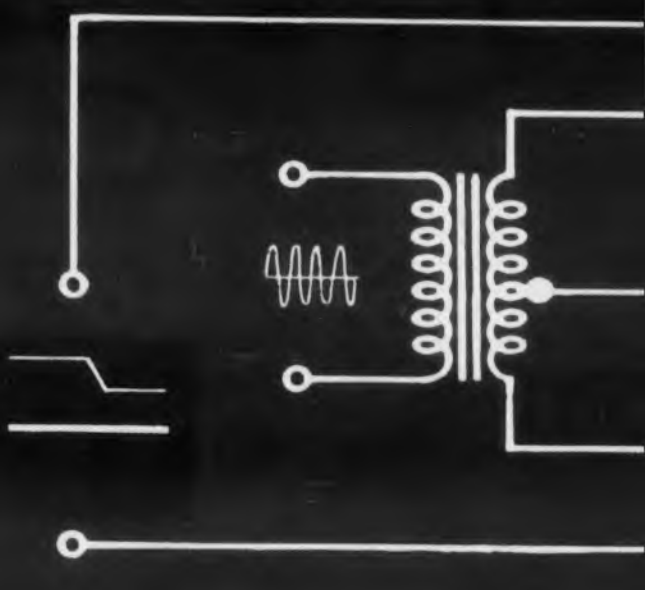
ELECTRO
DES

Transistor Modulator Replaces Chopper . . .



ONIC SIGN

JUNE 15, 1957

page 30

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Editorial

Thou Shalt Not Steal

We are all glory hounds and braggarts to an extent. We seem obliged to resort to such behavior to glean a bit of needed approval from our colleagues. We freely "borrow" another's ideas in coming up with recommendations and solutions to problems. Free trade seems the rule in communicating facts, ideas, etc. But as a matter of personal integrity shouldn't we acknowledge that the ideas we're proposing or propounding were originated by another? We must respect and credit the ownership of intellectual property—ideas and discoveries—according to Rudolph Kompfner of Bell Telephone Labs, if we expect to perpetuate cooperation and continued teamwork. If we persist in stealing another's property he will keep it locked in his skull.

At this point, your editor must state that the ideas in this editorial were taken from a paper on "Teamwork in Research" by Mr. Kompfner appearing in the Proceedings of the 1957 National Conference on Aeronautical Electronics. Next to picking the team, the establishment of the right spiritual climate is the most important aspect of successful teamwork according to Kompfner. He asks and observes:

". . . Is it recognized, even if only subconsciously, that the most important pieces of property are ideas and discoveries? And human nature being as it is, it is only too natural to covet this property, to fight for it, to rob it, just as in days past we coveted "real estate," gold, women.

"This matter of intellectual honesty cannot be overemphasized; on it rests the success of any teamwork. . . . Once the climate of scrupulous intellectual honesty has been established, people will be found only too willing to contribute their ideas and thoughts as they are formed, and only thus can we have completely free and unhampered exchange of ideas. And if there is one thing that furthers the creation of good ideas, sound thoughts and frequent discoveries, it is other people's ideas, thoughts and discoveries."

Are we giving the other fellow his due? Those in authority, particularly group leaders, must be extremely careful to recognize even the smallest intellectual contribution of others. Kompfner feels that it is better to ascribe to others ideas one had oneself if there is the slightest doubt. In the absence of copyrights, etc., there is probably no legal sanction that can be applied us for appropriating another's ideas as our own. This shouldn't prevent us in the slightest from crediting others for their contribution.—JAL

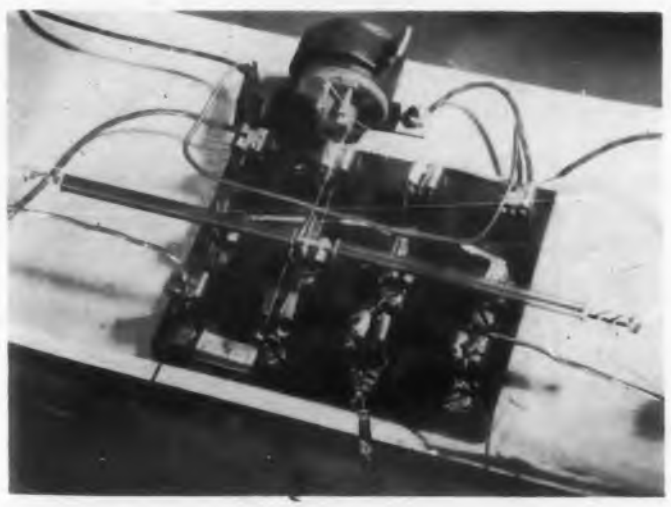
Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.

Disc-Loaded Torsional Delay Line

A new method for slowing down torsional waves has resulted in 25 times greater delay per unit length. The conventional method for delaying a torsional wave consisted of a uniform brass rod through which the signal was fed by a torsional transducer. This resulted in a delay of about 4.5 μsec per cm of the rod's length. This velocity is greatly decreased in the new delay line by the use of disc loading, in which the rod is composed of alternate large and small diameter sections.

A delay line of this type, which consists essentially of a series of equally spaced discs along a smaller diameter axial rod, is a low-pass filter for torsional waves whose cut-off frequency decreases with increase in diameter, thickness, or spacing of the discs. To obtain high cut-off frequencies therefore, small dimensions are necessary; the delay for a given length increases roughly as the square of the ratio between disc and rod diameters. Large delays at reasonable operating frequencies thus require small diameter rods and precise machining.



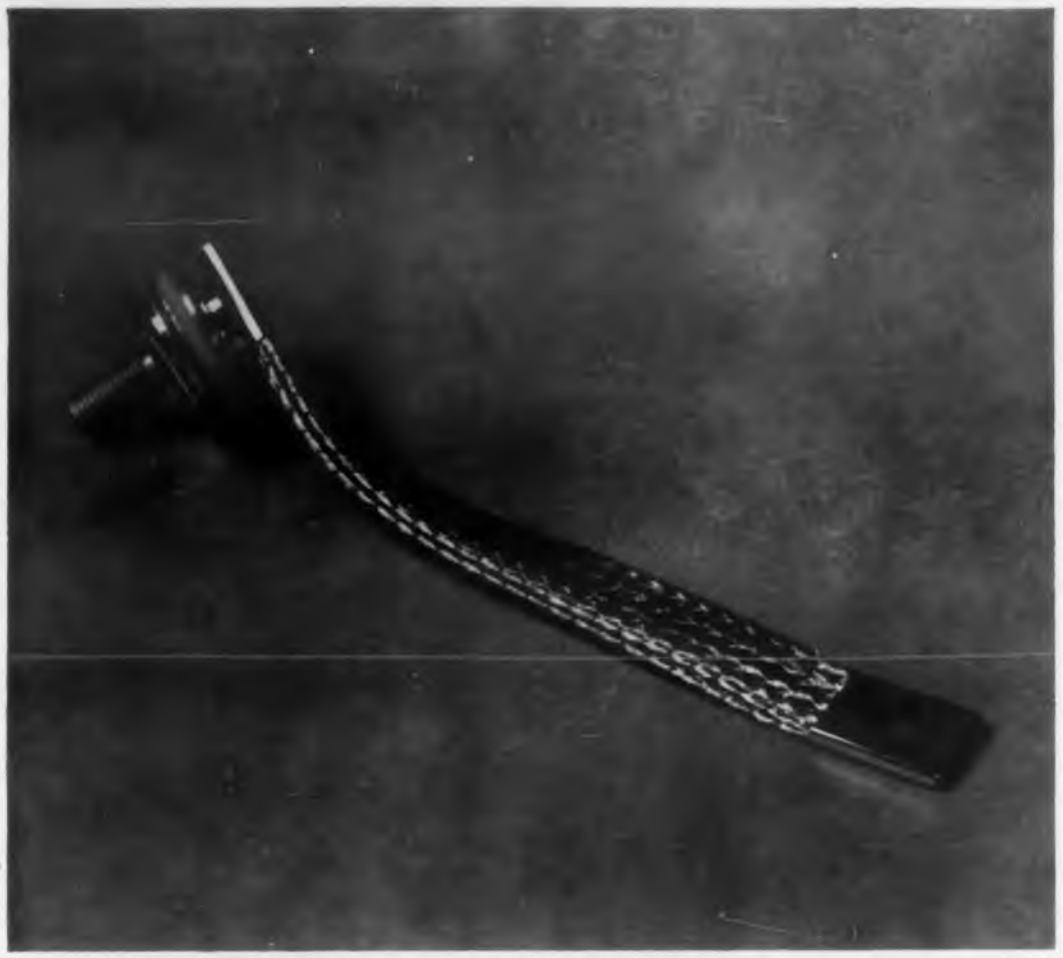
A succession of discs placed along the length of a brass rod has greatly increased the delaying power of this torsional delay line. The signal, which is fed into the line by a torsional transducer, is delayed as much as 114 μsec per cm by the difference in diameter between the discs and rod.

Two such delay lines, machined from solid brass rods, were developed and studied at Bell Telephone Laboratories, N.Y. One had diameters for disc and rod of 0.180 in. and 0.045 in. (4 to 1); the second had diameters of 0.220 in. and 0.044 in. (5 to 1). The cut-off frequency for these lines was about 50 kc, and a frequency of 32 kc was employed to check the characteristics of the lines. Low frequency torsional transducers were designed for the tests. Produced from barium-lead-calcium titanate, one was a split tube type 3.14 cm long and 0.255 cm in diameter, while a second dumbell or disc-loaded type, analogous to the line itself, was 1.43 cm long. These transducers were soldered to the ends of the brass delay lines.

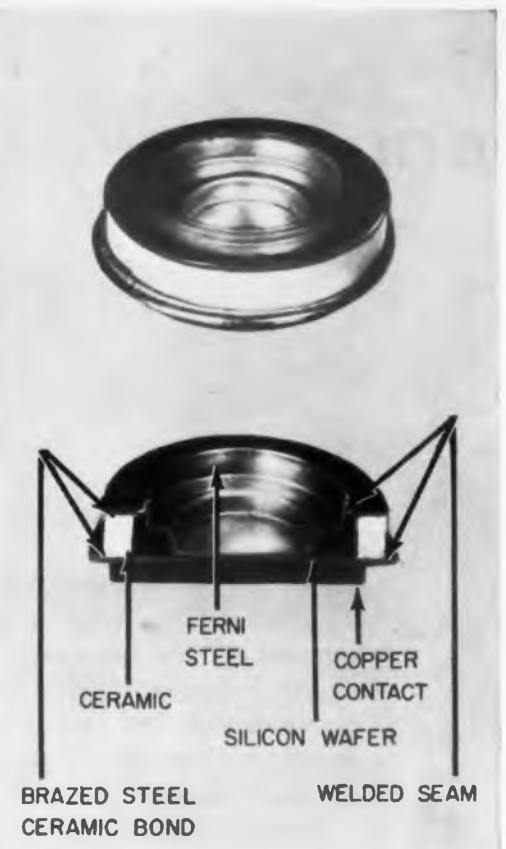
The delays were measured by first determining the delays in the transducers themselves and then subtracting this value from the total delay of the line-transducer assembly. For the 4-to-1 line, with 0.020 in. discs and spaces and a total length of 2-1/2 in., the delay was 43 μsec per cm with an insertion loss of 1.7 db. Bandwith was 4.6 kc, determined by the transducers. The delay in the 5-to-1 line with 0.015 in. discs and spaces and a total length of 3 in. was 114 μsec per centimeter, the insertion loss about 1 db, and the bandwidth 6.3 kc. Compared to the torsional wave delay in a brass rod of uniform diameter, the 5-to-1 disc-loaded line offers a 25-fold improvement in delay time.

Missile Test Tower: A test base for the Atlas intercontinental missile is revealed here in a night photograph taken at the Sycamore Canyon test site near San Diego, Calif. The base, situated in a remote section of a military reservation, is one of three where the Air Force's ballistic missile is tested by the Convair Division of General Dynamics Corp. Component testing is conducted at a fourth facility, on Point Loma in San Diego. Captive testing of the missile's systems and rocket engines are carried out both at Sycamore and at Edwards Rocket Base, Calif.

DESIGNER'S



HERMETICALLY SEALED silicon cell is mounted on a standard stud assembly for ease in mounting to almost any type of heat sink. The selected heat sink may be either forced-air or liquid-cooled as desired by the user. Positive contact on both sides provide efficient heat transfer.



ACTUAL SIZE view shows G-E silicon rectifier cell hermetically sealed to better protect the silicon wafer from moisture or other contaminants.

New G-E silicon cell provides more output, greater flexibility for large DC power

A new power-sized silicon rectifier is now available from the General Electric Company with cell ratings up to 140 amperes. In the field of electronics there are many types of applications such as filament power supplies, and power supplies for computers, radar, etc., for which this will be ideally suitable. It offers the advantages of lightweight, small size, high efficiency, and higher operating temperature as compared to other types of semiconductor rectifiers.

The basic part of the G-E silicon rectifier is the cell enclosure as shown in the cutaway view above. The specially processed silicon wafer is enclosed in a hermetically sealed package of ceramic and welded ferni steel. This same construction has been adequately field tested in 4 years of successful performance totalling over 35,000 KW of our high-power germanium rectifier components.

The package is intimately bonded to a threaded stud to provide a simple yet thermally efficient method of mounting the rectifier assembly to a proper heat sink (see fig. 1163340). Because of this design, it is now possible to obtain an effective heat transfer junction on single-plate type cooling fin.

Complete application information is available through your local G-E Apparatus Office or check coupon for bulletin GET-2689.

Packs 2.2 hp in

General Electric combination d-c motor-tachometer unit has high power in small space, plus extremely fast response

This General Electric d-c motor-tachometer combines—in one compact, space-saving unit—great power and extra-fast response to control signals. It's a natural choice for automatic machines that are subject to rapid acceleration, frequent starts, stops, reversals, and widely fluctuating loads.

For example, the 200-volt model shown is less than 15 inches long and only 5.16 inches in diameter. Yet it delivers 2.2 horsepower, when externally cooled, to

GENERAL ELECTRIC

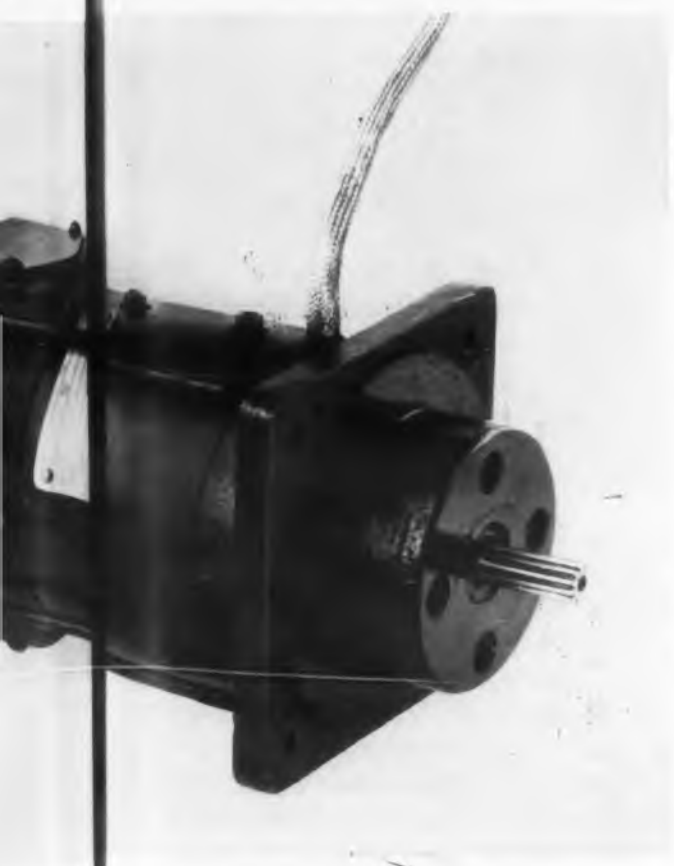
5.16-in. diameter

drive a ground radar antenna in a missile guidance system. In this case, the motor moves the radar antenna up or down, clockwise or counterclockwise, fast or slow, depending on the missile's track and speed.

The motor's speed of response is such that, at no load, it reaches 63 per cent of its rated speed of 5500 rpm in only .014 seconds from standstill. When blower-cooled, it delivers 2.65 lb-ft of torque throughout the entire shaft-speed range from standstill to 4500 rpm. Stall torque is 10 lb-ft.

This motor can be supplied with or without shaft-coupled tachometer-generator that is used for feedback control signals.

Available in two frame sizes, the motor features all-angle operation, can be powered by any d-c control power supply, and is applicable to practically any servo system. For more details on your application, see your nearest Apparatus Sales Office.



POWER-PACKED General Electric motor-tachometer-generator set features high power, small size, fast response. Model shown—rated 2.2 hp, 5500 rpm, 200 volts d-c, with Class B insulation—measures under 15 inches in length, only 5.16 inches in diameter.

For your design problems . . .

General Electric energy storage capacitors supply minimum inductance or low-cost joules

To meet the increasing needs of the electronics industry, General Electric has expanded its line of energy storage and discharge capacitors to include a new low inductance model. Shown at right in the photo the new unit is rated at 100 kv .25 uf, and will ring at 2.5 mc. The inherent low inductance of this unit means such advantages as maximum energy transfer to low inductance loads, extremely steep current rise, and simpler "crowbar" circuitry.

The existing standard type of G-E energy storage capacitor (shown at left in photo) is rated at 20 kv 7.5 uf and will ring at 200 kc. This standard model offers maximum joules at lowest cost.

BOTH CUSTOM DESIGNED AND STANDARD RATINGS AVAILABLE

Both models are available either in standard ratings or custom designed for your circuit problem. The standard model has applications in atomic energy research projects, photographic equipment, discharge welders, and several other energy storage uses.

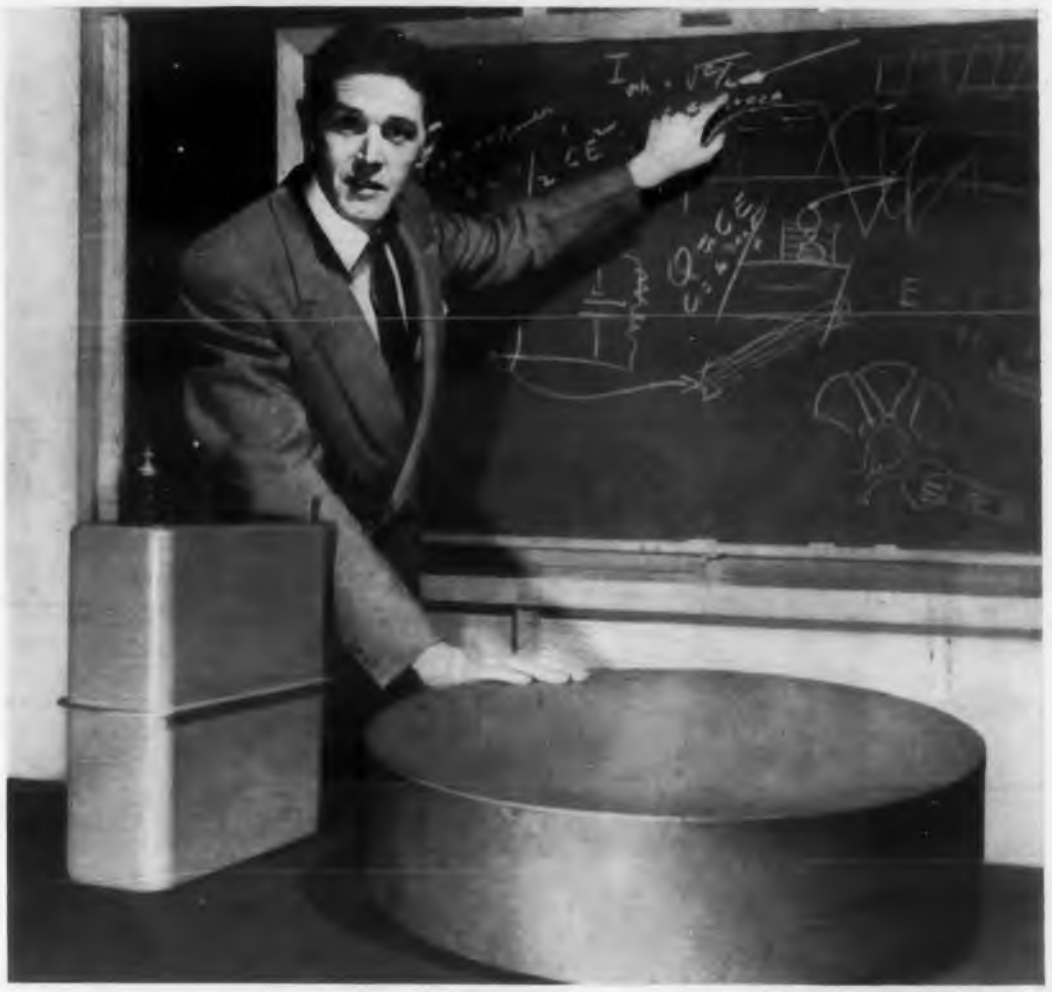
The low inductance model has similar applications, and is ideal in high frequency pulse circuits where an optimum rise time is essential. The use of Pyranol* impregnant in all energy storage units provides a relatively small, lightweight, stable capacitor which has a life consistent with the application involved.

CONSULT G-E CAPACITOR EXPERTS

General Electric invites you to discuss your application needs for energy storage units with capacitor specialists like Doug Warner who is shown in the photo.

With more than 20 years of G-E electronics experience, Doug probably will be able to come up with ideas that will solve your particular circuit problems. His recent paper, "The Application of Large Capacitors for Use in Energy Storage Banks," is available now. Simply write for Capacitor Facts No. 4, GET-2698. Additional information on Energy Storage and Discharge Capacitors from 2000 to 6000 volts, may be obtained by writing for Bulletin GEC-1357.

*Registered trade-mark of General Electric Co.



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Please send me the following:

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☐ GEC-1357—Energy storage capacitors
☐ GET-2689—High-current silicon rectifiers
☐ GET-2698—Capacitor Facts No. 4

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CIRCLE 4 ON READER-SERVICE CARD FOR MORE INFORMATION

Engineering Review

The Atom-Smashing Race

Shortly after the announcement by the Russians of the successful testing of a 10 billion electron-volt synchrotron, the Midwestern University Research Association (MURA) announced their development of a synchrotron several times more powerful. The Russians, however, have the lead at the present as far as an operating synchrotron is concerned.

Both the MURA synchrotron and the Brookhaven National Laboratory synchrotron have yet to be completed. The latter is a 25 billion ev machine, which makes available an energy of 6 billion ev upon collision of the protons with a stationary target. When the Brookhaven synchrotron is completed, it will be more powerful than that presently operated by the Russians, but only half as powerful as another 50 billion ev synchrotron on which the Russians have begun development.

The MURA synchrotron will surpass all other synchrotrons proposed or in operation by making available 30 billion ev of energy upon collision. The synchrotron will operate on the principle of head-on collosion; that is, two beams of protons capable of producing 15 billion ev each will travel in opposite directions on a collision course. The head-on principle makes available the same amount of energy as a single-beam synchrotron ten miles in circumference.

The construction of the MURA synchrotron is being assisted by the IBM 704, which permits the most efficient design to be used in the construction without the need for expensive working models. Although Russia is reported to have a generous supply of scientists, which most likely has given them their present lead in operational synchrotrons, yet it is predicted that their lack of computers similar to ours may keep them behind in future developments.

A Cat's Eye View of Mars

A light amplifier called the Cat Eye will be used to investigate canals on the planet Mars as well as other phenomena that have long concerned astronomers. The light amplifier, which grew out of a research program of the Air Research and Development Command, can see a scene at night and reproduce it with daylight brightness when even the human eye can see nothing. Research work on Cat Eye transducers was conducted for ARDC by Westinghouse Corp. and RCA.

Conventional photographs of planets and other heavenly bodies taken with even the best telescopes suffer from jitters. Jitter is caused by tremors of air masses in the earth's atmosphere which affect the

esolution of distant objects such as planets and galaxies, because light is deflected first in one direction and then in another. This shimmer causes photographs to blur, since conventional photographic techniques require exposures of several seconds for Mars, and even longer periods for more distant planets or the stars. The Cat Eye will reduce exposure time by a factor of 16,000, resulting in more revealing photographs of planets by eliminating this blurring.

The Cat Eye contains a transducer which collects and converts photons much more efficiently than the human eye. It is especialy sensitive in the red and near infrared portions of the spectrum, which are most suitable for observations of planets. Plans are being made to make further use of the light amplifier as part of reconnaissance systems which take aerial pictures at night.

High V, Low Amp: Electrostatic generators are experiencing a revival as the obvious source for high potential dc, where moderately little current is needed. A dc Overpotential Test Set has been developed for such purposes by the Societe Anonyme Des Machines Electrostatiques. The portable tester uses a Felici electrostatic generator controlled by feedback circuits. Characteristics are as follows: Voltage adjustable from 1 to 50,000 v; maximum current of 0.5 ma; regulation of 0.5 v; stability of 3 v at full voltage, and voltage drift of 0.1 per cent per hour.

The device has been designed for testing generators windings, and it is particularly suited for the measurement of very small leakage currents in circuits having high capacities. The tester is equipped with shielded cables, 3 range precision microammeter, weighs 100 lb and measures 24 x 23 x 9 in.

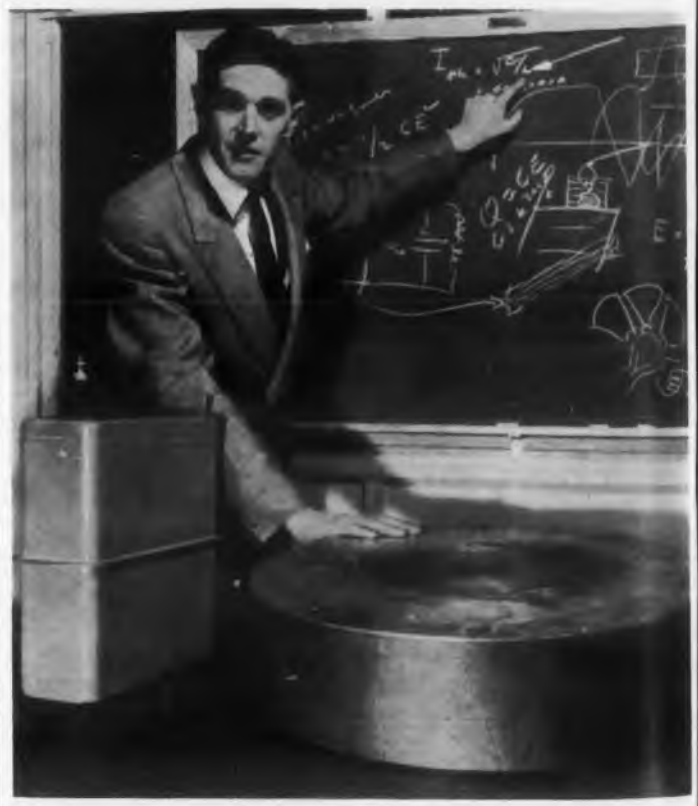
Engineering Review

Flying Spot Microscope

A technique used as a substitute for human vision in microscope studies, allows precision analyses and measurements of approximately one million particles per second. The system makes possible studies which were previously difficult due to human error and the spectral and other limitations of the eye.

The microscope incorporates standard and conventional microscope optics, but the light source, instead of being the usual evenly illuminated plane, is a rapidly moving spot of light. This spot rapidly scans a regular pattern of sequential lines. Variations in light transmissions of the scanned specimens are converted into electrical signals and displayed on a monitor as an enlarged image of the microscope specimen.

It was pointed out by Allen B. DuMont Laboratories, who developed the technique, that the electronic form of the information lends itself to computer analysis. Demonstrations of the technique included its applications as a counter for biological and industrial studies of microscopic matter; as a microdensitometer for measuring the optical density of blood cells and other microscopic biological material; and as a spectrophotometer for measuring optical density of microscopic material at specific spectral wavelengths.



Electron Storage Vault: A low inductance capacitor for energy storage, built by General Electric Co., is shown at right. The unit is rated at 100 kv, 0.25 μf, and has a ringing frequency of 2.5 mc. The existing standard type of energy storage capacitor, shown at left, is rated 20 kv, 7.5 μf, and has a ringing frequency of 200 Kc.

Ultrasonics Keeps Milk Fresh

A method of preserving milk by using ultrasonic waves is described among the new development projects of the National Research Development Corp., England. Pasteurized milk is treated with ultrasonic waves, poured into polythene bags and quickly frozen in a brine bath. The method has been developed in Britain by the National Institute for Research in Dairying with financial support from the N.R.D.C. The frozen milk can be stored for at least a year without deterioration. Two British firms are expected to go into production soon.

Silicon Carbide—1200 F

Operation of a silicon carbide rectifier at temperatures up to 1200 F has been announced by General Electric Research Lab. Currents of several amperes were rectified with usable efficiency, but it was added that the practical future of the compound in rectifiers and other solid-state devices will depend on progress in the preparation of the highly stable but stubborn materials. The problem lies in achieving purity. This essential for semiconductor devices is more easily obtained when using a single element, but it becomes exceedingly difficult when employing compounds.

It was emphasized that the silicon carbide rectifier is still in laboratory development and that the announcement was made simply to affirm the scientific fact that solid-state rectification has been observed in the range of temperatures from —100 to +1200 F.

Electronic Cop

As a result of having 10 firemen killed and 27 injured during the past five years because of traffic accidents, the City of Baltimore is now installing a pilot system of emergency vehicle traffic radio control (EL-TEC). The system allows emergency vehicles such as police cars, fire trucks and ambulances to control traffic lights from their dashboard. Developed by Electronic Protection Inc., Melrose Park, Ill., the radio control device is expected to substantially reduce the number of accidents between emergency and privately owned vehicles.

CIRCLE 9 ON READER-SERVICE CARD ➤

Engineering Review

Automatic Navigator Studies Jet Stream

Precise navigation is an important requirement for scientific exploration of the fast-flowing layer of air, called the "jet stream" which flows from west to east at altitudes of 35 to 40 thousand ft above the earth. The AN/APN-67 automatic navigator, developed by the Ryan Aeronautical Co. and the Navy's Bureau of Aeronautics, will help pursue this jet stream.

Frequently used by east-bound jet aircraft for "free rides," the jet stream is a seasonal phenomenon of shifting habits. The Navy research program will probe the velocities, directions, altitudes and other characteristics of this body of air, using the electronic navigator to better determine its nature and correlate it with weather data.

An advanced system of high speed navigation, the APN-67 is also being used by the Navy in Project Magnet, which measures the direction and intensity of the earth's magnetic field, and Expedition Deepfreeze, in connection with polar explorations during the International Geophysical Year.

Standard Solution

According to a recent ASA news letter, Russia has solved the problem of deviates from their program of standards by punishing such nonconformists with a prison sentence. Russia has 9000 standards, contrasting sharply with the 1700 American standards which are industry-made and completely voluntary. Some of Mexico's latest standards are for table wines; Israel's concern is peanuts; Japan, pliers; Russia and satellite countries, machines and machine tools; diagnostic X-ray tubes.

Detachable Fire Control System

The Douglas F4D Skyray, newest operational Navy fleet interceptor, will have a barrel-shaped fire control system designed to be housed almost entirely in its nose section. The cylindrically packaged unit consists of the AN/APQ-50 radar, the Aero 5B com-

◀ CIRCLE 10 ON READER-SERVICE CARD

er, and the AFCS MK-16 optical system for clear weather and daylight operation. Designated the Aero 13, it is designed to be supported by an overhead slide rail mounting so that it may be pulled completely from the nose of the aircraft for accessibility. Development and production of the system has been accomplished by the Westinghouse air arm division, with the assistance of the Naval Air Development Center and the Naval Research Labs. Each of the unit's subassemblies are designed in the form of hinged pellets that may be lowered independently of the others. As well as allowing reductions in maintenance problems, the over-all design provides important savings in space and weight.

Parallel Reactors for High Amp

Paralleling reactors have been designed to insure equal distribution of current loads to germanium rectifier junctions operating in parallel. Their development makes possible very heavy current installations of germanium rectifiers formerly limited by the difficulty of matching junctions. No derating of junctions is required when they are incorporated in a circuit, since they force each junction to share an equal current load. Heat failure of junctions and overload due to unbalanced forward conduction is greatly reduced, according to the manufacturer, International Rectifier Corp. of 1521 E. Grand Avenue, El Segundo, Calif.

32-Pound Crystal Grown

Chemists at the Army Engineers' Research and Development Laboratories, Fort Belvoir, Va., proudly report that the thallium chloride crystal which they have been busily growing has a weight of 32 lb. The crystal will provide means of measuring high energy electrons, X-rays, mesons and other atomic components produced by the Synchrotron at the California Institute of Technology. Particles are directed against the end surface of the crystal and absorbed. Their energies are then converted to emitted light called Cerenkov radiation, which can be measured quantitively. The crystal measures 7 in. long and 6 in. in diam.

CIRCLE 11 ON READER-SERVICE CARD ➤

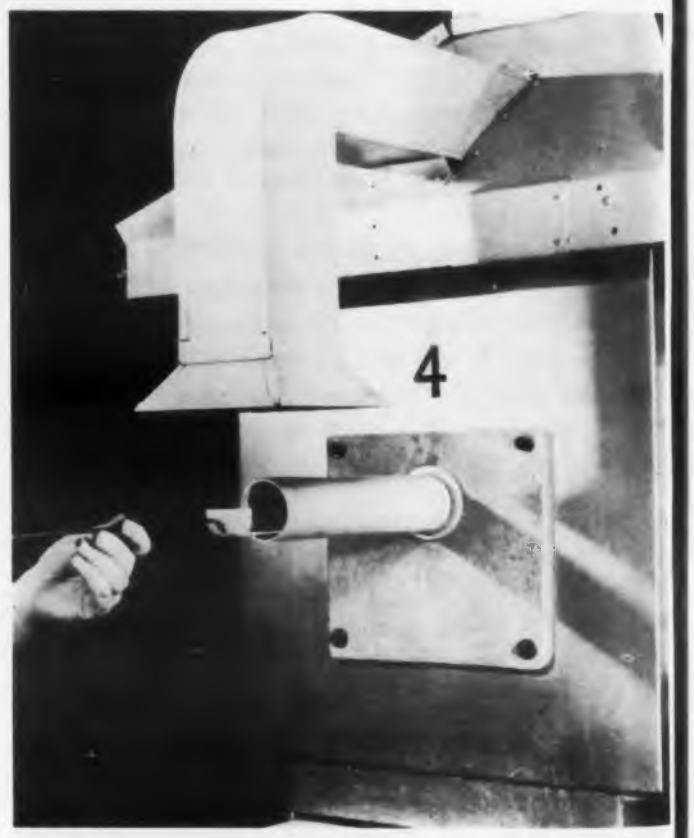
Engineering Review

Modified Ferrite Materials

Ferrite materials have been developed with such desirable properties as controllable saturation magnetization, low dielectric loss, and a high degree of reproducibility. The ferrites developed by Bell Telephone Laboratories constitute a forward step in production of the nonreciprocal microwave devices in which solid materials perform complex circuit functions.

The new materials are essentially magnesium, manganese, aluminum ferrites or nickel manganese ferrite with a small amount of copper replacing some of the magnesium or nickel. The addition of the proper quantities of copper and manganese to the basic ferrite is advantageous from several points of view. By increasing the reactivity of the mixture, copper decreases the necessary firing temperature by at least 100 C. Under comparable conditions this results in lower porosity and improved uniformity in the fired material. The manganese addition decreases electrical conductivity and thus the dielectric losses in these materials.

Microwave ferrites with low saturation magnetization are obtained by the modification of



A block of ferrite material resting in an alundum tray is being inserted in a furnace for firing. The material has been improved by adding copper and manganese in proper quantities to the basic ferrite. Copper increases the reactivity of the mixture and thus decreases the firing temperature by at least 100 C. The manganese addition lowers the conductivity, making possible smaller dielectric loss.

Mounted in the foreground is the experimental transistor which can provide 5 w at 10 mc. The transistor is designed with an intrinsic layer of silicon between the collector and other elements, which makes possible its high frequency performance.

magnesium ferrite. The saturation magnetization of this ferrite can be decreased in a controlled way by substituting aluminum for a part of the iron. While materials compounded in this fashion are basically satisfactory, their refractory nature makes it difficult to reproduce the magnetic properties required for many microwave applications. The added copper minimizes this difficulty, and also increases slightly the Curie temperature for comparable saturation magnetization.

Power Transistor; 5 W at 10 Mc

An experimental silicon power transistor, capable of providing an output of 5 w at 10 mc either as an oscillator or an amplifier, has been developed at Bell Telephone Laboratories. Unilateral gain is in excess of 20 db, and a collector efficiency of better than 40 per cent has been achieved.

The unit is a pnip diffused emitter and base transistor, in which a near-intrinsic or neutral layer of silicon separates the collector from the other elements. Introduction of an intrinsic layer to improve the high-frequency performance of transistors was announced by Bell Laboratories in 1954. Alpha cutoff is about 100 mc per sec, and some laboratory samples have provided as much as one watt output as an oscillator at 100 mc per sec. Input and output impedances are on the order of 20 ohms and 300 ohms, respectively. Although still experimental, improvements in the diffusion process, packaging, and other features are expected to result in a transistor which is reliable and relatively easy to manufacture.

Washington Report

Herbert H. Rosen

New Missile Czar

For the past several weeks, William M. Holaday has been the nation's missile Czar. Officially, the former Director of Research for the Socony-Mobile Oil Co. is the Special Assistant to the Secretary of Defense for Guided Missiles.

Holaday enters the new job under somewhat of a cloud. His predecessor, Dr. Bger Murphree, was severely criticized by a House Appropriations Subcommittee for ineffective action for the past year. They were referring principally to claims of undue duplication in the nation's guided missiles program. Holaday also has been long known as a strong advocate of basic research and was thought to have been exerting a disrupting influence in the formation of the new Research and Engineering Secretariate.

In taking over the new job, Holaday is also given the responsibility of coordinating the Vanguard Satellite program. This is a responsibility that even Murphree could not claim.

In his directive, Secretary of Defense Charles Wilson outlined in much detail the job his new special assistant was to perform. He will be the chairman of the OSD Ballistic Missile Committee. This is the group that must iron out all the differences among the services working in the field. Besides the ballistics programs, Holaday will also exercise specific coordination within the OSD over Redstone, Navaho, Snark, Triton, the anti-ballistic missile program, and guided missile range extension and utilization.

