. Nicholas A. Begovich in 1948-49. He now holds the basic patent rights for the idea, but can capitalize only on foreign applications since few non-U. S. Government applications are foreseen.

By 1952, Hughes had developed a single antenna to do the job and had demonstrated the feasibility of the electronic scanning technique. Simultaneous response along the three coordinates is made possible by digitally programming a succession of frequencies to produce changes in radiation angle at the antenna at rates of thousands of degrees per scond. Electronic scanning, thereby, makes vertical movement of the antenna to obtain height data unnecessary. Similar, but comparatively minor improvements, were made in the azimuth and range characteristics of the antenna.

Study Horizontal Scanning

The military is now supporting an R & D program aimed at producing a system that scans electronically in the horizontal plane. Further, the technique is so flexible that it can be used with properly designed end-feed antennas.

Another flexibility feature of the technique

(Cont. on page 6)

Plastic balloon, resting on mobile trailer bed like a golf ball on a tee, forms housing for antenna of Frescanar.

is that if power and antenna size were increased—creating a permanent rather than tactical installation—much greater ranges could be obtained. The system then could be used for missile guidance. It could even be employed in anti-ballistic missile applications. In its present configuration, the radar set could be adapted to air traffic control work.

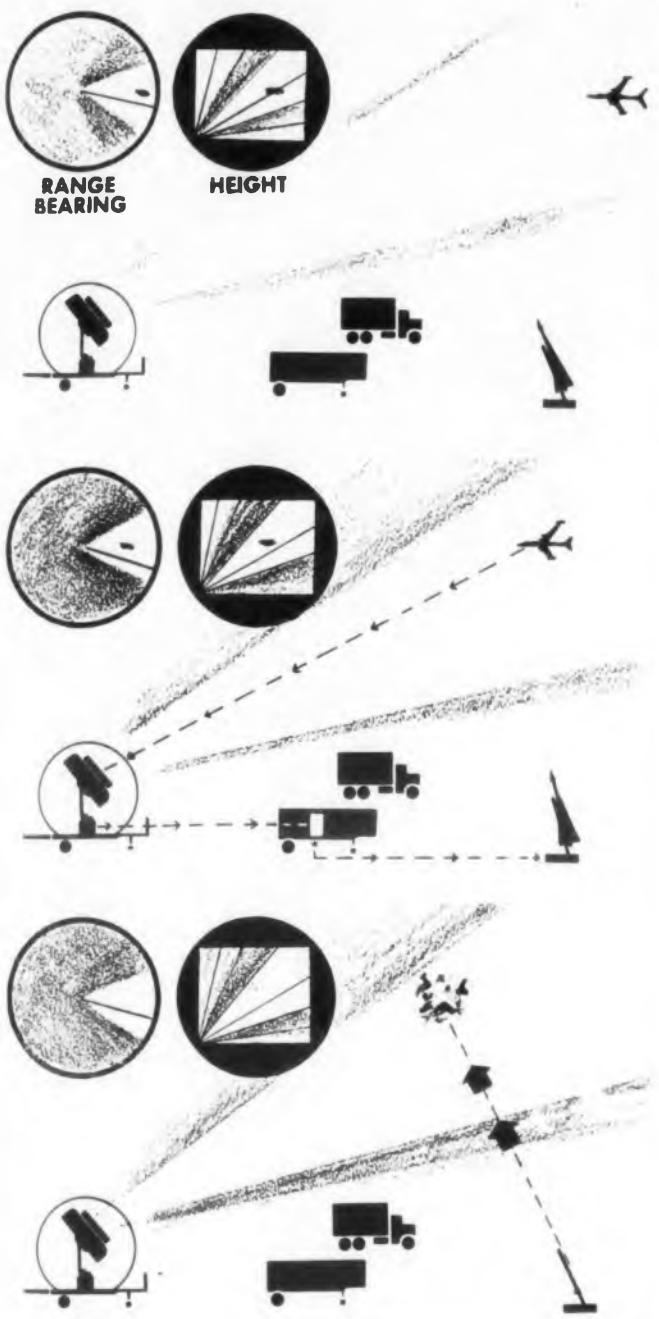
The versatility of the system makes some wonder if the Army's Missile Monitor is not a logical substitute for the Missile Master. However, the investment in this analog device and its much greater information capacity restricts the AN/MPS-23 to field sites. However, there is a good possibility that the Hughes radar could become a standard component for both the Missile Monitor and the Missile Master.

Part of the answer will come out of the experience the Army will gain from the three units now under field test. Some of the $10 million contract Hughes has with the Signal Corps pays for these test units. However, engineers associated with the program look upon the trials as mere formalities before official acceptance of the inventory.

Navy Version Under Test

The scanning technique has universal appeal. The Navy is now making sea trials of a shipborne version of the AN/MPS-23. In fact, some Navy money helped Hughes defray part of the developmental costs. The Air Force showed similar interest, although no equipment has as yet materialized.

Had the disclosure of this technique been made back in 1950, it would have been hailed as a breakthrough. However, in 1958, the hardware outgrowth of the idea is only a "significant achievement." By comparison with World War II radars, this unit is quite compact and mobile. It incorporated components of 1957 vintage—magnetic amplifiers, transistors, diode rectifiers, printed circuits, etc. The an-



Frescanar in Operation. In top panel, pencil-beam antenna is scanning skies for possible targets. "Enemy" bomber is detected in center panel and antenna flashes range and bearing for display on one monitor scope, altitude on the other. Digital information is relayed to batteries which launch counter missiles. Antenna and scopes continue to search.

tenna is designed to collapse hydraulically like a clam shell and fold into a nest so that when the sides are drawn up the vehicle will look like any other Army radar van.

How Begovich achieves frequency shifting remains classified. That he is able to put a high proportion of transmitter power into narrow pencil-like beams in fan-shaped array is highly significant. This achievement allows him to make the claim that the range for the unit is 20 to 50 per cent better than radars with similar missions. Again, figures remain classified, except that the lower limit is obviously greater than the range of the Nike-Hercules, which is said to be about 100 miles.

BEHIND THE NEWS

"Isolated Circuits" Improve HV Supply

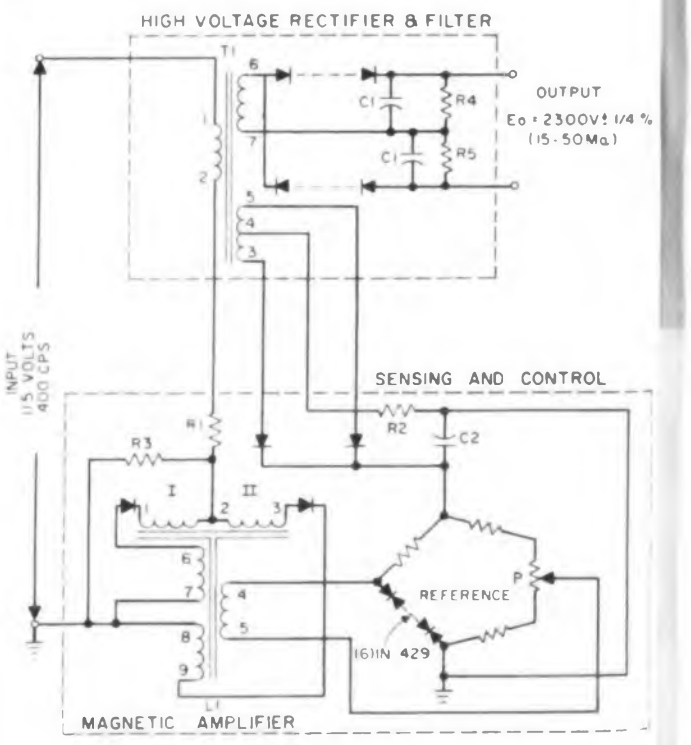
Both the control and output sending circuits are isolated from the high voltage output of a magnetically regulated dc power supply developed at Bell Telephone Laboratories. This circuit separation facilitates regulation and eases packaging requirements.

The supply provides 2300 v at 15-50 ma with 1/4 per cent regulation.

The unit was developed to supply a reference input voltage to the helix and anode of a Bell backward wave oscillator tube. Bell reports that the voltage level can probably be increased "indefinitely." In fact it is possible that the supply might prove "more advantageous" at higher voltages.

The designers have placed the control element—a self-saturating magnetic amplifier—on the low voltage input side of the regulated supply and have added an auxiliary winding for output sensing.

Silicon rectifiers are used in both the high voltage output circuit and in voltage reference circuit to assure ruggedness and reliability. A conventional voltage doubler serves as the high voltage rectifier. The filter uses sufficient capacitance to reduce the maximum rms ripple to 1/2 per cent at 50 ma. The reference voltage is provided by a series chain of six 6-v temperature compensated zener diodes connected in a bridge circuit.

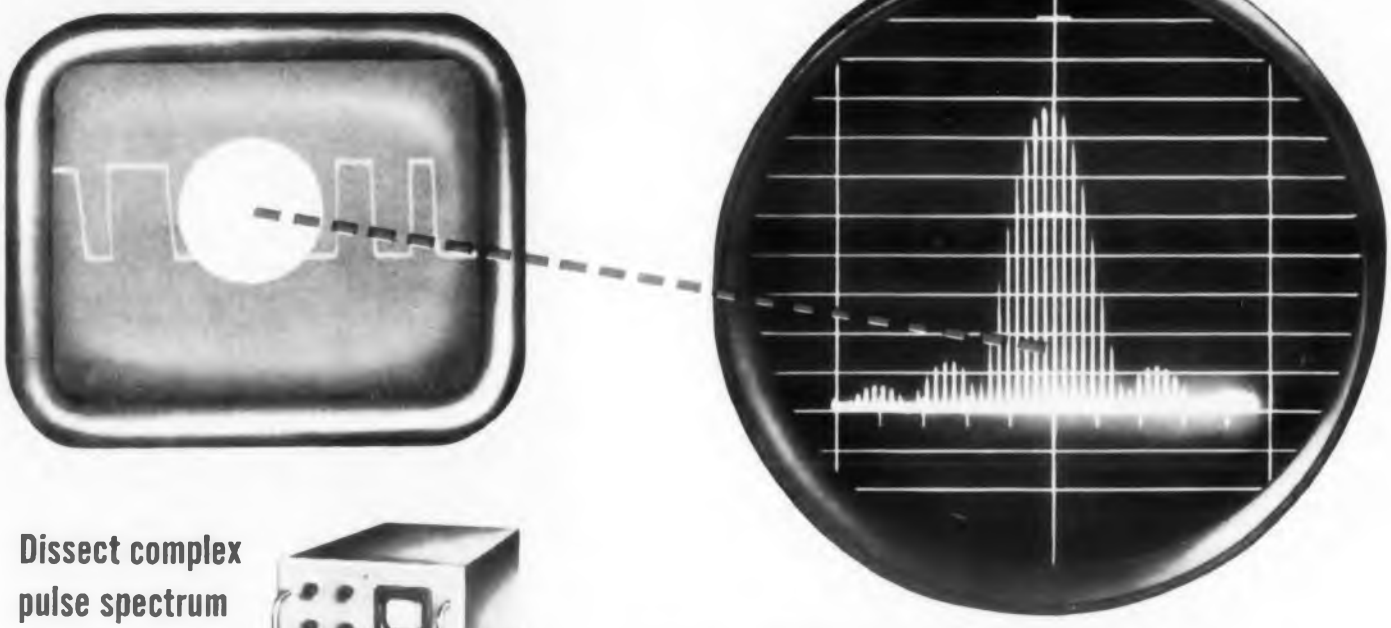


Schematic of 2300 v magnetically regulated power supply.

CIRCLE 7 ON READER-SERVICE CARD

VISUAL MICROWAVE ANALYSIS–10 to 44,000 mc

COMPLEX SPECTRUM DECODING



Dissect complex pulse spectrum visually by means of Polarad Model SD-1

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Used with any Polarad analyzer, this Model SD-1 Spectrum Selector permits complete analysis of any complex pulse modulated microwave signals. The unit decodes and isolates any segment of a complex pulse train and permits corresponding spectrum analysis of that segment.

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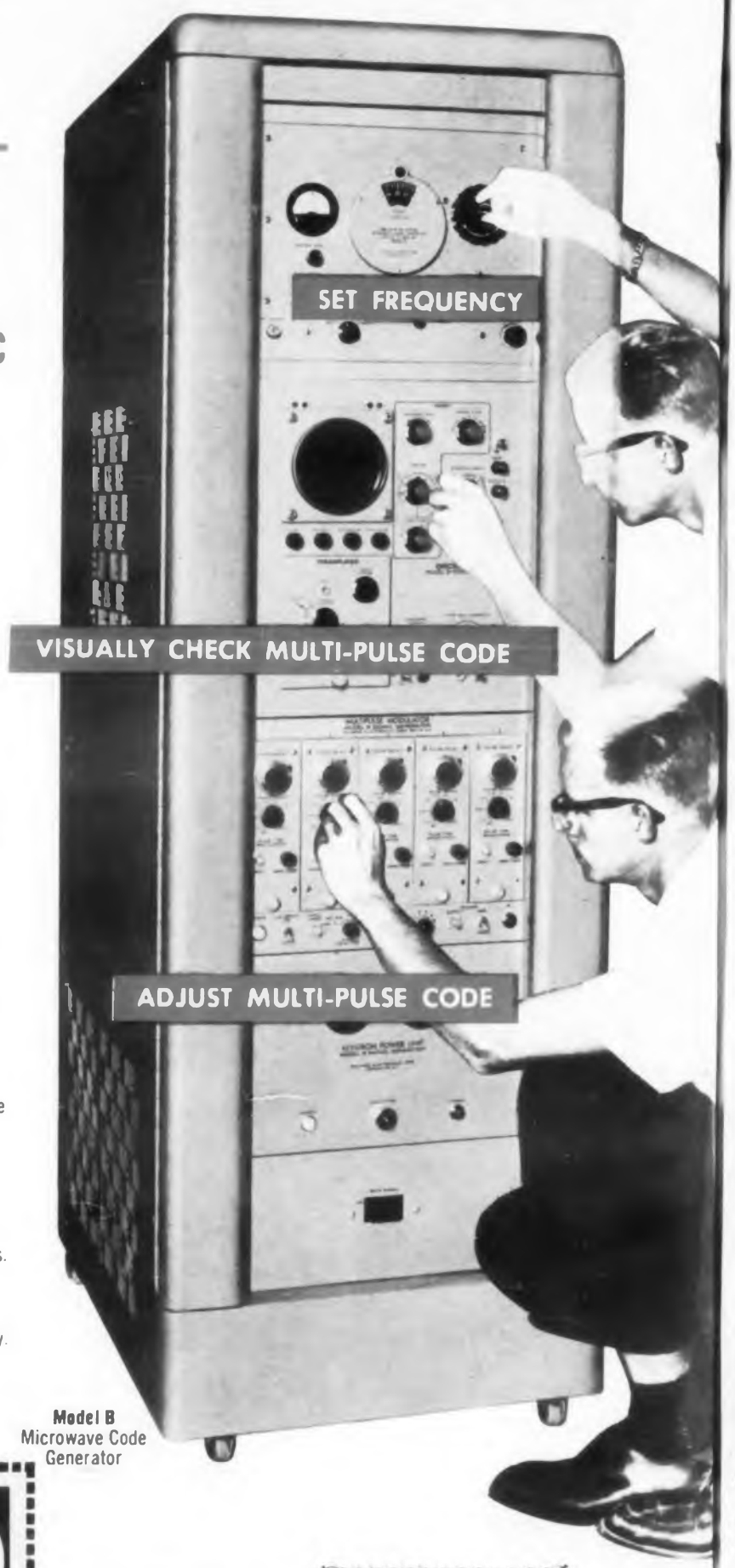

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Automation Expert Reports on USSR Tour

Where automatic control is concerned the Russians are generally unstandardized. The trouble is that under their present system, equipment manufacturers are obliged to manufacture everything that goes into the equipment. And they've got to build the machine that manufactures the parts.

This was one of the observations made by Dr. Eugene Grabbe of the Ramo-Wooldridge Corp., Los Angeles, Calif. He toured Russia as a member of a 13-man U. S. delegation which studied Soviet development and application of automatic control.

The power plant they visited was highly automated, Dr. Grabbe reported. The Russians are going in heavily for automation. But while they have some fifteen different varieties of numerically-controlled equipment, none is in production.

Dr Grabbe also felt that the Soviets were not using nonlinear theory, although it is generally recognized that they know a great deal about it. (See ELECTRONIC DESIGN serial translation of A. A. Kharkevich's book on nonlinear and parametric phenomena.) On a practical design level they approximate with linear equations as we do. This situation may change however, he said.

Dr. Grabbe noted that most Soviet computers are analog. There are only about 400 digitals—compared to our 4000—and most of these compare to small ones like the IBM 650.

D. **Grabbe** inspects a Russian numerically-controlled machine during recent Soviet tour.

CIRCLE 8 ON READER-SERVICE CARD ➤

CIRCLE 7 ON READER-SERVICE CARD

Thermoelectric Effort Security Riddled

There's a lot of research activity in thermoelectricity these days. But the four major researchers—RCA, Westinghouse, GE and Nortronics (a Division of Northrup Aircraft)—have slapped a proprietary label on a major part of their efforts. Indications are, however, that all are probably at the same achievement point—the early research stage.

The hush-hush is understandable. The rewards—particularly from the military loom fantastic. There's a financial bandwagon glued to the near horizon ("anywhere from 3 to 20 years away") and everyone is getting ready to jump on it. Some may have cashed in already.

RCA and Westinghouse report they have no military contracts for thermoelectric research. A GE spokesman said: "We have no military contracts that can be discussed." Nortronics recently delivered two miniature thermoelectric coolants to the Navy for evaluation, perhaps to activate some financial military interest.

Convert Heat to Nuclear Power

Certainly the refrigeration effect of Peltier devices is not the only phase under exploration. Applied thermoelectricity presents the possibility of directly converting heat or nuclear energy to electric power.

The concepts are by no means new. The Peltier cooling effect was discovered by the French physicist in 1834. He found that the junction between two dissimilar metals acted as a heat sink or as a heat source, depending on the direction of the current passed through the metals. Before this, Seebeck, in 1822, observed that two dissimilar metals at different temperatures upon contact generate a voltage.

But the space age has introduced countless possible applications. The systems promise minimum weight-volume requirements and high reliability. There are no moving parts. There is no vibration and nothing to wear out.

Much of the present secrecy concerns applications. Some immediately suggest themselves: infrared detector cooling; component spot cooling; thermoelectric, solar power generators; nuclear power generators—to name only a few. There won't be widespread activity for some years, however, the consensus has it.

Materials Major Problem

The biggest cooling problem now is to find suitable thermoelectric materials, i.e. those which will conduct electrical current and not heat. It happens that semiconductor compounds seem to do the job best. Nor are single crystal materials necessary. Pure polycrystals work fine. However, present efficiencies are generally not better than 10 per cent.

Infrared seeker—lead sulfide—and two Peltier devices in cascade are contained in this tube, made by Nortronics. The PbS sees infrared radiation through the sapphire window (shown at the top).

This thermoelectric cooler, another Nortronics device, is keeping a tray of ice cold. The metal connecting the n and p junctions is thermoelectrically neutral. The idea is to give a large cooling area to the junction.

Recently, however, Westinghouse announced it has discovered a new class of thermoelectric materials. (See *ED*, Oct. 1, 1958, p 10). These ceramic-type materials—mixed valence compounds of the transition metals—operate at "promising efficiencies" at 2000 to 3000 F.

Early last month, Nortronics, Inc. released its miniature infrared-detector cooler. The detector and cooler is shown. It contains the detector with two Peltier junctions in cascade. The two dissimilar metals are n-type and p-type semiconductors. Nortronics did not say what kind of material was used, however.

The device, under Navy study, is hermetically sealed. In present cooling methods liquid nitrogen is circulated around infrared detectors. The present unit however, can take an ambient of 80 C at most, Nortronics reports. The unit is not in production.

Westinghouse also indicated work on infrared detector cooling.

Much has already been written about consumer applications. RCA as early as 1955 demonstrated refrigerators and air conditioning units using the thermoelectric concept. Westinghouse exhibited a baby bottle warmer and cooler at this year's WESCON show and NEC show.

The importance of industrial applications certainly cannot be overemphasized to name a few: localized heating or cooling for chemical reactions; maintaining temperature-critical devices at safe operating temperatures in electronic equipment.

However, the big push will be in the military realm. New developments will be carefully guarded. There's a "keep cool" policy about.

WASHINGTON REPORT

Herbert H. Rosen

The Sweet Smell of Success

Rarely does a first venture in science result in a significant achievement. Yet, the initial job the National Aeronautics and Space Administration (NASA) was given—while less than two weeks old—was the sponsorship of this nation's highly successful shot at the moon.

While the Air Force deserves most of the credit for this success, the fact that the probe was performed under the aegis of NASA cannot be overlooked. Nor can NASA's part be discounted in the forthcoming man-in-space X-15 research aircraft experiment—and all future non-military probes into space.

As momentous a beginning as the moon probe is, it remains only symbolic of the job Dr. T. Keith Glennan has before him as the chief framer of the national space policies and scientific programs. He is well on his way toward carving out an organization that has at its core the National Advisory Committee for Aeronautics. But by comparison, NACA's past activities will pale in the light of the whole galaxy of new concepts, techniques, and goals that make the moon one of the nearer space targets.

The broad outline of what Glennan hopes NASA will achieve was disclosed shortly after the formal establishment of the organization. In space flight development, NASA will be concerned with "the entire spectrum of space flight operations including the design and procurement of vehicles and satellite payloads, the launching and monitoring of scientific satellites, the accumulation and reduction of data, and activities supporting the objective of launching man into space."

In the area of aeronautical and space research, Glennan envisions a continuation of NACA's basic and applied research programs. The additional effort required in these areas will be supported in "the laboratories of industry and educational and nonprofit institutions."

Most of the personnel best qualified to administer these activities have already been recruited. Many simply changed hats from NACA to NASA. Others have joined NASA from other government agencies and from industry.

Noteworthy among these transfers are about 150 scientists from the Navy's Project Vanguard staff—who may perhaps form the nucleus of a new space center to be built in nearby Beltsville, Md. Dr. Homer E. Newell, Jr. has taken over as Assistant Director for Basic Sciences, under Dr. Abe Silverstein. Dr. John Hagen will continue as director of the Vanguard program—for as long as it survives. Glennan reports that its future is still under study and he is uncertain as to what will happen at the close of the IGY.

Along with the transfer of Project Vanguard to NASA has come the responsibility for three more space probes and their instrumentation, (one Air Force, two Army) and three satellite attempts, (all Explorers). In relinquishing this role in space, the Advanced Research Projects Agency (ARPA), the original housekeeper, also transferred some $59.2 million to NASA.

These and related transfers bring NASA's 1958-59 budget to about $304 million. While this sum has come to the agency with comparative ease, the real battle for money begins next January. Then, the total needs of the new agency will be presented on their own merits. There will be no aid forthcoming (via transferred funds) from the Defense Department.

Wherefore ARPA?

NASA's proclaimed role in space has tended to heighten speculation over the need for an Advanced Research Projects Agency within the Department of Defense. ARPA's military budget for 1959 is approximately $420 million—much of this to be spent on antimissile effort.

Moreover, the Air Force has recently established a military space unit within its Ballistic Missile Division to monitor ARDC's space projects.

Then, skeptics ask, why is there an organization within the DOD that appears to constitute another layer of bureaucracy between the decision-makers and the doers?

Before that issue comes to a head, NASA administrator Glennan is reported to be facing a more immediate organization problem of equal magnitude. The legislation creating NASA also established a Space Council to include the Secretaries of State and Defense, the Chairman of the AEC, Mr. Glennan, Dr. Alan Waterman, (National Science Foundation Director), Dr. Detlev Bronk (head of the National Academy of Sciences), William A. M. Burden, and Gen. James Doolittle, (Council chairman).

Many of the Council members, however, are already so overburdened that they may not be able to devote the energy required by this position. Besides, as chairman of the Space Technology Labs, Doolittle may have a conflict of interest.

LETTERS

Simplifying Scientific Semantics

Dear Sir:

The opportunity to have the following comments published will be appreciated. They represent observations on a situation of long standing which merits careful consideration by the members of the engineering and physical sciences fields.

Over the last few years the value of interdisciplinary meetings has been discussed. Some courageous attempts and sometimes heartbreaking efforts have been made through certain professional groups, local societies, etc., to bring together workers in many professional fields. The logic and value of decent communication between disciplines is obvious—what is each of us going to do about the prosecution of this logic?

This problem is brought to focus with particular emphasis today. Space craft and satellites are upon us—and man himself is to be involved as the passenger. The recent symposium on the role of the Life Sciences in the development of manned satellites pointed up with remarkable clarity the interdependence of *all* sciences if we are to do a successful job. The biologist, physiologist, psychologist, psychiatrist, biophysicist, etc., must link their efforts inextricably with those of the engineer and physicist if we are to progress at a rate and at a cost which is economical and intelligent.

It seems to me that we of the physical sciences can contribute much to the understanding and forebearance required. Let us learn to speak with our colleagues of other specialization. Let us be patiently willing and sufficiently humble—not only to level our semantic difficulties, but to extend ourselves to listen, to learn, and to teach with understanding—and wherever we can. Without the aid of our friends in the Life Sciences man may get into space, but it is unlikely that he will prosper there. Without our aid, the Life Sciences will be delayed in their progress and contribution to science as a whole—indefinitely. Let us remember specifically that our colleagues have problems requiring experimental techniques and instrumentation some-

times complicated and delicate almost beyond belief to the average electrical engineer.

In the interest of man, science and our future with both—extend your hand and your mind to learn and to help. Your understanding and cooperation are needed urgently.

R. M. Goodman, Vice President
American Electronic Laboratories, Inc.
Philadelphia, Pa.

▶We can all agree with Mr. Goodman that it is necessary to communicate with other disciplines. But the specialist's vocabulary continues to become more esoteric. How should we overcome this paradoxical situation? We'd be interested in your comments.

Need High Temperature Facts

Gentlemen:

The overall subject of high temperature development of electronic components is most interesting. [High Temperature Components, *ED*, May 14, 1958.] Comprehensive listings of manufacturers, types of components, particular ranges, rated temperatures, and availability are very valuable. The discussion of electronic hardware being taken for granted should be emphasized.

A more thorough investigation and discussion of parameters creating the most difficulties in component development, over and above the materials problem, is desirable.

Future reports would be of much greater value should the listings and discussions of components developed, and being developed, include those sizes established and being considered. There is a desire to advance the philosophy of simultaneous requirements. For example: What are the results of a resistor or capacitor rated at 200 C when vibrated over the range of 55 to 2000 cps, 5 g's in an ambient of 200 C? Some believe the results would not be the same as at room temperature.

There is presently some feeling in industry, as well as in the military services, that a livable environment must be provided for electronics equipment. Military estimates are that future requirements will be for 95 per cent of components in the range —65 to —200 C and only 5 per cent for the 500 C range. This hardly justifies putting all the component development money into the 5 per cent category.

It is also apparent at this time that radiation resistance must be considered as closely as high temperature resistance. More data is becoming available and should be the subject of a future staff study.

I think your study is most useful as a summary of the "state-of-the-art" but you should caution

LETTERS

industry against going too far in high temper- ture development until more results are rela- from space.

H. Lane Dudl
Project Engin
Melpar, Inc.
Falls Church, V

▶ We agree. See our report on Nuclear Radia Effects on Components, Oct. 15 *ED*.

Transistors—Timely Topic

Dear Sir:

Your editorial in the excellent July 9 "Transi- tor Issue" is very good and very timely. Probabl also true is that, with increased predictabilit and standardization will come more elite desig methods. Present-day approximate methods, con firmed by lab breadboarding, sometimes brin forth a disdainful, "Ha! Vacuum tubes wer never like this!"

T. R. Nisbet
Electronic Research Engineer
Lockheed Missile Systems Developmen
Palo Alto, Calif.

▶ The above is the closing paragraph of Mr Nisbet's letter advising us of his change in affilia tion (He has another article coming up in a fu ture issue of ELECTRONIC DESIGN). We frequentl hear glowing accounts of what is possible wit transistors from engineers who have just disco ered them. Once they shake the habit of thinkin in terms of tube circuitry, new vistas are opene to them. The building block is a current gain device. Impedances can be varied by a host o network configurations. Mr. Nisbet's ejaculatio "Ha!" may after be "Ah!"

Know Your Makes

Dear Sir:

Reading your article entitled "Decade of Transistor Progress" in the July issue of ELEC- TRONIC DESIGN, I find that you attribute the 2N173 high power transistor to Sylvania. This transistor has been manufactured exclusively by Delco Radio. I am sure there is no harm done.

We always enjoy your ELECTRONIC DESIGN.

J. S. Schaffner, Manager,
Applications and Evaluations
Delco Radio Division
General Motors Corp.
Kokomo, Indiana

▶ We hope our readers weren't confused.

EDITORIAL

It's Not Catching

How often have you felt that your one great idea was going to really rock the engineering fraternity, only to see it accepted (if at all) with a great deal of scepticism and reluctance?

Value engineering, the objective redesign of an already designed product, is one of these ideas. Its ardent followers think it's the greatest. But for some reason, VE isn't setting the industry on fire. Why?

First, many industry executives believe that costs should be cut at the original design stage. Redesigning to cut costs shouldn't be necessary. It's only common sense, they say, to design for lowest-cost production in the first place.

Also, to staff a VE department, engineers of the highest caliber are required. They must have a combination of engineering skills —both theoretical and practical—with diplomacy and salesmanship as a necessary adjunct. Men such as these are hard to find.

And how can a value engineer justify his job within the company organization? One view is: either redesign and save money, or your services aren't required. Some industry executives have made that statement. It's not easy for an engineer to bluff his way through a project when the results can easily be measured in cold cash.

It seems that all these considerations require, not only skilled engineers, but those with enough self confidence to accept the challenge. They also require management with enough confidence in its staff to invest in a program such as this.

One of the giants in the industry started VE several years ago. A few others are slowly adopting the VE concept. Their experiences indicate that the concept works.

Perhaps our staff report will win some converts. At least it should start people thinking.

Lawrence D Sheppard

Measuring Microwave Interference

Robert Saul
Polarad Electronics Corp.
Long Island City, N. Y.

In the first part, a procedure for measuring interference in the 1000 mc to 10,000 mc range was discussed. This concluding part describes interference generated by microwave equipment. It suggests a means of controlling such interference (1) at the source of generation, (2) along the transmission path, and (3) in the susceptible instrument.

THE MOST effective and most economical means of controlling interference is by its elimination or suppression at the source of origin. An interference-free design can spare much subsequent engineering effort. The expense of interference-reduction components, which bring with them additional problems of increased size and weight, can be saved. Therefore, consideration should be given to the interference problem at very early stages of system and component design.

System Design Techniques

A good start can be made in the early planning stage through intelligent location of equipments expected to be mutually disturbing. The location of the various components of the system with respect to each other is an important factor in the reduction of interference hazards. Wide physical separation between interfering equipments will obviously assist in this respect.

Another basic rule is that the power output and bandwidth of the system should be the minimum necessary for satisfactory operation. Examples of other techniques for eliminating interference at the source by means of system design are given below. These are methods such as time-sharing, pulse-recurrence-frequency synchronization, synchronized antenna rotation, and frequency assignment.

Time-sharing. In the time-sharing method, the operations of various transmitting and receiving devices in a complex system are synchronized with each other in such a way that no two mutually-interfering equipments can operate at the same instant.

PRF synchronization. Pulse-recurrence-frequency synchronization is a type of time-sharing which is sometimes used in radar systems. This method makes use of a synchronizing pulse from one radar system to shift the occurrence in time of an interference signal in another system. By this means, the interference is made to occur when no intelligence is being received, and therefore, is not objectionable. For example, the interference on a radar system indicator may be shifted to occur during retrace time or in the ground clutter.

Synchronized antenna rotation. Antennas with variable speeds of rotation may be synchronized so that they are never directed at one another. In this manner, one antenna cannot receive the signal being transmitted by another.

Frequency assignment. Interference resulting from spectrum congestion (frequency crowding) may be minimized by staggering magnetron operating frequencies throughout the range. This technique is sometimes called the "Frequency Assignment" method. It attempts to control the interference problem by assigning specific frequencies of operation to all systems within a given area.

The assigned frequencies are selected after careful consideration of all possible combinations of the following types of interference: adjacent-channel, co-channel, cross-modulation, intermodulation, harmonic, image-frequency and intermediate-frequency interference. Each of these types of interference is defined and illustrated in Table 1. Formulas for computing each are also given.

Once the general frequency assignments have been selected after an analysis of the above factors, the precise frequency designations are made by performing actual interference measurements with the units at their operational sites. Such tests are necessary because it has been found experimentally that a small change in the operating frequency of a microwave transmitter can increase the amount of unwanted radiation by a ratio of more than 100 to 1. Therefore, the exact operating frequency of each component of a system must be determined experimentally as the result of interference measurements to establish which frequency, within the assigned range, gives the least unwanted radiation. The use of tunable magnetrons facilitates this procedure.

Component Design Techniques

The goal of an interference-free design should be applied to the individual units and components making up a system, as well as to the overall system. Particular attention should be given to microwave oscillators and amplifiers, and to nonlinear varying impedances because these are major sources of undesired responses.

Oscillator and amplifier techniques. The generation of interference from microwave oscillators and amplifiers should be minimized by careful regulation of the power supplies feeding magnetrons, klystrons, traveling tubes, and backward-

wave oscillators. Small changes in the operating voltages of these devices could change the frequency of operation and produce unwanted phase or frequency modulation. Cavities of klystrons and magnetrons should be designed with appropriate suppressors so that only one major mode of oscillation will be supported, and hence, no spurious signals will be generated.

Care should be taken in the selection of traveling wave tubes or backward-wave oscillators intended for interference-free applications because many types generate inherent spurious responses. The use of tunable, instead of fixed, magnetrons is desirable because it permits adjustment of the operating frequency to obtain a spectrum without excessive sidebands.

Non-linear, varying impedances. The common use of crystals as microwave mixers requires the associated use of low-pass filters to attenuate all frequencies beyond the pass-band, in order to prevent the generation of harmonics. Wherever possible, mixers should be preceded by microwave preselectors to prevent spurious signals from reaching the mixers.

Traveling wave tubes should not be operated in their nonlinear regions because extraneous signals may combine to produce undesirable sum and difference frequencies which may fall within the receiver pass-band.

Leakage From RF Transmission Lines

Although it is preferable to suppress interference at the source, such is not always possible. The next best remedy is to control the transmission paths which convey interference from the source to the points of leakage, or are themselves the actual sources of leakage. One type of interference transmission path is the legitimate r-f transmission line which, ideally, is supposed to carry microwave energy from one point to another without external losses, but which, in practice may leak a portion of the transmitted energy, and thus radiate an interference field. Waveguides and coaxial cables are examples of this type of transmission line.

Leakage from waveguides. Adequate control of leakage from waveguides demands tightly-sealed joints and mating parts throughout the transmission line. One way to achieve a low-resistance joint is through the use of a choke flange. Where it is necessary to divert a portion of the energy from the main line, properly designed directional couplers should be used to ensure that all the required energy is efficiently transferred and that none is radiated into space.

Leakage from coaxial cables. In flexible coaxial cables it may be necessary to have more than one outer shielding braid in order to prevent leakage through the minute openings in the braid when the cable is flexed or bent. All fittings

Table I. Types of Interference

Type of interference	Definition	Formula	Figs.
Adjacent-channel interference	Interference caused by sidebands of an adjacent channel signal which fall within the desired channel of reception.	$f_i = f_o + \Delta f$	1
Co-channel interference	Interference caused by the presence of an unwanted signal appearing in the desired channel of reception.	$f_i = f_o$	2
Cross-modulation interference	Interference caused when the modulation of an undesired signal (of any frequency) is superimposed on the desired signal.		3
Harmonic interference	Interference caused when harmonics of an input signal combine with the fundamental oscillator signal, or its harmonics, to produce an unwanted signal in the i-f bandpass.	$f_i = n\,(f_{LO}) \pm f_{IF}$ or $nf_i = f_o$	4
Image-frequency interference	An interference signal lying at twice the intermediate frequency from true signal.	$f_i = f_o \pm 2f_{IF}$	5
Intermediate-frequency interference	Interference caused when a strong signal at the intermediate frequency of a receiver reaches the mixer stage.	$f_i = f_{IF}$	6
Intermodulation interference	Interference caused by two or more signals such that their sums and/or difference frequencies fall within the desired channel of reception.	$nf_I \pm mf_2 = f_o$	7

In the above formulas: f_1, f_2 = the transmitter frequencies which create interference.
f_o = Frequency to which the receiver is tuned (i.e., the desired signal frequency).
m, n = Any integer (1, 2, etc.)
f_{IF} = Intermediate Frequency
f_{LO} = Local Oscillator Frequency

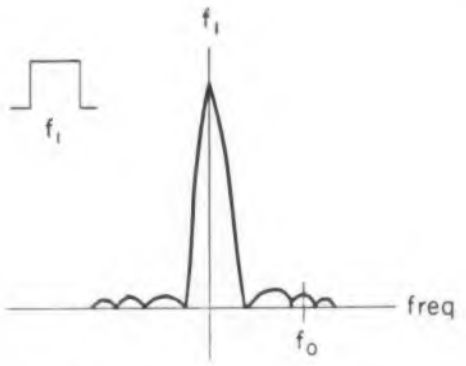

Fig. 1. Adjacent-channel interference.

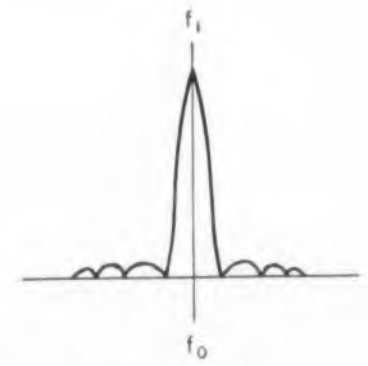

Fig. 2. Co-channel interference.

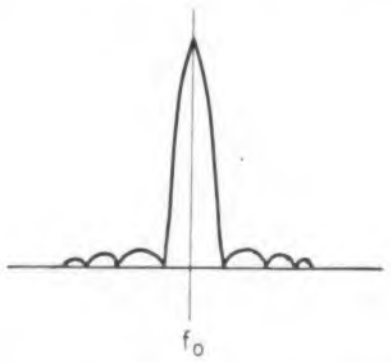

Fig. 3. Cross-modulation interference.

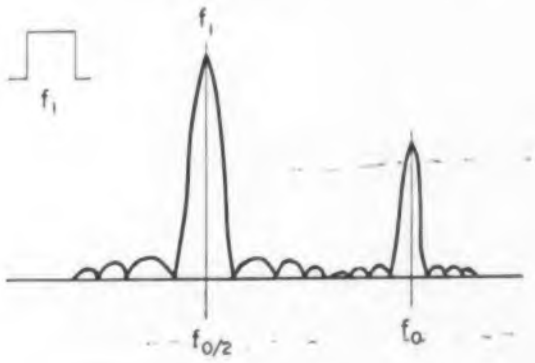

Fig. 4. Harmonic interference.

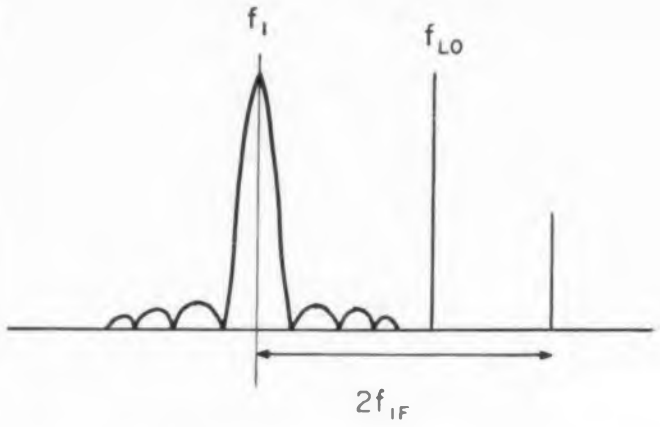

Fig. 5. Image-frequency interference.

Fig. 6. Intermediate-frequency interference.

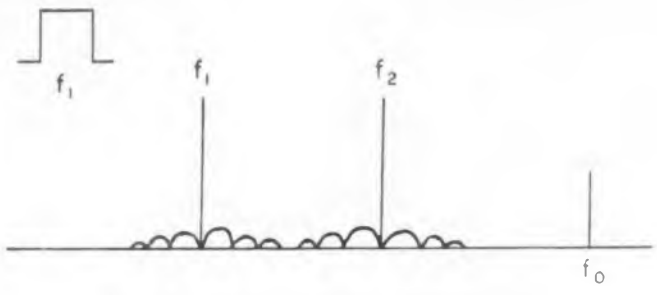

Fig. 7. Intermodulation interference.

and connections in a coaxial transmission system must also be mechanically tight. The shielding braid should completely enclose the fittings.

Other Transmission Paths

Mechanical shafts and tuning screws. Another type of interference transmission path occurs through components which are nonconducting to lower-frequency energy, but which become good transmission paths for microwave energy. Examples are mechanical shafts or tuning screws for varying or adjusting components, such as the shaft for adjusting a flap attenuator, or the micrometer-drive screw which tunes a wavemeter.

Any metal shaft which passes through a hole into a region of high field intensity acts as a coaxial transmission cable for microwave frequencies, and transmits energy over a broad frequency range. The use of a dielectric shaft made of nylon or Micalex is one solution to the problem.

Holes and openings. At microwave frequencies, round holes or rectangular openings behave as waveguide transmission lines. Therefore, it is necessary to extend such openings into the shape of a tube, and dimension the apertures so that the tube acts as a waveguide-beyond-cutoff attenuator. Formulas for determining correct aperture dimensions are given later in the section on high-pass filters.

Power leads. Leads furnishing power to an oscillator, or passing close to other sources of interference, may provide transmission paths for the signal.

Suppression Techniques

One of the major suppression techniques at lower frequencies is the use of bonding straps to connect one point with another so that they are at the same potential. This technique eliminates the possibility of currents or spark discharges from one point to another. At microwave frequencies, however, bonding is useless as a suppression measure because a bonding strap has a high impedance at these frequencies, and cannot serve the purpose. Furthermore, the length of the bonding strap may be of the same order as the wavelengths involved, with the result that undesirable resonances may occur.

Thus, in place of bonding, other suppression measures must be employed. Shielding and filtering are the two major methods—shielding to prevent radiated interference from entering and leaving, and filtering to contain conducted interference.

Shielding. The effectiveness of a shielding material at microwave frequencies is related to the thickness of the material, its resistivity and permeability. The shield must be thick enough to attenuate energy to a point below the residual nose level. The surface finish must provide good conducting paths at microwave frequencies, and must continue to do so under all environmental conditions to be encountered. Silver-plated or iridited aluminum surfaces are satisfactory in these respects.

Particular care must be taken to ensure that a shielding enclosure is not self-resonant for, if so, it will act as a radiator rather than as a shi ld

Such a phenomenon is much more likely to occur at these frequencies because the wavelengths involved may be of the same order of magnitude as the dimensions.

Low-pass filters. It should be noted first that by-pass capacitors, such as the button type which are commonly employed in interference filters, are ineffective at microwave frequencies.

One approach in microwave filter design is the use of low-pass filters to pass dc and line frequencies but attenuate microwave energy. Relatively cheap and simple low-pass filters can be made of microwave lossy materials, such as slugs of polyiron. As shown in Fig. 1, leads going to the base of a klystron tube may be passed through molded sections of polyiron to prevent microwave signals from being conveyed by the power leads.

High-pass filters. In order to prevent holes and openings from radiating energy, these are converted into high-pass filters by correct dimensioning of the apertures. The formulas for selecting the proper dimensions so as to give a tube attenuation that is independent of frequency, are given below. (It was assumed in deriving these formulas that operation is at ten times the cutoff frequency.)

Round Holes: $d = \frac{10(6.92)}{f}$

Rectangular Openings: $b = \frac{10(5.90)}{f}$

where:
d = hole diameter
b = largest dimension of rectangular opening
f = highest operating frequency in kmc

The formula for round holes gives an attenuation of approximately 32 db per diameter length of the tube. The formula for rectangular openings gives an attenuation of approximately 27.3 db per diameter length of the tube.

Control in the Susceptible Instrument

In addition to the suppression techniques described above, special circuits can be incorporated into susceptible instruments to reduce unwanted interference signals. Limiters, wave-traps, phase-cancelling and blanking circuits are examples.

In receivers, the bandwidth necessary for reception of desired intelligence should be kept to an absolute minimum to avoid the reception of spurious responses outside the minimum bandwidth. The number of leads entering or leaving a unit should be as few as possible. Switching should be done internally under shielded conditions. The case assembly itself should be used as a means of shielding the interconnecting cables.

Avoid production delays by proper . . .

Rush Job Scheduling

H. Stern

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Why do some aircraft electronic equipment suppliers have trouble meeting their delivery commitments on rush jobs? This question is asked in the purchasing department of every aircraft manufacturer throughout the country. The answer is simple: poor planning. Here is a "Before and After" study of an average company's scheduling policy pointing up errors in planning and how they can be avoided.

FLIGHT TESTS on Flyright Aircraft Company's all-weather fighter-bomber show a need for an electronic thrust controller. Since the aircraft is in production, there is very little time for a thorough engineering review or for a development program. The Flyright engineering department prepares a procurement specification, which is submitted to the Purchasing Department for parts to be obtained for the earliest aircraft installation. Here is how a typical procurement situation often develops.

Buyer's Mistakes

Two conditions have been set into the program at this point: first, delivery will be a prime factor in the placement of this order; and, second, the Flyright Engineering specification has been prepared hastily and is, therefore, incomplete and partially erroneous.

Purchasing asks a number of vendors on their approved bidders list to submit engineering proposals, cost, and delivery information on the electronic thrust controller system. The requests for quotes are released through the government

bid control, and the closing date is established as one month hence.

Bidder's Mistakes

Now another factor enters the little drama—all equipment manufacturers will make an incomplete analysis of the problem and will misjudge costs, technical difficulty, and manufacturing build-up time to some extent.

Let us assume that the "Verywell Control Co." has an alert salesman calling on Flyright. He informs his company that no order will be considered if the delivery commitment exceeds six months from receipt of purchase order with a rapid build-up thereafter. Also, knowing the Flyright Engineering department, he requests a complete engineering proposal. He outlines certain preferences of the Flyright engineers as to the design.

Verywell's Sales department decides to go after this business with a high priority effort. They are undergoing a temporary business lull, and this program has a high production potential. The number one job is to prepare the proposal within one month.

A project engineer is assigned to the task of outlining the engineering approach. He is given two weeks maximum to do this job. On the second day of this two week period, he discovers certain basic conflicts within the specification, plus some omissions. The project engineer decides that, in order to clear up the discrepancies, he must talk with the Flyright Engineering department. If he is a properly trained project engineer, he goes back to his Sales department and asks that a meeting be set up between Verywell and Flyright Engineering.

Verywell Sales department contacts Flyright and discovers that four other companies have also requested meetings. So, the earliest Verywell can discuss this is five working days, or one week later. One valuable week has been lost waiting for an engineering get-together.

After the get-together, the project engineer has a better understanding of the basic problem and goes back to the preparation of the proposal. Since there are only two days remaining to work on the proposal, he requires more time and requests a schedule extension from Sales.

Too Hasty Preparation

Another week is granted in which time he puts together an engineering document which is loaded with doubts and uncertainties, but as a proposal, it looks appealing; and the project engineer assures everyone it has the proper systems approach. Once accepted by management, the proposal must be reviewed from a cost and delivery standpoint.

The project engineer and the factory manager then prepare a bar chart. It looks something like Fig. 1. It is based on a forty hour work week and upon the quickest time that each phase can be done.

Too Optimistic Planning

It has one basic ground rule to start with: the first unit had to be ready for delivery in six months. It is explained to the Sales department that six months will be sufficient time, provided everything goes as planned and no unknown discrepancies arise. It is further argued that, since the chart is based upon a forty hour week, there is some cushion for contingencies because the work week could be increased.

The cost analysis is based upon the hardware and manufacturing processes outlined in the proposal. It may be fixed price or fixed price with renegotiation and redetermination. The price is maintained at a reasonable level in order to be competitive. The Sales department is convinced their approach is both logical and ethical, because they can do as well for Flyright as any of their competition.

Unrealistic Delivery Date

Flyright receives proposals from seven manufacturers for the electronic thrust control system. The engineering documents are turned over to the Design department for evaluation. The manufacturers are investigated as to financial status and past history by the Purchasing department. The cost and delivery quotes are reviewed by Purchasing. When the Verywell quote is reviewed, the price appears competitive and the delivery within production requirements. There is, of course, no knowledge that the delivery commitment was rigged to Flyright's needs. Two other companies have arrived at a similar delivery commitment (by the same method). To Purchasing, the delivery commitment appears realistic, because three companies have submitted voluntary quotes for a six month delivery. The four other companies whose sales force was less alert, or whose factory was busier, are placed in a lower category in the Purchasing evaluation.

The design engineering evaluation is returned. Four proposals are listed as acceptable, including Verywell's, three are unacceptable. One of the three companies with a good delivery commitment is eliminated by Engineering. That reduces the choice of two. Verywell is chosen as the competition winner using price as the deciding factor.

Beginning of the End

The background for the tragedy is now established. No one, either in Verywell or in Flyright, is aware of the overall situation:

- the Verywell Sales department does not know that there is a technical problem;

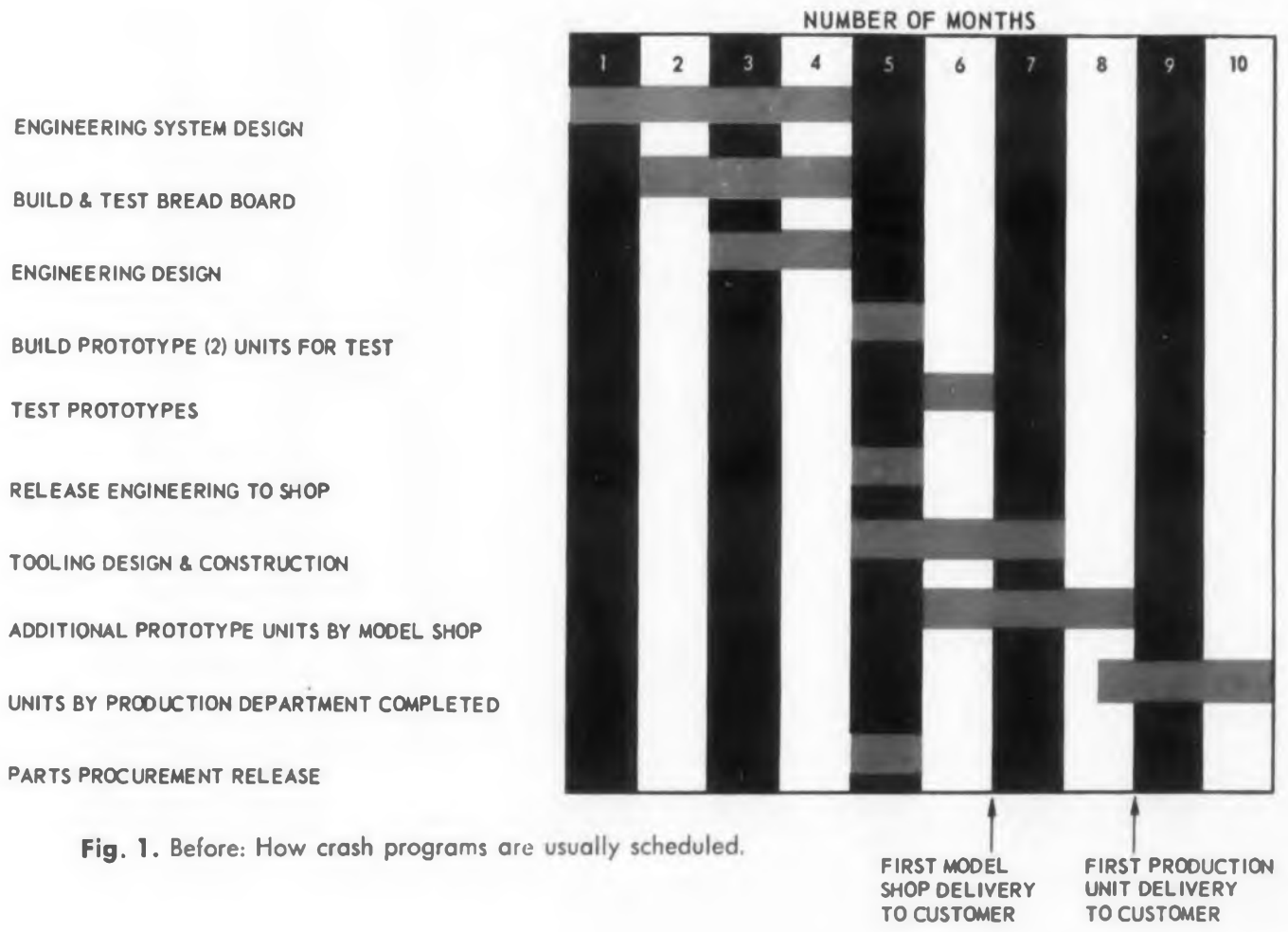


Fig. 1. Before: How crash programs are usually scheduled.

- the project engineer does not appreciate the schedule problem (although he is aware of the project budget);
- the Flyright Purchasing department is not aware that Verywell is starting out behind the eightball both in cost and delivery;
- the Flyright Engineering department does not believe that the few unanswered questions, or specification discrepancies, will create any problem in schedule delay.

Several other interesting factors are involved; although Flyright has awarded the contract using price as a final criteria, they would not for a moment have considered jeopardizing the schedule on the basis of price, and would, in fact have felt entirely willing to incur additional costs to guarantee timely delivery. Verywell knows that the price quoted is accurate only if everything proceeds satisfactorily, and that extreme measures to meet the schedule would involve large initial losses. They will therefore allow a schedule slippage rather than incur greater costs.

They'll Do It Every Time

Now let us add to these inconsistencies certain inevitable events:

- the initial engineering design will uncover unforeseen problems, so that the engineering design will fall behind schedule;
- the breadboard will fail in initial tests and will require some redesign;
- the prototype will fail under some environmental conditions (probably vibration) and will require some redesign;
- Flyright will make minor specification changes;
- vendors supplying parts to Verywell will miss their delivery commitments.

The preceding events are practically inevitable and will result in a delay of engineering releases. No one at Verywell will be concerned about the progress until the engineering release date is missed. At that time, it will be too late to recover anything by overtime, because the design deficiencies will not yield to mass tactics. The early time in the program, which is the truly valuable time, will be lost. Worse yet, engineering releases will be held until a fix is made and tested. The shop will not be able to tool up properly and, therefore, will be unable to build up their production until later in the program.

The engineering changes made by Flyright will be blamed for all the delays. This will result either in bad feelings between Flyright and Verywell Engineering; between Flyright Purchasing and Verywell Sales; or between Flyright Purchasing and Engineering, depending upon who believes whom.

The delays involved, in general, will not be small, nor will the production build up be anywhere close to that promised. Flyright will have a difficult time obtaining accurate information, but will be put off with promises for early delivery.

Who Gets Blamed?

In a soul searching examination made necessary by the appeal by Flyright top management to Verywell top management, the reasons for the delay will be set forth as:

- unexpected difficulties;
- state of the art development;
- Flyright Aircraft Co. changed the requirements;
- vendor difficulties.

Actually, the true reasons for the resultant mix up were:

- poor planning;
- improper communications;
- a misunderstanding of the basic problem;
- a lack of management guidance;
- an improper quote on the order.

True, this is an over-simplification. There are many side plots and variations to the theme in actual happenstance. But the elements of the confusion are usually pre-set.

It Should Be Done This Way

Verywell Sales calls in their top management to discuss the basic problem of delivery and to see if management is willing to expend the exceptional effort required to meet the rigorous schedule. If management says "go-ahead," the purchase order quote is prepared quoting the normal lead time required for such a job—say ten months—and the price for such a lead time. As an alternate, on a crash basis, it should be noted that a six months delivery can be achieved provided Flyright would be willing to pay a large extra sum for obsolescence, parallel engineering, overtime, extra shifts, etc. If Verywell gets the order under these circumstances, they will have the tools to do a job properly.

Remember that this is a production order, not a single prototype order, and that proper manufacturing build up is essential early in the program. The following basic ground rules are put into effect at Verywell:

- All parts are ordered as soon as parts list can be prepared. In case there are several choices for any one part—all are ordered.
- Manpower is built to a maximum as early in the program as possible. A drop off is scheduled for the month prior to delivery. This can be used as a cushion, if necessary.
- Design is released on schedule, whether correct complete or not.
- Tooling is started on schedule, even though changes are contemplated. Only a full scale effort will do.

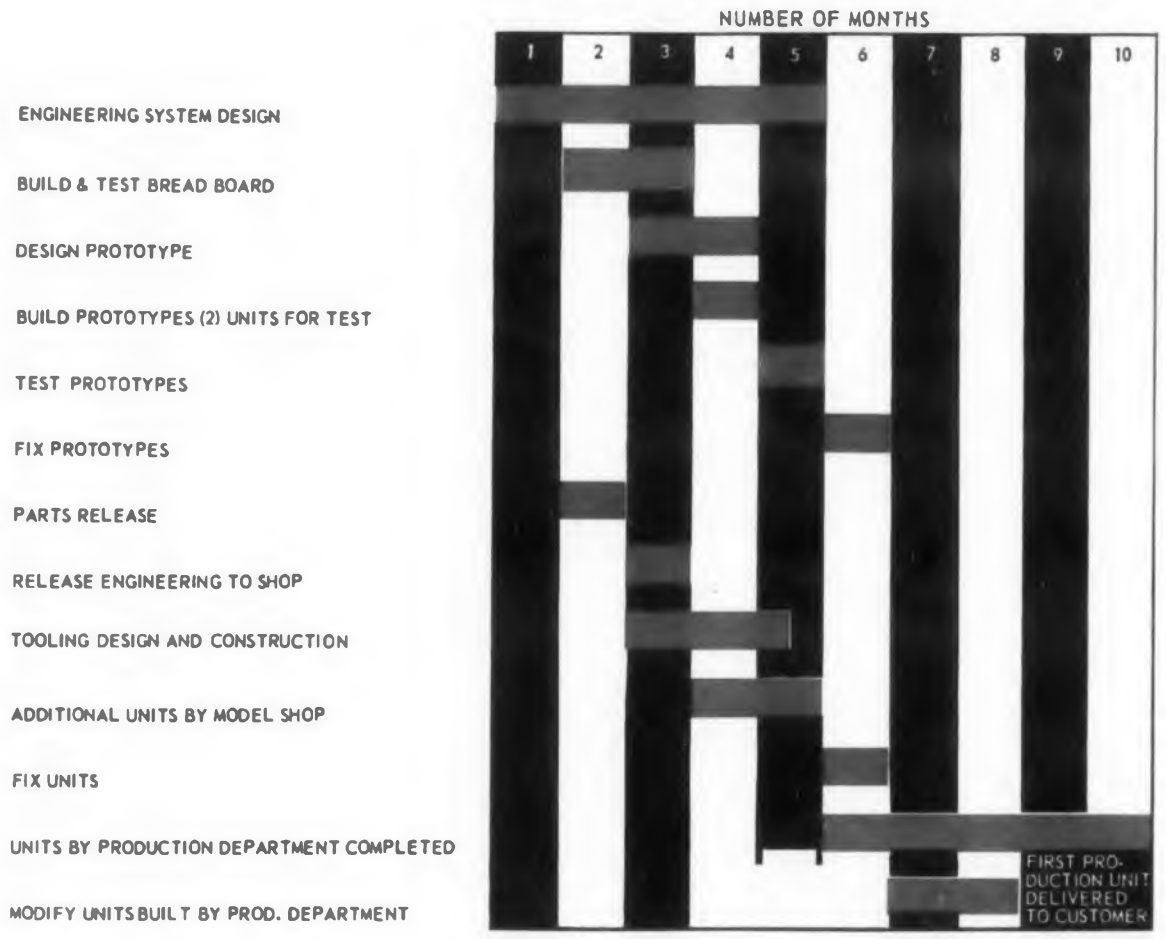


Fig. 2. After: How crash programs should be scheduled. Note the items advanced in the schedule as compared with the "Before" plan.

- At least a month is allowed for changes and corrections prior to delivery.
- Unless a major error is discovered, the shop proceeds with the released design on schedule and without changes. A month is allowed at the end of the shop schedule in order to change the unit, by modification, to an acceptable configuration.

Break Up Project

Management breaks up the task into different groups and makes each group's task independent upon the results of the previous group's work. For example, a prototype group builds a prototype, starting on time and ending on time, regardless of the progress of the breadboard. If the breadboard group does not supply information to the prototype group on time, the prototype group proceeds on the information which is available and make up their own, if necessary. This system creates both an inner and an outer pressure on every group.

Groups which fall behind struggle to catch up and to get their revisions into the modification program which occurs prior to delivery.

The schedule for this accelerated program is shown in Fig. 2.

Engineering changes requested by Flyright are incorporated into the modification program, and a specific but short time delay is incurred.

The programmed outline here makes use of certain logical considerations: first is to face the facts; second, to get the customer to agree to these facts with you; third, to start out with a program which has a good chance of succeeding; fourth, to hold your delays to the time necessary to fix discrepancies in the component itself, rather than to gear the delays to the time it takes to find and design corrections for the discrepancies.

This last point should be amplified. Suppose a breadboard shows an unsatisfactory drift characteristic and all production work is stopped until this is found and corrected. It may take two weeks to find and prove that one resistor value should be changed. Proper technique would be to continue all production while the investigation was proceeding and to take the completed units and change the affected resistor once the fix was found. This procedure is virtually self-evident, but it is surprising how seldom it is followed. It is usually avoided because the engineer fears that the fix may be major, and that considerable obsolescence will occur. In actual practice, such cases are a small proportion of the total. The "Engineering Hold" should be outlawed entirely or should require a top management signature. In general, the shop should not stop production on any design unless the new design has been defined.

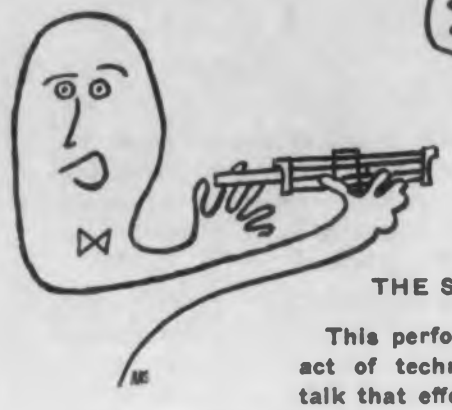
Some of the oddball engineering types who find themselves out in the world of commercialism include:

THE BORED TYPE

This engineer resents being taken from his work and doesn't care who knows it. "I'm a design engineer," he says, "not a systems man or a hardware peddler."

THE SUPERIOR TYPE

This man is condescending in his manner and talks down to prospective clients from the vantage point of his "superior" engineering knowledge.



THE SHOWMAN

This performer puts on an act of technological doubletalk that effectively prevents him from establishing communication with the people to whom he is talking.

THE BOGEY MAN

He seizes the opportunity to tell the client in agonizing detail about every engineering difficulty which has ever troubled him and frightens the customer into the arms of a competitor who can generate confidence in his ability to solve problems as well as recognize them.

Often engineers are called upon to help their company's sales effort. This gives an engineer the opportunity to add to his own job stature. But he must know how to effectively deal with customers. This article shows how.

Engineers Can Sell

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TO BE a success sales-wise, the engineer must accept the challenge involved in dealing with the customer. He must realize that a successful engineer is not necessarily a good salesman.

"I enjoy my work," the engineer says, "and like meeting and dealing with people. Even more important, I've a lot better chance to be in on management decisions and play an active part in shaping company plans. Also, I make more money than most fellows pushing a slide rule!"

He's right, of course; industry is willing to pay a premium to the man with engineering talent who can successfully communicate with customers and who can sell the services and products of his company.

Learn What The Customer Wants

Ninety per cent of selling is learning what the customer wants and then giving it to him. Finding out as much as possible about the customer's requirements and his reactions to different approaches to his problem before attempting to prepare a proposal is mandatory.

The preparation of a formal proposal is an expensive undertaking for a company, yet many sales representatives will prepare a costly proposal and then at the last moment reveal their brain-child to the customer like a magician whisking off a silk handkerchief to reveal the surprise. While dramatic, this technique leaves much to be desired. There are so many factors affecting the client's reaction to a proposal that it only makes good sense to find out beforehand if your ideas and concepts are acceptable.

Finding out how the client reacts is as simple as picking up the phone, calling him, and saying, "Tell me what you think of this idea . . ."

In some cases, it may be desirable to submit a preliminary, informal proposal as a way of clarifying questionable items before finalizing the proposal.

Make It Easy To Buy

A good salesman always tries to make it easy for his customer to buy. There are many ways of assisting the client. A single concept, system, or piece of equipment should be offered rather than a multiplicity of possibilities and options which must be resolved by the customer. The sales organization can help operating level people sell their own management by supplying arguments for acquisition of the equipment.

ABOUT THE AUTHOR:

Bill Bell's writing leans toward management-type articles. His first effort published in ELECTRONIC DESIGN (April 16, page 48) described the Uniterm System, a method of filing. Author of "A Management Guide To Electronic Computers," William Bell was co-founder of Telecomputing Corp. When we last visited Tucson, Arizona, the Chamber of Commerce was helping Bill find a new building in which to locate his firm, Mellonics.

For more complicated electronic gear, the problem of explicitly defining the hardware and the terms of its acquisition may represent a real problem for a purchasing department. In most companies, purchasing agents will be genuinely appreciative of anything you can do to furnish them with specifications written in contract language which they can readily incorporate into their own purchase orders.

Be Honest With The Customer

It is the engineer's job to have good answers to all the technical questions which are put to him by the client. If there are questions to which he does not have the answer, the only possible course of action is to say, "I don't know." An attempt to fool the customer, if found out, will destroy confidence in everything the engineer has said. Never underrate the customer's intelligence; maybe he is testing your probity with his questions.

Promises To The Customer

In a sales meeting, prospective customers will often request additional data, such as written explanations of certain technical details of the system, data on space and air-conditioning requirements, cost break-downs prepared in some different way, etc. If you tell the customer that he will be supplied with the requested data, always follow through. Make sure that he receives the information he wanted at the time it was promised. The reliability and integrity of a company are more important than a hardware concept. One way of demonstrating ability to perform is by promptly fulfilling all promises to the customer.

Emotional Selling

There are professional salesmen who believe that selling is done on an emotional basis and that a good salesman can sell anything to anyone. This is probably true for a pitchman, but questionable when marketing electronic systems that may sell for thousands, or even hundreds of thousands, of dollars. Such sales are not going to be made by an emotional appeal, but rather by demonstrating the worth of the equipment, the competence of the organization, and the ability to perform once a contract is let. No one within your company is better able to fulfill these vital sales functions than the competent engineer who masters the skill of dealing effectively with people.

One last thought: an engineer, any engineer, is really a salesman all of the time, if not outside his company, then certainly inside the organization. How else can the engineer put across his ideas, his concepts, his inventions? Sales experience is therefore invaluable to any engineer.

Magnetic field control resistance of . . .

Magnetoresisto

MAGNETORESISTORS are like rh Except magnetoresistors have no mo parts. Their resistance is a function of the m netic field passing through them.

Fast Response, Low Noise

No moving parts means low noise and fast sponse. Noise produced in the magnetoresi is about equal to the noise produced in co as electrons pass through it. Response time the unit is dependent on the relaxation time the majority carriers. Theoretical values for sponse time are 10^{-10} sec. Because of this cha teristic, the magnetoresistor is well suited feedback and control system applications wh fast response is essential.

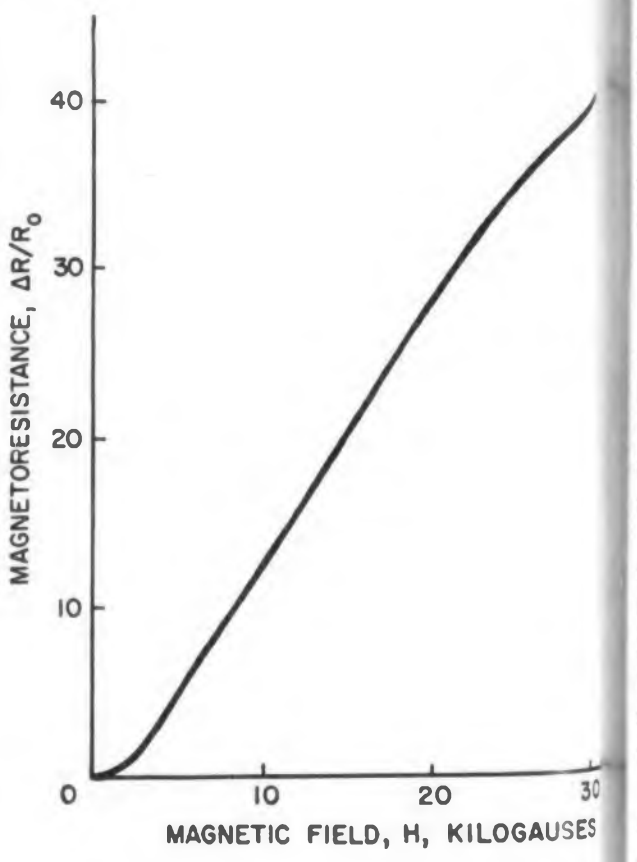

Fig. 1. Ratio of $\Delta R/R_o$ as a function of the magne field.

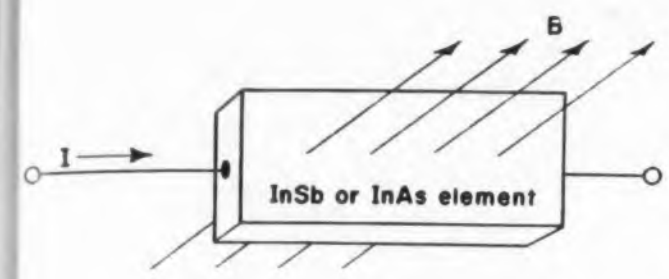

Fig 2. How magnetoresistor is positioned in a magnetic field.

The phenomenon of magneto-resistance is old hat. But its practical application is new. Highly purified and specially prepared high mobility intermetallic compounds are needed. In materials like indium antimonide (InSb) and indium arsenide (InAs) the magnetoresistive effect is great enough for practical applications.

Operation

In operation the magnetoresistor is located between the pole pieces of an electromagnet. One or more windings around the magnet are used to control the flux. The transverse magnetic field permeating the magnetoresistor deflects the charged carriers. It is this deflection which, in effect, varies the resistance of the unit. Resistance changes in the magnetoresistor are proportional to the square of the magnetic flux passing through it. More flux, more resistance, and vice versa. Resistance ratios of 40 to 1 have been achieved through flux variations. The ratio of $\Delta R/R_o$ as a function of the magnetic field is shown in Fig. 1. ΔR is the change in resistance as a result of flux, and R_o is resistance in a zero magnetic field.

Small In Size

Size-wise, the magnetoresistor element is small. It measures about 1/8 in. wide, 1/2 in. long and 5/1000 in. thick before being encapsulated. It will fit in an air gap of 25/1000 to 35/1000 in. In shape the magnetoresistor is flat and rectangular, as shown in Fig. 2.

Till now experimental models of the magnetoresistor—developed by Ohio Semiconductors, Inc., 1035 West Third Ave., Columbus 8, Ohio—have been distributed to some manufacturers. But now production lines are being set up to make the magnetoresistor commercially available.

Units having 0.01 to 50 ohms in a zero magnetic field are being designed. Power dissipations of up to 100 w are anticipated.

For more information on the magnetoresistor, turn to the Reader-Service card and circle 103.

How to determine gain for

Large Aperture Antennas

in the Fresnel Region

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Large aperture antenna gain can now be found graphically. No longer is there a need for the design engineer to work through the involved Fresnel region gain formulas. Three curves conveniently give the antenna's gain correction in the Fresnel Region. A practical design problem illustrates the use of these curves.

HERE ARE simple methods for determining the gain and power transfer for large aperture antennas. These methods have been tested in the field. The agreement between measured and computer power transfer was generally within 2 db with a few exceptions of 3 db differences. These procedures will be a big aid in attacking interference and personnel hazards due to electromagnetic radiation. Their biggest use, however, will be in properly designing a system before installation.

Large Aperture Antenna Fields

The field of a large aperture antenna is divided into the regions shown in Fig. 1. (See Ref. 1.) In the Fraunhofer region the antenna gain and pattern is a constant while in the Fresnel region the antenna gain and pattern is a function of Z, the distance from the aperture. Fresnel region gain formulas have been already derived for constant phase, rectangular aperture antennas. Actually, there is no sharp dividing line between the Fresnel and Fraunhofer regions. For large aperture antennas, it is safe to use Fraunhofer considerations when

$$Z = \frac{l^2}{\lambda}$$

where Z = distance from antenna
l = largest linear dimension of antenna
λ = wavelength
Z, l and λ are in the same units

If the Fraunhofer gain of the antenna is not known, it can be calculated from the antenna's physical dimension and illumination. (See Ref. 2.)

Fraunhofer Gain Calculations

A typical rectangular aperture antenna is shown in Fig. 2. The Fraunhofer gain can be calculated from:

$$G_o = \frac{4\pi A F_H F_V}{\lambda^2} K$$

where G_o = Fraunhofer gain (with respect to an isotrope)
A = Aperture physical area
λ = Wavelength (same linear units as A)
F_H = Correction factor depending on H direction illumination
F_V = Correction factor depending on V direction illumination
K = Efficiency

The factor, K, accounts for certain imperfections in any physical antenna which reduces the gain from predicted values. For most cases, K can be assumed to be about 0.75. However, this value of K becomes smaller as the physical aperture area is increased.

The correction factors, F_H and F_V, depending on illumination are found in Table 1.

Type of Illumination	Correction Factor F
Uniform	1.000
Cosine	0.810
Cosine Square	0.667

Fresnel Region Gain Correction

From Figs. 3 through 5 the gain correction can be obtained for antennas having uniform, cosine and cosine squared aperture illumination. The abscissa is the distance from the antenna in wavelengths and the ordinate is the gain reduction in db due to Fresnel region operation. Each graph has a family of curves corresponding to different aperture dimensions. The aperture dimension, L_λ, is in wavelengths.

The following example illustrates the use of these curves. Referring to Fig. 2,

$H = 7.5$ ft
$V = 3.75$ ft
Fraunhofer Gain = 24.5 db
Distribution in H plane is cosine

(Cont. on p. 32)

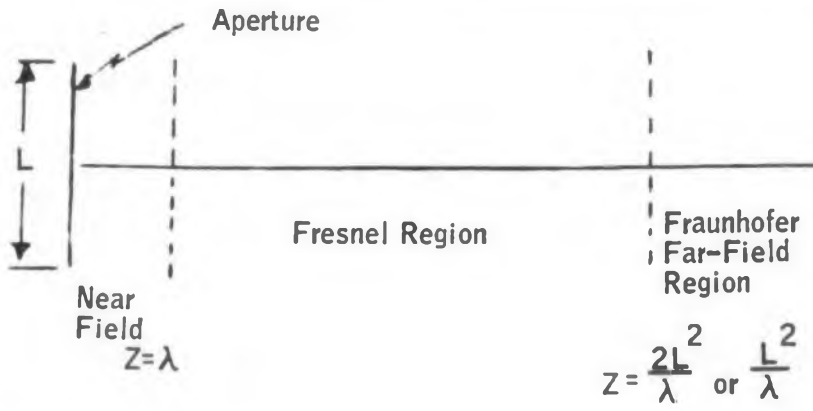

Fig. 1. Fields from large aperture antennas.

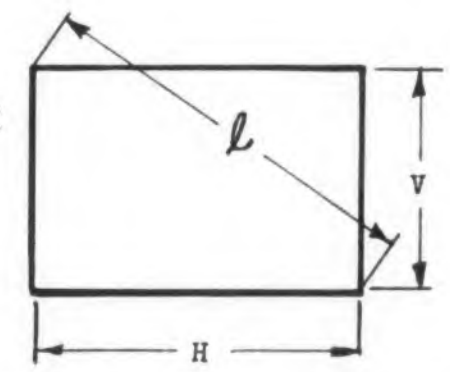

Fig. 2. Rectangular antenna aperture.

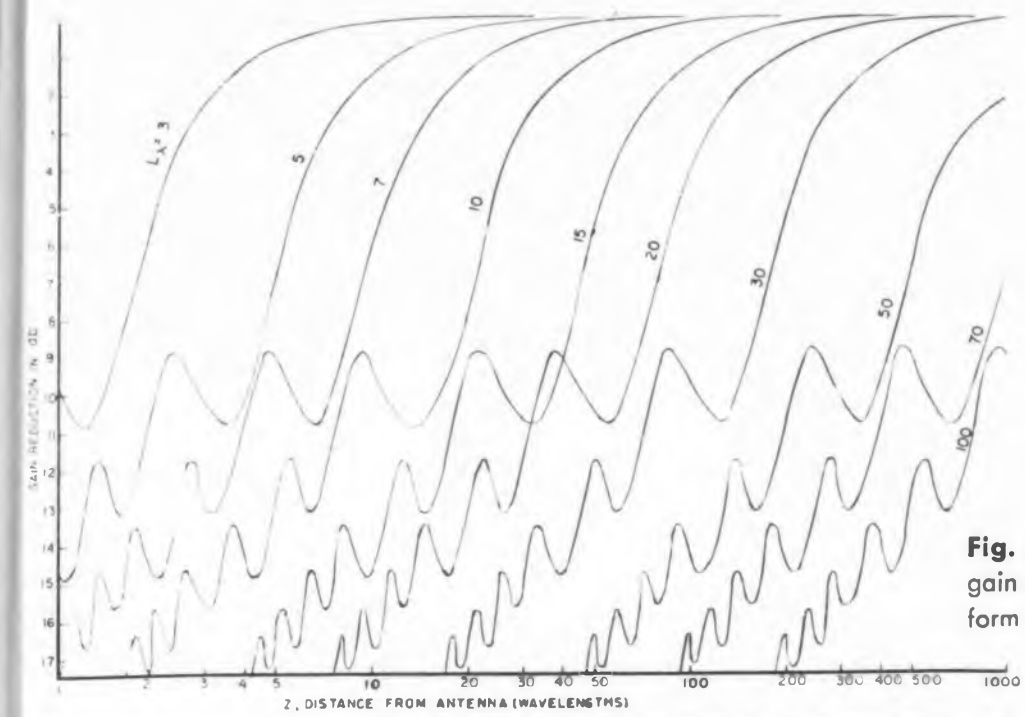

Fig. 3. Fresnel region gain correction for uniform illumination.

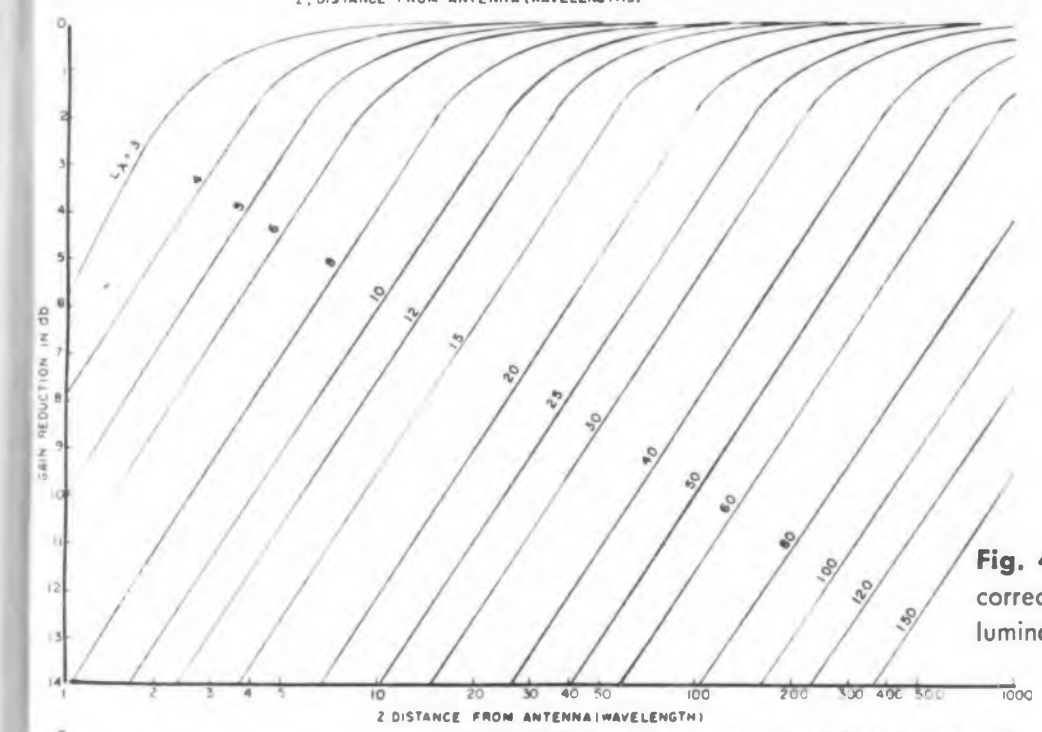

Fig. 4. Fresnel regain correction for cosine illumination.

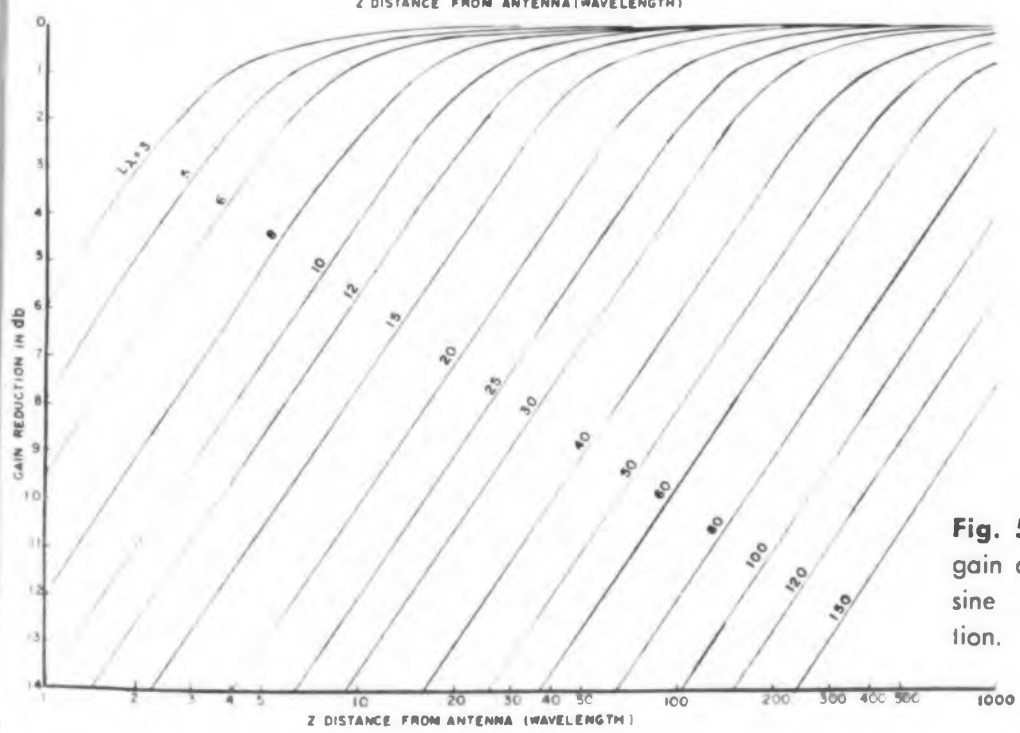

Fig. 5. Fresnel region gain correction for cosine square illumination.

Distribution in V plane is uniform
Frequency = 1310 mc

To find the gain of the antenna at distances of 7.5 ft and 75 ft, we proceed as follows:

$$\lambda = \frac{C}{f} = \frac{3 \times 10^{10}}{1310 \times 10^{6}} = 22.29 \text{ cm} = 0.75 \text{ ft}$$

where C, the velocity of light, $= 3 \times 10^{10} \frac{\text{cm}}{\text{sec}}$

$$H = \frac{7.5}{.75} = 10\lambda$$

$$V = \frac{3.75}{.75} = 5\lambda$$

$$7.5 \text{ ft} = 10\lambda, \quad 75 \text{ ft} = 100\lambda$$

From Fig. 4 on the $L_\lambda = 10$ curve the gain reduction is read as 6.1 db and 0.15 db at distances of 10 and 100 wavelengths respectively from the antenna. From Fig. 3 on the $L_\lambda = 5$ curve the gain reduction is read as 1.6 db and 0 db at a distance of 10 and 100 ft respectively from the antenna.

At a distance of 7.5 ft
$G = 24.5 - 6.1 - 1.6 = 16.8$ db
At a distance of 75 ft
$G = 24.5 - 0.15 - 0 = 24.35$ db

The gain in the Fresnel region is always lower than in the Fraunhofer region.

Estimating Aperture Illumination

Unfortunately, for many antennas the aperture illumination is unknown. Since the gain reduction in the Fresnel region depends on the illumination, it is necessary to estimate the illumination from other properties of the antenna. The following method uses the beam width at the half power points to determine the illumination. (See Ref. 3.)

Let

θ_H = full beam width at half power points in H direction in deg
θ_V = full beam width at half power points in V direction in deg

A constant R is defined as follows

$$R = \frac{\pi}{180} \frac{\theta_H H}{\lambda} \text{ or } \frac{\pi}{180} \frac{\theta_V V}{\lambda}$$

In Table 2 limits are given for R to use in estimating the illumination.

Limits of R	Estimated Illumination
$R \leqslant 0.88$	uniform
$0.88 < R \leqslant 1.2$	cosine
$1.2 < R \leqslant 1.45$	cosine square

Power Transfer Between Two Antennas

When Z, the distance between two antennas $\geq l_1^2/\lambda$, the power transfer is given by the Friis transmission formula (See Ref. 4),

$$\frac{P_R}{P_T} = \frac{G_{TO}\, G_{RO}\, \lambda^2}{16\, \pi^2\, Z^2}$$

where G_{TO} = Fraunhofer gain of transmitter
G_{RO} = Fraunhofer gain of receiver
Z = Distance apart
l_1 = Largest linear dimension of larger antenna
l_2 = Largest linear dimension of smaller antenna

By making a slight modification, the Friis transmission formula can be extended to include the Fresnel region.

$$\frac{P_R}{P_T} = \frac{G_L\, G_S\, \lambda^2}{16\, \pi^2\, Z^2}$$

where G_L = gain of larger antenna at a distance Z
G_S = Fraunhofer gain of smaller antenna
Z = distance apart

In the Fraunhofer region $Z > l_1^2/\lambda$ where eq (1) is valid, it is equivalent to eq (2) and no change results. However, eq (2) is also correct when one antenna is operating in its Fresnel region. The restriction now becomes $Z > l_2^2/\lambda$. When both antennas are operating in the Fresnel region ($\lambda < Z < l_2^2/\lambda$) eq (5) can be used as an approximation to predict the order of magnitude of the power transfer.

Use of Curves

Curves have been given for obtaining Fresnel region gain variation. It must be remembered that these data can only be used in situations involving rectangular apertures of uniform, cosine and cosine square illumination. It is believed that at the present state of the art, a majority of the rectangular antennas will fall into one of these illuminations.

A method has been presented for determining a good approximation of Fresnel region power transfer. This method should only be used when the antennas are directed toward others.

References

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3. Microwave Antenna Theory and Design, S. Silver, M.I.T. Radiation Laboratory Series, Vol. 12, McGraw-Hill Book Co., Inc., New York, p. 187.
4. A Note on a Simple Transmission Formula, H. T. Friis, *Proceedings of the IRE*, Vol. 35, No. 5, May 1946.
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Subminiature Socket Wiring Made Easy

THE DIFFICULT problem of connecting wires to subminiature tube sockets and transistor sockets can be made easy with the subminiature wire wrapping tool shown in Fig. 1 and Fig. 2. Manufactured by Winkler Laboratories, 5225 N. 20th St., Phoenix, Ariz., the tool makes secure electrical and mechanical connections like those in Figs. 3 and 4.

The operation is extremely fast, very simple, and almost obvious. It takes but three simple steps.

1. The end of the wire to be wrapped is inserted in the off-center hole of the tool.

2. The center hole of the tool is placed over the socket terminal to provide mechanical alignment.

3. The tool is spun with the fingers, wrapping the wire around the terminal.

During the wrapping, the wire is drawn out of the off-center hold. The nib on the end of the tool wraps the end of the wire neatly against the terminal; it is shaped to prevent snagging at the start of the wrapping operation. As the wrapping progresses, the tool is allowed to push itself away from the terminal. After wrapping, the connections may be soldered easily.

The difficulty of connecting wires to subminiature sockets has undoubtedly influenced other alternatives such as using printed circuit techniques and wiring tubes and transistors directly into the circuit. There is neither strength nor room to wrap size 22 awg (0.025 in. diameter) wire around terminals which are approximately 0.017 in. thick by 0.035 in. wide and spaced 0.096 in. center to center. It might be better to wrap the terminal around the wire. The practice of mounting components directly to subminiature socket terminals is similarly impractical; half watt resistors have size 20 (0.032 in. diameter) leads. For good joints, here are the important considerations.

- The conductor must be consistent in size with the terminal and its spacing. This can be accomplished if 28 awg wire is used. Under no circumstances should wire larger than size 26 be used.
- Some acceptable means must be available to mechanically secure the wire to the terminal.

For more information about this time-saving tool, turn to the Reader-Service Card and Circle **101**.

Fig. 1. Using the subminiature wire wrapping tool to connect 28 awg wire to a transistor socket.

Fig. 2. The subminiature wire wrapping tool.

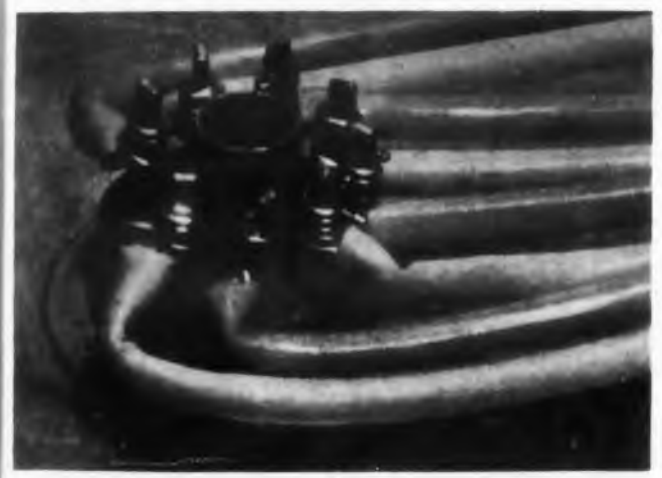

Fig. 3. Connections to subminiature button-base tube socket.

Fig. 4. Connections to subminiature flat-press tube socket.

High Power Transistor Switches

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The availability of germanium and silicon power transistors has stimulated interest in using these units as switches to handle moderately large amounts of power. This article analyzes the operation of the transistor switching circuit and develops a design procedure. The procedure developed includes the effect of high temperature operation and the thermal properties of the transistor.

GERMANIUM and silicon power transistors can be used as switches to handle sizeable amounts of power. Certain simplifying assumptions have to be made. It is assumed that the voltages and currents rise and fall linearly. This is true in practice except at the extremes where there are small departures from linearity as with any square wave or pulse. It is also assumed that there is no spiking or undershoots or overshoots when switching occurs.

The discussion to follow considers a circuit where the load is transformer coupled to the transistor. Modifications necessary for a purely resistive load will be made. All results are derived on a per transistor per cycle basis, and are directly applicable to a single ended or push pull operation.

Power Considerations

The power that can be handled by a transistor operating in the switching mode depends primarily on the maximum collector current, maximum collector voltage, ambient temperature and power dissipation capability of the transistor. Secondary limitations result from the decrease in current gain at higher emitter currents, and the thermal resistance from the transistor mounting base to the junction. The decrease in current gain requires higher driving power and results in higher total dissipation. This power is generally negligible compared to the collector circuit dissipation.

Internal thermal resistance between the collector junction and mounting base results in the junction being at a higher temperature than the ambient. In a well designed power transistor this thermal resistance is of the order of 2 C per watt of dissipation or less, and must be taken into account when computing maximum junction temperature.

Estimating Power Capabilities

The power capabilities of any transistor operating in the saturated switching mode can be esimated by the use of Eq. (1) which relates supply voltage V_{cc}, load resistance R_L and collector saturation resistance R_{cs}. The typical circuit for switching transistors is shown in Fig. 1, and the equivalent circuit for the "on" state is shown in Fig. 2. For these conditions

$$P'_o = V_{cc}^2 \frac{R_L}{(R_L+R_{cs})^2} = I_c^2 R_L \text{ watts/transistor} \quad (1)$$

$$P_o = \frac{t_{on}}{T} \frac{V_{cc}^2 R_L}{(R_L+R_{cs})^2} = \frac{t_{on}}{T} I_c^2 R_L \text{ watts/transistor} \quad (2)$$

Eq. (1) gives the total power supplied to the load R_L in the "on" state for one transistor. For square wave or pulse operation P_o must be multiplied by the duty cycle as in Eq. (2). When using push-pull, operation must be multiplied by 2. For high efficiency R_{cs} should be small and R_L should be large. The highest power is transferred to the load when $R_{cs} = R_L$.

Germanium power transistors, with values of R_{cs} of less than 1 ohm permit operation with efficiencies of the order of 95 per cent even at elevated temperatures when switching powers of

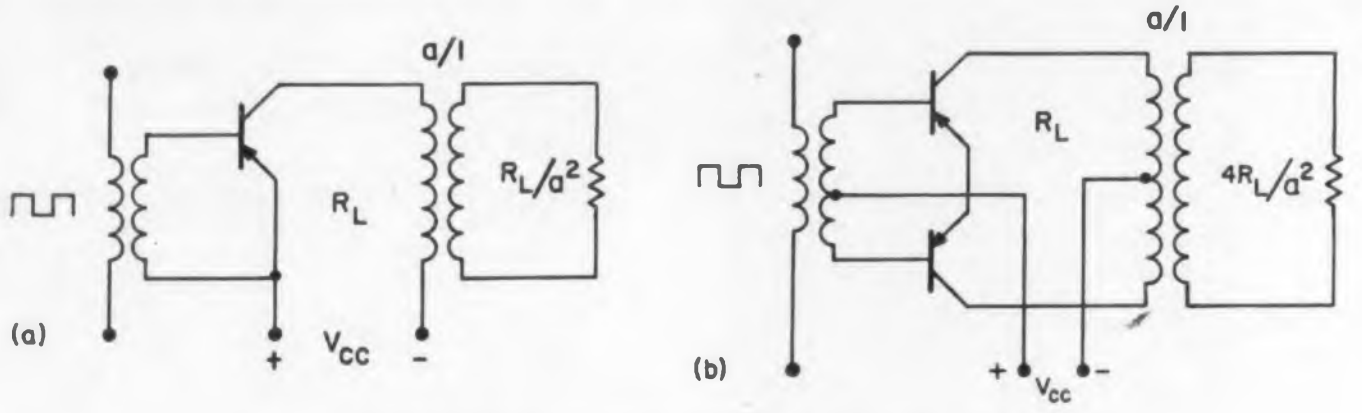


Fig. 1. Typical transistor switching circuits. *(a)* single ended, *(b)* push-pull.

Fig. 2. Equivalent circuit, "on" state of single ended or push-pull transistor switch.

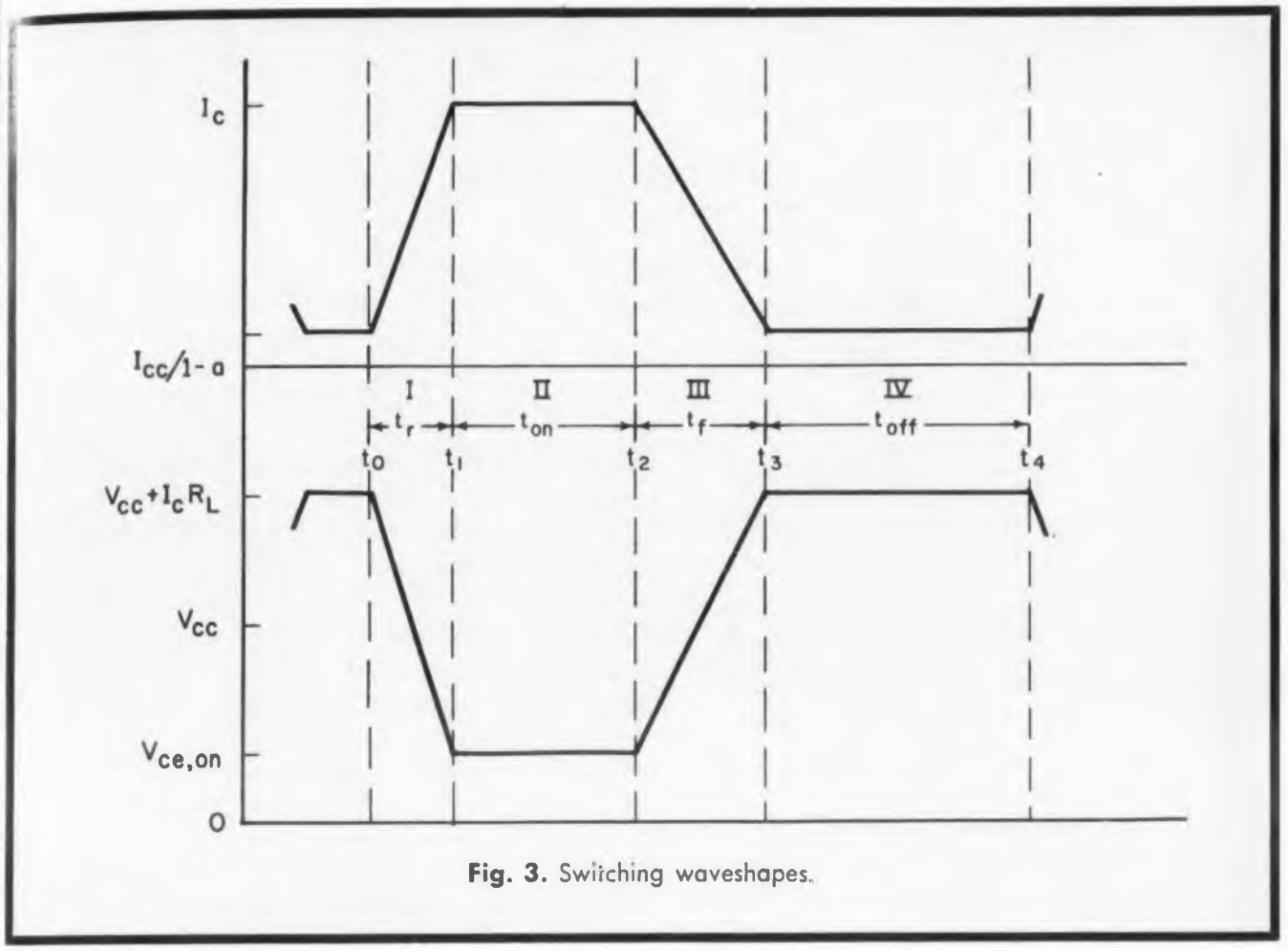


Fig. 3. Switching waveshapes.

the order of 100 w. Silicon power transistors, on the other hand, have values of R_{cs} of the order of 5 ohms, and operate with efficiencies of the order of 50 per cent or less when handling 100 w. Therefore, in many applications where only moderate ambient temperatures exist the use of germanium appears to be more satisfactory than the use of silicon.

Saturating vs. Nonsaturating Operation

The switching transistor may be operated either saturated or nonsaturated. Nonsaturated, or linear operation does have the advantage of control of output amplitude by control of input amplitude. However, the requirements on the input and output transformers are more stringent, and the efficiency and power handling capacity are decreased.

When using saturated operation, the transistor dissipation is a minimum, and parameter variations from transistor to transistor have negligible effects as long as they exceed a minimum value. Amplitude control can be obtained by controlling the collector supply voltage.

Switching Operation

A typical switch circuit is shown in Fig. 2. The instantaneous collector voltage and current waveshapes for one full cycle of operation are shown in Fig. 3. The full cycle waveshape can be broken into four intervals as follows:

Interval I, $t_1-t_0=t_r$ Transistor rise time (Turn on)

Interval II, $t_2-t_1=t_{on}$ Transistor "on"

Interval III, $t_3-t_2=t_f$ Transistor fall time (Turn off)

Interval IV, $t_4-t_3=t_{off}$ Transistor "off"

The total power dissipated in the transistor is the sum of the full cycle average power of each of the four intervals.

For each interval the full cycle average power is,

$$P_n=\frac{1}{T}\int_o^{t_n} v_c\, i_c\, dt \text{ watts/transistor} \qquad (3)$$

where t_n = interval length, microseconds

T = full period, microseconds

i_c = instantaneous collector current

v_c = instantaneous collector voltage

The solution of the power equation will be obtained separately for each interval, and then the results will be combined.

Interval I, Turn On. During this interval, the collector current rises linearly to I_c while the collector voltage falls linearly to V_{cc}, on. The collector current change is taken to be I_c in all cases, neglecting the minimum value of $I_{co}/1-\alpha$. This will lead to an error of less than 1 part in

1000 (fourth significant figure). The time required for the current and voltage changes is $t_r = t_1 - t_0$, the transistor rise time.

$$\therefore\ i_c = \frac{t}{t_r} I_c \tag{4}$$

and
$$v_c = V_{cm} - 2\, I_c\, R_L \frac{t}{t_r} \tag{5}$$

where t = time in microseconds

and $V_{cm} = V_{cc} + I_c\, R_L$

$$P_I = \frac{1}{T}\int_o^{t_r} \left(I_c \frac{t}{t_r}\right)\left(V_{cm} - 2\, I_c\, R_L \frac{t}{t_r}\right) dt \tag{6}$$

$$P_I = \frac{t_r}{T}\left(\frac{1}{2} I_c\, V_{cm} - \frac{2}{3} I_c^2\, R_L\right) \tag{7}$$

Interval II, On. The transistor is fully conducting and collector voltage and current are constant during this time.

$$\therefore\ P_{II} = \frac{t_{on}}{T} I_c\, V_{ce,\,on} \tag{8}$$

where $V_{ce,\,on} = V_{cc} - I_c\, R_L$

$= I_c\, R_{cs}$ (saturated)

In some applications, particularly those where high frequency switching is involved, it is desirable to include the effect or transistor storage time. This may be done by increasing the on time (interval II) by the storage time when computing P_{II}. When using push-pull operation, the pulse stretching effect of the storage time must be considered to prevent simultaneous conduction in both transistors.

Interval III, Turn Off. During this time, the collector current is falling from I_c to zero in the same manner as it rose during the turn on interval. Collector voltage is rising linearly toward V_{cm}. $I_{co}/1 - \alpha$ is neglected as in interval I.

Following the same procedure as for Interval I the power is,

$$P_{III} = \frac{t_f}{T}\left(\frac{1}{2} I_c\, V_{cm} - \frac{2}{3} I_c^2\, R_L\right) \tag{9}$$

Interval IV, Off. The transistor is now cut off, and the collector voltage has risen to V_{cm} due to the inductive rise across the input transformer primary. The only current flowing is $I_{co}/1 - \alpha$. The power dissipated is

$$P_{IV} = \frac{t_{off}}{T}\left(V_{cm} \frac{I_c}{1-\alpha}\right) \tag{10}$$

In the event that the switching circuit is to operate at elevated temperatures, the value of I_{co} which must be used is the value at the highest ambient temperature.

The complete expression for the total power dissipated per transistor can be written as

$$P_c = P_I + P_{II} + P_{III} + P_{IV} \tag{11}$$

$$P_c = \frac{t_r}{T}\left(\frac{1}{2} I_c\, V_{cm} - \frac{2}{3} I_c^2\, R_L\right) + \frac{t_{on}}{T}\left(I_c\, V_{ce,\,on}\right)$$

$$+ \frac{t_f}{T}\left(\frac{1}{2} I_c\, V_{cm} - \frac{2}{3} I_c^2\, R_L\right) \tag{12}$$

$$+ \frac{t_{off}}{T}\left(V_{cm} \frac{I_{co}}{1-\alpha}\right) \text{ watts/transistor}$$

When the load is noninductive in nature, the quantity to be used for V_{cm} is V_{cc}, collector supply voltage. When the load is inductive (transformer, relay coil, etc), V_{cm} is as defined in Eqs. (4) and (5).

Saturated collector operation using germanium transistors with inductive loading at elevated temperatures produces an interesting result when Eq. (11) is evaluated. The last term, the power dissipated during the off period, is many times larger than the sum of the other three terms, and is generally the controlling factor for high temperature operation. This is due to the exponential increase of I_{co} with temperature (approximately doubling every 11 C). This factor can be controlled by a reverse bias to decrease I_{co}.

Combining Eqs. (2) and (11) and simplifying,

$$P_c = I_c\, V_{cm}\left(\frac{t_r + t_f}{2T}\right) + \frac{t_{on}}{T} I_c\, V_{ce,\,on} \tag{13}$$

$$+ \frac{t_{off}}{T}\frac{I_{co}}{1-\alpha} V_{cm} - \frac{2}{3} P_o \frac{t_r + t_f}{T}$$

watts/transistor

Eq. (13) relates the power dissipated to the power output, and is used with Eq. (2) for design purposes.

Design Procedure

The design procedure which follows assumes that the required power output and the operating frequency, or frequency range is known. Also, it is necessary to have selected a suitable transistor. When operation is required over a range of frequencies, use the highest operating frequency when applying Eq. (13). This frequency will result in the highest dissipation, and the severest operating conditions.

Fig. 4 is a graphical representation of Eq. (1) and Fig. 2, and is used as follows:

1. The value of P_o/V_{cc}^2 is computed from the design criteria.
2. The intersection of the horizontal line representing the computed P_o/V_{cc}^2 and the saturation resistance curve of the transistor being used determines RL.

3. Compute I_c from

$$I_c = \frac{V_{cc}}{(R_{cs} + R_L)} \qquad 1 \quad (4)$$

Eq. (13) can now be evaluated from the above information and the manufacturers published data.

The temperature rise from mounting base to the transistor junction can now be obtained from:

$$T_r = P_c \times R_t \qquad (15)$$

where P_c = total transistor dissipation (watt)

and R_t = thermal resistance, mounting base to junction (degrees/watt)

The maximum mounting base temperature is

$$T_{max} = T_{jmax} - T_r \qquad (16)$$

where T_{jmax} = maximum junction operating temperature

When using Eqs. (15) and (16), either the Fahrenheit or centigrade temperature scales may be used, as long as one is consistent. In practice, it is advisable to have the maximum temperature (T_{max}) approximately 5 F (or 3 C) higher than the actual maximum temperature to be encountered. This allowance will generally take care of any increases in dissipation due to any spiking which may occur when switching.

Fig. 4. (below) Normalized power output. $R_{cs} = 0$ for germanium transistors.

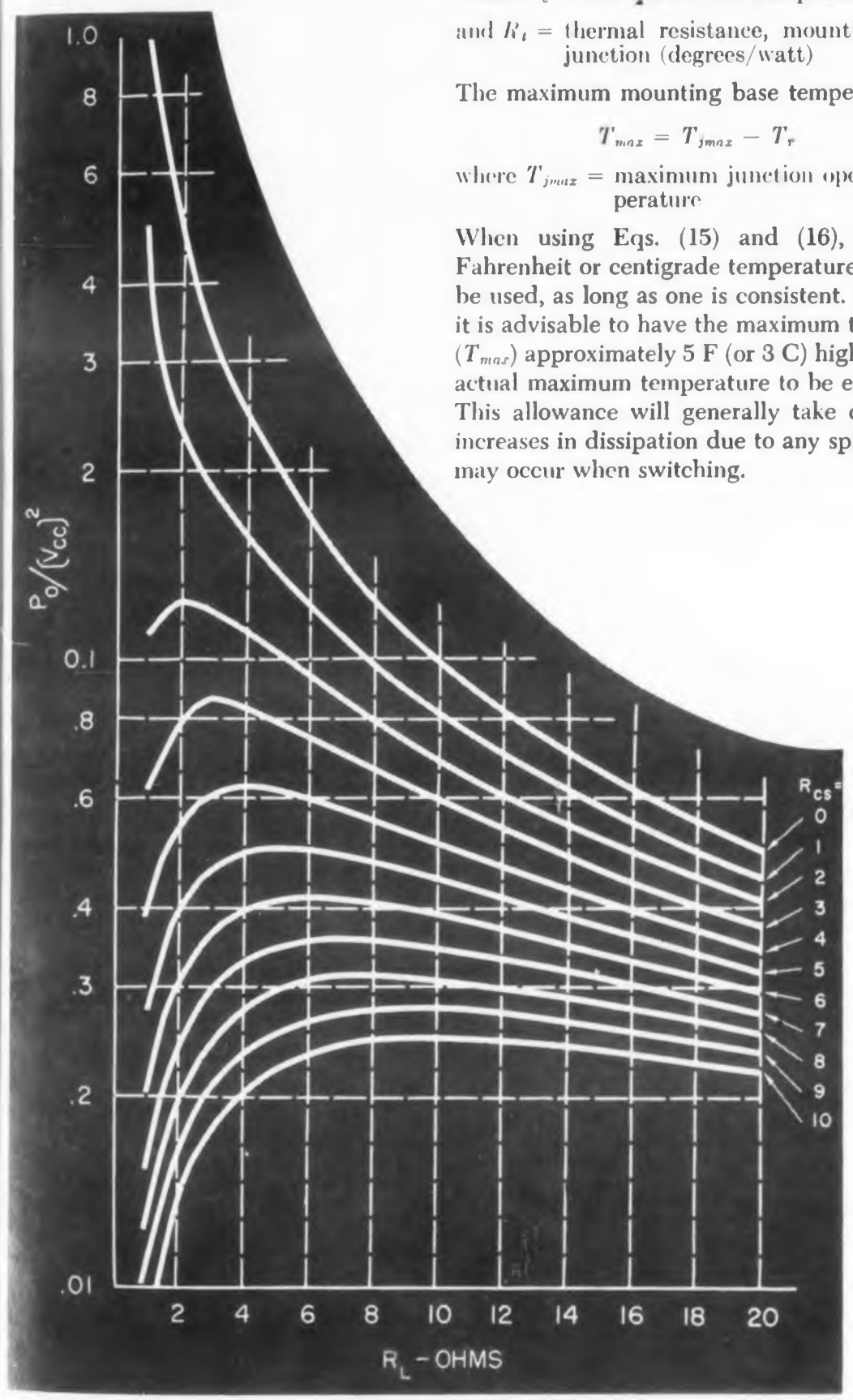


Fig. 1. A finished Vernitel unit.

Vernite

MAXIMUM error of ±3 per cent in existing FM/FM telemetering systems can be reduced to ±0.3 per cent. Vernitel does it. Vernitel is a single unit which can be added to FM/FM transmission systems with minimum alterations. Model 10057, shown in Fig. 1, is manufactured by Hoover Electronics Co., 110 West Timonium Rd., Timonium, Md.

Inside Vernitel

Inside the Vernitel unit is a quantizer and a differential amplifier. Information input voltage to the Vernitel may be derived from transducers. Or it may be provided by signal conditioners having an output of 0 to +5 v. The input may be commutated at standard IRIG rates. The Vernitel unit continuously separates an input voltage into 16 discrete levels and a vernier or residue voltage. This process is shown in Fig. 2. The sum of the quantized voltage, me_Q, and the vernier voltage, e_V, is equal (or directly proportional) to the input voltage e. This operation on the input voltage facilitates transmission of information with very little loss of accuracy even though the transmission medium (telemetered or magnetically recorded FM channels) is relatively inaccurate.

Output

Each of Vernitel's output voltages is used to control a standard FM, voltage controlled subcarrier oscillator. A block diagram of this operation is shown in Fig. 2. Each oscillator is provided with a 0 to +5 v signal for full modulation. By interpolation at the receiving station,

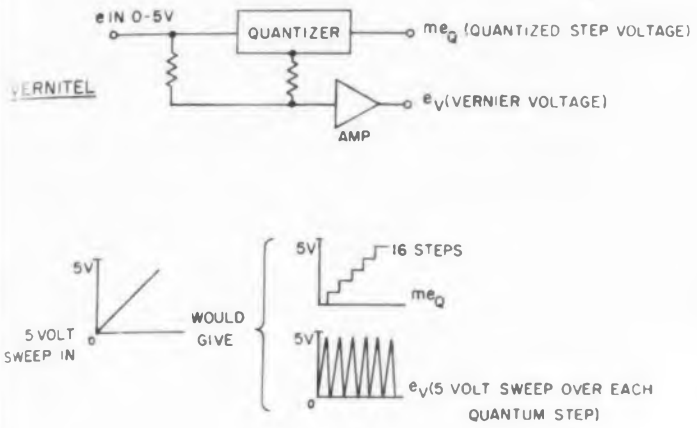


Fig. 2. Block diagram of Vernitel separating an input voltage, e into a quantized step voltage, me_Q, and a vernier voltage, e_V.

Improves telemetering systems

the output from the two standard discriminators may be added to provide a signal with an accuracy improved by a factor of approximately 10. Interpolation is required only for semi-automatic data processing equipment. If automatic processes are used, a quantum level detector must be added. When the telemetered information remains within one quantum level, the vernier voltage may be all that is required. In this case, the quantized signal would be used only as a reference for major deviations.

Specifications

Transistors and solid state diodes are used throughout the Vernitel unit. It is designed for rugged missile applications and meets equivalent military specifications. Operating temperature range is from −54 to +85 C. It can be used up to 70,000 ft and stand a shock of 25 g for 11 ms duration. Input impedance: 250 K. Output impedance: 5 K.

For more information on the Vernitel unit, turn to the Readers-Service card and circle number **147**.

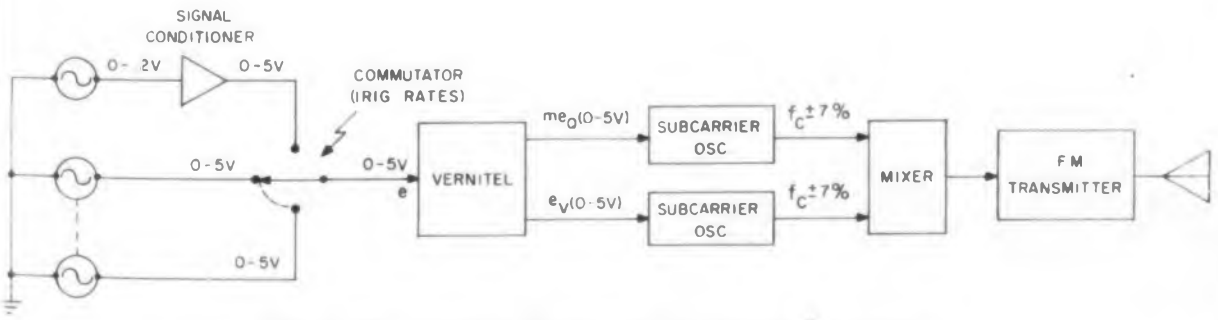


Fig. 3. How Vernitel fits into an FM transmission system.

MEETING REPORT

Astroelectronics Techniques Evolving Steadily

James A. Lippke
Managing Editor

Precision molded Supramica 555 ceramoplastic commutator plate with 3 contact rings and 3 slip rings.

SPACE-MINDED electronic engineers, over 900 of them, settled in comfortable chairs of the darkened auditorium of the Americana Hotel in Miami last month, partially listened to papers being read on the latest telemetering techniques, partially dreamed of conquering space. On the second day of the convention, September 23, the Executive Committee of the National Symposium on Telemetering voted to rename themselves, The Professional Group of Astroelectronics and Telemetering.

Although frustrated by lack of system planning direction coming from the Department of Defense and frequency spectrum problems, engineers exuded confidence and enthusiasm as they looked forward to finding out how to control space craft. Every telemetering man knows that the rocket and missile industry must first find out how test missiles behave in the outer universe. Only then can it be predicted exactly how to land on the moon or other distant geography. A telemetering engineer will furnish the answer. He must gather and analyze a thousand or so data points for every flight.

While some plotted and planned in a fairly ethereal atmosphere on how to get this information, many others forced themselves into the subtropic atmosphere of the hotel's un-airconditioned garage to inspect the latest equipment. Miami's weather except after 1 a.m. in the morning was sweltering, at least to the exponent 2, hot. Equipment kept operating despite being subjected to showers of perspiration from salesmen and interested buyers. New things could be seen in almost every booth. Some of them are tabulated at the end of this report.

Techniques Ahead of Planning

In many fields, the system planners are well ahead of the hardware builders. To put the Air Force's Global Communications System into operation new hardware will have to be built. In telemetering, to the contrary, the techniques are in advance of the system planners—in fact, there really are no overall system planners. Today's demands have forced users to buy what was available. This has prevented adoption of newer concepts when they come along. Once they have a big investment in fm-fm, or pwm equipment, they are reluctant to change the next scheme even though it has merit. Some companies such as Radiation Inc., have efficient pcm techniques worked out, but there is no "requirement" established for incorporating these advances because funds aren't available to buy better systems. Groups such as IRIG can recommend changes but they can't enforce them. In the words of Connie Hoeppner of Radiation Inc., "There is no central agency to set standards, define responsibility, or implement advances."

Adequate frequencies for telemetering plagues the telemetering engineer. Telemetering has 39 mc compared to 518 mc for TV. Telemetering can only exist on a non interference basis. There has not been great progress, though, towards using the higher frequencies in the 1300 mc range (*ED*, Aug 6, p 56). This reporter observed only one transmitter on display for operation in the 1500 mc region. See tabulation at the end of report.

New Needed Trends

Bandwidth is now often wasted because too much data is transmitted. This felony is then compounded in the data recording and analysis stage as useless information is processed. What is needed is predigestion of data in the air. Only essential data should be recorded or sent. Digital techniques are called for and transducers putting out digital signals would be ideal. Some companies that can afford the necessary research funds are pioneering in these areas without government support.