The delineation of Holaday's powers leads to certain speculation. For one, the question of Nike vs. Talos remains unresolved. But according to some reports, the Army missile program in Europe is not well received by the foreign nationals. They laugh at the 15 trucks and other impedimenta associated with Corporal. The English are supposed to have a much better missile than even Nike-Herculus. Besides, there isn't enough real estate in England and Europe to accommodate all the Nike installations needed for the NATO Fire Wall.

Still to be resolved is the fate of Jupiter. Army is fighting a stopgap battle by holding on to portions of its test program for the remainder of this year. The Air Force has made provisions in their budget for only one such missile—either the Jupiter, Thor, or combination of both. Both the Army and the Air Force still claim that their own particular brainchild is the better.

Publicity, the Advantage of Appropriation Hearings

One of the distinct advantages of budget hearings on Capitol Hill is that the public has a chance to look a little more deeply into what's going on in the Department of Defense. In cutting the Defense Budget by nearly $2 billion, the House Committee indicated its concern for the growing Russian submarine force. It has approved many plans concerning anti-submarine warfare and special ships and devices to improve our present position. Guided missiles, although cut in some areas, has jumped in budgeted cost by nearly a factor of two. But duplication and waste are being carefully studied. The House took special notice of Bell's Rascal and suggested that the program be dropped by the Air Force. The Committee also indicated that there should be some soul searching among the other 18 missile projects conducted by the AF.

Throughout these hearings it has become obvious that the first public estimate of the Defense Budget was very close to rock bottom as each service saw its function. That estimate added up to some $48 billion. In cutting back to $36.5 billion, some programs had to be eliminated. Others were delayed, and still others were stretched out. The cutback in B-52 production, stretching out the purchase of over 600 planes into '59 is one example. Another, revealed by Army's R & D Chief James Gavin, is that the Nike program has been set back four years by the cuts in R & D. And Gen. Twining of the Air Force believes that the cut back from $21 billion to $17.7 billion in his budget really hurt the Air Force procurement program.

In later action in the House, these figures have been cut back even more. Although nothing like the $3 to $5 billion threatened since the presentation of the Budget in January.

Actually, in the case of the Defense Department budget, much of the reduction is only a shuffling of funds from one check account to another. Where the real harm will come is in the future, since much of this money is coming from unobligated funds collected over the years for programs that have long lead times. However, the technique used in budget cutting lets the door wide open for the services to come back next Spring for what is called a supplemental appropriation. So far, Congress has voted three such supplementals to the Executive branch with not too much fanfare or opposition.

The outcome? More Government expenditures and modest tax reductions maybe in 1958. Even this is doubtful in the light of a staff report out of Congress. It estimates that the surplus for '57 and '58 will be only $1.2 and $1.3 billion. And this should be applied to the National Debt rather than be consumed in tax relief to business and to the individual. Defense is expensive. And the electronic engineers are going to find their bosses asking them to be more cost conscious than ever before.

Meetings

June 17-19: 1957 National Convention on Military Electronics
Sheraton-Park Hotel, Washington, D.C. The theme of the convention is "Missiles and Electronics." Both unclassified and classified papers are being presented. The sponsor is the Professional Group on Military Electronics, IRE. There will be exhibits. Topics to be covered include design goals, components, systems, reliability, test equipment, and ranging and tracking. Address all correspondence to George Rappaport, Emerson Radio and Phonograph Corp., 701 Lamont St., N.W., Washington 10, D.C.

June 19: Meeting of the New York Chapter of the IRE Professional Group on Engineering Management
Stewart Avenue School, Stewart Ave., Garden City, N.Y., 8 p.m. The subject of the meeting will be the unionization of engineers. Speakers will be Joseph Ammen, President of Engineers and Scientists of America, and Dr. Harry Raines of Hofstra College. For further information write Harold Hechtman, Airborne Instruments Lab., Inc., 160 Old Country Rd., Mineola, N.Y.

June 24-28: Summer General Meeting and 73rd Annual Meeting, AIEE
Sheraton-Mount Royal Hotel, Montreal, Que. An opening day session will deal largely with the Canadian Transcontinental Microwave system and papers concerning nucleonics. Other papers will cover radio communications, suburban electrification, dielectrics, magnetic amplifiers, safety, land transportation, telegraph systems, the textile industry, power generation, transmission and distribution, computers, communications theory, research and industrial control. For further information write to AIEE, 33 W. 39th St., New York N.Y.

June 27-29: Thirteenth Annual Meeting, Institute of Navigation
Sheraton-Park Hotel, Washington, D.C. The comprehensive program will deal with the problems of air and marine navigation and special navigation problems. There will also be a symposium on the question of a common air-marine system of navigation. For more information, write to Brig. Gen. Peter C. Sandretto, Federal Telecommunication Laboratories, Nutley, N.J.

Aug. 20-23: Wescon (Western Electronic Show and Convention)
Cow Palace, San Francisco, Calif. Sponsored by the San Francisco and Los Angeles Sections representing the Seventh Region IRE and West Coast Electronic Manufacturers Association. For more information write to Don Larson, Business Manager, 342

LaBrea Ave., Los Angeles 36, Calif. For those interested in submitting papers, check the paper deadlines at the end of this section.

Sept. 4-6: Special Technical Conference on Magnetic Amplifiers

Penn Sheraton Hotel, Pittsburgh, Pa. Sponsored by the AIEE and the IRE. The program's four sessions will deal with New Circuits and Techniques, Analysis and Design, and Applications. For more information, write to D. Feldman, Bell Telephone Laboratories.

Sept. 9-13: Twelfth Annual Instrument-Automation Conference and Exhibit

Cleveland Auditorium, Cleveland, Ohio. Sponsored by the ISA. Organized under the unifying theme, "Instrumentation for Systems Control," the conference will open with formal sessions devoted to data handling and instrument terminology. Following these there will be individual workshop sessions in limited discussion groups covering such topics as aircraft and missiles (excluding propulsion), wind tunnels, flight propulsion systems, process industries, power generation and distribution, meteorological, nuclear, medical, geophysical exploration and general industrial laboratories. Some 100 papers will be presented at the technical sessions. There will be about 500 exhibits. For details of the technical program write to Herbert S. Kindler, Director of Technical Programs, ISA, 313 Sixth Ave., Pittsburgh, Pa.

Sept. 17-18: RETMA Symposium on Numerical Control Systems for Machine Tools

Ambassador Hotel, Los Angeles, Calif. For details write to RETMA, Room 650, 11 W. 42nd St., New York 36, N.Y.

Oct. 7-9: Thirteenth Annual National Electronics Conference

Hotel Sherman, Chicago, Ill. Sponsored by the Illinois Institute of Technology, AIEE, IRE, RETMA and a number of universities. Papers will be given on antennas and propagation, audio, circuits and theory of synthesis, communications, components, instrumentation, information theory, microwaves, radar and radio navigation, radio frequency interference, semiconductor devices, servomechanisms, telemetering, ultrasonics and other subjects. For further details write to Virgil H. Disney, Manager, Electrical Engineering Research Dept., Armour Research Foundation of Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

Oct. 16-18: 1957 IRE Canadian Convention and Exposition

Automotive Building, Exhibition Park, Toronto, Canada. Sponsored by the Canadian Sections of the IRE. For information write to Grant Smedmor, IRE Canadian Convention, 745 Mt. Pleasant Rd., Toronto 7, Canada.

Oct. 31-Nov. 1: Third Annual Technical Conference of the Professional Group on Electron Devices, IRE.

Shoreham Hotel, Washington, D.C. Those interested in submitting papers should check the paper deadlines at the end of this section. For more information, write W. M. Webster, RCA Semiconductor Div., Somerville, N.J.

Nov. 11-13: Third Annual Instrumentation Conference

Biltmore Hotel, Atlanta, Ga. The theme of this conference will be "Instrumentation for Data Handling" with special symposiums on electronic instrumentation as applied to medicine and the sales and purchasing aspects of electronic instrumentation. Papers should be submitted to Lamar Whittle, Federal Telecommunications Lab., 1389 Peachtree St., N.E., Atlanta, Ga. For more information write B. J. Dasher, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

Nov. 13-14: Mid-America Electronics Convention

Municipal Auditorium and Hotel Muehlebach, Kansas City, Mo. Sponsored by the Kansas City Section of the IRE. There will be exhibits and twelve technical sessions. Approximately thirty papers will deal with medical electronics, airborne electronics, instrumentation, engineering management, electronics in nucleonics and a diversity of other subjects. Persons who want to submit papers should contact the Technical Papers Chairman, MAECON, 5109 Cherry St., Kansas City 10, Mo. The deadline for submissions is Aug. 15. For more information write Richard L. Clarke, 425 Volker Blvd., Kansas City 10, Mo.

Nov. 13-15: Eighth National Conference on Standards

St. Francis Hotel, San Francisco, Calif. Sponsored by the American Standards Association. Emphasis will be on standards as a key to progress and profits. Sessions will cover radiation exposure, electronics, industrial preparedness, motion pictures and television, purchasing, company standards, technical communications, government standards and safety. For more information, write to D. E. Denton, ASA, 70 E. 45th St., New York 17, N.Y.

Ralph Baer, author of "A Q-Probe for RF Monitoring" which appeared in the June 1 issue of ELECTRONIC DESIGN, is Vice President of Transitron, Inc., 186 Granite St., Manchester, N.H. Transitron, Inc., is a subsidiary of Van Norman Industries, Inc., manufactures precision electronic and electromechanical instruments, and should not be confused with Transitron Electronic Corp. of Wakefield, Mass., which produces semiconductors and transistors.

Nov. 15-16: New England Radio-Electronics Meeting

Mechanics Hall, Boston, Mass. Jointly sponsored by the Boston and Connecticut Valley Sections of the IRE. The meeting will include exhibits. Write Donn S. Randall, Larcom Randall Advertising, Inc., 51 Melcher St., Boston 10, Mass., for more information.

Nov. 18-20: Conference on Magnetism and Magnetic Materials

Hotel Sheraton-Park, Washington, D.C. Sponsored by the Magnetics Subcommittee of the Basic Science Committee of the AIEE. For further details write L. R. Maxwell, U. S. Naval Ordnance Lab., Silver Spring, Md. Persons wishing to submit papers should write to G. T. Rado, Code 6450, U. S. Naval Research Lab., Washington 25, D.C., before July 1.

Paper Deadlines

July 1: Deadline for technical papers to be presented at the 1957 national conference of the IRE Professional Group on Vehicular Communications. The meeting is to be held December 4 to 5 at the Hotel Statler in Washington, D.C. The central theme for the conference is "Meeting the Demands for Vehicular Communications." Submit brief descriptions of proposed papers to Committee Chairman Grant E. Woodside, Jr., Motorola Communications & Electronics, Inc., 1145 19th St., N.W., Washington 6, D.C., before July 1.

Aug. 1: Deadline for papers proposed for the Oct. 31-Nov. 1 conference of the **Professional Group on Electronic Devices, IRE,** in Washington, D.C. Abtracts should be submitted to the program chairman, W. M. Webster, RCA Semiconductor Div., Somerville, N.J. Subject matter should concern developmental techniques and devices, such as electron tubes and transistors, rather than basic research or circuit applications.

Selecting Plastic Laminates

Dr. Normal A. Skow, Director of Research
Synthane Corp., Oaks, Pa.

IT IS generally desirable for the electronic design engineer to specify the lowest-cost material available which will have the physical and electrical properties needed for a given job. The accompanying bar graphs are presented to aid in making an initial selection of plastic laminates with cost an important consideration. In these graphs, costs are related to the three most important characteristics of concern to the electronic designer—dissipation factor, dielectric strength, and water absorption.

Dissipation factor gives a "figure of merit" on dielectric losses that can be anticipated. Where low losses are important, a low dissipation factor is essential. Dielectric strength is a measure of breakdown voltage. And, per cent water absorption gives an indication of the material's dimensional stability under environmental conditions—water absorption being the one principal cause for dimensional changes in plastic materials.

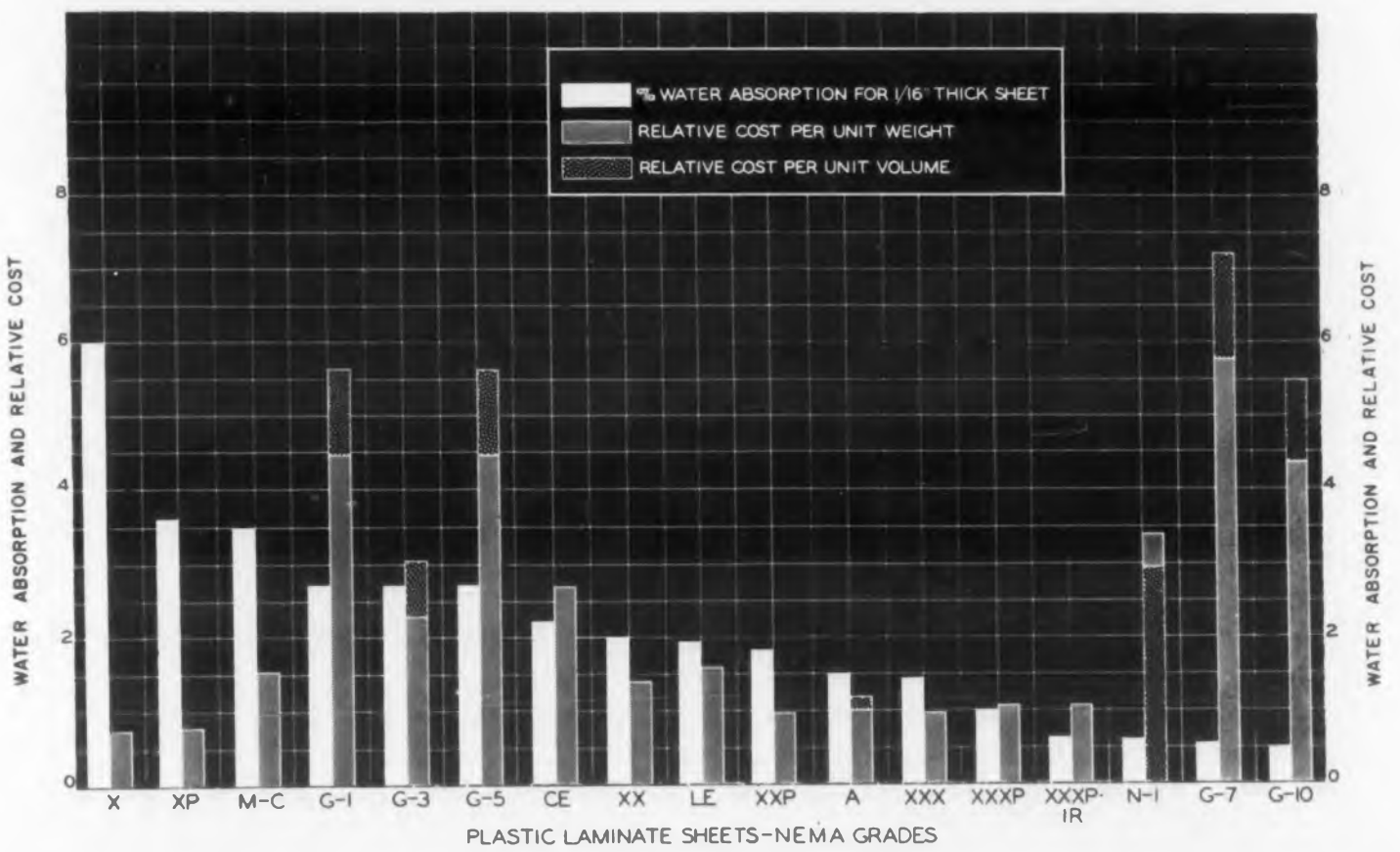
The bar graphs are intended to furnish qualitative rather than quantitative information. They should make it possible for a designer to quickly eliminate unsuitable materials and narrow his detailed investigation to a relatively few that can fulfill his requirements at minimum cost.

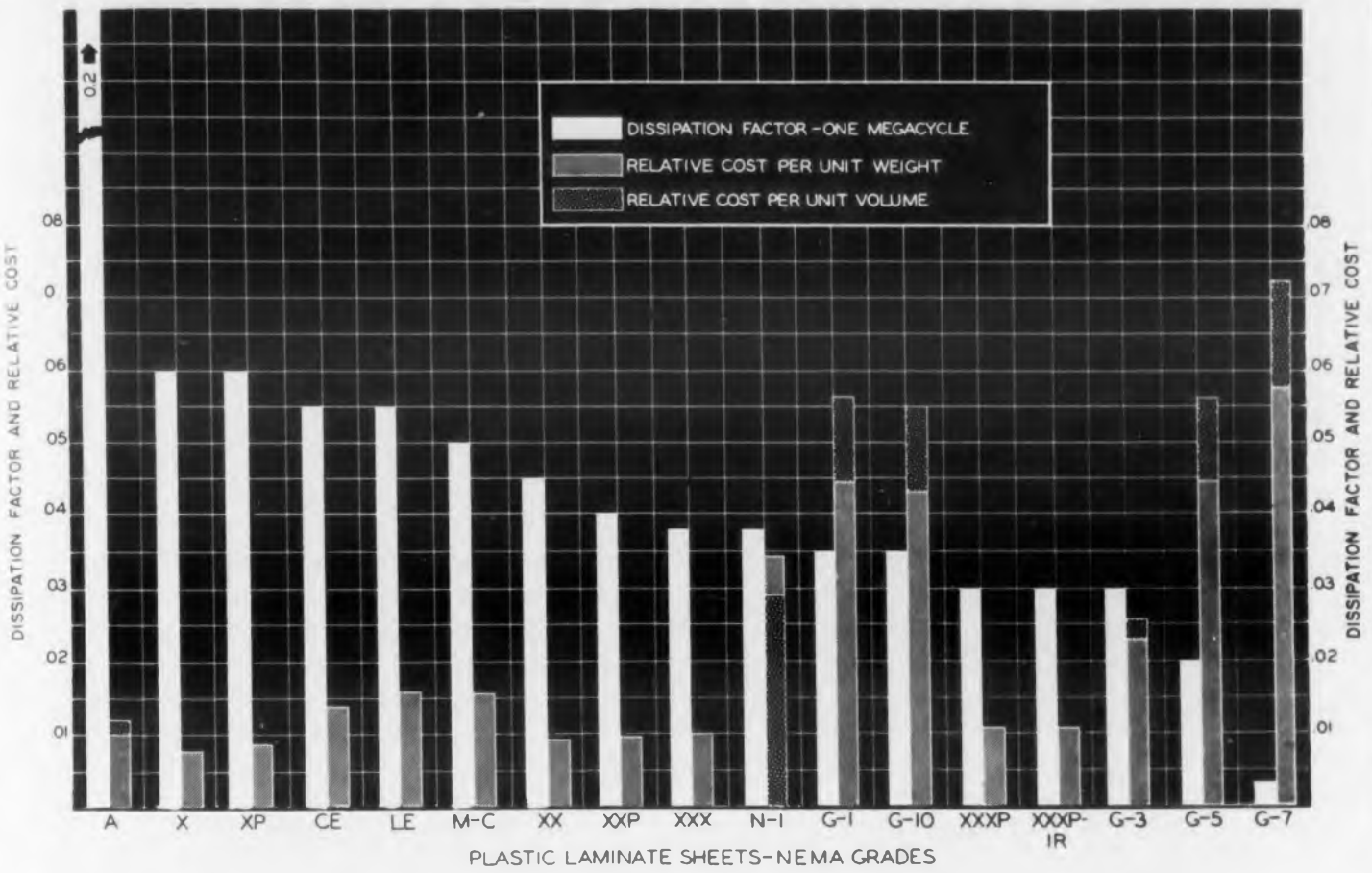
How to Use the Graphs

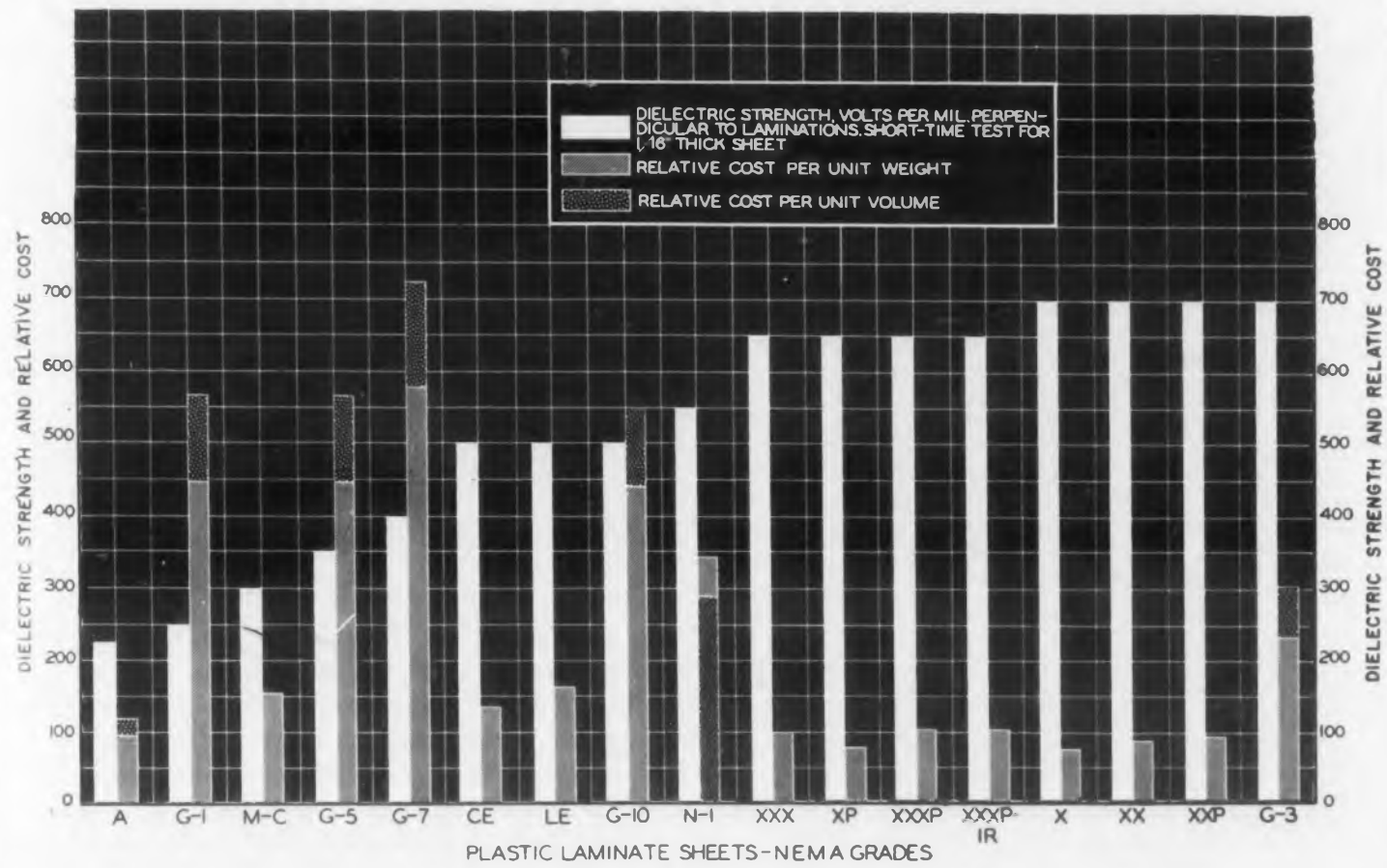
The easiest way to use the graph is as follows:
1. Go to the chart which relates the characteristic of first importance for the particular application. Select the laminate of lowest cost which comes within the allowable range of performance. There might be several of about equal performance but one with a decidedly lower cost.
2. Next, check the laminate selected in 1 on each of the other charts to determine whether its performance is acceptable in the two lesser requirements.
3. If not acceptable in one or both of the lesser requirements, go back to the "key" chart and pick the next costly laminate meeting major performance criterion. Try this laminate on the other charts for acceptance. Try a third or fourth laminate in this manner until all requirements are met. You may not have the cheapest laminate overall but you will have the cheapest laminate possessing the required characteristics to do your particular job.

NEMA Code Definitions

A	Asbestos paper phenolic
X	General-purpose paper phenolic
XP	Punch-grade paper phenolic
CE	Cotton-fabric phenolic
LE	Linen-grade cotton phenolic
M-C	Cotton fabric melamine
XX	Electrical paper phenolic
XXP	Punch grade paper phenolic
XXX	High-frequency paper phenolic
N-1	Nylon fabric phenolic
G-1	Glass fabric phenolic
G-10	Glass fabric epoxy
XXXP	High-frequency punch-grade paper phenolic
XXXP-1R	Humidity-grade XXXP
G-3	Stable grade glass phenolic
G-5	Arc and heat resistant glass melamine
G-7	Glass fabric silicone







Direct Coupled Transistor Logic Complementing Flip-Flop

This article is an investigation into the family of transistor building-block circuits utilizing direct-coupled transistor logic (DCTL). It is based on the development of complementing flip-flop circuits having no requirements on input pulse duration, and the design of a steering mechanism to complement the basic DCTL saturation flip-flop.

Part I deals with basic steering concepts and the principles of conditional steering circuits, culminating in a set of design rules. Part II will describe a variety of circuits including conditional steering with magnetic cores and shift register applications.

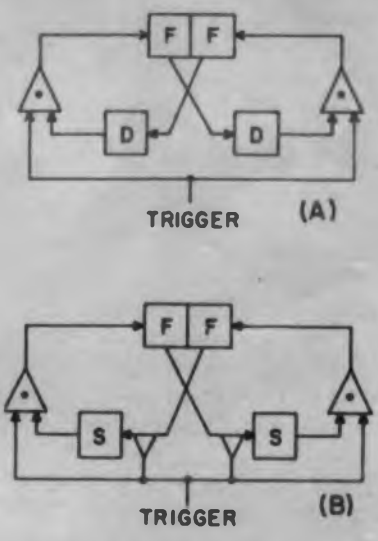


Fig. 1. Logical diagrams of unconditional steering (*A*), and conditional steering (*B*). In *A* the reversal of the steering gates after the change of flip-flop state is unconditional, while in *B* it is conditional upon removal of the trigger.

PREVIOUS practice in complementing flip-flops has been based on the Eccles-Jordan type, or "unconditional steering" type of operation. In cascading these complementing flip-flops (as in a counter), it is necessary to incorporate pulse standardizers between stages to provide the equivalent internal action limiting the effective duration of the complementing pulse input.

In contrast, the conditional steering type of gating advanced here is compatible with direct-coupled transistor logic. It can be applied to counters and shift registers using either direct-coupled gates or differentiation in place of more conventional forms of delay. The reduction of this philosophy to a set of general design rules has made possible the design of a variety of circuits which are insensitive to input pulse duration and appear to be generally useful.

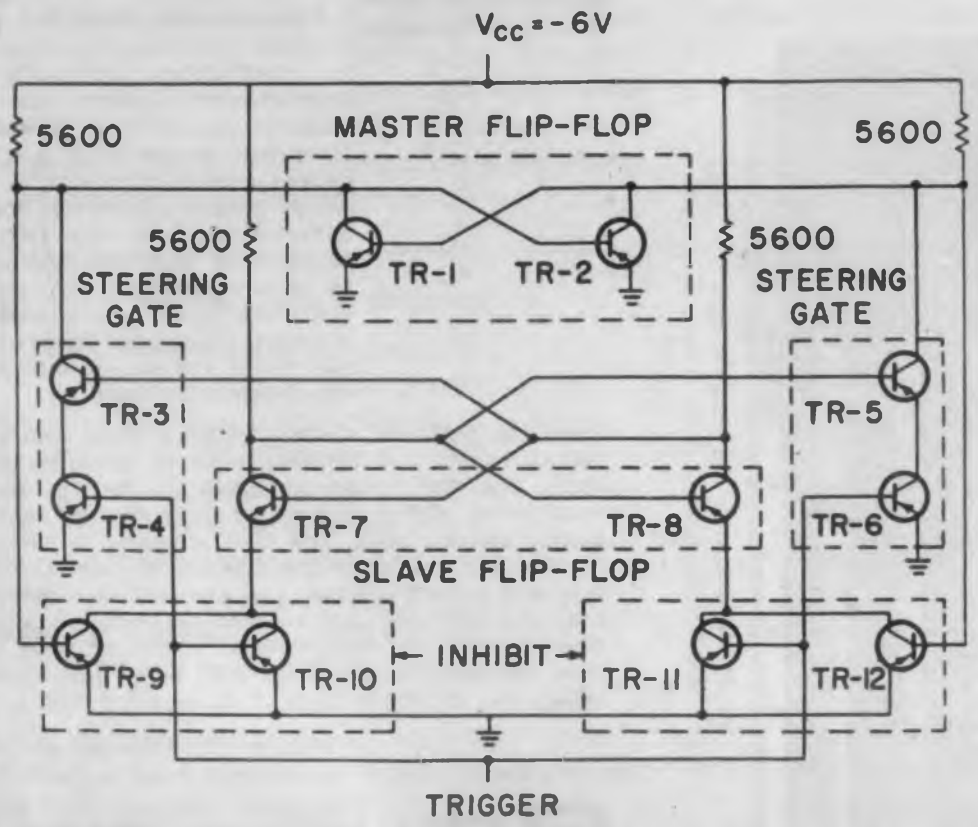


Fig. 2. Circuit illustrating the concept of conditional steering. Its operation is based on a second or "slave" internal flip-flop serving as the memory element.

Unconditional Steering

To distinguish between the two steering methods (Fig. 1a and 1b), it is convenient to regard each half of the complementing cycle as separated into two events. The first event consists of triggering the flip-flop to change its state. The second event is the reversal of the states of the steering gates in preparation for the next trigger. Reversal of states means that the disabled gate becomes enabled and vice-versa. In Fig. 1a the reversal of the steering gates following the change of flip-flop state is unconditional, while the same change in Fig. 1b is conditional upon removal of the trigger.

In the commonly used unconditional steering method, time race is prevented by delaying the reversal of the steering gates until the end of the trigger pulse. Any unconditional circuit, such as represented by the Eccles-Jordan flip-flop, will thus operate only on trigger pulse duration less than the built-in time delay *D* in the figure. In the usual vacuum tube Eccles-Jordan circuit, the flip-flop serves as its own gate and the delay is provided by the grid circuit RC time constant.

Conditional Steering

The diagram of Fig. 1b is introduced to explain conditional steering. In this diagram, the states of the internal memory elements or flip-flop slaves, S, rather than of the basic flip-flop, determine the states of the steering gates. The memory elements are slaved to the flip-flop by dc connections which are passed through inhibit circuits activated by the

Circuits – I

E. G. Clark

Burroughs Corp. Research Center
Paoli, Pa.

input trigger. The simultaneous application of the triggering dc level to both the steering and inhibit circuits changes the flip-flop state while preventing the transmission of this change to the memory element. Time race is prevented by making the reversal of the steering gates following a reversal of the flip-flop conditional upon removal of the input trigger. This mode of operation represents the "ideal" form of delay since the delay action is produced by the trigger itself, and thus circuits with conditional steering will operate with triggering pulses of indefinite duration change in (dc level). Conditional steering should not be confused with trailing edge triggering since the change in flip-flop state is produced by the leading edge of the trigger.

Circuit Considerations

The distinction between conditional and unconditional logic is sufficient basis for a practical circuit difference since, if a differentiating pulse standardizer were inserted in the input of an unconditional circuit, it would give "black box" characteristics identical with the conditional circuit. The significance of this distinction comes in two areas: it avoids the necessity of matching the internal delay to the input pulse duration. This can mean a higher operating frequency, since we are free to operate at the speed of the basic flip-flop. Also, it is possible to design conditional circuits of great reliability with simplicity comparable to that of unconditional steering by introducing an internal a-c coupling. This technique makes possible the design compromise between simplicity and speed.

Basic Conditional Steering Circuits

The circuit of Fig. 2 was designed to illustrate the reduction to practice of the conditional steering philosophy in its pure form. Its operation is based on a second, or "slave," internal flip-flop serving as the memory element. Base triggering of the "master" flip-flop is conventionally executed by the series by

the parallel inhibit gates (*TR-9, -10, -11* and -12). Without tracing through the details of operation, it is sufficient to note that both the triggering means for the master and slave and the forms of the steering and inhibit gates are negated forms of each other, and therefore the described operation can be achieved by proper cross-connections. Normal acceptance limits appear to be well within the transistor variations permissible for reliable inhibiting. Note that this is dc level triggering with no requirement for rate of change. Because completion of the complementing half-cycle requires release of the slaves, this circuit has been facetiously called the "emancipation circuit." With surface barrier transistors and the values indicated on the diagram, breadboard operation of this circuit was achieved with pulse repetition frequencies of up to 10 mc. Although the great complexity of this circuit limits its use, it is of value as an illustration of the "pure" application of both the direct-coupled circuit techniques and the principle of conditional steering.

The circuit of Fig. 3 illustrates a simplification over Fig. 2 but represents the same principle. Dc storage has been removed as such, and the bottom transistors of the two-element series gates are time shared. This time sharing of the normally off transistors *TR-7* and *TR-8* prevents the memory flip-flop (*TR-3, TR-4*) from conducting except for the trigger pulse duration. The flip-flop still serves the memory function since the state it will assume when triggering is applied is determined by the inverse steering action back through the collector-to-base diodes of *TR-5* and *TR-6* when their emitter circuits are open. This inverse steering action is inhibited by normal transistor operation for the trigger pulse duration so that these transistors serve a dual function.

The circuit of Fig. 3 is still too elegant and complex for practical applications. If the dc storage elements of Fig. 1b are considered the means by which isolation of the dc states of the flip-flop and the

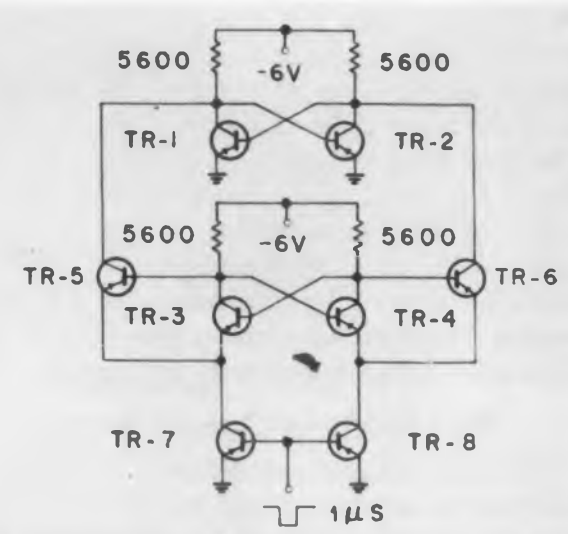


Fig. 3. Simplification of the circuit (shown in **Fig. 2**. Dc storage has been removed and the bottom transistors of the two-element series gates are time shared.

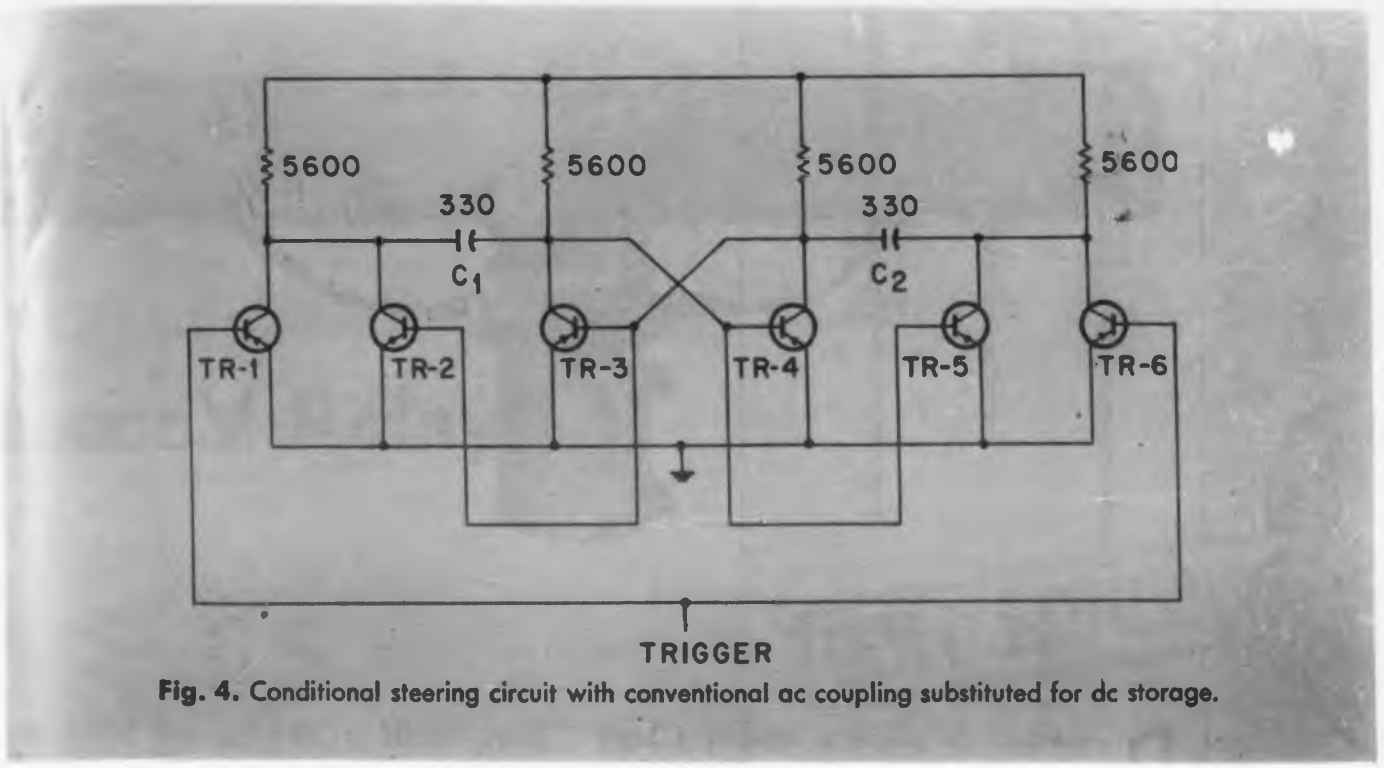


Fig. 4. Conditional steering circuit with conventional ac coupling substituted for dc storage.

steering gates is achieved, then it should be possible to simplify the circuit by substitution of a conventional ac coupling for this storage.