Back of the predigestion approach is a concept of the instrumentation engineer being able to get information only when it is important. The instrumentation engineer, according to Charles Doersam, Jr., PGTRC Chairman, should only observe when something of interest is happening. He should not look at everything. New concepts for querying the test spaceship are needed. A computer should ask different transducers to report their output. If behavior is normal, the computer will not send a signal back to earth. Too much transmitted information will jam the heavens.

L.E. Root of Lockheed, in a luncheon speech (*ED*, Oct 29, p 11), stated that satellite activtity may soon create a celestial junkyard. He advised engineers to equip satellites with cut-off switches so transmitters would not be stopped when useful transmission was over.

Papers of Interest

Indicative of the state of the art of astroelectronics are the titles of papers held at the classified (confidential) meetings. A few presented are:

Extrapolation of Atlas Instrumentation Techniques to Future Space Vehicles.

Multiplexing Techniques for Satellites.
Lunar Probe Telemeter System Developed.
The Problem of Communication During Reentry Flight.
Guidance of Satellites and Lunar Vehicles.
Radio Supervised Inertial Guidance of Very Long Ballistic Missiles and Satellite Research Vehicles.
Two-Way Doppler and Command Link For Space Flight.

Sampling of Latest Equipment

Solid state commutation switches, small transistorized fm-fm subcarrier oscillators, and calibration equipment were in abundance. Unusual interest was shown in a precision fm-fm transmitter. Vernitel, which equals pcm in accuracy. Many companies are engaged in methods of overcoming difficulty in calibrating and checking out instrumentation system. Here's a run down of some new techniques displayed by exhibitors and described in papers:

Frequency Calibrator. Greatly simplifies calibration of oscillators and discriminators in fm-fm systems. Generates its own crystal-standard frequencies. Novel circuit permits direct comparison of two frequencies. New models are 520 and 521A. Fenske, Fedrick and Miller Inc., 12820 Panama Street, Los Angeles 66, Calif. For more information, circle **104.**

Timing Signal Amplifier. Wide-band, transistorized, power amplifier for distribution service data transmission systems. Frequency response dc to 50 kc. Delivers 5 w to 150-ohm balanced load. Made up of four modules: differential amplifier, two driver stages and an output amplifier. Model TSA-100. Nems-Clarke Company, 919 Jesup Blair Drive, Silver Spring, Md. For more information circle **105.**

High-speed Low-level Multiplexer. Takes 24,000 samples per sec. Will take ±10 mv to ±10 v input signals. 50 channels available. See *ED,* Oct. 29, p. 32, for more information. Radiation Inc., P.O. Box 37, Melbourne, Fla. For more information, circle **106.**

Electrographic Recording Equipment. Newly perfected, still in prototype stage. No moving parts except paper feed mechanism. In development is page printer with speed of 72 in. per sec. Will record at rate of 45,000 characters per sec. Electrostatic charge defining the character is put on paper. Powdered ink adheres to charge and is made permanent by heat and pressure. Burroughs Corp., Defense Contracts Organization, Detroit 32, Mich. Write for more information.

Precision FM-FM Transmitter. Comparable to accuracy of pulse-code-modulation. Has special quantizer which separates input voltage into coarse voltage of 16 discrete levels and a vernier.

Each voltage controls a standard fm subcarrier oscillator. See ELECTRONIC DESIGN p. 40 for more details on this development. Hoover Electronic Company, 110 West Timonium Road, Timonium, Md. For more information, circle **107.**

VHF Quartz-Line Controlled FM Transmitter. Model 121 is a stable, "true fm" telemetering transmitter. Its frequency is quartz-line controlled and it is tunable to any point between 215 and 245 mc. Deviation of ±125 kc are obtainable from a ±1.4 v, peak, signal at frequencies between 100 cps and 100 kc. The quartz-line is modulated by a silicon diode. Four subminiature tubes are used. Electromechanical Research, Inc., Sarasota, Fla. For more information, circle **108.**

1500 and 2200 MC Telemetry Transmitter. Offers ±0.005% frequency stability, true frequency modulation (operating from fm-fm, fm/pdm-fm, and pcm). Frequency range for type 21A1 is 1435-1535 mc. Model 19A1 operates in the 2150 to 2350 mc range. General Electronics, 8521 Second Ave., Silver Spring, Md. For more information, circle **109.**

PDM Commutation Switch. 180 contacts, 0.030 in. in diameter, molded in 2 1/2 in. disc made of glass-bonded synthetic mica. Construction gives longer life at 900 samples per sec. than printed wiring approach. Contact shape, plating and brush are designed to give long life and low noise. A paper describing the unit is in the Symposium Proceedings. Mycalex Electronics Corp., 125 Clifton Blvd., Clifton, N.J. For more information circle **110.**

PDM Multicoder. MH series includes all electronic commutator and solid state pam/pdm converter. Zero dc input is adjustable from 80 to 150 μsec. Full scale output is adjustable from 600 to 750 μsec. General Devices, Inc., Princeton, N.J. For more information circle **111.**

Pressure Transducer. Makes gas pressure measurements from 3.0 psi to 1 x 10-6 psi. Exceptional response speed below 0.1 psi. Uses Equibar differential sensing principle. Trans-Sonics, Inc., P.O. Box 328, Lexington 73, Mass.

Voltage Controlled Oscillator. Transistorized unit. Tuned L-C network modulated by silicon junction diode network. Adjustable so that any voltage between 4 and 6 v will produce full deviation. Data-Control Systems, Inc., 39 Rose Street, Danbury, Conn. For more information, circle **112.**

Miniature FM Transmitter. Crystal-stabilized, true frequency modulator. Covers 215 to 260 mc. A conventional plug-in crystal and accessible coil tuning adjustment determines frequency. Tele-Dynamics, 5000 Parkside Ave., Phila. 31, Pa. For more information, circle **113.**

Telemetry Measuring Equipment. Four new in-

uments: model 115, am-fm signal generator, 0 cps to 100 kc; model 116, pre-set am-fm nerator, 400 cps to 70 kc; model 258, fm telemetering signal analyzer; model 259, telemetering fm demodulator. Waltham Electronics Corp., 751 Main St., Waltham, Mass. For more information, circle **114.**

Telemetry Recorder. New 700 series for direct analog, fm, pwm recording on any channel. Different type widths. Model 714 offers 14 tracks on 1 in. tape. Low flutter, 0.25% peak to peak to 10,000 cps. Fast start, speed of 60 cps reached without exceeding flutter spec, in 30 msec. Midwestern Instruments, P.O. Box 7186, Tulsa, Okla. For more information, circle **115.**

Miniature Radial Commutator. Motor mounted inside commutator structure. Height, 3-1/2 in.; width, 3-3/16 in.; length, 3-3/4 in. Rotor speed up to 30 rps for 30 channels are possible with 4 poles. Paper describing device in Symposium Proceedings. Instrument Development Laboratories Inc., Attleboro, Mass. For more information, circle **116.**

Voltage Controlled Oscillator. Extremely compact transistorized units simple to adjust. Operates over −50 to +125 C range, stable over wide power supply variations. For more information, circle **317.** Vector Manufacturing Company, Inc., Keystone Road, Southampton, Pa.

Other recent telemetering developments on display at the convention have been previously covered in our new products department.

Commutators received special attention at the convention. A number of papers described different set ups and results. Some have been mentioned above. Others of interest to ELECTRONIC DESIGN readers included a paper by M. M. Kranzler of ASCOP on choosing an electronic or mechanical commutator; a description of the Martin Company's experience using General Magnetics' Inc. magnetic modulator; a commutator using two magnetic core ring counters described by J. B. Crank and M. E. North of Texas Instruments Inc. (ring counters are driven by a dc-to-ac switching current and actuate a multiposition diode switch for sequential sampling) and a description of a low-level magnetic commutator by D. C. Kalbfell, consultant to the Cubic Corp.

A telemetering system which uses no commutators was described by L. Katz of Hycon Eastern Inc. Hycon's system uses a voltage controlled crystal oscillator. Because of the development of good crystal filters and narrow band frequency discriminators, subcarrier oscillators can be operated at closely spaced adjacent frequencies—close enough to obviate the need for commutators. A 200 channel system using 200 subcarrier oscillators with a deviation of ±40 cps was described. SSB transmission is possible.

Fig. 1. Pawn size silicon controlled rectifier looks for opening.

Silicon Controlled Rectifier

acts like gas thyratron

SILICON controlled rectifiers will be rolling off production lines in commercial quantities before the end of this year. Up till now experimental models of the device have been the talk of the electronics industry.

Like The Thyratron . . .

Developed by the Semiconductor Products Department of General Electric, Syracuse, N.Y., the three terminal semiconductor, type ZJ-39A, unit is able to handle 16 amp at piv ratings ranging from 25 to 400 v. The control rectifier is similar to the gas thyratron. Both devices block current flow until triggered by a pulse on their control element. Once fired, current flow can be halted only by removal or reversal of anode voltage. There the similarity ceases.

But Different

Unlike the thyratron, the silicon controlled rectifier is activated by *current* flowing into its gate element. Advantages of this unit over the thyratron include: higher efficiency, longer life, faster firing and recovery times, and absence of a power consuming filament.

Design Factors

When using a silicon controlled rectifier, thought should be given to:

Voltage. Excess voltage in forward direction cannot harm unit, but reverse voltages can.

Cooling. Heat sinks should be used to keep the unit within its specified temperature range: —65 to +125 C.

Connections. Soldering is sufficient, but screw and nut can be used on cathode.

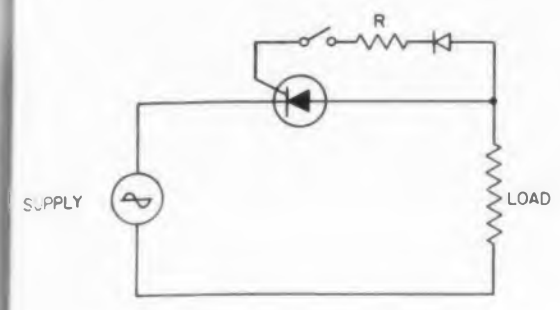


Fig. 2. Control rectifier in half-wave rectifier circuit.

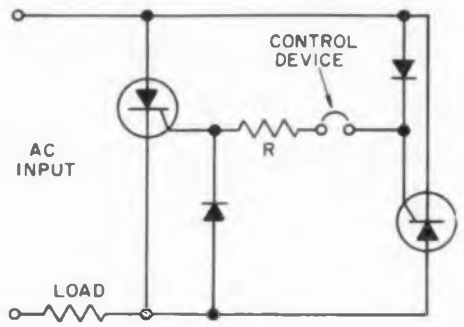


Fig. 3. Two control rectifiers in an ac static switch circuit.

Series Operation. Equalizing resistors are required, and shunt capacitors recommended for sharing high frequency transient voltages.

Parallel Operation. Forward conduction must be matched and cells selected for low firing anode voltages.

Switching Speed. Triggering can occur with gate current pulses as narrow as 0.3 μs. For resistive loads, switching time goes down as voltage goes up.

Typical Applications

There are many applications for the controlled rectifier. Here are a few basic ones.

Half-Wave Rectifier, Fig. 2: Simplest application of the silicon controlled rectifier is in a half-wave rectifier circuit with ac excitation. Gate current requirements are drawn from the main ac supply whenever the anode is positive with respect to the anode. This type of firing is limited primarily to full-on/full-off types of control. The diode in the gate circuit is provided to reduce gate circuit heating by eliminating reverse gate current during the negative half cycle.

AC Static Switch, Fig. 3: This circuit provides high speed switching of ac power loads. It is ideal for applications with a high duty cycle, such as welder controls, furnace heat controls or X-ray supplies. There is no contact sticking or bounce as when relays or contactors are used. Control of the device can be by light, heat, voltage, pressure or other actuating sources. Resistor *R* is provided to limit gate current. Its value depends on the magnitude of supply voltage and the current required for positive firing of the controlled rectifier. Because each unit essentially drops out every half cycle, there is no spread in current or voltage between pickup and dropout. Variations of this circuit can be used in connection with conventional dc rectifier power supplies to provide both switching and rectification with the same device.

Power Flip-Flop, Fig. 4: Variations of the dc switch transfer voltage from one load to the other each time a pulse is fed into the gate circuit. Optimized circuits of this type yield switching times in the order of 1 μsec. Charge on capacitor *C* acts to turn off the controlled rectifier which has been in conduction. Value of *C* depends on the dc voltage, load current, and energy stored in the circuit at the time of switching. For switching a 10 amp load operating from a 200 v dc source, 0.2 μfd is ample.

Depending on quantity ordered and voltage rating of units, prices for the controlled rectifier range from $30 to $195 per unit.

For more information on the silicon controlled rectifier, turn to the Reader-Service card and circle number **102.**

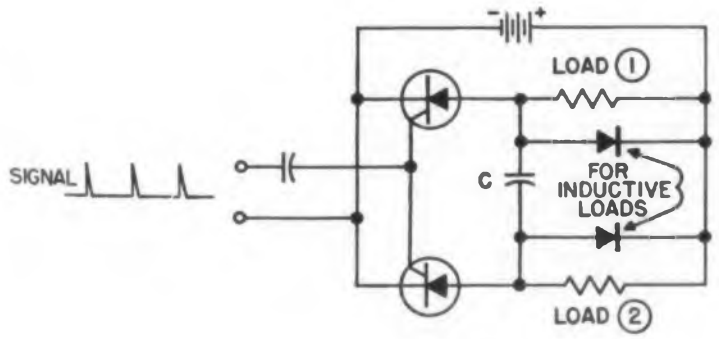


Fig. 4. Control rectifiers in a flip-flop circuit.

NEW PRODUCTS

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

METERS

There are meters for measuring volts, meters for measuring current, meters for measuring ohms, and meters for measuring just about every electrical quantity there is. Here are three new meters with some interesting characteristics.

Offering an accuracy of ±0.05%, this ac volt-ammeter is designed for the 20 to 20,000 cps range. The unit provides a current range of 50 ma to 50 amp, and a voltage range of 7.5 to 300 v. Ranges can be extended. Device operates on a thermal matching principle. An ac input is passed through a thermal converter to produce a signal. An internal dc source is adjusted to match the signal. Ac is then removed and a second dc source is passed through the converter to produce a signal equal to the first dc source. Adjustment of multipliers to produce null position on a galvanometer gives desired readings.

Charles Engelhard, Inc., Dept. ED, 850 Passaic Ave., East Newark, N.J.

CIRCLE 37 ON READER-SERVICE CARD

This voltmeter was designed to measure currents of less than 60 electrons per sec. Designated 300E, the unit has eleven scales. They cover 1 to 250 v full scale with ±2% accuracy of reading. Output terminals provide replica of input signal accurate to 0.02% for use with other instruments. Internal circuitry consists of a floating direct coupled amplifier.

American Transistor Products Co., Dept. ED, 1540 Cassil Place, Hollywood 28, Calif.

CIRCLE 38 ON READER-SERVICE CARD

This vacuum tube voltmeter displays on two separate meters the rms values of both in-phase and quadrature components of input signal voltage with respect to a given sine wave reference voltage of the frequency. Model VP 250-A is suited for obtaining indications free from errors induced by phase shift or spurious frequencies or harmonics. Frequency range: 20 to 2×10^4 cps. Accuracy of indication: ±2% on all ranges.

Solartron, Inc., Dept. ED, 530-532 Cooper St., Camden 2, N.J.

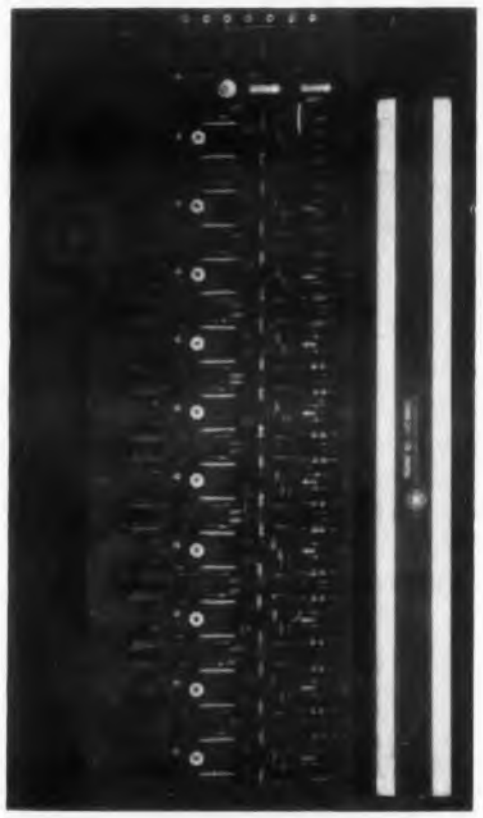
CIRCLE 39 ON READER-SERVICE CARD

PNP TRANSISTORS

Developed for 1 to 4 mc operation, these pnp transistors can withstand severe avionic environments. Units available in four alloy junction models: 2N1024, -25, -26, -27. Each unit has an input resistance of 35 ohms and is rated at 150 mw. Collector voltages are 15 or 35 v. Beta of four units ranges from 9 to 54; alpha cutoff frequency: 1 to 4 mc.

Sperry Rand Corp., Sperry Semiconductor Div., Dept. ED, South Norwalk, Conn.

CIRCLE 40 ON READER-SERVICE CARD



ELECTRONIC COMMUTATOR

This solid state commutator handles up to 1000 channels at rates up to 100,000 samples per sec. Unit can be used to commutate either ac or dc signals to a voltage-to-digital converter, or in output of a digital-to-voltage converter. Accuracy is a function of voltage amplitude. Commutation of full scale of ±1 v would have error of 0.07%; full scale of ±8 v would have error of 0.027%.

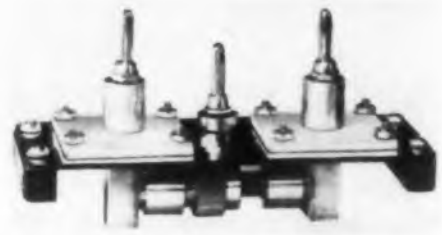
Packard-Bell Computer Corp., Dept. ED, 1905 S. Armacost Ave., Los Angeles 25, Calif.

CIRCLE 41 ON READER-SERVICE CARD

NEW PRODUCTS

Insulation Tester

Measures 5 x 10^{17} ohms per cm^3



Used with the company's megatrometer, this jig measures volumes resistivities up to 5 x 10^{17} ohms per cm^3. For testing plastic and other insulations, the unit is easy to use. It is 5 x 2.25 x 3 in.

Mid-Eastern Electronics, Inc., Dept. ED, 320 Commerce St., Springfield, N.J.

CIRCLE 508 ON READER-SERVICE CARD

Paper Tape Punch

Has foolproof verification

With the 10-key model 244 punch-verifier, paper computer tapes can be punched and verified in two operations. When there is an error, the keyboard locks up. The operator can then correct the mistake and go on.

Digital Service Labs, Dept. ED, 24202 Crenshaw Blvd., Torrance, Calif.

CIRCLE 509 ON READER-SERVICE CARD

Electronic Counter

Has four digital displays

The 1301 counter is designed for measurements in the 1 cps to 25 kc range. It has four digital display units. Internal 1 second gate and millisecond time mark generators are optional. The unit is 5-1/4 x 19 x 7 in.

Aerotronic Associates, Inc., Dept. ED, Concord, N.H.

CIRCLE 510 ON READER-SERVICE CARD

Pressure Switches

1 to 30 psia range

Series 58000 pressure switches have a 1 to 30 psia range. At 70 F, repeatable accuracy is within ±2% of the original setting. Ratings are 2.5 amp inductive, 5 amp resistive, at 28 v dc and 5 amp at 125 or 250 v ac.

Century Electronics & Instruments, Inc., Dept. ED, 1333 N. Utica, Tulsa 10, Okla.

CIRCLE 439 ON READER-SERVICE CARD

Phase Shifter

Has passive components

With no change in phase accuracy, series PG phase generators operate into loads from open circuit to zero ohms. This is done with passive components. The constant output voltage is phase variable through 360 deg.

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

CIRCLE 440 ON READER-SERVICE CARD

Miniature Beam Power Tubes

For vertical-deflection amplification

The miniature 6EM5 and 8EM5 are vertical-deflection amplifier tubes for 110 degree TV systems operating at ultor voltages to 20,000 v. These 9-pin, high perveance beam power tubes have a maximum peak positive-pulse plate voltage of 2200 v. Peak cathode current is 210 ma, and maximum plate dissipation is 10 w.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 441 ON READER-SERVICE CARD

CIRCLE 442 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Zener Diodes

0.25, 1, and 10 w units

Using diffused junction, these silicon zener voltage regulators have 0.25, 1, and 10 w ratings. In all sizes, zener voltage ranges are 5.6 to 200 v in 10% steps. Up to 56 v, ±5% tolerances are offered. Dynamic impedances are 1 to 1400 ohms, and test currents are 1 to 1000 ma.

Hoffman Electronics Corp., Semiconductor Div., Dept. ED, 930 Pitner Ave., Evanston, Ill.

CIRCLE 51 ON READER-SERVICE CARD

Servo Motor

Size 8 tachometer generator

Size 8, type 8MTG-6202 servo motor tachometer generators have a 1.15 gm cm² moment of inertia. On phase 1, excitation is 26 v; on phase 2, center tap control is 30.15 v. Stall input is 3 w per phase; stall torque, 0.3 oz-in.; no load speed, 6500 rpm; output, 0.25 v per 1000 rpm.

John Oster Mfg. Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 52 ON READER-SERVICE CARD

Low Voltage Power Supply

0.5 per cent ripple

Model KM87B aircraft battery substitute is a metallic, rectifier

pe power supply. It provides a epless, controllable output of 0 to 32 v dc at 20 amp. Ripple is 0.5% Regulation from 1/10 to full load is not over 12% at 32 v output.

Opad Electric Co., Dept. ED, 69 Murray St., New York 7, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

Time Delay Relays

Fixed or adjustable

Trans-O-Netic time delay relays have fixed or adjustable delays of 1.5 to 30 sec, accurate to ±10 per cent. For resistive loads, ratings are 0.5 amp, 50 v dc; 1 amp, 250 v ac; and 2 amp, 120 v ac. The transistorized spst units operate on 12 v dc.

Heinemann Electric Co., Dept. ED, 390 Plum St., Trenton 2, N.J.

CIRCLE 68 ON READER-SERVICE CARD

Frequency Standards

For missile environments

Type JK frequency standards operate without frequency dividers in missiles and aircraft. All transistorized, they incorporate dynamically balanced, electromechanical resonators. Accuracy is ±0.01%; frequency, 200 cps to 10 kc; output, sine or square wave, 3 v rms; and input, 24 to 30 v dc.

The Gyrex Corp., Dept. ED, 3003 Pennsylvania Ave., Santa Monica, Calif.

CIRCLE 69 ON READER-SERVICE CARD

CIRCLE 74 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Microwave Ferrite Switc

Minimum isolation of 25 db

Model SXL1 is a low power X-band ferrite switch that provides 25 db minimum isolation with 0.5 db maximum insertion loss. Several units in series produce multiples of this isolation. The switch is 1.7 in. long and weighs 15 oz.

Raytheon Mfg. Co., Special Microwave Device Group, Dept. ED, Waltham 54, Mass.

CIRCLE 81 ON READER-SERVICE CARD

Regulator Module

Two units in one

Combined in a single package is a voltage reference temperature compensated zener diode and an amplifying transistor. Unit provides a combined temperature coefficient as low as 0.002 per cent per degree C over a range of −55 to +100 C. Unit is engineered for chassis or printed circuit mounting in any position.

Transitron Electronic Corp., Dept. ED, Wakefield, Mass.

CIRCLE 82 ON READER-SERVICE CARD

DC Amplifiers

For data acquisition systems

Meant for data acquisition systems, these dc amplifiers have isolated differential inputs. Accu-

◀ CIRCLE 75 ON READER-SERVICE CARD

Data I has up to 100 cps frequency response and 100 K input impedance. Nonlinearity is 0.01%; and gain instability, drift, and noise are under 0.1%. AccuData II has most of the above features and is also fully transistorized.

Minneapolis-Honeywell Regulator Co., Boston Div., Dept. ED, 40 Life St., Boston 35, Mass.

CIRCLE 83 ON READER-SERVICE CARD

Wavemeters

1 to 8 kmc range

These wideband, coaxial, reaction wavemeters can be built into circuits or used as precision laboratory instruments. Insertion loss off resonance is under 1 db, at resonance, 2 db. Loaded Q is over 2000; vswr, below 1.5. Ranges are: 1 to 2 kmc for model RDW-5R; 2 to 4 kmc for RDW-6R; and 4 to 8 kmc for RDW-7R.

Radar Design Corp., Dept. ED, 3309 James St., Syracuse, N.Y.

CIRCLE 84 ON READER-SERVICE CARD

Pressure Transducers

Have 50 per cent overpressure

Series T pressure transducers have 50 per cent overpressure and per cent zero shift. Suited for aircraft and missiles, they come with ranges between 0 to 100 and to 5000 psig.

Rahm Instruments, Dept. ED, 5 Rushmore St., Westbury, N.Y.

CIRCLE 85 ON READER-SERVICE CARD

CIRCLE 86 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Connectors

For printed circuits

DEP printed circuit connectors are compatible with 0.1 x 0.1 grid system, automatic assembly, and dip-soldering processes. Plugs and receptacles may be board mounted. Contacts are gold over silver plate.

Armel Electronics, Inc., Dept. ED, 840 Fifth Ave., Brooklyn 32, N.Y.

CIRCLE 89 ON READER-SERVICE CARD

4 x 5 Film Holder

Converts cameras for 60 second pictures

With this film holder, Graphic and other 4 x 5 press-type cameras can be converted to take 60 second pictures. The holder has special film suitable for laboratory and record pictures.

Polaroid Corp., Dept. ED, Cambridge 39, Mass.

CIRCLE 90 ON READER-SERVICE CARD

Miniature Motors

Accuracy of one part in 20,000

Miniature motor MB-900 operates at 300 rpm with instantaneous speed of one part in 3600. In a 24 hour period, total error in revolutions is one part in 20,000. Input is about 900 μw; and the output shaft rotates at 2.4 rpm.

Park Products Co., Inc., Dept. ED, 4901 Perkins Ave., Cleveland 3, Ohio.

CIRCLE 91 ON READER-SERVICE CARD

◀ CIRCLE 87 ON READER-SERVICE CARD

Power Supplies

Encapsulated

In many voltage, current, wattage, and frequency combinations, these small, encapsulated power supplies meet MIL vibration and drop testing specifications.

Telectro Industries Corp., Dept. ED, 35-16 37th St., Long Island City 1, N.Y.

CIRCLE 156 ON READER-SERVICE CARD

Servo Motors

Bi-directional

Programmed by a tape, DM bi-directional digital motors can actuate many types of automatic equipment. They have a minimum of parts for repair, and are suited for missile flight control. Pulsing rates are 40 pulses per sec for model DMA, 30 for DMB. Temperature range is −65 to +165 F, and standard voltage is 28 v dc. The units stand 20 g vibration to 500 cps and 30 g shock for 11 msec.

Curtiss-Wright Corp., Electronics Div., Dept. ED, West Caldwell, N.J.

CIRCLE 157 ON READER-SERVICE CARD

Trimmer Potentiometers

For printed circuits

For printed circuits, these trimmer potentiometers are 3/4 x 3/4 x 5/16 in. Model 1W-O has an O ring seal and an inner coating to meet MIL-E-5272A humidity tests. It is fully adjustable. Model 1W-IR has a 1 to 25 ohm resistance range, infinite resolution, and low residual ends.

Handley Electronics, Inc., Dept. ED, 14758 Keswick St., Van Nuys, Calif.

CIRCLE 158 ON READER-SERVICE CARD

CIRCLE 550 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Zener Voltage Regulators

24 to 160 v range

Rated at 5 w, HZ silicon voltage regulators permit engineers to specify any zener voltage in the 24 to 160 v range. A replacement for conventional gas tube units, they operate from —65 to +165 C.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 44 ON READER-SERVIC ECARD

Miniature Transformers

For transistor application

These miniature transistor transformers are mu-metal shielded, epoxy impregnated, and hermetically sealed. The line includes 13 basic types of input, driver, output, and interstage units. In order, ranges for types A, B, C, and D are: 20 cps to 20 kc ±1 db; 50 cps to 10 kc ±2 db; 1 to 7.5 kc ±3 db; and 200 cps to 5 kc ±3 db.

Amplifier Corp. of America, Dept. ED, 398 Broadway, New York 13, N.Y.

CIRCLE 45 ON READER-SERVICE CARD

DC Power Supplies

5 to 50 v range

In a standard rack mount 19 in. wide, the M-1193 power supply provides 5 to 50 v dc at 50 amp.

◀ CIRCLE 507 ON READER-SERVICE CARD

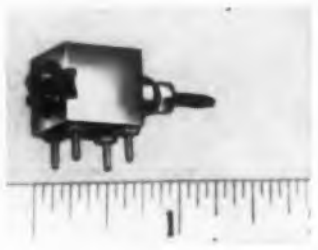
nput is 110, 220, or 440 v ac, 60 ps, single phase. Regulation is ±1% and maximum ripple is 5% rms. The unit has remote sensing.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 46 ON READER-SERVICE CARD

RF Coil

Horizontally mounted



Horizontally mounted, this rf shielded coil can be used with chassis or printed circuits. Suited for i-f strip work, it has a positive compression-type tuning core lock. Coil material is paper base phenolic in type 2560, Polypenco in 2561, and Kel-F in 2562.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 47 ON READER-SERVICE CARD

I-F Transformers

Up to 165 Q

On bases about 0.5 in. square, Weecoil i-f transformers include these types: single and double tuned, diode filter, 7-pin, and oscillator coil. Regular and unshielded units have up to 165 and 200 Q, respectively. Humidity and shock resistant, the line covers the 100 kc to 10.7 mc range.

Wells Electronics Co., Dept. ED, 1701 S. Main St., South Bend, Ind.

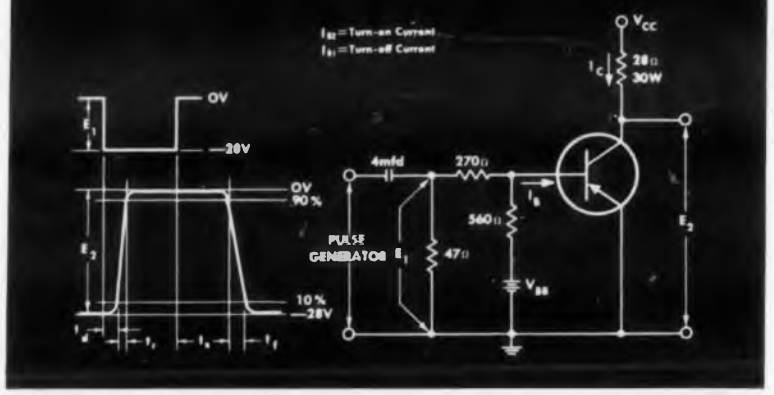
CIRCLE 48 ON READER-SERVICE CARD

CIRCLE 49 ON READER-SERVICE CARD ➤

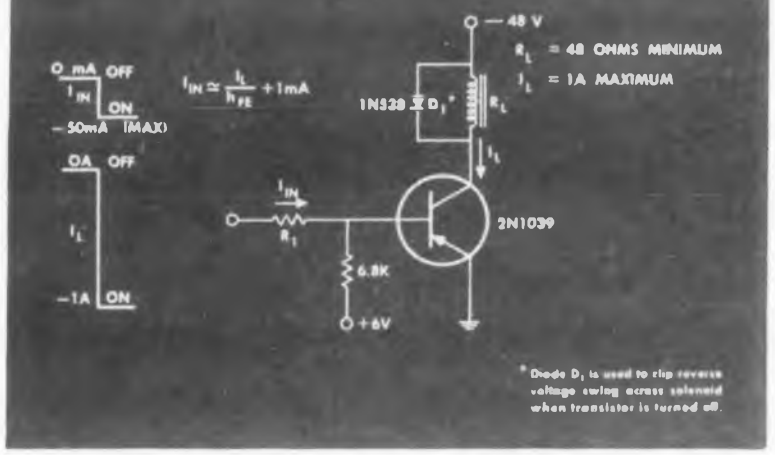
INDUSTRY'S BROADEST LINE OF

TYPICAL SWITCHING CIRCUIT AT 25°C

V_{CC} V	V_{BB} V	I_C A	I_{B1} mA	I_{B2} mA	t_d μsec	t_r μsec	t_s μsec	t_f μsec
−28	+28	−1	−50	+50	0.24	0.8	2.8	0.6



TYPICAL SOLENOID RELAY DRIVER



NEW POWER SWITCHING TRANSISTORS


(ACTUAL SIZE)

NEW P-N-P germanium power switching transistors *guarantee* 5.5 W dissipation at 25°C with voltage ratings of 40, 60, 80, and 100 volts for optimum design flexibility. The functional design of the heat sink assures rapid installation requiring only one mounting hole through the chassis.

You get *guaranteed* 20-to-60 beta spread and a low 0.16 ohm saturation resistance at the 3A maximum collector rating. In addition, a maximum 125 μA collector reverse current is *guaranteed* at one-half rated breakdown voltage with TI 2N1042, 2N1043, 2N1044, and 2N1045 alloy junction transistors.

These new devices are well suited for your switching circuits . . . relay drivers . . . audio and pulse amplifiers.

NEW MEDIUM POWER SWITCHING TRANSISTORS


(ACTUAL SIZE)

NEW P-N-P germanium medium power transistors give you switching times as low as 1.1 μsec. TI 2N1038, 2N1039, 2N1040, and 2N1041 alloy junction transistors provide 800 mW dissipation in free air at 25°C, 450 mW at 55°C . . . with voltage ratings of 40, 60, 80, and 100 volts.

In addition, *guaranteed* 20-to-60 beta spread and low 0.2 ohm saturation resistance assure reliable performance for your high speed switching circuits . . . relay drivers . . . low power audio and pulse amplifiers.

		Type	Dissipation at 25°C	Collector Voltage-V max	Collector Current A max	Beta min	Beta max	Collector Reverse Current I_{CO} max μA	Collector Reverse Current I_{CO} max V	Saturation Resistance Ohm
computer power	pnp	2N1046	15W	−80	−3	40	70 (Avg)	−1mA	−40	0.75
medium power		2N1038	800mW	−40	−1	20	60	−125	−20	0.2
	pnp	2N1039	800mW	−60	−1	20	60	−125	−30	0.2
		2N1040	800mW	−80	−1	20	60	−125	−40	0.2
		2N1041	800mW	−100	−1	20	60	−125	−50	0.2
power		2N456	50W	−40	−5	30 @5A avg.		−2mA	−40	0.048
	pnp	2N457	50W	−60	−5	30 @5A avg.		−2mA	−60	0.048
		2N458	50W	−80	−5	30 @5A avg.		−2mA	−80	0.048
		2N1021	50W	−100	−5	23 @5A avg.		−2mA	−100	0.08
		2N1022	50W	−120	−5	23 @5A avg.		−2mA	−120	0.08
		2N1042	5.5W	−40	−3	20	60	−125	−20	0.16
		2N1043	5.5W	−60	−3	20	60	−125	−30	0.16
		2N1044	5.5W	−80	−3	20	60	−125	−40	0.16
		2N1045	5.5W	−100	−3	20	60	−125	−50	0.16

IMMEDIATELY AVAILABLE IN PRODUCTION QUANTITIES OR . . .

TEXAS

WORLD'S LARGEST SEMICONDUCTOR PLANT

NEW PRODUCTS

Feedthrough Terminals

Have slotted lugs

Slotted-lug type FT-SM-65 feedthrough Teflon terminals have a heat-treated beryllium-copper insert that resists bending and breaking.

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

CIRCLE 481 ON READER-SERVICE CARD

Interval Timers

50 msec to 4 min delays

For measuring 50 msec to 4 min intervals, this transistorized time delay relay operates from an external power supply of 40 to 60 v dc at 0.05 ma maximum. Accuracy is ±4% over a supply variation of ±10 v dc. For any time cycle, repeatable accuracy is 1%. The unit is for spdt circuits up to 3 amp at 28 v dc or 115 v ac.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

CIRCLE 482 ON READER-SERVICE CARD

Tuning Fork Oscillator

Needs no dividers

Without dividers or multipliers the DFO-51 tuning fork oscillator provides any frequency from 400 cps to 10 kc. Frequency tolerance is ±0.005% from −55 to +125 C. Output is 5 v rms across a 10 K load. All transistorized, the unit is for missile and airborne use.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

CIRCLE 483 ON READER-SERVICE CARD

CIRCLE 480 ON READER-SERVICE CARD

NEW PRODUCTS

Relay Tester

Provides variable ac source

The Vari-Pac relay tester checks the accuracy and response of electrical protection devices. It also provides an infinitely variable ac voltage from 0 to 115 v. Continuous ac outputs are: 0 to 4 v at 100 amp; 0 to 8 v at 50 amp; 0 to 16 v at 25 amp; and 0 to 32 v at 12.5 amp. Input is 115 v, 60 cps, single phase. The integral ammeter and voltmeter are 2% accurate.

Sel-Rex Corp., Dept. ED, 75 River Rd., Nutley 10, N.J.

CIRCLE 484 ON READER-SERVICE CARD

Linear Accelerometer

Has low cross sensitivity

A seismic mass system, type TA2 accelerometer has low cross sensitivity and a 0.65 damping ratio. It operates from −40 to +100 C. Calibration is not affected by 10 million reversals.

Lind Corp., Dept. ED, Research Park, Princeton, N.J.

CIRCLE 485 ON READER-SERVICE CARD

Microwave Ferrite Isolator

For L-Band

Built of half-height waveguide, model 1LH2 microwave ferrite isolator is 6 in. high, 8-11/16 in. wide, and 17 in. long. Minimum isolation is 11 db; maximum insertion loss, 0.55 db. Average power capacity is 2.5 kw; peak power, 3 megawatts.

Raytheon Mfg. Co., Special Microwave Device Group, Dept. ED, Waltham 54, Mass.

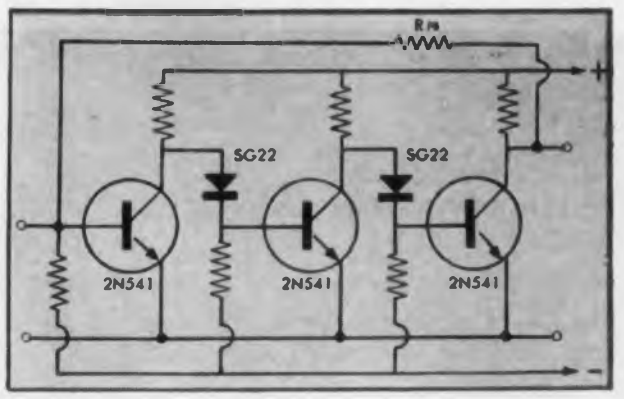
CIRCLE 486 ON READER-SERVICE CARD

HIGH BETA types... *current gain of 80 minimum.*

the highest level yet achieved in the industry. A useful end-of-life beta is maintained at temperatures down to −65°C, even at reduced collector current levels. The high gain of these transistors reduces the number of stages required in amplifier applications. A greater degree of degenerative feedback may be used to obtain much greater gain stability and uniformity, resulting in *reliable* amplifier operation.

TYPES	2N543	2N542	2N541	
Minimum Common Emitter Current Gain @ 1 Kc	80	80	80	—
Typical Common Emitter Current Gain @ 1 Mc	15	15	15	—
Maximum Collector Voltage	45	30	15	Volts
Maximum Collector Cutoff Current (25°C @ V_c Max.)	.5	.5	.5	μa

Complete data in bulletin TE-1353



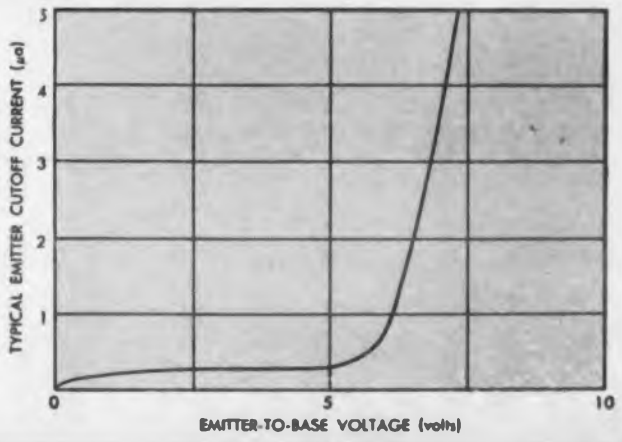
HIGH V_{EB}/SMALL SIGNAL types

... V_{EB} *of 5 Volts minimum*

eliminates the need for series diodes in many applications and protects against transients in pulse and digital circuitry. This improvement in emitter-to-base voltage is available in Transitron's entire line of small signal transistors, at no sacrifice of other characteristics.

TYPES	2N543A	2N480A	2N475A	
Maximum Emitter-to-Base Voltage	5	5	5	Volts
Maximum Collector Voltage	45	45	45	Volts
Minimum Common Emitter Current Gain	80	40	20	—
Maximum Collector Cutoff Current (@ V_c = 45 Volts)	.5	.5	.5	μa

Complete data in bulletin TE-1353



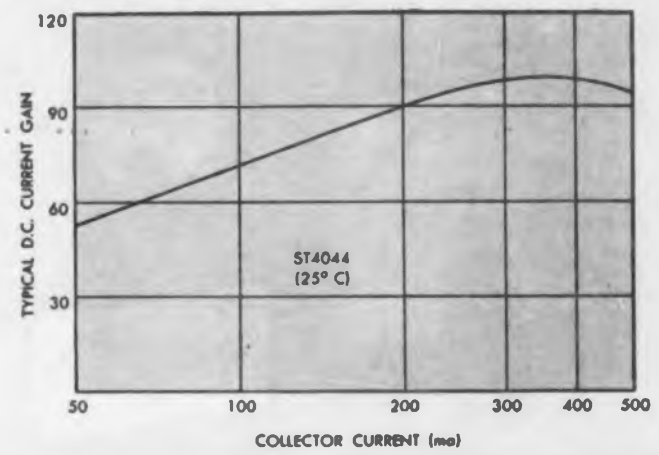
HIGH BETA/MEDIUM POWER types

... *current gain of 40 minimum*

at 500 milliamps. Typical power gain of 1000 into a 100 ohm load significantly reduces drive power requirements. When used in conjunction with small signal high gain types, these transistors reduce the number of components needed in a system and, hence, the overall weight and volume. I_{co} is measured at maximum rated collector voltage at 150°C.

TYPES	ST4044	ST4045	
Minimum DC Beta = 40 at I_c	500	200	ma
Maximum Collector Voltage	60	60	Volts
Power Dissipation (100°C, free air)	6	.6	Watt
Power Dissipation (100°C, stud heat sink mounting)	5	5	Watts
Typical Collector Saturation Voltage (@ specified current)	3	1.5	Volts

Complete data in bulletin TE-1355



HEAT SINK MOUNTINGS... *higher power ratings*

for medium power transistors in Transitron's TO-5 Outline package. These factory-fitted heat sink mountings make possible a realistic 5 watt rating at 100°C case temperature for the first time. The stud type offers the convenience of single-hole mounting, the same as for our JAN rectifiers in the 1/16" hex package. No clip is needed . . . insulation and mounting hardware are supplied. Complete data in bulletin TE-1355.

Transitron

electronic corporation • wakefield, massachusetts

Transistors Diodes Regulators Rectifiers

Pressure Switches

5 to 400 psig sensing range

Pressure switch 3078 has a 5 to 400 psig sensing range and a proof pressure to 500 psig. Snap action spdt or spst, the unit operates from −65 to +275 F. Rated at 10 amp resistive, 14 to 30 v dc, it has an AND 10066C connector.

Frebank Co., Dept. ED, 711 W. Broadway, Glendale, Calif.

CIRCLE 488 ON READER-SERVICE CARD

Power Rectifier

Operates directly from a 230 v line

No step-down transformer is needed with the 61-4037 single phase bridge rectifier. With a maximum input of 260 v rms, the unit connects right to a 230 v line. Outputs are 100 ma and 180 v dc.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 489 ON READER-SERVICE CARD

Rotary Selector Switch

For thermocouple use

Motor-driven model 103C is a high speed, multichannel sampling switch for thermocouple use. It has 6 poles with 30 nonshorting or 60 shorting channels per pole. Channel sampling rate is 1 rps.

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

CIRCLE 490 ON READER-SERVICE CARD

Toroidal Coils

60 cps to 50 kc range

For the 60 cps to 50 kc range, series 784 toroidal coils have inductances from 1 mh to 17 h. They are 1-7/16 in. in diameter and 3/4 in. high.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 491 ON READER-SERVICE CARD

◀ CIRCLE 487 ON READER-SERVICE CARD

NEW PRODUCTS

Transient Eliminators

Protect transistorized circuits

Placed in series with power sources, airborne EM 446 and laboratory EM 472 eliminators protect transistor circuits from high voltage transients. They are rated at 32 v dc, 15 amp.

Gulton Industries, Inc., Engineered Magnetics Div., Dept. ED, 13030 Cerise Ave., Hawthorne, Calif.

CIRCLE 493 ON READER-SERVICE CARD

Cathode Ray Oscilloscope

DC to 100 kc frequency response

For standard rack mounting, model 7000-B cathode ray oscilloscope has a dc to 100 kc frequency response. Because its horizontal and vertical amplifiers are electrically identical, the unit is suited for making phase measurements at various frequencies. All amplifiers are push-pull.

Waters Mfg., Inc., Dept. ED, Wayland, Mass.

CIRCLE 494 ON READER-SERVICE CARD

Crystal Oven

±0.75 full range stability

Maintaining 75 C ±2 C in ambients from −55 to +65 C, the CTO-75 crystal oven has a full range stability of ±0.75 C. At any given ambient stability is ±0.1 C. The unit holds one or two 3/4 or 1-1/2 in. crystal holders.

Dynamics Corporation of America, Reeves-Hoffman Div., Dept. ED, Carlisle, Pa.

CIRCLE 495 ON READER-SERVICE CARD

NPN Transistors

For data processing

These germanium alloy npn transistors are designed for high speed data processing. Respectively, types 2N439 and 2N679 have collector to base voltages of 30 and 25 v, and power dissipations of 100 and 150 mw. Maximum junction temperature is 85 C.

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

CIRCLE 497 ON READER-SERVICE CARD

Shaft Converter

Senses direction changes

This analog to digital converter shows shaft position and direction. It consists of: type 15A magnetic reading head which can turn at 10,000 rpm; type 20 demodulator which provides up to 60,000 pulses per sec; and type 83A pulse multiplier, which provides optional pulse rates of 500, 1000, or 2000 per revolution of the magnetic reading head.

Telecomputing Corp., Data Instruments Div., Dept. ED, 12838 Saticoy St., North Hollywood, Calif.

CIRCLE 498 ON READER-SERVICE CARD

FHP Speed Reducers

Have aluminum driven worm gears

SW-1 fhp speed reducers come with ratios between 3.5 to 1 and 60 to 1. Available with aluminum driven worm gears of bearing type alloy, they have solid or hollow output shafts. In nylon Fiberglas cases, the units weigh under 21 oz and measure 3-3/4 x 3-7/8 x 3-1/8 in. They may be used in business machines, control devices, servo mechanisms, and other power transmission systems.

Rampe Mfg. Co., Dept. ED, 1915 Woodworth Ave., Cleveland 9, Ohio.

CIRCLE 499 ON READER-SERVICE CARD

CIRCLE 496 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Tachometer Meter

Provides digital readout within ±1 rpm

For checking high speed rotating equipment, this digital tachometer direct readout is accurate to ±1 rpm. In three positions it reads rpm up to 9999, rpm multiplied by two, and per cent rpm.

Deltime, Inc., Dept. ED, 608 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 500 ON READER-SERVICE CARD

AC Voltmeter

Measures floating voltages

With its circuitry isolated from the front panel, model 480 multirange ac voltmeter measures floating voltages such as those across a servomechanism's windings. Calibrated in rms for a sine wave signal, it has an input impedance of 10 meg, 20 μμf and a frequency response of 20 cps to 100 kc. Accuracy is ±2 per cent to 50 kc, ±3 per cent thereafter. A switch selects full-scale ranges that begin with 10 mv and progress in 10 db steps to 300 v.

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

CIRCLE 501 ON READER-SERVICE CARD

Contactors

Switch 60 amp

With 2.7 w control signals, MB contactors switch loads up to 60 amp at 30 v dc. They can also handle 150 amp surges for 300 msec. The units are spst with contacts normally open or closed. A double throw version is derated to 20 amp.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 502 ON READER-SERVICE CARD

Sweep and Signal Generator

±0.25 per cent accuracy

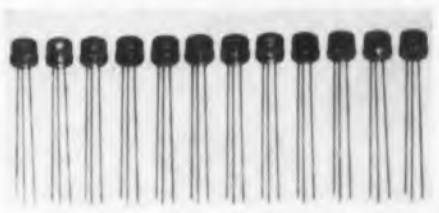
Combining functions of sweep and signal generator, pulsed cw, and marker generator, the SSX-2 is a versatile tester for i-f and r-f components. It has a 25 to 75 mc tuning range, 0 to 40 per cent sweep, and ±0.25 per cent accuracy. Signal generator output is 0.1 μv to 1 v, and attenuation is by steps to 131 db Vernier, 0 to 10 db. Marker calibrations are every 250 kc below 40 mc, every 500 kc above.

Telonic Industries, Inc., Dept. ED, P.O. Box 277, Laguna Beach, Calif.

CIRCLE 504 ON READER-SERVICE CARD

Switching Transistors

Computer type



Fast switching, these npn alloy-junction germanium transistors are suited for computer logic circuits and core drivers. Typical ranges are 4 to 12 mc with 100 and 150 mw maximum dissipation.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 505 ON READER-SERVICE CARD

Digital Voltmeter

0.015 per cent accuracy

Over its three automatically switched ranges of ±10, ±100, and ±1000 v dc, model 81 digital voltmeter has 0.015% resolution and accuracy. Input impedance is 10 meg at all times.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

CIRCLE 506 ON READER-SERVICE CARD

NEW PRODUCTS

DC Power Supply

Multiple output

Dc power supply model 3063 is a compact, multiple output unit for telemetering. Outputs are: 150 v dc at 225 ma with ±2% regulation and ±0.33% ripple; 12.6 v dc at 15 amp, with 0.7 v ripple; and 6.3 v ac. Input is 115 v, 3 phase.

Varo Mfg. Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 436 ON READER-SERVICE CARD

Portable Circuit Tester

Checks 10 circuits per second

Model 144 is a rugged, portable analyzer for complex and multiple circuits. It automatically tests for shorts, continuity, and insulation. It also tests relays, solenoids, and other resistive units. The waterproof unit has a 144 circuit capacity and tests 10 circuits per sec.

DIT-MCO, Inc., Dept. ED, 911 Broadway, Kansas City, Mo.

CIRCLE 437 ON READER-SERVICE CARD

Three Speed Drive

Shifts in 0.1 sec

With a solenoid-operated speed control, the Servotran variable speed drive can produce any three speeds, forward or backward, from 0 to 3600 rpm. It shifts in under 0.1 sec without disengaging the drive or the load. Units come in two sizes covering a 1/70 to 1/4 hp range.

Humphrey, Inc., Dept. ED, 3794 Rosecrans St., San Diego 10, Calif.

CIRCLE 438 ON READER-SERVICE CARD

◀ CIRCLE 435 ON READER-SERVICE CARD

Quadrature Rejection Amplifier

Power gain of 30 db

Transistorized amplifier 1805-0500 provides quadrature suppressed signals to ac servo amplifiers. Hermetically sealed, the 9-pin plug-in unit has an input impedance of 500 K, a load impedance of 500 ohms, and a power gain of 30 db. Output is 450 mv at 50 ohms; and quadrature rejection is 50 to 1. The unit weighs 7 oz. Its frequency is 380 to 420 cps.

M. Ten Bosch, Inc., Dept. ED, 30 Wheeler Ave., Pleasantville, N.Y.

CIRCLE 318 ON READER-SERVICE CARD

Braked Servo Motor

Stands extreme shock and vibration

Shock resistant, the size 10 P1711-001 braked servo motor is designed for missiles and aircraft. The brake stops and holds the rotor and shaft at any desired position, preventing creep in extreme vibration.

Kearfott Co., Inc., Dept. ED, 1378 Main Ave., Clifton, N.J.

CIRCLE 319 ON READER-SERVICE CARD

Snap Action Switch

For cam applications

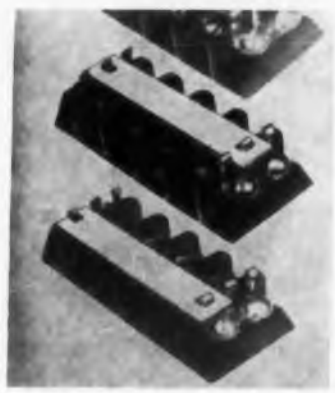
For linear cam, rotary, and rotary pin actuation, the S30-97A snap action switch turns a unit clockwise or counterclockwise with equal precision. Operating force is 2 to 7 oz. Ratings are 10 amp, 125 v ac and 5 amp, 250 v ac.

Cherry Electrical Products Corp., Dept. ED, 1650 Deerfield Rd., Highland Park, Ill.

CIRCLE 320 ON READER-SERVICE CARD

CIRCLE 53 ON READER-SERVICE CARD ➤

NEW PRODUCTS



Terminal Blocks

Have movable identification strip

These terminal blocks now come with a spring-mounted circuit identification strip. The strip may be positioned to expose either row of terminal screws. Or it may be center-mounted for installations where both rows of terminals should be readily accessible.

Marathon Electric Mfg. Corp., Dept. ED, Wausau, Wis.

CIRCLE 321 ON READER-SERVICE CARD

Signal Level Monitor

Lightweight

Weighing 4.5 lb, Model SM-1 was designed for antenna and rf laboratories. Input impedance of unit is 0.1 meg and full scale dc sensitivity is 500 μv. Untuned frequency range is from 40 to 10,000 cps. Untuned ac full scale sensitivity of monitor is 500 μv rms and tuned ac full scale sensitivity is 50 μv rms.

Scientific-Atlanta, Inc., Dept. ED, 2162 Piedmont Road, N. E. Atlanta 9, Ga.

CIRCLE 322 ON READER-SERVICE CARD

Relay Monitor

Checks contact chatter

The CCM-1 thyratron controlled monitor checks contact chatter, showing a red light when contacts stay open longer than a selected interval. One front panel control selects ten durations. Control positions are at 10 μsec intervals with a range of 10 to 100 μsec.

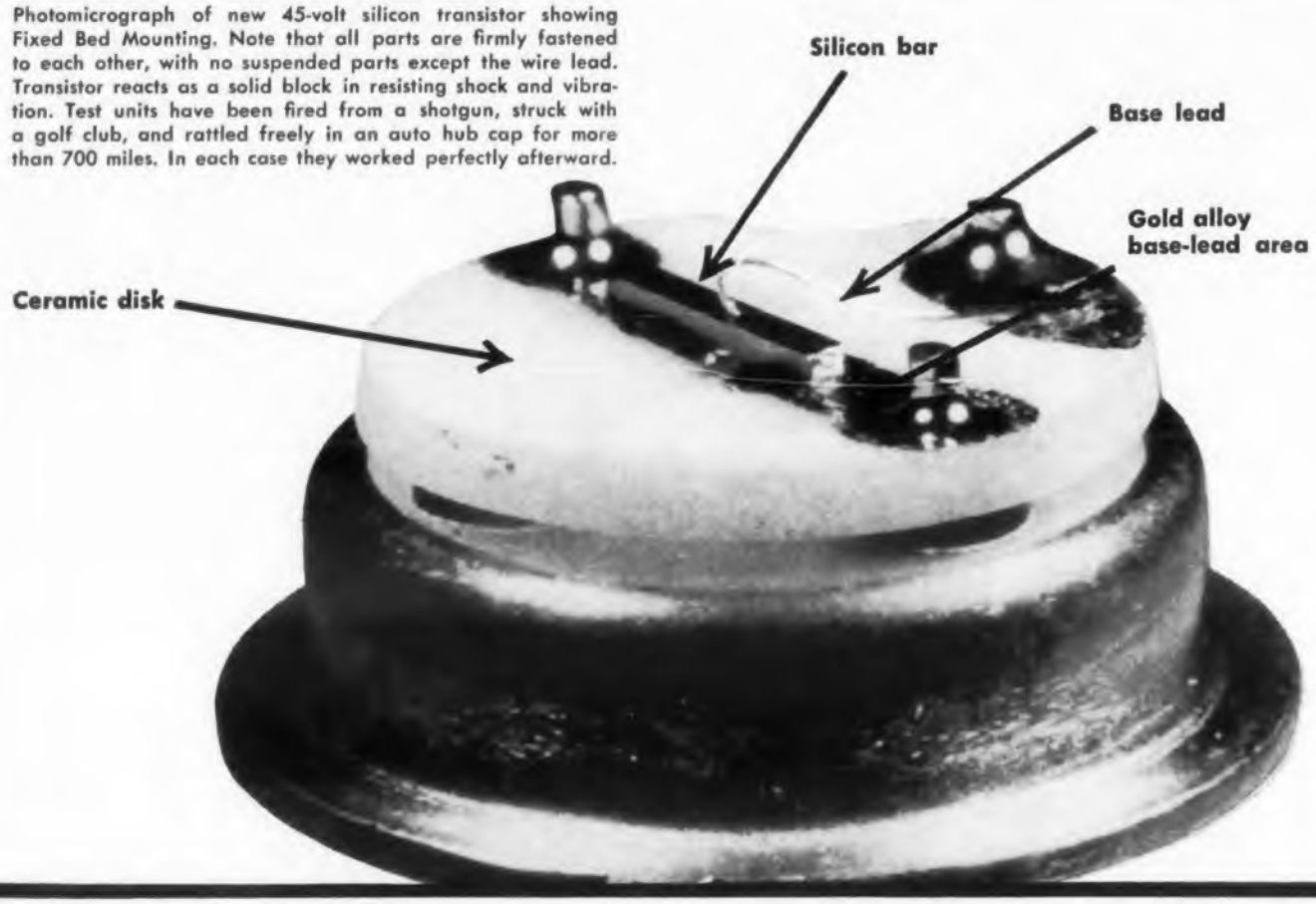
Mu Tronics, Dept. ED, 1514 S. La Cienega Blvd., Los Angeles 35, Calif.

CIRCLE 397 ON READER-SERVICE CARD

General Electric Semiconductor News

New 45-volt silicon transistor absorb

Photomicrograph of new 45-volt silicon transistor showing Fixed Bed Mounting. Note that all parts are firmly fastened to each other, with no suspended parts except the wire lead. Transistor reacts as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club, and rattled freely in an auto hub cap for more than 700 miles. In each case they worked perfectly afterward.



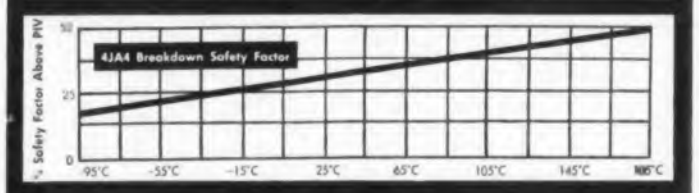
20% safety factor announced for low-current silicon rectifiers

Designers who now apply their own safety factor to the published peak inverse voltage rating may avoid this step by using G-E low-current silicon rectifiers.

General Electric's PIV figures are set by allowing a 20% safety margin at −65°C. This margin is applied at the point of sharp breakdown voltage and increases with temperature until a maximum safety factor of 33% is reached at 150°C.

If you are derating published PIV figures to provide over-voltage protection, you may be buying costlier cells than you need, or, in series applications, more cells than necessary. Thus the built-in safety margin of G-E low-current silicon rectifiers could save you money. *Note: This safety factor is provided for over-voltage protection only. Designs should, in all cases, be maintained within published maximum ratings.*

This is only one reason why you should consider G-E low-current silicon rectifiers for *all* your power requirements. You'll find these devices more attractive to use than ever before—both in quality and price—with equally fine values in low-current silicon stacks. Stud-mounted units are also available. Ask your G-E semiconductor representative for the "big news" on low-current silicon rectifiers.



Maximum Ratings and Specifications

	PIV	RMS Voltage	Cont Reverse D-C Volt	D-C Output (150°C Amb.)	D-C Output (50°C Amb.)	Ambient Operating Temp
1N536-40, 1N1095-98 series	50-600	35-420	50-600	250	750	165
1N440B series	100-600	70-420	100-600	300-500 (100°C)	300-750	150-165
1N1487-92 series	100-600	70-420	100-600	250 (125°C)	750 (25°C)	140
1N1692-95 series	100-400	70-280	100-400	250 (100°C)	600 (50°C)	115
	volts	volts	volts	ma	ma	°C

Power Supply

For military uses

Designed for military applications, the PS 4004 is a semiconductor power supply. Input may be varied from 105 to 125 v ac, 50 to 63 cps. Output voltages range from 260 to 300 or 130 to 150 v dc. Stabilization is less than ±0.05 v on 300 v output, less than ±0.025 v on 150 v output. Ripple and noise averages less than 1.0 mv after warm up.

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

CIRCLE 323 ON READER-SERVICE CARD

Circulator

For 5.975 to 6.425 kmc band

Model W269-2A-1 c-band circulator offers an isolation better than 20 db between any input terminals and output. Insertion loss is less than 0.7 db over entire range. VSWR is 1.25 at any input terminal over the band. Peak power handling capacity of 1.0 kw.

Kearfott Co., Inc., Microwave Division, Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 324 ON READER-SERVICE CARD

Silicon Transistor

Low level input

Operating at starvation current in dc amplifier input stages, the ST1026 silicon transistor is recommended for the 2 to 200 μa range. Drift is 0.05 mμa per degree C and 0.5 mμa per day, making the unit useful in circuits with high impedance sources.

Transitron Electronic Corp., Dept. ED, Wakefield, Mass.

CIRCLE 325 ON READER-SERVICE CARD

NEW PRODUCTS

Revolution Counter

Direct reading

This precision turns counter sets, adjusts, and relocates the shafts of multiturn potentiometers and variable capacitors. It shows shaft position in 1/100 turns, providing direct digital readings to 999. Units fit 1/8 or 1/4 in. shaft diameters.

General Controls Co., Dept. ED, 80780 McCormick Blvd., Skokie, Ill.

CIRCLE 326 ON READER-SERVICE CARD

Feed Through Connectors

Side mounted

Miniature series G connectors are side mounted to save space and permit stacking. The reverse pin and socket construction is adaptable to varied circuit requirements. Widths are 1/2 to 7/8 in.

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

CIRCLE 327 ON READER-SERVICE CARD

Terminal Block

Locks with turn of a screw

A quarter turn with a screwdriver connects this terminal block. In each terminal a reverse rotary V-cam wedges wire ends against the rectangular bus walls. Blocks

◀ CIRCLE 55 ON READER-SERVICE CARD

have 2 to 20 stations and take wire sizes to no. 18. They handle up to 15 amp and withstand 220 F. Dielectric strength is 2500 v between terminals, 3000 v from terminal to base.

Camblock Corp., Dept. ED, 825 Bronx River Ave., New York 72, N.Y.

CIRCLE 328 ON READER-SERVICE CARD

Automatic Tube Tester

Has 10 trillion switching combinations

In the RD 1230 tube tester, code cards actuate a switch which automatically sets voltages and conditions for each tube. This switch has 10 trillion combinations. Accuracy of the tester is within 1 to 3 per cent of the best known standards for transconductance and plate current measurements.

The Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 329 ON READER-SERVICE CARD

Silicon Power Rectifiers

Flat design

Flatline power rectifiers have low silhouettes to save space. Flush or stud mounted with positive or negative base polarity, they have a piv range of 50 to 300 v. Current ratings are 20 to 200 amp.

Sarkes Tarzian, Inc., Dept. ED, 115 N. College Ave., Bloomington, Ind.

CIRCLE 330 ON READER-SERVICE CARD

CIRCLE 56 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Transistorized Digital Ohmmeter

0.01 per cent accuracy

An all transistorized, five-digit ohmmeter, model DOA-500 is accurate to 0.01 per cent, plus or minus one digit, from 0.01 ohm to 9.9999 meg. Readout time is 1.5 sec. Ranging is automatic.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

CIRCLE 331 ON READER-SERVICE CARD

FM Telemetry Transmitter

Covers 215 to 260 mc band

Type 1004A fm telemetry transmitter completely covers the 215 to 260 mc frequency band. Modulation frequency is 20 cps to 100 kc; deviation characteristic, 0.02 v rms per kc; distortion, less than 1 per cent for 12.5 kc deviation of any subcarrier; center frequency stability, 0.01 per cent.

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

CIRCLE 332 ON READER-SERVICE CARD

Floating Anchor Nuts

Withstand high temperatures

For missile and avionic use, these four miniature two-lug floating anchor nuts meet MIL-N-25027 (ASG) requirements. They come in a va-

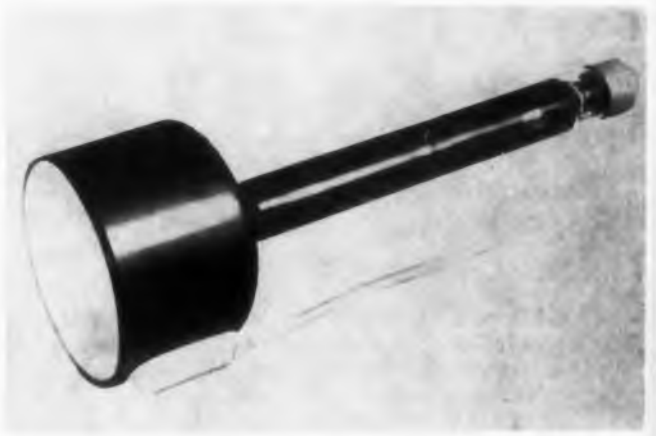
riety of sizes and rivet hole spacings. Types LHTA521M and 531M withstand 550 F; types LHTA3300 and 3452 withstand 900 F.

Elastic Stop Nut Corporation of America, Dept. ED, 2330 Vauxhall Rd., Union, N.J.

CIRCLE 333 ON READER-SERVICE CARD

Cathode-Ray Tube

Spot less than 0.001 in.



Powered and operated by conventional methods, the K1725 cathode-ray tube is capable of producing a spot size less than 0.001 in. The 5 in. tube, with electromagnetic focus and deflection, uses the Du Mont Extra-Fine P-16 screen for high light output at fast writing rates.

Allen B. Du Mont Labs, Inc., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

CIRCLE 334 ON READER-SERVICE CARD

Voltage Monitor

Accurate within 0.1 percent

This frequency and rms voltage monitor ha an accuracy within 0.1 per cent. The frequenc and voltage units may be operated singly an remotely from each other. Voltage monitor ha a useful range of 40 cps to 20 kc and a voltag range of 1.5 to 500 v. Frequency monitor ha a 40 to 5000 cps range. Both frequency an voltage monitors have limit controls. Excursion above or below limits trigger a light. The sam signal may be used for controlling other circuit

Aerojet-General Corp., Dept. ED, Azus Calif.

CIRCLE 335 ON READER-SERVICE CARD

NEW PRODUCTS

Digital System Building Blocks

High and low frequency

For use in digital systems, these transistorized building blocks can be mounted 25 to a 5-1/4 x 19 in. chassis. Each unit takes up 3.25 sq in. of panel space. Because all types have compatible signals, high and low frequency units can be used in one system.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

CIRCLE 336 ON READER-SERVICE CARD

Miniature Cable

Rip-cord type

This 250 C miniature 2-conductor flat cable has an easy-to-strip outer binding of transparent Teflon tape. It comes in AWG sizes from 20 to 32.

Tensolite Insulated Wire Co., Inc., Dept. ED, West Main St., Tarrytown, N.Y.

CIRCLE 337 ON READER-SERVICE CARD

Crystal Filters

For five bandwidths

Series A 10.7 mc miniature crystal filters find use as i-f filters, as carrier pickoffs, in telemeter-

ng, and in radar. They come in bandwidths of 15, 20, 30, 40, and 50 kc at the 3 db points, with the shape factor to the 60 db points better than 2 to 1.

Bulova Watch Co., Electronics Div., Dept. ED, 42-06 62nd St., Woodside 77, N.Y.

CIRCLE 338 ON READER-SERVICE CARD

Differential Transformer

Has extended single-ended range

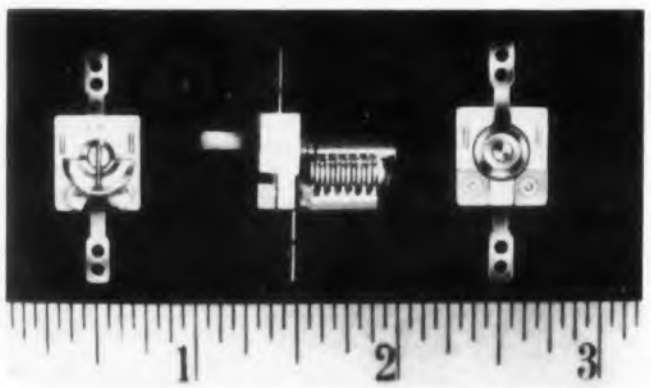
Series ES-L single ended linear variable differential transformers are designed with the null position at the end and a full linear range. This construction extends the range to twice that of conventional transformers. The units have a frequency range of 60 cps to 10 kc and a temperature range of −65 to +200 F.

Schaevitz Engineering, Dept. ED, Route 130 and Schaevitz Blvd., Pennsauken, N.J.

CIRCLE 339 ON READER-SERVICE CARD

Variable Capacitor

Machined from solid brass



Type "U" sub-miniature air variable capacitor has its rotor and stator machined from one piece of solid brass. Requiring less than 0.2 sq in. for chassis or panel mounting, the unit provides freedom from moisture entrapment found in trimmer capacitors of the enclosed type. All metal parts are silver plated. Breakdown ratings up to 1300 v dc. Units come in various capacitive sizes.

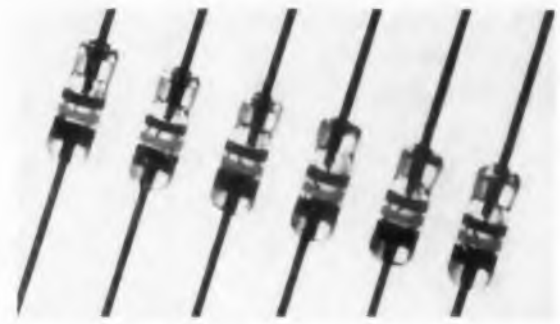
E. F. Johnson Company, Dept. ED, Waseca, Minn.

CIRCLE 340 ON READER-SERVICE CARD

NEW PRODUCTS

Indium-Bonded Diode

Junction-type



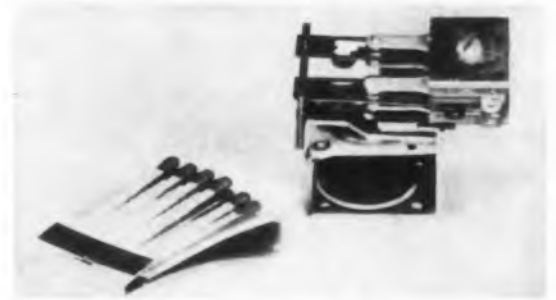
Type 1N699 indium-bonded junction-type germanium diode is highly resistant to catastrophic failures. It is 0.3 in. long and 0.11 in. in diameter, and has flexible leads for soldering or welding. Forward-to-reverse current ratio is high.

CBS-Hytron, Semiconductor Operations, Dept. ED, Lowell, Mass.

CIRCLE 341 ON READER-SERVICE CARD

Power Relay

For high amp loads



This relay was designed for handling higher amperage and inductive loads. Contacts are rated at 15 amp, 1/2 hp. Biggest dimension is 2.1 in. Circuit arrangement is single pole through double throw. Switch is snap action.

Robertshaw-Fulton Controls Co., Dept. ED, Columbus, Ohio.

CIRCLE 342 ON READER-SERVICE CARD

Diplexing Assembly

Has 2 fixed-tuned filters

Composed of two fixed-tuned filters (at different frequencies), this unit permits two different

frequencies to be transmitted or received through a common antenna. The two filters can be individually fixed-tuned to any frequency within the 5925 to 6425 mc band. VSWR for the whole assembly does not exceed 1.20 within its pass band.

Airtron, Inc., Dept. ED, 1096 West Elizabeth Ave., Linden, N.J.

CIRCLE 343 ON READER-SERVICE CARD

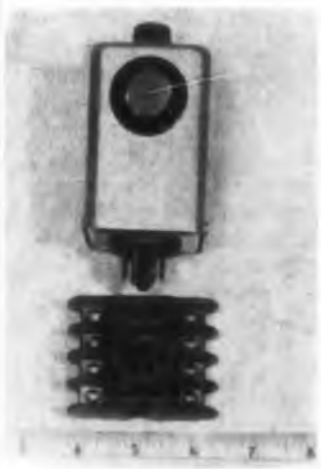
Power Transistors

Choice of packages

PNP germanium power transistors, available in 20, 30 or 40 w sizes, can be ordered in one of five packages. The units come in 36 collector-to-base voltages and have large signal current gains.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 344 ON READER-SERVICE CARD



Photocell Control Switch

Modular plug-in design

A modular photocell control switch, model R photorelay is used in counting, sorting, measurement control, and level control. The switch needs no vacuum tubes and can operate with a light intensity of 1 ft-c. It includes a dpdt relay with contacts rated at 5 amp, 120 v ac. Mounting in any position, the unit plugs into an octal socket or an amphenol base with screw terminals. It operates from any 110 v ac source.

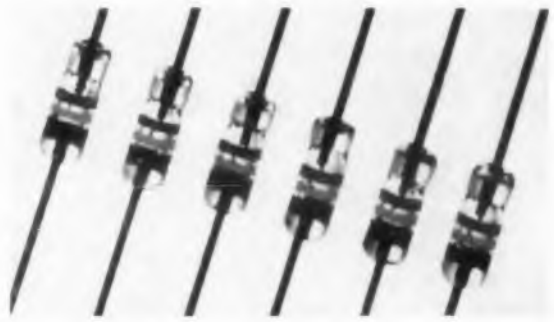
Berkeley/Dynamics, Dept. ED, 2831 Seventh St., Berkeley 2, Calif.

CIRCLE 345 ON READER-SERVICE CARD

NEW PRODUCTS

Indium-Bonded Diode

Junction-type



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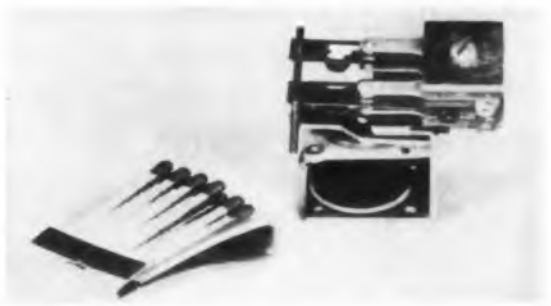
For high amp loads



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Robertshaw-Fulton Controls Co., Dept. ED, Columbus, Ohio.

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Airtron, Inc., Dept. ED, 1096 West Elizabeth Ave., Linden, N.J.

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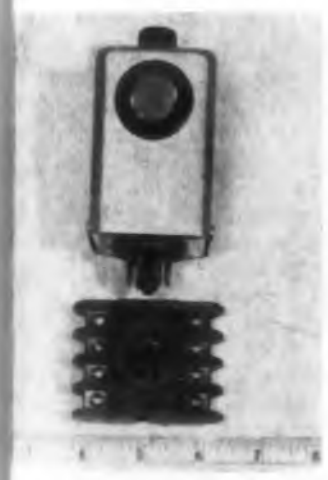
CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 344 ON READER-SERVICE CARD



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Berkeley/Dynamics, Dept. ED, 2831 Seventh St., Berkeley 2, Calif.

CIRCLE 345 ON READER-SERVICE CARD

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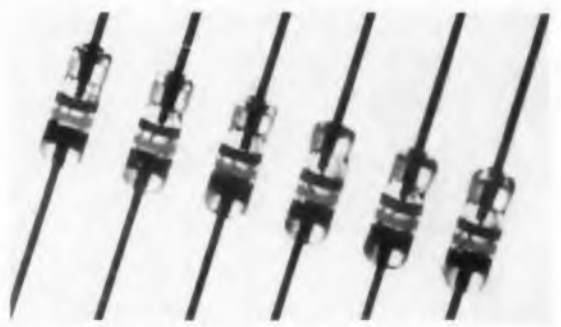
Junction-type



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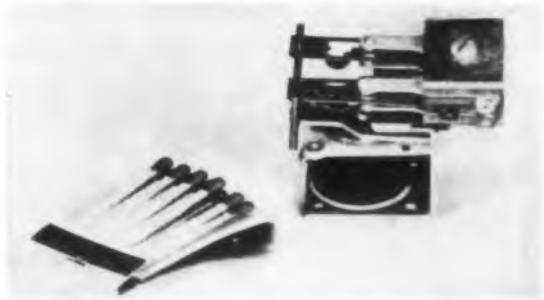

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Robertshaw-Fulton Controls Co., Dept. ED, Columbus, Ohio.

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Airtron, Inc., Dept. ED, 1096 West Elizabeth Ave., Linden, N.J.

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CBS-Hytron, Dept. ED, Danvers, Mass.

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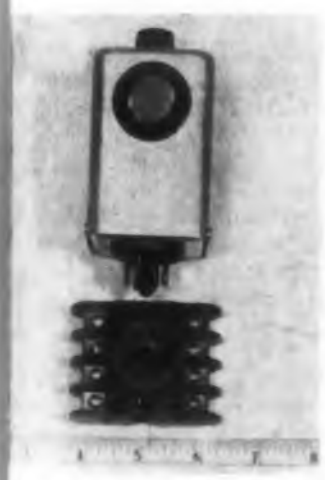

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Berkeley/Dynamics, Dept. ED, 2831 Seventh St., Berkeley 2, Calif.

CIRCLE 345 ON READER-SERVICE CARD

NEW PRODUCTS

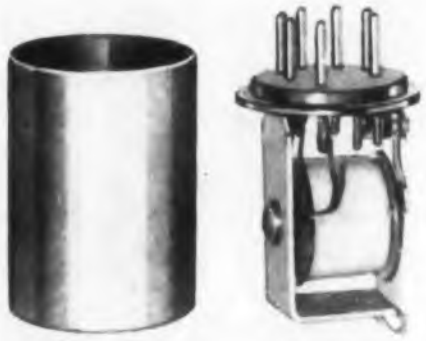
RF Switching Relay

Has ceramic insulation

Developed for radio frequency switching applications, the miniaturized MC relay has a ceramic-insulated switch stack to minimize intercontact capacitance. For an open relay the capacitance rating is 1.5 μμf between contacts; 6.0 μμf in a sealed relay. Palladium contacts can handle 1 amp at 115 v, for a 60 cycle resistive load. Contact arrangements up to dpdt or 3 pst are available.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 346 ON READER-SERVICE CARD



Miniature Relay

Has plug-in tube base

The DF miniature relay has a 7 pin tube base. Contacts on the unit are spdt and can handle 2 amp, 115 v ac, 60 cycle or 26.5 v dc non-inductive load. The unit extends 1 in. above chassis and has a 3/4 in. dia.

Line Electric Co., Dept. ED, 271 So. 6th. St., Newark 3, N.J.

CIRCLE 347 ON READER-SERVICE CARD

Tubular Capacitors

For computers, aircraft, missiles

Precision-made, these tubular capacitors are for computers, servo-mechanisms, airborne electronic equipment, and guided missiles. Capacities for the line are from 0.001 to 1 μf for Mylar and Polystyrene units, 0.001 to 0.47 μf for Teflon, and 0.005 to 10 μf for metallized Mylar.

Condenser Research Corp., Dept. ED, P.O. Box 161, Seymour, Ind.

CIRCLE 597 ON READER-SERVICE CARD

3rd MARS Design Contest

HACKENSACK, N. J. — The MARS Outstanding Design Contests have uncovered numerous interesting designs which might otherwise never have been brought before technical audiences. They have attracted such wide interest that MARS Pencils is sponsoring another contest in 1959.

Dr. Manfred Mannheimer, Newark, N.J., one of the winners in the 1958 MARS Contest.

If you are an engineer, architect or student, the MARS contest offers you a "showcase." It provides you with a valuable opportunity to have projects you designed shown in leading magazines where they will be seen by the men in your profession.

$100 Awards

Send in your designs. Every winner will receive $100; winning entries will be reproduced in the wide list of technical publications in which the MARS Outstanding Design Series appears. There are no strings attached. You will be given full credit. All future rights to the design remain with you. You can reproduce it later wherever you like and sell or dispose of it as you wish.

The subject can be almost anything — aviation, space travel, autos, trains, buildings, engineering structures, household items, tools, machines, business equipment, etc. Projects will be selected on the basis of appeal to design-minded readers, broad interest, attractive presentation. Do not submit a design that is in production. The project, in fact, does not need to have been planned for actual execution. It should, however, be either feasible at present or a logical extension of current trends. It cannot be unrealistic or involve purely hypothetical alterations of natural laws.

The sooner you send in your entry, the greater the chance of its selection.

It is Simple To Submit a Design For Mars Outstanding Design Series

Just mail in an inexpensive photostat or photocopy of the subject — one you can spare, since it cannot be returned — and a brief description.

If your entry is accepted, we will ask for a clear illustration of your design in order to prepare a sharp rendering, or photograph suitable for reproduction. Your material will then be returned to you.

Send your entry to:

J.S. STAEDTLER, INC.
Hackensack, New Jersey

CIRCLE 62 ON READER-SERVICE CARD

CIRCLE 63 ON READER-SERVICE CARD

WON'T SMEAR ON MYLAR®!

Duralar

The only pencil

that **can't smear** on Mylar,
that **keeps a point** on Mylar,
that **erases** on Mylar.
Duralar drawings on Mylar **reproduce** perfectly, **microfilm** without loss and can even be **cleaned** with soap and water.

For a free sample

send coupon below with business letterhead. Specify whether you wish included a test sample of matte-surface Mylar tracing film.
See for yourself how the sensational new Mars Duralar solves your drafting problems. And Duralar is available (pencils, leads and lead holders) in five special new degrees of hardness (K1 to K5).

Sold only at engineering and drawing material suppliers.

® trademark of E. I. du Pont de Nemours & Co., Inc.

Another first from

MARS

J. S. STAEDTLER, INC. HACKENSACK, N. J.

Gentlemen: Please send me FREE

- ☐ The revolutionary new DURALAR pencil
- ☐ Include a sample of Mylar film for testing the DURALAR pencil.

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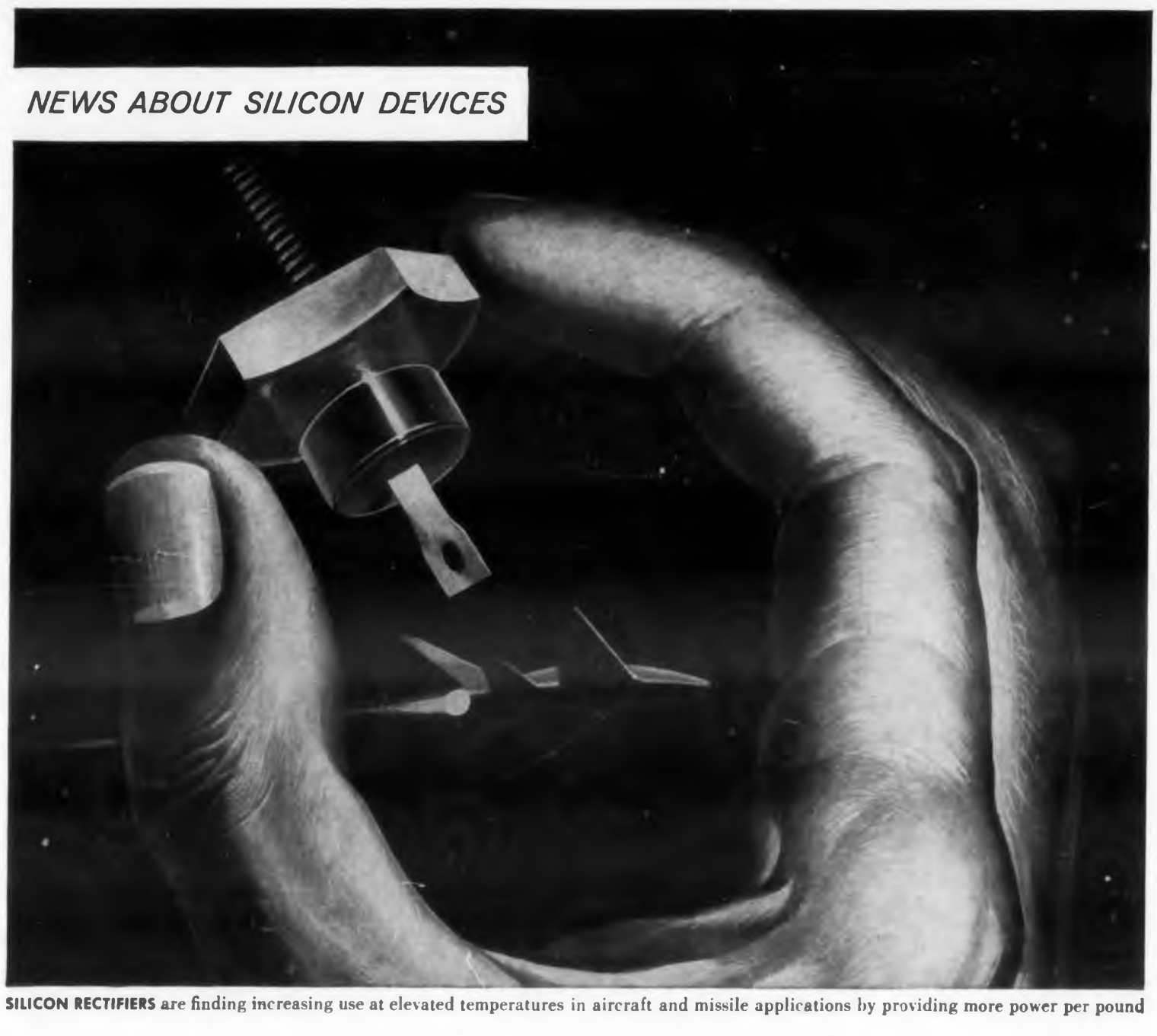
FIRM _____

STREET _____

CITY _____ ZONE ___ STATE _____

NEWS ABOUT SILICON DEVICES



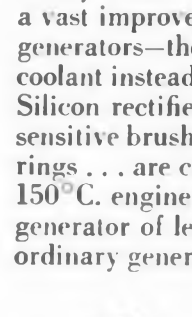
SILICON RECTIFIERS are finding increasing use at elevated temperatures in aircraft and missile applications by providing more power per pound

Now...design improvements made possible with components of Du Pont Hyperpure Silicon

Today silicon rectifiers make possible a vast improvement in jet-age aircraft generators—the use of engine oil as a coolant instead of less-efficient ram air. Silicon rectifiers take the place of oil-sensitive brushes, commutator and slip rings . . . are completely unaffected by 150°C. engine oil. Result: a *brushless* generator of less weight and size than ordinary generators.

Silicon devices can similarly help you miniaturize—improve design and performance. Silicon rectifiers have excellent stability . . . can operate continuously at —65 to 200°C. They're up to 99% efficient—reverse leakages are only a fraction of those of other semiconductors. Both transistors and rectifiers of silicon can pack *more* capacity into *less* of your equipment space.

Note to device manufacturers: You can produce high-quality silicon transistors and rectifiers with Du Pont Hyperpure Silicon now available in three grades for maximum efficiency and ease of use... purity range of 3 to 11 atoms of boron per billion... available in 3 forms, needles, densified, cut-rod. Technical information is available on crystal growing from Du Pont . . . pioneer producer of semiconductor-grade silicon.



NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Silicon N-2496-ED-11, Wilmington 98, Delaware.

PIGMENTS DEPARTMENT

DU PONT

REG. U. S. PAT. OFF

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

CIRCLE 64 ON READER-SERVICE CARD

Electronic Switch

Controls 4 independent signals

Type ES-141 multi-channel electronic switch accepts four independent signals and sequentially connects them to a single output in a four way display on one oscilliscope. Self contained, regulated power supply requires 115 v, 60 cycle at 1 amp or less.

The Newton Co., Dept. ED, Manchester, Conn.

CIRCLE 348 ON READER-SERVICE CARD

Digital Voltmeter

All electronic design

Designed as a general purpose instrument in data handling system and similar applications, Model 26.044 digital voltmeter is completely electronic in operation. Three range scales are provided from 0 to 10, 10 to 100 and 100 to 1000. Accuracy is 0.01 per cent of full scale on all ranges. Numerals are visible at distances up to 50 ft. Positive and negative inputs can be read.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.

CIRCLE 349 ON READER-SERVICE CARD

Shift Register

For transistor driver

The DK 101-T is a two-core-per-bit shift register for use with a transistor driver. Its nominal drive current is 300 ma.

Airtronics, Inc., Dept. ED, 5522 Dorsey Lane, Bethesda, Md.

CIRCLE 350 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Rectifie

High curre capacity

Type 1N, a series of ten silicon rectifiers rated at a maximum dc output current of 750 (at +50 C). The ten units are rated in steps fr peak reverse voltage of 50 v to 600 v inclus Maximum full load forward voltage drop is o 1/2 v.

Fansteel Metallurgical Corp., Dept. ED, No Chicago, Ill.

CIRCLE 351 ON READER-SERVICE CARD

Torque Moto

For servo system

Model 22 torque motor weighs 2-1/2 oz an can operate in temperatures up to 400 F. Th unit consumes 1.5 w and its hysteresis is 3 p cent max. Motor stroke is ±0.006 in.; natur frequency is 900 cps.

Raymond Atchley, Inc., Dept. ED, 2340 Sa telle Boulevard, Los Angeles 64, Calif.

CIRCLE 352 ON READER-SERVICE CARD

Rotary Actuator

8 in-lb load at 1000 rpm

Model D-1900 rotary actuator operates unde a normal load of 8 in.-lb. at 1000 rpm. An ad

justable travel limit mechanism permits up to 250 turns of the output shafts. Higher total output turn ranges are available.

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

CIRCLE 353 ON READER-SERVICE CARD

Power Supply

1.75 ma peak at 15 kv dc

Designed to operate on 117 v, 60 or 400 cycle input, Model No. PS-15T can deliver 1 ma continuous or 1.75 ma peak current at 15 kv dc. The unit is hermetically sealed, oil filled and has a ripple of 0.5 per cent at 1 ma. Regulation is approximately 7 per cent from no load to full load.

Film Capacitors Inc., Dept. ED, 3400 Park Ave., New York 56, N. Y.

CIRCLE 354 ON READER-SERVICE CARD

RF Voltmeter

Up to 6 switch-controlled ranges

A true rms responding, direct-reading rf voltmeter, model RFV is used to check and calibrate oscillators, signal generators, electronic voltmeters and like apparatus. It can also serve as an ac-dc transfer standard. Frequency is dc and 7 cps to 5 mc with not more than 0.5 of 1 per cent frequency influence. Units have up to 6 switch-controlled ranges between 1 and 300 v.

Positive Research Instrument Corp., Dept. ED, 10 Main St., New Rochelle, N.Y.

CIRCLE 355 ON READER-SERVICE CARD

NEW PRODUCTS

Relay

10 amp

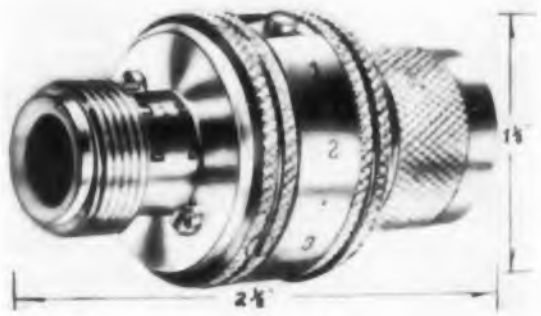
The BR-7 10 amp relay is a compact dpdt un rated for 100 g shock and —65 to +125 C. C power is 480 mw for 10 amp contacts, 80 mw f 2 amp, and 50 mw for dry circuit requirement

Babcock Radio Engineering, Dept. ED, 164 Monrovia Ave., Costa Mesa, Calif.

CIRCLE 356 ON READER-SERVICE CARD

Double-Stub Tuner

Weighs 2.5 oz



The two stubs in this 2.5 oz tuner afford a 2. x 0.5 in. center to center adjustment. For trans mission lines and other rf equipment, the uni provides a variable susceptance over the 1000 t 10,300 mc range.

Don-Lan Electronics, Inc., Dept. ED, 110 Olympic Blvd., Santa Monica, Calif.

CIRCLE 357 ON READER-SERVICE CARD

Timing Signal Amplifier

For data transmission systems

For distribution service in data transmissio systems, type TSA-100 timing signal amplifier i

...ully transistorized, wideband power amplifier with a frequency response of dc to 50 kc at full output of 5 w, peak and dc to 180 kc at reduced output. The unit amplifies balanced or unbalanced inputs to deliver 5 w into a 150-ohm balanced load. Voltage gain is 82.

Nems-Clarke Co., Dept. ED, 919 Jesup-Blair Dr., Silver Spring, Md.

CIRCLE 358 ON READER-SERVICE CARD

Microdial

3 digit, 10 turn

Model 1310 Microdial is available in a 3-digit, 10-turn version. Model 1309 has the addition of a finger-tip brake which locks settings in place when desired. Three rows of knurled bands on the aluminum control knob make the dial easy to set especially under forced-fastsetting conditions.

The George W. Borg Corp., Equipment Div., Dept. ED, 120 South Main St., Janesville, Wis.

CIRCLE 359 ON READER-SERVICE CARD

Potentiometer

Modular construction

Potentiometer functions are easily replaced with these Change-Quick units. The individual function cups are substituted by removing the external clamp and fitting the new cup into position. After indexing and phasing, the clamp is replaced. All cups of a seven-gang assembly can be indexed and phased quickly, with shaft rotation alignment error of less than 0.1 deg. The Change-Quick units are available in linear and non-linear, in all AIA sizes.

Electronic Associates, Inc., Dept. ED, 99 Dover St., Somerville 44, Mass.

CIRCLE 360 ON READER-SERVICE CARD

NEW PRODUCTS

Angular Divider

20 sec error

Angular divider will position component under test with 20 seconds-of-arc error. This represents the composite of positioning, coupling, and reading errors. Life tests indicate that service or re-calibration is usually not required after one year's operation on a 2-shift, 6 day per week basis.

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

CIRCLE 361 ON READER-SERVICE CARD

Voltage Regulator

Transistorized

From inputs of 24 to 32 v dc, this transistorized voltage regulator delivers outputs of 6 to 20 v dc adjustable at 0.5 amp. Line regulation is ±10 mv for 10 v input variation, and load regulation is 50 mv for 0 to 0.5 amp load changes. The unit is available with fixed or variable voltage output.

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

CIRCLE 362 ON READER-SERVICE CARD

Drive Circuit

For V-scan shaft encoders

This modular, plug-in, transistorized circuit drives self-selecting brush V-scan encoders. Controlled by the least significant encoder digit

it provides a 20 v output of up to 25 ma for the first pair of encoder logic brushes. A transconductance amplifier stage limits switching voltage, thus extending encoder life.

United Aircraft Corp., Norden Div., Dept. ED, Wiley St., Milford, Conn.

CIRCLE 363 ON READER-SERVICE CARD

Amplifier

Features low noise

Quiet Amplifier 108 provides a gain of 100 over a range of 1 cps to 1 mc. The equivalent input noise is 1.5 μv maximum for a 10 kc bandwidth between 10 cps and 1 mc, and 4 μv maximum for a 100 kc bandwidth. Input impedance is 8 meg; output impedance, 600 ohms. Maximum output is 10 v rms.

Zacharias Electronics Corp., Dept. ED, P.O. Box 172, Livingston, N.J.

CIRCLE 364 ON READER-SERVICE CARD

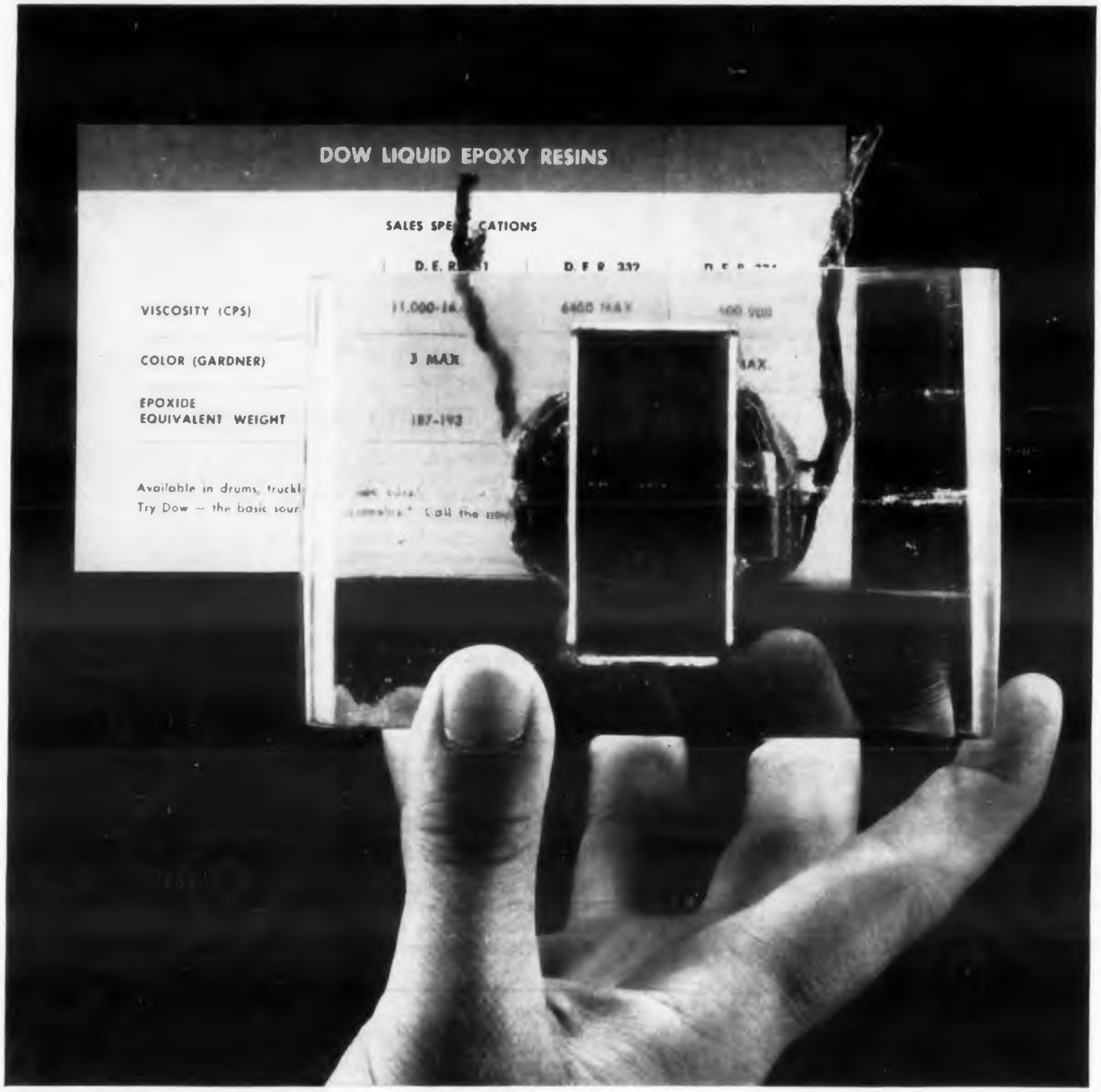
Waveguide Shutter

For X-band use

A compact rotary waveguide shutter, the MA-710 is for RG-52/U X-band use. It exhibits greater than 30 db attenuation over the 8.5 to 9.6 kmc band while in the normally closed position. In the open position, insertion loss is less than 0.5 db over the specified bandwidth.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 365 ON READER-SERVICE CARD



This hand-poured casting was not evacuated to remove bubbles.

See for yourself the clarity of new Dow Epoxy!

This unretouched photo demonstrates how easy it is to see through several inches of Dow Epoxy Resin 332—and thus how easy it is to visually inspect parts which are encapsulated in D. E. R. 332.

But a perfect inspection "window" is not the only advantage you get when you use D. E. R. 332 for encapsulation. Compared to ordinary epoxies, the high purity of D. E. R. 332 makes possible more uniformity, lower viscosity, longer pot life and greater heat resistance. Of special interest also for electrical applications, D. E. R. 332 and D. E. R. 331 are very low in total and hydrolyzable chlorides.

D. E. R. 331 is a standard unmodified resin designed for customary applications and D. E. R. 334 is a modified low-viscosity resin especially suited for laminating.

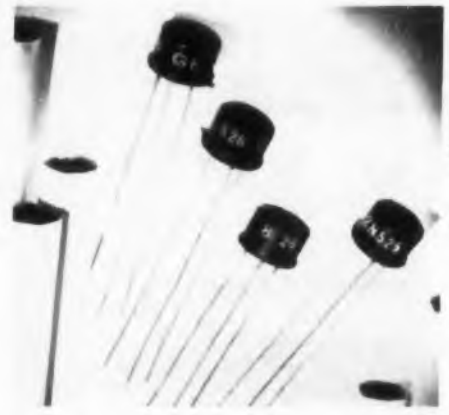
All three of these Dow Liquid Epoxy Resins are available for prompt delivery to you in drums, truck or tank car lots. For complete information on Dow liquid and solid epoxies and epoxy novolaks, call your nearest Dow sales office. Or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Coatings Sales Dept. 2262P-3.

EPOXY DOW

YOU CAN DEPEND ON

CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS



Transistor

30 v 1/2 amp

These PNP germanium transistors, designate 2N524, 2N525, 2N526, and 2N527, are rated 30 v and 1/2 amp. They were designed fo medium power amplifier and low frequenc high current switching applications. All units a capable of 225 mw dissipation in free air at 25 and may be operated up to temperatures of 85

General Electric Co., Dept. ED, Syracus N. Y.

CIRCLE 366 ON READER-SERVICE CARD

Power Supply

For missile ground support

For missile ground support applications, mode M1134B is a magnetic amplifier-transistor regu lated power supply with a dc output of 24 to 32 at 500 amp. Response time is adjustable from 2 to 200 msec for dynamic load changes of no loa to full load. The unit is built to MIL-T-6457 specifications.

Perkin Engineering Corp., Dept. ED, 34 Kansas St., El Segundo, Calif.

CIRCLE 367 ON READER-SERVICE CARD

X-Y Plotter

Transistorized

X-Y variplotters 205S and T have a 30 x 30 in. plotting surface for presenting analog computer output. Amplifiers and power supplies in the 250 lb automatic units are all transistorized. The servo motors operate at 400 cps.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.

CIRCLE 368 ON READER-SERVICE CARD

Capacitors

For transistor circuitry

Rugged and reliable, series EP metallized paper capacitors are suited for wave filters, transistor circuitry, and other circuits having up to 100 v. Triangular, half-round sections, and other form factors are available in all capacitance values.

Electron Products Co., Dept. ED, 430 N. Halstead Ave., Pasadena, Calif.

CIRCLE 369 ON READER-SERVICE CARD

In-Line Display

90 degree

With the help of a mirror, images received at the top of this 90 degree in-line display appear in front. The device shows +, −, and 0 through 9 in any combination and may also serve as an annunciator. Units come singly or assembled in groups.

Industrial Electronic Engineers, Dept. ED, 3073 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 370 ON READER-SERVICE CARD

Blower

For missile use

Designed to cool electronic missile gear, the pimax-2 fan is 3 in. across and 1.4 in. deep. rovides 120 cfm at 20,000 rpm.

tron Mfg. Co., Inc., Dept. ED, Woodstock,

CIRCLE 371 ON READER-SERVICE CARD

NEW PRODUCTS

Multiturn Limit Stop

Infinitely adjustable

The LS 104 is a multiturn, infinitely adjustable limit stop for miniature servo and instrument mechanisms. Synchro mounted, it has a torque rating of 18 oz-in. and can be set to limit rotation to any angle from 0 to 20 revolutions.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.

CIRCLE 372 ON READER-SERVICE CARD

Power Transistors

15 amps

Two series of high current power transistors with current gains of 40 and 75 at 10 amp are now in production. These transistors have a max collector current rating of 12 amp. The transistors have collector-to-emitter breakdown v ratings of 30, 40, 70, and 80 v. The corresponding collector-to-base breakdown ratings are 20 v higher.

Bendix Aviation Corp., Red Bank Div., Dept. ED, 201 Westwood Ave., Long Branch, N.J.

CIRCLE 373 ON READER-SERVICE CARD

DC Power Supplies

High voltage

Hypac miniature, solid-state power supplies have dc outputs from 1 kv at 2 ma to 10 kv at 5 ma. Inputs are dc and 105 to 125 v ac, 60 or 400 cps. Regulation is ±0.5 per cent.

ERA Pacific, Inc., Dept. ED, 1760 Stanford St., Santa Monica, Calif.

CIRCLE 374 ON READER-SERVICE CARD

Solid Tantalum Capacitors

For higher voltages

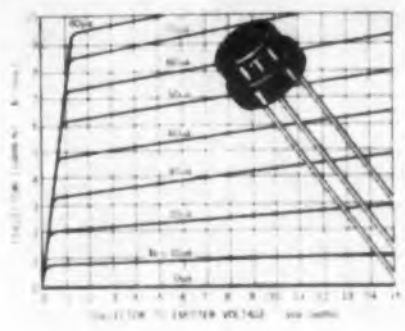
Four Type S-T-A (solid tantalum) capacitors with higher working voltages have been made available. Two are rated at 50 wv dc and the other two at 60 wv dc. Capacitor values range from 0.6 to 1.2 mfd. The units can operate in temperatures from —75 to +85 C. Maximum leakage current at +25 C does not exceed 3μa.

Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.

CIRCLE 375 ON READER-SERVICE CARD

High-Beta Silicon Transistor

Minimum current gain of 80



Operating at 15, 30, and 45 v respectively, 2N541, 2N542, and 2N543 high-beta silicon transistors offer a minimum current gain of 80. A useful beta is maintained from —65 to +150 C and at reduced collector current levels.

Transitron Electronic Corp., Dept. ED, Wakefield, Mass.

CIRCLE 376 ON READER-SERVICE CARD

Microwave Meter

Measures power density

Microline 646 is a portable search meter that measures the power density of microwave fields. It detects hot spots and leakage around antennas, transmitter tubes, and plumbing. Three models cover the S, C, and X bands. They give continuous direct readings in milliwatts per square centimeter with —0, +2 db accuracy.

Sperry Microwave Electronics Co., Dept. ED, Clearwater, Fla.

CIRCLE 377 ON READER-SERVICE CARD

NEW PRODUCTS

LOGIC UNIT.—Breadboard with up to 23 magnetic core logical elements. All connections end in plug-in terminals for quick, easy patch-cord connection.

Di-An Controls, Inc., Dept. ED, 40 Leon St., Boston 15, Mass.

CIRCLE 378 ON READER-SERVICE CARD

DATA RECORDING CAMERA.—Dynafax takes motion-analysis photographs at upper rate of 25,000 16-mm frames per sec. Uses standard 35-mm film; weighs 28 lb. Exposure times adjustable between 1 and 5 μsec.

Beckman & Whitley, Inc., Dept. ED, 973 E. San Carlos Ave., San Carlos, Calif.

CIRCLE 379 ON READER-SERVICE CARD

LOCK NUTS.—One-piece hexagon washer nuts that need no separate washer. For shock mountings, retaining spring coils, and other uses under tension. Size 10 through 1/2 in.

Illinois Tool Works, Shakeproof Div., Dept. ED, St. Charles Rd., Elgin, Ill.

CIRCLE 380 ON READER-SERVICE CARD

POTTING COMPOUND.—For potting electrical connectors, harness junction molding, repairing cable jackets, sealing instrument cases. Dielectric constant, 3.2; dielectric strength, 1500 per mil; insulation resistance, 10^{12} to 10^{14} ohms.

Electronic Production & Development, Inc., Dept. ED, 138 Nevada St., El Segundo, Calif.

CIRCLE 381 ON READER-SERVICE CARD

PANEL HANDLES AND THUMB SCREWS.—Nickel plated brass, stainless steel, or aluminum in variety of sizes. Meet commercial and government specifications.

Vemaline Products Co., Dept. ED, Box 222, Hawthorne, N.J.

CIRCLE 382 ON READER-SERVICE CARD

ELECTRONIC COUNTER.—Superscaler SC-18B has recessed front panel to protect control lights and switches. Both present time and present count can be set at once.

Tracerlab, Inc., Dept. ED, 1601 Trapelo Rd., Waltham 54, Mass.

CIRCLE 383 ON READER-SERVICE CARD

MERCURY BATTERY HOLDERS.—Clips 2475, 2477, and 2324 are 3, 4 and 5 cell units built to hold the company's TR-133R, TR-134R, and TR-135R batteries under severe shock and vibration.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 384 ON READER-SERVICE CARD

DOLLY.—For frequency counters, scopes, and other major test units. Formed and welded from sheet metal.

Northeastern Engineering, Inc., Dept. ED, 25 S. Bedford St., Manchester, N.H.

CIRCLE 513 ON READER-SERVICE CARD

TRANSISTORIZED POWER SUPPLY.—Model SC-36-1 delivers 0 to 36 v 0 to 1 amp. Regulation, 0.1%; ripple, 1 mv rms; recovery time 50 μsec.

Kepco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 514 ON READER-SERVICE CARD

MINIATURE SERVO VALVES.—Suited for missiles. Flow rates up to 10 gpm; supply pressures to 3000 psi. Only 2 moving parts.

Kearfott Co., Inc., Dept. ED, 1378 Main Ave., Clifton, N.J.

CIRCLE 515 ON READER-SERVICE CARD

LIQUID CASTING RESIN.—Maskast 1225 for volume epoxy casting. Pours easily and cures quickly at room temperature.

Hastings Plastics, Inc., Dept. ED, 1531 Twelfth St., Santa Monica, Calif.

CIRCLE 516 ON READER-SERVICE CARD

STANDOFF TERMINALS.—Molded ceramic insulated units. In swage and internal or external thread types. Gold over silver plate terminals.

Goe Engineering Co., Dept. ED, 219 S. Mednik Ave., Los Angeles 22, Calif.

CIRCLE 517 ON READER-SERVICE CARD

POLYCARBONATE RESIN.—Lexan thermoplastic molding material is tough and heat resistant. Has high impact strength, dimensional stability, and good electrical properties.

General Electric Co., Chemical and Metallurgical Div., Dept. ED, Pittsfield, Mass.

CIRCLE 518 ON READER-SERVICE CARD

VIBRATION ISOLATING SYSTEMS.—Finnflex systems absorb vibration through a network of stainless steel cable. Suited for missiles and aircraft, they stand extreme shock and vibration and temperatures to 500 F.

T. R. Finn & Co., Inc., Dept. ED, 200 Central Ave., Hawthorne, N.J.

CIRCLE 519 ON READER-SERVICE CARD

COAXIAL CABLE CONNECTORS.—Have self-threading sleeve and supported flare to provide mechanical strength and gas tight seal. Center contacts cannot spring open.

Edlen Inc., Dept. ED, 8105 Woodmont Ave., Bethesda 14, Md.

CIRCLE 520 ON READER-SERVICE CARD

NEW PRODUCTS

HIGH PERMEABILITY ALLOYS.—Nickel-molybdenum-iron. HyMu 400 provides minimum 60 cps ac permeability of 35,000 at 40 gauss for 0.014 in. thick strip. Vacument HyMu 800 is vacuum-melted, has minimum permeability of 55,000 at 40 gauss.

The Carpenter Steel Co., Dept. ED, Reading, Pa.

CIRCLE 523 ON READER-SERVICE CARD

REGULATED POWER SUPPLIES.—Magnetic model KM-253 has two ranges: 20 to 40 v, 0 to 6 amp and 40 to 60 v, 0 to 4 amp. Regulation, ±1%; ripple, 0.05%.

Kepco Labs, Inc., Dept ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 524 ON READER-SERVICE CARD

CLUTCHES AND BRAKES.—Three additions to Dyna-torQ magnetic friction clutch and brake line. Flange-mounted brake and clutch, and bearing-mounted clutch with 0.667, 5, or 20 lb-ft torque capacities. For use in light machinery.

Eaton Mfg. Co., Dynamatic Div., Dept. ED, Kenosha, Wis.

CIRCLE 525 ON READER-SERVICE CARD

PORTABLE FREQUENCY METER.—Type 5890-B for split or adjacent channels in 25 to 74 mc range. Can service and maintain multiple transmitter installations operating on 1 to 24 channels. Stability of ±0.00025%.

Allen B. Du Mont Labs, Inc., Dept. ED, 760 Bloomfield Ave., Clifton, N.J.

CIRCLE 526 ON READER-SERVICE CARD

FLEXIBLE COUPLING.—Series CN for fractional hp applications. Replaceable center disc of molded nylon resists shock and compensates for misalignment. Rated 1/8, 1/4, and 1/2 hp at 1750 rpm.

Climax Metal Products Co., Dept. ED, 863 E. 140th St., Cleveland 10, Ohio.

CIRCLE 527 ON READER-SERVICE CARD

RECTIFIER ANALYZERS.—Model S-101 and S-102 rapidly perform five standard circuit tests for signal diodes and silicon, germanium, and selenium metallic power rectifiers. Mainly for production lines and laboratories.

Cedco Electronics, Inc., Dept. ED, Erie, Pa.

CIRCLE 528 ON READER-SERVICE CARD

WATERPROOF PRESSURE CELLS.—Series 80 and 90 solid state devices for use with liquid, gas, and mechanical force. Sensitivities from 1 g full scale to 600 psi.

Clark Electronic Labs, Dept. ED, Box 165, Palm Springs, Calif.

CIRCLE 529 ON READER-SERVICE CARD

TRANSISTORIZED AUDIO AMPLIFIERS.—Miniature Audiotran amplifiers are hermetically sealed, fit standard 7-pin sockets. Outputs are 120 mw to 2 w; power gains 45 to 66 db; frequency responses, 175 cps to 12 kc; input impedances, 400 ohms to 50 K.

Ferrotran Electronics Co., Dept. ED, 693 Broadway, New York 12, N.Y.

CIRCLE 532 ON READER-SERVICE CARD

PRINTED CIRCUIT TAPES AND SHAPES.—For master layouts. B-150 photographic tape and B-255 precut shapes have transparent adhesive, leave no smudge marks.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 533 ON READER-SERVICE CARD

PORTABLE TENSION METER.—DR-10 direct reading meter provides continuous indication of static and dynamic strain. Covers range of 60,000 microinches per inch. Operates with gage resistances of 60 to 1000 ohms.

Bytrex Corp., Dept. ED, 294 Centre St., Newton 58, Mass.

CIRCLE 534 ON READER-SERVICE CARD

SHAFT SEAL.—Hexseal series NLK-9000 for locking-type potentiometer and variable capacitor shafts. Maintains seal in locked and unlocked positions. Recommended for pressurized equipments.

A. P. M. Co., Dept. ED, 252 Hawthorn Ave., Yonkers, N.Y.

CIRCLE 535 ON READER-SERVICE CARD

DECADE AMPLIFIER.—Mainly for sound measuring systems. Has internal calibration source, 100 μv full scale sensitivity, and switch-selected average and peak meter readout. Produced by Bruel & Kjaer, Denmark.

B & K Instruments, Inc., Dept. ED. 3044 W. 106th St., Cleveland, Ohio.

CIRCLE 536 ON READER-SERVICE CARD

ALUMINUM FOIL MARKERS.—Self-sticking numbers and letters. Resistant to water, oils, alkalies, and common solvents. Variety of sizes.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 537 ON READER-SERVICE CARD

MODULAR METAL CABINETS.—For housing electronic components or instruments. Parts can be ordered separately for on the spot assembly. They include pedestals, ball cornered sides and doors, panels, tops, drawers, and foot rests.

Bud Radio Inc., Dept. ED, 2118 E. 55th St., Cleveland 3, Ohio.

CIRCLE 538 ON READER-SERVICE CARD

NEW PRODUCTS

PRESSURE SENSITIVE TAPES.—In widths down to 1 64 in. ±0.005 in. Slit to order from Vinyl, Mylar, acetate, aluminum foil, paper, glass, cotton, and other materials.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 541 ON READER-SERVICE CARD

PULSED MODULATORS.—Models 75M-1, -2, -3 with peak pulse powers of 0.6, 1.2, and 2 megawatts, respectively. Units drive wide range of magnetrons, klystrons, and twt's, have 0.5 to 5 μsec standard pulse lengths.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 542 ON READER-SERVICE CARD

ELECTRICAL INSULATION TAPE.—No. X-1060 is inorganic, pressure-sensitive, coated glass cloth that holds and insulates from −50 to+180 C. Dielectric strength, 7000 v; insulation resistance, 7500 meg; tensile strength, 150 lb per in.

Minnesota Mining and Mfg. Co., Dept ED, 900 Bush St., St. Paul 6, Minn.

CIRCLE 543 ON READER-SERVICE CARD

TERMINALS.—"Leed-savrs" 1028 through 1031 allow removal of pigtail leads with minimum heat, thus reducing costly parts spoilage.

Alpine Electronic Components Corp., Dept. ED, Wolcott Rd., Waterbury, Conn.

CIRCLE 544 ON READER-SERVICE CARD

BATTERY HOLDER.—Molded polyethylene tube with screw end cap. For radios, military equipment, other units powered by dry batteries. In varied lengths that hold up to four C or D flashlight type cells.

Mayfair Molded Products Corp., Dept. ED, 3700 N. Rose St., Schiller Park, Ill.

CIRCLE 545 ON READER-SERVICE CARD

LONG TIME DELAY RELAY.—Class 66S relay has long slugs for operate delays to 0.15 sec, release delays to 0.25 sec. Heavy duty telephone type. For dc operation only in all standard voltages to 230.

Magnecraft Electric Co., Dept. ED, 3350D W. Grand Ave., Chicago 51, Ill.