AC Coupled Circuit

The circuit of Fig. 4 illustrates such a substitution. The parallel gates (*TR-1*, *TR-2*, and *TR-5*, *TR-6*) perform the dual function of steering and inhibiting. In general terms, this double function is accomplished by differentiating the edge of the external trigger waveform to provide a trigger pulse for the internal flip-flop, while the same pulse inhibits the change in dc state of the gates. A complete cycle of operation can be described in the following sequence: Assuming the initial flip-flop state to be *TR-4* "on" and *TR-3* "off," then the parallel steering gate *TR-1* and *TR-2* will be nonconducting, which, in this circuit, is the enabled state. The opposite gate, *TR-5*, will be "on" (disabled). The application of a negative trigger pulse cause *TR-1* to bottom, applying the positive charge on capacitor or C_1 to the base of *TR-4*, turning it off. The resulting reversal of state of the internal flip-flop transfers conduction from *TR-5* to *TR-2* but has no effect on the gates' outputs since they are in the bottomed state by the trigger transistors. At the conclusion of the trigger pulse both gates are released to the control of *TR-2* and *TR-5* and assume the states determined by the internal flip-flop. Charging of capacitor C_2 completes the half-cycle. The spurious pulse generated by the recharging is of such a polarity as to have no effect on the flip-flop.

Design Rules For Circuit Using Differentiation Principle

The significant performance characteristics of this circuit (Fig. 4) are: excellent reliability, wide design tolerances and reduced maximum operating frequency. The latter is due to the recharging time of the differentiating capacitors and could be substantially increased through the use of RL differentiation. The restrictions demonstrated by this circuit have been stated as a set of design rules which are necessary and sufficient for the execution of a design based on this differentiation principle. The rules are as follows:

1. The steering gates shall be coupled to the internal flip-flop by means of differentiator (ac coupling).
2. Enabling of the steering gates shall be by direct coupling from the internal flip-flop.
3. The change in the enabling dc supplied to the active steering gate during a flip-flop transition shall be in the same sense (direction) as the external trigger.

This rule has the following corollary:

3*a*. The pulse output from the inactive gate differentiator on the nontriggering edge of the external trigger shall be in the direction to maintain the flip-flop state produced by the triggering edge. Further, if the differentiating is achieved by the capacitive coupling of the outputs of parallel gates to the bases of the internal flip-flop, the following holds:

3*b*. The dc to the steering gates shall be of such polarity that the charge on the inactive gate differentiating capacitor will be zero at rest. (*Part II of this article will appear in the July 1 issue of* ELECTRONIC DESIGN.)

(Based on a paper presented at the IRE-AIEE-U of Pa. Transistor and Solid State Circuits Conference, Philadelphia, Feb. 1957).

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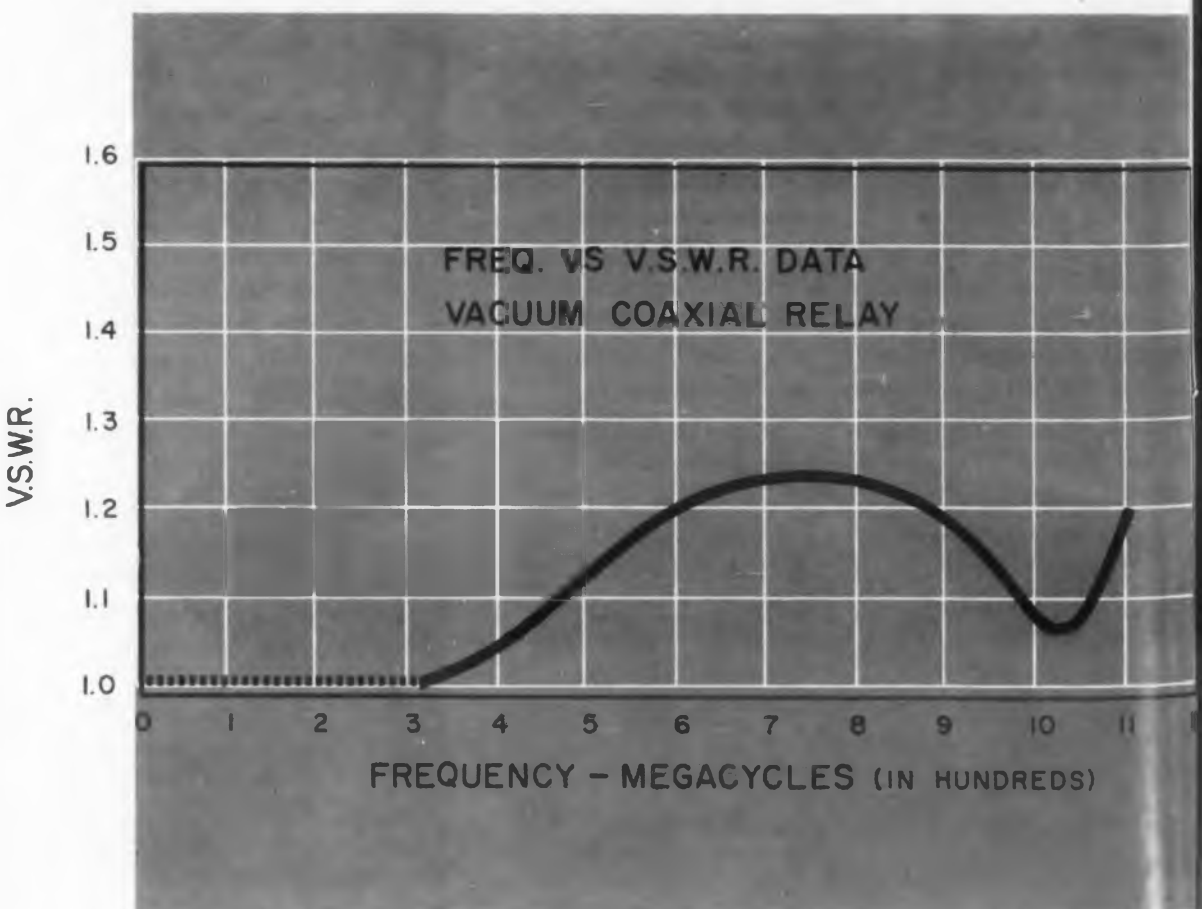
Vacuum C

Developed for the first time is a high power coaxial transmission line switching relay which permits switching under full power when necessary. The design permits its use for television, communications and radar transmitters to 1100 mc.

Some of the outstanding features of this relay are low voltage-standing-wave-ratios at frequencies to 1100 mc as shown in the graph; negligible crosstalk because of a short circuit on the line not being used; evacuation of all contacts surfaces which prevents their corrosion or oxidation; and no damage to contacts when switching "hot", because negligible arcing occurs upon current interruption in the vacuum. The relay described was developed and is manufactured by Jennings Radio Mfg. Corp., 970 McLaughlin Ave., San Jose 8, Calif.



Coaxial Relay

How It Works

The entire center section of the "T" shown in the illustration is thoroughly degassed and evacuated. Motion is transmitted into the vacuum through a copper bellows in each arm of the "T".

The contacts are actuated by air pistons inside the center conductor. They are controlled by an electric solenoid air valve mounted on the outside of the relay. When air pressure is applied to one of the pistons, contact is made with the outer conductor of that line, shorting out the line internally. When air pressure is released, the vacuum inside the relay pulls that contact against the center conductor of the incoming line. The air line to each piston is equipped with a pressure sensitive relay to operate indicator lights.

System Design

The design of this relay is such that using standard parts, it is possible to transpose the incoming line with one of the outgoing lines, so that two different configurations are available to aid in the layout of the switching system.

Specifications

This coaxial relay is designed for 50-ohm transmission lines and has a power rating of 30 kw cw at 200 mc or 20 kw cw at 1000 mc. It is designed to operate from 0-1100 mc with a negligible insertion loss—less than 0.01 db over the entire frequency range. Actuating air power is 25 psi controlled by 115 vac solenoids.

For additional information on this coaxial relay, fill out the Reader's Service Card and Circle 24.

Electronically Modulated Transistorized DC Amplifier

MODULATED entirely by electronic means, this all-transistor dc amplifier has no mechanical chopper to introduce problems of noise, maintenance and wear. The eleven transistor unit provides sufficient gain to drive most galvanometric recorders from millivolt signals. Since no vacuum tubes are used, the unit is reliable, requires no warm-up time, and quickly stabilizes itself. A floating input allows the amplifier to operate from any source resistance.

A unique feature of the Model 301 DC Amplifier manufactured by the Industrial Instrumentation Division of Texas Instruments Inc., 3609 Buffalo Speedway, Houston, Texas, is the all-electronic transistor modulator. This design was chosen to eliminate any mechanical or moving parts for stability and reliability. Fig. 1 is a complete schematic of the modulator which is similar to that described by R. L. Black in AIEE paper 55-156. With PNP transistors a negative potential of about one volt on the base will drive the transistor into conduction. Therefore, with ac excitation on the bases of two transistors they alternatively are conducting and then cut-off. The sensitivity characteristics of this action are shown in Fig. 2. The slight amount of output with no input is due to the equivalent battery of the transistor when in the closed condition.

Since the modulator response is not completely linear, it is necessary to bias it into the linear region. This is done by feeding some of the excitation voltage through the 220 K resistor onto the load. This feedthrough is suppressed by a zero suppression circuit on the output of the amplifier as

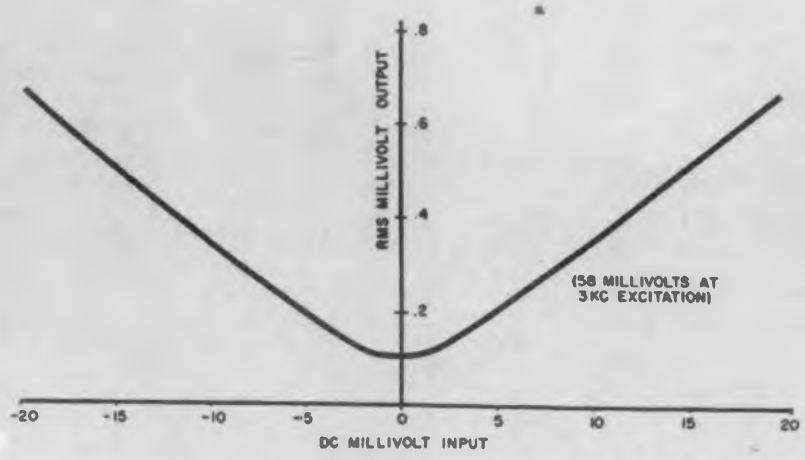


Fig. 2. Characteristic curve of the transistor modulator, showing that a rather sharp null can be obtained and the output is extremely linear beyond a certain point.

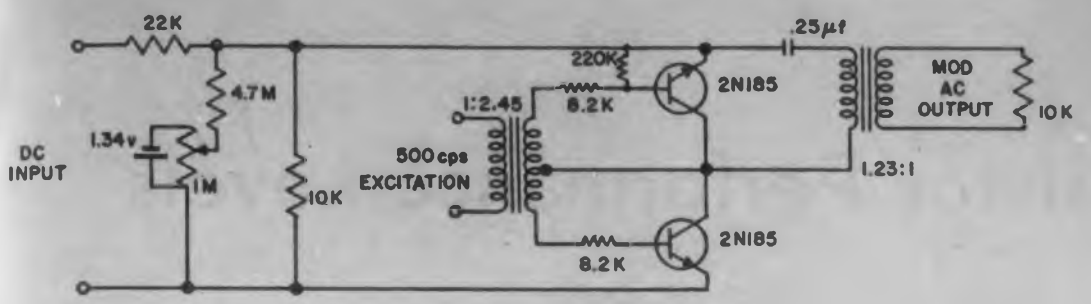


Fig. 1. Complete schematic of the transistor modulator. Since the input signal is in effect the supply voltage for the modulator, the complete output characteristics are shown in Fig. 2.

shown in Fig. 3. For ac input signals this resistance could be switched to a lower value so that an equivalent 0.5 ma signal is fed to the recorder for center-zero operation.

The low saturation resistance of alloyed junction transistors makes the input to the modulator see the output impedance through the closed or conducting transistor. It is desirable to have as high an input impedance as possible for amplifiers of this type, but since the cut-off transistor acts as an equivalent current generator, the modulator output is dependent on input impedance. To eliminate this dependence on input impedance a bucking current generator consisting of a mercury cell and a large resistance is inserted in the input, as in Fig. 1.

Fig. 3 is a block diagram of the amplifier. The dc signal being monitored enters the modulator where it modulates a 500 cps carrier and thence into a high gain ac amplifier. The output of the amplifier is demodulated on the output stage of the ac amplifier. A damping network required to give proper damping for galvanometer recorders is shunted across the ouput. The 500 cps carrier is supplied by a one transistor phase shift oscillator.

The ac amplifier has four stages with the output stage also acting as the demodulator. Temperature compensation is accomplished by a thermistor in the feed-back loop of the amplifier. The supply voltage for the ac amplifier is furnished by a three-transistor regulator which allows for a 40 per cent reduction in battery voltage thus giving a battery life in excess of three hundred hours, besides regulating the ac line voltage.

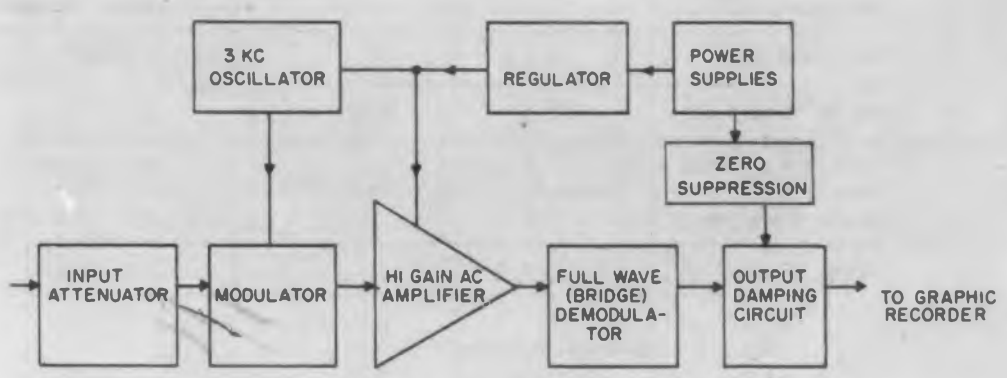


Fig. 3. Block diagram of the dc amplifier. The transistor regulator lengthens battery life to '200 hours or regulates wide fluctuation in ac line voltage.

Resistor Performance Levels

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Fort Monmouth, New Jersey

General purpose resistors are the most commonly used components in electronic equipment. Four U. S. companies alone manufacture over two billion annually. Most of this output is now absorbed by the radio and television industry. However, in the event of complete mobilization, the military demand alone could be twice this number.

The composition resistor, first developed in the early days of radio, has remained basically the same throughout the intervening years. Even today's highly mechanized production systems were in use prior to World War II. While performance levels have remained more or less static over the last decade, Army electronic equipment demands for component stability and reliability have progressively become more rigorous, so that composition resistors today will no longer fulfill all of the requirements for general purpose applications.

Performance characteristics of general purpose composition resistors and of deposited carbon film resistors are quantitatively reviewed in this paper. This review is supplemented by the introduction of a new Signal Corps sponsored development—low cost, pyrolytic film resistors, equivalent in size to present composition types and capable of being mass produced on machinery similar in basic principles to that presently used for composition resistors.

A life analysis of composition and deposited carbon film resistors has been made, based on extensive evaluation consuming millions of resistor hours. Their performance characteristics are compared with the new Army requirements.

Failure Rate Program

The life data are based on 1500 resistors in each of the two classes concerned. The test samples represent 500 each from six manufacturers, three manufacturers for each class. The program is being conducted by Battelle Memorial Institute under a Signal Corps contract. It represents the first of a series to be undertaken. Initially, the study has been confined to 1/2 w resistors of the critical resistance value—the value required to consume full power with maximum permissible voltage applied. This value could well represent the worst condition in connection with load life performance since both maximum voltage and wattage are contributing factors.

All resistors were tested concurrently at an ambient temperature of 70 C. with measurements made very frequently for the first 500 hours and every 500 hours thereafter. Tests have progressed well beyond 5000 hours, but data presented here will not go beyond the 5000 hour measurement. This measurement represents 7,500,000 resistor-hours for each class. All of the resistors included are of the insulated (ceramic solder sealed or molded) variety.

This reliability program stems from the new Army requirements shown in Fig. 1. It is intended that this program will provide a method of accurately predicting failure rates and related control tests.

The 5000 hour performance of the two groups is shown in Fig. 2. Four "open" or "short" circuit failures occurred in each class, three of which, in the deposited carbon class, open circuited at approximately 150 hours. These three units showed erratic operation from the beginning of the test. It is expected that this type of early failure can be readily spotted by the application of rated voltage for a short duration. Abnormal performance of these three units was noted even during the first five hours. The fourth failure occurred after 3000 hours. In the composition class, the first failure occurred in 1500 hours. In Fig. 3, failure rates are given for 1, 2, 5 and 10 per cent deviations from initial value.

Two manufacturers were selected, one for each class, whose resistors exhibited the best life characteristics. Fig. 4 gives a continuous average indication of the number of samples deviating by more than 5 per cent from the initial resistance value. No

CHARACTERISTIC		PRESENT DAY ARMY REQUIREMENTS	MIL-R-11B SPEC LIMITS
MOISTURE RESISTANCE	(MAX ΔR%)	3.0	15
TEMP CYCLING	(MAX ΔR%)	2.0 (-55 TO 175°c)	4 (-55 TO 85°c)
TEMP COEFF OF RES	(PPM / °c)	500 MAX	600 TO 3000
VOLTAGE COEFF OF RES	(% / VOLT)	0.01	0.035
CLOSEST TOLERANCE	(% OF NOMINAL)	5	5
LOAD LIFE	(AVG ΔR% / 1000 HR.)	3 (100°c)	6 (70°c)
STORAGE LIFE	(MAX ΔR% / YR.)	0.5	NO REQ
FAILURE RATE	(MAX % / 1000 HR.)	0.01	NO REQ

Fig. 1 General Purpose Resistor Characteristics and Associated Requirements

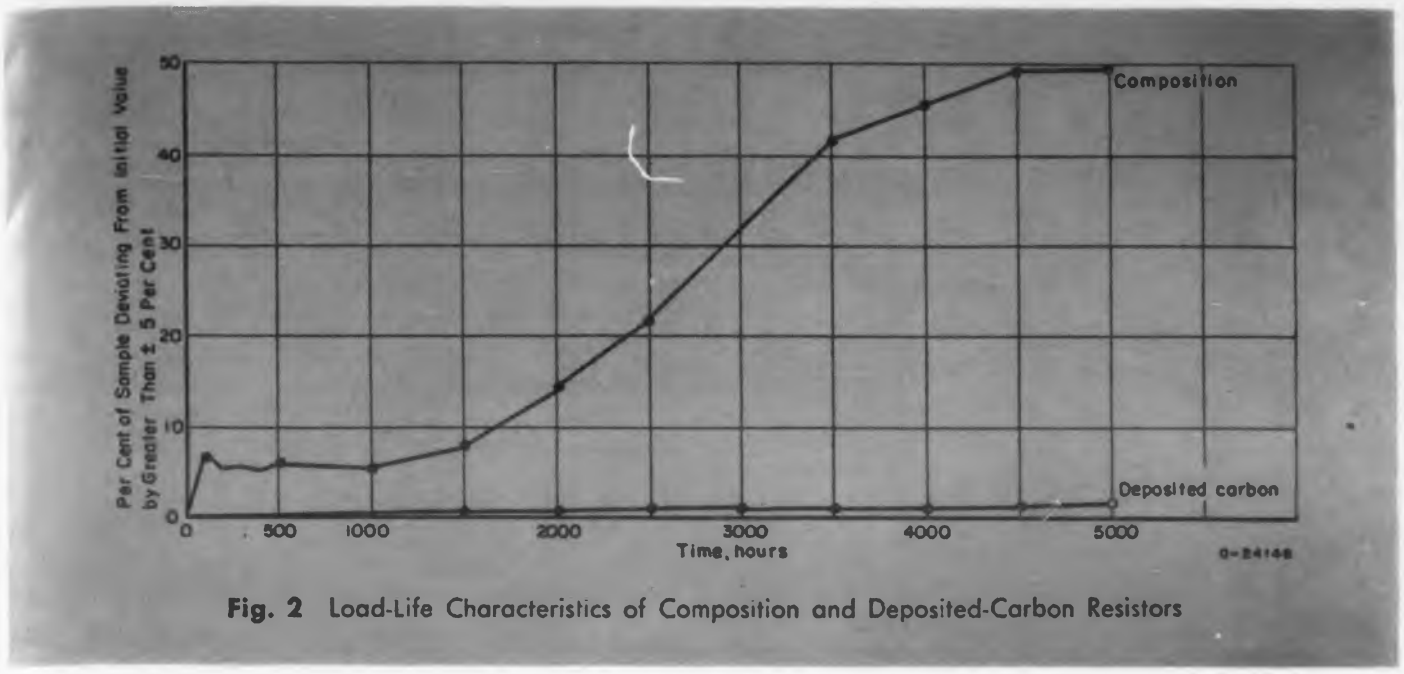

Fig. 2 Load-Life Characteristics of Composition and Deposited-Carbon Resistors

"open" or "short" circuit failures were noted in either case.

Moisture Resistance

One hundred samples from each manufacturer were subjected to a moisture resistance evaluation in accordance with Method 106 of MIL-STD 202, with 50 samples energized and 50 samples polarized. (*Polarizing* involves subjecting the resistor to 100 vdc across the tied together terminals, and the body. This tends to accelerate electrolysis, which sets up corrosion more rapidly if moisture gets to the resistance element.) Twenty cycles, instead of the specified ten cycles, were used as a performance objective. Due to the erratic performance of some groups of these samples, no combined evaluation was attempted. The moisture resistance characteristics of the most stable types from two manufacturers, one for each class, are exhibited in Fig. 5 together with the characteristics of a group of deposited carbon sealed resistors.

PYROLYTIC GENERAL PURPOSE RESISTORS

A new low cost insulated film resistor has been developed by the International Resistance Company under Signal Corps contract. It is being projected as an ultimate replacement for composition

HOURS	CLASS*	CRITERIA OF FAILURE			
		1%	2%	5%	10%
1000	C COMBINED	33.3	33.3	4	0
5000		—	—	10	4
1000	DC COMBINED	14	1	0.6	0.26
5000		1.9	0.46	0.4	0.053
1000	C INDIVIDUAL	0.0	0.0	0.0	0.0
5000		—	—	8	2.6
1000	DC INDIVIDUAL	1.0	0.2	0.0	0
5000		0.2	0.16	0.16	0

Fig. 3. Resistor Failure Rates—Per Cent per 100 Hrs. *Legend: C represents general purpose carbon resistors, *DC* represents deposited carbon film resistors, *Combined* indicates total sample, *Individual* represents the batch from the manufacturer whose resistors exhibited the best life characteristics.

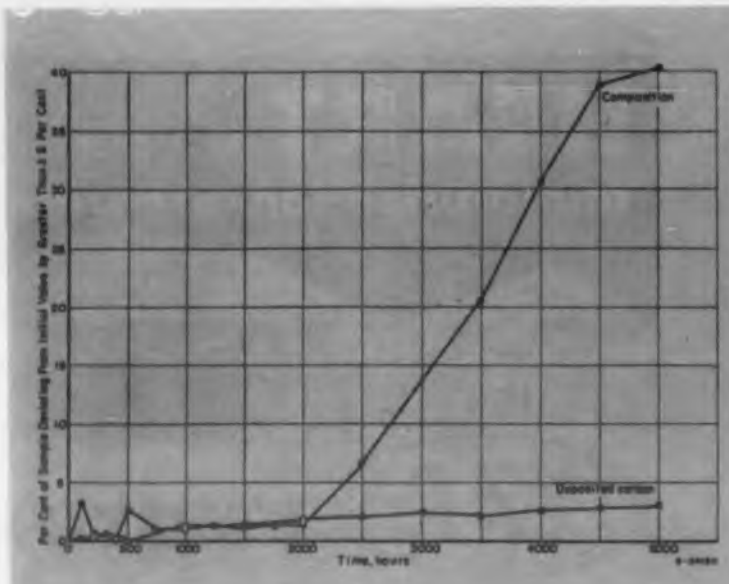

Fig. 4 Load-Life Characteristics For Most Stable Group of Composition and Deposited-Carbon Resistors

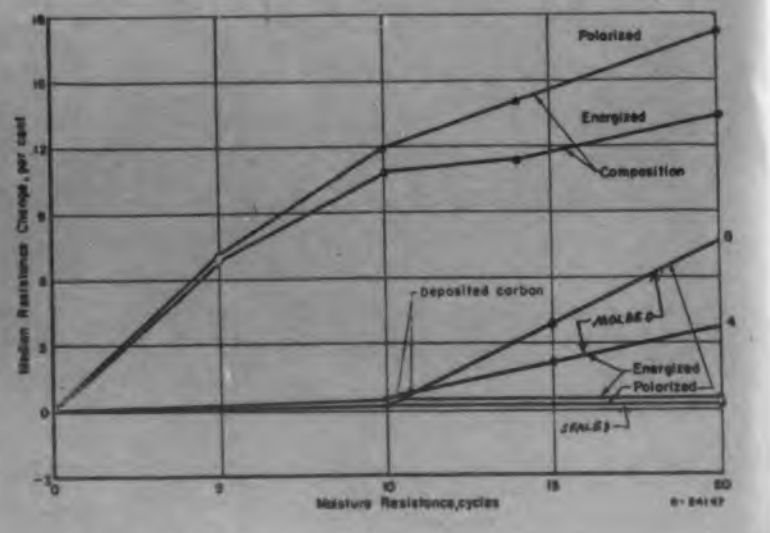

Fig. 5 Moisture-Resistance Characteristics of the Most Stable Group of Composition and Deposited Carbon Resistors

resistors in the production of Army equipment. It demonstrates the possibility of meeting all of the new Army requirements. It will operate continuously in an ambient temperature of 100 C at full rated conditions, in contrast with 70 C for the deposited carbon type. Mass produced cost is expected to be approximately one-third to one-half that of regular molded deposited carbon resistors and about double that of the composition type.

These resistors, having the same physical size as their 1/2, 1, and 2 w composition counterparts, are available in 5 and 10 per cent tolerances. High speed composition resistor equipment, with appropriate modifications, is used in their manufacture instead of the much lower productivity batch system involved in deposited carbon resistor production.

The film is deposited instantaneously in a continuous manner on a high temperature glass instead of prefabricated ceramic rods with the associated, relatively slow deposition process. Resistance spiralling of the new films is performed in a continuous fashion during the early production stage. In conventional deposited carbon resistors, spiralling to range is done on an individual unit basis.

This new process is capable of producing four feet of coated adjusted resistance element per minute. This element is continuously monitored for resistance tolerance and then ultimately cut into two foot lengths for further processing into completed resistors. In the one-half watt size, the length of glass coated element turned out at one end of the equipment is approximately equivalent to 15,000 resistors per hour. Unlike the conventional method of depositing pyrolytic films on prefabricated ceramic rods, this method actually fabricates the substrate as part of the process. Several advantages accrue from this feature in that the substrate surface is uniform and non-contaminated.

The properties and the quality of a film resistor are dependent on the nature of the substrate as well as on the nature of the film itself. The substrate must be chemically neutral and must meet rigid specifications with regard to physical dimensions and surface properties. This new method of fabrication of the substrate as part of the process will consistently meet these specifications. The film deposition takes place immediately following the glass drawing operation. It is accomplished at temperatures in excess of 1000 C, and is completed in a fraction of a second. Depending on the characteristics desired, the deposited film may consist of carbon, metal, or more complex combinations of conductors and semi-conductors. The extreme flexibility of the process, its rapidity, and the large capacity combine to offer a potential of truly unique resistors at low cost.

The characteristics achieved show very substantial gains in performance levels, as indicated in Fig. 6, which shows performance for the three classes of resistors concerned. Military specification limits are shown for the other two classes of resistors as an indication of performance levels. Resistors of the critical value in the deposited carbon class usually exhibit a temperature coefficient

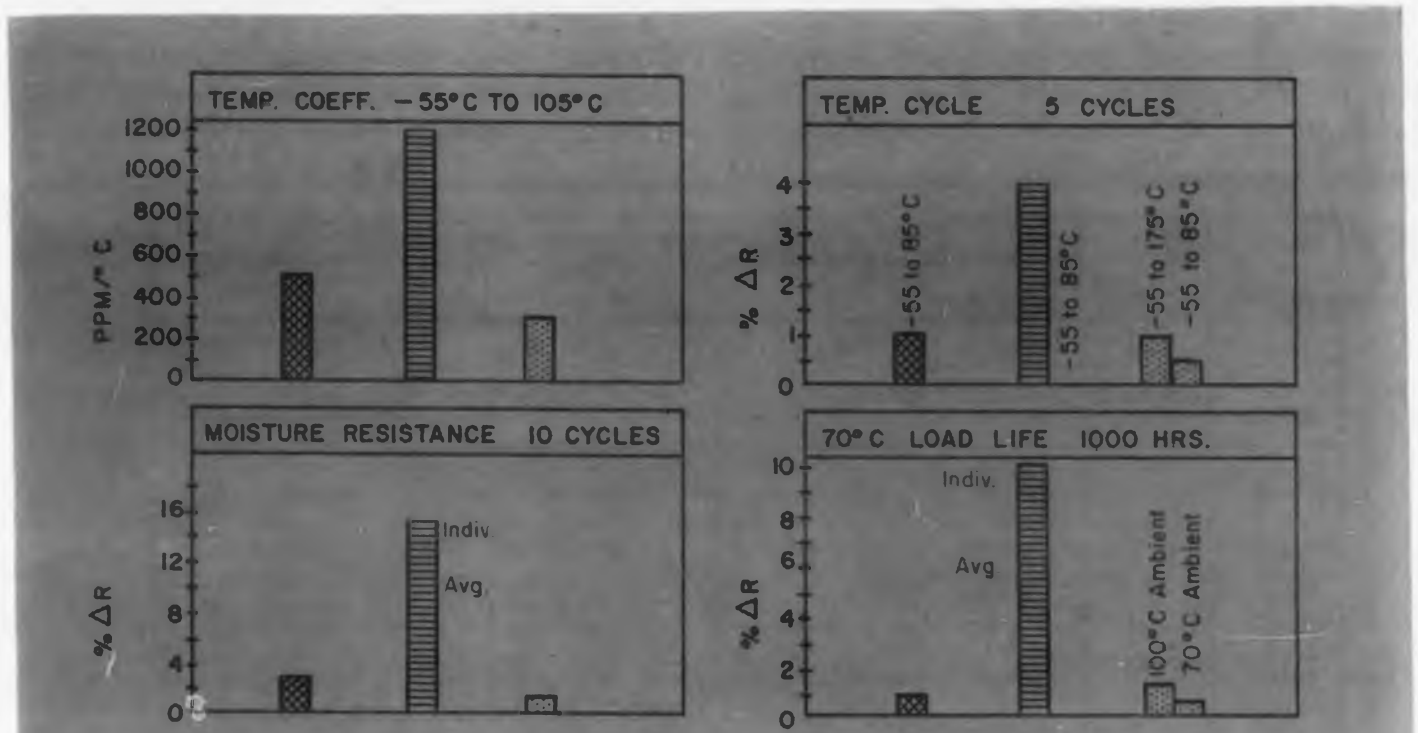

Fig. 6 Performance Characteristics—1/2 w Critical Value

resistance lower than indicated; nevertheless, the specification permits the maximum for all values. The temperature coefficient of deposited carbon resistors and of the new pyrolytic general purpose resistors varies directly with resistance value between the limits of approximately 250 and 500 ppm per deg C.

For composition resistors, the specification requirements are listed in steps. The limit shown in Fig. 6 is the step which includes the one-half watt critical value. Maximum and average limits, where necessary to conform to the specification, are shown on the appropriate bar graphs. Higher upper ambient temperature performance for the pyrolytic general purpose resistors is shown in the temperature cycling test and the load life test.

Since specification limits generally reflect the maximum deviations to be expected, and since these maxima usually occur in the higher resistance values in the moisture resistance test, it is anticipated that the performance levels of the deposited carbon and general purpose pyrolytic resistors will be very close in this characteristic. In view of the size difference, the load life performance of the new resistors might well merit a higher rating.

Future Developments

Additional development work is needed to extend the resistance range of the new pyrolitic resistors. The objective is 10 ohms for the lower limit and 22 meg for the upper limit. At the present time the lower limit appears feasible. The upper limit for all power ratings is still a problem. However, an upper range of 5, 10 and 15 meg for the 1/2, 1 and 2 w units, respectively, appears to be within reach.

A failure rate program has been initiated to determine the reliability level of the new process, the character of failure, the mechanism of failure, and to develop corrective techniques aimed toward a failure rate not to exceed 0.01 per cent per 1000 hours. It is expected that the development phase of the program will be completed within 18 months and the failure rate evaluation phase will have progressed sufficiently to begin the preparation of technical requirements to be incorporated in subsequent procurement data.

References

1. Final Report on Tasks XXXI and XXXIV Signal Corps Contract DA36-039 sc-63136 with Battelle Memorial Institute.
2. Third Quarterly and Final Report on Signal Corps Contract DA36-039 sc-64665 with International Resistance Company.

Acknowledgements

Assistance in the preparation of this paper by the following personnel is gratefully acknowledged:

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Dr. Sidney J. Stein and his staff of the Research Department, International Resistance Company.

This paper was originally delivered at the 1957 IRE convention.

3-D Printed Circuit Laminate

TWO MONTHS AGO ELECTRONIC DESIGN ran an article on "Molded Printed Circuits." The new approach described there may have surprised some of our readers, particularly when existing printed circuit techniques were reasonably reliable and saved money over old-fashioned hook-up wiring and cabling. But, depending upon the application, some methods and materials are better than others. Also, improved materials and methods are constantly being explored. Described here is the first commercially available "3-D" laminated printed-circuit board. Unfortunately, the illustrations show only two-dimensional molded laminate; but, the shape of the cured board depends upon the shape of the preform and the dies used in the compression-molding press where the pre-formed laminate is cured.

The process described and illustrated here was developed by Rogers Corp. of Rogers, Conn. In a number of ways it is similar to the molded printed circuits described in ED, April 1, p. 40. Its advantage is that the basic material is a laminate with excellent flexural and impact strength.

The printed wiring is die blanked and molded into a laminated base board of any selected NEMA grade using only standard stamping and compression molding machines. No chemical etching is required and no copper is wasted in the process. The copper scrap from the blanking can be reused. Inserts can readily be installed during molding. The copper circuitry can be either depressed below or raised above the surface of the board, as desired. Tooling is relatively simple and inexpensive. And, it is quickly available. Typical cost is $1,000 for the stamping dies and $1,000 for the molding dies plus a product cost of about 1-1/4¢ per sq in. of XXXP grade laminate. Production can be underway within 60 days from receipt of printed-wiring drawings.

The Rogers Corporation has developed their own base laminate material—a cellulose fibre sheet—which meets NEMA XXXP specifications but is superior in a number of characteristics. The table gives the comparison of their RM 2035 base laminate and NEMA specification values.

As with the molded circuitry previously described in ELECTRONIC DESIGN, two-sided printed circuitry is possible. Also an epoxy resin film insulation over otherwise exposed wiring can be molded in and cured along with the base board. This improves the electrical properties of the board in addition to preventing shorts.

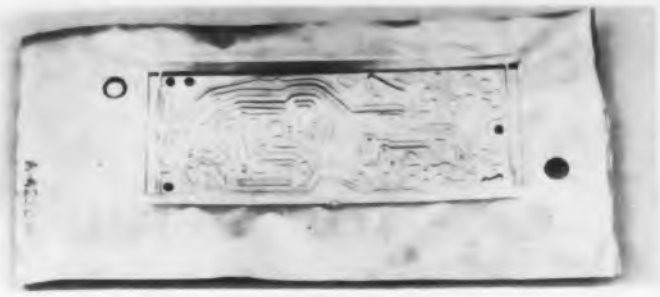
Advantages

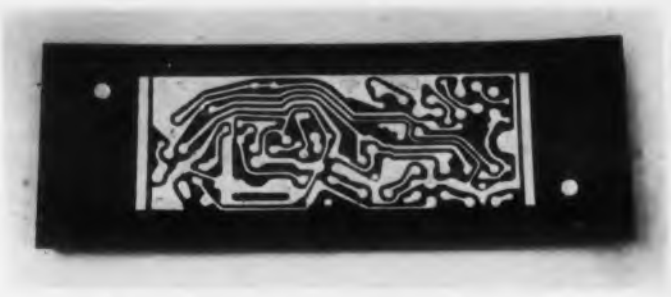
Some advantages of molded laminate printed wiring over conventional punched boards are:

- Increased thickness at mounting corners, insulation barriers, or other third dimensional effects can be incorporated in the design of the part.
- The molded board may be tapered in thickness.
- Reinforcing ribs may be added to strengthen thin sections, thereby saving material.
- Holes from approximately .030 in. diam can be molded into any thickness base.
- The holes may be tapered or stepped in depth allowing more flexibility in the design of mechanized assembly systems.
- Molding results in the formation of a resin skin sealing all edges, hole-walls etc., thereby reducing moisture absorption.
- Terminal pins and other hardware can be molded into the board, eliminating subsequent mounting and staking operations.
- Individual preforms of the uncured laminate can be molded together to form a single homogeneous part.
- Molded holes concentration can be twice that permissible in a punched XXXP part.
- Angles, channels, or other self-supporting forms may be readily molded.

Although the method of fabricating printed wiring boards at Rogers Corporation involves blanked-out copper circuitry, at least one other company has been licensed to use the process and can furnish etched or electroplated circuitry on the molded base laminate. The process is flexible and can be adapted to the needs of the user. Where electrodeposited circuitry may be desirable for low-current low-resistance circuits, die blanked circuitry can be heavy enough to handle electrical appliance loads of 70 amp or greater.

For additional information regarding this development, fill out the Readers' Service Card and circle 375.





Two steps in making printed circuits are shown. Copper is first punched into the molding board and then excess copper is stripped away. Later the board is cured in a compression mold.