CIRCLE 546 ON READER-SERVICE CARD

TWT AMPLIFIER.—Model TA-6 1-w unit for C-band. Minimum gain, 30 db; power output, 30 dbm; spurious modulation, 35 db below signal; noise figure, 30 db.

Menlo Park Engineering, Dept. ED, 721 Hamilton Ave., Menlo Park, Calif.

CIRCLE 547 ON READER-SERVICE CARD

MOLDING AND ENCAPSULATING TERMINALS.—Designed for plastic headers used in printed circuits and miniature tube sockets. Units meet MIL-E-1; have 0.00002 in. 24 K gold flashing over heavy silver plate.

Alpine Electronic Components Corp., Dept ED, Wolcott Rd., Waterbury, Conn.

CIRCLE 561 ON READER-SERVICE CARD

IMPULSE GENERATOR.—Model 10450 initiates explosives after a device such as a bomb is launched from a parent vehicle. Electrical energy is developed by the separation force, eliminating need for electrical connections to parent vehicle.

Microloc Corp., Dept. ED, 5808 Marilyn Ave., Culver City, Calif.

CIRCLE 562 ON READER-SERVICE CARD

HIGH TEMPERATURE HEADERS.—Metallized alumina units function above 1000 C.

Mitronics Inc., Dept ED, 1290 Central Ave., Hillside, N.J.

CIRCLE 563 ON READER-SERVICE CARD

LIQUID-TIGHT ENCLOSURES.—Provide liquid and dust protection for installed electrical components. Accommodate all standard makes of oiltight pushbuttons, switches, and pilot lights. In 10 sizes with or without holes.

Keystone Mfg. Co., Dept. ED, 23328 Sherwood Rd., Warren, Mich.

CIRCLE 564 ON READER-SERVICE CARD

MECHANICAL VIBRATION MACHINE.—Model BVA-25 handles specimens to 25 lb at accelerations to 20 g. Has 10 in. sq table that vibrates vertically at 2 to 20 cps. One adjustment provides double amplitudes to 1 in. maximum.

L. A. B. Corp., Dept. ED, P.O. Box 278, Skaneateles, N.Y.

CIRCLE 565 ON READER-SERVICE CARD

TRANSDUCER SYSTEM.—Model 502400-2 for continuous, accurate measurement of LOX or fuel head in missiles. Typical values for a 22 ft liquid column: repeatability, 0.04 in.; hysteresis, 0.08 in.

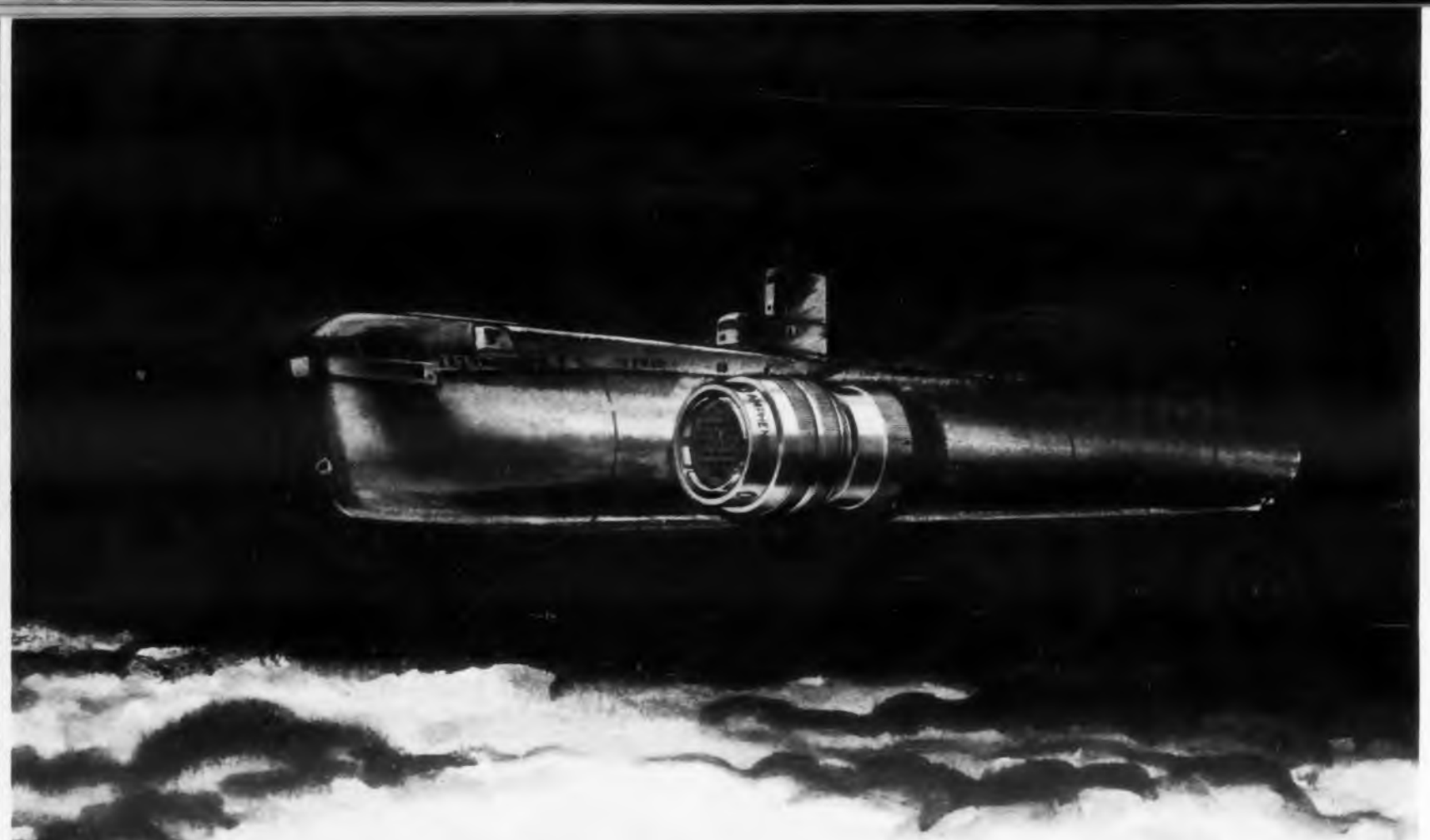
Wallace O. Leonard, Inc., Dept. ED, 373 S. Fair Oaks Ave., Pasadena 1, Calif.

CIRCLE 566 ON READER-SERVICE CARD

PHOTO-DRAWING TECHNIQUE.—With this process specifications can be drawn directly on a photograph taken from any angle.

Technical Reproduction Service, Dept. ED, 375 South St., Newark 5, N.J.

CIRCLE 567 ON READER-SERVICE CARD



a FLYING SUBMARINE?

AMPHENOL engineers and laboratory test group refer to 67 Series *MINNIE* connectors as "flying submarines." It started as only a humorous name but it is actually a quite accurate description of these miniature "E" connectors. Here's why. The performance conditions under which *MINNIE* connectors will operate are exactly like those of a submerged submarine—flying at 80,000 feet altitude!

Another description for "flying submarine" is *altitude-moisture resistant*. Under a new test devised by industry and the military, wired *MINNIE's* are completely submerged in salt water and altitude cycled to 80,000 feet for one minute, to 65,000 feet for one half hour and then returned to ambient pressure for another half hour.

Following this test, the minimum insulation resistance of *MINNIE* connectors is 1000 megohms, well in excess of the 100 megohms required by MIL-C-5015C after moisture.

What can a "flying submarine" do for you? If you use electrical connectors in aircraft, missile or naval applications (including non-flying submarines), *MINNIE* connectors will provide *assured environmental resistance to moisture* at sea level and at high altitudes. Write for complete cataloging plus information on AMPHENOL's *MINNIE* connectors!

AMPHENOL's Authorized Industrial Distributors stock MinniE's and other standard AMPHENOL components—and provide on-the-spot delivery.

AMPHENOL ELECTRONICS CORPORATION
chicago 50, illinois

WHAT THE VE ENGINEER DOES

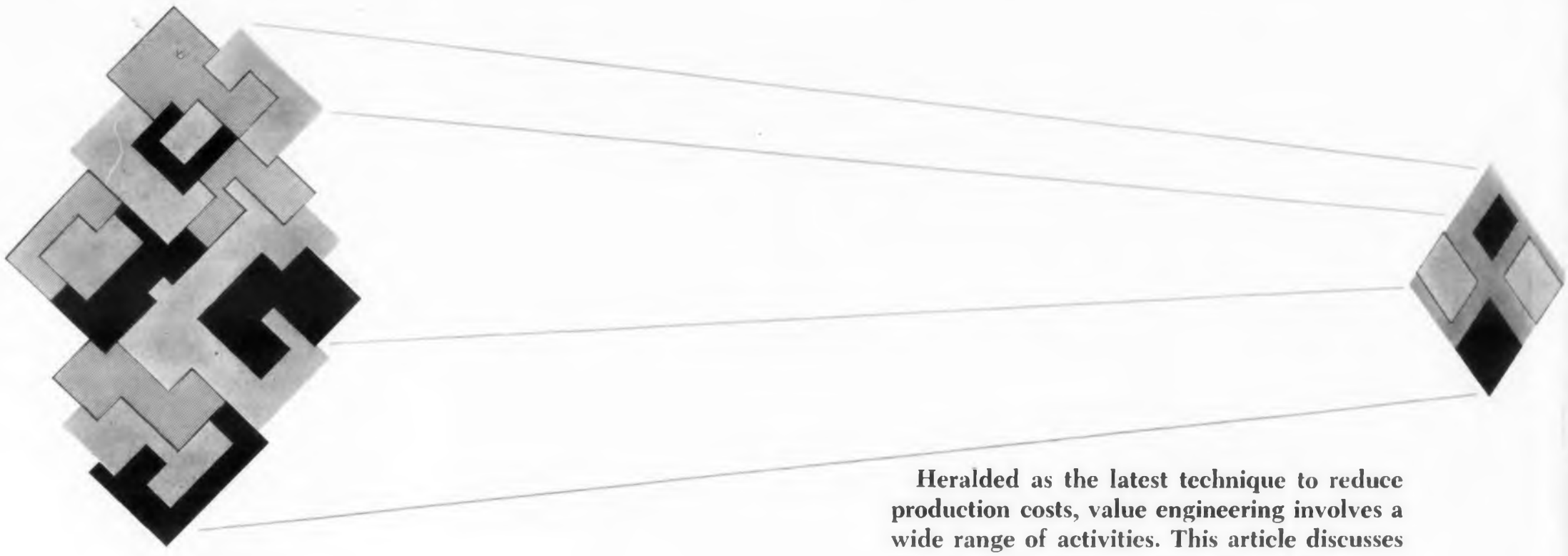
BEFORE THE ITEM IS MADE:

1. Can we do without it?
2. Does it do more than is required?
3. Do you think it costs more than it is worth?
4. Is there something better to do the job?
5. Can it be made by a less costly method?
6. Can a standard item be used?
7. Considering the quantities used, could a less costly tooling method be used?
8. Does it cost more than the total of reasonable labor, overhead, material profit?
9. Can someone else provide it at less cost without affecting dependability?
10. If it was your money, would you refuse to buy the item because it cost too much?

AFTER THE ITEM IS MADE:

1. Tries to eliminate functions and parts . . .
2. Simplifies . . .
3. Changes a design so that a high speed method can be used . . .
4. Changes a design so that standard parts or materials can be used . . .
5. Uses a lower cost material that will do the job reliably . . .
6. Uses a higher cost material which, by its nature and properties, will simplify the design and facilitate lower cost assembly.

◄ CIRCLE 592 ON READER-SERVICE CARD



Heralded as the latest technique to reduce production costs, value engineering involves a wide range of activities. This article discusses its objectives, how to apply it and its major problems.

Value Engineering—That Second Look

Laurence D. Shergalis
Associate Editor

VALUE ANALYSIS is an objective evaluation of a piece of electronic equipment with these three objectives:

- Reduce cost while maintaining quality.
- Enhance performance without increasing cost.
- Greatly improve performance with only a minimum increase in cost.

However, value analysis involves a great deal more. It also includes the promotion of ideas, the use of a creative imagination, and the ability to get along with people. These last items are personal characteristics required of the value engineer if he is to operate successfully in the organization.

What Is Value Engineering?

Specifically, value engineering is an organized effort by a specially chosen group of people to reduce costs without impairment of quality. Primary objective of the group is to relate the cost of each item with its value to the equipment as a whole. Included in the cost consideration are the materials, production processes, testing and inspection. Purpose of all this is to determine the minimum functions necessary, the minimum number of parts needed and the least expensive materials and procedures. And, of course, all this leads to reduction of the total cost of the equipment without adversely affecting its essential characteristics.

Why Is Value Engineering Needed?

Costs in every area have increased rapidly. Recently many manufacturers have discovered that an increase in gross sales has been accompanied by a decrease in profit ratio.

An obvious solution is to cut overhead, automate production or other savings. But in addition, value engineering is able to step into an area formerly ignored—that of surveying the original design work of the engineering department. For example, a design should be checked to see if corners can be cut here or there; whether the designer used standard parts where possible; whether the equipment is overdesigned for the job it is to do.

Summing up, value engineering is needed to rid industry of some of its costly habits and attitudes. It also is needed to avoid carrying high costs of design over into production. Further, it will provide data on techniques that can be used in future cost analysis projects.

Who Does It?

Here is the area in which we find the most controversy over value analysis. One group insists that a separate team of value engineers must be set up to operate successfully. Opposing this are the people who feel that value engineering should be taught all company engineers so that its principles can be applied from the early design stages. Both have valid arguments.

One point of view is expressed by Fred Kirch of Arma Corp. on page iv. In the case of Arma, a separate value group is impractical. Concurring are management groups who feel that value analysis is "common sense" and should be incorporated into every stage of product engineering and development. Good engineers, claims this group, worry about value coincident with their engineering activities.

(Continued on following page)

The other view, however, is being promoted by a growing group of companies, and the military. They justify the presence of a separate staff of value engineers in this way:

- An individual engineer doesn't always have time to work out the ultimate in lowest cost materials or processes.
- Often the individual engineer is too close to the forest to see the trees. He is most concerned with getting a unit finished and operating properly in the shortest possible time.
- Sometimes an engineering change affects other departments over which the engineer has no authority. Red tape involved in working back through these departments can be discouraging.
- General resistance to change after a design becomes final is another major roadblock. Many engineering departments informally determine the value of a design to the company by counting the number of engineering changes required. Products that have a long record of change orders are generally the most poorly designed.

Therefore, the solution is to organize a separate, full-time, engineering staff with the authority to make necessary changes. And, incidentally, whose very existence depends solely upon their cutting costs and meeting the other objectives of a value engineering program. However, the personnel to fill this job must be carefully chosen.

How to Choose the People

Experience has proven that value analysts cannot be picked at random. For example, the value analyst must first be a good engineer, as well as practical and possessing a creative imagination. He must have had a wide range of experience so that his knowledge includes the essentials of electrical and electronic circuits, materials and production processes. In addition many companies use a purchasing analyst whose duties include the valuation of purchased parts and to determine whether to make or buy.

Obviously, one man capable of filling these requirements would be a rare bird indeed. So the value engineering function must be set up as a group of specialists. Stromberg-Carlson, for example, built the nucleus of their group around a mechanical engineer, an electrical engineer and a production man. These men were then taught value engineering techniques.

Personality is an extremely important factor. The value engineer must be a man respected within his company. He must be self-starting and enthusiastic about the possibilities of improving his company's products. Besides, he should be a salesman, diplomat and aggressive

EVALUATE THE FUNCTION

Using the value engineering technique to evaluate the function rather than the part utilizes these five key questions:

(1) WHAT IS THE PART?
(2) WHAT DOES IT DO?
(3) WHAT DOES IT COST?
(4) WHAT ELSE WILL PERFORM THIS JOB?
(5) HOW MUCH WILL THAT COST?

without being obnoxious. He must be mature, stable and not easily discouraged. Another important requirement is that he be able to listen to other people's views. He must be able to evaluate their suggestions objectively rather than subjectively. He should also be able to talk the shop man's language.

What Are His Duties?

Before discussing the value engineer's duties, it must be understood that he does not design. He begins work on a project after it is put on paper. He gets into the project after the original design concept has been evolved.

Then he begins by putting a price on each function. Its usefulness is weighed against cost. Here he may be able to combine or simplify parts. At the same time he checks tolerances, making them more realistic if necessary. Costs of materials are considered, both on the basis of their initial cost and their final cost after processing.

With these considerations as a start, he is able to arrive at the most economical and fastest production process. Often he may choose a more expensive material or part to facilitate production. By virtue of his ability to evaluate the entire project, he may increase costs in certain areas to effect greater savings elsewhere.

During the design and development stage he questions tooling, styling, vendors, standard or specialty parts. In other words, he works across the board. It becomes essential that he maintain close communications with everyone concerned with the project — the designer, production man, packaging engineer, purchasing department and the customer.

Although we refer to the value engineer here as an individual, it should be recognized that this operation is carried out by a team of experts. Besides these "everyday" duties, they carry on a number of other activities.

An important function of a value engineering group is a familiarity with military standards and specifications. Here, the value engineer can become a valuable consultant.

Post-mortem work is another important facet of an overall value engineering program. Cost data, vendor performance data, new product data and processessing records should be kept for future reference.

RCA points out that they use value engineering as a discipline during the design cycle to achieve objective appraisal of specifications. maintainability, etc. It is applied as early as possible and continued through a design review procedure at predetermined stages of a design.

Know Production Equipment

Value engineers must be familiar with production processess and should have a speaking acquaintance with the equipment used. Purchase of a new piece of production machinery may be justified by an increased rate of production. Resultant cost savings could certainly be equated to the cost of the new equipment. In this issue (page 144) is a listing of some of the latest equipment designed for lower cost production.

Where Outsiders Fit In

Component manufacturers can be called upon for advice in the design stage. Usually they are given blueprints with instructions to make the item. But, engineers often fail to take advantage of the production know-how their vendors possess.

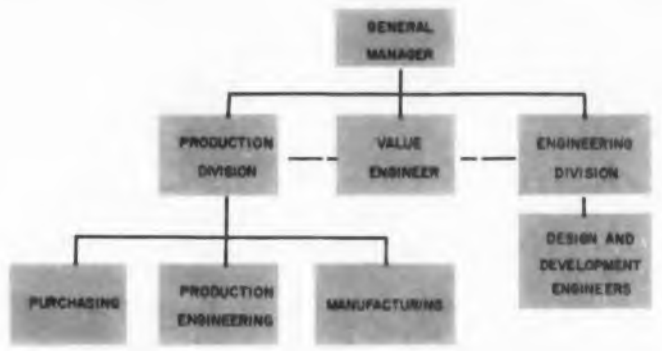
Jack Scheinman, Willor Mfg. Corp., reports that his firm, after 40 years, is now getting calls for advice at the creative stage of the design. He finds that firms where a value engineer program is in operation are making it more and more a practice to call on Willor, a custom sheet metal fabricator.

Willor's function has been to recommend production shortcuts. For example, they show design engineers where dies can be reduced to a minimum; where spot-welding and brazing can replace expensive deep draws; where a change in tolerance has resulted in large savings. Certainly this practice, extended to other vendors. will prove invaluable to the value analyst.

Industry Interest

Value engineering is relatively new. It was started by General Electric about 12 years ago. Since then, it has become accepted by Philco. RCA, Raytheon, Stromberg-Carlson and Westinghouse. Aircraft companies, Convair for one. have also started value engineering groups.

EIA's subcommittee M-73, Value Engineering, lists representatives from Raytheon, Westinghouse, Willor Mfg. Co., Stromberg-Carlson, General Electric, General Instrument Corp., RCA, Engleman & Co., Inc., and Convair. Industry is beginning to recognize value engineering as a worthwhile concept, but progress has been slow.



Stromberg-Carlson's organization places value engineers in a strategic position between production and engineering.

Military Interest

Spearheading the Military interest in value engineering has been the Bureau of Ships of the Navy Dept. A Specification, MIL-V-19858 (Specification for Value Engineering of Naval Electronic Equipment) has been prepared which requires a contractor to conduct an evaluation study as prescribed. The contractor is required to perform the study before going into production. The amount of time allowed varies between one to four months. It depends upon the complexity of the equipment.

Incentive for value engineering studies has always been a problem. Under the Navy's interpretation of their specification, from 10 to 40 per cent of the savings made by applying value engineering to a contract can be retained by the contractor.

What Are The Results

In this issue (page vi) are examples of how value engineering has been applied to electronic equipment. Reports from firms that have adopted programs of this type indicate that it works. A report on military experience is on page 140.

BuShips reported that they have saved over $8 million in three years. Actual savings, they report, were $8.30 for each dollar spent on value engineering.

Stromberg-Carlson found they are getting a return of about $7 for each dollar spent. Using past data early in subsequent designs, they have on occasion, realized a $20 return. And these figures were realized at the end of the first year.

The Defense Electronics Products division of RCA started a formal value engineering program in early 1957. In a little over one year, they performed value engineering on six projects and achieved an average saving of about 15 per cent per equipment. Average ratio was 12 to 1 in amount of savings compared to the cost.

For a free reprint of this report, turn to Reader's-Service card and circle **100.**

Value is Everybody's Business

In this article the author shows where value analysis as a separate group function is not desirable. He suggests an approach where every company engineer is trained to apply value engineering principles throughout his early design stages. Thus the need for a separate "value" redesign would be eliminated.

Fred Kirch
Senior Engineer
American Bosch Arma Corp.
Garden City, N.Y.

ABOUT THE AUTHOR

Fred Kirch is coordinator of standards for Arma Corp. He agrees with the principles, objectives and procedures practiced by value analysts. However, in setting up standards for value analysis, he has found that some deviations are necessary. In some cases, a separate group to evaluate designs isn't practical. Anyway, everyone on the engineering staff should be concerned with value. That's the way it's done at Arma, he says.

IN A competitive market, the fundamental concept of value analysis is a popular theme. It represents an application of the common-sense principle of "getting your money's worth." While value analysis, value engineering and similar catch-phrases are employed to maximum advantage to implement what are essentially cost evaluation programs, the extent to which such programs may be applied is limited by a number of factors. The benefits in some instances may be more apparent than real.

Value, in most instances, can be equated directly to cost. But it is not a logical conclusion to assume that cost reduction is the sole objective of value analysis. In some instances, increased value to the customer may result from increased cost.

In terms of reliability of military electronic equipment, analysis of value can indicate the necessity to increase cost to insure that equipment will perform satisfactorily in the environment for which it is designed. Facility of maintenance and improved operational "climate" reflected in the design of equipment cost more. But substantial dividends are returned to the customer in improved service.

Of Interest to Everyone

There can be no argument with the objectives or accomplishments of any program established to reduce costs without impairing functional characteristics of a product. But it should be recognized that value represents areas of interest to the consumer as well as to the producer. And customer interests control the market value of any product.

Has Limitations

To reduce costs and resolve production problems are worthy objectives. Analysis of value is an excellent tool for accomplishing these desired results. However, a tool is not an end item, but only a means to an end. And value analysis, like any tool, has capabilities and limitations.

The principles and techniques of value analysis demonstrate a substantial degree of application of modern methodizing. Results reported have substantiated the validity of the basic principles and procedures. It seems obvious that analysis of value of a product whose design has been stabilized, can be performed efficiently as the separate and distinct function of a value analysis group. Hundreds of examples are available to prove this.

Need Different Approach

But the application of value analysis to military electronic equipment, for ex-

ample, requires a different approach. To submit such "hardware" to a value analysis group is impractical. Usually the design has become "frozen" at this point and no changes can be made. In this type of operation, then, everyone should have been concerned with value early in the design of the equipment.

Orientation and indoctrination of personnel to develop an awareness of the principles of value analysis as an essential tool is difficult and time-consuming. There appears to be no quick and easy way to accomplish this. It is essential to reach people at the working level so that designers, draftsmen, engineers, buyers—all develop value consciousness as an integral part of their every day work. Admittedly, the degree of saturation will vary according to the extent and frequency of exposure. It must be emphasized that this is not something new. It is not a "program" in the accepted sense.

How To Do It

Meetings must be conducted at regularly scheduled intervals to demonstrate principles and procedures to "working" personnel. These meetings are more effective when conducted by people selected from the various departments concerned. Specific examples of instances where value analysis was applied (or should have been applied) emphasize the principles and procedures.

A series of short bulletins can be issued, perhaps semimonthly, to serve as reminders of value analysis principles and procedures.

Publicity in a house organ with "action" pictures of meeting participation is another way of bringing value analysis to the attention of all personnel.

A periodic review of designs by a checking group provides an indication of the extent of application of value analysis to engineering functions.

All these activities combine to make each engineer more value conscious. As a result, the original design of a piece of equipment incorporates the effects of a value analysis program, without the benefit of a separate group of analysts.

In other words, we cannot say that value analysts as a group can be used efficiently in any type of engineering operation. Under the conditions described, the training of every engineer in value analysis principles is a better way of achieving our objectives.

Does it really work? Here we present a few examples of the results of value engineering studies.

Applying Value Engineering

Before a new concept becomes widely accepted its results must be thoroughly evaluated in the right circles. And there are always a few firms willing to do the pioneering work and publicize their results. Experience files of value engineered electronics projects are admittedly slim to date. However, this collection of examples show the possible potential of value engineering.

Blower Assembly At Raytheon Mfg. Co., the value engineer can also save the taxpayer money by providing high quality Government equipment at the lowest possible cost. For example, these $134.00 custom blower assemblies, used for cooling electronic equipment, were replaced by standard components which performed the same job at a total saving of over $60,000.

Mounting Ring

Mounting Ring shown demonstrates how Philco's Value Engineering techniques simplified the fabrication of a difficult part. The old method of producing the part involved many separate machining operations. The four bosses and irregular cut-outs were milled to the required contours in addition to the operations of removing excess stock to obtain the required profile. Precision casting of the part, eliminated some of the machining operations and simplified others. The underside of the ring is left as cast. The new method reduced the cost of the ring 40 per cent.

Before

After

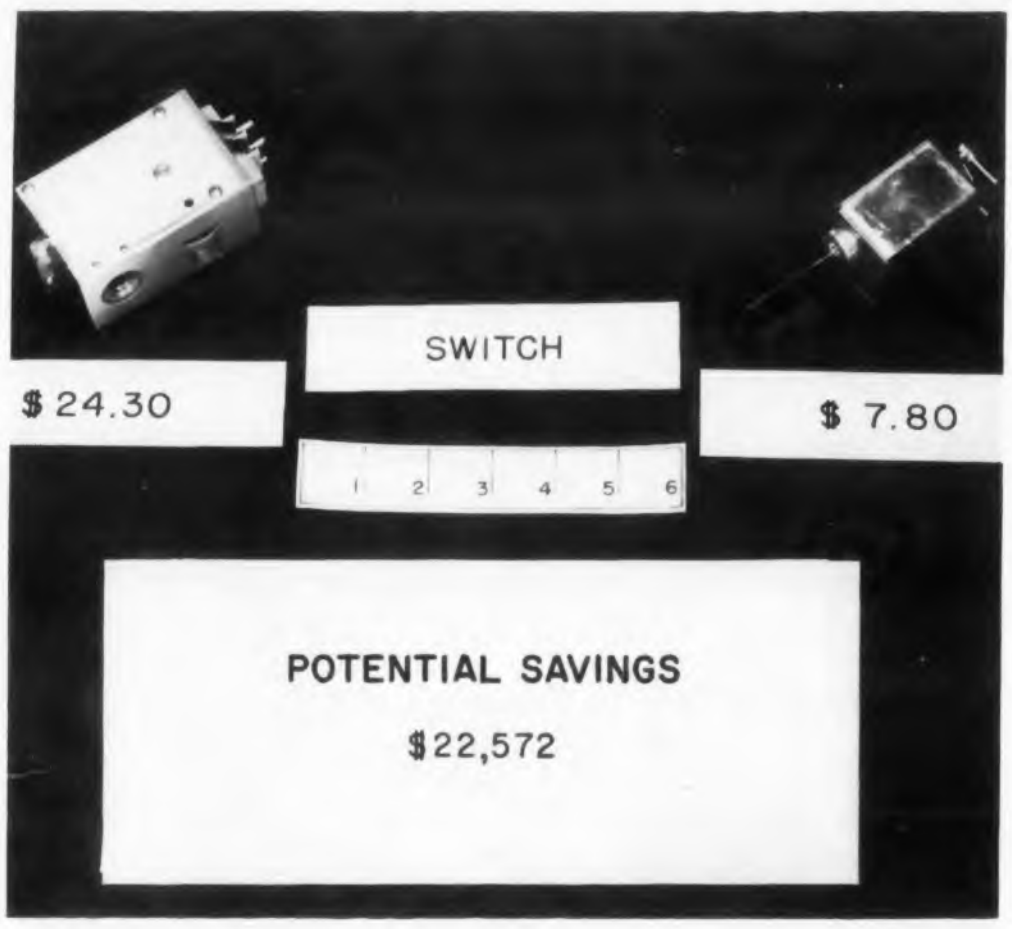
Connector Plate

A special machined plate was used to support and position a spring loaded miniature electrical connector. The part was machined from aluminum bar stock to close tolerances and surface finish. After examining various means of fabrication in relation to the basic function, Philco changed the design to a stamping which proved to be the most economical. A cost reduction of 40 per cent resulted.

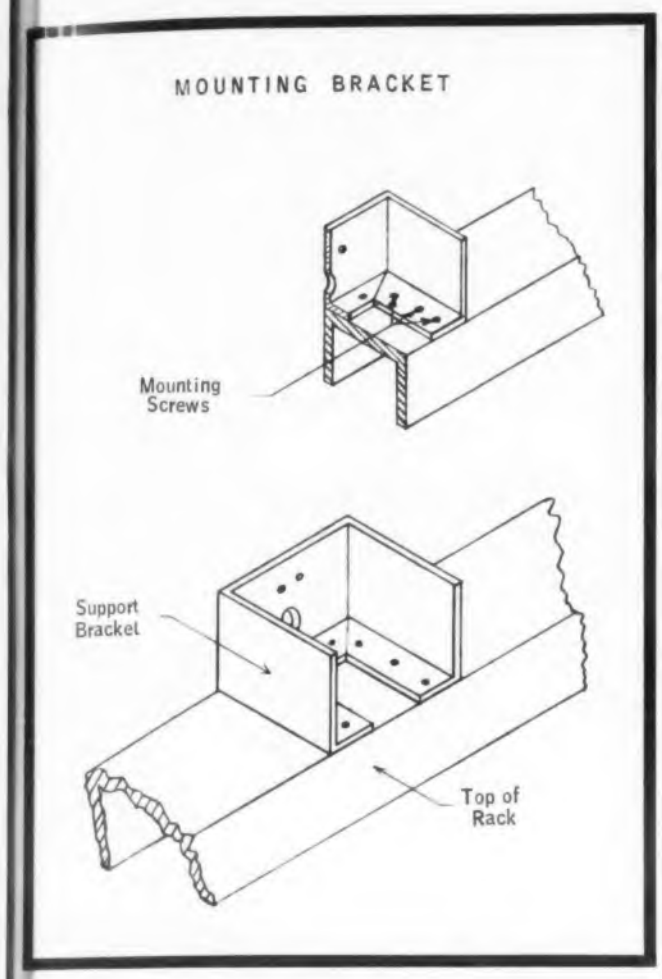
Cabinet Mounts Many times an analysis of installation or location of equipment will reveal opportunities for cost savings. The value engineer has to get all the facts as in this case where ground installation of this electronic equipment did not need the expensive shock mount used for ship mounted cabinets. A simple leveling plate saved nearly $30,000. Raytheon Mfg. Co.

Line Section Raytheon Mfg. Co. depends on its reliable suppliers. Working with and through the Purchasing section, the value engineer finds that these people make many contributions to value, as the vendor did in this small microwave component where a new design and material not only saved money but improved quality.

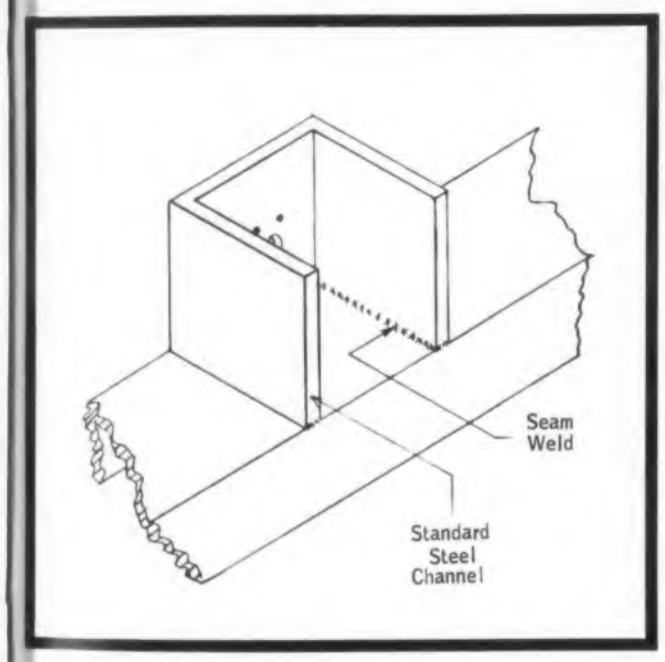
Captive Screw Assembly What does a part cost? What else will do the job? What will that cost? These three questions the value engineer has to answer. In this case, a slot instead of a Hex socket in these panel screws would do the same job with a substantial savings of over $8000. Raytheon Manufacturing Co.



Switch, Air Flow "Find the best supplier" is a technique that often results in better value as in this case where a vendor could supply an air operated switch at 1/3 the cost. Raytheon Mfg. Co.



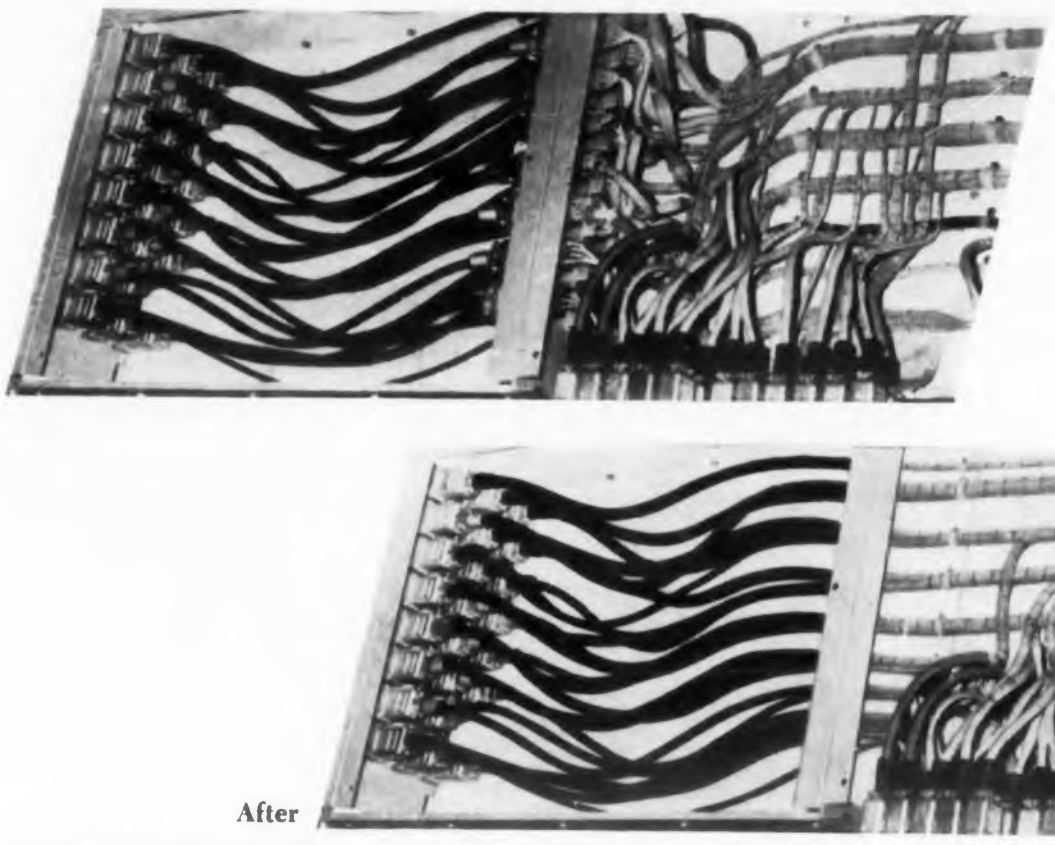
Before



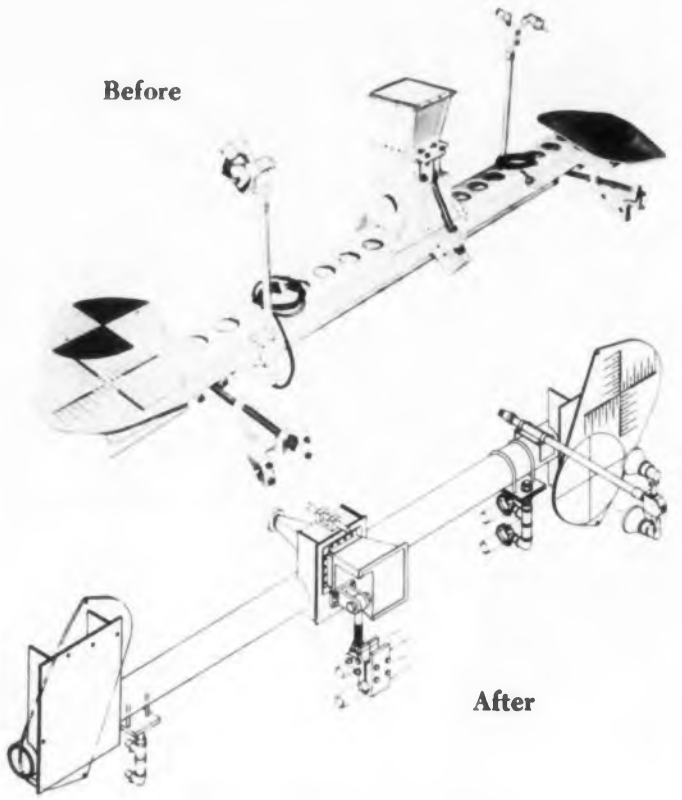
After

Waveguide Bracket

A special formed waveguide bracket was replaced by standard steel channel. The original part required four blanking and forming operations. It was then fastened to the top of a rack with nine screws requiring drilled and tapped holes in the rack, plus hardware. Philco's value engineers replaced this by a section of standard steel channel, which was seam welded to the top of the rack. Unit cost reduction 55 per cent.



Radar Set Wiring RCA originally designed a ground radar set to permit a high degree of flexibility. Interconnecting cables were used between sections. Length varied depending upon the need. However, production units were subsequently designed that eliminated the need for this flexibility. Connectors were eliminated and cables run straight through the bulkhead. Net cost savings amounted to a little over $5000. Reliability was also improved by eliminating soldered connections and connectors.



Boresight Assembly

An RCA project involved producing a boresight assembly for radar calibration. Value analysts reviewed the design with the express purpose of reducing its cost. As shown, the original design used many special castings and complex leveling systems. By using standard commercial hardware, cost was reduced to almost $1500 per assembly. Adjustment has been made more rapid and assembly quality is improved.

Preamplifier Housing

Former preamplifier housing design involved an aluminum housing of very irregular shape which required many machining operations. The part was precisely machined from aluminum bar stock to the required contour, then drilled, tapped and counter bored to the close finish tolerances. A plated metal tube shield was pressed into the tube opening. The new design is formed from molded plastic and accommodates the same number of electronic parts. Electrical shielding of the tube is obtained by press fitting the same plated shield into the tube opening. The molded housing is fastened to a base plate by means of a stamped and formed aluminum mounting bracket which also shields the entire housing. A cost reduction in excess of 50 per cent was realized by Philco Corp.

Umbilical Connector Base

The original umbilical connector base was completely machined from bas stock. While the tolerances were not particularly close, the irregular contour required several intricate machining operations. The part was redesigned by Philco's value engineers and investment cast. Two holes were added for increased mounting rigidity and to accommodate a cable clamp. All machining operations except drilling and tapping were eliminated, cutting the unit cost 30 per cent.

Disconnect Housing

Here is how an aluminum umbilical disconnect housing was redesigned by Philco Corp. to utilize precision casting techniques thereby eliminating practically all the machining operations. The original part was machined from aluminum alloy bar stock. The interior and exterior dimensions were finish machined to meet the required specifications. A 0.247 in. diam stainless steel pin was pressed into a drilled and reamed hole. The nonstandard diameter required that the pin be ground from 0.250 in. diam bar stock. Two locking grooves were milled into the bottom of the cavity by means of a special milling cutter. The housing was redesigned slightly and

precision investment cast. A standard split roll pin was substituted for the nonstandard pin. The only machining required after casting consisted of drilling a 1/4 in. diam hole for the locking pin and milling the base flat to obtain a good seal with the mating part. A cost reduction of 35 per cent was realized without impairing reliability or function of the part.

Mica Spacers

The value engineer attempts to simplify through elimination of parts as in the case of a Raytheon receiving tube where 61 per cent savings was achieved by an ingenious method of using specially designed mica spacers to support the grids instead of four clips. Simplicity means reliability as demonstrated by this example.

Plate Tabs

Value engineering in the Receiving Tube Div. of Raytheon has shown opportunities for substantial savings through design modifications which simplify production and reduce material and labor costs. For example, the addition of tabs to vacuum tube plates eliminates the need for the side rods and eyelets resulting in a 26 per cent reduction, a $25.52 per thousand savings. Value improvement of this type results when skilled analysts question function and creatively answer the question, "What else will do the job?"

Tube Cathode

In a search for better value, all methods of manufacturing parts should be analyzed for relative costs and possible application. The use of a lock-seam integral tab cathode in a vacuum tube resulted in a 38 per cent savings. Raytheon Mfg. Co.

Tube Cathode

In the case of a receiving tube manufactured by Raytheon, tube reliability and quality were enhanced at the same time that costs were reduced. The use of a double beaded cathode eliminated the need for pinching and allowed the use of a 10 leg heater.

Flicker Specifications

Unrealistic specifications often result in excessive costs. RCA's Defense Electronic Products Div. reports a specification for an item that stated, "There shall be no flicker." Cost to produce an item in which no flicker was present was estimated at $12,000. However, the customer was convinced that the specification could be reduced to read, "There shall be no flicker 99.5 per cent of the time." This 0.5 per cent reduction resulted in a saving of $5000 in the cost of the power sup...

High Temperature Component

Specifications for the Terrier and Tartar missiles required that the missile components be designed for a condition of solar radiation causing internal temperatures up to a certain temperature. An investigation disclosed that the type of paint on the missile exterior could affect the actual temperatures by as much as 25 F. Convair requested, and received, approval to change the external paint from Navy grey to white enamel, with a corresponding reduction in temperature requirement of 25 F. While it is impossible to determine the exact dollar savings which resulted from this change, a significant saving did result. In both of these missile programs certain components prevented the missiles from meeting the duty cycle specified. The need to replace these components with ones capable of meeting higher temperature requirements (and in some cases such components prevented the missiles from meetwas eliminated by the change in paint. Thus the savings resulted from elimination of new component development and testing, as well as the fact that these newer components would themselves have been more expensive in production. Convair Div., General Dynamics Corp.

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ELECTRONIC DESIGN acknowledges with appreciation the cooperation of the following firms and organizations in the preparation of this staff report:

All American Tool & Mfg. Co.
Arma Div., American Bosch Arma Corp.
Bodine Corp.
Branson Ultrasonics Corp.
British Industries Corp.
Convair Div., General Dynamics Corp.
Engleman & Co., Inc.
General Electric Co.
General Instrument Corp.
Industrial Education Institute
Kahle Engineering Co.
Lodge & Shipley Co.
Philco Corp.
Raytheon Mfg. Co.
Radio Corporation of America
Stromberg-Carlson Div., General Dynamics Corp.
U. S. Navy Bureau of Ships
Westinghouse Electric Corp.
Willor Mfg. Corp.

Touring Air Test Laboratory

A trailer laboratory for testing air filtering equipment is making a nation-wide tour. Air filtering demonstrations are planned for all major cities. The laboratory has air testing equipment which duplicates that used by the National Bureau of Standards and a visual tester to show the efficiency of all types of air filters. The test equipment is portable and may be taken into plants for tests under actual operating conditions.

Trion, Inc., Dept. ED, McKees Rocks, Pa.

CIRCLE 569 ON READER-SERVICE CARD

Ceramic-Metal Assemblies

Engineering and manufacturing services in metallized ceramics, ceramic to metal seals, and other assemblies using these components are offered. The company is equipped to provide prototype and production quantities to specifications.

Ceramic-Metal Assemblies Corp., Dept. ED, Donohue Rd., Latrobe, Pa.

CIRCLE 570 ON READER-SERVICE CARD

Hot Solder Dipping for Wires

Facilities for hot solder dipping of special alloy wires are announced. Hot tin or solder dipping consists of drawing wire first through baths that clean and prepare its surface, and then through a molten bath of pure tin or 60-40 composition solder. This process prepares the wire for use in printed circuit assemblies and other places where multiple dipped soldering technique is employed. Typical wire types that might be prepared with the hot tinned surface would be phosphor bronze, bronze, brass, beryllium copper, or copper clad. Belle Falls Alloys, Dept. ED, 191 Caldwell Ave., Paterson, N.J.

CIRCLE 571 ON READER-SERVICE CARD

A plane's best friend is

Aircraft parts of Synthane laminated plastics combine light weight, strength and electrical insulating properties.

Almost anyone who flies spells "Reliability" with a capital "R". Which is one reason why the aviation industry is a good customer for Synthane laminated plastics. There are other reasons.

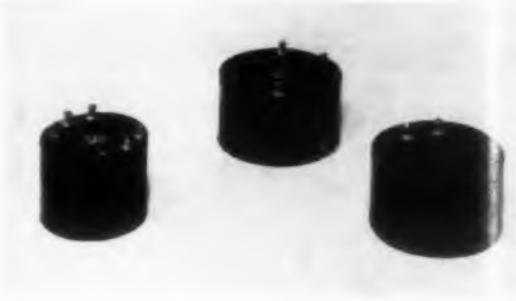
Synthane is a material with many useful properties in combination. It's light in weight (half the weight of aluminum). It's an insulator with high dielectric strength, low dielectric losses, excellent insulation resistance. It's easily machined and resistant to chemicals. You'll go far to find one material with all these desirable characteristics.

But Synthane is more than a material. It is an investment in reliability. Quality control from the raw materials to the finished product assures you of uniformity and rigid compliance with your most exacting requirements.

CIRCLE 573 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

Custom Toroidal Components



Engineering assistance on both standard and custom toroidal components is offered to manufacturers of filters, communications equipment and transistor flip-flop power supplies. The company can deliver volume production or pilot runs on any item.

A. W. Welch Mfg. Co., Inc., Dept. ED, 36 E. 29th St., Indianapolis, Ind.

CIRCLE 574 ON READER-SERVICE CARD

Free Training Program

A continuous training program in visual communication techniques is offered by Tecnifax Corporation at its Holyoke, Mass. plant. The "Visucom Program" is designed to give first-hand experience in the use of diazotype processes, photography, photo-copying, and xerography, as visual communication tools. The psychology of communications is extensively discussed with emphasis placed on the preparation of transparencies for overhead projection. Courses are offered on one, three or five-day bases on dates convenient for registrant. Company will bear expenses for facilities, materials, and instruction for government, military, industrial, and educational personnel eligible for the program. Travel and board will be paid for by those attending, but Tecnifax will arrange hotel and travel details.

Literature available from Department NE, Tecnifax Corp., 195 Appleton St., Holyoke, Mass.

CIRCLE 575 ON READER-SERVICE CARD

Visiting LOX Laundry

Housed in a 35-foot trailer, Wyle Laboratories' LOX-cleaning facility can come to the customer. The "Mobile Controlled Environment Facility" was developed to provide missile component manufacturers with a certified LOX-cleaning source which most of them do not have. In its hospital-like interior, the trailer has a filtered air system, an airlock entryway, cleaning solution dip baths, a vapor degreaser, a drying oven,

and black light inspection equipment. As a testing facility, the unit has provisions for the introduction of high-flow liquid and gaseous oxygen and also for mounting large components. The trailer is set up for packaging too. Components are packaged in sealed and sometimes pressurized containers and delivered, certified LOX-clean, for storage or installation.

Wyle Associates, Dept. ED, 128 Maryland St., El Segundo, Calif.

CIRCLE 576 ON READER-SERVICE CARD

Vibration Testing

Automatic cycling type vibration test equipment has been added to the environmental testing division of Bowser-Morner Testing Labs., Inc. This equipment will make rapid, accurate tests on all types of materials and assemblies under conditions very close to real. It consists of a high frequency electrodynamic vibration exciter capable of random force outputs of up to 1200 lb sinusoidal force at frequencies up to 2000 cps. It includes automatic cycling function and an electronic amplifier and power supply. A vibration meter and oscillograph are used to show the vibration cycle during tests and to photograph cycle results where necessary. Tests can be made at temperatures from —65 to +160 F.

Bowser-Morner Testing Labs., Inc., Dept. ED, 141 Bruen St. at Scott, P.O. Box 51, Dayton 1, Ohio.

CIRCLE 577 ON READER-SERVICE CARD

Frequency Response Movie

The Instrument Society of America is offering for sale or rent a 37-minute film on the principles and techniques of frequency response analysis. For designers, manufacturers, users, and students of control equipment, the film presents the elements of frequency response in nonmathematical terms and describes frequency response analysis as applied to a liquid-level system. It shows the input curve picturing sine wave oscillations being put into the control valve of the system and then the output curve which registers the resultant variation in liquid level. A composite of several such records gives a pictorial display of a different equation for an instrument or system.

Prices for the film range from $600.00 per copy for outright purchase to $25.00 per showing for private organizations and $5.00 per showing for schools. For full details write ISA Headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

SERVICES FOR DESIGNERS

Cryogenics "GOX" Lab

The missile industry's only complete gaseous oxygen and combined environmental test laboratory has been opened to serve aviation and missile manufacturers with a source for advanced testing techniques.

Equipped and instrumented for environmental-functional testing of gaseous oxygen flow components under acceleration, vibration, ambient temperature, and humidity conditions, the lab is also designed to test electronic, mechanical, pneumatic and hydraulic devices under extreme environmental conditions.

The lab's GOX facility will provide gaseous oxygen flows at 1 to 33 pounds per second and at pressures of 2 to 70 psig., at fluid temperatures down to —275° F.

Whittaker Controls, Div. of Telecomputing Corporation, Dept. ED, 915 N. Citrus Ave., Los Angeles 38, Calif.

CIRCLE 580 ON READER-SERVICE CARD

Radar and Microwave Components

Custom-engineering of radar and microwave communication system components is now offered by Narda Microwave Corporation. This service is suited to manufacturers who want specialists to design the more intricate components of these systems.

A new System Components Division has been established for this purpose with its own manufacturing facilities separate from those devoted to the company's regular catalog items.

Components designed by this group have been successfully operated over broad band-widths from one to several octaves in frequency, and include adapters, attenuators, cavities, directional couplers, filters, hybrid junctions, stripline components, and terminations.

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

CIRCLE 581 ON READER-SERVICE CARD

Equipment Made New

A service to incorporate the latest improvements and modifications into Tracerlab equipment now in use has been announced. The service combines complete tracing and testing of circuitry and all mechanical components with complete overhaul and modernization of physical appearance.

Tracerlab, Inc., Dept. ED, 1601 Trapelo Rd., Waltham 54, Mass.

CIRCLE 582 ON READER-SERVICE CARD

Nuclear Safety Planning

A Nuclear Safety Division has been formed by Byrne Associates to offer specialized services in planning new laboratory and plant facilities and in remodeling existing facilities to assure maximum protection against radiation for employees, members of the community, and equipment.

Other engineering services offered are ventilation, air conditioning design, electrical layouts, and structural design. Consultation services for radioisotope utilization in products studies as well as feasibility studies for other applications will be available, in addition to assistance for plant location and similar problems associated with the establishment of business in the atomic energy field.

Byrne Associates, Inc., Dept. ED, 50 Broadway, New York 4, NY.

CIRCLE 583 ON READER-SERVICE CARD

New Consulting Firm Opens

A new consulting firm, Eisler Associates, has recently been organized in Beverly Hills, California. The firm specializes in the planning, formulation, and design of electronic data processing systems for both military and commercial use.

Eisler Associates, Dept. ED, 242 South Rexford Drive, Beverly Hills, Calif.

CIRCLE 584 ON READER-SERVICE CARD

Aluminum Soldering Facilities

For soldering aluminum and its alloys, Paraplegics Mfg. Co. is using an economical process developed by Bell Labs. Tests show that joints made by these methods are stronger than commercial aluminum itself. No flux is used; no deleterious elements such as lead, tin, bismuth, or cadmium.

Paraplegics Mfg. Co., Inc., Dept. ED, 10068 Franklin Ave., Franklin Park, Ill.

CIRCLE 585 ON READER-SERVICE CARD

Digital Tape Recorder Movie

A 15-minute color movie about magnetic tape handlers for digital computers is available to interested groups. Called "Rx Ampex," the film has unusual sequences of high-speed photography which show a new tape recorder start, stop, and reverse its motion more than 100 times a second. For prints, contact a representative of, or write to Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood City, Calif.

SERVICES FOR DESIGNERS

Overnight P-C Prototypes

In 24 hours Techniques, Inc. can make printed circuit prototypes and have them on their way back to customers via air mail. The work can be done either from master artwork or negatives. Two panel sizes are available, and as many as six circuits per panel can be provided. The stock Mil Specification materials offered are 1/32 in. XXXP, 1 oz copper and 1/16 in. epoxy-glass 2 oz copper. Both single and double sided boards can be provided. Special finishes on copper include gold-flash, solder coated, and water dip lacquer. Parts are returned in panels with or without the above finishes.

Techniques, Inc., Dept. ED, 52 Jackson Ave., Hackensack, N.J.

CIRCLE 588 ON READER-SERVICE CARD

Low-Temperature Transducer Calibration

For LOX-range temperature transducers, this service provides calibrations of any increments from —300 to —285 F. Accuracy at any point is 0.1 F. The facility is adaptable for calibration in other low-temperature ranges such as liquid helium and hydrogen.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

CIRCLE 589 ON READER-SERVICE CARD

Instrument Photoprints For Layouts

Cut-out and paste-on photoprints of its instruments are offered by The Bristol Co. The 1/4 scale reproductions can give an accurate picture of proposed control panels during early planning stages.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 590 ON READER-SERVICE CARD

Special Contact Pins

By a new method, A. L. Johnson Co. can furnish special contact pins with no tool charge. Delivery is fast—only 3 hours for local customers. The company also offers seamless or butt seam pins, both in open staking end style.

A. L. Johnson Co., Dept. ED, 8030 N. Ridgeway Ave., Skokie, Ill.

CIRCLE 591 ON READER-SERVICE CARD

Small -Run Chassis

For users of Press-Fit Teflon terminals, Sealectro Corp. is offering a small-run (1 to 5000) chassis fabrication service. It will fabricate complete chassis in a wide range of shapes and sizes up to 12 x 12 in. and mount the required terminals. The facilities include a unique method of installing a large number of terminals at once. This gang-mounting technique saves considerable time and money.

Sealectro Corp., Small-Run Chassis Service, Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 443 ON READER-SERVICE CARD

High Temperature Testing

A high temperature laboratory to test hydraulic control equipment is available for outside contracting. Designed to provide a continuous 10 gpm flow through the use of special recirculation heat exchangers, the facility will provide fluid temperatures up to 700 F at pressures of 4000 psi or less, and ambient temperatures up to 100 F.

Hydraulic Research, Subsidiary of the Bell Aircraft Corp., Dept. ED, 2835 N. Naomi St., Burbank, Calif.

CIRCLE 444 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Precision Plater

For electronic components

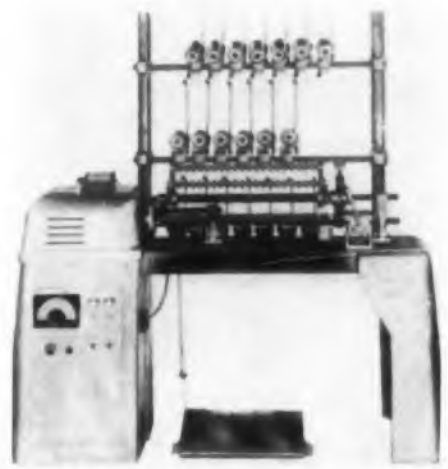
This precision electronic plater is designed to apply precious metals to electronic components. To insure accurate readings for plating minute parts, the unit has a 0 to 1 amp meter with 20 ma graduations. Another meter shows how much metal is needed to replace deposits. Plating interval is regulated by an automatic timer.

Ramyr Mfg. Co., Dept. ED, 1779 N. Main St., Los Angeles 31, Calif.

CIRCLE 445 ON READER-SERVICE CARD

Transformer Winder

Pitch selector eliminates gears



Model 405-AM, using a pitch selector which eliminates gears, has a winding range of 19 through 454 turns per in. and a winding speed up to 2000 rpm. The unit can multiple wind various types of paper section transformers up to 9 in. OD if round and up to 4.5 in. OD if rectangular. Transformers up to 6 in. long can be produced using wire sizes 16 through 44.

The winder is furnished with motor, instant resetting predetermining counter, magnetic brake, positive locking 1 in. stroke compression type tailstock, tilting table paper feed and 20 tensions.

Geo. Stevens Mfg. Co., Dept. ED, Pulaski Rd. at Peterson, Chicago 46, Ill.

CIRCLE 446 ON READER-SERVICE CARD

Toroidal Winder

Precise turns counting

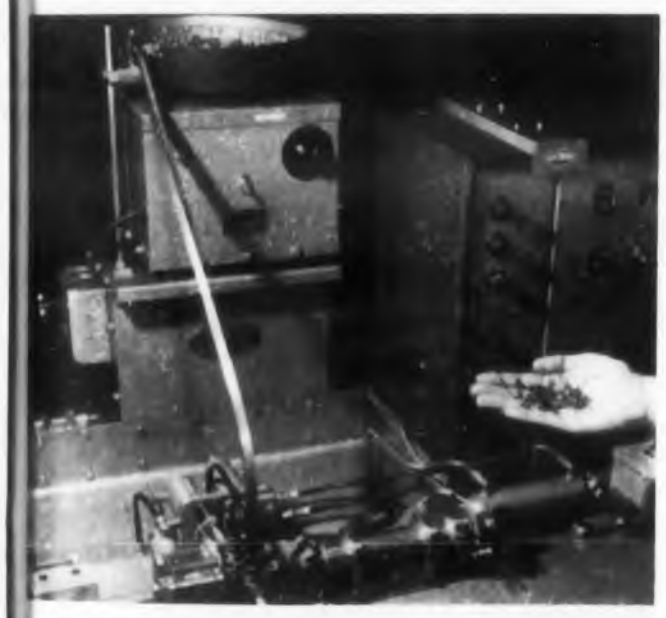
Model TW 300 toroidal winder offers uniform winding and precise turns counting. It uses a control counter to provide slow start and stop of the driving motor, automatic winding of segments, and progressive winding.

Boesch Mfg. Co., Dept. ED, 45 River St., Danbury, Conn.

CIRCLE 447 ON READER-SERVICE CARD

Automatic Pigtail Welder

Turns out 3000 assemblies an hour



Tended by one operator, this automatic assembly and welding machine can turn out 3000 precision-welded pigtail assemblies an hour. Primarily for handling conventional resistors, capacitors, diodes, and rectifiers, the machine can be adapted to special types such as tantalum capacitors. It straightens, feeds, and cuts pigtails and welds them to cups fed from a vibratory hopper.

Raytheon Mfg. Co., Commercial Equipment Div., Dept. ED, Waltham 54, Mass.

CIRCLE 448 ON READER-SERVICE CARD

New! Miniaturized!

Kellogg Type "L" Relay

TYPE "L" RELAY FACTS

CONTACT FORMS	FORM A (MAKE)	FORM B (BREAK)	FORM C (BREAK-MAKE)	FORM D (MAKE BEFORE BREAK)	REMARKS: 13 SPRINGS MAX. PER STACK. ONE FORM D MAX. PER STACK.
CONTACT RATING (NON-INDUCTIVE)	TWIN CONTACTS: PALLADIUM .062"x.020" 4 Amps. 150 Watts; GOLD .062"x.020" 1 Amp. 150 Watts; SILVER .062"x.020" 2 Amps. 100 Watts		SINGLE CONTACTS: PALLADIUM .093"x.031" 4 Amps. 450 Watts; TUNGSTEN .125"x.050" 3 Amps. 450 Watts; SILVER .125"x.050" 4 Amps. 450 Watts		RATINGS PERTAIN TO CURRENT CARRYING CAPACITY UNDER NORMAL CONDITIONS. SPECIAL APPLICATIONS USUALLY REQUIRE ENVIRONMENTAL TESTING
TIMING (IN MILLI SECONDS)	STANDARD COILS: OPERATE RANGE 3-30; RELEASE RANGE 4-20		SLUG COILS: OPERATE RANGE 20-60; RELEASE RANGE 30-100		TIMING VALUES ARE SUBJECT TO FURTHER LIMITATIONS DEPENDING UPON CONTACT ARRANGEMENT AND APPLIED VOLTAGE
MISC.	COIL RESISTANCE: SINGLE WOUND UP TO 20,000 OHMS; DOUBLE WOUND UP TO 6500 OHMS EACH WINDING		WEIGHT: APPROX. 2¼ OZ.	RESIDUALS: AVAILABLE WITH SCREW OR FIXED TYPE RESIDUALS	

"Compact, lightweight, extremely versatile, *reliable*" . . . these are some of the comments of engineers who have tested Kellogg's new type "L" relay. It is a sturdy re-engineered version of the model used for years in telephone offices around the world. Now, its many new features make it particularly adaptable to industrial applications including computer systems, two-way radio and automation devices.

Efficient design gives the Kellogg type "L" more operating force than relays of comparable size. This means greater sensitivity, gram pressure and more springs per pileup. In addition, the new relay features:

- **rear mounting,** for ease of wiring
- **wide variety of coils** for any circuit requirements; single or double wound
- **bifurcated stationary springs** for independent contact action and high reliability; (single contacts also available)
- **heavy duty bronze** yoke and stainless steel bearing pin insure long life and stable adjustment
- **single or double** arm type armatures available
- **hermetically sealed** models, if desired
- **operating speed:** minimum of 1 to 2 milliseconds
- **contact points:** gold, silver, palladium, tungsten; other materials available
- **residual:** adjustable
- **time delay:** heel-end slugs and armature-end slugs for release time delay and operate time delay, respectively
- **terminals:** slotted
- **weight:** Net, 2¼ oz.
- **dimensions:** 2-1/4" L x 1-1/8" W, ranging in height from 17/32" to 1-1/16" (max.)
- **operating voltages:** up to 220 V.D.C.

Behind the superior reliability and design of Kellogg's type "L" relay are more than 60 years of experience as a leading producer of telephone equipment. And as the communications division of International Telephone and Telegraph Corporation, Kellogg has the research talent of 3500 engineers and technicians at its disposal.

Inquiries are invited. Send for a free catalog on relays and other components manufactured by Kellogg.

Kellogg Switchboard and Supply Company, 6650 South Cicero Avenue, Chicago 38, Illinois. Division of International Telephone and Telegraph Corporation.

KELLOGG Communications Division of IT&T
CHICAGO, ILLINOIS

Manufacturers of: Relays • Hermetically sealed relays • Switches • Solenoids

CIRCLE 162 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Riveting Machine

For assembling terminal boards

This spin-riveting machine is designed to rivet turret terminals into punched or drilled terminal boards. Its automatically-controlled elements are adjustable so that each job can be set up for exact performance. The machine virtually eliminates cracking and splitting of terminals.

Hill Machine Co., Dept. ED, 1311 Eddy Ave., Rockford, Ill.

CIRCLE 449 ON READER-SERVICE CARD

Compacting Press

Produces tantalum anodes with pigtails

Model T-4 dual-pressure compacting press has been specially adapted for the production of tantalum capacitor anodes with a tantalum wire pigtail. The wire is automatically fed into the die and cut off after the powder has been compacted around it.

F. J. Stokes Corp., Dept. ED, 5500 Tabor Rd., Philadelphia 20, Pa.

CIRCLE 450 ON READER-SERVICE CARD

Carbide Drills

Diameters down to 0.024 in.

In diameters down to 0.024 in., these fluted, solid cemented carbide drills are next to diamonds in hardness. They drill holes in titanium, copper, brass, aluminum, plastics, and other abrasive materials.

Super Tools Co., Dept. ED, 21650 Hoover Rd., Detroit 13, Mich.

CIRCLE 451 ON READER-SERVICE CARD

Punch Press

Miniature

The Mini-Line miniature press is designed for instrument work, fine punching, staking or forming operations. It can be used for eyeletting terminals on printed circuits, pressing in bearings and pins, and riveting.

The MagneTec Corp., Dept. ED, 11785 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 452 ON READER-SERVICE CARD

Extruding Machine

For Teflon-insulated wire

The TE-1A extruding machine handles Teflon-insulated wire through triple-pass vaporizing and sintering ovens, producing the wire three times faster without added oven length. It accommodates any wire size and has capstan adjustment of speeds from 0 to 105 fpm. Extruder cylinders, in sizes starting at 1 in., are easily interchangeable.

...nings Machine Corp., Dept. ED, 3452-A ...ow St., Philadelphia 4, Pa.

CIRCLE 453 ON READER-SERVICE CARD

Electronic guidance equipment mounted to *both* sides of UAP cold plate, contained in UAP pressurized case . . . for control of air-to-air missile.

PRODUCTION PRODUCTS

Automatic Miller

Slices crystals

Model 8SA automatic milling machine slices and dices germanium and other crystalline materials used in transistors and semiconductors. It can cut germanium into wafers 0.013 in. thick ±0.0005 in.

The Robert E. Morris Co., Dept. ED, West Hartford, Conn.

CIRCLE 454 ON READER-SERVICE CARD

Vacuum and Pressure System

Impregnates electrical components

Series 1100 is a vacuum and pressure system for impregnating electrical components. Its treating tank, 36 in. across and 51 in. high, operates from high vacuum to 250 psig.

General Vacuum Corp., Dept. ED, 400 Border St., East Boston 28, Mass.

CIRCLE 455 ON READER-SERVICE CARD

Impregnating Machines

High vacuum and pressure

Mogul high vacuum, high pressure impreg-

machines are especially designed to handle transformer windings and electronic parts. Heated types have glass wool insulation and two tanks with dual 2 or 9 cu ft capacity. Each tank has thermostatic controls from 0 to 500 F.
Metallizing Company of America, Dept. ED, 3520 W. Carroll Ave., Chicago 24, Ill.

CIRCLE 456 ON READER-SERVICE CARD

Transistor Tester

Handles up to 1200 units an hour

Automatically grading and sorting, model 2675 transistor tester handles up to 1200 units an hour. It makes eight different tests on any one transistor. Patchboard programming allows a choice of any type dc test and sequence.
Eder Engineering Co., Inc., Dept. ED, 1568 S. First St., Milwaukee 4, Wis.

CIRCLE 457 ON READER-SERVICE CARD

Diamond Cutting Wheel

High accuracy

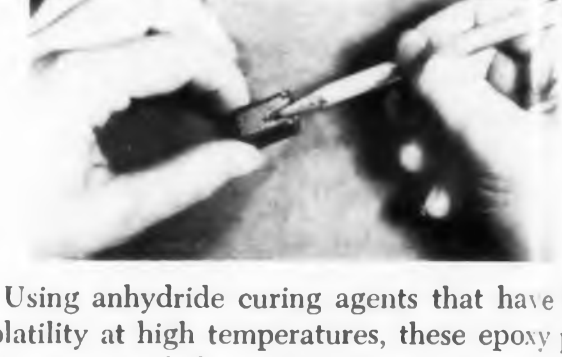
Highly accurate, Diatronic wheels cut fully hardened steels, silicon and germanium crystal, glass tubing, tungsten carbide, and other materials. They are 0.006 x 3 in., and have rim tolerance of + 0.0005 in.
Van Products, Inc., Dept. ED, 900 N. Sepulveda at International Airport, Los Angeles 45, Calif.

CIRCLE 458 ON READER-SERVICE CARD

NEW MATERIALS

Epoxy Potting Compounds

Longer pot life



Using anhydride curing agents that have low volatility at high temperatures, these epoxy potting compounds have a pot life up to one week. The compounds are suited for potting, encapsulating, and impregnating components. Some of the low-viscosity formulations are used for simultaneous impregnation and potting of toroidal choke coils, transformers, motors, and similar units where the liquid resin must penetrate the finest interstices.

Mitchell-Rand Mfg. Corp., Dept. ED, 51 Murray St., New York, N.Y.

CIRCLE 459 ON READER-SERVICE CARD

Nylon Patchcord Insulators

Prevent current leakage

Produced to close tolerances by automatic injection molding, these nylon cellular blocks and plugs prevent current leakage in patch-cord programming systems. Each block has a molded-in hole, so that standard, coaxial, or shielded patch-cords can be inserted.

Gries Reproducer Corp., Dept. ED, 400 Beechwood Ave., New Rochelle, N.Y.

CIRCLE 460 ON READER-SERVICE CARD

Tantalum

High purity

This tantalum is low in oxygen, carbon, and other impurities which adversely affect melting and fabrication. Ingots have unusual ductility and low hardness, permitting size reduction from 3-in. diameter ingot to 0.0005-in. foil without intermediate annealing.

Columbia-National Corp., Dept. ED, 70 Memorial Dr., Cambridge 42, Mass.

CIRCLE 461 ON READER-SERVICE CARD

High Temperature Seal

For ceramic to metal composites

Area Seal is designed to give high reliability to lead-through seals in ceramic to metal composites. For single or multiple terminal units, the seal features thin, washer-like fittings around each terminal. It stays vacuum tight in processing temperatures above 900 C, permitting the use of high melting-temperature braze alloys in fabricating composites.

Ceramics for Industry Corp., Dept. ED, Cottage Place, Mineola, N.Y.

CIRCLE 462 ON READER-SERVICE CARD

Fluorocarbon Tapes

—350 to +500 F operating range

Made from Teflon and coated with pressure-sensitive adhesive, Fluorolin tapes have an operating range from —350 to +500 F. They are unaffected by all chemicals except molten sodium and Fluorine gas at high temperatures. The fluorocarbon tapes come in all types, including skived, extruded, unsintered, extruded sintered, and cast films.

Joclin Mfg. Co., Inc., Dept. ED, 100 Lufbery Ave., Wallingford, Conn.

CIRCLE 463 ON READER-SERVICE CARD

Cast Teflon Film

High dielectric strength

For various electrical-tape applications, this cast Teflon film has high dielectric strength, negligible water absorption, and inertness to chemicals and solvents. It performs over a wide thermal range. Film thicknesses range from 0.25 to 4 mils. Roll lengths are 100 and 500 ft in widths from 1/4 to 12 in.

Electrix Corp., Dept. ED, Allen Blvd. and Grand Ave., Farmingdale, N.Y.

CIRCLE 464 ON READER-SERVICE CARD

NEW MATERIALS

Epoxy Adhesive

Powdered for preforms

Type SBC is a single part epoxy adhesive which can be molded readily into a preform. The material is supplied in powder form, heated slightly, molded under moderate pressure, and then allowed to cool. The resulting preforms are then usable as a quick setting adhesive for numerous jobs such as bonding anode caps to vacuum tubes or cementing tube bases. Complete cure is completed in a few minutes at from 350 to 500 F.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 465 ON READER-SERVICE CARD

High Purity Metals

Purity of indium improved

Lead, cadmium, bismuth and silver with a guaranteed purity of 99.9999 per cent, and zinc with a purity of 99.9997 per cent. For transistor and semiconductor requirements, the purity of indium has been improved to 99.9999 per cent.

The Consolidated Mining & Smelting Co. of Canada Ltd., Dept. ED, 215 St. James Street W., Montreal, P.Q.

CIRCLE 466 ON READER-SERVICE CARD

Porous Sponge Teflon

For potting and encapsulation

Low dielectric loss and uniformity at various humidities and temperatures make this porous Teflon sponge suitable for uhf equipment such as wave guides, radomes, and thermal insulation. It can be used to insulate high frequency sending and receiving equipment in supersonic aircraft and missiles. Pore sizes are 5 to 50 microns; void contents, 5 to 55 per cent.

Liquid Nitrogen Processing Corp., Dept. ED, 451 Booth St., Chester, Pa.

CIRCLE 467 ON READER-SERVICE CARD

Silver Metallic Paint

Highly conductive

Used in printed circuits, this silver metallic paint is highly conductive and withstands great heat without oxidizing. It can be applied to ceramics, titanates, glass, mica, and other inorganic materials in a range of firing temperatures.

Western Gold and Platinum Co., Dept. ED, Belmont, Calif.

CIRCLE 468 ON READER-SERVICE CARD

Clad Metal With Copper Core

For tube anode plates

Used for anode plates, this five-layer strip improves heat dissipation in vacuum tubes. Aluminum-iron clad, the copper core has a thickness up to 40 per cent that of the total strip. The layers are inseparably clad together by a metallurgical bond. No intermediate brazing materials are used.

Metals & Controls Corp., General Plate Div., Dept. ED, Attleboro, Mass.

CIRCLE 469 ON READER-SERVICE CARD

Nickel Coated Titanium Wire

For ceramic to metal brazing

For ceramic to metal brazing, this nickel coated titanium wire is used mainly as a sealing material for ceramic base vacuum tubes. About 71.5 per cent titanium and 28.5 per cent nickel, the wire comes in sizes from 0.062 to 0.004.

Little Falls Alloys, Inc., Dept. ED, 189 Caldwell Ave., Paterson, N.J.

CIRCLE 470 ON READER-SERVICE CARD

Epoxy Resin Systems

Designed for specific uses

Made for specific uses, these four epoxy resin systems eliminate costly sampling. PRH 308 is a class H single component thixtropic system that needs no mixing or weighing because it contains its own curing agent. Paste-like, it is suited for end-capping field coils. PRH 400 is a solvent based system that provides protective coating for printed circuit and electronic components. Although it cures at room temperature, moderate heat cure produces optimum electrical properties, adhesion, and moisture resistance. PRH 401 is a fluid, heat curing epoxy adhesive that bonds metal to metal; and PRH 402 is an epoxy varnish for protecting metal parts.

Permacel, Dept. ED, New Brunswick, N.J.

CIRCLE 471 ON READER-SERVICE CARD

NEW MATERIALS

Precision Punched Mica Parts

In thicknesses down to 0.001 in.

Close tolerances are held on these parts punched from natural mica insulation. High dielectric strength and thermal resistance is maintained in parts with thicknesses down to 0.001 in. The line includes shims, washers, and multi-holed, eyeletted fabrications.

Ford Radio & Mica Corp., Dept. ED, 536 63rd St., Brooklyn 20, N.Y.

CIRCLE 472 ON READER-SERVICE CARD

Magnetic Alloy Laminations

High permeability

Hymu 80 magnetic alloy laminations provide 30 to 50 per cent higher low-induction permeability than standard Hymu 80 laminations. They are available in a variety of small shapes.

Magnetic Metals Co., Dept. ED, Hayes Ave. at 21st St., Camden 1, N.J.

CIRCLE 473 ON READER-SERVICE CARD

Chrome-Copper Wire

High flex life

These fine chrome-copper alloy conductors are highly resistant to vibration and flexing fatigue. A 26 gage stranded wire has a tensile strength of 49,000 to 52,000 psi.

Tensolite Insulated Wire Co., Inc., Dept. ED, W. Main St., Tarrytown, N.Y.

CIRCLE 474 ON READER-SERVICE CARD

Epoxy Material

For high temperatures

Hysol 6000HH-867 epoxy is available in sheet, rod, and tube form for coil forms, resistor bobbins, resistor shells, and other intricate parts to be used at elevated temperatures. Readily machined, the epoxy has a heat distortion point greater than 150 C. Passes ASTM test method

D-635-56T, and MIL-16923B flame resistance and moisture absorption.

Houghton Labs., Dept. ED, Olean, N.Y.

CIRCLE 475 ON READER-SERVICE CARD

Metal to Glass Compression Seals

Tolerances within ±0.005 in.

Tolerances of these metal to glass compression seals are held within ±0.005 in. for decimals and ±1/64 in. for fractions. For hermetically sealed relays, capacitors, semiconductor devices, and other assemblies, the terminals are available in a wide variety of designs and finishes.

International Telephone and Telegraph Corp., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

CIRCLE 430 ON READER-SERVICE CARD

Asbestos Paper

Has integral glass reinforcement

Type GT asbestos paper is integrally reinforced with parallel glass threads which give it the strength of adhesive-plied paper. Slit into tapes, the material is suitable for high speed winding and wrapping operations. The paper can be saturated and/or coated with resins and varnishes.

Johns-Manville Sales Corp., Dept. ED, 22 E. 40th St., New York 16, N.Y.

CIRCLE 476 ON READER-SERVICE CARD

Bright-Silver Plating Process

Works at room temperature

Permanently hard, bright-silver finishes in both flash and heavy deposits are obtained with the Silva-Brite plating process. For barrel or tank plating, the process is relatively fast and accomplished at room temperature. Suitable for waveguides and electronic contacts, the finishes have 100 per cent specular reflection.

Engelhard Industries, Inc., Dept. ED, 231 New Jersey Railroad Ave., Newark 5, N.J.

CIRCLE 477 ON READER-SERVICE CARD

Microwave Absorber

Design-it-yourself type

With Eccosorb PM sands, engineer can design a microwave absorber to function at almost any frequency. Variations are determined by shape and one of the three available resistivities. Packed into place and heat cured at 300 F, these wet sands turn into rigid absorbers in a few minutes.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 478 ON READER-SERVICE CARD

BOOKS

Circuit Analysis of Transmission Lines

John L. Stewart, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 186 pp, $5.50.

Primarily using an analytic approach this book offers a short, unified treatment of the science and analysis of ordinary transmission lines. The more important graphical techniques are also discussed. Special attention is given to radio frequencies and measurements. The author examines matching devices and the design of resonators and transmission cavities. The test also provides a discussion of the standing-wave ratio and an introduction to the principles and applications of the Smith chart. The book offers preparation for study and work with microwaves and examines the role of economics in power systems.

Space-Charge Waves and Slow Electromagnetic Waves

A. H. W. Beck, Pergamon Press, 122 East 55th St., New York 22, N. Y. 396 pp, $15.00.

A picture of the small-signal operation of all types of modern microwave valves is presented. The treatment is based on Maxwellian electrodynamics; it develops the idea of space-charge waves which can be used to interact with slow circuit waves. This theory occupies the major part of the book. Special points of modern valves, klystrons, traveling wave amplifiers, backward wave oscillators, and carcinotrons are discussed. Appendices deal with measurements on circuits, the theory of the maintenance of electron beams, and Llewellyn's electronic equations. A knowledge of Bessel's functions is assumed.

Automatic Control: Principles And Practice

Werner G. Holzbock, Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. 258 pp, $7.50.

This non-mathematical treatment offers the practical results of scientific research on control systems. The book begins with the dynamic behavior of control systems, including static requirements and adjustments for peak performance. Next, it covers mechanical and electrical components-measuring elements, controllers, and the specific part played by control valves. The final section describes the various control systems and their specific applications. Material on servo systems is concerned with practical concepts rather than theory.

Insulation Engineering Fundamentals

Graham Lee Moses, Lake Publishing Corp., 718 Western Avenue, Lake Forest, Ill., 117pp, $2.75.

The basic concepts that form the foundation of insulation engineering, together with discussions of the present status of insulation engineering in several fields are presented. It includes examples of how insulation is used, its importance, and its achievements. The weaknesses of insulation, and the problems that may arise in its use, are discussed in the light of present day technology on a variety of equipment. This book attempts to present the fundamentals in simple, understandable terms which are accurate without being oversimplified.

Audio Design Handbook

H. A. Hartley, Gernsback Library, Inc., 154 West 14th Street, New York 11, N.Y., 224pp, Paper ($2.90), Hard ($5.00).

The how and why of audio design for the non-professional are outlined in this volume. The author covers amplifiers, transformers, feedback, tone controls, speakers and enclosures. He offers practical design data which saves many hours of tedious work. The book is fully illustrated with photos, charts, graphs and schematics, and many helpful tables make the designer's task considerably easier.

BOOKS

The Solid State for Engineers

Maurice J. Sinnott, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y. 522 pp, $12.50.

This book deals with the features of solid materials that are of special interest to the engineer. A series of fundamental principles, which provides a convenient reference to problems concerning the choice and use of materials, is set forth.

The author surveys the basic concepts of various sciences which bear on the behavior of the solid state of material.

Problems interspersed throughout the book illustrate principles and concepts. The author includes examples of how these principles can be applied to practical problems, both in a quantitative fashion and from a qualitative viewpoint.

Electronic Measuring Instruments

E. H. W. Banner, The MacMillan Co., 60 Fifth Ave., N.Y. 11, N.Y. 496 pp, $7.95.

A broad survey of the principles of electronic instruments, their principal types and component devices is provided. Vacuum and cathode-ra tube are described, followed by two ection on measuring instruments emb odying these elements. Instruments cov red i- clude industrial, scientific, and medical. Of special interest to the engin er e- gaged in nuclear research is the secti on on radiation measurement. Thi com- pletely revised edition contains over 1 additional pages of data covering t latest developments in the electronic field including: special reliability and subminiature tubes; waveform error metal rectifier instruments; palladium leak detector; and electronic tachometer

Conference on Extremely High Temperatures

Fischer & Mansur, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 258pp, $9.75.

Based on the Conference held this year, this book is a summary of the underlying basis for commercial or usable thermonuclear reactions. Emphasis is on high temperatures as they relate to the

...pulsion fields, with sub-emphasis on the physics of the topics covered.

Subjects treated include: production of high temperature gas by magnetic acceleration; combination of electrically exploded wires and electric arc; analysis of the direct-current arc; microwave thermometer for millions of degrees; plasma motors; the megatron; magnetohydrodynamic propulsion.

Transients in Electrical Circuits

Gladwyn V. Lago and Donald L. Waidelich, The Ronald Press Co., 15 East 26th St., New York 10, N.Y. 393 pp, $7.50.

The first four chapters employ the classical method of solving ordinary linear differential equations by using electrical circuits as examples. The concept of duality is introduced in these chapters and is used throughout the book.

The Laplace transform method of solving integro-differential equations is presented. The operational impedance concept is developed, and the poles and zeros of the impedance function are used to show the correlation between transient response and ac steady-state response. The concept of electrical analogues of these systems is explained. Another application is concerned with the transient analysis of servomechanisms. The book concludes with three chapters devoted to the theory and application of Fourier series, integrals, and transforms in the solution of various circuit problems.

Atmospheric Explorations

Edited by Henry G. Houghton, The Technology Press, Mass. Institute of Technology, and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 125 pp, $6.50.

Papers included in this volume were presented at the 1956 Benjamin Franklin Memorial Symposium. The book deals with the developments in various fields of atmospheric exploration. The five authors have distinguished themselves in their chosen subjects. Their efforts represent the viewpoints of the ionospheric physicist, the meteorologist and the physicist.

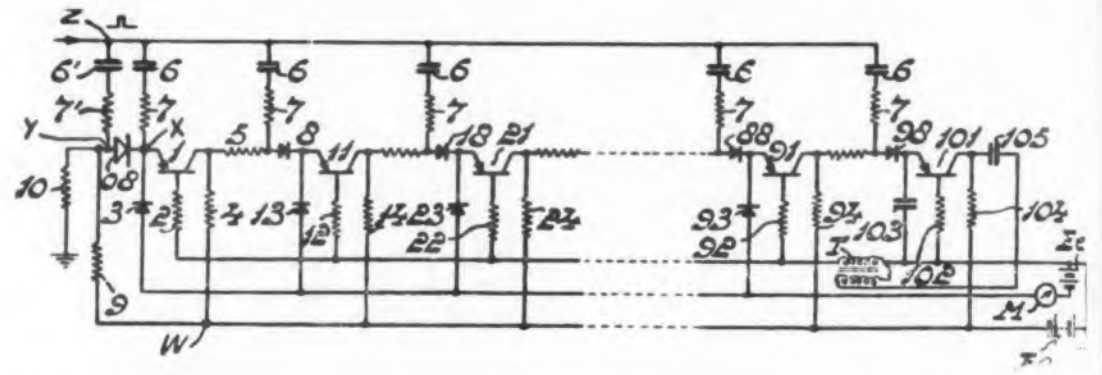
PATENTS

Transistor Counter Circuit

Patent No. 2,838,664. Eric Wolfendale. (Assigned to North American Philips Co., Inc.)

The digital counter consists of a chain of bistable transistors connected in a ring to a monostable transistor. Stepwise reversal of emitter current in each transistor, reverses the bias on each interstage diode to permit the counting of the pulses.

A positive impulse applied to the first stage changes the forward emitter current. The collector voltage changes so that interstage diode 8 conducts. A second impulse is passed by this diode to trigger the forward current in the second transistor. This adjusts the bias on the third interstage diode 18 to pass the third impulse and to trigger "on" the succeeding transistor. This action repeats until the final monostable stage is triggered. The positive going output is coupled through transformer T to the base of each transformer to cause the emitter current to reverse. After a time set by the product of the capacitance of capacitor 103 and the internal resistance of the transistor, the monostable stage flips back to its former condition and the chain is reset for a new count.



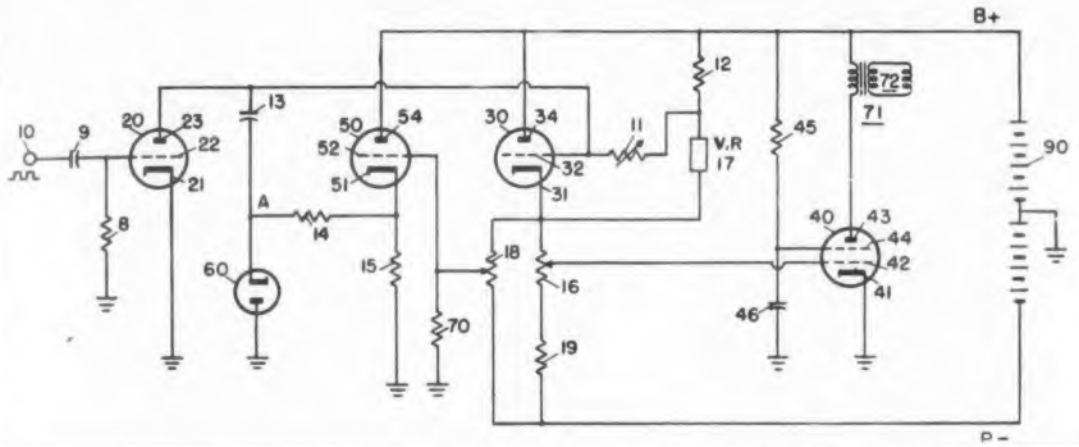
Adjustable Sweep Circuit

Patent No. 2,823,274. Robert F. Casey. (Assigned to Allen B. DuMont Laboratories, Inc.)

The circuit produces an adjustable waveform consisting of a pulse, a sawtooth and an exponential which controls the vertical deflection of a cathode ray tube. Each component may be set individually and one control adjusts the magnitude of the composite waveform.

Positive gating signals are applied to grid 22 to discharge condenser 13. During the negative portion of the gating signal, triode 20 is cut off and grid 32 rapidly rises to the pulse level. Condenser 13 charges linearly. The pulse and sawtooth waveform are cathode coupled through potentiometer 16 to grid 42 of the output stage. At the voltage set by potentiometer 18, triode 50 begins to conduct. Regenerative action raises the voltage on cathode 51. Voltage on condenser 13 is raised and subsequently that grid 32 is raised. The exponential waveform is coupled to the output tube 40. The action continues until a positive pulse on grid 22 grounds plate 23 to discharge condenser 13. The cycle is repeated after the positive input has terminated.

After the desirable individual settings are made, the amplitude of the output may be adjusted by potentiometer 16.

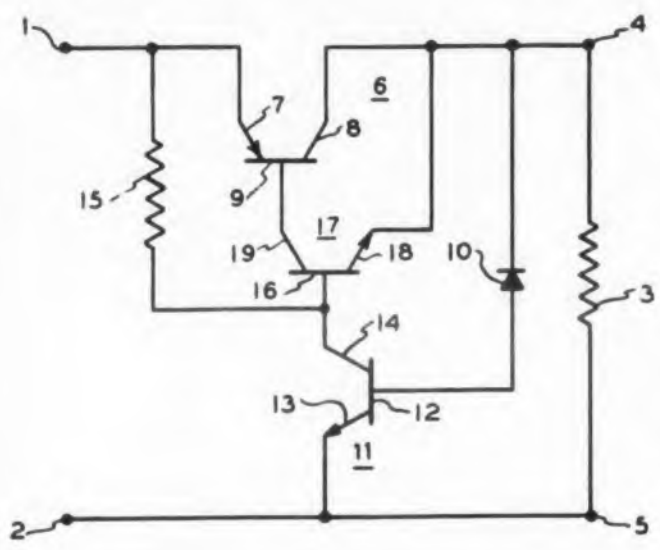


PATENTS

Transistor Voltage or Current Regulator

Patent No. 2,832,035. George Bruck, Joseph J. Lamplot, William R. Harter. (Assigned to Avco Manufacturing Corporation)

Two npn control transistors in cascade with a pnp series regulator transistor are combined with a low dynamic resistance (10-ohm) Zener diode to stabilize the voltage across a load. When a resistance is connected in series with the voltage source, the combination maintains constant the current delivered to a fixed load. Since no inductance or capacitance is present, the circuit compensatory response to output changes is rapid. Zener diode 10 is in series with the emitter-base circuit of the first control transistor 11 such that even a slight increase in output voltage causes a large change in emitter-base current. The current at collector 14 is increased. The base voltage of second control transistor 17 is reduced and, in turn, the current from base 9 is reduced. Current out of emitter 7 decreases resulting in less output voltage. Similarly, a decrease in output voltage ultimately produces an increase in the emitter and collector current of series regulator transistor 6 and the output voltage increases.



The system has high sensitivity since the error signal is amplified three times and the low dynamic resistance Zener diode produces a large current for small voltage change.

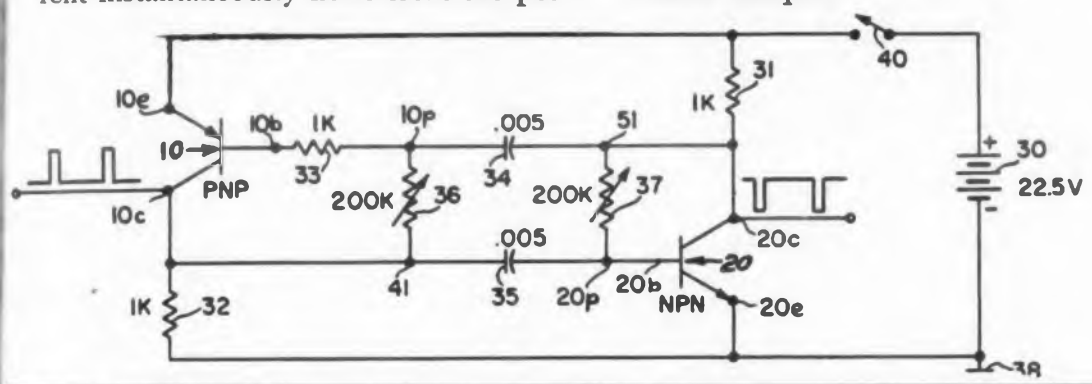
Transistor Circuit

Patent No. 2,839,686. Howard E. Tompkins. (Assigned to Burroughs Corporation)

The free running multivibrator has a low duty cycle and requires negligible power since both transistors are simultaneously "on" for part of the cycle and "off" for the other part. With the indicated circuit components, an RCA TA-153 pnp transistor and an RCA TA-207 npn transistor, 22-v, 22-ma pulses are generated having a pulse width of 10 μsec and a variable total period of from 60 to 200 μsec. Pulses of opposite phase are available at the collector electrodes.

Briefly the circuit operates as follows: when switch 40 is closed, saturation current instantaneously flows from the positive terminal of battery 30 into emitter 10e, out the base 10b and through resistors 33, 36 and 32 to the negative battery terminal; the current flow is likewise through resistors 31 and 37 into base 20b, out of emitter 20e and back to the negative battery terminal. Then condensers 34 and 35 charge until both transistors sharply cut off. The condensers thereafter discharge until the transistors begin to conduct, the action being cumulative to saturation and the cycle repeats.

The purpose of resistor 33 is to equalize the time constants of the two transistors where the transistors are not matched. However, as an alternative, the coupling capacitors 34 and 35 may be made unequal.

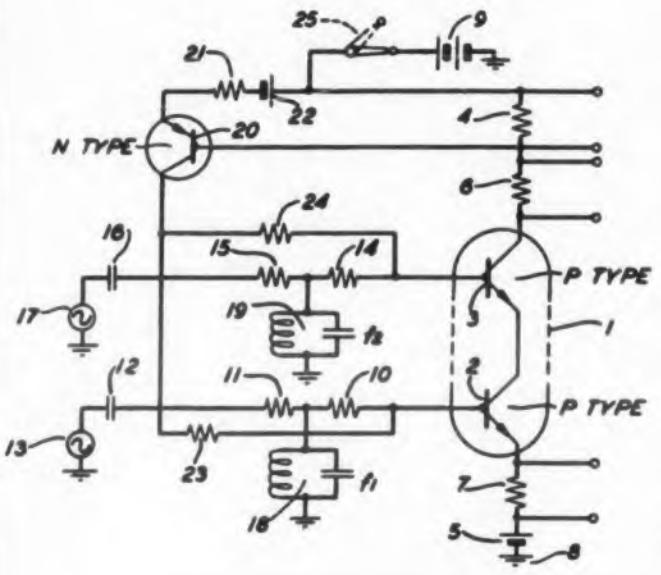


PATENTS

Bistable Transistor Coincidence Gate

Patent No. 2,831,126. John G. Linvill, Robert L. Wallace, Jr. (Assigned to Bell Telephone Laboratories, Inc.)

Transistors of like conductivity are connected with their emitter-collector paths in series with the load to provide a positive and unambiguous response to concurrent control signals. In addition a transistor of opposite conductivity is connected in a regenerative circuit to maintain the conductivity of the transistors in series with the load after the concurrent control pulses have terminated.



Unit 1 consists of either two p-type transistors or a single multiple- zone junction transistor in series with the load 7. Bias battery 5 maintains the series circuit at cut off in the absence of concurrent positive pulses applied to the base electrodes of the transistors. Transistor 20 is quiescent at cut off due to battery 22.

Coincident signals applied from generators 17 and 13 cause the series circuit to conduct. The load current simultaneously flows through resistor 4 to produce a voltage which overcomes the bias due to battery 22. Transistor 20 conducts maintaining the base electrodes of the series transistors until the regenerative path is broken by opening switch 25.

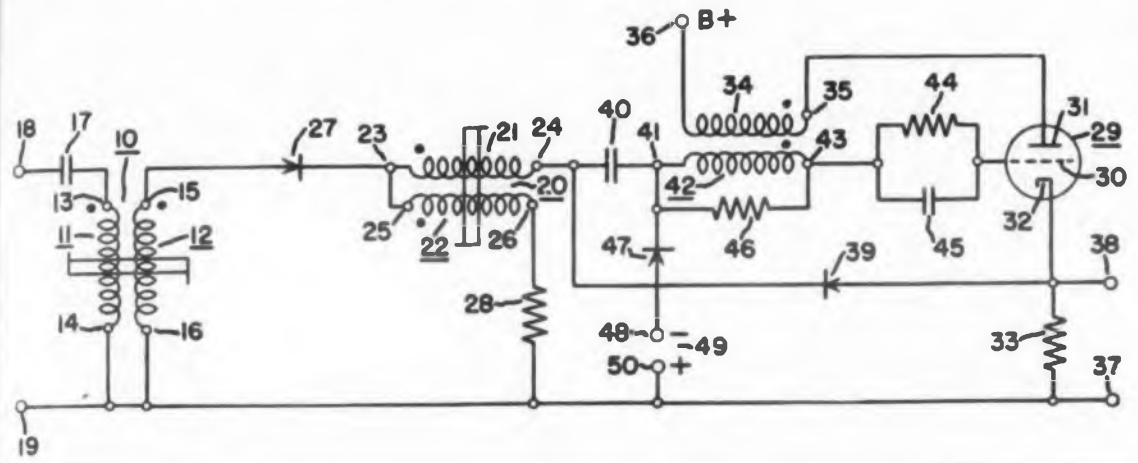
Counting Network

Patent No. 2,838,669. James R. Horsch (Assigned to General Electric Company.)

Saturable core magnetic transformers in a blocking oscillator circuit provide fast, positive switching and noise cancellation. Compared to step charging capacitor counters having exponential steps, the circuit develops equal amplitude steps to insure stability of counting.

Saturable core *10* is wound with pulse input winding *11* and output winding *12*. This device produces uniform volt-second area pulses when non-uniform input pulses are being counted. These input pulses must be of sufficient magnitude to drive the core from one direction of saturation to the other. During the time the core is not saturated capacitor *17* charges.

After the input pulse terminates, capacitor *17* discharges to reset the core. When core *10* is reset, the pulse is passed by diode *27* through winding *22* and resistor *28*. After core *20* had counted a set number of pulses to drive it from saturation in one direction to saturation in the other direction, it saturates and transmits the next pulse to fire the blocking oscillator tube *29*. A pulse is then applied to diode *39* to reset core *20* and start a new count.



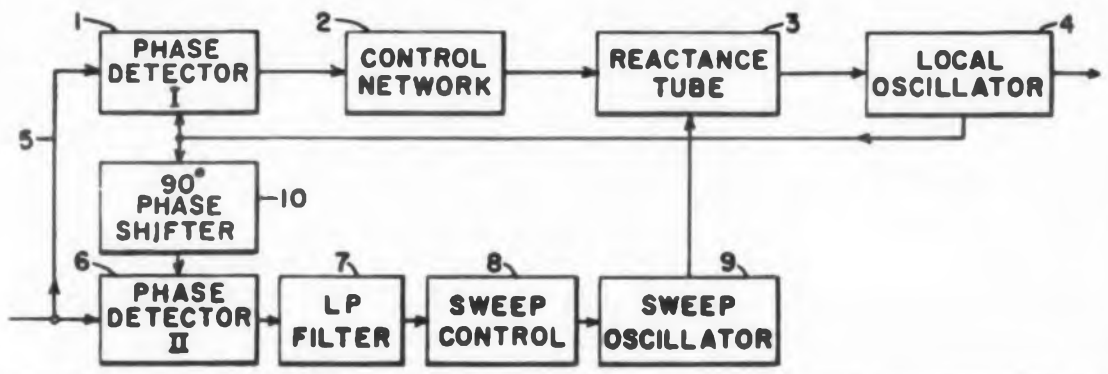
PATENTS

Hunting AFC System

Patent No. 2,833,923. Wolf J. Gruen. (Assigned to General Electric Co.)

Effective wide band phase and frequency control of the local subcarrier oscillator of a color television receiver is achieved with a dual mode system. The system combines a conventional detector and reactance tube frequency control circuit with a phase sensitive slow scan pull-in circuit. Noise voltages which produce color oscillator phase shifts and objectionable color patterns on the screen are reduced.

As illustrated, the local oscillator output is compared with the synch signal in phase detector I. The reactance tube adjusts the oscillator to lock on. The local oscillator output is shifted 90 deg and compared with the synch signal in phase detector II which produces a control voltage whenever the phase difference is not 90 deg to gate the gas tube sweep oscillator. When there is no synchronism, the sweep oscillator wobbles the dc input voltage to the reactance tube causing the local oscillator to sweep slowly until synchronism is reached. Thereafter the conventional automatic frequency control produces a voltage to maintain the system in synchronism.

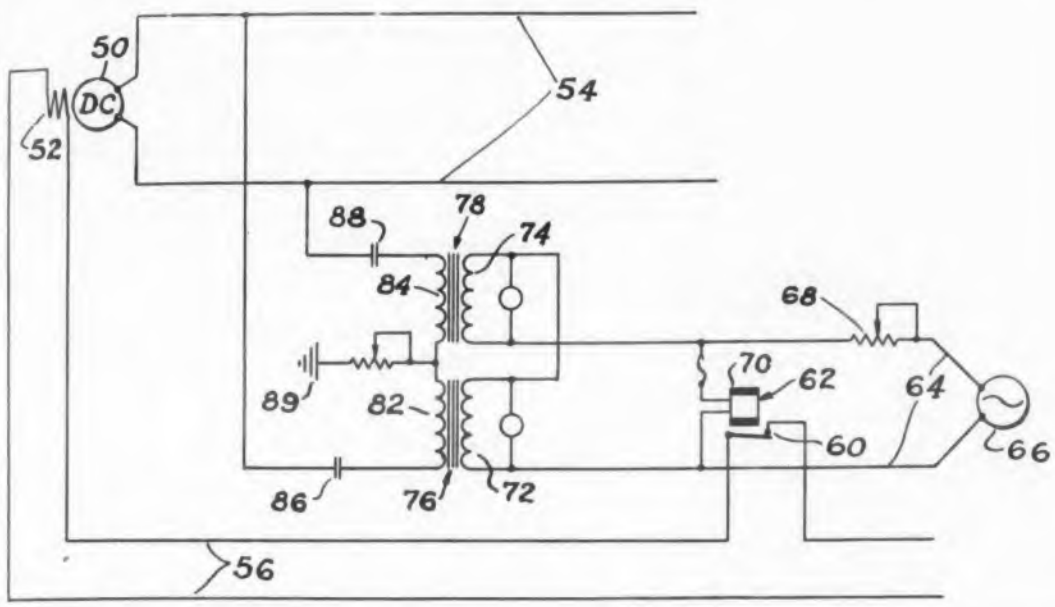


Ground Detector

Patent No. 2,832,916. Theodore R. Kennedy (Assigned to Ajax Electrothermic Corp.)

Sensitive control circuit is continuously responsive to unbalance due to grounds and to failure of an element in the control circuit.

Protection of dc generator *50* against grounding of load *54* is achieved by control of the current through relay coil *70*. In the normal condition coil *70* is closed. Generator *66* supplies hf voltage to relay winding *70* and to transformer *78*. The primary windings are in series opposition and negligible current flows in the transformer under normal conditions. However, a ground reflects as a change in impedance in the transformer primary and the transformer now draws current from generator *66*. The volt-drop across resistor *68* increases and relay *60* opens the generator field to reduce the dc voltage to a safe value.



NEW LITERATURE

Circuit Terminations 204

Six page brochure, in color and illustrated, describes AMP products and engineering assistance available to engineers and companies. Facilities of company are also covered. Amp Incorporated, Harrisburg, Pa.

Printed Circuit Design

This 16-page booklet, entitled "Some Suggestions on Printed Circuit Layout and Design," gives a thorough description of the preferred methods of producing printed circuits. Topics range from the making of the original photomaster, through the selection of materials, the importance of tolerances, and the final packaging. The company is equipped to handle all or any part of printed circuit work. *The booklet may be obtained for one dollar by writing directly to Arthur Ansley Manufacturing Co., Dept. ED, New Hope, Pa.*

Digital Indicator 205

Catalog 51-1800 describes a company's precision in-line digital indicator. The illustrated catalog has fold-out drawings and is punched for notebook insertion. Fischer & Porter Co., 67 Jacksonville Rd., Hatboro, Pa.

Insulation 206

Catalog 24 lists and describes a variety of insulation products in 16 pages. Standard packaged slot insulations, fibre washer kits, polyester film wedges, contour slot insulators, and crimped paper transfromer layer insulations are among the items covered. The illustrated catalog contains selection guides and prices. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Self-Locking Clinch Nuts 207

Design Manual 5803 reviews a company's available standard and miniature types of clinch nuts for the avionic, electronic and electrical equipment industries. The 18-page illustrated handbook includes a visual-descriptive index of all clinch nut types; a guide to selection of the correct fastener type to the job requirement; installation tips for the best results in production; suggestions for installation tools and their effective use. Elastic Stop Nut Corporation of America, 2330 Vauxhall Rd., Union, N.J.

Ceramics 296

Short form bulletin "Coors Space Age Ceramics," gives production facilities and mechanical and electrical properties of high alumina ceramics for temperature resistance and high strength in modern electrical and mechanical equipment. Bulletin No. 858 available from Coors Porcelain Co., 600 Ninth St., Golden, Colo.

Relays 297

Catalog of latest relays features list of each major relay manufacturer's entire line in alphabetical order according to code letters and numbers. Relays Sales, Box 186 EC, W. Chicago, Illinois.

Hardware 298

A line of wear-resistant, steel threaded inserts for use in aluminum or brass is described in Bulletin No. 58-2. The 4-page illustrated brochure catalogs 5 types of captive nuts and a line of studs. National Co., Inc., 61 Sherman St., Malden 48, Mass.

Voltage Limiter 299

Data Sheet 3066 (one page) gives description, specifications, and characteristic curves for the Model 66 Voltage Limiter used to protect transistors and other voltage-sensitive devices. Electronic Measurements Co., Inc., Eatontown, N.J.

Mach Charts 300

Provide Mach altitude-temperature information. One chart compares Mach number with altitude and also gives the ram temperature rise; the other chart shows the relationship of Mach number and temperature. G. M. Giannini & Co., Inc., Pasadena, Calif.

Electronic Catalog 301

A 320-page catalog of electronic parts and equipment contains minutely detailed product information on wide range of electronic components and equipment for industrial applications. Dalton-Hegge Radio Supply, 912 W. Fourth St., Winston-Salem, N.C.

NEW LITERATURE

Diode Tester 218

Bulletin describes the Model 1001 dynamic diode tester. The two pages cover the operating principles of the tester and explain the type of diode characteristics which can be analyzed, such as forward and back resistance, hysteresis, and stability. Other possible uses of the diode tester are suggested. Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa.

Microwave Reflector 219

This brochure describes the construction, properties, and uses of the Luneberg Lens as an antenna element. It also includes an adaptation of the lens to produce a reflective device used as a radar target for enhancement or marking purposes. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Magnet Wire 220

Information on the properties of silicone magnet wire coating is contained in this four-page, two-color brochure. It reports laboratory tests on wire twists, motorettes, and motors. These tests indicate that magnet wire coated with this enamel is suitable for use in servos, solenoids, motors, transformers, and other electrical devices designed for operation at Class H temperatures. Dow Corning Corp., Midland, Mich.

Zippertubing News 221

Zippertubing developments are detailed in this 4-page, 2-color publication. It features 3 types of shielded zippertubing, which allow the application of a jacket and a shield for wires and cables in a single operation. Also included are articles on Mylar, neoprene, polyethylene, Teflon, and tapered zippertubing. This is the first edition of the newspaper which will be published bimonthly. The Zippertubing Co., 752 S. San Pedro St., Los Angeles 14, Calif.

PC Soldering 222

Brochure contains instructions on printed circuit soldering. Includes a general discussion of printed circuitry, an explanation of proper solder composition, flux requirements, solder pot considerations, and step-by-step techniques of dip soldering. The pamphlet is lucid and self-explanatory and no prior knowledge of printed circuitry or dip soldering is required. Anchor Metal Co., Inc., 966 Meeker Ave., Brooklyn 22, N.Y.

Printed Circuit Plating 224

Solutions to the problem of the failure in service of plated printed circuits are offered in this 4-page article. Starting with the specific application and intended service of the printed circuit, the article discusses developments in printed circuit plating technology. Precious metals, and various base metals, are covered with their advantages and disadvantages for specific applications. A table gives recommended thicknesses of electroplate of various base and precious metals, predicated by the application of the printed circuit. Sel-Rex Corp., Precious Metals Div., Nutley 10, N.J.

Measurements Report 225

The quarterly publication describes problems in instrumentation and measurement and suggests methods for overcoming them. It also explains the design and operation of laboratory measuring devices such as oscilloscopes, frequency generators, microwave power meters, microvoltmeters, ohmmeters, etc. The feature article of the issue describes a large-screen oscilloscope which permits measurement and comparison of 40 separate input signals on the face of a single cathode-ray tube. International Telephone and Telegraph Corp., Industrial Products Div., 250 Garibaldi Ave., Lodi, N.J.

Transistor Cooling 226

The 8-page brochure gives test results on diode radiator cooling units, as used on both metallic and phenolic chassis, which reduce temperatures as much as 30 C. Specifications on these components and a number of transistor clips and heat radiators are given. The Birtcher Corp., Industrial Div., 4371 Valley Blvd., Los Angeles, Calif.

Technical Report Catalogs

Five Catalogs of Technical Reports have been published listing research reports available from the OTS collection in the fields of powder metallurgy, stroboscopy, stereoscopy, semiconductors, and air conditioning. Many of the reports listed in the catalogs are the result of research conducted for the Army, Navy, Air Force, and other agencies of the U.S. Government. Others are German documents captured by the Allies during World War II. *Copies may be obtained by sending 10¢ for each to the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.*

NEW LITERATURE

Wires, Cables 231

Designed for aircraft, missile, and rocket applications, these wires and cables are discussed in a 16-page booklet. It provides listings of wires and cables which have armed service qualification approvals as noted for each product. Two pages are devoted to custom-built types of cables that are available for rocket, missile, and ordnance systems. Cables included range from 75 to 3000 v. General Electric Co., Bridgeport 2, Conn.

Potentiometers 232

This six-page data sheet describes both a thermocouple and standardizing potentiometers. It lists specifications as well as recommended accessories. An interior view of the thermocouple instrument is shown with design features described. Circuitry is discussed with the aid of schematic diagrams. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Mercury Switch 233

Data sheet 149 on the ultra small AS419A1 mercury switch gives features of the switch. It is 9/10 in. long and weighs 1.8 g complete with leads. Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Zinc Ferrite 234

The two-page bulletin on zinc ferrite is complete with curves and property charts. The material is expected to gain wide acceptance in transformer applications due to its permeability (max at 4500), saturation (1600 gauss), and loss (100 mw per cc). General Ceramics Corp., Keasbey, N.J.

PC Design 235

Described in a 7-page brochure prepared for both military and commercial application. It provides cost analysis and engineering drawings necessary for production. Avionics Research Corp., 329 Hempstead Turnpike, W. Hempstead N.Y.

Torque vs RPM Chart 280

Chart tabulates oz-in. torque vs rpm at stated horsepower. Engineering data given ranges from 1/2000 to 1/3 hp and from 1 to 14,000 rpm. John Oster Mfg. Co., Avionic Div., 1 Main St., Racine Wis.

PC Transformers 281

A bulletin describes a line of miniature transformers for printed circuit application. Typical characteristics are given, along with a table showing case sizes, pin terminal arrangements, and other data useful in printed circuit design. Audio Development Co., 2833 Thirteenth Ave., So., Minneapolis 7, Minn.

Connectors 282

Solderless terminal catalog includes terminals illustrated in actual size, with schematic drawings, bolt cutter—crimping tool and terminal paks. Vaco Products Co., 317 E. Ontario St., Chicago 11, Ill.

Capacitor Standards 283

Complete line of fixed and variable capacitors for use as precision laboratory reference standards described. Includes features, applications, and specifications of capacitors ranging from 10 μμf to 4 μf including variable capacitors from 6 to 230 μμf. Int'l T & T Corp., Industrial Products Div., 250 Garibaldi Ave., Lodi, N.J.

Rack, Panel Connectors 284

Nineteen contact arrangements are illustrated in this 4-page bulletin on Series DTX rack and panel connectors. The connectors have applications in both military and industrial fields. H. H. Buggie, Inc., Box 817, Toledo 1, Ohio.

Capacitors 285

This bulletin describes sintered anode sub-miniature tantalum capacitors. It includes applications, graphs, specifications, and performance characteristics. Minitronics Corp., 328 Grand St., New York 2, N.Y.

NEW LITERATURE

Acoustical Noise 291

Seventeen-page bulletin describing high-intensity acoustical vibration testing as applied to aircraft and missile components and structures. The facility simulates the noise environment in the neighborhood of jet and rocket engines; unexpected and important malfunctions, not equivalent to those produced by mechanical shakers, are developed. Rototest Labs, Inc., 2803 Los Flores Blvd., Lynwood, Calif.

Automation 292

This 24-page illustrated brochure contains specifications, descriptive data, operational charts, and a selector guide for photoelectric systems in industrial control applications. Also described are miniature and sub-miniature photoelectric receivers and light sources for control application on special machinery. Electronics Corp. of America, Photoswitch Div., 1 Memorial Dr., Cambridge, Mass.

Cooling Fan 293

Catalog Sheet 50110-1A gives data on the company's Propimax-2 fan which provides air delivery of 12 deg CFM free air from a fan weighing 6 oz. Dimensions are 3 in. diam by 1/4 in. depth. Rotron Mfg. Co., Inc., Schoonmaker Lane, Woodstock, N.Y.

Relays 294

Engineering bulletin no. 0558 describing transistorized time delay relays includes a description of electronic and mechanical design, along with voltage and temperature performance curves. Also presented are specifications, mounting styles and dimensions, and ordering information. Tempo Instrument Inc., P.O. Box 338, Hicksville, N.Y.

RF Coils 295

Features and specifications of X-L Coils designed for automated or hand insertion into printed circuit boards are presented in spec sheet. Essex Electronics, 550 Springfield Ave., Berkeley Hghts., N.J.

...ge Regulators 208

...lletin S358EMT, a 12-page illustrated bulle-..., describes a standard line of Stabline type ...MT automatic voltage regulators. Listed are ...tings from 2 to 100 k va for 115, 230 or 460 v, ...0/60 cycle, single or three phase service. Su-...erior Electric Co., Bristol, Conn.

Propellant Actuated Devices 209

Six generic types of products utilizing propel-...nt cells for their initiating power are illustrated ...nd described in a folder identified as form ...AD-358. The devices shown include guillotine-...pe cutters, destructors, electrical disconnects, ...angible fasteners, igniters and valves. The ...older includes a schematic illustration of the ...anner in which single or dual bridge-wire ...ropellant cells can be interchangeably com-...ined with mechanical safety devices and booster ...ower charges. Beckman & Whitley, Inc., 973 ... San Carlos Ave., San Carlos, Calif.

Power Supply 210

A technical data sheet describing model ...A28-125 tubeless dc power supply is available. ...he illustrated sheet includes performance and ...haracteristics. Sorensen & Company, Inc., Rich-...rds Ave., South Norwalk, Conn.

Cadmium Strip 211

This data sheet tabulates the physical and ...hemical characteristics of ultra-thin and high-...precision tolerance cadmium strip and foil. It ...presents mechanical properties, nuclear data, ...nd mill limits in easy-to-use form. American ...ilver Co., 36-07 Prince St., Flushing 54, N.Y.

Gyro Primer 212

A 64-page illustrated gyro primer has been pre-...pared that explains how gyros work, gyro terms, ...nd gyro operating principles. Specifications for ...ate gyros, free gyros, directional gyros, and ...ompensated vertical gyros are included. United ...Aircraft Corp., Norden Div., Commack, N.Y.

Protected Markings 213

Th...e folders describe the practical applica-...tions of laminated plastics for all types of mark-...ings. They include the methods for protecting ...print... legends for plates, dials, and panels. Com-...merci... and military applications discussed. ...Dura... Corp., 1025 Race St., Philadelphia 7, Pa.

NEW LITERATURE

Power Supplies 307

As stated in Bulletin 2.050, the REGOHM-controlled precision power supplies offer ±0.1 per cent regulation and power ranges up to 500 w. Complete specifications, a schematic diagram, typical performance curves, and applications are also provided. Electric Regulator Corp., Pearl St., Norwalk, Conn.

PC Transformers 308

A bulletin describes a line of miniature transformers for printed circuit application. Typical characteristics are given, along with a table showing case sizes, pin terminal arrangements, and other data useful in printed circuit design. Audio Development Co., 2833-Thirteenth Ave., S. Minneapolis 7, Minn.

Instrument Enclosures 309

A 64-page catalog, "The Custom Look," covers the basic frames, turrets and surfaces to such minor but important details as cowling lights, door locks and drawer slides. Numerous line drawings on each page show exactly how units are mounted or joined to other components. Amco Engineering Co., 333 W. Ainslie St., Chicago 31, Ill.

DC Power Supply 310

Bulletin GEC-1505, two pages, provides information on custom-built, voltage-stabilized dc power supply units. Photos, lists of benefits, typical data table, schematic diagram, and current-limiting effect curve illustrate key features of these units. General Electric Co., Schenectady 5, N.Y.

Decade Counters 311

Bulletin No. 826 contains specifications and descriptive information on decade counters containing beam switching tubes. Four models of the decade counters designated as types DC-101, DC-102, DC-103, and DC-105 are described in this 6-page brochure. Burroughs Corp., Electronic Tube Div., Plainfield, N.J.

Toroidal Cores 313

Featured in a 12-page handbook which covers permeability, temperature coefficient of inductance, dc stability, core size, and finish. Graphs and technical data on the loss characteristics of these cores are presented, along with charts of physical and electrical properties. Design notes on the use of toroidal cores are also included. Wallace E. Connolly & Co., P.O. Box 295, Menlo Park, Calif.

Switches 314

This 32-page brochure includes a dictionary of terms and a technical discussion for switches. The final 22 pages catalog and describe types of switches available from the manufacturer. It is amply illustrated and goes into detailed specifications on all products that are included. Licon, Div. of Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

Instruments 315

A 24-page catalog completely describes products such as Pye amplifiers and voltmeters; fluxmeters; galvanometers; Kelvin and other type bridges. Ealing Corp., 40 University Road, Cambridge 38, Mass.

Contact Use

A 54-page manual of contact selection and use contains a wealth of data on composition contacts produced from powders. Different material combinations discussed as applied to modern contact requirements.

Copy of the 12-A catalog available to contact users on letterhead request to Stackpole Carbon Co., Dept. ED, St. Mary's, Pa.

Toroids, Filters 316

The catalog discusses toroids, filters, and related networks in military and industrial communications. Contains applications with schematics and performance curves. Developments in the field of telemetering including a series of constant delay band pass and low pass filters are also included in the 16-page brochure. Burnell & Co., 16 Pelham Pkwy., Pelham, N.Y.