Comparison—RM 2035 Molded Cellulose Fibre Laminate and NEMA XXXP Grade

Properties	NEMA XXXP Specification	RM 2035
Density, Gms/cc	1.30	1.32
Heat Distortion Temp Min. Deg F		300
Water Absorption Per Cent	1.00	0.35
Flexural Strength, Flatwise		
Machine Direction	12,000	24,000
Cross Machine	10,500	17,000
Impact Strength, Edgewise, ft-lb/in.		
Machine Direction	0.35	0.65
Cross Machine	0.30	0.45
Bonding Strength, lb		1,360
Resistance to Hot Solder (30 sec at 250 C) 1 x 1 x 1/16 in.—1 oz cu Clad One Side	Blisters	Does Not Blister
Abrasion Resistance Weight Loss, Grams	0.160	0.045
Dielectric Constant, 10^6 Cycles	4.60	4.40
Power Factor, 10^6 Cycles	0.030	0.027
Dielectric Breakdown, Parallel,		
Step by step, KV	60	100
Dielectric Strength, Perpendicular, Step by step, volts/mil	450	750
Insulation Resistance, mgh	20,000	20,000
Volume Resistivity, mgh/	—	33,000 M
CM^3	—	3,500 M
Surface Resistiivty, mgh	—	800,000
		200,000
Arc Resistance, Sec.	< 5	70

Typical properties of molded sheet under average typical conditions: pre-conditioning and after-baking recommended for best electrical properties.

These ideas emerged long ago to provide a basis for commercial transactions in the buying and selling of goods, real estate, construction of buildings, monuments and the like. The graduated stone cubit, used by the Egyptians, is a tangible example of this idea. The idea of agreed-upon units, works for those who agree to use the units. Such agreements can be local, as they were in early times, or they may become national or international as they are today. The point to note is that the unit is useful only within the group that makes its measurements in terms of it.

When commerce takes place between groups having different units and standards, great difficulty arises until the relationship between differing units has been worked out. This often leads to conversion factors and confusion. There is, therefore, a natural and worthwhile tendency to extend the scope of application of a few widely agreed-upon units and standards. Today, there is international agreement in the use of the meter, kilogram, and second. It is not enough to have the names of these units alike. The unit must be the same whenever used and the standards in which the unit finds expression must be the same.

Each discovery of science which leads to concepts of some new quantity which must be measured leads to a need for a new unit and along with it a new standard. Historical examples are development of the concepts of electric current, voltage or resistance; more recently—attenuation, molecular and atomic cross-section. In some cases, only an extension of an already used unit, such as the erg to the electron volt, is required. In other cases, new units such as the poise, or the calorie are defined.

As our knowledge increases, it is necessary to make our units and standards form a consistent set and to remove the strait jacket of disciplinary or specialized compartments from the realm of science. This is another important function of the national standardizing laboratories and the international committees through which they operate. All units are referred to the primary units of mass, length, and time as rapidly as knowledge and art permit.

Since the whole scheme of using units has an essential arbitrariness, at least one unit arbitrarily established is required to set the scale for all. But no more than one arbitrary unit is needed. Why we elect to use three is a matter of historical accident and subsequent convenience.

Basic Standards for Science

INSTRUMENTATION is measurement in action. For effective measurement, there must be some parameter to be measured by the instrument and some agreed-upon units in which the measurement is to be expressed. Standards represent the physical realization of the agreed-upon units and are established as a basis for instrument calibration.

Role of Standards

Once one sets out to measure something it is first necessary to agree upon a unit (foot, inch, pound, degree, electron volt, etc.) in which to express the result. It is next necessary to give this unit physical realization in the form of a standard against which measuring devices can be calibrated.

Precision Required

In commerce the need for precision is not great. In mass production, another aspect of measurement comes into a position of great importance—interchangeability of parts. The devices made today are complex in structure and have many parts which must fit together functionally. They are made in scattered factories and brought together for assembly. Each part is made to meet specifications and measured to see that it is within tolerances.

The product of our research and engineering laboratories is often information rather than devices. If there is to be effective exchange of data between all laboratories, the information must be interchangeable. It is thus necessary that all collaborating laboratories use the same units and refer to the same standards. The need for national and international standardizing laboratories also become clear, as does their basic functions: the maintenance of standards and their dissemination through the calibration of instruments used by industrial producers, scientists and engineers.

There are thus three roles of standards: to provide a consistent basis for the interchange of commodities in commerce; to provide the measurement framework for making interchangeable parts needed in mass production; and to provide the measurement framework that permits information

and Industry

R. D. Huntoon
Assoc. Director
National Bureau of Standards
Washington, D. C.

to be interchangeable among research and engineering laboratories.

As the application of mass production technique is extended and as research continues, the need for more and more refined measurement increases. It is, therefore, the latter two roles of standards that bring about the demand for improved standards, improved instruments, and, in some cases, for even more precise and refined definitions of the basic units themselves. Two fundamental units—length and time—are now in process of redefinition. Others will undoubtedly follow.

Consistency

As scientific understanding advances; and as unifying laws, such as the relationship between mechanical and thermal energy are discovered, there become relations between the units which were only arbitrarily defined originally. It then becomes necessary to have the units so defined as to become consistent with one another. This insures that identical physical quantities are the same when determined in the different branches of science. Once there were three units of energy—mechanical, thermal, and electrical. The thermal unit has been made consistent with the mechanical unit through the determination of the mechanical equivalent of heat. In 1950 the units of current and resistance were redefined in terms of mechanical measurements so that the electric watt and the mechanical watt are identical in magnitude. To do so, it was necessary to drop the arbitrary units: the international ampere and the international ohm.

Physical Constants as Secondary Standards

It is desirable to have standard units defined in terms of some constant reproducible properties of nature such as the size of the earth, the period of its rotation, or the length of a wave of light, rather than in terms of the length of some particular piece of metal or weight of a particular piece of platinum. If the original metal were lost, it could never be reproduced. The present metric system is based

upon an unsuccessful attempt to establish standards based upon the properties of nature. Since the initial measurements were faulty, only arbitrary standards resulted and not independently reproducible ones.

Science is concerned with the measurement of the properties of nature. These are characteristic of the particular science and not of the units arbitrarily agreed upon for making the measurement. Out of the measurements come the determinations of physical constants such as the velocity of light, the charge of the electron, Avogadro's number, the mass of the proton, the boiling point of water, the density of mercury and the like, all of which are expressed in terms of our arbitrarily chosen units. Measurements of most of these are complicated by phenomena of nature. For example, the boiling point of water depends upon the adjustment of a number of other measurable parameters, such as atmospheric pressure and contamination, and do not represent the measurement of a single characteristic, but rather the measurement of a particular property when other observables are specified.

The measurement of the physical constants, such as the velocity of light *in vacuo*, or the mass of the proton, or the Faraday, which do not represent properties requiring the specification of values of other observables, lead to uniquely specifiable answers. These can be measured with more or less accuracy as the case may be, but it is expected that in all places at all times the same answer would be obtained within the experimental uncertainty.

Each of these measurements gives a determination of a natural or physical constant in terms of our arbitrary units and standards and serves to lock them (units and standards) into the phenomena of science. Once one of these constants is precisely and accurately determined in terms of our units and standards, it can itself be used subsequently as a standard for other measurements in its related fields. Or this physical constant can be used by reversing the chain of measurement to reproduce the arbitrary standards.

These physical constants form a grid of secondary standards located conveniently throughout the fields of science. They can be used at will to serve for standards of reference for the calibration of instruments. One outstanding example is the determination of the gyromagnetic ratio of the proton. It was carefully determined at N.B.S. in 1949, and has subsequently been used for the direct measurement of magnetic fields and for the calibration of devices for measuring magnetic fields ever since.

Thus, it becomes apparent that the determination of physical constants becomes one of the most effective ways of disseminating the units and standards on a consistent reproducible basis to all fields.

From Standards to Physical Constants

The chain of measurement stems from the national primary of standards of mass, length and time to some of the important physical constants.

Meter Will Be Redefined

The unit of length is the meter. It was originally defined to be $1/10^7$ of the quadrant of the circumference of the earth from equator to pole. Actually the measurement was in error. Thus, the standard established to reflect the defined unit does not exactly do so. The unit is now the distance between the marks on the bar which forms the physical standard. The N.B.S. has a group of 10 meter bars; one of these, No. 27, is our National standard and has been compared with the international standard in Sèvres, France several times. Such comparisons can be made with a probable error of about 3 parts in 100 million, i.e., to about 1 millionth of an inch.

This precision is obtained for measurements of line standards which are very nearly alike. Degradations in accuracy arise when lesser or greater lengths are to be determined from it, being, for example, about 3 in 10^5 for one millimeter.

Today this standard is not good enough to meet the needs of industry and of research laboratories. Electronic techniques are being developed which may increase the precision by an order of magnitude. However, as the accuracy requirements continue to increase, questions about the stability of the meter bar itself arise, i.e., as to its constancy of length. There are now extensive plans and experimental work leading toward a redefinition of the meter in terms of the length of certain wavelengths of light. The particular one to be selected will presumably be settled in 1960.

The meter has been compared with the wavelength of red Cadmium light a number of times since 1890 with a precision of about 1 in 10^7. No significant differences to indicate a change in its length have been observed. The objective of the redefinition of the unit is to get a unit of length which is defined with an accuracy of the order of 1 in 10^9 or 10^{10} and to be able to make measurements in terms of this unit with similar precision. There need be no alarm about the new unit causing adjustments. It will be so defined that existing measurements with presently achievable precision will be no different than before.

Mass Standard Is OK

The unit of mass, the kilogram, was defined to be the mass of one cubic decimeter of water under standard specified conditions. A platinum cylinder was established as a standard to represent this unit. Unfortunately, there were troublesome errors here also so that the unit was changed from its basic definition to be the mass of this particular cylinder.

The N.B.S. has a group of standard kilograms of which Kg No. 20 is our national standard and has been compared with the international standard a number of times. The probable error of such comparisons is about 5 in 10^9, i.e., about 5 millionths of one gram or about the mass of one day's growth of one whisker of the average human male.

This precision and accuracy seems to meet today's needs quite adequately. No direct physical constant of mass has appeared which could be used as a standard of mass and there is no plan at present to change the definition of the unit.

Time Definition More Accurate Than Measurement

Responsibility for determination of time in the United States is assumed by the U.S. Naval Observatory. The National Bureau of Standards maintains the standard of frequency which is continuously checked with astronomical time, and broadcast in the standard frequency bands by radio stations WWV near Washington and WWVH in Hawaii with guaranteed accuracy of 1 in 10^8. Corrections to the broadcast frequencies are later published making them accurate with a probable error of 1 in 10^9 (1 sec. in 30 years).

The second to time is unique among standards. Until recently, it was defined as a certain part (1/86,400) of mean solar day. Since the average rotational speed of the earth may vary by almost 1 in 10^7, the second of mean solar time did not represent an invariable standard. Even within one year, seasonal changes in the sidereal rotation of the earth amount to ± 1 in 10^8. Although this seasonal fluctuation has behaved rather regularly for the last few years, no great assurance is felt that it will continue to be regular in the future, or that irregular changes in the rotational speed, which have occurred in the past, will not occur again.

On the other hand, the orbital motion of the earth about the sun, and that of the moon about the earth, behave more regularly and furnish a basis for uniform time, called Ephemeris Time. For this reason the General Assembly of the International Astronomical Union adopted at Dublin in 1955 a definition of the second as a certain part (1/32,556,-925.975) of the tropical year 1900.0. This number precisely defines the second which is identical with the second of Ephemeris Time.

Using a group of carefully controlled crystal clocks for interpolation and nightly observation of the stars with a photographic zenith telescope, an accurate scale of relatively uniform time (UT2) may be established. This scale is based on the average sidereal rotational speed of the earth. During a year of observation, this scale was established by the Naval Observatory with an accuracy of about 1 in 10^9 in terms of the average speed of the earth and checked against atomic frequency standards.

Relating the rotation of the earth to the relatively uniform scale of time is accomplished by assuming that the rates of the crystal clocks are monotonic functions of time and any periodic differences between star time and clock time are due to seasonal changes in the earth's rotational speed. Monotonic

changes in the earth's rotational speed would not be detected by this means but would be interpreted as a change in rate of the clocks. It is this smoothed standard of time, called universal time (UT2), which is currently broadcast by the naval radio stations of the United States and the National Bureau of Standards stations WWV and WWVH.

To divide up this universal time scale into seconds as defined by the tropical year 1900.0, an extended series of observations on the moon is required. Data on the relative motions of the sun, moon, and earth compiled by astronomers for many centuries are also used. With data from additional moon observations from 20 cameras planned for the International Geophysical Year 1957-58, it is hoped to determine the length of the second of Ephemeris Time in terms of our present universal time standard with a probable error in accuracy of about 1 in 10^9. Thus, *the second of time is defined more precisely than it is possible in the present state of the art to measure it.*

During recent years, measurements have been made on the frequency associated with low-energy transitions of atoms and molecules in accordance with the relationship of $E = h\nu$. One of the most useful of these for time measurements is the transition in the cesium atom involving the reversal of spin of a single electron which gives rise to the hyperfine structure of its optical spectra. The frequency associated with this transition has been measured by the National Bureau of Standards (9,192.632 mc) and more recently with greater precision by the (British) National Physical Laboratory (9,192.63183 mc). At the present time, the precision with which the characteristic frequency of this atomic transition can be measured, appears to be better than the precision with which the average rotational speed of the earth can be measured over a one year period, and somewhat better than the accuracy with which the newly defined standard second can now be determined.

The standard of time is in a unique position at the present time. There is a demand for the definition of the unit in two ways: one in terms of the tropical year; and one in terms of the frequency associated with a transition in a cesium atom. There is even talk of having both, one for the physical measurements and another for the civil purposes.

This is the first part of a two-part article based on a talk given by Dr. R. D. Huntoon at the Instrumentation and Control in the Process Industries Conference in Chicago, Feb. 6, 1957, under sponsorship of Armour Research Foundation of Illinois Institute of Technology. The second part will consider derived standards, precise physical constants, and fundamental physical constants. It will also include a bibliography.

MICROWAVE PROGRESS

Signal Sources and Receivers

What a tankful of gasoline is to the automobile, the klystron tube is to the microwave system—a reliable and efficient power source.

Internal and external cavity type klystrons are used in PRD microwave oscillators. Both types belong to the reflex klystron group which is usually preferred because it provides easy tuning over a relatively wide frequency range and easy frequency or amplitude modulation.

The coaxial cavity is most often used for broadband oscillators since its principal mode is the TEM. This permits greater frequency coverage than either the TE or TM modes of rectangular waveguide sections.

PRD's line of signal sources is conveniently operated through the use of PRD Klystron Power Supplies. Electronically regulated beam, grid, and reflector voltages provide extremely stable klystron output signals.

A spectrum analyzer is a special type of self-contained receiver. It presents an instantaneous display of the power spectrum of the input r-f pulse on an oscilloscope screen. Basically, it is a superheterodyne receiver with a frequency modulated local oscillator.

While the analyzer delivers an accurate envelope of the pulse frequency spectrum, it does not necessarily display each frequency component, since the frequency separation between adjacent spectral lines on the screen is a function of the local oscillator sweep rate, f_s, as well as the PRF, f_R. Actually, the number of lines produced on the screen is f_R/f_s. By varying f_s, the operator can control the spectrum detail presented.

Data such as that contained in the foregoing paragraphs are available in our PRD Reports. Published periodically, these reports give practical information on virtually every aspect of microwave research and engineering. Mathematical derivations, graphs, and charts are always included. If you'd like to receive these reports (there's no charge of course), we'll be happy to add your name to our mailing list. Please address your request to: Reports Dept. R-6.

PRD Klystron Power Supply for low and medium voltage klystron tubes

Three Protective Devices Prevent Klystron Burn-out!

Another first from PRD. A compact, easily transportable klystron power supply that provides: a protective diode to safeguard the reflector against turning more positive than the cathode; a fuse in the klystron cathode return to protect the beam supply; and a "Beam Off" position to allow for warming up of the klystron filament.

A special feature of Type 809 Klystron Power Supply eliminates readjustments when changing from cw to square wave modulation. The top of the square wave is automatically clamped to the previously chosen reflector voltage.

With good stability and regulation, and with square wave and saw tooth modulation plus provision for external modulation, Type 809 Klystron Power Supply is equally at home in the laboratory or on the production line.

SPECIFICATIONS

	Type	Voltage (volts)	Current (milliamperes)	Additional Specifications
Output	Beam	Continuously variable 250 to 600	0 to 65	Ripple: < 5mv RMS
	Reflector	Continuously variable 0 to −900	50 μa max.	Ripple: < 10mv RMS
	Filament	6.3	2 amperes	±3% center tapped

	Type	Frequency Range (cps)	Nominal Voltage (volts)	Rise	Decay Time (microseconds)	
Modulation	Square Wave	400 to 2000	0 to 90	<10	<10	Clamping circuit maintains top of square wave within 2 V of cw reflector voltage.
	Saw Tooth	60 (fixed)	0 to 125			

Price—$350 f.o.b. Brooklyn, N.Y.

For additional details on PRD 809 Klystron Power Supply, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. TIG-6.

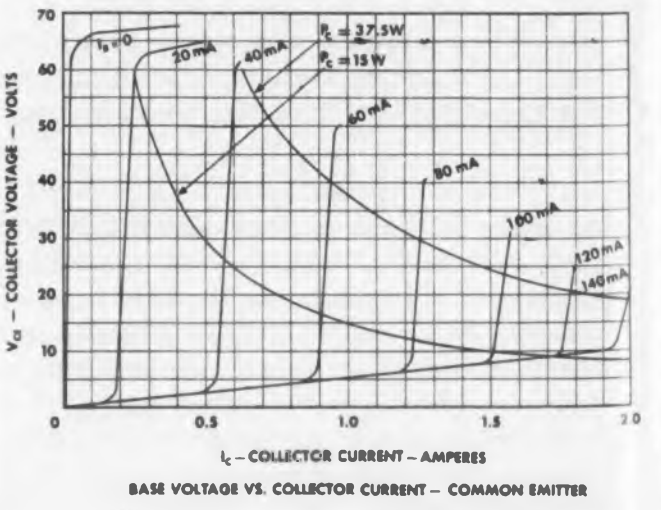
Polytechnic Research and Development Co., Inc.

202 Tillary Street • Brooklyn 1, N. Y. • Tel: UL 2-6800

Cable Address: MICROWAVE, NEW YORK

CIRCLE 34 ON READER-SERVICE CARD FOR MORE INFORMATION

High Power Silicon Transistor



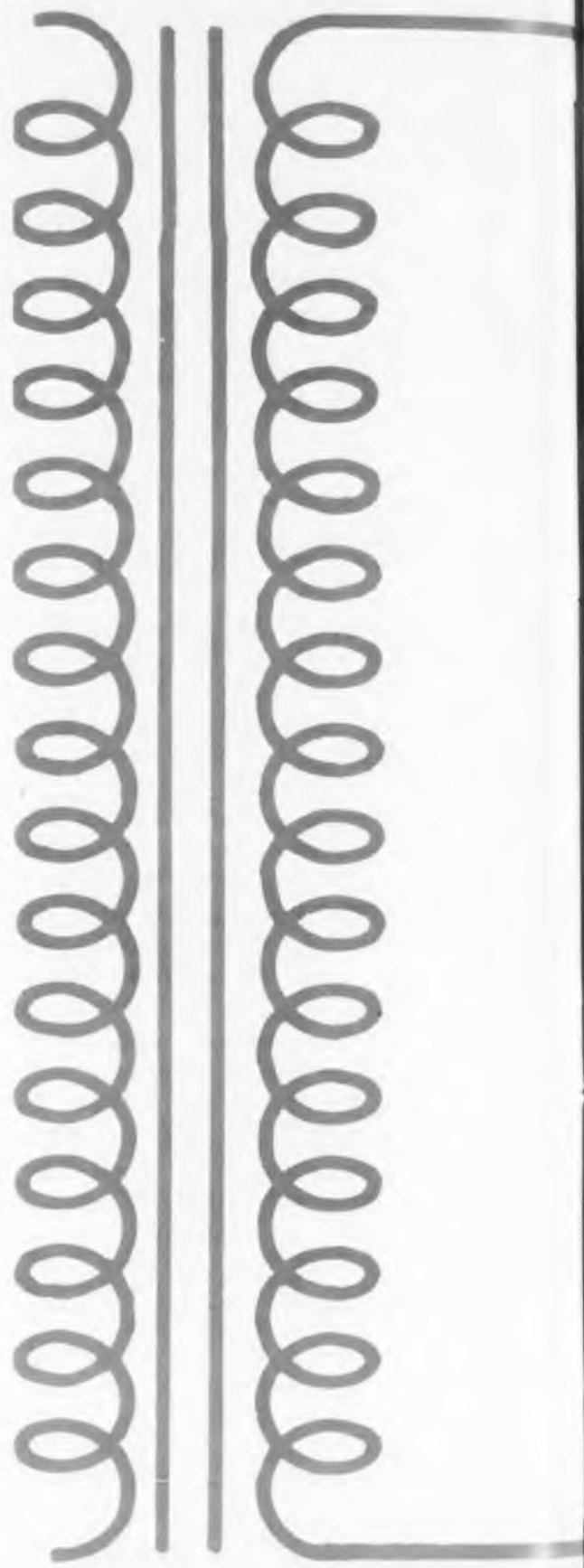
A RATED power dissipation of 37.5 w at 25 C and 15 w at 100 C makes this diffused junction silicon transistor applicable to transistorized servo and audio output systems. The 2N389 can also operate as a power amplifier at frequencies up to 5 mc, although its probable application will be in power supply voltage regulators and servo amplifiers.

Developed by Texas Instruments Inc., 6000 Lemmon Ave., Dallas, Texas, the 2N389 has an operating temperature range from −65 C to +150 C, which makes it useful for extreme environmental circuitry such as guided missile and geophysical applications. For high-power reliability the 2N389 is projection welded in a metal case designed to meet the requirements of MIL-T-19500. It can deliver 15 watts of audio power with less than 10 per cent distortion at 100 C, or 9 watts at 1 mc with a beta of 10 measured at 0.3 amps collector current, grounded emitter configuration.

With a 2 amp collector current, the 2N389 features a maximum saturation resistance of six ohms, a low figure for silicon power transistors. When used in aircraft applications, a 60 v collector-to-emitter rating allows power to be taken directly from the 28 v supplies used by military aircraft. Maximum base-to-emitter voltage is −2 v, collector current is 2 amp, and base current is 0.5 amp. This transistor combines high levels of gain and frequency with the stability and reliability of a silicon device.

FOR MORE INFORMATION CIRCLE 36

Transformer Design



Nomograph—IV

Martin Berger
Minitran Corp.
[illegible] Oliver Street
Newark, N. J.

This is the fourth of a series of five transformer design nomographs appearing in Electronic Design. Calculations of wire size and mean turn lengths, as well as the necessity to refer to resistance charts, can be eliminated in the preliminary design of transformers by using this nomograph. For known core sizes, it gives the resistance of windings versus turns without reference to wire size.

This chart is calibrated to two types of winding—random on bobbins, and layer winding with normally encountered insulation between each layer. It is further subdivided to distinguish between windings occupying the full window of a core and windings occupying only a half-window.

Examples of Use

Two examples of how the nomograph can be used are as follows:

Example 1. *What is the resistance of a transformer secondary consisting of 400 turns on an EE-24-25 core and occupying the outside half of the window space? The coil is random wound on a bobbin.*

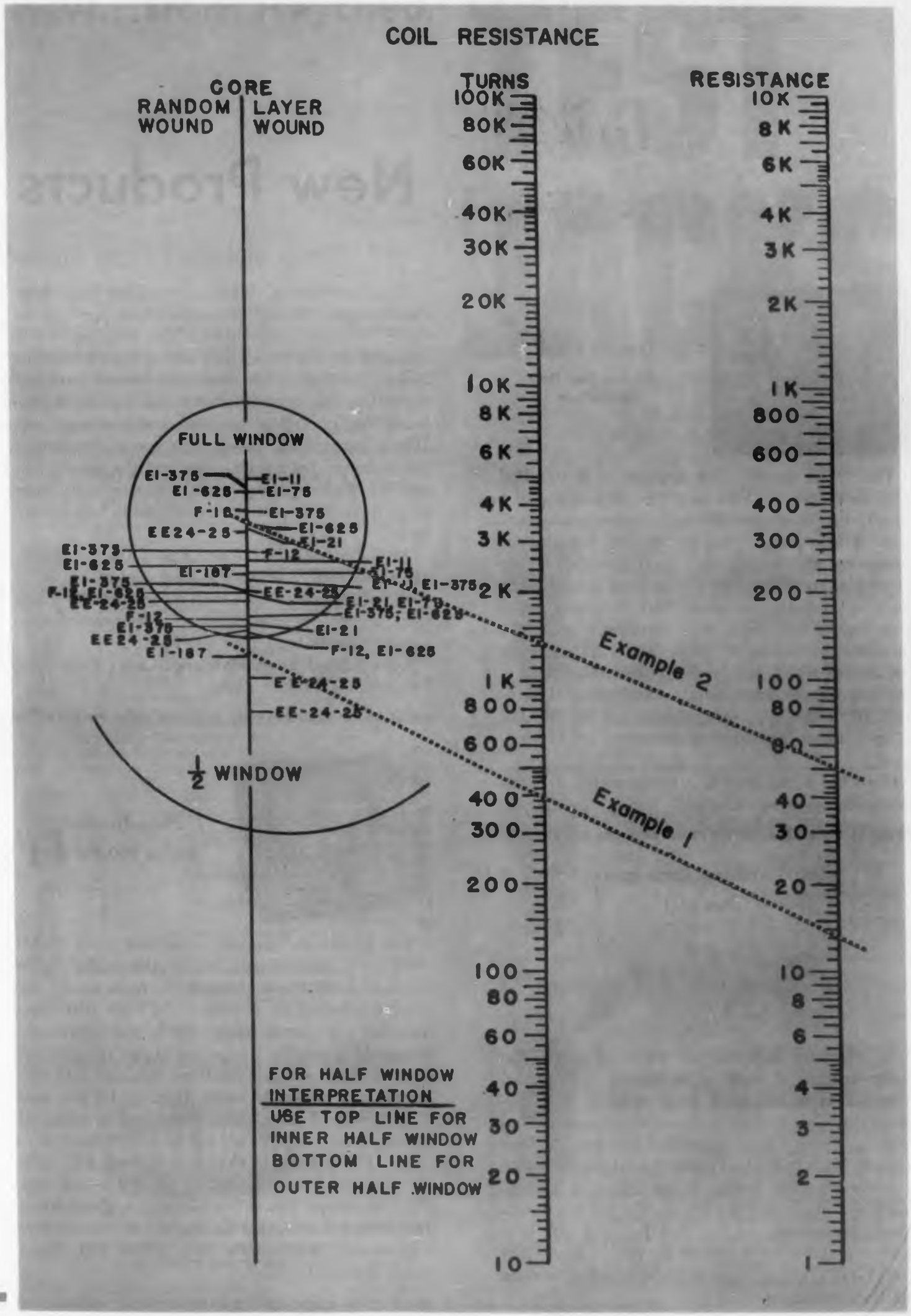
Drawing a straight line from the lower EE-24-25 mark in the 1/2 window grouping on the "Core—Random Wound" scale through 400 on the "Turns" scale gives an answer of about 14 ohms resistance on the "Resistance" scale.

Example 2. *A choke is to have a dc resistance of not more than 50 ohms. Check an EI-625 core for the permissible number of turns. The choke will be layer wound.*

Drawing a line from EI-625 in the "full window" circle of the "Core—Layer Wound" scale to 50 ohms on the "Resistance" scale gives an answer of 1200 turns from the "Turns" scale.

For other fractions of full window space, the chart can also be used. For instance: Suppose in *Example 2* the 1200 turns were to occupy only 1/3 the window area. The procedure is as follows:

Multiply the 1200 turns by the reciprocal of 1/3; i.e. $3 \times 1200 = 3600$ turns. Drawing a straight line from the previous EI-625 mark through 3600 turns crosses the resistance scale at 430 ohms. This value is then multiplied by the original fraction to give the corrected resistance; i.e., 430/3=143 ohms.



New Products

Quartz Clock

.01 Sec Per Day Accuracy

The B-288 quartz clock consists of 6 standard units mounted on slides in a case measuring 18 x 18 x 15 in. A high precision chronometer, rate variation is less than .01 sec per day. It is useful for measuring and testing very short periods of time as well as for timekeeping over long periods. The clock is unaffected by accidental variations in the main supply. As a frequency standard, it generates standard frequencies of 100 kc, 10 kc, 1 kc, 200 cps and 50 cps which can be distributed throughout a building without intermediate amplification. Due to high phase-stability, the accuracy of the 50 and 60 cps outputs is as good as that of the 100 kc oscillator.

Ebauches S. A., Dept ED, Oscilloquartz Department, Neuchatel, Switzerland.

CIRCLE 38 ON READER-SERVICE CARD FOR MORE INFORMATION

High-Altitude Connectors

Teflon Seal

Designed for high-altitude flight operation, the design feature of these connectors is a staggered construction which gives long creepage path between pins despite small connector dimensions. The body is of aluminum, anodized for corrosion resistance. Each individual pin of the mated connector is surrounded by Teflon. Series 100 is a square-flange receptacle, 1-1/4 x 5/8 in.; the 200 is a panel-mount receptacle, 1-1/2 x 3/4 in.; and 300 is a cord receptacle, 1 1/4 x 7/16 in. With a series 400 plug, 1-1/4 x 1/2, any one of the connectors weighs less than an ounce.

Noise generation, shorts, and voltage drops have been avoided through a design which provides for three separate seals—around the entering wires, around each pin connection, and at the interlocking faces. This assures an insulation resistance of 10^6 meg. The ring pressure seal is accomplished by a small ring of Teflon near the center of each pin. When compressed, these rings spread, causing a pressure seal between the pin and the insert. This method effectively lengthens the leakage path, since there is no direct path such as found in face-to-face seals.

Available with 1, 3, 7 or 19 pins, the connectors are rated 1800 v ac at sea level and 800 v ac at 70,000 ft. They can withstand a shock of 200 g and show no resonance to 2000 cps. Operational temperature range is 67 F to 400 F.

Consolidated Electrodynamics Corp., Dept. ED, 740 Salem, Glendale, Calif.

CIRCLE 39 ON READER-SERVICE CARD FOR MORE INFORMATION

Megohmmeter

50K to 200,000 Meg

The Model 35 measures resistance from 50,000 ohms up to 200,000 meg, and is also calibrated in terms of conductance. Conversion from one to the other is effected by reversing the scale plate surrounding the central range switch. The instrument is especially suitable for testing highly capacitative circuits. Test voltages used are 100 and 500 vdc. Accuracy is generally better than ± 1.2 per cent of full scale of each range, expressed in terms of conductance. Short-circuit test current is limited to 10 ma. The instrument cannot be damaged by ordinary misuse. Power supply is 100-120 v and 200-250 v, 40-60 cps. Power consumption is about 30 w. The instrument weighs 22 lb.

Electronic Instruments Ltd., Dept ED, Richmond, Surrey, England.

CIRCLE 40 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Generator

10 w at 10 v

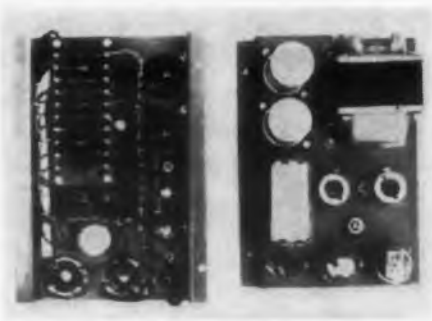
A permanent magnet dc generator, Type 13-PG-6901-01, has a 10 w output at 10 v minimum dc at 8000 rpm continuous duty with 1000 hr life and 25 C maximum temperature rise. Diameter is 1.25 in., length 2.6 in. and weight 7 oz. It can be made to meet MIL-E-5272A. The device has 3 oz in. input torque and is face mounted.

Avionic Division, Dept. ED, 1 Main Street, Racine, Wis.

CIRCLE 41 ON READER-SERVICE CARD FOR MORE INFORMATION

Reference Power Supply

0.1 Per Cent Regulation



To be incorporated into larger equipment as a reference, Model C25 supplies 300 v, 0-50 ma, regulated for line or load to 0.1 per cent or better, using the 5651 as a reference tube. Ripple is held to 1 mv. Power supply is floating above chassis, with negative or positive output. Input voltages from 105 to 125 v ac at 50 to 60 cps may be utilized. Dimensions are 8 in. long, 5-7/8 in. wide (including 1/2 in. flanges with mounting holes), and 4-5/8 in. maximum height.

Universal Electronics Co., Dept. ED, 1720 22nd St., Santa Monica, Calif.

CIRCLE 42 ON READER-SERVICE CARD FOR MORE INFORMATION

Sound Level Recorder
High Writing Speed

The model S1-2 performs basically the function of a VTVM but is superior in that it produces a permanent record of the measurement under investigation. It is particularly suited for acoustical and electro-acoustical measurements, especially for reverberation, sound intensity, vibration, sound decay measurements, and other impulses or phenomena that can be converted into an electrical signal. Input Impedance is 10,000 ohms, of cathode follower type. Frequency Ranges from 20 to 200 kc. Sensitivity is adjustable from 6-12 mv. Reference voltage of 10 mv is available. Interchangeable range input potentiometers are available for linearly calibrated scales for 0-10 up to 0-75 db. Writing speed is variable and controlled from 200-1000 mm per sec. Chart is advanced by a strictly synchronous motor at speeds of 100, 50, 10, or 1 mm per sec.

Sound Apparatus Co., Dept ED, Stirling, N. J.

CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

Broadband Thermistor Mounts
1120 to 40,000 MC

Broadband thermistor mounts that provide an excellent match over the full waveguide frequency range from 1120 to 40,000 mc, without necessity for adjustable tuning elements, are now available for either c-w or pulsed-power measurements. They are intended for use in conjunction with power meters or other bridge circuits. Nominal sensitivity is 10 ohms/mw, sufficient for detecting powers as small as 10 microwatts. Designated FXR Series 216, they utilize a thermistor bead mounted inside a section of ridged waveguide which features a constant characteristic impedance over a broad frequency range; can withstand overload without burning out, and have an efficiency rating approaching 100 per cent.

F-R Machine Works, Inc., Dept. ED, 26-12 Borough Pl., Woodside 77, New York.

CIRCLE 44 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Rotary Switch Pair
Doubles Control

Gear-operated pairs of 16-position, 12-section Type HT rotary multiple switches double the number of electrical circuits that can be controlled by a single knob. Detent mechanism assures positive positioning of rotors at each 22-1/2 deg angle of rotation of the switch handle. Electrical rating is 5 amp 125 v ac at 0.80 power factor. Contacts are break-before-make. The geared-pair assembly has 15 ON and 1 OFF positions.

Electro Switch Corp., Dept. ED, Weymouth 88, Mass.

CIRCLE 352 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply
0 to 300 v, 150 ma

Model 7P13 is a 300 v 150 ma voltage regulated laboratory-type power supply. Input voltage is 105 to 125 at 50 to 60 cps. Three output voltages are available; continuously variable 0 to negative 150 v dc at 5 ma; and 6.3 v ac at 8 amp. High voltage regulation is ± 0.5 per cent from 20 to 300 v at 0 to 150 ma during line variations from 105 to 125 v ac. Metering is accomplished with separate voltmeter and milliameter. Cabinet mounting measures 12-1/2 in. wide x 8 in. high x 8-1/14 in. deep.

Western Gear Corporation, Dept. ED, P O. Box 182, Lynwood, Calif.

CIRCLE 353 ON READER-SERVICE CARD FOR MORE INFORMATION

Differential Transformers
Laboratory Kit

The sensing of position change, as small as 0.0001 in. in magnitude, can be accomplished with this kit. The kit consists of seven complete differential transformers having a linear range from ±0.01 to ±2.5 in., a flexure plate and clamp for positioning

...ls, and a demodulator which converts ac output ... the differential transformer to dc voltage. In addition, each kit contains a copy of the 32 page Transducer Handbook which describes differential transformers. Data is provided in curves and tabular forms. One section of the handbook is devoted to application circuits, and another to accessory control equipment.

Automatic Temperature Control Co., Dept. ED, 5200 Pulaski Avenue, Philadelphia 44, Pa.

CIRCLE 354 ON READER-SERVICE CARD FOR MORE INFORMATION

Micro-Microammeter

10^{-13} to 10^{-7} amp

Model 412, features a single six-inch meter scale covering six decades from 10^{-13} to 10^{-7} amp. Response time is less than 2 sec to 90 per cent of currents larger than 10^{-12} amp with 500 μμf across the input. Zero drift is within 0.5 decade in eight hrs; accuracy, within 0.2 decade. A 216 v tap for polarizing ion chambers is provided and a 6 v output (proportional to input) can drive either 50 mv or 5 ma recorders.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 355 ON READER-SERVICE CARD FOR MORE INFORMATION

TV Camera Tubes

With Particle Shield

The Vidicon GEC 6198—A is intended primarily for industrial use, and the 6326-A is a studio-quality tube for film-scanning and live broadcast purposes. Features which have been incorporated in these 1-in. camera tubes are the elimination of the side tip which characterized earlier models, and the inclusion of a particle shield to keep any loose particles of cathode and getter material from falling on the light-sensitive surface. This makes it possible for these Vidicons to be operated in the face-down position, previously not recommended.

General Electrodynamics Corporation, Dept. ED, Garland, Texas.

CIRCLE 356 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Calibrating Unit
Uses Series Technique

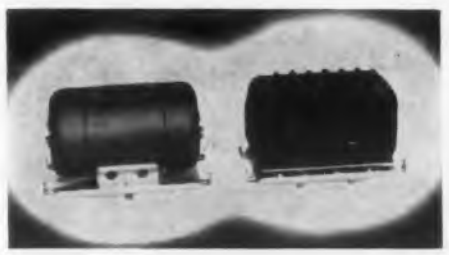
Designed to embody the instrumentation technique of series calibration and eliminate the need for data reduction personnel to average through calibration pulses or fair zero and base line references. The calibrating bridge balance unit, 24-202, provides means for the balance, control and series calibration of strain gages, accelerometers, pressure pickups and other resistive-type transducers. It is of special value when recording dithering type information and provides calibration steps that are truly square wave for clearer interpretation.

The unit provides independent adjustment for each channel of: voltage (individual channel control switches); balance; galvanometer damping (shunt and series); sensitivity; calibrating level and phase. The model 24-202 can be chassis or panel mounted. The chassis mounted model measures 15-1/2 x 9-1/4 x 5-1/4 in. and weighs 24-1/2 lb. The panel mounted model is 19 x 12-1/4 x 5-1/4 in. and weighs 26 lb.

B & F Instruments, Inc., Dept. ED, 4732 No. Broad St., Philadelphia, Pa.

CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

High Voltage Power
From 28 V DC



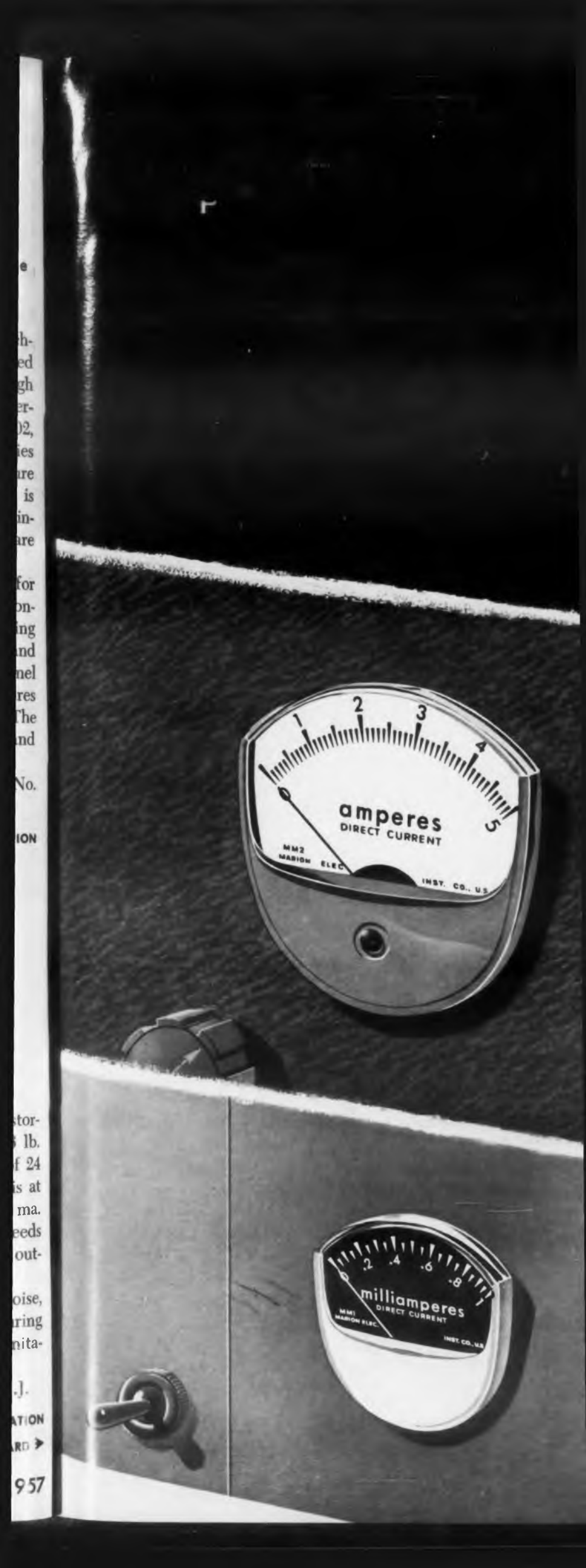
Known as the DVIOA Dynaverter, this transistorized unit has no moving parts and weighs 1.6 lb. The Dynaverter is designed for input voltage of 24 to 2 dc, with a nominal of 27 v. Input current is at 2.3 amp. Output voltage is 270 v dc at 150 ma. Voltage regulation between 15 and 150 ma exceeds 85 per cent. Temperature rise is 10 C at 150 ma output. The ac ripple component is .03 per cent.

High efficiency is attained in filtering out rf noise, and none additional is expected to develop during life of the Dynaverter. There are no known limitations on operating efficiency at high altitudes.

Aircraft Radio Corp., Dept. ED, Boonton, N.J.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 372 ON READER-SERVICE CARD


1
2
3
4
5
amperes
DIRECT CURRENT
MM2
MARION ELEC
INST. CO., U.S.
.2
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milliamperes
DIRECT CURRENT
MM1
MARION ELEC.
INST. CO., U.S.


50
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50
100
100
microamperes
DIRECT CURRENT
MM3
MARION ELEC. INST CO
MANCHESTER, N.H., U.S.A.
10
20
30
40
0
volts
DIRECT CURRENT
50
.2
.4
.6
.8
milliamperes
DIRECT CURRENT

Record-Reproduce Heads

Wide Range Available

Originally developed for use with the company's magnetic recording systems, ET200 Magnetic Recording Heads are offered in a broad range of electrical and mechanical characteristics. Typical of the ET200 line is the Type 2A Head, with an inductance of approximately 500 mh and a resistance of 200 ohms. Gap width is 0.00025 in.; the head has a track width of 0.05 in. Type 2A Heads measure 0.656 x 0.77 x 0.125 in. The heads are available either singly or in multiple-head blocks. They can be permanently imbedded or made individually replaceable. All heads are vacuum impregnated and potted in epoxy resin. Shielding is of Mumetal.

Electrodynamic Instrument Corp., Dept. ED, 2508 Tangley Road, Houston 5, Texas.

CIRCLE 49 ON READER-SERVICE CARD

Packaging Trays

Foam Plastic

To eliminate the tarnishing and oxidation of silver and gold plated electronic parts, packaging trays and shipping platforms of polystyrene foam have been developed. Polyfoam, which is essentially expanded polystyrene foam plastic, is completely free of sulphur or any other trace chemicals which cause damage to bright finishes. Polyfoam platforms are custom-made with prepunched and milled recesses. Additional benefits in cushioning and shock protection are afforded by the cellular plastic, thus eliminating the need for extra wadding and packing materials. A cubic foot of Polyfoam weighs less than 2 lb.

Glo-Brite Products, Inc., Dept. ED, Polyfoam Packers Div., 6415 N. California Ave., Chicago, Ill.

CIRCLE 50 ON READER-SERVICE CARD

CIRCLE 372 ON READER-SERVICE CARD

CIRCLE 51 ON READER-SERVICE CARD

New Products

Heavy Teflon Tapes

Up to 3/16 in. Thick

Teflon continuous-roll tapes in thicknesses to 3/16 in. have been developed in lengths from 40 ft to several hundred feet. The tape is available in thicknesses of 3/32 in., 1/8 in., 5/32 in., and 3/16 in., in virgin Teflon, TFMC, Enflon and also in cementable or pressure-sensitive types.

Enflo Corp., Dept. ED, Route 38, Pennsauken, N.J.

CIRCLE 52 ON READER-SERVICE CARD

Plaster Release

Dry Powder

Lubikold Plaster Release is a white powder compound that releases plastic as well as plaster. Because of its fine texture, Lubikold serves as a coating in the mold, thereby reducing moisture on wet plaster and eliminating gas pockets that can affect the quality of the cast, which is important when pouring metals with a low melting point. When using modeling clay, sticking can be eliminated by rubbing the powder on the surface of the clay and dusting it in the cavity.

Lubikold Co., Dept. ED, 516 Bergen St., Brooklyn 17, N.Y.

CIRCLE 53 ON READER-SERVICE CARD

Vibration Pad

Placed Under Machinery

Molded from reinforced fiber glass and vinyl resin, this pad has a strong grip which holds machinery to the floor. Designed with suction cups molded into the parallel surfaces, the Tiger Paw holds machinery without the use of adhesives, and at the same time eliminates vibration problems. No setting or bolting is required; the pad is simply placed under the machine. This isolates vibration from without as well as eliminates it from within. The pads withstand oil, soap, detergents, water, fungus, acids, bases and salts.

Bullard Clark Co., Dept. ED, Danielson, Conn.

CIRCLE 54 ON READER-SERVICE CARD

CIRCLE 55 ON READER-SERVICE CARD ➤

NONRETURNABLE REELS

REELS

packages can help you earn greater profit?

MOLDED-FIBER CASES assure safe arrival of spools. This Anaconda-developed container won top honors at the 7th Annual Exposition of the Society of Industrial Packaging and Materials Handling Engineers.

Fiber lining protects spools against even slight injuries that can conceivably impair the performance of your windings. Molded halves nest when empty — take ⅓ the space of wooden boxes. Lighter weight speeds handling. Molded fiber eliminates danger of splinters, and convenient shape lends itself to easier handling with less chance of mashed fingers.

REELS. Anaconda's unique program of reel inspection enables it constantly to ship good reels. Wire arrives in your shop in better shape . . . and there's less chance of damage to the wire as you use it off the reel.

Large reels — 12", 16" and 24" — enable users to reduce reel-end scrap . . . save set-up time . . . improve morale and efficiency of winding machine operators.

Nonreturnable reels are also available . . . simplify handling . . . reduce bookkeeping and paper work.

PALLETS. For ease of handling and storing, Anaconda offers pails and reels packaged on sturdy pallets.

For personal attention on your magnet wire problem — packaging or whatever it may be — call the Man from Anaconda. Anaconda Wire & Cable Company, Magnet Wire Headquarters, Muskegon, Michigan.

57376

ANACONDA® FOR MAGNET WIRE

One to 50 μfd Capacitors

Miniaturized Line

Miniaturized Stabelex D Capacitors are available in voltage ratings up to 25 v and in capacities from 1 to 50 μfd. They are approximately 1/4 the volume of the standard D line, due to improvements in insulation resistance and dielectric absorption. These capacitors, if allowed to stand charged, will lose only 0.1 per cent of their initial charging voltage after 600 hrs.

Industrial Condenser Corp., Dept. ED, 3243 N. California Ave., Chicago 18, Ill.

CIRCLE 56 ON READER-SERVICE CARD

Microwave Pressure Windows

Broadband

These windows provide a vacuum-tight seal and protection against humidity, dust, etc. and are used to seal waveguide and antenna systems, gas switching tubes, power tubes and ferrite components. The windows are available at frequencies from 2.45 to 75 kmc. These cover-flange-mounted designs are normally mounted between two choke flanges in waveguide assemblies. Windows are available for direct insertion into radar waveguide, or for test bench applications in a variety of bands.

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

CIRCLE 57 ON READER-SERVICE CARD

Jack Panel

1-3/4 In. Double Row

The PJ-340 Double Row Jack Panel provides for 52 jacks mounted on 5/8 in. centers. It is constructed of molded black phenolic plastic reinforced with steel for maximum rigidity. It is 1 3/4 in. wide and fits a standard 19 in. relay rack. The PJ-340 comes complete with 52 ADC type PJ-318 normally closed circuit jacks. Mounting brackets, designation strips, and jacks are plated to withstand a 50 hr salt spray test. This jack panel is equivalent to the Western Electric 230A. It is also available without jacks as ADC type PJ-30.

Audio Development Co., Dept. ED, 2833 13th Ave. So., Minneapolis 7, Minn.

CIRCLE 58 ON READER-SERVICE CARD

◄ CIRCLE 55 ON READER-SERVICE CARD

New Products

VTVM—VOM Kit

Transistorized Unit

The transistorized circuit of this instrument is battery operated. As a VOM the instrument measures ac and dc, af output voltage-frequency response, volume level, dc resistance, and dc circuit current. As a VTVM it measures dc voltage, resistance and current. No warm up time is required for operation. It has an internal method for calibrating and checking VOM readings against the VTVM readings. The meter is a 50 μa movement. The molded plastic components case has individual pockets for each resistor, shunt, and battery. The kit is divided into three packages which may be purchased separately on the pay-as-you-wire plan.

Transvision, Inc., Dept ED, New Rochelle, N. Y.

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Amplifier

Package

Package—for cathode-ray oscillographs and tape recorders, a 7-channel dc amplifier package is offered for use with wire strain gages, load and pressure transducers, accelerometers, thermocouples. Employing an amplification technique which features built-in power supply, the Model 210's system insures that the signal from the phenomenon under study is not disturbed in the band-pass frequency. Frequency response is from dc to 10 kc. It has balanced input and high output impedance. There is no operational delay when these instruments are overloaded.

Allegany Instrument Co., Dept. ED, 1091 Wills Mountain, Cumberland, Md.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

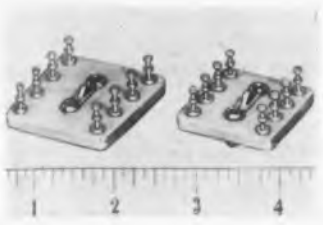
Recording Gages

Weatherproof

Gages for pressure, vacuum, and water or liquid level measurements are available in weatherproof cases. The gages are designed for wall or pole mounting outdoors. Measurements of water depths or other liquids can be accomplished with float-type, pressure-type, differential-pressure-type, or bubbler-type liquid level gages; pressure gages are offered in all ranges. Both 8-in. and 12-in. round chart models are available in the cases; flowmeters and thermometers are also offered.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION



Terminal Boards

Ceramic

Designated X2036 and X2030, these terminal boards are for applications in equipment that will be subjected to high temperature. Terminals, Type X2034-C, are silver plated brass and the ground straps are silver plated copper. The insulation material is Grade L-5 ceramic, silicone impregnated. Mounting studs are 4-40 internal thread. The X2036 is 1-17/32 in. long by 1-3/8 in. wide. The X2030 is 1-1/4 in. long by 1-3/16 in. wide. Both units stand approximately 5/8 in. high over-all when mounted.

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

CIRCLE 63 ON READER-SERVICE CARD FOR MORE INFORMATION

Photographic Recorder

High Speed

The VDR-5400 16mm high speed Photographic Recorder has frame speeds of 400, 300, and 150 per second. It utilizes a standard 100 ft daylight loading spool. Power requirements are 28 v dc and 4 amp. Small and compact in size. This new recorder is based on the VDR-5T which is in widespread use. All recorders are designed and constructed especially for aircraft and missile use.

Vought Co., Dept. ED, P.O. Box 1350, Beverly Hills, Calif.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Contact Switch
Long Life

Model 100 momentary-contact switch has had a normal life under pilot load in excess of 20 million cycles,and under full load, switch has a normal life in excess of 1-1/2 million cycles. Rating of the switch is 15 amp, 1 hp, 120 or 240 ac. The dc rating is 1 amp, 125 volts; 1/2 amp, 250 volts. It is offered in four models, all dust in molded phenolic cases and all designed for installation by means of screw terminals, soldering lugs, speed connectors or wire leads.

McGill Manufacturing Co., Inc., Dept ED, Valparaiso, Ind.

CIRCLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION

Vitreous Enamel Resistors
3, 5, and 10 w

Of axial-lead construction, these types offer small physical size for their dissipation ratings. Designated types 3-AE, 5-AE, and 10-AE, they are of 3, 5, and 10 w ratings respectively. Thermally matched materials provide high resistance to thermal shock. All three types are made in accordance with the MIL-R-26C specifications.

P. R. Mallory & Co. Inc., Dept ED, Indianapolis, Ind.

CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION

Loop Antenna
Lightweight

A loop antenna for use in aircraft weighs 7.5 lbs as compared to 15 lbs for the loop now in use. The space required for the antenna is approximately 35

pe cent of previous requirements. The antenna, consisting of a directional ferrite-core loop, has a frequency range from 190 to 1760 kc and is electrically interchangeable with the loop commonly used with automatic direction finders. Housing design, plus the fact that the housing extends only 2-1/2 in from the skin of an aircraft, provides for minimum friction and drag.

The Magnavox Co., Dept ED, Fort Wayne 4, Ind.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

Vertical Gyro

Fast Erection Rate

The WG-2 gyro provides accurate and reliable two-axis vertical reference data in the form of two synchro output signals. The spin-axis is slaved to gravity by means of a gravity sensitive vertical reference device which supplies electrical control signals to torque motors which maintain the gyro spin-axis parallel to the gravity vector.

Its vertical repeatability is to within 10 min of the arc cone and the initial erection, at the Super-Fast Rate, is from any standing position at any temperature from —55 C to +71 C to within +30 min of arc of vertical within 25 sec after application of power.

Waltham Watch Co., Dept ED, Waltham, Mass.

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Speed Detector

Flange Mounted

Designated Syncro-Pak, this utilizes a centrifugal switch as the sensing element. It is dust tight and provides its own shaft mounted in ball bearings. The unit can be flange mounted to the equipment to be protected or controlled. Shown is a 2-stage speed detector rated at 5 amp. It incorporates two centrifugal switches, one of which limits overspeed, the other underspeed. It is accurate to the standard tolerance of ± 1 per cent.

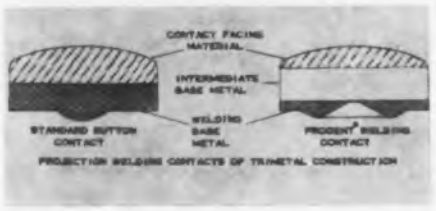
Torq Engineered Products, Inc., Dept ED, 32 Monroe Street, Bedford, Ohio.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Welding Contacts

Increased Conductivity



These contacts decrease welding flash blowouts, improve thermal and electrical conductivity, increase effective weld areas as a result of configuration, and eliminate mushrooming by promoting flat seating and parallel welding. Product contacts are especially recommended for welding to thin springs and thin mounting supports. No equipment change over is required in their use. They are available with facings of silver alloys, silver-cadmium oxides, precious and noble metals and their alloys, and a number of sintered metal compositions. Contact specifications include diameter ranges from .062 in. to over .375 in.

Metals & Controls Corp., Dept ED, Attleboro, Mass.

CIRCLE 73 ON READER-SERVICE CARD FOR MORE INFORMATION

Brake Motor

2.5 Hp, Weighs 10 Lb.

A 2.5 hp 400 cycle, 200 v, three phase aircraft brake motor weighs less than 10 lb and has a 5 hp peak. Known as Model IH42YK5B, the motor has a rated speed of 11,000 rpm and a starting torque of 715 oz in. It measures approximately 4-1/2 in. x 7 in.

Western Gear Corp., Dept ED, Lynwood, Calif.

CIRCLE 74 ON READER-SERVICE CARD FOR MORE INFORMATION

Milliohmmeter

0.0005 to 1200 Ohms

The Model 47A is designed for the measurement of resistance from 1200 ohms down to 50 μohms. It is a direct reading instrument, with a linear scale, is line operated with no batteries required. A self-calibration circuit allows the accuracy of the instrument to be checked at any time. Test voltage ranges

up to 12 mv for any range, varying with test resistance. Open-circuit voltage is 1.25 v. Effect of inductance is absolutely none with normal circuits and components, including even high Q air or dust cored coils. But since the instrument fundamentally measures impedance at 60 cps, care should be used when testing iron-cored inductors. Accuracy is generally better than ± 2 per cent of full scale. Weight of the instrument is 19 lb.

Electronic Instruments Ltd., Dept ED, Richmond, Surrey, England.

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

Isolator

34.5 to 35.9 Kmc

A 100 Kw resonant absorption ka band isolator weighs less than 3 lbs, and is designed to operate over the frequency range of 34.5 to 35.9kmc. Electrical characteristics include an isolation of 20 db minimum and an insertion loss of 1 db maximum. It operates over a temperature range of —55 C to +100 C. These operating characteristics are guaranteed under vibration specification MIL-E-5272 A.

Airtron, Inc., Dept ED, Linden, N. J.

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermocouples

For Exact Locations

These Delta-Couples measure temperatures at precise, ± .003 in. or closer, in-wall locations, employing a technique of embedding ribbon junctions in weld nuggets at selected depths in 1/4 in. threaded plugs of steel and aluminum. Adequate output, minimum disturbance of heat flux, simultaneous response with the wall material, and a temperature range of —50 to +1000 F in steel or —50 F to the melting point of aluminum are featured.

Detroit Controls Corp., Dept ED, 1650 Broadway, Redwood City, Calif.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Current Drivers

Test Magnetic Cores

Types 3003 and 3004 are designed specifically for the testing of square loop, tape wound bobbin cores. Type 3003 is a high impedance, high current source and produces negative current pulses. Type 3004 is designed for low impedance operation functioning as a cathode follower and producing positive current pulses. Each unit can be adjusted for a rise time of 0.2 to 1 μsec, duration of 1 to 10 μsec, and an amplitude up to 1 amp of the rectangular output current pulse.

Burroughs Corp., Dept. ED, 1209 Vine St., Philadelphia 7, Pa.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION

Angular Divider

Synchro Positioning

Without the use of additional fixturing, the angular divider will position a synchro shaft with less than 15 sec error. It will rotate the synchro in precise 5 deg steps through use of a ball-detent mechanism. The interval between is spanned by a fine-angle device. Designed for ease of operation. Backlash and reading errors commonly associated with dividing heads are absent. It accommodates synchro sizes 8 to 31. Dimensions are 12 in. diam x 5-3/4 in. high.

Theta Instrument Corp., Dept. ED, 204 Market St. East Paterson, N. J.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Industrial Relay

All-Purpose

A General Purpose Relay incorporates such design features as inter-changeable coils and a removable multi-position base. Contacts rated at 20 amps, 115 v 60 cycle ac or 24 v dc, are single-and-double pole, single-and-double throw. Mounting arrangements are provided for auxiliary spdt contacts if desired. The relay is 2-7/16 in. high with a base measuring 1 x 3-7/8 in. Choice of mounting base (metal strap or bakelite), choice of coil volt-

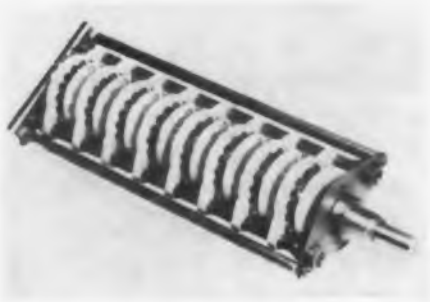
(ac—6 through 230 v, or dc—6 through 115 v), and choice of terminal connections are available.

Wheelock Signals, Inc., Dept. ED, Long Branch, N

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

Ceramic Switch

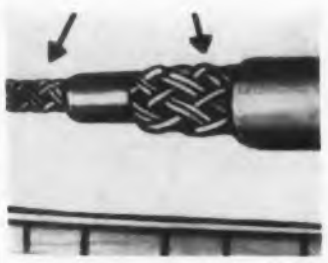
Eight Decks Ganged



Up to eight decks of this switch can be ganged, with one, two or three poles per deck provided as standard. Occupying less than 1-1/2 sq in. of panel space, the switch contains up to 18 positions on a single wafer. Silver alloy contacts, rotors, and slip rings are provided. Ceramic parts are silicone impregnated to function under humidity. It meets and exceeds the electrical and environmental requirements of MIL-SPEC S-3786. Flashover voltage at 60 cycles is 1000 volts peak and current carrying capacity is 2 amp.

Daven Co., Dept ED, Livingston, N. J.

CIRCLE 82 ON READER-SERVICE CARD FOR MORE INFORMATION



Miniature Coax

Air Dielectric

This cable has a nominal overall diameter of 0.22 in. The conductor is #30 AWG, 7/38 silver plated copperweld. A choice of outer jackets of Teflon, lacquered nylon braid, Teflon or silicone impregnated glass braid, etc., are available as standard constructions. The low attenuation of the 10 μμf cable makes it useful for high frequency, low level applications and as low capacitance probe cable. Capacitance values of less than 10 μμf, with somewhat larger overall diameters, are also available on request. Flexibility is one of the features of the air dielectric coaxial cable. Among the other physical characteristics are solderability, light weight, small size, and adaptation to a variety of connectors.

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

CIRCLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Oscilloscope

Direct Reading

This instrument features dual calibration of amplitude and time. Designated as Model LA-259, the instrument is militarized, has a frequency response from dc to 15 mc within 3 db, and features direct reading calibration of both signal amplitude and duration with verification of both. The LA-259 is designed for use both in the laboratory and for field applications. Rise time is 22 μsec.

Lavoie Labs., Inc., Dept. ED, Morganville, N.J.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotary Selector Switch

Encapsulated

Series BHM encapsulated switches are rated at 50 ma. at 300 v ac or dc and 500 ma at 30 v ac or dc. Entire switch is encapsulated with the exception of bushing and shaft. Body diam is 29/32 in.; body length is 1-1/8 in. maximum. Manufactured to meet salt spray, humidity, sand and dust, and fungus resistance, the switch exceeds requirements of MIL-E-5272A and MIL-STD-02. Moisture seal is provided between bushing and shaft, and on bushing mounting surface. It is encapsulated in a high dielectric plastic compound. Available in sp 12 positions, 2 p 6 positions, 3 p 4 positions, 4 p 3 positions, and in either shorting or non-shorting contacts. It will meet or exceed test paragraph 4.5.3 thru 4.5.13 of MIL-S-3786.

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

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

Quartz Crystal

Will Stand 100 g

A quartz crystal which is extremely stable functions as a frequency determining element for missiles, aircraft and other applications involving extreme environmental conditions. The ST-73X crys-

tube has a frequency range of 16 kc through 350 kc, with lower frequencies possible in holders of different configurations. Shock tests of 100 g, and dynamic vibrations tests per MIL-T-5422, MIL-E-5272 and MIL-E-5400 were met without adverse results. Storage temperatures over a range of −65 to +185 C can be coupled with an operation temperature range of −55 to +100 C. Low excursions of frequency, ±0.015 per cent, were observed over this range.

Bulova Watch Co., Dept. ED, Electronic Div., Woodside 77, N.Y.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

Alumina Terminals

Rated at 3500 V

The PC-52 alumina terminal is designed for reliable operation at high voltages and temperatures. 3/8 in. in diam, the terminal employs high-alumina ceramic to achieve a voltage rating of 3500 v (sea level), a high temperature rating, and reliability. The center conductor and insulating sleeve are vacuum-sealed in a metal flange which can be hermetically sealed to the mounting surface with either soft or hard solder. Applications include high altitude operation.

Raytheon Mfg. Co., Ceramic Sales, Dept. ED, Waltham 54, Mass.

CIRCLE 89 ON READER-SERVICE CARD FOR MORE INFORMATION

Rate Switch

5 to 500 Deg Per Sec

This switch is designed for use in control systems, such as target drones, and for vertical gyro cutout. The rate switch, designated Type RS01, operates on either ac or dc power supply. It is equipped with primary spdt switch action. Contacts are rated at 100 ma, 28 v inductive load. For higher ratings the instrument can be furnished with built-in relays for service to 5 amp, 115 v. The rate ranges are from 5 deg to 500 deg per sec.

Humphrey Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 90 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Signal Generator
Broadband

The MSG-34 broadband microwave signal generator covers C and X band frequencies from 4,200 to 11,000 mc with a power output of 1 mw. Large, direct-reading dials indicate frequency and attenuation. The device has a provision for external modulation by multiple pulses, an automatically tracked power monitor, and a non-contacting oscillator choke. The modulator, utilizing printed circuit techniques, permits internal pulse and square wave modulation from 10 to 10,000 pps at pulse widths from 0.2 to 10 μsec.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

Blower
17 Cu Ft per Min

This blower offers a movement of 17 cu ft of air per min with the advantage of compact package. Over-all dimensions are 3-1/2 in. W, 2-7/8 in. D, 3-3/4 in. H. The model 17 as pictured operates at 3000 rpm (free air) from 115 v ac 60 cps 1 phase source and it draws 10 w. The total weight is 22 oz. The motor is a quiet-running, sleeve-bearing Barber-Coleman product.

Minarik Electric Co., Dept. ED, 224 E. 3rd St., Los Angeles 13, Calif.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

High Temperature Wire
Up to 1500 F

This conductor wire has the physical qualities of steel and the same conductivity and temperature coefficient as nickel wire. Calorel wire offers advantages over nickel as an electrical conductor at tem-

...tures up to 1500 F. Basically pure iron, coated with aluminum and aluminum-iron alloy, Calorel Wire has approximately six times the resistance of copper and increases in resistance at about four times in 1000 F. With no embrittlement temperature, low corrosion and oxidation characteristics, it meets the requirements for conduction under extreme heat conditions. The wire is available in quantity in all standard sizes for temperatures up to 1500 F. Extra high temperature wire is available in 20 ft lengths for up to 2200 F use.

Continental Wire Sales Co., Dept. ED, Wallingford, Conn.

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION

Goniometer
Quartz Crystal

A quartz crystal x-ray goniometer permits unskilled operators to orientate crystal surface and lattice planes quickly to accuracy within 30 seconds of arc. Among the features for the instrument are a large direct reading scale, simple controls, and a higher sensitivity than required for even weakest quartz reflections. The goniometer is suitable for routine testing of both large and small crystal blanks, and may be used with either a high intensity micro-focus x-ray unit or with conventional x-ray diffraction equipment.

Jarrell-Ash Co., Dept. ED, 26 Farwell St., Newtonville 60, Mass.

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Amp and Volt Meters
0.5 Per Cent Accuracy

A line of dc moving ammeters, milliammeters, microammeters, voltmeters and millivoltmeters are made in Switzerland to PRL specifications. The voltmeters have an accuracy of 0.5 per cent and an internal resistance of 1000 ohms/v. The ammeters are rated at 150 mv. All instruments come with mirror scales and knife-edge blade-type pointers.

Physics Research Labs., Inc., Dept. ED, P.O. Box 555, Hempstead, N.Y.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Collector Ring
Resin-Bonded

Resin bonding eliminates the need for screw fastening, providing an unbroken backing plate surface for this collector ring. Weight and thickness is reduced by this method. Also available is a complete line of standard collector rings ranging from 3-1/16 to 5 in. O.D. with capacity from 15 to 100 amp.

The B. A. Wesche Electric Co., Dept. ED, 1622 Vine St., Cincinnati 10, Ohio.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

Oscilloscope
Low Noise & Drift

This oscilloscope has built-in quadrant switching identical vertical and horizontal dc to 50 kc amplifiers, and low noise and drift. It can be used as an output indicator with analog computers, characteristic curve generating devices, etc. Unit will operate from 105-125/210-250 v, 50/60 cy lines.

American Electronics Labs., Dept. ED, 121 No. Seventh St., Philadelphia 6, Pa.

CIRCLE 101 ON READER-SERVICE CARD FOR MORE INFORMATION

Strain Indicator
Transistorized

The Type N Strain Indicator uses printed circuits and transistors and is functionally equivalent to the Type M Indicator, which it replaces. The Type N

offers these advantages: There is no calibration error when the instrument is used for direct readings with a full external bridge instead of a pair of strain gages; and when the indicator is used as a preamplifier with a standard oscilloscope, frequencies up to 300 cps at amplitudes of 3500 microinches per inch can be observed without appreciable distortion. The Type N weighs 9 lb and measures 10 in. high x 9 in. wide x 6 1/4 in. and requires no warm-up period.

Electronics & Instrumentation Div., B-L-H, Dept ED, 42 Fourth St., Waltham, Mass.

CIRCLE 102 ON READER-SERVICE CARD FOR MORE INFORMATION

Audio Oscillator
10 CPS to 100 KC

The Model 401A oscillator covers the range 10 cps to 100 kc. It delivers a full half watt into 600 ohms (20 v open circuit) with output constant to within ±1/2 db over the entire frequency range. Distortion is below 1/4 per cent at any power or frequency setting for loads of 600 ohms or more. The circuit used virtually eliminates switching and tuning transients. Weight is 121 lb.

Waveforms, Inc., Dept. ED, 333 Sixth Ave., New York 14, N.Y.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

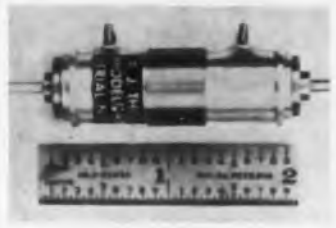
DC Power Supply
0 to 150 V

This magnetic amplifier controlled dc power supply, Model C169, has a voltage range of 0 to 150 v, at currents from 0 to 1-1/2 amp. The unit is regulated to ±1 per cent for line or load, with a compensating adjustment control to secure positive or negative impedance, thus giving 0 per cent load regulation. Ripple is 0.1 per cent for all line or load conditions. Transient response is better than 0.2 sec. Line input range is from 105 to 125 v ac at 60 cy.

Universal Electronics Co., Dept. ED, 1720 22nd St., Santa Monica, Calif.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Electromagnetic Clutch

Double Input

Units operate on dc voltage and no slip rings are required. The miniature line has two input gear hubs and one output shaft. Normally both input hubs and the output shafts are free running; energizing either coil clutches its respective input hub to the output shaft. The functions of the shafts may be reversed so that a single input can be connected to either of two outputs. These Type MCC units are suited for use as a speed or direction changer in servo type applications. All units will withstand vibrations as specified in MIL-E-5272A. Life tests at 60 cps have exceeded 6 million cy.

Autotronics, Inc., Dept. ED, Rt. 1, Box 812, Florissant, Mo.

CIRCLE 361 ON READER-SERVICE CARD FOR MORE INFORMATION

Soldering Device

For Most Guns

Known as the Solder-Matic Attachment, this new tool greatly speeds up soldering operations as the solder is always at the tip of the gun. A trigger feeds solder from a spool in the attachment through a guide tube to the tip of the gun. This attachment can be mounted on all popular models of electric soldering guns.

Atlas Mfg. Co. Inc., Dept. ED, 1126 S. Decatur St., Montgomery 6, Ala.

CIRCLE 362 ON READER-SERVICE CARD FOR MORE INFORMATION

Resin Bobbins

For Wire-Wounds

These bobbins, used for the construction of hermetically sealed resistors, are machined from filled and unfilled thermosetting epoxide resin rods. This resin has been selected because of its electrical and mechanical properties. Its adhesion quality is ideal

hermetic sealing of wire wound resistors. The potting compound used for the encapsulating of the resistors is composed of the same resin as the bobbin form. This technique insures the hermetically sealed condition of the resistor at extreme temperatures, since the bobbin and encapsulation contract and expand to the same degree.

Morrich Plastics Corp., Dept. ED, 35 E. 32nd St., New York, N.Y.

CIRCLE 363 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Relay
High Shock

The MHJ relay has a vibration rating of 10 to 55 cps at 0.125 in. double-amplitude, 55 to 2000 cps at 20 g. Available in both four- and six-pole, double-throw. Contact rating; low level up to 2 amp non-inductive or 1 amp inductive at 29 v dc or 115 v ac. Temperature range is −65 to +125 C. Operate time is 15 msec or less at rated voltage at 25 C. Release time is 5 msec or less at rated voltage at 25 C. The relays measure 1-3/4 in. max x 1-3/64 in. diam, and 1-3/4 in. max x 1-3/16 diam.

Allied Control Co., Inc., Dept. ED, 2 East End Ave., New York, N.Y.

CIRCLE 364 ON READER-SERVICE CARD FOR MORE INFORMATION

Synchro Bridge
Measures Angular Error

Designed to measure the angular error of synchro components or systems, this device introduces less than 10 sec-of-arc error. Through use of a bridging method, the deviation of actual synchro output from theoretically perfect output is determined. Specifications: measurement intervals, each 5 deg. through 360 deg; accuracy, 10 sec; resistance of each leg, 10,000 ohms; case dimensions, 3-5/16 x 3-7/8 x 5-3/16 in.; dial diameter, 4 in. OD.

Theta Instrument Corp., Dept. ED, 204 Market St., East Paterson, N.J.

CIRCLE 365 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Transit Cases
Deep Drawn

These deep-drawn cases can comply with all applicable sections of MIL-T-945, MIL-STD-108 and MIL-T-4734 (USAF) and environmental conditions of MIL-C-4150. Constructed and fitted to meet the customer's environmental requirements, such as water-tightness, resistance to internal or external pressure or vacuum, drip and spray resistance, resistance to salt spray or chemical, shock or vibration mounting of contents, heat exchange or ventilation, electronic shielding temperature of fungus resistance, etc. Twenty-four basic sizes with a variety of depths of case and lid are available.

Zero Mfg. Co., Dept. ED, 1121 Chestnut St., Burbank, Calif.

CIRCLE 111 ON READER-SERVICE CARD FOR MORE INFORMATION

Sequence Relays
With Release Operation

Known as Frame 211, the relays come with a variety of dpst and dpdt contact arrangements and have a double cam movement permitting contacts to be adjusted to operate when the coil is de-energized. The cam rotates a half step when the coil is energized, and completes the step when de-energized. The ability to transfer contacts on either the operate or release phase offers sequence arrangements not usually practical. This allows make before break between two contacts to be more positive than usual by overlap during the time the relay is energized.

Frame 211 relays are equipped with contacts which may be set to open, close, or transfer in any desired sequence, providing the number of steps in a complete cycle is divisible into six or eight. Power consumption is 5 to 6 w dc or 10 to 12 va ac. Contacts will carry 150 per cent of rated load. Contacts are silver convex buttons, mounted on phosphor-bronze flexing arms. Ratings are 5 amp ac; or 0.5 amp dc at 115 v, and 5 amp dc at 24 v.

Struthers-Dunn, Inc., Dept. ED, Pitman, N.J.