A case history study of a typical military project. Examples are given of changes where (1) specification changes were required and (2) where specs were not required to be changed.

Value Engineering of Military Equipment—

A Case History

Albert Sikorsky
Bureau of Ships, U.S. Navy

and

J. B. Singel
Westinghouse Electric Corp.
Baltimore, Md.

Incentives for Contractors

". . . Those contractors who constantly forge ahead in technological innovation and production efficiency can expect to be most successful in obtaining Navy work . . . There is now, as never before, a critical necessity for reducing costs and improving efficiency."—Rear Admiral A. G. Mumma, USN, Chief, Bureau of Ships.

". . . We suggest that the Navy ask its contractors having contracts of this type to inform us of that fact in renegotiation proceedings, and to be prepared to describe and document their value engineering accomplishments thereunder. This will enable us to explore the matter fully in each individual case, obtaining from the Navy pertinent facts and opinions through the performance reporting procedures already established between our agencies.

"Having developed the facts in each case, all due consideration will be given thereto under the statutory factors in the determination of the case. As you know, the factors in the law are quite comprehensive of this type on the part of defense contractors."—Thomas Coggeshall, Chairman, The Renegotiation Board.

VALUE engineering studies by Westinghouse on the Navy WRT-1 and 2 communications transmitter resulted in huge savings. When applied to the design and specifications, the proposals will save over $3 million in future procurement. These first few examples illustrate value engineering proposals where specifications had to be changed. These results are presented in condensed form, and represent only a small fraction of the total investigation done on each item.

Lifting Eyes

Lifting eyes (Fig. 1) used only during installation and removal have always been provided with equipment. Yet, these same lifting eyes are standard items carried by professional rigging crews that hustle the equipment from the dock to point of installation aboard ship. Eyes were packed in a bag attached to the equipment when shipped.

More often than not, the rigger uses his own lifting devices or resorts to other types of carrying cradles. Their elimination is hardly noticed. Cost of each eye is small, yet, total saving on future procurement runs to $20,000.

Two-Piece Frame

In Fig. 2, hand points to split in frame which is characteristic of the two-piece assembly of transmitter that is to be installed in submarines. Disassembly into two pieces enables the transmitter to go through submarine hatch and down into compartment where it is finally installed. This particular equipment was originally intended for both submarines and surface vessels.

Later on, it was decided to use a different equipment for submarines and use this one for surface vessels only. Since design was already suitable for surface vessels, no changes were contemplated until value engineering team at Westinghouse put the spotlight on this feature. Redesign to a one-piece frame now saves $130.00 per equipment.

Drop MIL Spec

Transformers and chokes (Fig. 3) required obtaining qualification approval to MIL-T-27A. Since a large number of the same type transformers and chokes have already been installed on other military equipment and are performing satisfactorily, the value engineering team suggested the deletion of the qualification test requirement.

Furthermore, these transformers are tested as part of the over-all performance and durability tests of the pre-production and production equipments. Bureau project engineers, who had been looking at this requirement critically for some time, took quick action to approve the proposal and are now looking at the prospect of applying the idea to a much broader area. The resulting savings of $16,293 on this contract alone gives them justification to do this.

Nonessential Extras

Items that were eliminated as nonessential result in savings of more than $1/4 million in future procurement of transmitters. Cam latch (Fig. 4) was installed on development model as a "fix" to give extra leverage when securing drawer assembly to frame. This was needed on the development model because tolerances were not too well maintained in the early model. In

Fig. 1. Value engineers found that these lifting eyelets weren't needed.

Fig. 2. This two-piece cabinet design, made to facilitate installation in submarines was eliminated when the units were allocated to surface ship use only.

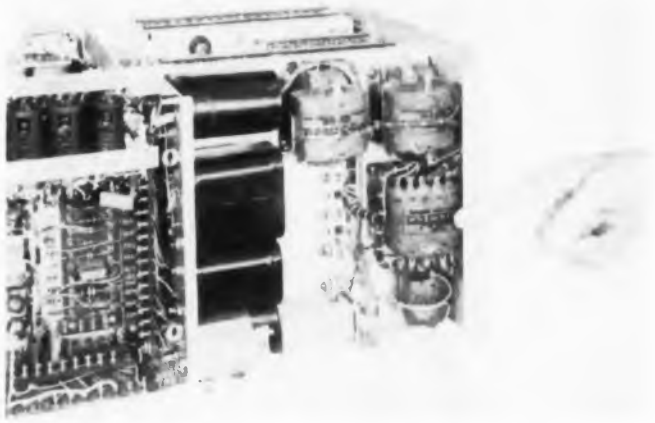


Fig. 3. Expensive testing to MIL specs was avoided after investigation showed these units had performed to specs in other equipment.

production version, units slide in and out with more positive action because of better quality control.

The latches would have gone unnoticed however, until value engineering team put the "unnecessary cost" spotlight on them. Their elimination not only saved money but got rid of a safety hazard as well. The latches would strike down when unit was slammed into frame and gashed hands and fingers that were in the way.

The filament on the time meter (Fig. 5) was eliminated as an unnecessary embellishment. The running time meter on the right in Fig. 5 was considered adequate since life of the tubes is based primarily on the length of time high voltage has been applied rather than duration of the filament supply voltage which meter to the left indicated.

Left in Fig. 6 is a tool kit of standard Allen wrenches and one special tool formerly supplied. Now, only the special tool is supplied with a simple retaining clip, as shown to the right.

Spec Changes Not Always Needed

Following are a few examples not requiring specification changes. When and if any of these items are implemented depends on the scheduling of the various stages of engineering, drafting, and manufacture which ultimately depend on the schedule delivery date. Some items effect substantial cost reduction, whereas others save only a nominal sum.

Machined Casting vs Machined Plate

A bearing plate was needed as part of the mechanism for rotating the equipment drawers to provide fast and easy maintenance by always working from the top. The design called for the plate blank to be cut from a large 7/8 in. thick aluminum sheet and then "hogged out" and machined to final dimensions. The value engineering group's investigation disclosed that a saving of about $10.00 would result if the plate were machined from a casting. This includes amortizing the cost of the pattern.

Machined Thumbnut vs Wingnut

The drawers of the equipment under study are moved in and out on slides on which the rotating mechanism is mounted. When closed, a drawer is held in place by means of a latch beneath the drawer, but the final tight takeup to prevent leakage radiation is made by means of the wingnuts. A small item, but perhaps not so small when one considers that one equipment contains 32 pieces.

Fig. 7 shows five different fasteners which were considered. The large one on the left is the most expensive, and the small one on the right is the least expensive, with numbers 3 and 4 being almost the same price. The wingnut, second from the left, is the one called for by the manufacturing information. The design calls for machining the stem from stainless steel and welding it to a wing blank purchased from a vendor. The wing it then given a rubberized finish. In a finger tightening comparison between numbers 2 and 4, number 4 could be tightened as tightly as number 2, and could be made extremely tight, of course, by the use of a screwdriver. The elimination of the wings also gives more finger clearance when grasping the drawer handles. Number 4 is made on an automatic screw machine from stainless steel rod and has a cost of about $1.00. Number 5 was considered inadequate.

Fig. 4. Handle latch, needed on developmental models, was eliminated on production models when closer tolerances were held.

Fig. 5. Filament on time meter function was being duplicated by running time meter (right). It was eliminated.

Fig. 6. Tool kit was simplified by substituting set of wrenches (left) with special tool (right).

Smaller Cable

In the equipment under investigation shielder cables are of the RG-62/U variety and due to their size as well as the size of their connectors cause some congestion in several places. In the cable helix, (Fig. 8), the use of the smaller cable will reduce the "wear" on the cable group and thereby promote reliability. Easier servicing of the helix as well as drawer units is also a resultant benefit of the smaller cable.

No appreciable change in impedance is involved since the smaller cable has very nearly the same rf resistance, capacitance, and inductance. The voltage rating is more than adequate. Consequently, no circuits are affected electrically. In the implementation of the smaller cable, the benefits dervied were deemed to be sufficiently worthwhile to increase the cost by approximately $12.00 per equipment.

Grommets—Metal or Rubber

A cable group, passing through a notch in the chassis was protected by a metal grommet. To the value engineering group, it appeared that the metal grommet was very likely far more expensive than a rubber grommet. An investigation disclosed that to construct the metal grommet the following operations were usually required: Shear to size, mill the small notch, mill the radius slot, drill mounting holes, tap mounting holes, tumble to remove rough edges, and apply finish. Deducting implementation costs such as changing manufacturing information and accounting for the cost of the rubber grommet, the net saving approximates fifty cents per grommet.

Tube Shield Finish

This example illustrates, in a small way, how a cost reduction can be made by using a vendors

Fig. 7. Economics of manufacturing of these thumbscrews showed that the second from the right was least expensive and could perform same functions as any of the others.

Fig. 8. Use of smaller coaxial cable saved maintenance costs by reducing wear and permitting easier servicing.

product. Fig. 8 shows a small portion of one drawer in which several miniature tubes are mounted and covered with tube shields. The tube shield, of course, is mainly to provide electrostatic shielding, but its black paint provides corrosion resistance as well as improved heat dissipation by means of radiation. In tests conducted by the Material and Standard Engineering Section on painted tube shields purchased from a vendor, it was indicated that the vendor's shields met the requirements of the appropriate MIL-STD Specification for corrosion resistance, and the ability to radiate thermal energy was equal or superior to the finish applied locally.

Accordingly it was deemed worthwhile to purchase tube shields that were already painted instead of buying them unpainted and applying the finish locally. The approximately seven cent net saving per tube shield, although relatively small, can represent a substantial saving when considering the number of tube shields used in the course of a year.

Stop Washer Problems

For a number of years, turns-counting stop washers have been made in a multitude of designs by many different manufacturers. To a large extent, the design is dictated by the total job quantities required as well as by the number of washers required per shaft, and the available mounting space. Several design attempts were made (Fig. 10) to filfill a particular requirement. The washers are used in stacks to limit the rotation of control shafts to a predetermined number of turns for the purpose of protecting tuning elements. Since as many as 12 or more washers may be used in a single stack, close tolerances are necessary in order to provide the required accurracy. Furthermore, great strength is necessary because hand cranking speed and momentum cause the mechanism to bang against the end stop with considerable force. All washers are made of stainless steel.

After testing, it was obvious that #3 washer and #5 washer would be satisfactory for the application. Number 3 washer is machined from stainless steel bar stock to close tolerances and is an expensive operation unless special machinery is available. To be considered, however, is the fact that the manufacturing information for the use of #3 is complete whereas to use #5, the information would require some changes because of the difference in width of the projection. The summary of costs (both local as well as quoted bids) is still to be made and will consider

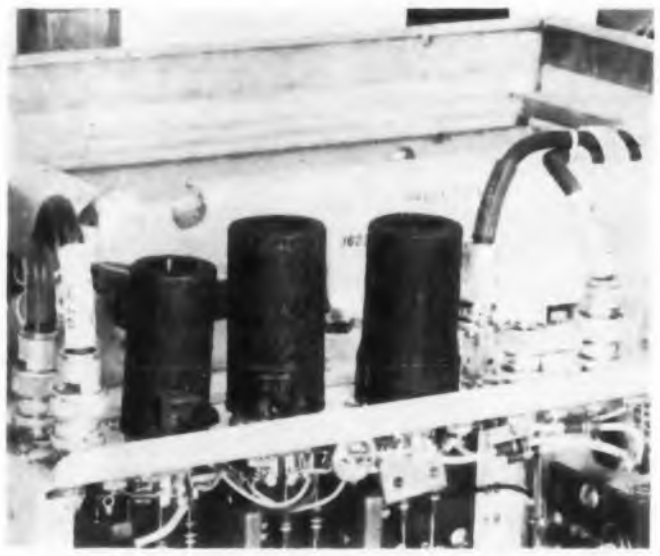


Fig. 9. (left) Tube shields painted by the vendor saved about 7¢ each over finishing them to rigid standards within the shop.

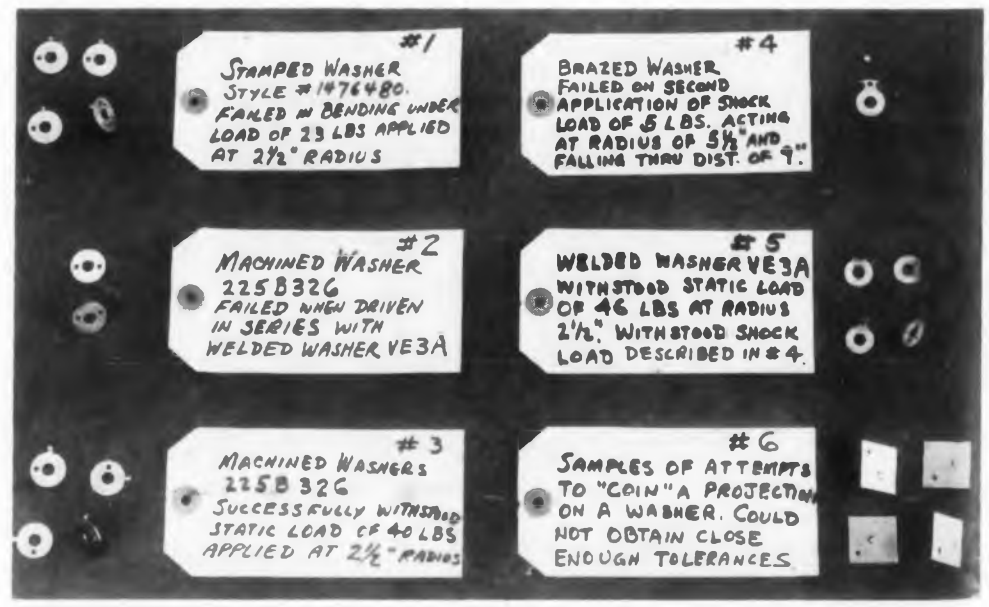


Fig. 10. (right) Results of tests on various stop washers to determine the one least expensive which would meet tolerance limits.

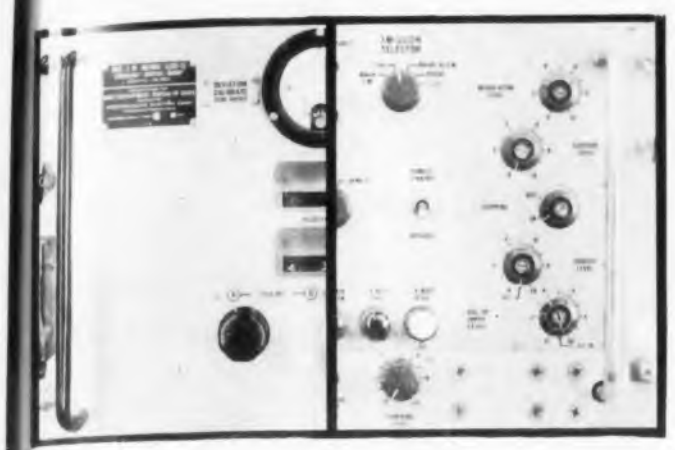


Fig. 11. Special drawer handle (left) was not really needed and was replaced with a better, less expensive handle (right).

implementation costs of washer #5 Preliminary figures indicates a worthwhile cost reduction resulting from the investigation.

Drawer Handles

Drawer handles shown at the left of Fig. 11 is covered with a special black coating. The handle has an offset bend at top and bottom to provide greater clearance to controls. Some of the supposed features of the black coating are that it improves the appearance, protects against corrosion, and makes the handles thicker to give a more comfortable fit when grasping them. To a large degree, these facts are a matter of opinion, except that the coating will give some protection against corrosion. This however, is a doubtful necessity since the handles are stainless steel to begin with.

On the other hand, to make the offset bend without exposing the die to breakage with every operation requires that the end of the handle be suitably annealed. When all of these things were considered, it seemed that there was room for improvement.

Accordingly, it was proposed that a bare stainless handle without the offset bend be provided. The additional clearance could be accounted for by moving the handles ¼ in. toward the outer edge of the panel. Further, the handle rigidity could be improved by encasing both ends in a bushing, which would also improve the appearance. The single bend can easily be made by the die and no annealing is necessary.

The proposed handle is shown in Fig. 11, right. The two cam-latch mounting holes, as well as the slot, would be removed and an additional stainless steel thumbscrew would be added to the panel in the general neighborhood of the lower hole. The approximate saving to be realized by use of the handle on the right as opposed to the handle on the left is approximately $2.50 per handle.

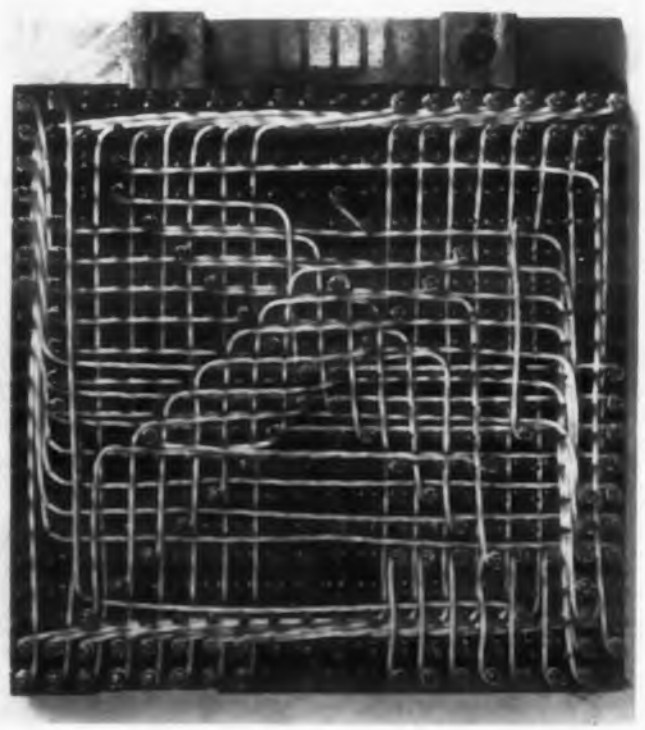
Equipment and Processes . . .

for Low-Cost Production

Some knowledge of production equipment and processes is important to the design engineer. Designing a piece of equipment without this important background usually results in an expensive product. Proper utilization of production tools will facilitate design and keep costs down. The items shown here are only a few of the wide range of tools available to the electronics engineer.

Plastic Molding Machine

Machines in capacities from 60 through 450 tons are available with such features as automatic loaders which feed the molding powder into charging cups in accurately controlled amounts; molding powder preheaters which speed operating cycles; and pick-up combs which receive parts when ejected from the molds and unload them into the containers automatically. The machines are designed so that they can be run unattended. Their operation is also highly flexible to make possible economical production of limited quantities of parts. Baker Brothers, Inc. Circle **117** on Reader-Service Card.



Wire Wrap Machine

Point to point wiring of computer panels and other electrical equipment whose terminals are located on a modular basis is possible with this automatic wire wrap machine. Module for this particular unit is 0.2 in. center to center. Different modules can be designed into the machine. No heat is involved in the process. The machine can wrap on a **10 x 10 in.** area. Hughes Aircraft Co. has been using the device since May of this year. Gardner-Denver Co. Circle **118** on Reader-Service Card.

Slicing Machine

Efficient slicing of semiconductor materials or shock sensitive materials is possible with this Micro-tom-atic Slicing Machine. The machine is furnished as a complete integrated production unit consisting of the base machine, scarf salvaging coolant system, and necessary tooling. Table speeds up to 50 ft per minute can be obtained for rapid traverse and return strokes. Slices thinner than 0.012 in. are regularly obtained with thickness held to within 0.001 in. The DoAll Co. Circle **119** on Reader-Service Card.

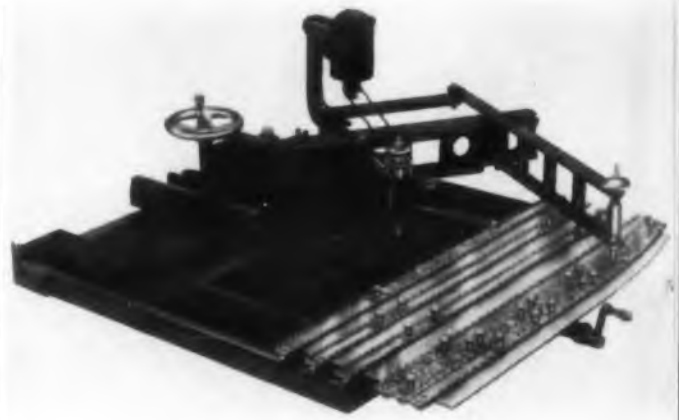
Plating Turning Head

Turning head with variable speed control is designed for plating of essentially round components such as shafts or housings, where a bearing surface may require build-up. Adjustment of rotation can be varied from zero to 400 rpm. Applications include plating of commutators or similar electrical components for longer wear and better conductivity. Cam surfaces or parts with regular cross-sections may also be handled. Marlane Development Co. Circle **120** on Reader-Service Card.

Ultrasonic Gage

Thickness of metals, glass, and plastics between 0.005 and 2.5 in. can be measured with the self-contained ultrasonic thickness gage. Readings are obtained instantaneously by applying a transducer to one side of the work and reading the thickness indication on the instrument's screen or chart. With this Model 14 Vidigage, resonant frequency of the material is detected and converted directly into its thickness. No calculation is needed. Branson Instruments, Inc. Circle **121** on Reader-Service Card.

Tapping-Drilling Machine *(Below left)* This new combination tapping-drilling machine is a versatile tool for multiple and single spindle tapping and drilling operations. It is completely air controlled for up to 50 semi-automatic cycles per minute. Of special interest is the direct spindle-reversing feature eliminating the need for separate single or multiple spindle clutch type tapping heads. Taps fit directly into collets or chucks. This new machine eliminates hand feeding in the production of one hole at a time. It may be power fed with output to six, seven, or eight holes at a time. Boice-Crane Co. Circle **122** on Reader-Service Card.



Engraver

(Above) This machine is especially designed for engraving over-size panels which cannot be accommodated by other conventional engraving machines. Complete assembly, motor, and copy table are built as an independent unit. This permits panels up to 25 in. in any dimension to be clamped on the machine base and engraved over their complete surface. For longer work, the complete chassis can be removed from the base and placed anywhere directly on a workpiece of any dimension. New Hermes Engraving Machine Corp. Circle **123** on Reader-Service Card.

Dynamic Balancing Machine

After this Dynograph balancing machine detects the amount and angular location or unbalance, the spinning work is quickly decelerated by dynamic braking. The rotor automatically stops at the exact position for drilling out or marking the measured amount of unbalance. R. B. Annis Co. Circle **124** on Reader-Service Card.

Encapsulating Machine

This automatic encapsulating machine is precision built for the embedment of electronic components in epoxy resins under high vacuum and controlled heat. Visual observation of the entire process cycle is possible. Design of the unit provides for no-clogging of the pipes, valves and other components. Red Point Corp. Circle **125** on Reader-Service Card.

Ultrasonic Machine Tool

Compact bench-model ultrasonic machine tool requires less than 2 ft by 4 ft bench space. It has an effective machining area ranging from 1/ 64 in. to 1 in. in materials such as germanium, silicon, ferrite, hardened steel and carbide. Typical operations include cutting, drilling, engraving, slicing, dicing, and production of complex shapes and forms. The Sheffield Corp. Circle **126** on Reader-Service Card.

Printed Circuit Scrubber

This machine removes all traces of grease, oxidation, and other contaminants from the surface of copper clad laminates. Maximum width capacity is 24 in. Minimum length of panel which can be conveyed is 12 in. Flat sheets fom 0.025 to 0.25 in. thick may be processed. Fuller Brush Co. Circle **127** on Reader-Service Card.

Spot Welder

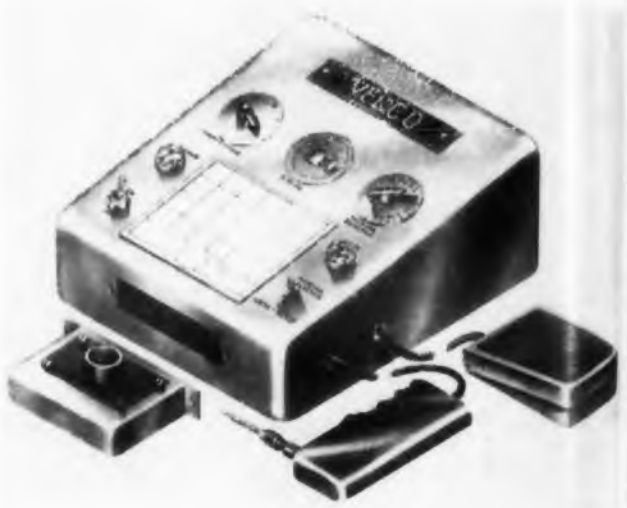
This air operated, press type spot welder is available with either five, ten, or fifteen kva transformer. The operator merely presses a foot switch and the machine automatically makes the spot weld. The machine can also be adapted for automatic production. Operating speeds of up to 200 welds per minute are possible. Some of the applications include straight spot welding with mild steel or stainless steel. It also welds stranded copper wire to lugs or chassis. Relay and switch contacts may be welded to springs and related parts. Peer Inc. Circle **128** on Reader-Service Card.

Glass Sealing

New method of flameless sealing of glass to glass, providing an inexpensive, high-production means of packaging transistors and rectifiers. Process incorporates the use of a metal ring inserted in powdered glass, and an induction coil which heats the metal ring, causing the glass to flow and thereby creating an airtight seal. About 1000 units can be sealed per hour. Trans-Sil Corp. Circle **129** on Reader-Service Card.

Press Brake

In the electronics industry, applications for press brakes lie mostly in the fabrication of chassis, cabinet panels, and parts formed from sheet metal. Press brakes handle larger work than punch presses, use standard bending dies, and are very versatile for short to medium runs and prototype work. This Model 24-A-412 has a bending capacity of 24 tons. Length of bed and ram is 48 in. Speed can be adjusted to 20 to 40 strokes per minute. W. Whitney Studies, Inc. Circle **130** on Reader-Service Card.



Soldering Machine

This VELCO Soldering Machine uses a special carbon-rod electrode as one side of the circuit. The carbon tip does not depend on surface area contact to transfer heat, but on contact resistance. The tip can be tapered to a sharp point to increase efficiency. An adjustable control and timer prevents cold solder joints. One application of the machine is for soldering multiple contact miniature connectors. Virginia Electronics Co., Inc. Circle 131 on Reader-Service Card.

Wire Stripper

This Model 2086 Intermittent Wire Stripper was designed to intermittently strip round film insulated wire. Units accommodate wire size AWG #14 through #24 with the length of strip adjustable up to one in. It may be modified to strip longer lengths and take a greater range of wire. The Eraser Co., Inc. Circle 132 on Reader-Service Card.

Drilling and Tapping Machines

Model 409 fully-automatic, hopper-fed drilling or tapping machine positions and holds rivets or similar parts for drilling or tapping. Heads of the work are clamped axially, eliminating any possible distortion which would cause the tool to weld to the workpiece. Other advantages include inexpensive tooling, fast operation, absence of cams for spindle advance and the ability either to drill or tap. The machine can tap to within 1/16 in. of the bottom of blind holes. Batchelder Engineering Co. Inc. Circle **133** on Reader-Service Card.

Color Coding

Color coding is accomplished through the use of a special automatic printing system which prints all panel coding in a single operation, after the panel is punched. Virtually any number of colors on almost any size panel can be printed with this inexpensive method. Taylor Fibre Co. Circle **134** on Reader-Service Card.

Chemical Milling

Chemicals are used for milling to extremely close tolerances. For example, the weight of parabolic antennas may be reduced after they are formed. Even magnetic materials may be milled to specific shapes. Chemical milling does not affect the properties of magnetized metal. Metal removal from intricate waveguides is also possible. Chemical milling may be the only means of producing certain intricate contours and thicknesses required by the designer. U. S. Chemical Milling Corp. Circle **135** on Reader-Service Card.

EQUIPMENT AND PROCESSES (cont.)

Bending Machine

Model RM 25 Universal Bending Machine mad by Bihler Co. of Western Germany can combine u to 16 operations. These include stamping, sawing threading, and electric point welding. Output is u to 350 pieces per minute. Pan American Supply C Circle 136 on Reader-Service Card.

Indexing Unit

This conveyor type unit is available with either 27, 35, 43, or 51 work carriers for automatic assembly or production. The carriers are integral with conveyor chain links which position the work accurately to each station. These chassis can be the basis for a wide range of automatic machines using straight line intermittent motion. Standard Tool & Manufacturing Co. Circle 137 on Reader-Service Card.

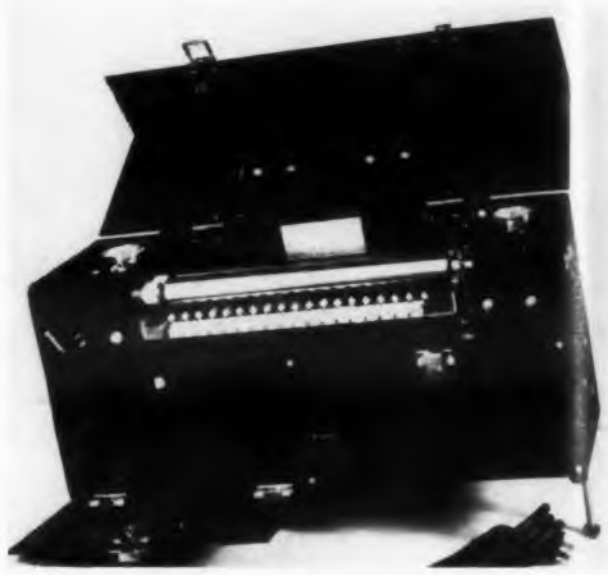
Miniature Punch Press

This Mini-Line press is designed for instrument work, fine punching, staking or forming operations. It can be used for eyeletting terminals or printed circuits and terminal boards. It measures only 7 in. high and has a controlled 3/8 in. stroke. Magnetec Corp. Circle **138** on Reader-Service Card.

Automatic Marking Machine

Operating from a geared headmotor and single revolution clutch, this unit prints specification data and trademark identification on small parts as they pass on the line. Its offset printing principle makes it suitable for either round, flat or irregular shaped parts. Jas H. Matthews & Co. Circle **139** on Reader-Service Card.

EQUIPMENT AND PROCESSES (cont.)



Production Micrometer

Up to 10,000 miniature parts per day may be sorted by this high precision production micrometer. It was designed to sort and measure small to miniature parts, for precise classification, by thickness, in production quantities or small lots, and with total tolerances down to 0.00003 in. Among the parts which the machine can sort and grade are mica discs; instrument pivots; bearings; washers; and glass beads. Affiliated Manufacturers Inc. Circle 140 on Reader-Service Card.

Metal Cutting Shears

This versatile ring and circle shear cuts circular discs, holes, rings, irregular outlines and straight lines in metal blanks of any shape. Two power and two hand models are available for cutting circles from 3-1/2 to 44 in. in diam. Capacity is 20 ga mild steel. Other models are also offered with larger capacities. Niagara Machine & Tool Works. Circle 141 on Reader-Service Card.

Turning and Boring Machine

Clausing Hydra-Cycle is a semi-automatic turning and boring machine capable of performing several machining operations simultaneously or in continuous sequence. Model 6405 is a hydraulically operated cross slide mounted on a hydraulically operated longitudinal table. Work setups are easy and inexpensive—simple block tool holders, carbide insert bits and standard boring bars will handle most jobs. Swing is 12-3/4 in. over bed, 4-11/16 in. over cross slide when mounted on table, 9 in. over table. Clausing Div., Atlas Press Co. Circle **142** on Reader-Service Card.

Printer *(Above left)* This Model 122A is designed to imprint trademark and code designation on both top and side of Jetec 30 cases, cylindrical transistors, miniature relays and transformers. Printing head for top of case marking may be equipped for interchangeable printing plates. Side marking is accomplished by a consecutive serial numbering unit or interchangeable printing plates. Maximum imprint size for top marking is 2 x 3 in. For side marking, the size of the case is the only limitation. Operating speed is 45 per minute. Markem Machine Co. Circle **143** on Reader-Service Card.

Extruder

New line of thermoplastic extruders capable of increasing output demands of both the wire and cable and plastics industries. A 2-1/2 in. bore unit has a 20 to 1 L/D ratio. Thrust capacity of this unit at 1 rpm is 5000 psi. A complete selection of straight delivery heads, crossheads, sheeting, pelletizing and valving heads are available with electric heating. Davis-Standard, Div. of Franklin Research Corp. Circle **144** on Reader-Service Card.

Dial Index Feed

Positive and extremely accurate indexing is accomplished with a 6-1/2 in. diam. indexing gear at press speeds as high as 280 spm. Total table height is 2-3/8 in; total shut height is 4½ in. With 12 stations, the table comes to a complete dwell during a 220 deg rotation of the press crankshaft, allowing ample time for punch engagement and withdrawal before cycling to the next station. Benchmaster Mfg. Co. Circle **145** on Reader-Service Card.

Dry Screen Process

This low cost method of printing wiring production is based on printing thermoplastic resist through a heated screen. With the new Model Mark IV, rigid material up to 3/4 in. in thickness may be handled. The machine is manually operated and has a capacity of 200 impressions per hour. Dry Screen Process, Inc. Circle **146** on Reader Service Card.

IDEAS FOR DESIGN

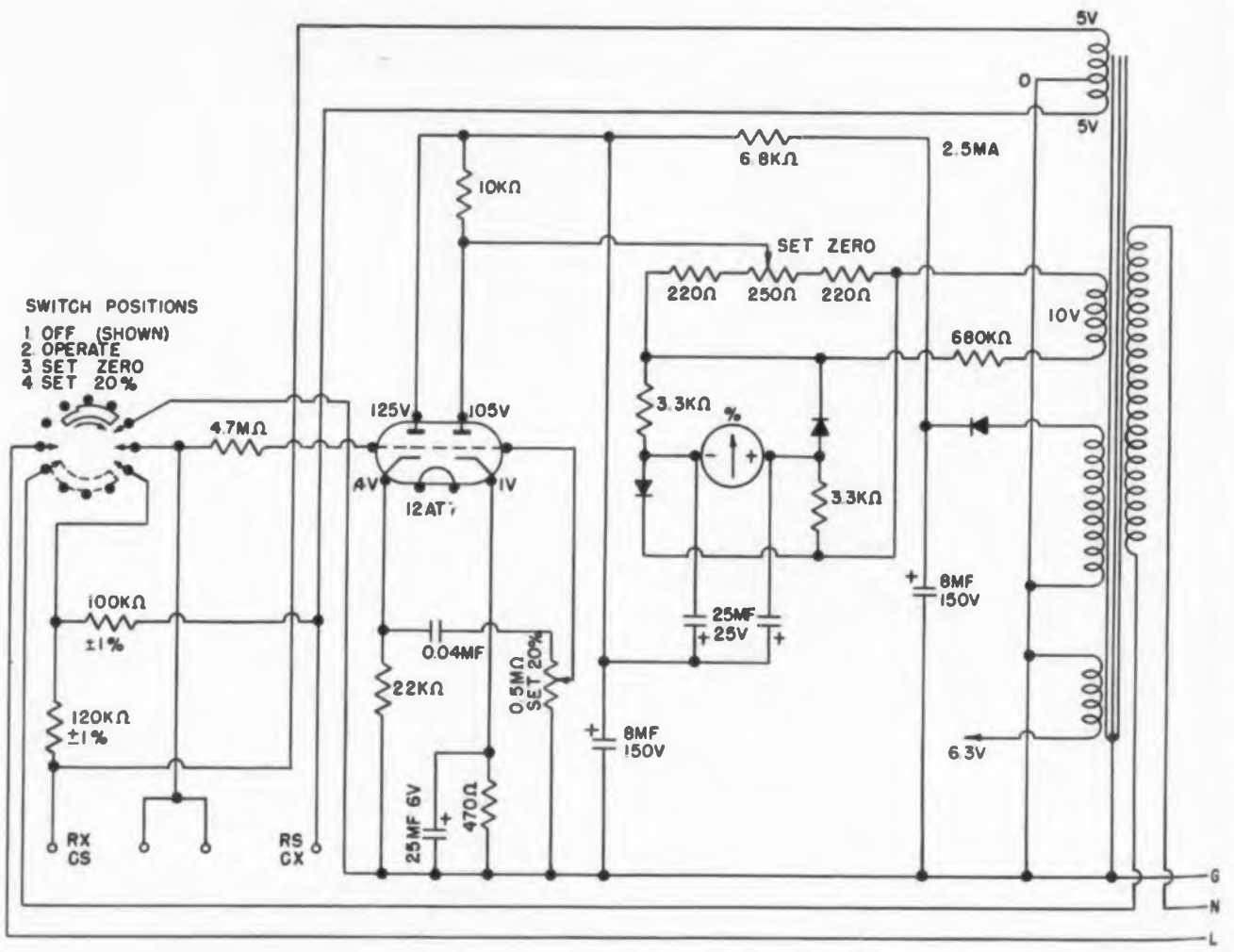
Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication. Full information and an "entry blank" can be obtained by circling #148 on the Reader Service card.

A Simple, Direct Reading Deviation Meter

THIS small, inexpensive deviation meter provides the high testing rates required on many assembly lines. It need be no larger than the conventional volt-ohm-milliammeter, and since there is only one tube, a meter, and a power transformer as the main components, the cost need not be great.

Many component comparators or deviation meters are available. Most use a test voltage at 1000 cps. These are naturally large and expensive. Their only advantage is that by virtue of the higher bridge frequency they can check lower-value capacitors. But this advantage is not as great as it seems. The only other type of comparator available is an ac operated bridge; this requires manual adjustment for each test and is therefore very slow.

This deviation meter operates at line frequency and indicates the percentage error of the component under test immediately, with no



This simple instrument measures deviation quickly. It uses only three major components: the power transformer, a meter, and one vacuum tube.

manual adjustment. Only two preset controls must be set up. The circuit is such that no damage can occur to the indicating meter due to any combination of components being tested. In short, it is simple and relatively foolproof, and can be used without any training.

How It Works

Essentially a deviation meter is a bridge in which the out-of-balance voltage operates a meter calibrated in per cent. The usual bridge is adjusted until the detector indicates zero volts into it, so the impedance of the detector (at balance) is unimportant because no current flows through it. In a deviation meter this is generally not so, and the detector impedance must be high enough not to load the circuit.

To obtain a very high input impedance, a cathode follower is required, and unless a pentode is used with ac coupling from screen to cathode, one still has an input capacitance of approximately C_{gp}. This capacitance appears in parallel with the input resistance. The latter quantity can be in the order of 300 meg with C_{gp} about 1.5 μμf. This capacity has a reactance of about 1700 meg at 60 cps. Thus the input impedance of the cathode follower at 60 cps will be about 300 meg, and at 1000 cps about 95 meg.

It can be shown that the percentage error of the meter reading is given by:

$$\text{Error} = \frac{100\ Z_1\ Z_2}{Z_1Z_2+Z_2Z_3+Z_3Z_1} \text{ per cent}$$

where Z_1 and Z_2 are the impedances being compared and Z_3 is the detector impedance.

Hence, for an error of, say 10 per cent of the meter reading (i.e. the meter reads 9 per cent when it should read 10 per cent), the top limit of a 60 cps deviation meter would be 67 meg or 42 μμf, while for a 1000 cps meter it would be 21 meg or 7.5 μμf. The possibilities of a 60 cps meter are, therefore, considerable.

The deviation meter, shown in schematic form, consists of a simple bridge whose four arms are two halves of a winding on the power transformer, the component under test, and the component against which it is being compared. When this bridge is unbalanced, a signal at line frequency is applied to the grid of the first half of the double triode. This half tube is operated as a cathode follower. To increase its input impedance the conventional grid return is omitted, and a protective series resistor used. Although this may alarm the purists, none of the

instruments in use show any tendency for the grid either to cut off or run positive. Furthermore, shorting out the 4.7 meg series resistor produces no noticeable change in the meter reading, thus indicating the high input impedance.

The second half of the tube operates as a straightforward amplifier via the gain control which sets the sensitivity.

The detector bridge is essentially a ring demodulator in which two of the diodes are replaced by resistors. This reduces sensitivity but is more economical. It would be worthwhile to use four diodes in a series ring if full scale deflection were required for a deviation of about 5 per cent.

Using a less sensitive meter is not practical as distortion at higher output levels (where limiting takes place) would cause undue cramping of the meter scale. Greater sensitivity results from increasing the bridge test voltage—it is only 5 volts. If low value resistors are not to be checked this can be done safely.

Construction Tips

There are a few important points in the construction of the instrument. The feed to the grid of the cathode follower should be short, and the power leads to the switch should be twisted together and kept away from the grid lead. If wired as in the schematic, the pointer should move in the positive (clockwise) direction when the switch is turned to "Set 20%." If it moves in the opposite direction, it may be reversed by reversing the meter connections, the test bridge supply voltage, or the phasing supply (10 volts). The phasing supply is not critical; nor is the 680 ohms series resistor; all that is required is sufficient voltage to open the bridge.

When the meter reads in the correct direction, it should be possible to "Set Zero" and "Set 20 per cent." At this stage the meter will probably indicate other than zero when switched to "Operate," and with both pairs of test terminals open.

This is due to unequal capacitances across each of the transformer windings which feed the test bridge. It may be corrected with a small trimmer (up to 5 μμf) across either R_xC_x or R_sC_x. The low side of the trimmer should be joined to one side of the transformer winding. It is advisable to adjust the trimmer after the case has been put on, as this materially influences the setting. Good grounding is also advantageous, particularly if very high impedances are to be checked.

Errors

There is no detectable error in comparing resistors in the range of 50 meg down to 1000 ohms. The error is less than 0.5 per cent at 100 ohms when reading the per cent deviation scale. This is due to the impedance of the test bridge supply. To measure low resistors, a transformer capable of supplying the bridge at low impedance should be used. In capacity measurements, values in excess of 10 μμf show no appreciable error. The low limit is set by residual capacity in the instrument and the loading caused by the input circuit. This gives a low limit of about 100 μμf for an error of less than 0.5 per cent when reading 10 per cent deviation.

Apart from checking the tolerance of components, the instrument can be used for any impedance measurement, such as the output impedance of a stabilized power supply, or the mutual conductance of a tube (by measuring its output impedance as a cathode follower).

C. D. Lindsay, Electronics Engineer, Stromberg-Carlson, A Division of General Dynamics Corp.

New Use for Magnetic Chucks

Flames used to seal the glass components to metal in magnetron subassemblies heated up old-style metal chucks with their many moving parts to such a degree that they became distorted and warped from expansion. This problem increased along with the demand for magnetrons made to ever-closer tolerances.

Adapting an idea long used in the metalworking trade, we now use a magnetic chuck. The

Flames don't bother magnetic chuck.

new chuck has no moving parts. Heat and consequent expansion do not affect it.

As applied to magnetron production, this chuck has also proved its versatility by holding delicate assemblies of irregular design. By the

same token, in development engineering, it allows more latitude in magnetron design.

Another advantage is that it is now possible to insert an assembly, make the glass-to-metal seal, and remove the finished assembly without stopping the machine. This factor alone has served to step up production while at the same time lessening operator fatigue.

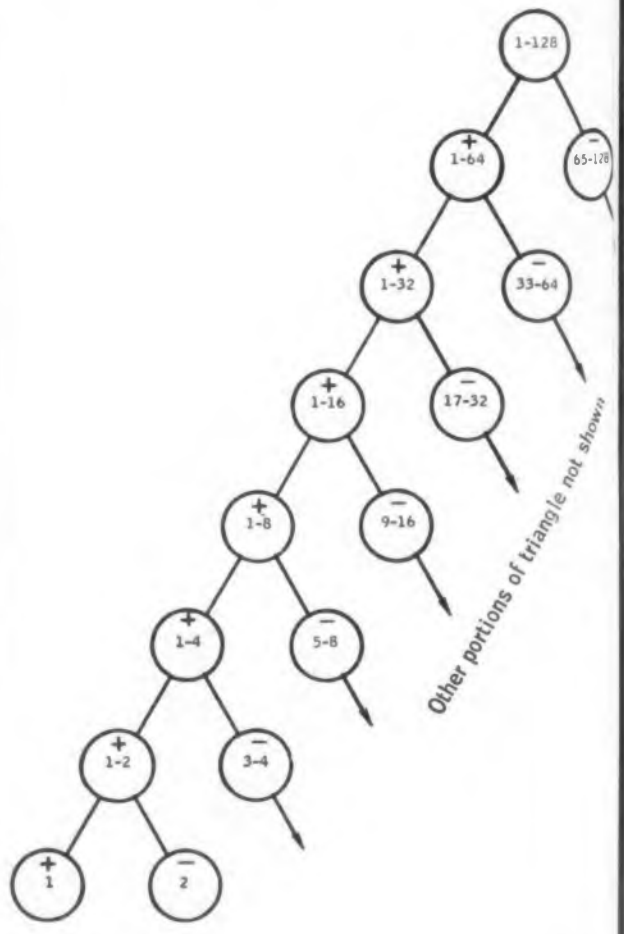
W. Harold Small, Manager, Glass Department, Power Tube Div., Raytheon Mfg. Co., Waltham, Mass.

Fast, High Potential Test For Multiconductor Cables

We needed a fast method of running high potential tests on complex multiconductor cables and harnesses, and one which would also comply with the standard one minute duration requirement. Each wire had to be checked against every other wire. Thus, in a 128 wire harness, the conventional method requires 127 (factorial 127) minutes.

One commercial technique uses a stepping relay to successively test each wire against all others, grounded. This is an improvement, but still requires 128 minutes.

With a triangle matrix, the complete test on a 128 wire harness can be made in just seven min-



ut's. Even more striking advantages are achieved with more complex harnesses. A 1024 wire harness takes only 9 minutes.

In the sketch, the top circle represents a 128 wire harness. For the first step, the wires are divided, electrically, into two cables, one with wires 1 through 64, the other with 65 through 128.

High voltage is applied to the two cables for one minute, with the polarity indicated. This checks every wire in one cable to every wire in the other cable.

In the second steps, these two cables are divided to make four cables, and the opposite dc polarity is applied for one minute. Polarity changes can be accomplished by relays or multi-deck, multi-position selector switches.

The third step takes eight cables, the fourth takes sixteen, etc. At the seventh step, 128 individual wires with opposite polarities, are tested for one minute.

At the end of the seventh step, each wire has been high voltage tested against every other wire for a full minute, and the total test time is 7 minutes.

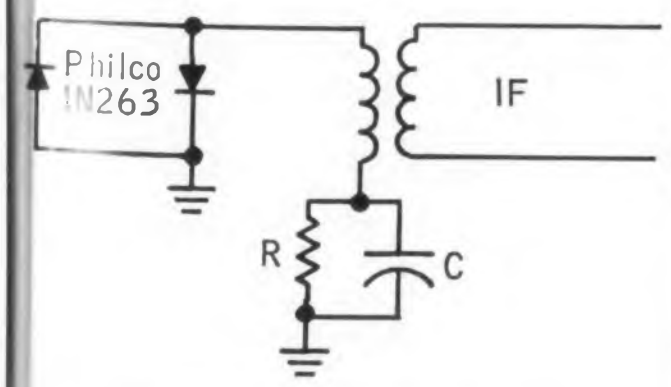
M. K. Kessie, Senior Design Eng., Atomics International, Canoga Pk., Calif.

Self-Balancing Balanced Mixer

Here's a simple bias arrangement for microwave mixer diodes that will improve a-m suppression in the balanced mixer of a radar receiver by approximately 6 db.

The circuit uses self-bias provided by an RC network. This network develops a voltage, back-biasing the diode having the larger signal amplitude. The diode having the smaller signal amplitude will be forward biased since it is reversed. This action can, by proper choice of the RC time constant, provide a self-balancing action to compensate for unequal conversion gain of the diodes, or unbalance in signal level applied to the mixer.

Lewis C. Orlowski, Senior Engineer, Philco Corp., Philadelphia 44, Pa.



Balanced mixer with self-balancing.

IDEAS FOR DESIGN

Extend VTVM Ohms Range With Simple Probe

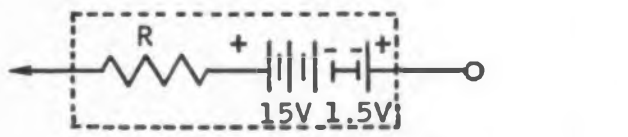
Here's a simple gadget to extend the resistance range of a standard vtvm to 20,000 megohms. It's compact. It doesn't affect circuit stability. And, it tracks the ohms scale.

The trick in getting the resistance scale to track is to provide a probe wth a resistance nine times the input resistance of the vtvm, and a battery voltage nine times the value of the vtvm's internal battery.

For use with meters of the RCA Voltohmyst type, with their 10 meg input resistance, and 1.5 v battery, the probe includes a 90 meg resistor, a 15 v transistor battery, and a 1.5 v bucking penlight cell.

A good ground like a water pipe must be provided to insure stability. The probe is plugged into the vtvm in place of the usual ohms lead, and scale readings are multiplied by 10.

R. G. Middleton, V. P. Engineering, E-I School, Bellwood, Ill.

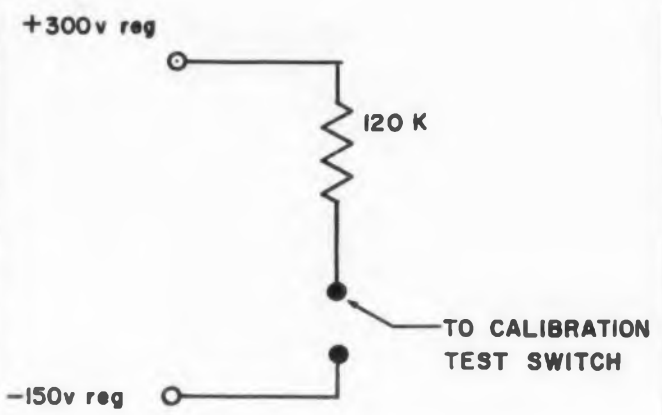


Simple probe to extend vtvm resistance range.

Simple Zero Suppressor Improves Transistor Curve Plotters

With many transistors, the change in base voltage over the operating range is much less than the static base voltage for zero base current. As a result, the curves are extremely crowded if the reference voltage is zero. This difficulty is largely eliminated by introducing a zero set to suppress the zero for the curves.

The Tektronix 575 plotter, for example, is ideally arranged for introducing a zero-set for a negative base bias voltage. It provides a spring-back switch to check both the zero setting and the full scale negative deflection setting. It is easily modified to provide a full scale positive deflection as well. The only parts needed are in



Simple circuit eliminates curve crowding near zero.

SPDT switch and a precision 120 K resistor. The arm of the switch goes to the calibration test switch for a 10 division deflection.

Keats A. Pullen, Jr., Ballistic Research Labs., Aberdeen Proving Ground, Md.

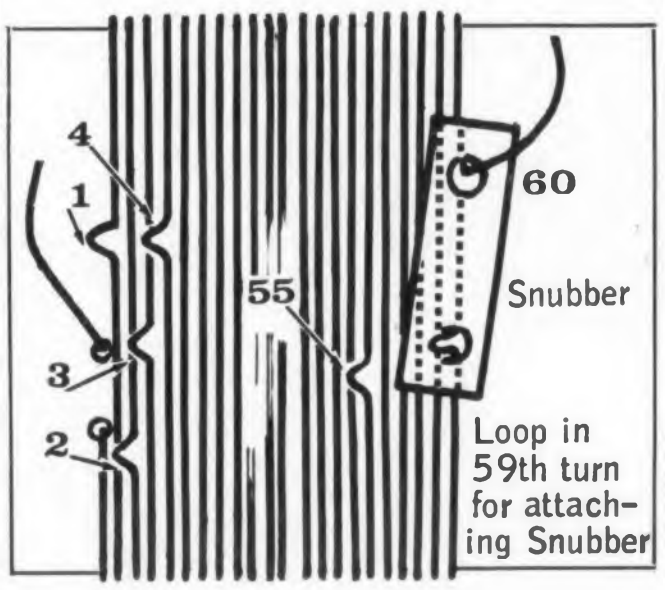
Many Taps from Few

It is often necessary to have a large number of single turn taps on an rf coil with a minimum number of terminals. Also, it's often necessary to snub the end of the coil when a suitable hole is not available in the form (as when a ceramic form is used).

The sixty turn coil in the drawing is tapped at 1, 2, 3, 4, 25, 30, 35, 40, 45, 50, 55, and 60 turns, a total of 12 taps. By selecting the proper combination of taps on the terminal board, one can get any number of turns from 21 to 60.

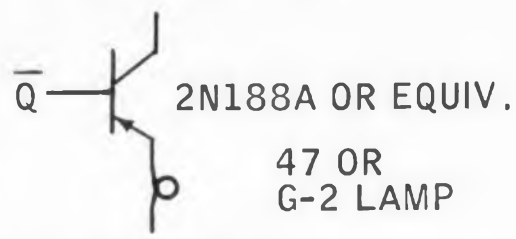
The snubber is simply a strip of insulation with two holes drilled in it. A loop on the next to last turn is put through one hole and spread open. The end of the last turn is threaded through the other hole and bent back.

Thomas D. Reid, Aeronautical Communications Equipment, Inc., 3090 S.W. 37th Av., Miami, Fla.



IDEAS FOR DESIGN

FALSE VOLTAGE



TRUE VOLTAGE

Flip-flop monitor gives high illumination with low drive power.

Simple Flip-Flop Off-On Indicator

During test of large digital computer systems it is desirable to simultaneously observe the states of many flip-flops. In computer systems using vacuum tubes flip-flops, neon lamps are frequently used. For transistorized computers the presently available indicators are high impedance miniature triode indicator tubes which require filament power and special sockets. These tubes do not produce much light.

A cheap and simple circuit to perform this function for low voltage transistorized computers is the emitter follower lamp configuration.

In the circuit Q represents the complementary output of the flip-flop to be observed. The flip-flop supplies the drive to the base of the indicator in the same manner that it is used to supply drive to logical gates in the system. In our system a "one" or a true signal is represented by dc ground and a "zero" or false signal is represented by −6v dc. Using a 47 panel lamp approximately 2 ma of drive is required for full brightness. The Western Electric lamp provides an excellent indication and requires less than 0.2 ma drive. For different true and false levels the lamps may be changed.

Louis Kurkjian, Hughes Aircraft Co., Los Angeles 45, Calif.

For Sharp Breaks In E-I Characteristics

Many voltage comparator circuits require diodes with a sharp break in the forward voltage-current characteristics. Conventional silicon and germanium diodes follow the logarithmic relationship so there is rounding of the knee when displayed on a linear plot as in Fig. 1c.

The unijunction transistor can be used in the inverted connection to provide characteristics which are more nearly ideal than those of conventional diodes. The emitter of a typical uni-

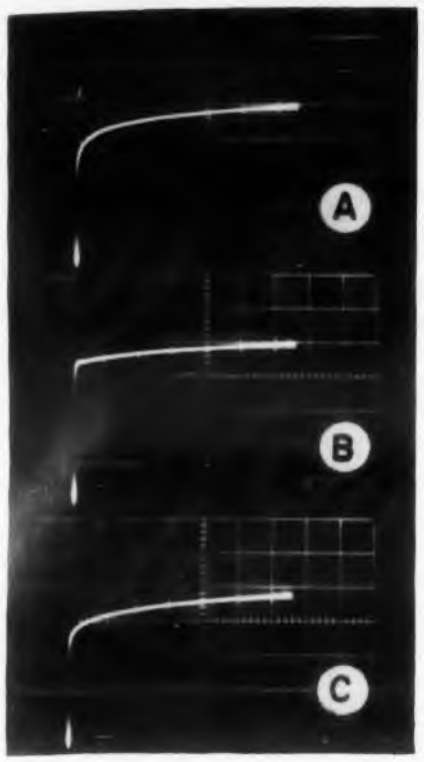


Fig. 1. Diode voltage-current characteristics. The horizontal scale is 0.2 ma/div while the vertical scale is 0.2 v/div. **a.** Conventional diode characteristics. **b.** Inverted unijunction transistor characteristics. **c.** Emitter to base 2 diode characteristics with base 1 open circuited.

junction transistor is physically very close to base 2, so the characteristics between emitter and base 2, with base 1 open (Fig. 1c) resemble the characteristics of a conventional silicon diode (Fig. 1a).

If a small positive bias is applied between base 2 and base 1, as shown in Fig. 2, the forward voltages at low currents are increased while the forward voltages at high currents are not affected.

This tends to sharpen the E-I characteristic and makes it approach the ideal, as in Fig. 1b. Over a decade range from 30 to 300 μa, the change in forward voltage drop is about 20 mv for a unijunction transistor while it is about 100 mv for a conventional silicon diode.

T. P. Sylvan, Application Engineer, General Electric Co., Syracuse, N.Y.

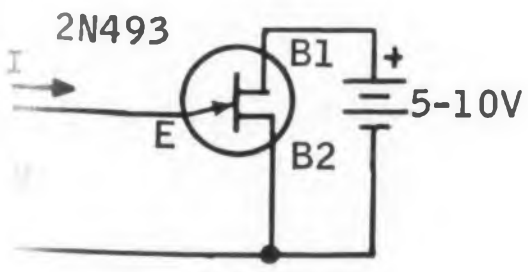
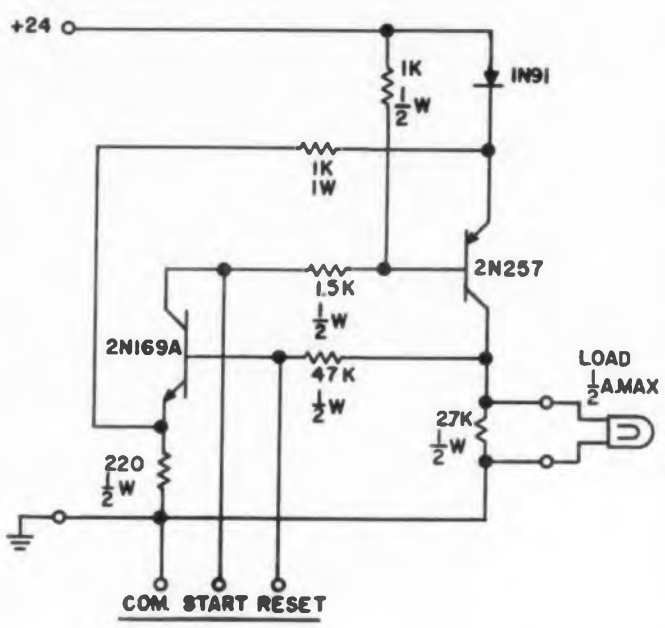


Fig. Inverted connection for the unijunction transistor.

IDEAS FOR DESIGN



This annunciator control requires only 20 ma of standby current. It can work from lines with internal resistance as high as 5000 ohms.

Reliable Annunciator Control Works From High Resistance Lines

We needed an exceptionally reliable annunciator control which could be controlled through complex telephone circuitry. It had to require very little maintenance.

The transistorized flip-flop shown in the schematic did the trick. It is based on the pnp-npn "hook" circuit. It can be triggered and reset by control circuits with as much as 5000 ohms internal resistance, and, unlike conventional flip-flops, it requires only about 20 ma of idle current. By changing the 1N91 diode to a larger one, one can control 2 amp lamp loads.

Here's how it works: In the non-operating state, both transistors are cut off by biases developed across the 1N91 diode and the 220 ohm resistor. Grounding the start lead switches on the 2N257, whereupon the drop across the lamp load switches on the 2N169A.