CIRCLE 112 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized Voltmeter

A wide band low level instrument, the Transvolter incorporates negative feedback for stable operation and permits the replacement of transistors without impairing the stability of the instrument. It operates on 110 v 60 cps with a built-in regulated supply and can also be powered by 4 Mercury cell batteries for portable operation. Frequency range is from 10 cps to 10 mc, with direct reading in v and db. Voltage range is from 1 mv to 1 v full scale with seven ranges. Accuracy of measure is ±5 per cent full scale reading. Frequency amplifier has flat response ±0.5 db over range. It will measure 250 μv, and has an input impedance of 5 μμf capacity, resistance loading 0.5 meg at 1 mc. The audio-video amplifier has a maximum output of 0.25 v at 75 ohms, with a gain up to 40 db.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

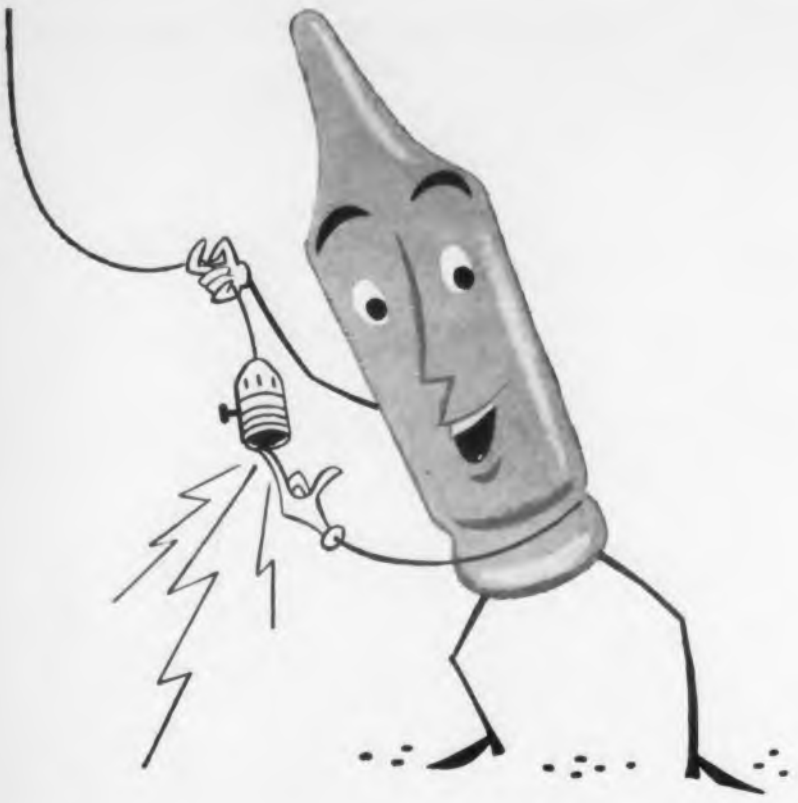
CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

Motor Generator
15 Kva to 22.5 Kva

This unit delivers 400 cps, 3-phase, 120 or 208 v, 15 kva continuous, 22.5 kva for short period overloads. A totally enclosed fan-cooled construction is utilized. Weight is within 500 lb, for complete motor-generator combination. Overall dimensions are 36 x 19 x 21 in. Because of intrinsic regulation of machine, regulators are obviated, yielding high degree of ruggedness, simplicity and dependability. The total elimination of brushes reduces maintenance to the infrequent lubrication of bearings. The motor operates at a speed of 1800 rpm, from standard 220 or 440 v 3-phase, 60 cps supply. Elimination of sparking makes the machine safer and obviates the need for rf suppression.

Georator Corp. Dept. ED, Manassas, Va.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION



G-E GLOW LAMPS OBEY THE IMPULSE ...TO SERVE AS INDICATORS

Every live circuit should have an indicator—and with radio-type resistors, G-E Glow Lamps become simple indicators that give long, uninterrupted service. Only glow lamps offer small size, low wattage, long life, wide voltage tolerance, and rugged construction—for as little as 3½¢ each! They don't fail suddenly, so there's almost no chance of false indications. All these features help make General Electric Glow Lamps the ideal choice for hundreds of applications as indicators in the electrical and electronics industries.

If you'd like more information on the amazing G-E Glow Lamps, send today for your free copy of the folder, "G-E Glow Lamps for Pilot and Indicator Use". Write: General Electric Co., Miniature Lamp Dept. ED-67, Nela Park, Cleveland 12, Ohio.

A Single G-E Glow Lamp May Serve As A:
RELAXATION OSCILLATOR • LEAKAGE INDICATOR
SWITCH • VOLTAGE REGULATOR • VOLTAGE INDICATOR

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Simulator

For Transistor Circuits

This instrument eliminates broadboard layout by simulating complete transistorized amplifier stages. Any ac or direct-coupled amplifier stage short of high power audio output can be simulated with the LF-1 Transimulator, as can multivibrator, switching, phasing, push-pull, Class A and B circuits, and others by using cross-coupled Transimulators. Common or grounded emitter, base, or collector circuits may be simulated using PNP, NPN, or surface barrier transistors.

Everything required for RC amplifier circuits is built right into the instrument, including 2 μf and 20 μf direct coupling capacitors and posts for external coupling on both input and output.

Sprague Products Co., Dept. ED, 347 Marshall St., No. Adams, Mass.

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Monitor

Ignores Transient Shocks

This vibration monitor system is sensitive to increases in vibration yet ignores both starting vibration and transient shocks normal to operation. The system combines the model 65 malfunction detector, for mounting on the protected equipment, and the model 651 ac control unit mounted remotely. The malfunction detector is designed for use in Class I, Group D; and Class II, Groups F and G locations. In operation, the detector trips whenever the vibration exceeds the preset vibration level. The control unit must reset the detector in rapid sequence several times before the shutdown time delay relay, selected for a 2 or 5 sec delay, will actuate. The unit is held inoperative for a selected time of up to 120 sec after starting to allow the protected equipment to reach full speed.

Fielden Instrument Division, Robertshaw-Fulton Controls Company, Dept ED, 2920 Fourth Street, Philadelphia 33, Pa.

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION

Computing Amplifiers

Parallel Summation

A parallel summation computing amplifier, Model 808, can accept up to 100 different summations all with equal accuracy. Also available is the Model 809, an automatic gain control computing amplifier for stabilizing error voltage and controlling gain of input error voltage.

The Model 808 can be used for parallel voltage summation or for isolation of Mach 4 Mod 0 resolvers or equivalent. It can also be used as an isolation amplifier for any device providing 400 cps analog ac voltage output signals. The 808 is a highly dependable component wherever equations are to be mechanized. Accuracy of the 808 is ±0.05 per cent; maximum output voltage is 22 v rms; phase shift is less than 0.15. The Model 809 agc amplifier maintains constant loop gain over a scaling voltage range of 100 to 1. It operates with a maximum undistorted output of 0.4 v into a 10 K load. Both model 808 and 809 are transistorized.

W. L. Maxson Corp. Dept. ED, Long Island City, N.Y.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION

Selenium Rectifiers

High Compactness

A line of Siemens-process, high current density selenium rectifiers, known as HCD Petti-Sel, makes possible smaller rectifiers for a given load with less complex power cell assemblies and increased efficiency. A single rectifier of 8 in. x 16 in. x 24 in. will handle 4500 amp at 14 v dc. The single stack eliminates wiring connections, and the rectifier requires a smaller and much less elaborate housing. Low forward drop together with low rate of change of both forward and reverse characteristics with both time and temperature are claimed to make these rectifiers useful for magnetic amplifier applications.

Radio Receptor Co., Dept. ED, 240 Wythe Ave., Brooklyn 11, N.Y.

CIRCLE 122 ON READER-SERVICE CARD FOR MORE INFORMATION

world's first man-made satellite uses controls produced by

bernco!

bernco

Controls
Test Equipment
Wiring Harnesses
Thermocouples

It happens once in a lifetime . . . an opportunity to work on the rocket for launching the earth's first man-made satellite into outer space. It happened to BERNCO. Our "feet-on-the-ground" creative craftsmen welcomed this challenge.

Specifications for controls on the satellite rocket were carefully screened, quality standards were rigid and production was 100% inspected, as with all BERNCO controls.

The finished controls are *reliable* and at *reasonable* cost because of BERNCO's quality control system and production techniques.

It will be a while before the earth satellite is eventually orbited in space. In the meantime, BERNCO would like to be of service to you.

BERNCO offers a *complete* service in the design, production and environmental-testing of electrical, electronic or electro-mechanical component parts—*completely customer designed*, *partially* BERNCO *designed* or *completely* BERNCO *designed*.

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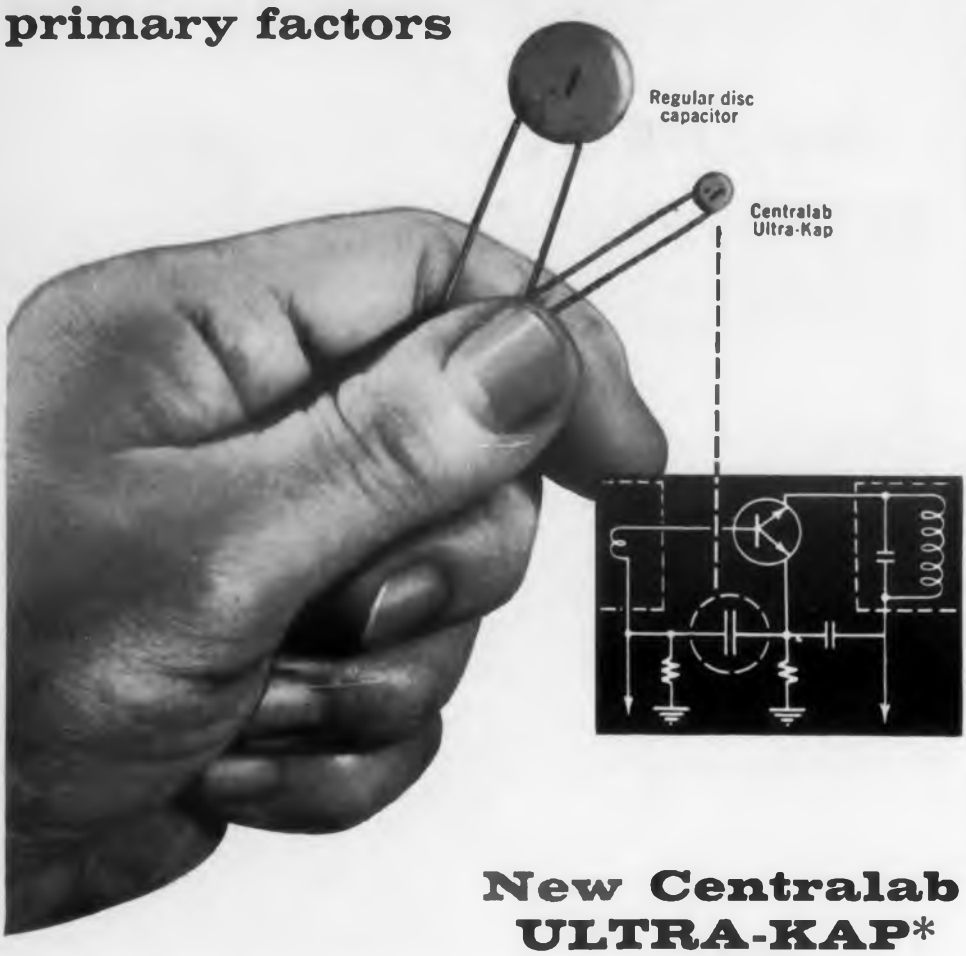
CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

In transistor applications where size and cost are primary factors



New Centralab ULTRA-KAP* outperforms much larger and higher-priced components

A radically new approach to a ceramic disc capacitor that combines unusually high capacity with small physical size.

Has stable capacity curve over wide temperature range. Capacity vs. temperature: ±25% over +10°C to +85°C.

Ideal for by-pass in transistorized applications.

Costs far less than electrolytic and tantalytic capacitors of equal or greater capacity.

DIAM.	MAX. THICKNESS	CAPACITY MFD.	TOLERANCE
1/4"	.156"	.22	GMV
3/8"	.156"	.56	GMV
9/16"	.156"	1.0	GMV
3/4"	.156"	2.2	GMV

Write us for further information. Or have the nearby Centralab representative tell you more. If you don't know who he is, ask us for his name.

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In Canada:
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D-2458

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Permanent Magnet Alternator

400 Cps, 12,000 Rpm

The rotor construction of these brushless generators permits them to be driven by electric motors, jet air drives, turbines, and two and four-cycle gasoline engines. They can withstand high acceleration and overspeed condition for extended periods of operation. Advantages claimed for the alternators include smaller sizes and weights than conventional generators, due to ability to operate at high speed. The first production unit, Model 5854, 400 cps Permanent Magnet Alternator is rated at 12,000 rpm continuous duty. The alternators are claimed to be virtually maintenance-free since each rotor is a solid mass and requires no insulation.

The alternators are offered for most standard voltages, 400 cps, single phase; or three phase, either Y or delta connected. Other available configurations include: compound units, delivering both ac and dc, with built-in forced air-cooled rectifiers; two-bearing type units for belt or direct coupling drive, or for direct outboard mounting on driving motor or engine; and units with standard AN pads for hydraulic motor drives. Output ratings range from 500 to 4500 V. A.

Lear, Inc., Dept. ED, Santa Monica, Calif.

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

10 W Resistor

200 to 70,000 Ohms

LP-10, a 10 w unit available in ratings from 200 to 70,000 ohms, is made by permanently bonding a metallic oxide film to Pyrex brand glass. The LP resistors are essentially non-inductive. Tolerance of the LP-10, as that of other LP's is ±10 per cent, but ±5 per cent is available at a slightly higher price. The power rating of the LP-10 is based on 25 C ambient temperature and an average hot spot of 265 C. Average changes in resistance due to normal soldering techniques are less than 0.1 per cent.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

Soldering Iron

Miniature

Weighing less than 1-1/2 oz, this new iron is designed for production line soldering of subminiature equipment, printed circuits, and instruments. A tiny tubular heater, located in the extreme tip of the iron, develops a tip temperature of 750 to 850 F. This design provides extremely rapid recovery under production conditions. The tip is vacuum processed iron, highly resistant to harmful effects of tin and high temperatures. The tip and heater assembly can be changed in less than 30 sec. The iron is rated 6 v, 12 w. It is available with 6-v transformer integral with a 6-ft cordset, or with cordset and terminals less transformer. Tip is approximately 5/32 in. in diam and the shank is 1/8 in. in diam.

General Electric Co., Dept. ED, Industrial Heating Dept., Schenectady 5, N.Y.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

4-Channel Oscilloscope

Strain Analysis

Uses for the H-42B range from pulse control and meaurement to stress and strain analysis, resonance studies, studies of impact and vibration, and similar fields. Frequency range is dc to 100 kc ± 0.5 db; or 150 kc ± 3 db. The 4-gun tube has a 5″ flat face and provides high intensity spot for recording on moving film. Input innformation may be either differential or single-ended. Thus associated transducers may include ferro-electric or piezo-electric crystals and strain gauges in quarter or half bridge of any resistance between 50 and 5000 ohms.

Features include automatic amplitude calibration; stable dc amplifiers adjustable to both static and dynamic balance; driven sweep with automatic lockout; 4-step sequence timer; crystal-controlled timing pulse and full provisions for synchronization and control of drum, still and moving film cameras.

Electronic Tube Corporation, Dept ED, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

Critical operating examination of electronic products and systems under simulated environmental conditions

Trial by Ordeal

Altitude
Vibration
Radio Noise
Salt Spray
Humidity
Shock

Private industry and government agencies now have access to one of the nation's most modern, instrumented, performance and environmental testing laboratories. Here, electronic equipment is subjected to trial by ordeal, analyzed and evaluated with respect to compliance with performance requirements.

Four distinct laboratory phases are offered, all with automatic programming and/or recording of test schedules: 1/ Formulation of testing techniques, 2/ Qualification and reliability testing, 3/ Environmental testing, 4/ Engineering analysis and product evaluation.

Rain
Sand & Dust
Temperature
Acceleration
Sunshine
Explosion
Combined environments

Complete engineering reports are prepared on all phases of the test program. Design change recommendations for equipment improvement are included when requested. Write for illustrated technical folder BJ 58-116.

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CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

Designing to total dynamic environment . . .

A NEW CONCEPT in shock and vibration protection

for missiles and jets

The total dynamic environment against which equipment must be protected in missiles and jets is so violent that protection by conventional unit isolators is impractical. Unit isolators built to meet the demands of this service would be relatively huge, yet there is no room for even admittedly inadequate present-day isolators.

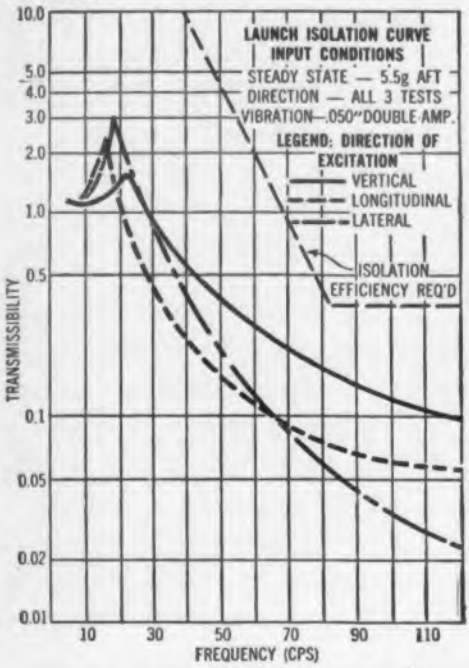

Figure 1. Graph showing specified limits of isolation efficiency during missile launching and the performance of distributed-element mounting system.

The total dynamic environment

Severe shock during launching, high *g* values of sustained acceleration with superimposed vibration, high-amplitude vibrations, and operation through all flight attitudes from horizontal to vertical — these are the elements of the dynamic environment met in currently operational missiles and detailed in the following specifications.

- Effective vibration isolation under steady-state acceleration of 6 g
- Shock transmissibility not over one for 15-g, 11-millisecond half-sine-wave shock, per Procedure I, MIL-E-5272A
- No snubber contact under high-amplitude low-frequency vibration input
- Low transmissibility at resonance
- Effective vibration isolation for all frequencies above 50 cycles per second
- Compliance with these requirements for every mounting position or attitude
- Provision of the required characteristics in an isolation system of minimum size and weight.

Obviously, MIL-spec isolators are inadequate to meet these stringent requirements.

A distributed system

A totally new design concept — a distributed-element isolation system — not only does the necessary job but provides substantial space savings as well. This is how it works. A number of small, single-degree-of-freedom, spring-and-friction-damper elements are so disposed about the mounted units that spring rates are equal for all directions of loading. This makes the isolation characteristics the same for every operating or installation position.

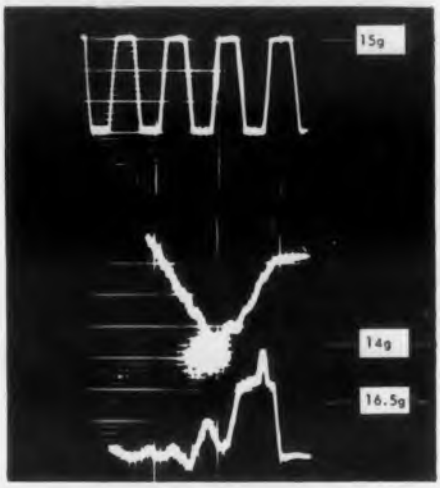

Figure 2. Oscillogram for shock test along vertical axis for an integral mounting system carrying two, six-pound electronic units. Upper trace: amplitude calibration at 60 cps. Middle trace: output from mockup of equipment. Lower trace: input to mounting assembly.

Matching the environment

With this new design concept, both the stiffness and the damping of the individual isolation elements can be selected so that the system is matched to the application. Thus it becomes feasible to provide greater shock protection in one plane, to design for different vibration inputs from different directions, or to provide whatever compensation is needed to suit the total dynamic environment. And because the separate elements can be located wherever space is available, this system minimizes space requirements.

A further advantage of this protection system is the ability to accommodate large vibration amplitudes without snubber contact. This is a result of the non-linear friction damping that can be set to limit the movement of the equipment under resonant conditions. This type of damping also allows efficient isolation of low-amplitude, high-frequency vibration because only slight damping occurs at the higher frequencies.

Additional design data

Ask for Report No. 602 giving detailed information on the specifications being met by Barry Integral Bases using the "distributed-element isolation" concept of characteristic selection.

Barry's new Western Division, in Burbank, Cal., offers fast, on-the-spot design and prototype service, and production of special systems.

BARRY B MOUNT

BARRY CONTROLS

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SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

775 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Electronic Timer
High Accuracy

This timer was designed for highest accuracy at the shortest time intervals. It has a repeat accuracy of better than ±0.01 sec and a reset time of less than 0.01 sec. Accuracy is essentially independent of line voltage between 100 and 125 v ac, 60 cy, 1 phase. A plug-in packaged unit in a watertight box, it can be incorporated into other equipment or used by itself. There is a single calibrated dial covering a range from 0.05 to 2 sec. Other ranges are available. The arrangement of the outlets vary from one that has full line voltage output independent of the timed cycle to three relay load outlets, one wired normally closed, one wired normally open and one that can be wired either normally open or normally closed. They are rated for 2 amp, 115 v, ac noninductive.

C. W. Logeman Co., Dept. ED, 633 Bergen St., Brooklyn 38, N.Y.

CIRCLE 133 ON READER-SERVICE CARD FOR MORE INFORMATION

Switches
Corrosion Resistant

Designed for use in rockets and similar aircraft applications, these precision switches successfully resist the corrosive effects of many rocket propulsion gases. The 21AX Series consists of an environment-proof, high capacity switch unit attached to a cam-type actuator that will withstand heavy impact. The unit is qualified under MS24331. Contact arrangement for the 21AS1 is a two-circuit dt, and that for the 21AS2 is spst.

Minneapolis Honeywell Regulator Co., Micro Switch Div., Dept. ED, Freeport, Ill.

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

Microwave Absorber
Waveguide or Coax

Eccosorb MF is a series of plastic rods and sheets which is used in waveguide or coaxial line as absorbers, attenuators, terminations and loads. Easily machinable, these materials have a high total dissipation factor over the entire microwave frequency range. Suggested designs for both step and uniform tapers are supplied. Completely nonporous, Eccosorb MF needs no moisture protection on machined surfaces. It can be used up to 350 F. Each member of the series has a different attenuation per unit length.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION

Ferrite Isolator
S-Band Miniature

The 400KW resonant absorption isolator furnishes sufficient isolation between the magnetron and RF energy reflected from line mismatches to insure optimum magnetron spectrum and power output. Since the ferrite is mounted directly on the waveguide wall, heat conduction away from the ferrite is quite rapid, allowing operation at high power levels without forced air cooling. It operates over a frequency range of 2700 to 2900 mc, with an isolation of 15 db minimum, an insertion loss of 0.5 db and an input vswr of 1.10 with matched loads. Operational characteristics are guaranteed under vibration specification MIL-E-5272A.

Airtron, Inc., Dept ED, West Elizabeth Avenue, Linden, N. J.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Zippertubing

REDUCES TIME AND LABOR COSTS

IMPORTANT ADVANCE IN ELECTRONIC HARNESS ASSEMBLY-ELIMINATES LACING AND TYING OPERATION

Meets military specs. MIL-I-7444A (1), MIL-I-631C

AIR FORCE APPROVED

This revolutionary new zipper-style plastic tubing, "Zippertubing," is used to enclose, protect and identify multi-conductor wiring in the aircraft, electronic or electrical industries. The extreme simplicity and ease with which wiring can be encased will reduce the normal time spent on wire harnessing and cable covering by as much as 90%. With Zippertubing, a secure jacket can be applied in seconds and prevents abrasive wear on expensive custom cabling, or used as a substitute for lacing and tying, as wiring ducts, for wire marking, etc. When Zippertubing is used, the need for dilating conventional tubing is eliminated.

Zippertubing is flexible, provides accessibility to work points, and offers ease of application. Zippertubing is available in nine colors, including black and clear plastic, and can be obtained in continuous lengths from 20 to 300 feet. When closed, it will withstand a linear strength test of 45 lbs. per inch and is available from ½" to 4" I.D.'s. Additional strength available if required.

Write today to find out how Zippertubing will reduce your time and labor costs. CALL THE DISTRIBUTOR OR REPRESENTATIVE IN YOUR AREA. HE WILL BE HAPPY TO DISCUSS YOUR APPLICATION.

Short length used as cable marker—closed manually or sealed.

Zippertubing Cross Section of Standard Configuration for General Purpose Use.

Zippertubing Cross Section of Military Configurations, Air Force Approved Construction.

The broad applications, specifications and versatility of Zippertubing are completely described in this bulletin available to you. Write for it today.

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Patented & Patents Applied for

Division of Walter A. Plummer Co.

Sales Office: 5333 So. Sepulveda Blvd. — Culver City, California

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New Products

Capacitors
High Stability

The capacitance drift of these plastic film capacitors, within a temperature range of —20 to 150 F, will not exceed 1/10 of 1 per cent. In a wider range of —30 to 212 F, the drift will not exceed 1/4 of 1 per cent. From —60 to 250 F, the deviation is not greater than 1 per cent. Size of these capacitors is held to small dimensions. The 1 mfd 300 v unit, for example, measures 1 in. in diam x 2 7/16 in. long. Insulation resistance is 1000 megs x mfds at 250 F. Units are hermetically sealed in non-magnetic tubes with compression glass seals. Designated PS-200, the line is available in 300 v, 600 v and 1000 v ratings, and in all case styles.

Electron Products Co., Dept. ED, 430 No. Halstead Ave., Pasadena, Calif.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

Tachometer Calibrator
Accuracy of 1 RPM

A new type of test instrument is now being offered to fill a long-standing need of instrument repair shops, particularly those concerned with aviation instrumentation.

Known as the Model ST-901 Tachometer Calibrator, the test instrument is basically a decade type counter combined with an adjustable-speed drive. The tachometer under test is driven at a speed of (usually from 0 to 5000 rpm) that is infinitely adjustable by means of a 10-turn potentiometer. For rapid production testing, a push-button switch will select any one of five predetermined test speeds. The driving speed is continuously displayed with an accuracy of ±1 rpm, plus line frequency error. Provisions are made for use of the counter for other purposes such as checking inverter frenquency, telemetering switch counts, etc. Counting speeds up to 50,000 per sec are possible. An electronic pickup is supplied as a standard accessory to permit checking rotational or lineal speed.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Rd., Hawthorne, N.J.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

Coax Switches

0 to 500 Mc Range

Type 149 switches are designed for complex coax switching in the 0-500 mc range. The vswr varies with frequency and number of inputs. Typical values for 6 inputs are 1.05 at 100 mc and 1.25 at 400 mc. They can be supplied with each input normally shorted to ground, normally open or normally resistor terminated in a 1/2 w shielded resistor. With normally open or resistor terminated inputs the crosstalk is 60 db at 19 mc and 40 db at 400 mc. With normally shorted inputs the crosstalk figure is 25 db greater. Different types range from 1 to 6 p and 2 to 12 t. There is one coil for each input. Two or more coils may be energized to connect two or more inputs to the common output. Type 149 switches are available only with dc operating coils for 6, 12, 24, 48, 100 or 120 v dc. Each coil requires 2 w operating power. The switches are available with MB, BNC, UHF or Type C connectors.

Danbury-Knudsen, Inc., Dept ED, P. O. Box 170 Danbury, Conn.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Clutch

For Low Torque

An electro-magnetically operated miniature clutch has been designed for use on low torque drive of instruments and miniaturized control mechanisms. The model designation for the clutch is SD-100. The unit gives instantaneous, positive engagement and release of loads up to 2 lb in. (static torque rating). Axial length of the unit is 7/8 in. and diameter is 1-1/8 in. In the clutch, torque is transmitted through the rotor to the armature which may be keyed to the driving or driven member. Power required is 6 w maximum.

Warner Electric Brake & Clutch Co., Dept ED, Beloit, Wis.

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You don't need a light touch to keep from stripping threads

...use HELI-COIL® Screw-Thread Inserts

Precision-Formed Stainless Steel Wire Inserts Produce Permanent Threads in Tapped Holes.

No need to worry about too much load on tapped threads when you use *Heli-Coil* Inserts. They withstand excessive torque and, even in soft metals, bolt will shear off before female threads strip. Thread life is increased . . . corrosion, seizing and galling eliminated. *Heli-Coil* Inserts allow designers to use standard bosses, lighter materials, shorter and fewer fasteners—save time, space, weight and assembly costs. Mail coupon for complete data. Also ask for information on the *NEW* Screw-Lock Inserts which give all benefits of the regular insert *plus* an internal lock. Use instead of lock nuts, lock wiring, etc.

*Reg. U.S. Pat. Off.

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CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

for waveform analysis...

there's nothing like LF-2

FOR FLEXIBILITY
FOR HIGH RESOLUTION

The LF-2 is a heterodyne type analyzer which automatically presents a permanent paper recording of the frequency and amplitude of components between 0.5 cps and 2250 cps. The LF-2 is used for vibration and sound analysis of large structures or devices in which members rotate or oscillate at approximately the same or multiples of the same rate • acoustics • noise analysis • servo analysis • geophysical investigations • medical studies • general low frequency waveform investigations.
By analyzing waveform content—obtained through converting any given parameter into electrical energy by means of a sensing device such as a microphone or other transducer—you can

detect defects,
check variations,
make adjustments,
test production,
improve design

PANORAMIC'S SUBSONIC Waveform ANALYZER LF-2

No rigid frequency segments here! The LF-2's scan range selector provides 6 different scan widths which may be centered at almost any point of the instrument's frequency range with the variable center frequency control. Check the table below.

A maximum resolution of 1/10 cps! The LF-2's range of scan intervals and sweepwidths make possible exceptional resolution. Check the table below.

Definitive amplitude! The LF-2's dual amplitude scales —20 db linear and 40 db log—permit a broad range of comparative analyses.

Scan Range	Linear Scan Widths (cps)	Cps Resolution at Scan Intervals of		
		10 sec.*	2 min.	16 min.
X 1.0 (0—2250 cps frequency)	500	12	3.5	1.5
	100	6	1.7	0.75
	20	3	0.7	0.5
X 0.1 (0—225 cps frequency)	50	—	1.0	0.5
	10	—	0.5	0.25
	2	0.7	0.18	0.1

*Useable only with external oscilloscope.

Yes, there's nothing like the LF-2. Complex? Not at all! It's as simple as this:

1. For a quick overall look, set dials for maximum scan width and short scan interval.
2. Select area of interest.
3. Select scan width and scan interval for detail and degree of resolution desired. (The narrower the scan width, the longer the scan interval, the higher the resolution.)
4. Result—a quickly obtained, accurate, detailed, recording of waveform content.

Investigate this VERSATILE TOOL today. There's a Panoramic Spectrum Analyzer (Subsonic through Microwave) to meet every need! A Panoramic Applications Engineer is always available to discuss specific problems.

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Clutches and Brakes

No Release Drag

A poleshoe and hub assembly adapts these miniature electromagnetic clutches and brakes to applications that require zero drag release. The assembly provides complete release when the clutch or brake is de-energized and zero backlash when it is energized. The new poleshoe retains the design feature that permits the units to handle considerable misalignment (up to 3 deg angular) without binding or loss of power.

Clutches or brakes in either the 100 or 130 series are available from stock with the poleshoe and hub assembly. Series 100 units measure 15/16 in. diam by 2 in. long and deliver torque in excess of 3 in. lb. Series 130 units measure 1-5/6 in. diam by 2-3/4 in. long and deliver 7 in. lb of torque. Maximum power consumption is 3 w.

Dial Products Co., Dept ED, 9 Ave. E Bayonne, N.J.

CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION

Terminal Blocks

Low Cost

Molded of U.L. approved plastic, these terminal blocks feature low moisture absorption, dimensional stability and good dielectric strength. The disconnect terminal blocks are available in many sizes, shapes and terminal arrangements to meet custom multiple circuit requirements. Barriers eliminate terminal turning. All models accept standard female terminal connectors. Model 665, shown, also provides binding screws for incoming feed attachment where amperage exceeds U.L. specifications for single tab connections.

Molex Products Co., Dept. ED, 9515 Southview Ave., Brookfield, Ill.

CIRCLE 150 ON READER SERVICE CARD FOR MORE INFORMATION

Instrumentation Amplifier

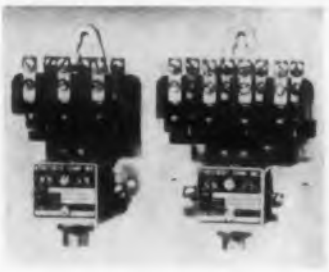
Gain of 15 to 100

The REL-102 instrumentation amplifier covers the subsonic, sonic and ultrasonic regions. The design accomplishes the function of amplifying and impedance transforming low level signals from transducers, to a level and an impedance suitable to drive a transmission line, subcarrier oscillator, direct writing recorder or an oscillograph recorder at a considerable distance from the pick-up.

The REL-102 will handle input signals in the range of 10 to 50 mv pp. The gain control stage is capable of varying the gain from 15 to 100 continuously. The square wave frequency response is flat within $\pm$.75 db from 5 cps to 20 kc. The total amplitude distortion throughout the passband is less than 0.5 per cent. The noise output referred to the input is less than 6 mv with a gain setting of 100. The REL-102 will deliver a 5 v pp signal into a 600 ohm load.

Rheem Manufacturing Co., Dept. ED, 9236 East Hall Rd., Downey, Calif.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION



AC Contactors

3 and 4 Pole

Type 48KXX three-pole and Type 48LXX four-pole ac contactors are single-unit versions of the S-D Type 175KXX mechanically-interlocked reversing contactor. Suited for built-in control, these contactors are expected to find wide use in the control of ac motors, solenoids, heaters and other loads. Single-throw double-break contacts are individually sprung to maintain contact alignment. Contacts are of fine silver in melamine arc chutes and afford a generous safety factor under high overload conditions. Conservatively rated at 15 amp standard ac voltages to 600 v. Horsepower ratings range from 3 hp for 440- to 550-v service and 2 hp for 110- to 22-v 2- and 3- phase service, to 1-1/2 hp for 230-v and 1 hp for 115-v single-phase service.

Struthers-Dunn, Inc., Dept. ED, Pitman, N.J.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

8 laboratories at FTL

offer unlimited opportunities to top engineers and scientists

1. Radio Navigation **2.** Missile Guidance
3. Electronic Countermeasures **4.** Electronic Systems
5. Radio Communication **6.** Physical-Chemical
7. Electron Tubes **8.** Wire Communication

In suburban New Jersey—only a few minutes away from New York City—at least *one* of these 8 research and development "centers" comprising Federal Telecommunication Laboratories offers a solid future to you!

Whether your field is computers, data processing, radio communication, air navigation, missile guidance, electronic countermeasures, antennas, transistors, traveling wave tubes or telephone switching, you can be sure your assignment will be interesting, challenging and rewarding.

Opportunities at FTL are unlimited. Our program is long-range . . . commercial and military. We have the finest facilities . . . our future is expanding on both coasts. Ability reaches the spotlight quickly under our "small-company" project system.

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FTL's East Coast Laboratory, Nutley, N. J.
—only 28 minutes from New York City

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● Opportunities for relaxed living and career-building also available at FTL's West Coast Laboratory . . . with openings in Digital Computers, Inertial Navigation Systems and Infra Red Systems. Write to 15191 Bledsoe St., San Fernando, Cal.

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Federal Telecommunication Laboratories
500 Washington Avenue, Nutley, N. J.
Please send literature describing opportunities and benefits at FTL, in Nutley, New Jersey.

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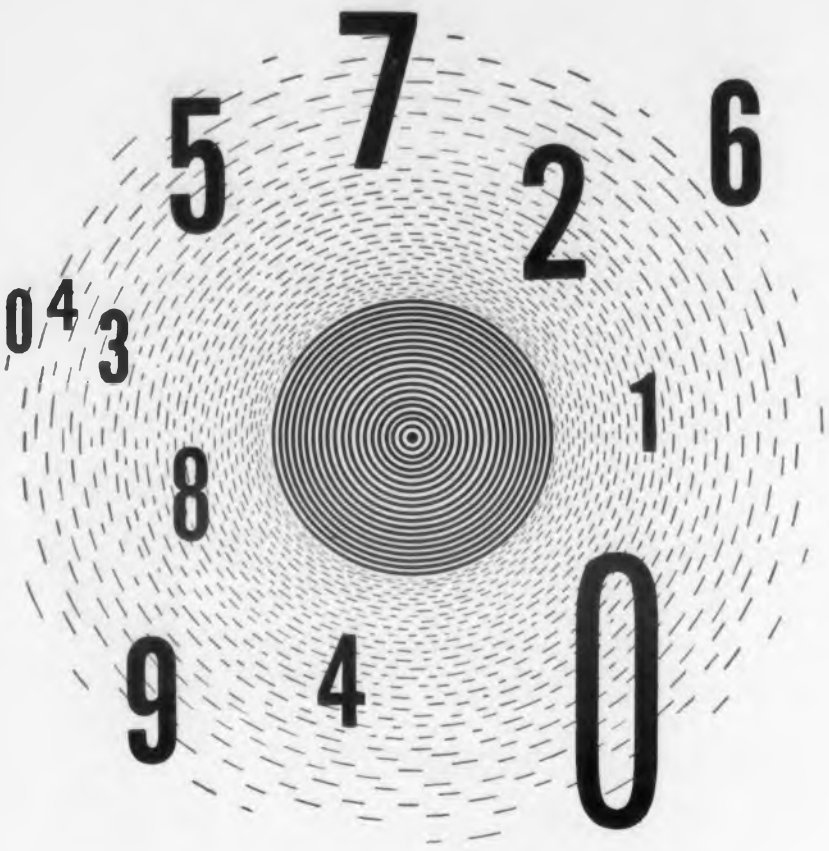
A DIVISION OF IT&T

Federal Telecommunication Laboratories
A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

CIRCLE 567 ON READER-SERVICE CARD FOR MORE INFORMATION



analog-to-digital

KEARFOTT ANALOG-TO-DIGITAL CONVERTERS

TRANSLATE SHAFT ROTATION INTO ELECTRICAL AND VISUAL DIGITAL FORM

KEARFOTT DIRECT DRIVE ADAC is a shaft-positioned analog-to-digital device utilizing coded drums, interconnected by high-speed odometer type gearing to provide an electrical impulse representing shaft position. Available for a wide variety of capacities and codings.

KEARFOTT MECHANICAL COUNTERS are used to provide precise visual presentations of angular position, latitude, longitude, or any information imparted by shaft rotation. Both types are designed to provide long life at maximum slewing speeds up to 1800 R.P.M.

KEARFOTT LATITUDE COUNTER

KEARFOTT ANGLE COUNTER

KEARFOTT ADAC (2^{15}) 32,768

KEARFOTT ADAC 0° TO 359.9°

KEARFOTT COMPONENTS INCLUDE:
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Indicators and other Electrical and Mechanical Components.

KEARFOTT SYSTEMS INCLUDE:
Directional Gyro Compass Systems, Three Gyro Stable Platform Systems and Inertial Navigational Systems.

Send for bulletin giving data of components of interest to you.

KEARFOTT COMPANY, INC., Little Falls, N. J.

Sales and Engineering Offices:
1378 Main Avenue, Clifton, N. J.

Midwest Office:
23 W. Calendar Ave., La Grange, Ill.

South Central Office:
6211 Denton Drive, Dallas, Texas

West Coast Offices:
253 N. Vinedo Avenue, Pasadena, Calif.

Kearfott

A SUBSIDIARY OF GPC
GENERAL PRECISION EQUIPMENT CORPORATION

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Ultrasonic Probe

For Calibration

Model UP-800 and UP-800C probes provide a simple method of checking and calibrating ultrasonic equipment. The probes, with a range of 2 kc to 2 mc, will calibrate ultrasonic medical units, check the operation of industrial ultrasonic equipment, and will measure and control ultrasonic intensity levels or beam uniformity. Model UP-800 is calibrated at 500 kc and the UP-800C is calibrated at five points: 40 kc, 300 kc, 500 kc, 700 kc, and 1 mc, to an accuracy of ±2db. Both styles come complete with Glennite C-5 connectors and cables for direct reading through standard laboratory voltmeters. The probe causes only minimum disturbance of the acoustic field being measured.

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

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Power Supply

0.5 Per Cent Regulation

The Model KM236-15 is a 2 to 36 v, 0 to 15 amp continuous duty dc supply regulated by magnetic amplifiers. In the range 2 to 36 v, the output voltage variation is less than 0.5 per cent for line fluctuation from 105 to 125 v, and less than 0.5 per cent or 25 mv, whichever is greater, for load variations from minimum to maximum current. The ripple is less than 0.5 per cent or 25 mv rms. Output voltage is always within 0.5 per cent during the recovery period, and a short circuit will not damage the supply, and the full current may be drawn at any voltage from 2 to 36 v. It measures 12-1/4 in. high by 19 in. wide by 17 in. deep. The supply is also available in 30 and 50 amp versions.

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

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION

Package Circuit

Wide Range of Components

Designed primarily for use with printed wiring applications, the packaged circuit, called Pac, permits the insertion of a wide range of capacitors and resistors in simple or complex circuitry. Each unit is based on components of uniform dimensions, 1/8 in. in diameter and 5/8 in. long. Components available with the Pac unit include an extensive range of capacitance values available in the company's tubular ceramic capacitors and the complete range of resistance values available in fixed composition resistors. Center to center spacing between components is 0.2 in. Maximum number of components in a single package is limited only by the length of the strip considered practical to use.

Components available with the Pac include temperature compensating capacitors in three groups: RETMA U2M (10-148 μμf), RETMA Y5Y (148-2400 μμf), RETMA Z5Z (2401-5100 μμf); resistors are available ranging from 10 ohms to 20 meg.

Jeffers Electronics Div., Dept ED, Speer Carbon Co., Dubois, Pa.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

Temperature Control

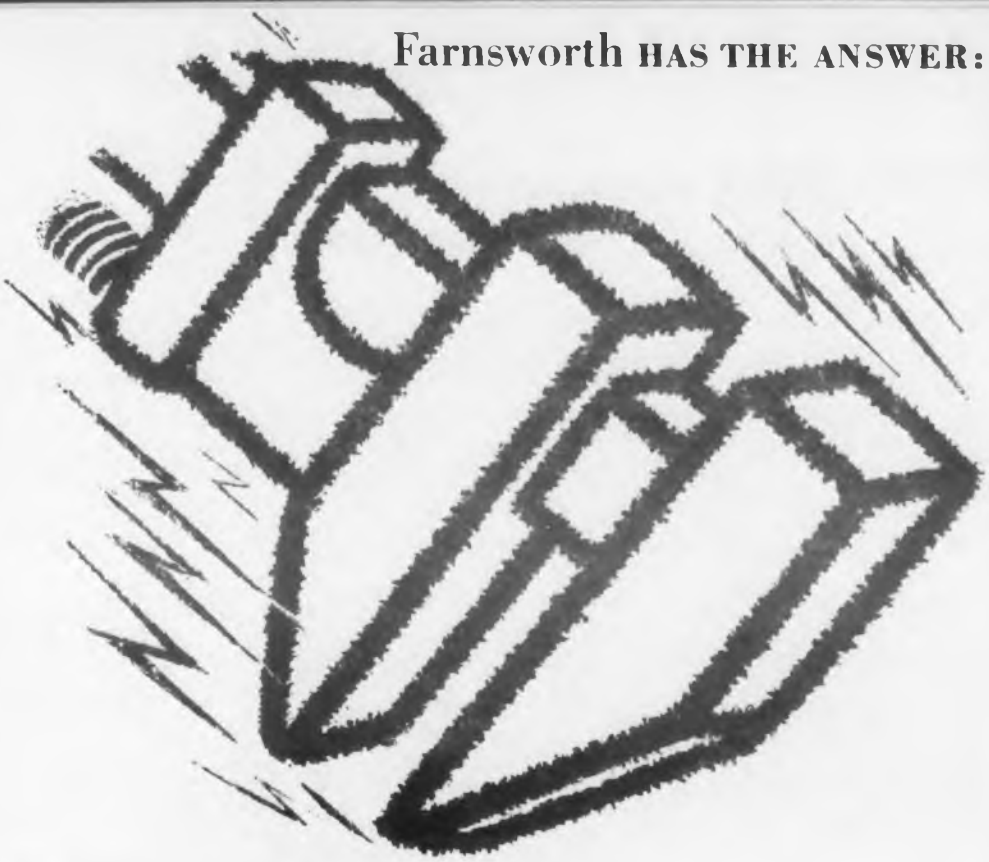
High Sensitivity

This thermocouple consists of a high sensitivity meter-relay and load relay together with other components, all contained in a single compact package. Control action may be either limit or automatic. Limit compacts trip a relay and lock and must be reset externally. These may be used for temperature monitoring or alarm. Automatic compacts include an automatic interrupter for periodic reset and these will control heaters or coolers. Also available are low limit and high and low double contact models for detecting any change in temperature. Accuracy is 2 per cent from 40 to 90 F, and 5 per cent from −40 to +150 F ambient.

Assembly Products, Inc., Dept. ED, P.O. Box XX, Palm Springs, Calif.

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

Farnsworth HAS THE ANSWER:



How to throw an *Electronic* Monkey Wrench

Attack . . . counterattack . . . offense . . . defense — for every tactical movement there must be an effective answer. That is why we must be able to employ a defense that literally "throws a monkey wrench" into the enemy's operations.

Our very survival may depend upon what is known to the military as—countermeasures. These embrace most of the sciences; they call for vast knowledge, many skills and unlimited imagination . . . in the use of radar, infrared, microwave, and other techniques.

Farnsworth scientists and engineers have these abilities and facilities . . . that is why they have been selected to devise, test, and produce various electronic countermeasure systems and equipment that will confuse, stall, and stop the enemy.

Farnsworth

CAREER OPPORTUNITIES: There are important new openings on our professional staff for graduate engineers and scientists in these fields. Write for information. Confidential.

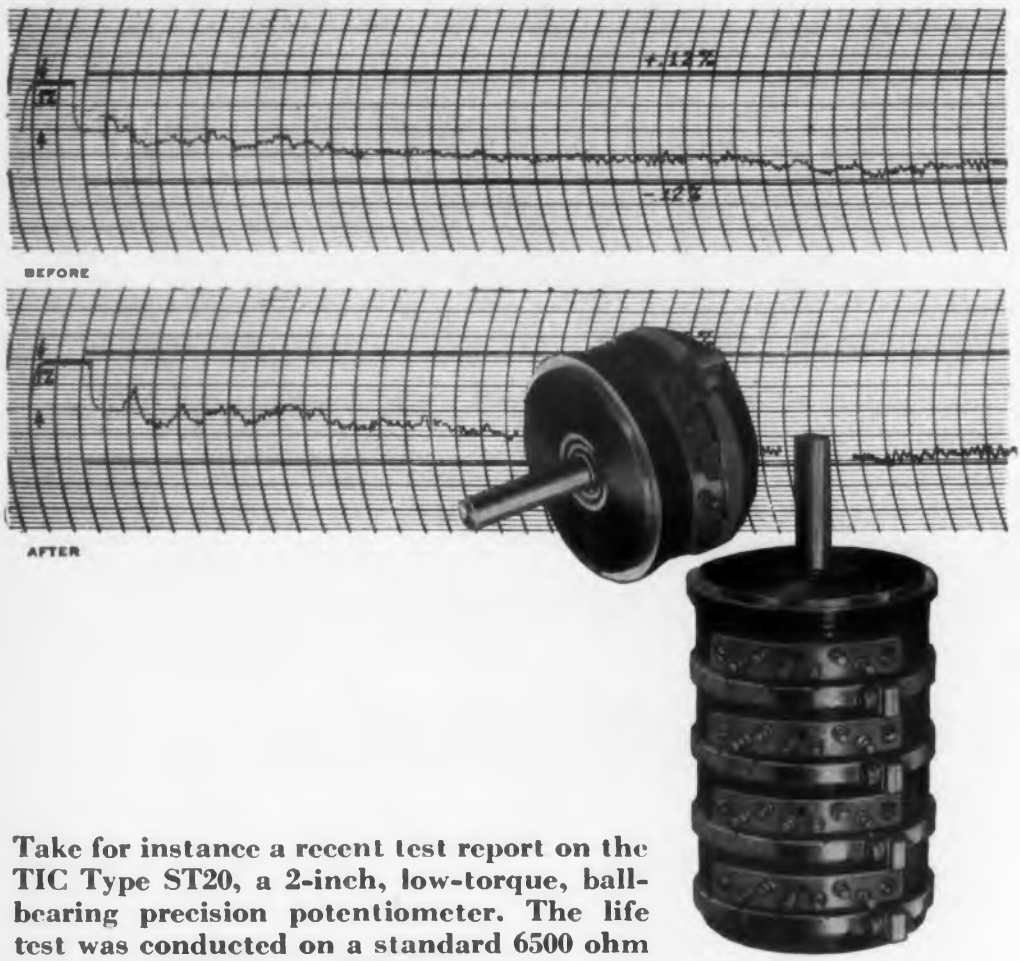
A DIVISION OF IT&T

FARNSWORTH ELECTRONICS COMPANY, Fort Wayne 1, Indiana
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION

LIFE IS NO PROBLEM

WITH TIC PRECISION POTENTIOMETERS



Take for instance a recent test report on the TIC Type ST20, a 2-inch, low-torque, ball-bearing precision potentiometer. The life test was conducted on a standard 6500 ohm unit. At 30RPM the ST20 was subjected to 700,000 cycles, reversing direction every 30 minutes. The linearity graphs shown above show the before and after of the ST20's independent linearity. *As can be seen, the linearity change is imperceptible.*

Some of the change in linearity after the life cycling can be attributed to change in effective resolution due to contact wear. Other results from the life test indicate less than 100 ohm equivalent noise resistance except for one spot, where it was less than 1000 ohms. The 1000 ohm spot was of such short duration that the linearity recording did not pick it up. **Test Summary: The ST20 will perform with only infinitesimal degradation for over 700,000 cycles.** If it's long life *at full precision performance*, that you want, specify precision potentiometers by TIC.

TECHNOLOGY INSTRUMENT CORP.

555 Main Street, Acton, Mass. COlonial 3-7711
West Coast Mail Address, Box 3941, No. Hollywood, Calif. POplar 5-8620

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Hook Up Wire

No Overbraid or Jacket

Using a thin-wall insulation this type does not require an overbraid or thick jacket and offers the advantages of less contact resistance when penetrating terminals are used, elimination of wire breakage, and greater conductivity for the same overall OD wire.

The wire is a copper conductor either solid or stranded with a thin-wall of Synthinol covering. Wire breakage was lessened by increasing the conductor size from 24 to 22 AWG without increasing the overall OD. Dimensions of the hook-up wire are 0.051 for stranded (conductor alone .030) and .46 for solid (conductor alone .025). The synthinol covering is resistant to cut-through and penetration, eliminating the need for protective coverings.

Rome Cable Corp., Dept. ED, Rome, N.Y.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

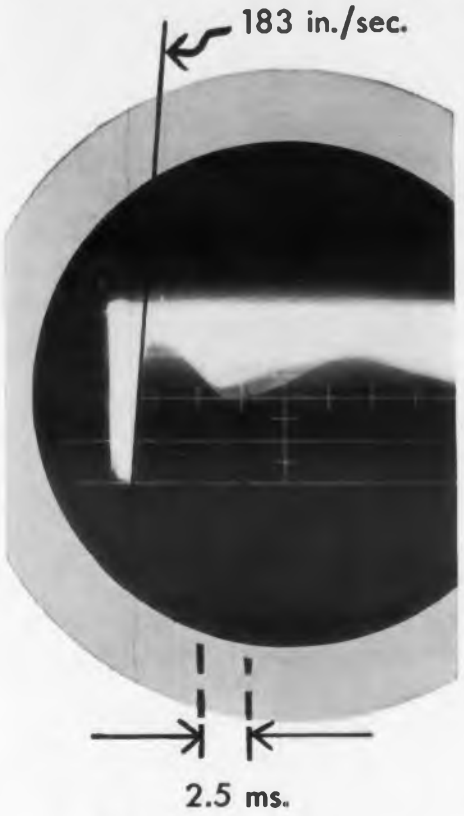
Thermowells

Wide Variety

An expanded line of thermowells, both bar stock and built-up types, provide a means of protecting thermocouples against mechanical injury and corrosive or contaminating atmospheres. T-E Thermowells are available in over 5700 different combinations to satisfy almost any temperature, environmental or installation requirements. A wide range of alloys provides individual thermowells to meet specific conditions of high temperature, oxidation or reduction, chemical corrosion, metallic amalgamation, mechanical shock or stress, and sudden temperature change. They are available flanged or threaded, with hex head or wrench flats or with ground joints.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N.J.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION



How to move a plunger **at 900 g's**

Problem: Design an assembly to release a gate on the sorting mechanism of a business machine.

The assembly must actuate a plunger, getting it out of the way in 2.5 milliseconds.

It must be reliable over a long life. Keep it small. Keep cost low.

Our solution: A marriage of pulse circuit techniques and electromagnetic plunger techniques in an electromechanical transducer.

The final unit develops an acceleration of *950 g's* and a peak velocity of 183 inches per second. A force of 74 pounds moves the 1.25 ounce plunger .051 inches. The plunger moves 90% of this distance in only 0.5 millisecond—only 1/5th of the time allowed.

If you want an electronic assembly, designed and produced in large or small quantities, contact...

CALEDONIA
ELECTRONICS AND TRANSFORMER CORPORATION

Dept. ED-6, Caledonia, N.Y.

In Canada: **Hackbusch Electronics, Ltd. 23 Primrose Ave., Toronto 4**

CIRCLE 167 ON READER-SERVICE CARD

Frequency Monitor
± 1 Per Cent Accuracy

A transistor driven switch, Model 1033 M, is actuated as a function of the input signal frequency, and has an accuracy of ± 1 per cent over the entire environmental range. The switch contacts close whenever the input signal frequency is 380 cps or greater. If the signal frequency drops below 380 cps, the contacts will reopen. The switch is spdt with contacts rated at 2 amp at 28 ds. The device is designated to withstand 30g shock and 10g vibration from 10 cps to 2000 cps. Recommended operating temperature limits are —55 to +85 C. Input power required is 115 v 400 cps ac. Similar units with operating frequencies from 15 cps to 200 kc are also available.

Atlas Electro-Mechanical Laboratories, Inc., Dept ED, 14734 Arminta Street, Panorama City, Calif.

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION

60 Cps Choppers
For Low Level DC

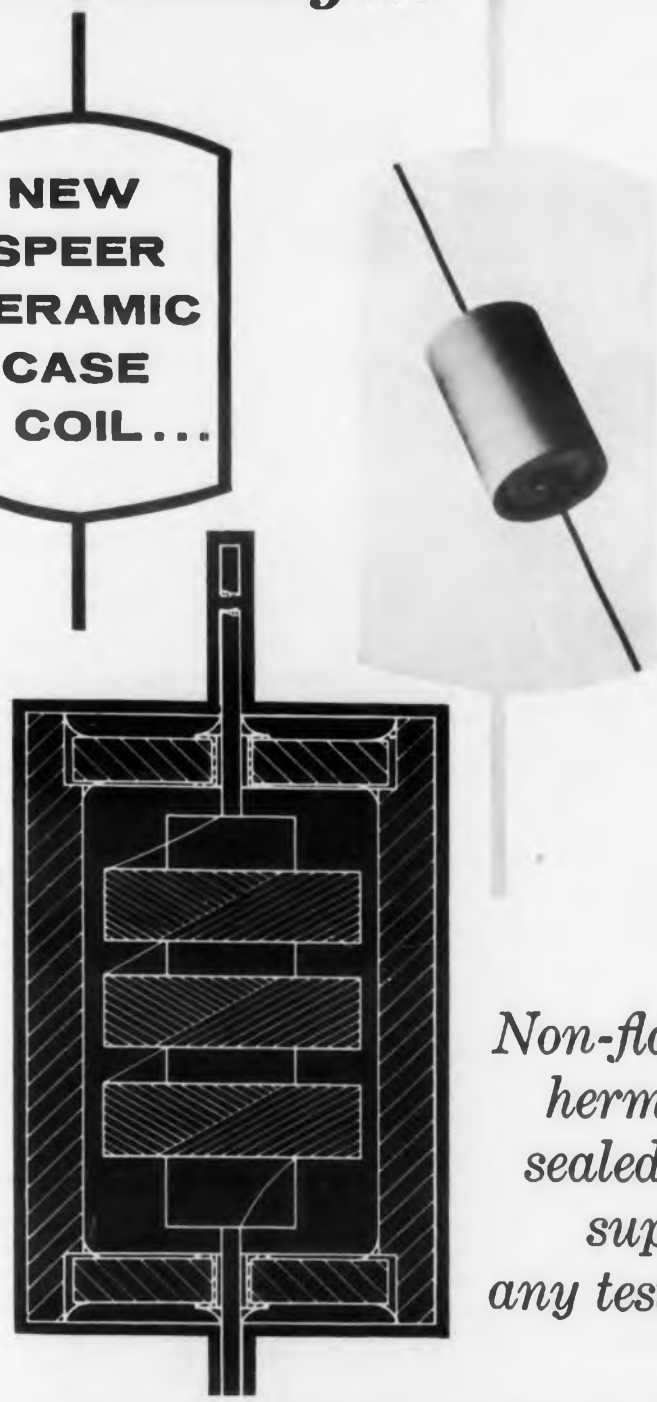
The Microverter may be used to convert a low level dc signal, e.g. 10 μv such as produced by thermocouples and photocells, into a low level ac signal which can be further amplified to operate various control apparati. The chopper may also be used as a synchronous rectifier to convert low level ac signals to dc without loss. An important field of application is chopper stabilized operational amplifiers where minimum amplifier zero drift is important. Construction has contributed to a service life of 10,000 hrs at a contact load of 1 ma at 1 v dc resistive. Standard coils with dc resistances from 13 ohms to 7950 ohms are available for a driving voltage range from 0.5 v to 12 v rms.

Barber Colman Co., Dept. ED, 1400 Rock Street, Rockford, Ill.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

Announcing...

NEW SPEER CERAMIC CASE COIL...



Non-flammable, hermetically sealed . . . superior to any tested.

Now producers of precision electronic equipment have at hand a highly rel able, long-life inductance coil in a hermetically sealed moistureproof cerami case that is virtually unaffected by atmospheric conditions. Originally deve oped for use on high-speed computer equipment, it is eminently suited fc close tolerance inductance requirements under the most stringent operatin conditions.

Protection under all operating conditions, with no interference t the coil's frequency response, is assured by the steatite case.

Exact dimensional conformance of the case makes these coils ide for automatic assembly.

Performance characteristics and properties of steatite housing mat rials are well known and defined, while its non-strategic, ample suppl avoids possibility of shortage delays.

The new Speer Ceramic Case Coils are available in a complete inductance range up to 20 millihenries, and in a variety of designs, coil forms and physical sizes to meet every requirement. For complete test data and information contact:

JEFFERS ELECTRONICS

JEFFERS ELECTRONICS DIVISION
Speer Carbon Co. Du Bois, Pennsylvania

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

NOW – PORTABLE

400 cycle power

This new frequency changer makes it possible to provide well regulated 400 cycle power conveniently and quickly. This unit, Model FCR 250, is extremely useful in a wide variety of applications including testing, production, airborne frequency control, computers, missile guidance system testing, and in practically any application where the use of 400 cycle power is advantageous.

Model FCR 250 is only one of a complete line of frequency changers available from Sorensen . . . the authority on controlled power for research and industry. Write for complete information.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1 phase, 50-65 cycles
Output voltage	115 VAC, adjustable 105-125V
Output frequency	320-1000 cps in two ranges
Voltage regulation	±1%
Frequency regulation	±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)
Load range	0-250 VA

MODEL FCR 250

Sorensen

SORENSEN & COMPANY, INC. • STAMFORD, CONN.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Molding

New Techniques

Better use of the insulating properties of Teflon are being made through improved molding technique. Difficult to mold because of an absence of thermal flow inherent in other plastic materials, Teflon has always been an expensive material to work. The molding techniques now offered permit taking advantage of the wide range of Teflon's physical characteristics, and thus yielding parts of varying density, rigidity, and crystallinity as desired.

When shapes are simple and close tolerances are not required, the molding operations may merely consist of pressing the pre-form and sintering it. With very careful control of the weight of the powder to be preformed, of its distribution in the mold, and of the pressure applied, calculation of the dimensional changes can be estimated with sufficient accuracy to maintain fairly close tolerances without subsequent operations.

If satisfactory dimensions cannot be obtained in this manner or if the required contours are complex, a subsequent operation—either coining or machining—is necessary. Coining has distinct limitations, since the sintered shape must be fairly close to that of the required part. The coining sets up strains in the material which may increase the tendency to cold flow and limit the temperature at which coined parts can be used. Machining, although ordinarily more costly, will result in parts with closer tolerances and better dimensional stability, especially at higher temperatures.

Walter Lee Chemical Corp., Dept. ED, 1381 Seabury Ave., New York 61, N.Y.

CIRCLE 173 ON READER-SERVICE CARD

Subminiature Tubes

Pass White Noise Test

Consisting of four pentodes (types

NOW – PORTABLE

400 cycle power

This new frequency changer makes it possible to provide well regulated 400 cycle power conveniently and quickly. This unit, Model FCR 250, is extremely useful in a wide variety of applications including testing, production, airborne frequency control, computers, missile guidance system testing, and in practically any application where the use of 400 cycle power is advantageous.

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Frequency regulation	±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)
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MODEL FCR 250

Sorensen

SORENSEN & COMPANY, INC. • STAMFORD, CONN.

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Walter Lee Chemical Corp., Dept. ED, 1381 Seabury Ave., New York 61, N.Y.

CIRCLE 173 ON READER-SERVICE CARD

Subminiature Tubes

Pass White Noise Test

Consisting of four pentodes (types

6788, 6943, 6944, and 6945), two double triodes (types 6947 and 6948), and one single triode (type 6946), the tubes feature a shortened mount structure specifically designed to meet the environmental demands of missile usage. All seven tube types have passed the white noise vibration test. The seven tube types are of button header construction with bulb temperature rating of 250 C, and a maximum plate voltage of 250 v.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.

CIRCLE 174 ON READER-SERVICE CARD

Aircraft Control Valve

Rated at 4500 PSI

The Model MV-137-G is a three-way, normally open magnetically operated miniature pilot valve weighing 0.375 lb, and rated for up to 4500 psi service. A hermetically sealed solenoid, which operates within a 14 to 32 v range, controls the flow through what is equivalent to a sharp edge orifice diam of 0.030 in. The MV-137-G has an ambient temperature range of −100 F to +250 F. Its fluid temperature range is −65 F to +250 F.

Marotta Valve Corp., Dept. ED, Boonton, N.J.

CIRCLE 175 ON READER-SERVICE CARD

Aluminum Foil Tape

Pressure-Sensitive

A pressure-sensitive aluminum foil tape with silicone adhesive, Type 7402, has a 2-mil annealed foil backing and a completely inorganic silicone rubber adhesive. A holland-cloth liner allows easy dispensing. Temperature range for the foil tape is rated from −150 to +550 F, and in actual applications the tape has performed satisfactorily above 1000 F. Impermeable to water and vapor, the tape retains adhesion at high or below zero temperatures.

Mystik Adhesive Products, Dept. ED, 2635 N. Kildare Ave., Chicago 39, Ill.

CIRCLE 176 ON READER-SERVICE CARD

READY NOW!

New STYLE 506

SUB-MINIATURE RELAY

for Critical Applications in *Low Level Circuits* and for *General Purpose Use* on Aircraft and Missiles

STYLE 506 RELAYS—designed to meet the requirements of MIL-R-25018 (USAF)—are now in production at Price Electric Corporation. They are available in two types — for low level operation, and standard design for general purpose use. Both are hermetically sealed.

COIL DATA: Standard DC voltage is 26.5 VDC with DC coil resistance of 400 ohms ± 10% at 25C.

DUTY: Continuous

CONTACTS: Contact arrangement is DPDT. Standard contacts are suitable for low level circuits or general purpose use. Normal rating is 2 amperes, non-inductive at 26.5 VDC.

LIFE EXPECTANCY: Mechanical life in excess of 20,000,000 cycles. Exceeds 750,000 cycles at 2 amperes non-inductive.

CONSTRUCTION:

Low-Level Circuits

—special design permits isolation of all organic materials from the contact chamber. Each relay is assembled under "ideal" conditions in air-conditioned, pressurized room.

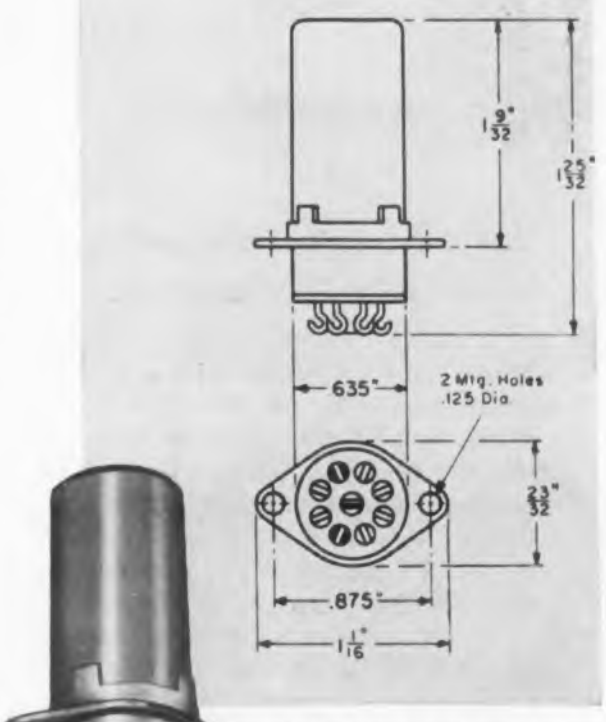
General Purpose

—standard design, without the isolation feature.

New balanced armature design gives high immunity to shock, vibration, and acceleration.

Two types of terminals available —solder (illustrated) or plug.

WEIGHT: 1.5 ounces



NOTE: When ordering, specify whether for "Low Level" or "General Purpose" use.

Actual Size

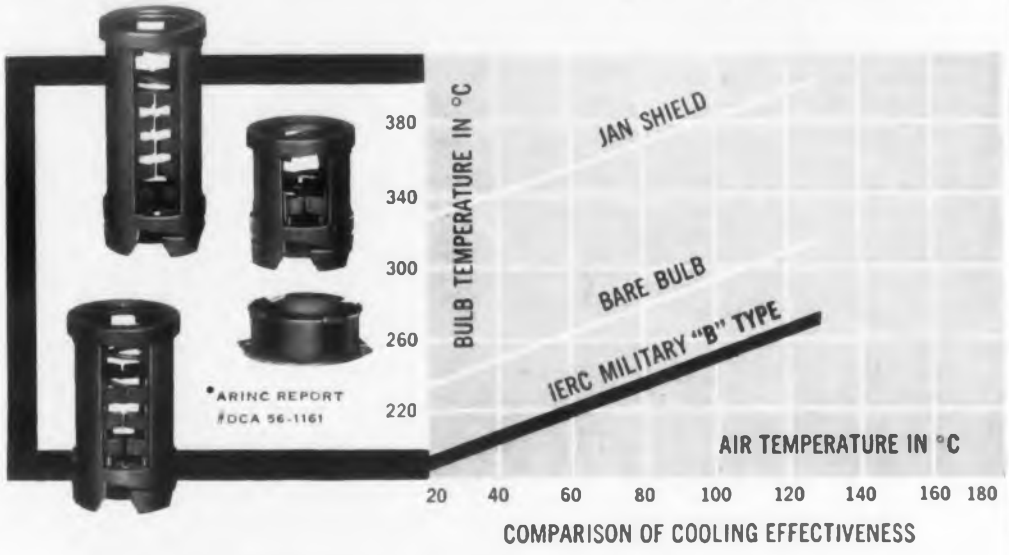
Price Electric CORPORATION

FREDERICK, MARYLAND

PRICE ELECTRIC CORP., FREDERICK, MD. HUSKY RELAYS, CONTROLS ®

CIRCLE 178 ON READER-SERVICE CARD FOR MORE INFORMATION

NOW—increase electron tube life *12 TIMES!



COMPARISON OF COOLING EFFECTIVENESS

Exclusive IERC Tube Cooling Effectiveness Provides Greatly Extended Tube Life And Reliability!

Though electronic engineers know that even the *slightest* tube temperature reduction improves tube life, the greatest success enjoyed in obtaining *extended* tube life has been when IERC Heat-dissipating Tube Shields have been specified and used. Results show that extensive gains in tube life and reliability are easily achieved—that tube operating temperatures are reduced as much as 150°C—that IERC's Military Type "B" shield is the *only effective answer* to obtain these benefits in *your* new equipment. Positive shock and vibration protection plus electrostatic shielding is provided. Graphs show temperature reductions when IERC "B" and "TR" shields are used with 6005 tube operating at full plate dissipation. Meets or exceeds Mil—S—9372B (USAF).

PATENTED OR PATS PEND CROSS-LICENSED WITH NORTH AMERICAN AVIATION, INC.

Retrofit For Maximum Tube Life

No modification is required with IERC "TR" Type Heat-dissipating tube shields! TR's fit easily to existing JAN sockets—greatly extend tube life through excellent cooling and retention against shock and vibration.

Complete IERC literature and Technical Bulletins sent on request. WRITE TODAY!

International
electronic research corporation

145 West Magnolia Boulevard, Burbank, California

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Heat Sensitive Film

For Graphic Recording

A heat sensitive film for graphic recording instruments features easy duplication, projection, or optical evaluation. The 100 gage polyester film base has transparency, stability, and resistance to tear. Heated or pressure loaded stylus renders the coating transparent. The coated film may be printed with a grid using a high solvent ink which also changes the coating from an opaque white to transparent. Hence, the printed and recorded film chart can be readily duplicated or projected for multiple viewing and discussion.

This recording medium is being used to transcribe data on multichannel pen recorders. Marginal notes, typed without a ribbon may be duplicated or projected with the chart grid and recording. The film is extremely thin which permits a long chart to be rolled within a small diameter.

Technical Paper Co., Inc., Dept. ED, 2430 East Linden Ave., Linden, N.J.

CIRCLE 181 ON READER-SERVICE CARD

Insulated Terminals

Miniature

Press-Fit subminiature terminals are as small as .093 in. diam and range from .250 to .5 in. overall height depending on whether they are stand-offs or feed-throughs. The terminals press-fit into chassis holes by means of an insertion tool and drill-press equipment, without need of nuts, washers, lockwashers or any sealing. Utilizing a Teflon body, they are non-breakable and shock-proof; they resist humidity, corrosion and fungus, and are immune to elevated temperatures.

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

CIRCLE 182 ON READER-SERVICE CARD

Infrared Detector

Sensitive to 7 Microns

An infrared detector is now in production which is sensitive to microns with a time constant of less than 1 usec. Operating without the need for cooling or bias voltage, the detector has a noise equivalent power of 0.001 nw.

Radiation Electronics Corp., Dept. ED, 8241 No. Kimball Ave., Skokie, Ill.

CIRCLE 183 ON READER-SERVICE CARD

Thermocouple

Metal Immersion

A thermocouple is available for high temperature molten metal measurements up to 3100 F. It uses a metal ceramic LT-1 secondary protecting tube a vitrified alumina primary tube, and a platinum 10 per cent rhodium thermocouple. A curved stainless steel tube of any required length leads to a wooden grip and thermocouple assembly head. Life tests indicate that the secondary LT-1 tube will normally withstand about ten dips in molten steel between 2700 and 3100 F. Lower temperatures will give proportionally longer life.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 184 ON READER-SERVICE CARD

Plastic Extrusions

True Metallic Color

Spectro-Chrome is an extruded plastic, straight or spiral in form, with a metallic appearance. Gold, brass, silver, chrome and annodized aluminum colors are achieved by extruding a variety of clear and tinted translucent plastics over metallic core materials. Insulated by its plastic cover, the extrusion is available in round spirals from a minimum of 1/8 in. ID to any practical diameter. Square and rectangular spirals of varying dimensions are also offered. Straight extrusions are manufactured in sizes and shapes to meet specific requirements.

Schwab Plastics Corp., Dept. ED, 730 S. Dix Ave., Detroit 17, Mich.

CIRCLE 185 ON READER-SERVICE CARD

From sea level to 70,000 ft.

Rotron 400 CPS

ALTIVAR® fans

are 500% lighter

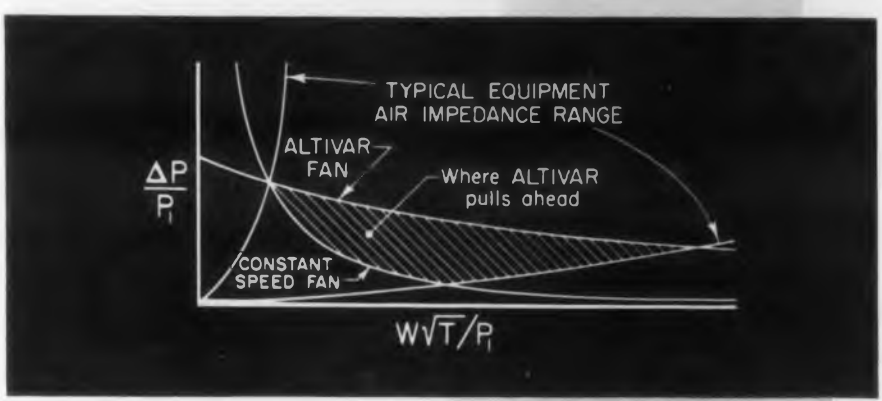
draw 95% less power

are 50% quieter

...compared with any

conventional

constant speed counterpart



Altivar® induction motor fans

increase speed 3 to 5 times

from sea level to 70,000 ft.

Send for Catalog Sheet 30101-3

ROTRON mfg. co., inc.

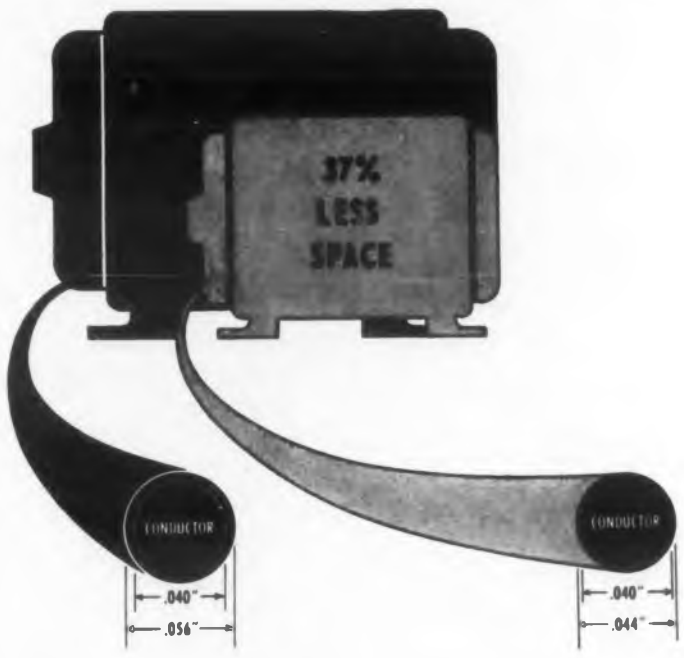
WOODSTOCK • NEW YORK

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

Fused Teflon Insulation

A NEW method of coating wire with Teflon insulation makes possible the use of an extremely thin insulation layer for high voltage application. The qualities of Teflon as an insulator are well known, but the process of applying it to wire left much to be desired. Formerly, weak spots would exist at the seams between successive wraps of the Teflon tape. Pinhole leaks were often common, and it was occasionally difficult to provide a uniform layer around the wire.

The new process utillizes Teflon tape in its uncured form. The tape is cured and cooked in such a way that an even 0.002-in. thickness, without seams or other irregularities, exists around the wire. Called the Fused-Film process, the insulation will not break due to twisting and remains stable when temperature-cycled from —200 to +500 F. The film is "fused" only in respect to itself; that is, it does not adhere to the wire itself and is stripped as easily as conventional insulation. It can withstand pressures of 6000 v for 6 hrs without breakage. On the scrape abrasion resistance test, the film withstood 86 scrapes to breakthrough. According to the company, this is exactly twice the endurance of the best conventional insulation of comparable application.



Two imaginary motors are shown, one using conventional Teflon coated magnet wire (left), and the other using the same size wire with Fused Film insulation, (right). The size of the motor would actually be further reduced since Fused Film makes supplementary insulation unnecessary.

Although the process can be theoretically applied to wire of any shape or dimension, it is currently being used on magnet wire suitable for motors, generators and the like. The advantage of a thin insulation in this field is the obvious reduction in size and increase in power; secondary insulation, which was often necessary in certain locations, can be eliminated.

Dielectric tests on magnet wire with the 0.002-in. Fused-Film insulation were conducted by Westinghouse Electric Corp. at the request of the manufacturer. The Twist and Shot dielectric tests, listed below, were done in accordance with the ASTM standard tests for magnet wire.

No Heat Aging:	
Twist Test	No failure after 3 min at 6000 v
Shot Test	Failed at 6000 v
250 C for 200 hrs:	
Twist Test	No failure after 3 min at 6000 v
Shot Test	Failed at 6000 v
315 C for 100 hrs:	
Twist Test	Failed after 30 sec at 6000 v
Shot Test	Failed at 4000 v
315 C for 200 hrs:	
Twist Test	Failed at 3000 v
Shot Test	Failed at 1500 v

Inso Products, Ltd., Dept. ED, Subsidiary of Adam Consolidated Industries, Inc., Union, N.J.

CIRCLE 204 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicone Rubber

Coats Glass Tape

K-1014 is primarily designed for use as a basic stock for solvent coating solutions. It exceeds Navy Specification MIL-C-2194B for coated glass tapes with high dielectric strength, high crease resistance and high moisture resistance. It is recommended for the following uses: as solvent solution coatings for glass fabrics and tapes for electrical insulation, flexible hot air ducting, hoses, harnesses, etc.; for glass sleevings; for dip coating of electrical components; and for antiadhesive coatings on molding rugs.