Upon release of the start circuit, the 2N169A collector current flows through the 1500 and 1000 ohm 2N257 base drive divider. This locks the 2N257 on. Grounding the release lead cuts off the 2N169A. The current to the 2N257 is interrupted, after which both transistors are held off by their normal biases.

Elbert S. Kennedy, Chief Electrical Engineer, Telecom, Inc., 1019 Admiral Blvd., Kansas City, Mo.

Resistance Multiplier Makes Long R-C's

Very large resistances and capacitors are normally required in electronic timing circuits for long time durations. A high input impedance cathode follower can serve as a resistance multiplier so the component values can be more reasonable.

The figure shows how a resistance multiplier was used in a one-shot multivibrator whose output pulse could be varied from 0.2 to 10 seconds. A 2.5 meg pot and a 0.1 μfd capacitor were used as the *RC* time constant.

The input resistance of the cathode follower is

$$R_i = \frac{R_c}{1 - \dfrac{A\,R_2}{R_1 + R_2}}$$

where

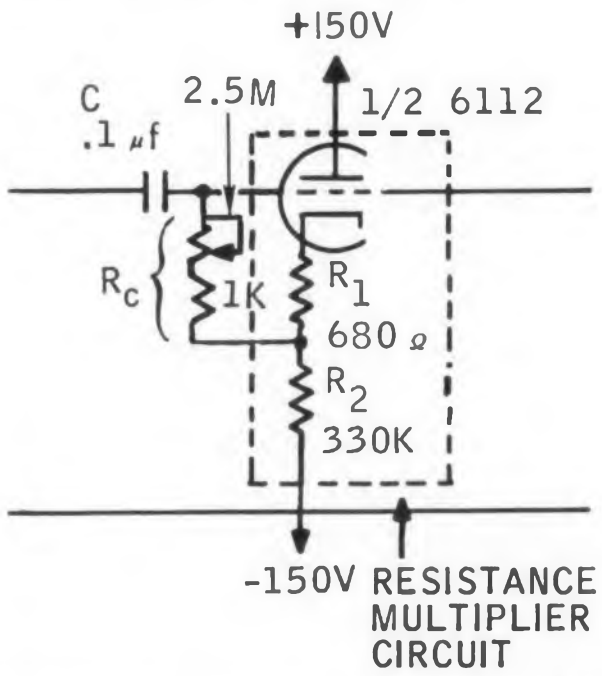
$$A = \frac{\mu\,R_k}{r_p + R_k\,(\mu + 1)}$$

Since R_1 is much smaller than R_2, the input resistance R_i is approximately equal to $R_c/(1\text{-}A)$. When R_k greatly exceeds r_p, A is approximately $\mu/(\mu+1)$. Then

$$R_i \cong \frac{R_c}{1 + \mu/(\mu + 1)} \cong R_c\,(\mu + 1)$$

and since μ is much greater than 1, R_i is approximately μR_c. Hence a resistance multiplication by μ is effected.

Dee J. Neville, Design Engineer, Gilfillan Brothers, Inc., Los Angeles, Calif.



Resistance multiplier extends timing range of one-shot multivibrator. When used in the multivibrator, the 0.1 μf capacitor goes to the plate of the first tube, and the grid of the 6112 goes to the grid of the second multivibrator tube. The effective time constant is μ times the R_cC product.

REPORT BRIEFS

Diffused Semiconductor Devices

Laboratory models of the special test equipment needed to test the high-frequency parameters of the device have been constructed. An analysis of the equation used to obtain the most optimum diffusion cycle for the particular graded base layer is presented in this report. A summary of the parameters controlling the design of the 200 mc power oscillator is given. Distribution charts of the electrical characteristics for 50 "State of the Art" feasibility samples of the device are included in the appendix. The target specifications for the L-5402, the 200 mc power oscillator, are included as Appendix A. *Industrial Preparedness Study on Diffused Semiconductor Devices, J. D. McCotter and C. G. Thornton, Philco Corp., Philadelphia, Pa. April 1957, 51pp, microfilm $3.60. Order PB 126259 from Library of Congress, Washington 25, D.C.*

External Circuit TWTs

This report presents a theoretical investigation of traveling-wave tubes, using external slow wave circuits of either the lumped elements or a combination of the lumped and the distributed elements. The analysis is undertaken using two methods. the normal mode expansion method using Fourier series expansion of the electric fied which interacts with the electron beam; and the method of equivalent current generator for a planar one-dimensional model. *Analysis of External Circuit Traveling-Wave Tubes, Chih Tang Sah, Stanford University, Electronics Laboratories, Stanford, Calif. June, 1956, 147 pp, microfilm $7.20, photocopy $22.80. Order PB126782 from Library of Congress, Washington 25, D. C.*

Backward-Wave Beam Analyzer

The operation and design of an Electron Beam Velocity Analyzer are described and some of the theoretical aspects of the deflection system are investigated. The buildup of current and velocity modulation were observed for backward wave operation. The modulation buildup was found to be similar to that observed by other investigators on the forward traveling-wave tube. Appendix I: Dynamic analysis of the deflection system. Appendix II: Electrostatic lens as a space-charge-wave transducer. *Beam Analyzer for Backward-Wave Interaction Study, Amnon Yariv, California University, Div. of Electrical Engineering, Electronics Research Laboratory, Berkeley, Calif. August, 1957, 44 pp, $1.25. Order PB131445 from OTS, Washington 25, D. C.*

Reliability Prediction

The purpose of this paper is to summarize the concepts and goals of the new field of reliability engineering. The paper does not attempt to cover the field in detail or to present new information not covered by other publications. *Elements of Reliability Prediction, J. C. Bear, Aeronautical Radio, Inc., Reliability Research Dept., Washington, D. C. October, 1956, 61 pp, microfilm $3.90, photocopy $10.80. Order PB132764 from Library of Congress, Washington 25, D. C.*

Glass for Electronic Components

Covers the use of glass in fabrication of radio insulators, potentiometers, printed circuits, enclosures, ferromagnetics, fused metal coils, thin-walled coil forms, disc-type resistors, glass-to-metal seals, glass sockets, small-sized insulators, plugs and jacks, inserts, air-core coil forms. *Glass for Electronic Components. Corning Glass Works, Corning, N. Y. July 1956, 244 pp, photos, microfilm $11.10, enlarged proofs $39.30. Order PB132833 from Library of Congress, Washington 25, D.C.*

Stabilization of a High-Voltage Discharge

Simple experiments show that an air vortex exercises a stabilizing influence on a high-voltage electrical discharge in its axis and alters its character considerably. These effects are probably caused by a centrifugally produced pressure gradient that confines the hot ionized gas of the discharge to the vortex axis. *Stabilization of a High-Voltage Discharge by a Vortex, B. Vonnegut, C. B. Moore, Jr. and C. K. Harris, Arthur D. Little, Inc., Cambridge, Mass. May 1956, 9pp, microfilm $1.80. Order PB 126391 from Library of Congress, Washington 25, D.C.*

Radio Reflections from Meteor Ionization Trails

Certain characteristics of radio signals propagated by reflection from meteor ionization trails from a low-power continuous-wave transmitter 960-km distant are studied at radio frequencies of 23.3, 46.4, and 92.8. The percent of the total time that meteor reflections were detectable at each frequency is presented, and shown to be in qualitative agreement with theorectical expectations. *Some Properties of Oblique Radio Reflections from Meteor Ionization Trails, O. G. Villard Jr., A. M. Peterson, L. A. Manning and V. R. Eshleman, Stanford University, Radio Propagation Lab., Stanford, Calif. May 1955, 39 pp, microfilm $3.00, photocopy $6.30. Order PB126470 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Multicolor Storage Tube

Multicolor storage tubes for applications involving low frame rates have been built by modification of direct-viewing storage tubes. A perforated shadow-mask is placed between the three writing guns and the storage surface. This mask allows electrons from each writing gun to strike discrete storage areas, each containing a single aperture in register with a color dot on the view plate. In this way it is possible to write and store electrical signals independently in adjacent color areas. The design and operation of the tube are discussed in detail. Several sources of color impurity are described, together with the steps taken to minimize their effects. *Multicolor Storage Tube, Lorin L. Vant-Hull and Chester D. Beintema, Hughes Aircraft Company, Research Laboratories, Culver City, Calif. March, 1958, 64 pp, $1.75. Order PB131766 from OTS, Washington 25, D. C.*

Electrostatic Focusing of Hollow Electron Beams

An experimental traveling-wave amplifier tube, operating in the UHF region, was designed and constructed. The results confirm the practicability of this focusing method. Some problems encountered in this application are discussed. It is concluded that Harris flow can be applied to practical beam-type tubes, and, although more complex to design and build, these tubes will enjoy the unique advantage of focusing without the usual heavy magnet structure. *Theory and Application of Uniform Electrostatic Focusing of Hollow Electron Beams, C. B. Crumly, Stanford University, Applied Electronics Lab., Stanford, Calif. Nov 1955, 86 pp, microfilm $4.80, photocopy $13.80. Order PB127636 from Library of Congress, Washington 25, D. C.*

C-band Video Receiver

The specific problem involved in this program was the development of a video receiver to operate in the 4500- to 5000-mc frequency band. The general properties required were high gain, good sensitivity, and low noise figure. The design target for this receiver was a 15-db noise figure, or better, over a 500-mc band, with a 40-db gain. This is expected to produce 0.6 μw as the second detector. *C-band Video Receiver. International Telephone and Telegraph Corp., Federal Telecommunication Laboratories, Nutley, N. J. May 1955, 54 pp, microfilm $3.60, photocopy $9.30. Order PB127444 from Library of Congress, Washington 25, D. C.*

New Approaches to Printed Circuitry

Experimental work continued with four methods of forming electronic circuit elements vacuum evaporation, chemical deposition, screen stencil printing and electrostatic printing. In vacuum deposition the maximum evaporation chamber pressure for uniform deposition was found to be 2 x 10^{-4}mm of Hg. A dual-etch circuit board of electroplated copper on a Nesa resistive film showed good high temperature serviceability. In bimetallic screen printing, hot-dip filled stainless steel screen was found to be superior to either electro-plated or cold rolled material. Zinc has been found most practical for the filler material. Performance of a new type electrostatic printing master was examined for use in printing metallic powders. *Performing Research on New Approaches to Printed Circuitry. Scientific Report No. 4, Dec. 1, 1956-Feb. 28, 1957, John H. Dessauer, Frederick A. Schwertz and others. Haloid Co., Rochester, N.Y. Mar 1957, 31 pp, $1.00. Order PB131366 from OTS, Washington 25, D. C.*

Low Frequency Propagation

This report is divided into two parts. Part I is concerned mainly with whistlers and related low-frequency signals which pass through the ionosphere. Part II covers certain studies of low-frequency propagation in which the signals are reflected from the ionosphere. *Low Frequency Propagation Studies. Part I: Whistlers and Related Phenomena, R. A. Helliwell, Stanford University, Radio Propagation Lab., Stanford, Calif. Oct 1956, 154 pp, microfilm $7.50, photocopy $24.30. Order PB126783 from Library of Congress, Washington 25, D. C.*

Research for 500 C Component Operation

This study was made to determine the feasibility of operating electronic components at an ambient temp of 500 C. Major emphasis was placed on operation at that temperature, rather than operation over a temperature range or determining upper temperature limits in cases where 500 C is known to be beyond the capabilities of given materials and fabrication techniques. Extensive experimental evaluation of inorganic dielectrics performed as a part of this study has shown that forsterite, several alumina ceramics, boron nitride, and some types of mica exhibit lower over-all dissipation factors at 500 C than the other dielectric materials tested. *Electronic Component Parts Research for 500 C Operation, Part I, Morton E. Goldberg and Harlan G. Hamre, Armour Research Foundation, Chicago, Ill. Feb. 1958, 111 pp, $2.50. Order PB131815 from OTS, Washington 25, D. C.*

REPORT BRIEFS

Equivalent Circuits of Linear Amplifiers

The usefulness of the equivalent circuits of linear amplifiers for the circuit designer may be enhanced if the reciprocal forward- and reverse-equivalent circuits are derived. Applications to the grounded cathode vacuum tube amplifier and to the grounded emitter transistor amplifier are shown. *On the Equivalent Circuits of Linear Amplifiers, L. M. Vallese, Polyetchnic Institute of Brooklyn, Microwave Institute, Brooklyn, N.Y. May 1955, 20 pp, microfilm $2.40, photocopy $3.30. Order PB127233 from Library of Congress, Washington 25, D. C.*

Synthesis of a Linear-phase Network

This report is intended to illustrate the application of the iterative method of synthesis to linear-phase networks. Equal-ripple approximation is adopted in the design. The potential analogy is used to help clarify some important facts. The iterative method itself, rather than the results of design, is considered most important. *Iterative Synthesis of a Linear-phase Network, C. Y. Chang, Stanford University, Electronics Lab., Stanford, Calif. June 1956, 48 pp, microfilm $3.30, photocopy $7.80. Order PB126784 from Library of Congress, Washington 25, D. C.*

Low Anode Voltage Thyratron

During early stages of the work, cathodes of thoria on tantalum, nickelate, tantalum, Philips L, and lanthanum hexaboride were designed and fabricated for use in bell jar investigations and in developmental tube structures. Experimental diodes and triodes with both hollow and cylindrical cathodes were built and evaluated as were Schumann grid tubes. Investigations of rubidium vapor as the gas atmosphere in a low anode voltage thyratron included studies of surface ionization and impact ionization in ion injector tubes, in large diodes, and in small diodes and thyratrons, culminating in the successful development of a 2.5-amp ceramic thyratron with less than 4 v arc drop and capable of stable operation for at least 4000 hrs. The concluding portion of the program dealt with further investigations of the observed ability of a low negative grid voltage (20 v) to interrupt the dc discharge in a rubidium vapor atmosphere. Also included is a report on materials technology developed for use with alkali vapors. *Low Anode Voltage Thyratron, William J. Kearns and John O. Pehek, General Electric Co., Power Tube Dept., Schenectady, N. Y. March 1958, 78 pp, $2.00. Order PB131777 from OTS, Washington 25, D. C.*

16 Place Logarithm Table

The book contains sixteen place tables of logarithms of numbers from 5.0000 to 10.0000 at intervals of 0.0001. *Table of Natural Logarithms for Arguments between Five and Ten to Sixteen Decimal Places, National Bureau of Standards Applied Mathematics Series 53, Supersedes Mathematical Table 12. March 29, 1958, $4.00. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C*

TWT's with Slow-Wave Structures

This report describes an investigation of a traveling-wave tube using an external slow-wave structure consisting of lumped circuit elements connected as conventional filters. *Investigation of Traveling-wave Tube with Interchangeable External Slow-wave Structures, Allen R. Matthews, Stanford University, Electronics Research Lab., Stanford, Calif. Feb. 1956, 172 pp, microfilm $8.10, photocopy $27.30. Order PB126329 from Library of Congress, Washington 25, D. C.*

Coupled Helices for TWTS

Based in part on a thesis by G. Wade, Stanford University, 1955. Reprinted from the IRE Transactions, July 1955, p. 15-24. 1. Helix-Coupling-Theory 2. Waves, Electromagnetic-Propagation-Theory. *Coupled Helices for use in Traveling-Wave Tubes, G. Wade and N. Ryan, Stanford University, Electronics Research Laboratory, Stanford, Calif. December 1955, 11pp, microfilm $2.40. Order PB 126331 from Library of Congress, Washington 25, D.C.*

Solid State Research

A single crystal of lead telluride was grown. Apparatus and electronic equipment are described. Method of growth of the crystal and the circuit for measuring Hall coefficients are discussed. *Solid State Research, Paul B. Pickar, Loyola University, New Orleans, La. January 1954, 17 pp, microfilm $2.40, photocopy $3.30. Order PB 128204 from Library of Congress, Washington 25, D.C.*

Energy Bands in Semiconductors

Thesis—University of California. Technical Report 66: 1. Brillouin function; 2. Germanium—resonance levels; 3. Silicon—resonance levels. *Electronic Energy Bands in Semiconductors with Cubic Crystal Structure, Gene Frederick Dresselhaus. University of California, Berkeley, Calif. September 1955, 93 pp, microfilm $5.40, photocopy $15.30. Order PB 124893 from Library of Congress, Washington 25, D.C.*

Nonlinear and Parametric Phenomena in Radio Engineering

Part 5

A. A. Kharkevich

(Translated by J. George Adashko)

The fifth part of our translation of Professor Kharkevich's book covers Rectification. This appears in the Russian book in Chapter I, Section 8.

8. Rectification

The simplest rectifier circuit is shown in Fig. 14. The circuit contains a nonlinear element, which is assumed to have a finite conductivity in one direction and zero (or very low) conductivity in the opposite direction. The direction in which the rectifier passes the current is called the forward direction, the other the backward direction. The conductivities or resistances are similarly designated. The ratio of the forward to backward conductivity is called the rectification coefficient.

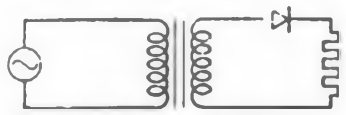


Fig. 14. The simplest type of rectifier.

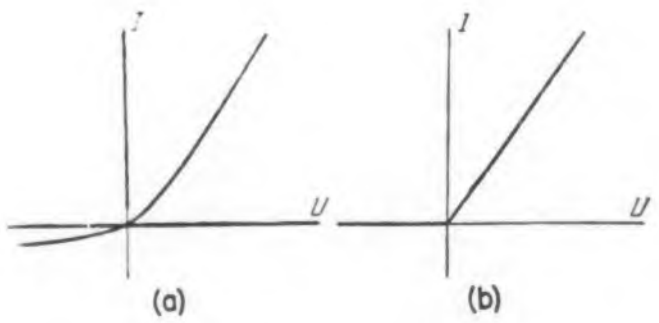


Fig. 15. Rectifier characteristics, real at *a*, ideal at *b*.

Real and idealized rectification characteristics are shown in Figs. 15a and 15b. If a sinusoidal voltage is applied to the circuit of Fig. 14, with a characteristic as shown in Fig. 15b, the current pulses flowing in the circuit will correspond to the positive half cycles of the voltage (Fig. 16). This is the so-called half-wave rectification. The current flowing in the circuit is pulsating i.e., changing in magnitude but not in direction. It contains the required dc component, but in addition it also contains an ac component with a complex spectrum. The dc component is

$$I_0 = \frac{1}{\pi} I_m.$$

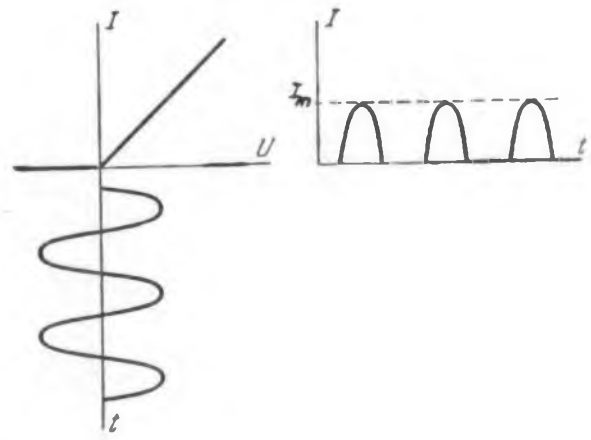


Fig. 16. Output of an ideal half wave rectifier with a sinusoidal input.

The spectrum of the ac component can be determined by expanding the expression for the current in a Fourier series. This expression is

$$I = I_m \cos \omega t$$

$$\left[-\frac{T}{4} < t < \frac{T}{4}, \text{ or } -\frac{\pi}{2} < \omega t < \frac{\pi}{2}\right].$$

During the remaining fraction of the cycle the current is zero. (Fig. 17). Thus

$$I_n = \frac{1}{\pi} I_m \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \cos x \cos nx \, dx$$

$$= \frac{1}{\pi} I_m \left[\frac{\sin (n+1)x}{n+1} + \frac{\sin (n-1)x}{n-1}\right]_0^{\frac{\pi}{2}}$$

$$= \begin{cases} \frac{1}{2} I_m & \text{for } n = 1, \\ \frac{2}{\pi} I_m \frac{1}{n^2 - 1} & \text{for } n \text{ even}, \\ 0 & \text{for } n \text{ odd}. \end{cases}$$

Thus the rectified current contains a first harmonic, with an amplitude

$$I_1 = \frac{1}{2} I_m,$$

and, in addition, all even harmonics, whose amplitudes are

$$I_2 = \frac{2}{3\pi} I_m, \; I_4 = \frac{2}{15\pi} I_m, \ldots$$

Most frequently one employs full-wave rectification, in accordance with the scheme shown in Fig. 18. The effect of the two rectifiers

such that the resultant characteristic can be represented as shown in Fig. 19. The dc component in a full-wave rectifier is obviously twice as large as in a half-wave rectifier. This is one of the advantages of full-wave rectification.

As to the spectrum of the current, we note first that it contains no first harmonic. This is understandable, since the fundamental frequency of the rectified current (if both branches of the circuit are symmetrical) is twice the frequency of the supply voltage, and consequently, the lowest frequency in the current corresponds to the second voltage harmonic. The spectral composition of the rectified current is

$$I_0 = \frac{2}{\pi} I_m, \quad I_2 = \frac{4}{3\pi} I_m, \quad I_4 = \frac{4}{15\pi} I_m.$$

The rectified current is rid of the ac component by using ordinary low-pass filters. A typical double-diode rectifier circuit is shown in Fig. 20. This explains still another advantage of full-wave rectification. The point is that in full-wave rectification, the fundamental frequency of the ac component is twice that obtained in half-wave rectification. This makes it possible to double the cutoff frequency of the filter, and consequently, to reduce the inductance and capacitor ratings by one half. Even easier to filter is the dc obtained by rectification of polyphase current (three- or six-phase), for the resultant pulsations are of lower amplitude and higher frequency. The greater the number of phases, the smaller the pulsations. It must be emphasized that we do not consider, in this section, the operation of a rectifier as a whole, with filter included. In fact, a rectifier circuit with filter is described by means of a considerably more complicated nonlinear differential equation. We shall return to this problem in Section 31.

It should also be added that rectification is frequently used to measure alternating voltages and currents by means of dc meters (d'Arsonval movements). All modern multi-scale universal instruments are detector instruments, i.e., they are equipped with rectifier elements, permitting the use of a single meter for measuring both ac and dc. The vacuum tube voltmeter, the basic instrument for electronic measurements, is also a d'Arsonval meter combined with the vacuum tube rectifier circuit. However, the requirements that must be satisfied by rectifiers used for measurement purposes are somewhat different than the requirements for rectifiers used in power supplies. The difference is that ac meters must measure effective values of currents and voltages that may also be non-sinusoidal. This condition is satisfied only if the rectifier has a quadratic characteristic. For further details on this subject, the reader is referred to any standard text on radio measurements.

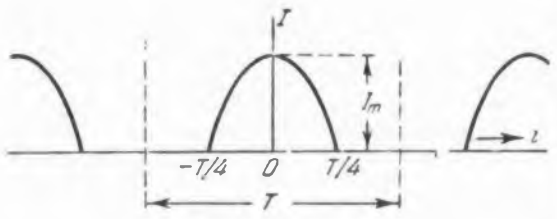


Fig. 17. The spectrum of the ac component resulting from ideal half wave rectification.

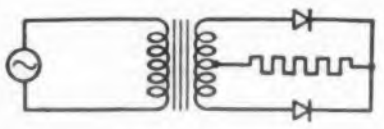


Fig. 18. A simple full wave rectifier.

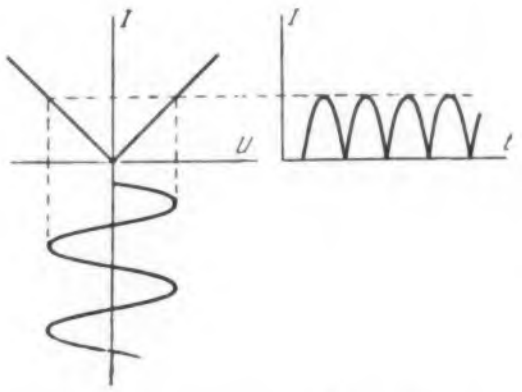


Fig. 19. A representation of ideal full wave rectification.

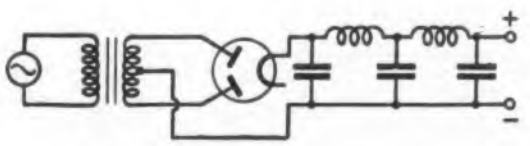


Fig. 20. A typical full wave rectifier with a low pass filter.

What the Russians Are Writing

J. George Adashko

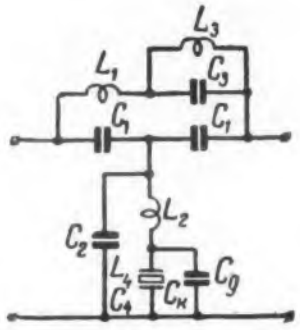


Fig. 1. Diagram of filter proposed by Z. Ya. Gel'mont.

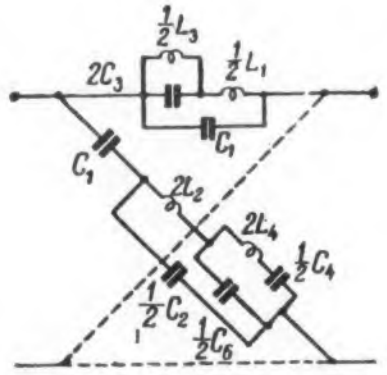


Fig. 2. Equivalent lattice network of the same filter.

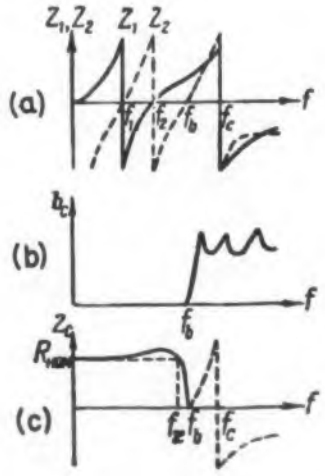


Fig. 3a. Impedance characteristics of the equivalent lattice network.

Fig. 3b. Attenuation characteristics of the filter.

Fig. 3c. Characteristic impedance of the filter.

CIRCUITS

Error in the Tuning of a Pulsed-Signal Receiver When Using Automatic Frequency Control with Diode-Phantastron Control Circuit by G. A. Levin and M. V. Zerova. EC 2/58, pp 3-11, 7 figs.

Equations are obtained for the deviation and the rate of change of frequency in an AFC with diode-phantastron control circuit. The value of the residual mismatch error is obtained for the steady state at a fixed value of the signal frequency.

Piezoelectric Unbalanced Low Frequency Filter by Z. Ya. Gel'mont. EC 6/58, pp 67-74, 9 figs.

Discussion of the theory and design procedure for a piezoelectric low frequency filter using a bridged T circuit. Graphs are given for the calculation of the attenuation on the basis of approximate formulas. See Figs. 1-4.

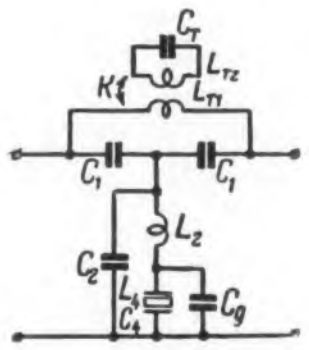


Fig. 4. More economical version of the low frequency filter, in which the inductances L_3 of Fig. 1 are replaced by transformers with fixed coupling coefficients.

Passage of Pulse Through an Amplifier with High Speed Automatic Gain Control by B. Kh. Krivitskiy. RE 4/58, pp 63-76, 8 figs.

The features of the passage of a trapezoidal pulse through an amplifier equipped with a simple high speed automatic gain control are examined. The waveform and the magnitude of the output losses are determined in an approximate manner.

Compensation of Nonlinear Distortion by Means of "Envelope" Feedback in Transmitting Apparatus by V. M. Khatskelevich and L. M. Shur. EC 4/58, 4 figs, pp 8-15.

The authors discuss the influence of the amplitude-frequency characteristics of various portions of the feedback loop on the operation of the feedback, and explain the causes why the compensation becomes worse at high modulation frequencies. Relations are derived for the available margin in the use of the frequency band necessary to insure effective feedback, and give tentative data for computations.

Relay Phenomena in Ring Systems Containing Magnetic Cores with Rectangular Hysteresis Loops by V. A. Zhozhikashvili and K. G. Mityushkin. AT 1/58, pp 64-70, 10 figs.

Describes relay phenomena observed in circuits containing magnetic cores with rectangular hysteresis loops and employing positive feedback. The static characteristics and the character of the transients due to single or multiple disturbances are analyzed, as well as the effect of noise pulses.

Fourier Series Formalism as a Method for the Study of Linear Systems by A. M. Zayezdny. RE 4/58, pp 3-14, 7 figs, 1 table.

The article contains a new method of harmonic analysis, based on the direct utilization of transform tables. It is shown that when such tables are available, a wider use of the Fourier series is possible for the study of linear systems under the influence of sinusoidal voltages and currents than is commonly practiced.

AUTOMATIC CONTROL

Contribution to the Theory of One Relay System by V. S. Boyarinov and N. N. Leonov. AT 2/58, pp 114-134, 16 figs.

Analysis of control systems that include "on-off" relays as regulators. It is claimed that the previous analysis (*Discontinuance Automatic Control*, Princeton, 1953), by Pfluge-Lotz, Klotter, and other investigators is either incomplete or erroneous, and a detailed analysis is made of this system in two-dimensional phase space.

Determination of the Parameters of Correcting Devices Used in Linear Servosystems from Specified Values of Their Generalized Parameters by M. M. Kreymerman. AT 2/58, pp 135-147, 10 figs, 2 tables.

The parameters referred to in the title are the cut-off frequency, the phase margin, and the relative figure of merit. A table of the fundamental design formulas for these parameters is given and examples of series and parallel correcting networks.

On the Design of Reactor Magnetic Amplifiers Employing a Single-Phase Rectifying Bridge by N. A. Kaluzhnikov. AT 3/58, pp 239-256, 15 figs.

The load supplied by the amplifier discussed in this article is assumed to be either capacitive or reactive. An ideal, linear magnetic amplifier is assumed in the theory employed.

Certain Optimum Relations in an Ideal Magnetic Amplifier with ac Control Signal by K. S. Volchkov. AT 1/58, pp 85-94, 6 figs.

An investigation of the performance of an ideal saturating magnetic amplifier with active load controlled by an ac signal. Optimum relations insuring max gain are derived both for amplifiers intended for single-frequency amplification, and for those amplifying an ac signal within a specified frequency.

A connection is estalished between the coefficient of the frequency distortions of the amplifier and its time constant. This paper was delivered at a Seminar on Magnetic Amplifiers at the Institute of Automation and Telemechanics on February 13, 1957.

RUSSIAN TRANSLATIONS

INFORMATION THEORY

Effect of Weak Pulsed Noise on fm Receivers by V. M. Sidorov. RE 3/58, pp 21-24, 12 figs.

The effect of weak pulsed noise on a fm receiver is considered for an arbitrary frequency deviation of the signal at the instant of occurrence of the noise pulse. Also examined is the influence of the type of receiver filters on the time behavior and on the spectral density of the pulse noise at the receiver output.

It is shown that the waveform of the noise voltage at the receiver output depends on the type of high frequency and low frequency filters used in the receiver and on the signal frequency at the instant when the noise occurs. The peak signal to peak noise ratio at the output of the fm receiver depends substantially in general on the types of filter and on their bandwidth. In general, the noise spectrum at the output of the fm receiver contains not only cosine terms, but also sine terms. Consequently, the max value of the noise cannot be determined by mere arithmetic addition of the components without taking the phases into account.

Estimate of the Carrying Capacity of Certain Real Communication Channels by I. A. Ovseyevich and M. S. Pinsker. RE 4/58, pp 15-25.

Using the results obtained by the authors in an earlier article ("Estimate of the Carrying Capacity of a Communication Channel, whose Parameters are a Random Function of Time," *Radiotekhnika*, October 1957), the authors estimate the carrying capacity of (a) a real communication channel with parameters that are constant in time; (b) a channel whose parameters vary in time as a white noise; (c) a channel that is a combination of the first two. Examples are used to show that the results obtained are generalization of the known cases treated by Sunde ("Theoretical Fundamentals of Pulse Transmission," *BSTJ*, No. 3-4, 1954) and Feinstein ("Information Theory Aspects of Propagation Through Time-Varying Media," *Journal of Applied Physics*, 26, No. 2, 1955).

PROPAGATION

In-Phase (Broadside) Broadband Shortwave Antennas by G. Z. Ayzenberg, V. D. Kuznetsov and

L. K. Olifin. EC 1/58, pp 15-21, 10 figs.

Description of two variants of broadside antennas, one with a tuning reflector and one with a periodic reflector. Theoretical and experimental directivity patterns are given for the first of these antennas in the horizontal and vertical planes. Gain and directivity vs. wavelength curves are also given. The matching of the antenna with the supply feeder over the operating range is experimentally investigated.

Propagation of Decimeter Radio Waves Under Conditions Prevailing in a Large City by N. D. Dymovich. EC 1/58, pp 26-33, 5 figs, 3 tables.

Report on measurements of the field intensity in the decimeter range in Leningrad under conditions when the receiving antenna is placed below roof level. An empirical formula is derived from these measurements, and is found to be in good agreement with that of other investigators (see, for example, Akens and Lacy, *Proceedings IRE*, Vol. 38, No. 11, page 1950; Joseph Fisher, *Electronics*, September 1949, W. R. Young, *Bell System Technical Journal*, No. 6, 1952, and G. Braun, *RCA Review*, No. 9, 1948, and Epstein & Peterson, *Proceedings IRE*, No. 5, 1953).

Statistical Character of Scattering of Centimeter Waves from Rough Sea by S. Ya. Braude, N. N. Komarov and I. Ye. Ostrovskiy. REE 2/58, pp 172-179, 5 figs.

A signal propagating over a rough sea is considered as consisting of direct wave, coherently reflected, and a sum of elementary reflected waves with random phases and amplitudes. Starting with this representation, the authors determine the probable distributions of the amplitudes and phases, and the low-frequency spectrum of the envelope of the signal fluctuations, the constant rms velocities of the portions of the rough sea surface. Reference is made to work by Blake (*Proceedings IRE*, 1950, 38, 3, 301), Rice (*Communication of Pure and Applied Mathematics*, 1951, Part IV, V, 351), and Davies (*Proceedings IEE*, 1954, Part IV, 101, 7, 209).

SEMICONDUCTORS

Impedance of Rectifying Contacts of Germanium and Silicon Detectors at Microwave Frequencies by N. A. Penin and N. Ye. Skvortsova. REE 2/58, pp 267-275.

The authors have previously published on this subject in *Radiotekhnika i Elektronika* (August 1956, page 1071, March 1957, page 296, and August 1956, page 1058). In this article they investigate the dependence of the total im-

RUSSIAN TRANSLATIONS

pedance of the blocking layer of germanium and silicon detectors, with both formed and attached contacts, on the positive bias current, at various frequencies in the centimeter-wave band. The positive-bias current and the frequency is shown to affect the impedance of the rectifying contact in germanium and silicon detectors in a manner that can be explained with the aid of the theory of the impedance of p-n junctions, in which the injection effect of non-equilibrium carriers and the charge capacitance of the blocking layer are taken into account.

On the Theory of Semiconductors with Excited Impurity Band by M. I. Klinger and G. A. Makarycheva. Journal of Technical Physics. 2/58, pp 264-266, 4 figs.

The authors calculate the electric conductivity and the Hall-constant of the impurity band in the ground and excited states.

New Semiconducting Compounds by V. P. Zhuze, V. M. Sergeyeva, and Ye. L. Shtrum. Journal of Technical Physics. 2/58, pp 233-236, 5 figs, 2 tables.

The authors have synthesized four new compounds of composition $A^{I}B^{VIII}X_2^{VI}$, where A is copper or silver, B is iron and X is selenium or

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AJ	Acoustic Journal *(Akusticheskiy Zhurnal)*
AT	Automation and Telemechanics *(Avtomatika i Telemekhanika)*
CJ	Communications Journal *(Vestnik Svyazi)*
EC	Electrical Communications *(Elektrosvyaz)*
IET	Instruments and Experimental Techniques *(Pribori i Tekhnika Eksperimenta)*
JTP	Journal of Technical Physics *(Zhurnal Tekhnicheskoy Fisiki)*
ME	Measurement Engineering *(Izmeritel'naya Tekhnika)*
R	Radio
RE	Radio Engineering *(Radiotekhnika)*
REE	Radio Engineering and Electronics *(Radiotekhnika i Elektronika)*

Translations Available

Commerce Department announces the services of a new foreign technical information center. The Foreign Technical Information Center, part of the Office of Technical Services, Business and Defense Services Administration, now publishes abstracts of all important sections of Referativnvy Zhurnal (the Russians' own abstract journal), and a semimonthly review of various areas of Soviet science compiled by the Central Intelligence Agency. Abstracts of each issue of the 141 journals can be purchased from OTS on a subscription or single issue basis, as may CIA's Scientific Information Report. The various sections of Referativnvy Zhurnal will be sold initially by single issues, but subscription sales may be offered later.

tellurium. Certain characteristics of these new semiconductors are reported.

MEASUREMENTS

Influence of Higher Harmonics in the Measured Voltage on the Indications of a Vacuum Tube Voltmeter with Exponential Characteristics by M. M. Levin. Izmeritel'naya Technika. 1-2/58, pp 67-70, 4 figs.

The article estimates the error in the measurement of the first harmonic of a non-sinusoidal voltage, for all types of distortion, in the case when the waveform does not differ much from sinusoidal. This problem is of particular interest in the calibration of vacuum tube voltmeters, in the measurement of the initial level of standard signal generators subject to nonlinear distortion, and in the determination of the measurement error of "practically sinusoidal" voltages that contain a relatively small higher harmonic.

Modern Automatic Electronic Potentiometers and Bridges by M. A. Zemel'man. Izmeritel'naya Tekhnika 1-2/58, pp 75-79, 5 figs.

A survey article, discussing the general state of the art. It is noted that the status in Russia in this field is behind western countries with respect to the number of types of automatic potentiometers produced and with respect to incorporating in these bridges the latest accomplishments in instrument-building techniques. The need for development of these instruments in Russia is the fact that what instruments built are developed not by the instrument-building organizations, but by the other organizations requiring these instruments. Consequently such instruments are not made on a mass production basis but are custom built.

MEETINGS

Calendar of Events

NOV. 1958

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

17-18 IRE Region 3 Convention, Atlanta, Ga.*

17-20 Conf. on Magnetism and Magnetic Materials, Phila., Pa.*

17-21 8th National Plastics Exposition and Conference, Chicago, Ill.*

18-20 40th Annual Meeting American Standards Assoc., New York, N.Y.*

19-20 Northeast Electronics Research and Engineering Meeting, Boston, Mass.*

19-21 Elec. Tech. in Medicine and Biology, Minneapolis, Minn.*

DEC. 1958

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

2-4 3rd EIA Conference on Reliable Electrical Connections, Dallas, Tex.*

3-5 Eastern Joint Computer Conf., Phila., Pa.

3-5 Symp. on Global Communications, St. Petersburg, Fla.

4-5 Annual Conference Professional Group on Vehicular Communications, Chicago, Ill.*

*Indicates meetings described in the following columns.

Conference on Magnetism and Magnetic Materials, Nov. 17-20

Sheraton Hotel, Philadelphia, Pa. Sponsored by the Basic Science Committee of AIEE. There will be sessions on ferrites, computer components, micromagnetics-domain walls, magnetic properties of metals and alloys, fine particles, amplifiers, microwave applications, resonance

metallurgical considerations, fundamental interactions, instrumentation, thin films, and neutron diffraction and irradiation. For further information write C. J. Kreissman, Remington Rand Univac, 1900 W. Allegheny Ave., Philadelphia 29, Pa.

IRE Region 3 Convention, Nov. 17-20

Architecture Auditorium, Georgia Inst. of Technology, Atlanta, Ga. The majority of papers will be on the subjects related to the missiles and space program and to ionospheric propagation.

8th National Plastics Exposition and Conference, Nov. 17-21

Exposition at International Amphitheatre, Conference at Hotel Morrison, Chicago, Ill. Sponsored by the Society of the Plastics Industry, Inc. Theme to be stressed: "Plastics for Profits." Will cover materials, methods, machines, and techniques. Write Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N.Y.

40th Annual Meeting American Standards Association, Nov. 18-20

Hotel Roosevelt, New York, N.Y. Meeting to be held in conjunction with the Ninth National Conference on Standards Association. Theme of the conference is "Standardization—What's in it for me?"

Northeast Electronics Research and Engineering Meeting, Nov. 19-20

Mechanics Hall, Boston, Mass. Sponsored jointly by the Boston, Connecticut and Western Massachusetts Sections of the IRE. Will feature the theme of "Today's Electronic Developments—Tools for Tomorrow." Original papers will be given on computers, components, techniques, circuits, reliability and testing, inventions and patents, electron devices, information theory, and technical information. For additional information write Stewart K. Gibson, c/o Instruments of New England, 108 Greenwood Lane, Waltham 54, Mass.

11th Annual Conference on Electrical Techniques in Medicine & Biology, Nov. 19-21

Pick-Nicollet Hotel, Minneapolis, Minn. Sponsored by IRE, AIEE, and ISA. The theme this year is Biology and Computers. Sessions will

MEETINGS

cover possible applications of electronic computers in the fields of electrocardiology and circulatory studies, electroencephalology, and living computers. Further information may be obtained from Mr. Robert Erskine, Minneapolis-Honeywell Co., 2753 Fourth Ave., South Minneapolis, Minn.

3rd EIA Conference on Reliable Electrical Connections, Dec. 2-4

Statler-Hilton Hotel, Dallas, Tex. Manufacturing point-of-view as well as Government and Military aspects will be covered. All types of electrical connections will be considered including: (a) those which are out-of-sight and within (internal) component parts, such as connections inside capacitors, and (b) those which are exposed (external) and parts of an electrical or electronic system.

One full day will be devoted to each of three general subjects: (1) Fixed connections (wrapped, soldered, crimped, and welded); (2) sliding and wiping connections (such as are encountered in potentiometers, rheostats, switches, and the like); and (3) connect-disconnect connections (plugs and jacks).

An attempt will be made to cover all the facets of the foregoing subjects, such as (1) choice of materials being joined together; (2) methods and equipment used to join them; (3) materials and processes used to protect the connections; (4) effects of usage or environments of the finished parts or systems on the electrical connections, and (5) servicing or maintenance aspects of the parts or systems.

For information, write W. O. Richards, 224 Cedar St., Syracuse 3, N.Y.

Annual Conference Professional Group on Vehicular Communications, Dec. 4-5

Hotel Sherman, Chicago, Ill. Fifteen papers to be presented and nearly 20 leading manufacturers of two-way radio and accessory equipment will be exhibiting.

1959 Solid State Circuits Conference, Feb. 12-13, 1959

Philadelphia, Pa. Sponsored by IRE, AIEE, and Univ. of Pennsylvania. Devoted to transistor circuit technology, applications, and circuit techniques of a variety of solid state devices.

First International Conference on Information Processing, June 1959

Paris. Sponsored by UNESCO. The conference program has been expanded to six major topics: 1. Method of digital computing; 2. Logical design of digital computers; 3. Common symbolic language for digital computers (includes automatic programming); 4. Automatic translation of languages; 5. Collection, storage, and retrieval of information; 6. Pattern recognition and machine learning.

Sections

A series of lectures on Space Technology, cosponsored by the LI Section of IRE and the American Rocket Society are being held at the Garden City High School, Garden City, N.Y. Nationally recognized authorities in important areas of space engineering will discuss latest developments in space research and the problems which still remain to be solved.

Paper Deadlines

November 30th: Deadline for papers (in triplicate) to be considered for inclusion at the **International Convention on Transistors and Associated Semi-Conductor Devices** to be held in London, May 25-29, 1959. Before submitting papers, authors are asked to send a short summary of each paper of about 200 words, giving title and range of subject matter covered. Address enquiries to Industrial and Trade Fairs Ltd., Drury House, Russell St., London, W.C. 2.

December 22: Deadline for receipt, in triplicate, of a detailed 750-word summary of papers for presentation at the **International Symposium on Circuit and Information Theory** to be held at the University of California at Los Angeles on June 16-18, 1959. All correspondence should be addressed to Dr. G. L. Turin, Hughes Research Laboratories, Culver City, Calif.

Seminars

R & D: American Management Assoc. is presenting seminars on Organizing and Controlling Research and Development; Effective Utilization of Outside Research Facilities; Effective Supervision of Engineering Projects; Creating and Evaluating Research Projects; Administering Salary Programs in the Technical Organization. Address enquiries to Registrar, AMA, 1515 Broadway, New York 36, N.Y.

STANDARDS AND SPECS

Sherman H. Hubelbank

Instrument Transformers

AIEE No. 75, Proposed Test Code for Power-Factor Testing of Mineral-Oil-Insulated Instrument Transformers, April 1958

Instrument transformers with high-voltage windings, insulation class 2.3 kv and above, and low-voltage windings below 1 kv insulation class that are immersed in mineral oil are covered by this test code. Copies of this test code may be obtained without charge from the American Institute of Electrical Enginers, 33 West 39 Street, New York 18, N.Y.

Standard Samples of Phosphors

The National Bureau of Standards has recently made available 14 standard samples of phosphors selected in cooperation with the Electrochemical Society. The phosphor samples are for industrial and research use in quality control and development of improved phosphors for radar screens, television sets, and radioactivity counters and detectors. Phosphor samples may be obtained from the Standard Sample Section, National Bureau of Standards, Washington 25, D.C., for $3.00 each.

Standard Abstracts

An abstracting service on standardization, called "internorm" has recently been announced. Edited by Dr. N. A. J. Voorhoeve, the system contains abstracts of carefully selected literature on standardization, published the world over in books, pamphlets, and periodicals such as official standardization periodicals and periodicals in other fields. Further particulars may be obtained from Dr. N. A. J. Voorhoeve, 87 Parklaan, Eindhoven, The Netherlands.

Transformers

MIL-T-27A, Audio, Power, and Pulse Transformers and Inductors, 9 June 1958

Ten additional MS military standards have been added covering two-winding power inductors.

Dynamotors

MIL-D-24B, General Specification for Dynamotors, 14 April 1958

Wherever possible, the test methods of MIL-STD-202, Test Methods for Electronic and Electrical Component Parts, have been referenced for use. High altitude brush life, high-frequency vibration, and corona discharge tests have been added. A closer limit has been specified for dynamic balance. Preproduction tests have replaced qualification tests.

Television Color Standards

Brightness standards for color television tubes have been made available by the National Bureau of Standards in cooperation with the Joint Electron Tube Engineering Council of RETMA. Each set consists of three standards: red, green, and blue. This closely matches in spectral energy the three phosphors which in the tube act together to produce various colors in the image. The standards are used to calibrate instruments for measuring the color and brightness of the phosphors. They thus provide a simple, accurate means for achieving uniform color reproduction in the television tubes. The standards can be used for calibrating either photoelectric or visual photometers. After calibration, the photometer may be used to measure the luminance of the color tube. Sets of the standards are available from the Photometry and Colorimetry Section, National Bureau of Standards, Washington 25, D.C., at $250.00 a set. To facilitate the use of these standards, a detailed report of their design and calibration is included with each set.

Drafting

MIL-STD-1A, General Drafting Practice, May 23, 1958

This standard deals with the methods of projection, line convention, sections and sectioning conventions, scales and lettering as applied to mechanical drawings.

Electron Tubes

MIL-STD-200D, Electron Tubes, Diodes, and Semiconductor Devices, 29 May 1958

This standard provides a list of types of electron tubes used by the Department of the Army, the Navy, and the Air Force in the design and manufacture of electronic equipments; requirements for the application and utilization of electron tubes; and requirements for the reporting of electron tube complements.

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STANDARDS AND SPECS

Energy Loss

NBS Circular 577, Supplement, Energy Loss and Range of Electron and Positrons

The material in this supplement extends the data in NBS Circular 577 by including the effect of the polarization of the medium (density effect) on the mean energy loss and range of incident electrons and positrons. Copies of this supplement are available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. for 30 cents. Order Catalog No. C13.4:577/supp.

Crystals

MIL-C-239C, Quartz Crystal Unit CR-5/U, 9 June 1958

Requirements pertaining to the holder for the crystal unit have been deleted. Specific defects to be checked in visual and mechanical inspection have been designated. Each defect is now classified as major or minor. Changes have been made in the method of selection of specimens for acceptance inspection, and the number selected. The drop and humidity tests have been deleted. Shock and moisture resistance tests have been substituted.

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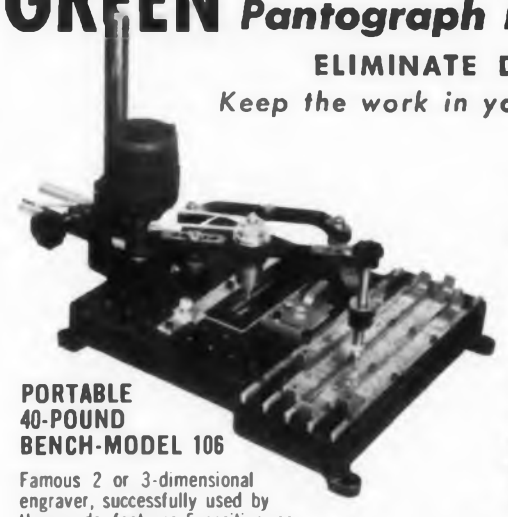

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Electrical Wire

EIA SMC-2, Electrical Wire (Insulated, High-Temperature), August 1958
This spec for military components has been prepared by the Electronic Industries Association to satisfy the requirements of manufacturers of military equipment for high-reliability components. The spec covers wire designed for the internal wiring of meters, panels, and electrical and electronic equipment to have minimum size and weight consistent with service requirements. The high temperature rating of wire included in this spec ranges from +100 to +200 C, with potential ratings up to 1000 v, as specified on the applicable item identification sheets. Copies of this spec are available from the Electronic Industries Association Engineering Office, 11 W. 42nd Street, New York 36, N.Y. for $2.35 each.

Testing

MIL-STD-202A, Test Method for Electronic and Electrical Component Parts
A proposed initial draft is currently being circulated for study to cover the lightweight shock-testing apparatus of MIL-S-901 and the utilization of the apparatus by various component specifications in determining the suitability of parts to withstand certain conditions of shock experienced in the field.

Drafting Standards

Section 11—Plastics—indicates preferred design and drafting practices specifically related to parts formed of plastic material. To assist the designer and draftsman in the delineation of plastic drawings, a brief discussion of materials and manufacturing processes and operations has been included in the standard, together with design and drawing hints for parts formed from plastics of the molding and laminating types.

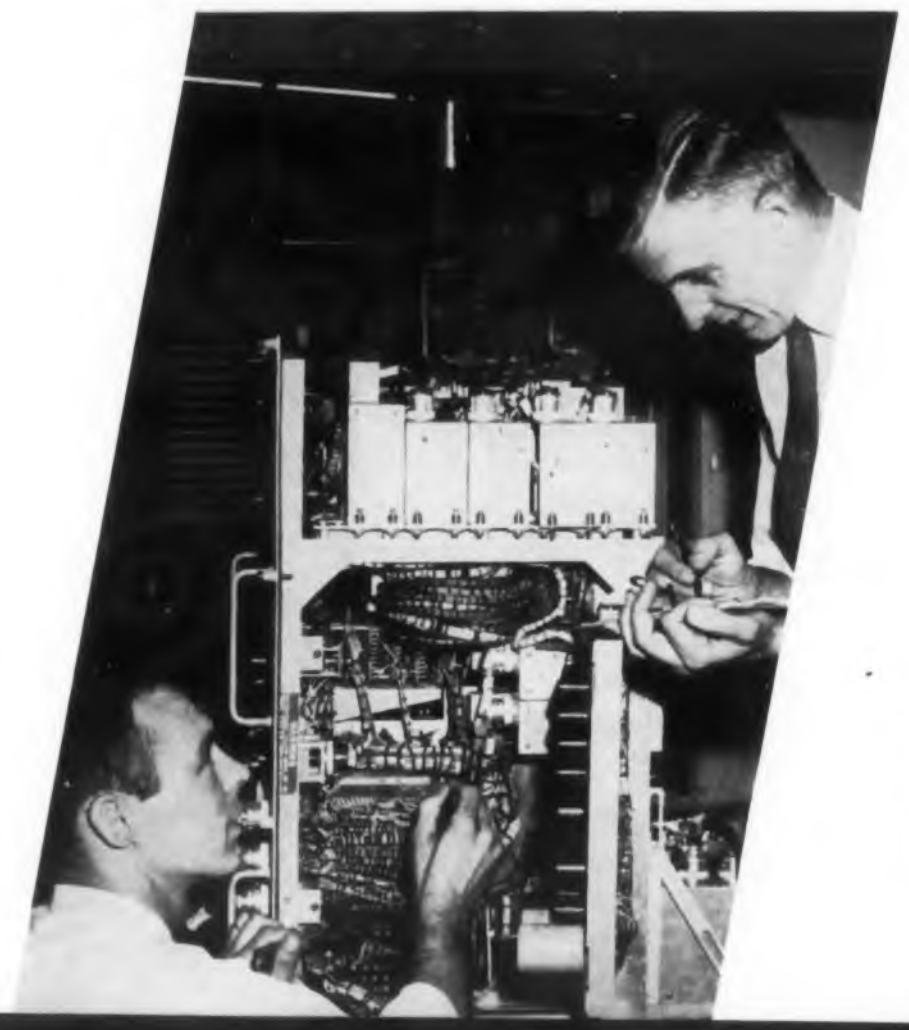
Section 11, designated American Standard Y14.11-1958, is one of 17 sections of the American Drafting Standards Manual, which, when completed, will provide the means for uniform drafting practices throughout the United States.

No attempt has been made to cover over-all product design. Tolerances are discussed only from a general standpoint. Typical drawing notes are shown which are commonly observed on plastic parts drawings. Methods of dimensioning of plastic parts have not been included in Section 11 because they are the same as for any other material, and they are covered in other sections of the American Drafting Standards Manual.

Section 11—Plastics—is available at $1.50 per copy from American Standards Association, 70 East 45th Street, New York 17, N.Y.

TEST EQUIPMENT ENGINEER John W. Lloyd tells why his work on the B-70 Weapon System at IBM Owego affords him the creative engineering career he always wanted.

WHAT IT'S LIKE TO BE A CREATIVE ENGINEER AT IBM



"Test equipment engineering," says John Lloyd, "is particularly stimulating when it's part of a project as new and important as the B-70, sometimes described as 'a huge flying computer.' Right now I'm coordinating the design of engineering support equipment for an advanced digital airborne computer, part of the B-70's bombing-navigational and missile guidance system. There's a minimum of routine. In order to design test equipment you must know — or learn — about the equipment to be tested; among these are radar, servo systems, digital and analog computers, inertial guidance. I see my professional growth assured as IBM continues to develop computers for airborne applications."

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- **Information & network theory**
- **Magnetic engineering**
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- **Transistor circuits**
- **Units & systems test equipment**

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Mr. P. E. Strohm, Dept. 555-Y
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2. For systems theoretical design and analysis.
3. For design of special purpose low noise reconnaissance receivers — manual, panaramic, signal seeking.
4. To supervise integration of antennas (emphasis on broadband ECM receiving types) into a reconnaissance system.

SECTION HEAD, PHYSICISTS or EE

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2. Design in 1 or more: advanced navigation techniques including Tacan; data link; digital techniques; transistor circuitry; advanced automatic test equipment; systems design; sonar; countermeasures; microwave and antenna techniques; communications, including advanced pulse techniques.
3. For network design (modern synthesis filters, delay equalizers, loss and phase equalizers) and circuit analysis (transistor amplifiers, transistor pulse forming networks, transistor switching circuitry).

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November 12, 1958

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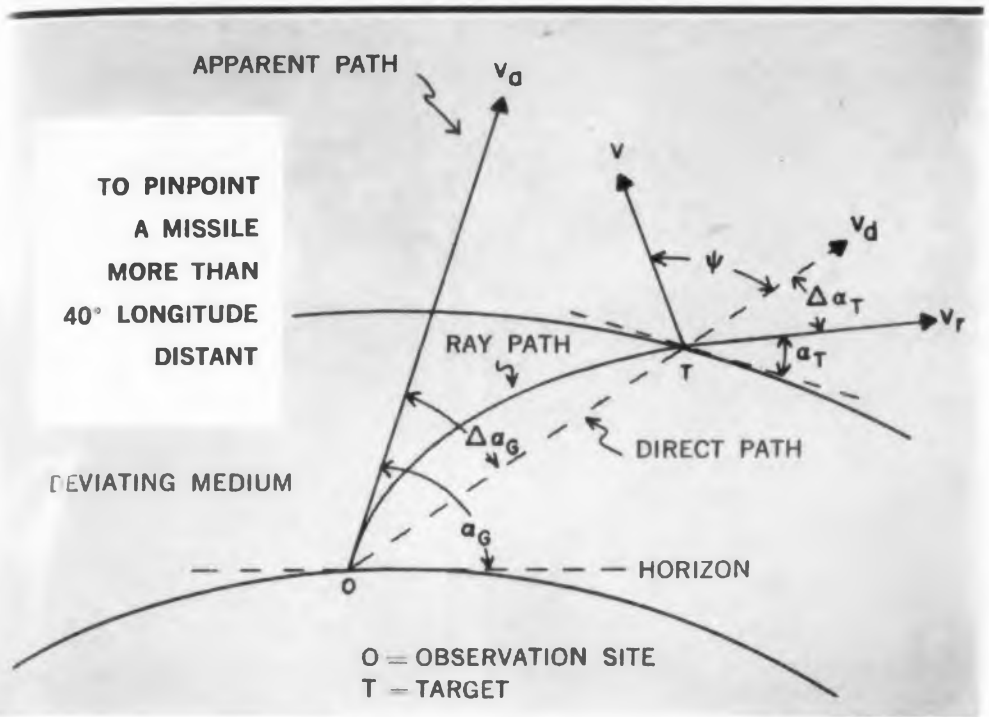

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Senior Electronic Design Engineers—Experienced in development of logical design using standard computer elements, must also evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding. This data processing system is concerned with bank automation.

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CAREERS

WHILE NERO FIDDLED

One windy Tuesday in Rome during the reign of the infamous Nero, a new mobile radar unit, on its way for delivery to the emperor's legions outside the city, suddenly caught fire. A tube blew, the sparks flew, the horses bolted, and soon all Rome was ablaze.*

Nero was furious. He had the members of the ill fated crew brought before him. "I'll make the punishment fit the crime!" he roared. While he thought about it, he picked up his violin and began to play. Since he was the vilest of violinists, the feelings of his listeners may better be imagined than described. He scraped his way through 'Keep the Rome Fires Burning' and 'Smoke Gets in Your Eyes.' At last he paused, confronting his trembling listeners.

"I'm going to have you all boiled in oil!" he boomed.

"THANK GOODNESS!" one of the doomed wretches exclaimed fervently as they were being led away. "For a minute I thought he was going to play 'Smoke Gets in Your Eyes' again!"

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