K-1014 is also used for encapsulation of electrical components and in molding applications where ease of processing, low hardness and reversion resistance coupled with moderate physical strength and good electrical properties are desired. The compound is a soft, white material, and the coating solution is a thick, white fluid. They are available in either catalyzed or uncatalyzed forms.

Union Carbide Corp., Dept. ED, Silicones Div., 30 E. 42nd St., New York 17, N.Y.

CIRCLE 205 ON READER-SERVICE CARD FOR MORE INFORMATION

Polystyrene Molding

For Thin Walls

A polystyrene molding compound, developed specifically for producing thin walled articles with improved resistance to breakage, is announced by Bakelite Co., a Division of Union Carbide and Carbon Corp. Designated SMD-3700 Crystal 11, the new material provides generally greater strength across the lines of flow in thin-walled sections than do the general-purpose polystyrenes.

The new material flows within wall cavities at lower cylinder temperatures and at lower pressures than the general-purpose styrenes. While SMD-3700 is designed for use in fast-cycling, fully automatic injection molding equipment, it can be used in other types of molding machines as well. The compound can be molded at cylinder temperatures between 350 and 650 F, depending upon the part and the cycle. Mold temperatures for the materials are sometimes slightly lower than are used for general-purpose polystyrenes. The normal range of injection pressures, 10,000 to 20,000 psi, is often more than adequate for the material.

SMD-3700 is available in cylindrical pellets 0.1 x 0.1 in. and in a fine granulation for dry coloring. In crystal form it is free from color and has excellent clarity. It molds with the same hard glossy surface as does general-purpose polystyrene. The material can be printed or coated by the same techniques as are used for other polystyrenes.

Bakelite Co., Div. of Union Carbide and Carbon Corp., 200 Madison Ave., New York 16, N.Y.

CIRCLE 206 ON READER-SERVICE CARD FOR MORE INFORMATION

New Materials

Magnesia Insulation

For Thermocouple Wire

Swaged magnesia insulated wire is flexible enough to bend yet rigid after bending. It is its own insulator and conduit, and can be embedded in concrete, plaster, or buried underground. To make thermocouple elements, it can be cut to the length desired, the wires can be exposed and fused together with the other end attached to a thermocouple head or other standard connector. As a heating element, it can be cut to any length for the desired resistance, wrapped around the object to be heated and have standard connectors attached to it. It can also be used anywhere where temperature extremes, moisture, vibration and abrasion are present.

The insulation is pure magnesium oxide. Insulation resistance between wires, and between wires and sheath is about 1 meg at 600 v ac for 1098 size to about 50 meg for 1092 size. It can be bent to twice the sheath diameter to center line without loss of insulation. Inert arc, electric arc, oxyacetylene, braze, silver solder, resistance, or soft solder weldments may be performed upon the sheath without loss of insulation. Insulation is pressure tight to 5000 psi on some of the smaller diameters; closed-off sheath will withstand pressures upwards of 50,000 psi. MgO melts at about 4400 F and is a good electrical insulator up to 2500 F.

Aero Research Instrument Co., Inc., Dept. ED, 315 N. Aberdeen St., Chicago 7, Ill.

CIRCLE 210 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Spaghetti Tubing

Treated for Potting

Spaghetti tubing is being offered in three grades; thin wall, standard wall and heavy wall. Sleeving is dimensionally accurate and is made of virgin Teflon. In any grade and size, the insulation is extremely flexible and is a nonwoven solid material which prevents leaks from cracks, splits or perforations. To assure adherence of all potting compounds, Teflon surfaces of all spaghetti and other components are available in a specially treated form. Other characteristics include dielectric strength of 500 to 1000 v per mil; dielectric constant of 2.0 and dissipation factor of 0.0002 of any solid dielectric; no water absorption; and a service temperature ranging from −110 to +500 F.

Fluorocarbon Products, Inc., Dept. ED, Div. of U.S. Gasket Co., Camden 1, N.J.

CIRCLE 211 ON READER-SERVICE CARD FOR MORE INFORMATION

New Beryllium Copper ROLLPIN

Now . . . extend the proved advantages of Rollpin to a wide variety of applications where resistance to corrosion, good electrical properties and nonsparking or nonmagnetic characteristics are required.

Use it as you use carbon steel Rollpins—to replace taper pins, straight pins and set screws; to serve as a rivet, dowel, hinge pin or stop pin—to cut production costs by eliminating special machining, tapping, and the need for hole reaming or precision tolerances. Driven into a hole drilled to normal production standards, Rollpin locks securely in place, yet can be readily drifted out and reused whenever necessary. Beryllium Copper Rollpins are available from .062"-diameter to .250".

For all the information you need, write Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey, Dept. R36-657

ROLLPIN TRADEMARK

ESNA

ELASTIC STOP NUT
CORPORATION OF AMERICA

CIRCLE 214 ON READER-SERVICE CARD FOR MORE INFORMATION

---

standard knobs

widest choice

fastest delivery

Variety and versatility in a complete standard line of thermosetting plastic knobs. Combinations, variations in types, sizes and colors delivered promptly. Send for catalog.

kurz-kasch

Kurz-Kasch, Inc., 1415 S. Broadway, Dayton 1, Ohio

CIRCLE 215 ON READER-SERVICE CARD FOR MORE INFORMATION

Metal-to-Glass Cement

Withstands —420 to +1000 F

This refractory cement will hold metal to metal, glass, or ceramics despite temperatures between —420 and +1000 F. Called CA-9, the adhesive is dielectric and shock-resistant throughout its temperature range, the upper limit of which can be extended to 1500 F by modifying the composition. The material remains slightly malleable after drying. Thus it will not crack, craze or check even if used on a constantly flexing surface or to join materials with widely different thermal expansion coefficients. Waterproof, nonhydroscopic, and unaffected by most reagents, specimens of CA-9 put down seven months ago show no signs of aging.

A joint formed by the cement between two pieces of metal will resist 80 lb per sq in. of shear force at room temperature up to 900 F. It is unaffected by 15 min of 45 g vibration through a 1 in. double amplitude at 1500 cps. Wires embedded in the cement are not shorted by complete submersion in water. The surfaces to be joined need only be cleaned with chloroform or trichlorethylene. No mechanical surfacing is required. since the cement has an excellent wetting action. The material can be diluted with xylene to a convenient consistency. The cement is composed of ground phlogopite, a polysiloxane polymer, and refractory oxides.

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

CIRCLE 216 ON READER-SERVICE CARD FOR MORE INFORMATION

Epoxy Dipping Compound

High Adhesion

A high viscosity opaque dip or brush coating compound possesses outstanding adhesion to metals and plastics. The compound consists of two components, Epocast 19-B and Hardener 9011 combined in equal proportion by weight. Pot life after combination is approximately one week and cure takes place at 200 to 250 F. The long pot life permits production dipping and application without the necessity of frequent mixing of compounds. Means for adjusting flow characteristics are indicated.

Epocast 19-B has importance in the dip coating of electrical components and in use as a connector potting compound due to its resilient characteristics and high adhesion. Its usefulness up to 150 C is evident.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles 39, Calif.

CIRCLE 217 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW!

transistorized

PLUG-IN COUNTING CIRCUITS

AMAZING DESIGN LATITUDE—
STOCK CIRCUITRY
CUSTOM
PACKAGING

Substantial space and material savings with Walkirt's expanding line of subminiaturized units: Plug-In's ("P" Series) fit standard 7 pin miniature socket; easily retained with standard tube shield. Cartridge types ("C" Series) for permanent installations feature high space density stacking, miniature styling Epoxy-Resin Embedded!

FROM THE ORIGINATORS OF THE PLUG-IN CONCEPT

THE WALKIRT CO.

145 WEST HAZEL ST., INGLEWOOD 3, CALIF.

CIRCLE 218 ON READER-SERVICE CARD FOR MORE INFORMATION

Now... shake-test to 5000 cps with 1750 lbs force!

With highest operating frequency in its force range, the Model C10 VB exciter exhibits no table diaphragming or disturbing resonances under 5000 cps. It delivers up to 1750 lbs force output for continuous sinusoidal testing . . . and extends the range of random motion testing to 5000 cps.

This exciter can be used with the MB Model T666 amplifier and TEMC control cabinet to subject specimens such as relays, electronic and control components through a wide range of vibratory frequencies to as high as 58 "g". Also, by the addition of the MB Model T88 complex motion console, it can be used for complex motion testing where specimens are subjected to the actual "noise" spectrum of the environment. Send for Bulletin 420-C.

manufacturing company

A DIVISION OF TEXTRON INC.

1058 State Street, New Haven 11, Conn.

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

Services for Designers

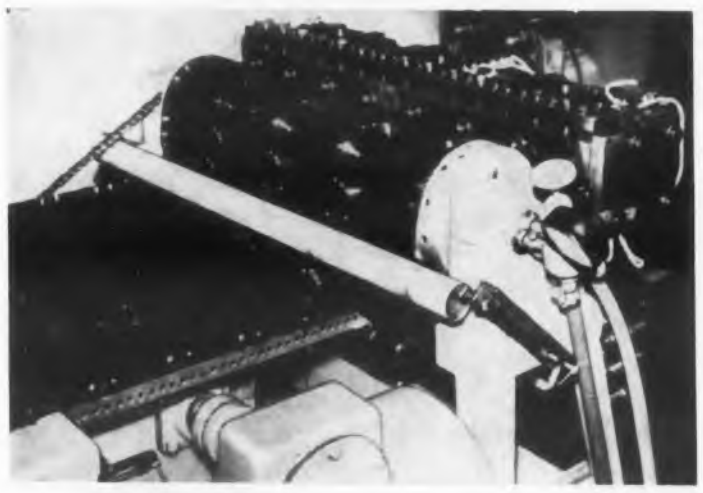
Radioisotope Standards

Nuclear-Chicago Corp., 229 West Erie St., Chicago 10, Ill., is beginning the preparation and distribution of short-lived radioactivity standards of the type previously supplied by the National Bureau of Standards. Standard solutions of iodine-131, phosphorus-32, gold-198, sodium-24, and potassium-42 will be distributed on a semi-annual schedule at no increase in the previous Bureau price of $20.00 per standard. The standards are derived from comparisons made with the primary standards maintained by the National Bureau of Standards and contain 10^5 disintegrations per sec. per ml. in three ml. of solution. They are contained in glass ampoules 5/8 in. in diameter by 3 in. high. The gamma emitting standards may be counted directly in scintillation well counters. Nuclear-Chicago invites additions to its "Standards Mailing List" for routine notification thirty days in advance of the availability of each standard.

Continuous Vacuum Forming Process

Quick Plastics, Jackson, Michigan, announces a new continuous method for vacuum forming sheet plastic. The sheet is taken directly from the extruder and, while still warm and soft, passed over a vacuum roll where it is formed in the desired pattern. The result is a very low cost continuous sheet of formed plastic now offered to industry. Styrene, polyethylene, acetate and butyrate are being formed by this method and other materials can also be used.

Present equipment makes sheets 24 in. wide in continuous lengths, with thickness varying from .008 in. to over .080 in. The formed sheet may be any color as well as black, white, transparent or translucent. This new continuous process promises a low cost formed sheet material for widely diversified applications. For further information write Quick Plastics, 1743 Cooper St., Jackson, Michigan.



Continuous vacuum forming of sheet plastics results in low cost formed sheets of styrene, polyethylene, acetate, and butyrate.

Photoelastic stress technique used on full-size structure, coated with a thin layer of photoelastic plastic.

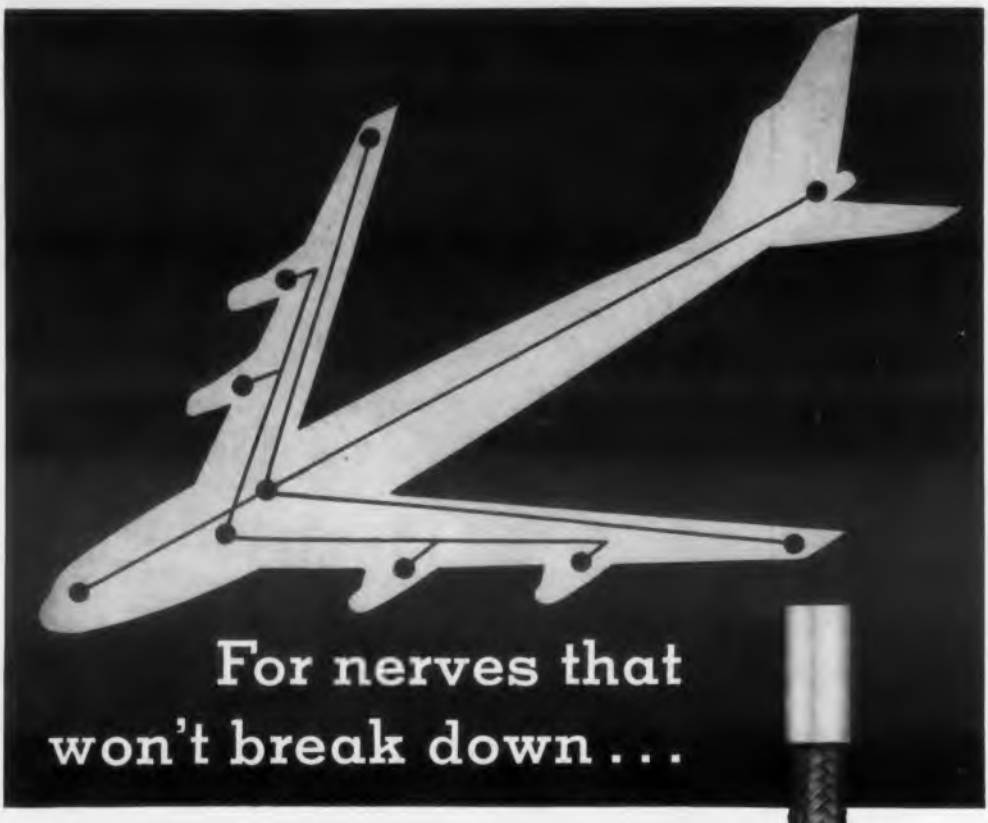
Stress Analysis Uses Actual Structure

Tatnall Measuring Systems Co. (a subsidiary of The Budd Co.), has acquired rights to PhotoStress, a new stress analysis technique. PhotoStress uses conventional photoelastic methods for the experimental stress analysis of actual full size structures or components made of metal concrete, wood, glass, plastic, rubber, stone or other structural materials. It eliminates the plastic model of the part formerly required.

Difference between PhotoStress and other conventional photoelastic techniques is first that this transparent plastic is bonded to the actual part and strains are determined under actual test conditions. It is both quantitative in terms of micro in. per in. strain and qualitative by showing direction and magnitude of principal strains. It can be used both statically and dynamically and it combines both optical and electronic methods. When a load is applied, strains are transmitted to the plastic coating which then become doubly refractive. This change is directly proportional to the intensity of stress.

Employer's Plan for Technician Training

A new plan to provide electronic technicians for employers without hiring new personnel has been announced by Cleveland Institute of Radio Electronics, 4900 Euclid Ave., Cleveland 3, Ohio. This program was developed to use the capabilities of people in their own organizations to do the job. The plan lets the employer pick his own man or men who are interested and have the aptitude for electronics work. They are then enrolled in the Institute's special home study course in electronics. The Institute will guarantee to train him in the fundamentals of electronics until his proficiency is great enough to pass the FCC License examinations.



For nerves that won't break down . . .

. . . specify REVERE TEFLON* CABLE

Electronic cables, the "nerves" of monitoring and testing systems in missiles, rockets and aircraft, are constantly being stressed by the searing heat around jet engines . . . the sub-zero cold of the stratosphere . . . immersion in fuels, chemicals or solvents. Revere Teflon Cable meets these high service requirements . . . and those of computer and radar applications, too.

Revere Teflon Cables are available with 1, 2, 3 or 4 teflon-insulated, silver plated, stranded copper conductors, rated for continuous operation from —90°C. to +210°C. Cables are shielded with silver plated copper to give 90% coverage. Jackets to suit application — silicone treated glass braid, teflon, Kel-F**, vinyl, nylon, etc.

Conductor size: 24 to 18 gage in .008" (300 volt), .010" (600 volt) and .015" (1000 volt) wall thicknesses. Ten and fifteen mil wall conductors meet applicable requirements of MIL-W-16878, Type E and EE.

*E.I. du Pont trademark
**M.W. Kellogg trademark
† Wire passes 500 hr., 250°C heat-aging test . . . also cold bend test

TYPICAL SPECIFICATIONS — Single Conductor Teflon Insulation

Spark Test Voltage	3000 volts
Insulation Resistance	Greater than 10^4 megohm/1000 ft.
Continuous Operating Range	—90°C. to +210°C. (†)
Dielectric Constant @ 1 MC/Sec	2.5 maximum
Power Factor @ 1 MC/Sec	Less than 0.0003
Flammability	Does not support combustion
Shrinkage	Less than ⅛" in 18" @ 250°C for 96 hrs.
Abrasion (per MIL-T-5438)	Passes 38" of 400 grit, aluminum oxide, ½ lb. weight
Moisture Absorption	0.0%
Specific Gravity	2.2 average
Chemical and Solvent Resistance	Excellent

Write today for Engineering Bulletin 1905 describing Revere TEFLON CABLE.

36

Revere CORPORATION OF AMERICA

WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company

CIRCLE 229 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Tube Handbook 230

All data including operating specifications and characteristic curves are contained in this LM Ericsson Technical Handbook just released.

Such types as 5842/417A, 5847/404A, 2C51/396A and others are included. The book has all pertinent data grouped together so maximum information is obtained with a minimum of confusion. One of the features of the book is the two-page ready reference chart. State Labs. Inc., 649 Broadway, New York 12, N.Y.

Time Delay Relays 231

Three basic hermetically sealed time delay relays are described in Bulletin No. TD 406 just released. A complete description is given of each relay as well as application and specification details. The illustrated bulletin also gives the relay lengths and the various motors and switches. A. W. Haydon Co., Waterbury, Conn.

Zipper-tubing 232

Zipper style plastic tubing that eliminates or reduces lacing and tying of electrical harness assemblies is described in a pamphlet now available. The illustrated pamphlet gives the specifications as well as the many advantages of using this type of tubing, which can be reused unless sealed. This tubing has Air Force approval. Walter A. Plummer Co., 752 So. San Pedro St., Los Angeles 14, Calif.

Synchro Null Connections 234

This chart describes the precise method of obtaining null connections for all types of synchros. Due to the variety of synchro inputs and outputs these connections are not readily obtained. The chart should be particularly useful to synchro users and manufacturers. Theta Instrument Corp., 204 Market St., East Paterson, N.J

SYNCHRO NULL CONNECTIONS

TYPE OF SYNCHRO	EXCITATION BETWEEN	READ NULL BETWEEN	NULL ANGLE (DEGREES)
CONTROL TRANSMITTER (CX)	R1 and R2	S1 and S3 S3 and S2 S2 and S1	0 and 180 60 and 240 120 and 300
CONTROL TRANSFORMER (CT)	S2 and S1, S3 S1 and S2, S3 S3 and S1, S2	R1 and R2 R1 and R2 R1 and R2	0 and 180 60 and 240 120 and 300
CONTROL DIFFERENTIAL TRANSMITTER (CDX)	S2 and S1, S3	R1 and R3 R2 and R1 R3 and R2	0 and 180 60 and 240 120 and 300
	S3 and S1, S2	R2 and R1 R3 and R2 R1 and R3	0 and 180 60 and 240 120 and 300
	S1 and S2, S3	R3 and R2 R1 and R3 R2 and R1	0 and 180 60 and 240 120 and 300
	R2 and R1, R3	S1 and S3 S3 and S2 S2 and S1	0 and 180 60 and 240 120 and 300
	R3 and R1, R2	S2 and S1 S1 and S3 S3 and S2	0 and 180 60 and 240 120 and 300
	R1 and R2, R3	S3 and S2 S2 and S1 S1 and S3	0 and 180 60 and 240 120 and 300
RESOLVER (R) (Short Unused Primary)	R1 and R3 R2 and R4 R1 and R3 R2 and R4	S1 and S3 S2 and S4 S2 and S4 S1 and S3	0 and 180 0 and 180 90 and 270 90 and 270
	S1 and S3 S2 and S4 S1 and S3 S2 and S4	R1 and R3 R2 and R4 R2 and R4 R1 and R3	0 and 180 0 and 180 90 and 270 90 and 270

CAPACITORS

Standard! Special! Unusual!

AEROVOX makes them all . . . from the largest capacitors for heavy-duty, high-voltage applications to micro-miniature units for critical requirements in guided missiles. And . . . capacitors need not conform to conventional shapes, but can run the gamut of physical configurations. Illustrated here are just a few of the many unusual capacitors Aerovox has been called on to design and produce in recent months.

SPECIAL . . . bracket or "hat-type" mounting assembly for a standard bathtub capacitor.

SMALL . . . only .175" D x 7/16" L., this hermetically-sealed metal cased unit is rated at .01 mfd at 200 vdc.

BIG . . . rack-mounted oil units for energy storage and pulse applications.

MULTI-SECTION . . . one of the many multi-section capacitors designed for critical military applications.

UNUSUAL . . . metal cased mica capacitor for application in high power sonar equipment.

TOROIDAL . . . in shape is this hermetically-sealed filter for RF noise suppression usage.

SLIM . . . and thin metallized-paper capacitor designed for a special application.

Maybe these unusual shapes and designs offer suggestions for your capacitor requirements. If so, write . . .

AEROVOX CORPORATION

New Bedford, Mass.

In Canada: AEROVOX CANADA, LTD., Hamilton, Ont.

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CIRCLE 236 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Miniaturized Transformers 239

Miniaturized transistor drivers and output transformers are described in the 1957 Transformer Catalog now available. This twenty page booklet lists hermetically sealed, molded, cased, and open transformers available for typical servo, missile, or airborne applications with MIL-T-27 specifications.

The models are illustrated and include schematics with specifications and characteristics on each. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N.Y.

Tape Wound Core Manual 240

Since applications of high permeability magnetic materials have broadened so tremendously, catalog TWC-200 has been prepared with a separate section which serves as a design manual. The literature supplies engineers with basic information on magnetic terminology, design equations, material characteristics and testing data.

The first part of the twenty-eight page catalog describes the advantages and construction of "Performance-Guaranteed" tape wound cores. All the standard sizes of tape wound cores are listed, with complete dimensional data. Typical hysteresis and ac dynamic loops are compared and shown for Hy Mu 80, 48 Alloy and Orthonol to complete the first part of the book.

The design manual part of the book gives detailed methods of dynamic testing, El loop testing, dc testing and core matching. Tables are devoted to basic units and conversion factors, properties of nickel-iron alloys and magnetic values of these alloys.

Several pages of curves show variations of magnetic properties with changes in temperature and core loss variations with changes in frequency. Magnetics, Inc., Butler, Pa.

Custom Molding Service 241

Complete information on a custom molding service, which covers the compression and transfer techniques for custom molding of chemical resistant products is made available. The facilities have been expanded to insure efficient handling of quality products, with or without inserts, which require the qualities of epoxy plastic. Many products, such as connectors, electronic embedments, impellers and housings, pipe fittings, disc pistons for meters, coil forms, slip rings, spacers, metal forming dies, pump components, stators, can be custom molded. High precision and tolerances result from this molding. The molding of small parts for miniaturization is particularly well suited for this operation. Epoxy Products, Inc., 137 Coit St., Irvington, N.J

Vibration Detector 242

A device that protects rotating and reciprocating machinery by anticipating malfunction, is described in 4-page bulletin No. 600-1 now available.

The device, known as the Vibraswitch malfunction detector, will automatically shut down protected equipment, or sound an alarm the instant normal operating vibration is exceeded. It is used for attended as well as unattended machinery.

The bulletin covers in details different models of the vibration detector, as used in exposed, hazardous, and protected locations. Typical applications include the protection of pumps and motors, compressors, centrifuges, generating equipment, fans and blowers, gas and Diesel engines, and turbines. Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 No. Fourth St., Philadelphia 33, Pa.

Glass Properties 243

A complete revision of "Properties of Selected Commercial Glasses" is available as Bulletin B-83. Several new glasses, among them aluminosilicate glass, low loss iron sealing glass, fused silica, and radiotron tube and capacitor glass, have been added to the property data chart. Discussed at some length in the 16-page text are thermal, electrical and chemical properties. Viscosity temperature curves for several commercial glasses and heat transmission data are also presented in the pamphlet. Corning Glass Works, Technical Products Div., Corning, N.Y.

High Vacuum Equipment 244

Over 400 items of industrial and laboratory high vacuum equipment including standard components, packaged systems and engineered plants are enumerated in a 16-page price list and product index. Some specific items covered are oil and mercury diffusion pumps, rotary gas ballast pumps, mechanical booster pumps, vacuum gages, seals, valves, analytical equipment, vacuum melting furnaces, crystal pulling furnaces, freeze drying equipment, leak detection equipment, metalizers and portable pumping systems. NRC Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass.

Specialized Metal Tubular Parts 245

Facilities and services for the design, tooling, and fabrication of precision tubular parts and subassemblies in the range of 0.010 in. to 5/8 in. diam with guaranteed tolerances as low as 0.001 in. are described in 4-page Bulletin 2056.

The bulletin illustrates typical precision parts and outlines reasons why manufacturers of electronic equipment should consider sub-contracting such components. H&H Machine Co., Inc., Noble & Jackson Sts., Norristown, Pa.

MINIATURE CONTROL COMPONENTS

. . a WRIGHT specialty

SIZE 9 SERVO MOTOR TACHOMETER GENERATOR

Diameter: 7/8 inch
Input: 26V-400 cy.
Speed: 9500 RPM
Torque Rating: 0.25 oz.-inch
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New Literature

Centralized Control 249

An eight-page, 5-color booklet, F 8031, entitled "Electronic Control Centers," describes an automatic temperature control. It gives the functions, uses and advantages of centralized automatic control with visual supervision of the entire heating and air conditioning system. Among the special features of the booklet are descriptions of remote control point adjustment, remote temperature indication and remote temperature recording, with illustrations. Barber-Colman Co., 1400 Rock St., Rockford, Ill.

Heating Element Tips 250

"Hot Tips," or Form A-1472, is a 12-page booklet on the care and use of silicon carbide heating elements. Illustrated with cartoons, the pocket-sized brochure offers suggestions for handling, unpacking, storage, installation and replacement. The Carborundum Co., Globar Div., Hyde Park Blvd., Niagara Falls, N.Y.

Millivoltmeter Recorder 251

Bulletin E1117 introduces a portable weatherproof millivoltmeter recorder for electrolysis survey work. In four pages, it describes the instrument's use in surveys of electrolytic corrosion and deterioration of underground structures such as pipe and cables. A bibliography on actual testing methods and their significance is included. The Bristol Co., Waterbury 20, Conn.

Radar I-F Amplifiers 252

Cataloged in a six-page folder are several series of i-f amplifiers for radar and guided missiles. Each type is accorded a full description, a list of specifications and dimensions and an illustration. Listed are a variety of miniature and subminiature amplifiers and preamplifiers for use in microwave receivers and automatic frequency control units. Special-purpose, transistorized, and laboratory units are also shown. LEL, Inc., 380 Oak St., Copiague, N.Y.

Battery Buying Guide 253

"Before You're Going to Buy an Industrial Battery," is the title of a 16-page illustrated reference booklet, (GB 1788) just released. Designed to help buyers select the best battery for their operation, this pocket-size booklet outlines the significance of battery design, the contributions of research and development to lower operating costs, greater productivity and greater profits. Gould National Batteries, Inc., Trenton, N.J.

Breadboard Parts Catalog 254

Electromechanical experimental and developmental work is described in 24-page, two-color catalog just released. Photographs, dimensional drawings, easy-to-understand descriptions giving full details on each part with suggestions for its use are among its features.

Included in the catalog is everything needed for developing servo prototypes or setting up test systems. Each part is cross indexed for easy reference. Helipot Corp., Div. Beckman Instruments Inc., Newport Beach, Calif.

Transistorized Computer 255

The completely transistorized computer type S-2000 is described in a 12-page brochure just issued. The booklet features many illustrations including a typical installation which shows the compact basic unit containing the arithmetic, control and memory sections and also the supplemental equipment that can be added.

The system outlined is designed to offer the advantages of extreme compactness, light weight, low power consumption, high speed and extreme reliability. Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.

10-Turn Precision Pots 256

Recent improvements in Series AJ miniaturized 10-turn precision potentiometers are pointed out in Data Sheet 54-07. Lists of specifications, coil characteristics and available modifications enlarge the descriptive text. The two-page leaflet is illustrated with a photograph, a labeled cutaway and dimensional diagrams. Helipot Corp., Newport Beach, Calif.

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CIRCLE 260 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Adapter Sleeves 262

"Extension and Adapter Sleeves for cable/connector compatibility" is the title of a four-page bulletin No. 257 just released. The illustrated brochure shows that a reliable electrical circuit exists and a sturdy mechanical connection of the connector of the cable is maintained.

The extension and adapter sleeves are fully described and the extension sleeve increases the space available in the backshell area of a connector. While the adapter sleeves have been designed with a "step-up" or "step-down" feature which permits the use of the proper AN clamp with any given cable and AN connector. Also, the booklet includes a valuable chart which gives an accurate, scientific method of specifying and ordering the exact extension and adapter sleeves required; the maximum and minimum cable sizes are itemized and AN clamps and bushings are shown by number. Pacific Automation Products Inc., 1000 Air Way, Glendale 1, Calif.

Ultrasonic Test Equipment 263

A folder of 4 pages is devoted to ultrasonic test equipment designed to cover frequency ranges from 6 to 75 mc. The operation, performance and applications of each instrument are adequately described. Specification lists and illustrations are also provided. The units covered are a wide band amplifier, a high power pulse oscillator, a preamplifier, and precision attenuators. Arenberg Ultrasonic Lab., Inc., 94 Green St., Jamaica Plain 30, Mass.

Coils and Armatures 264

Listed in a 4-page folder are a number of miniature and subminiature electronic components. Each unit is presented with a photograph and a brief description. Armatures, stators, coils, a slidewire assembly, an accelerometer and a precision potentiometer are the components shown. Clifton Mfg. Co., Inc., 20 N. Springfield Rd., Clifton Heights, Pa.

Precision Potentiometers 265

Four-page reprint of article entitled "Noble Metal Wire For Precision Potentiometers" has just been released.

The reprint includes table showing the characteristics and specifications of the three precious metal alloys customarily used in potentiometer winding, as well as graphs showing comparative noise patterns. Sigmund Cohn Corp., 121 So. Columbus Ave., Mt. Vernon, N.Y.

Dispersions for Industry 266

A four-page bulletin, "'dag' Dispersions for Industry," listing 44 colloidal and semi-colloidal dispersions of graphite, molybdenum, mica, copper and glass has just been released. Carriers and dilutents are given for each product, along with typical applications and important physical data. Acheson Colloids Co., Port Huron, Mich.

Demineralization Equipment 267

Improved ion-exchange water purification techniques and equipment is discussed and illustrated in an informative, catalog-type brochure now available. It describes an all-plastic unit for producing high-purity demineralized water by the ion-exchange method. These units are available in various sizes with a variety of connective fittings. Enley Prod. Inc., 1236 Broadway, Brooklyn 21, N.Y.

Time-Rate Indicator 268

Time-Rate indicator, Model 501 is described in four-page bulletin No. 501—Feb. 1957 just released. The instrument, known as a 10 mc digital type frequency meter is also usable for measuring period, time, interval, total and ratio.

The illustrated brochure lists the specifications and suggests uses for the instrument. Laboratory for Electronics, Inc., 75 Pitts Street, Boston 14, Mass.

A-C and D-C Voltmeters 269

Data Sheet 875 lists and describes 126 standard military and commercial models of expanded scale a-c and d-c voltmeters. Liberally illustrated with photographs and dimensional drawings, the four pages also contain specifications and an order table. Helipot Corp., Newport Beach, Calif.

New!

Miniature *Precision* Rotary Selector Switch

Here's the exceptionally positive action only a multi-leaf wiper, button-contact switch can offer—now in the smallest sizes consistent with the quality and dependability required for today's compact, precision equipment:

- Features solid silver alloy button-type contacts, collector rings, and spring suspension leaf-type wiper arms for low contact resistance—0.002 ohms.
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SHALLCROSS MANUFACTURING COMPANY, 526 Pusey Avenue, Collingdale, Pa.

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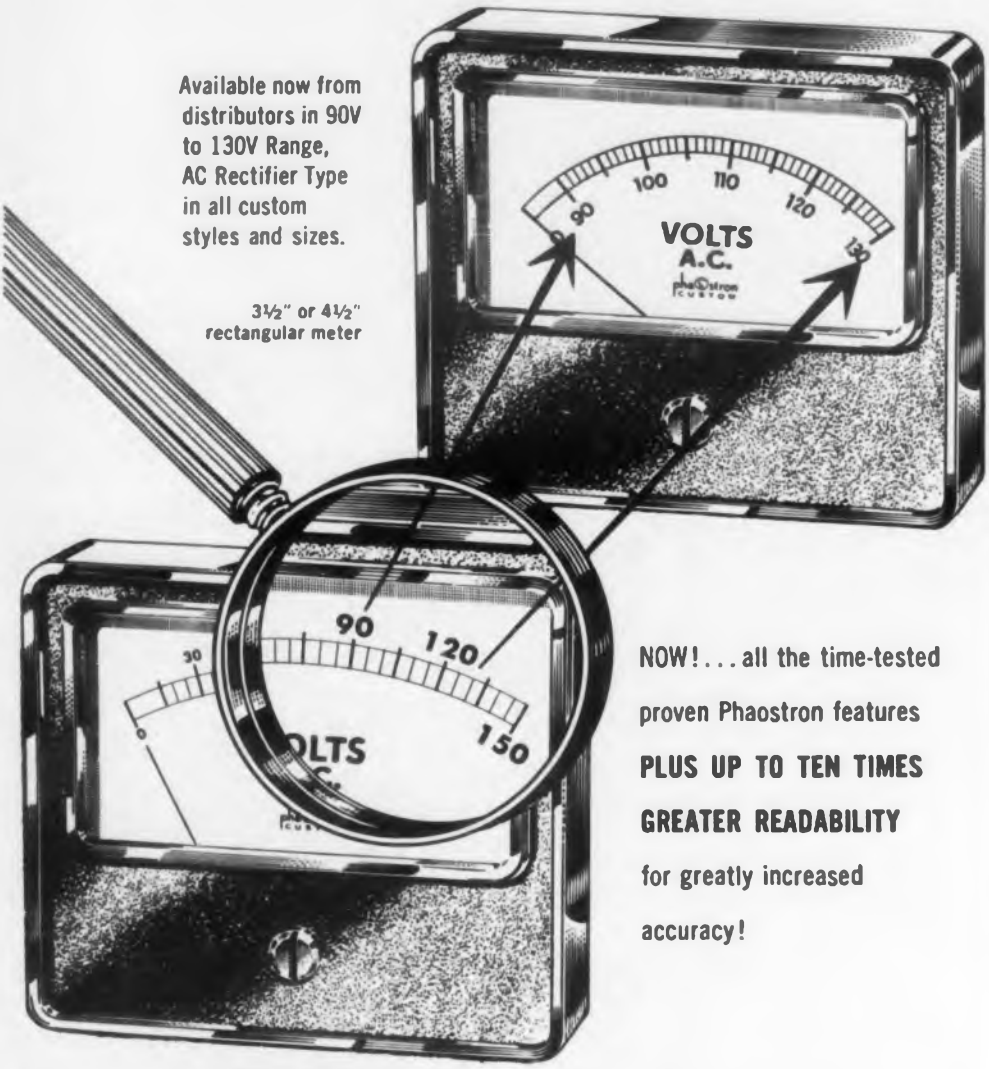

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All meters available with illuminated dial on special order

Phaostron has squeezed down that under 90V portion of the scale, where you don't need it, and expanded the section where you need it most—between 90 and 130V. Precisely calibrated 1 volt scale increments provide greater reading accuracy. Wide frequency range—linearity—true rms reading and Phaostron craftsman construction.

Phaostron Custom Panel Meters, with expanded scale, 90V to 130V AC rms, are available in nine types at your Parts Distributor. For special requirements for AC or DC expanded scale meters, write to Product Development Dept. for practical recommendations.

PHAOSTRON

PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 PASADENA AVE., SOUTH PASADENA, CALIF.

CIRCLE 272 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Laboratory Equipment 274

LANCO Apparatus Review No. 7 has full-page descriptions of crystal lattice models, organic molecular models, Beckman pocket pH meters, Thelco ovens, and analytical and dispensing balances. Shorter treatment is accorded a quantity of other laboratory equipment. Photographs illustrate all listed items in this 20-page booklet. Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Galvanometer Recorder 275

Specifications and features of a two-channel rectilinear galvanometer recorder are contained in the six pages of Bulletin No. R-502. The detailed coverage includes design, operation and application information. Labeled interior and exterior photographs illustrate construction features. Pictures and brief descriptions of accessory equipment are also provided. Texas Instruments, Inc., Industrial Instrumentation Div., P.O. Box 6027, Houston 6, Tex.

Welding Controls 276

Standard-line non-synchronous control for resistance welding, is described in Bulletin 6408, 12 pages. It shows a variety of available combinations, lists typical applications, explains use of plug-in control units and ignitron contactors, lists features and provides dimensions of various contactor and control enclosure combinations. General Electric Co., Schenectady 5, N.Y.

Radiation 277

Publication of a brochure describing radiation testing of materials, radiation effects and damage evaluations, and the institution of an industrial irradiation service in Long Island City, New York has been announced. Information about the use of nuclear radiation in industry and the design and installation of a cobalt facility is also included in the illustrated pamphlets. Radiation Applications Inc., 342 Madison Ave., New York 17, N.Y.

Fiberglas Tubing and Sleeving 278

10-page catalog of data sheets on flexible fiberglas tubing and sleeving is now available. Descriptions and detailed specifications are arranged in table form. The catalog's plastic binding provides for the addition of extra pages. Bentley, Harris Mfg. Co., Conshohocken, Pa.

Infrared Monochromator 279

An Airborne Infrared Monochromator (AIM) that can be installed in a bomber to observe radiations from other aircraft and missiles is described in Bulletin No. 1256 now available.

The AIM is designed to determine the absolute spectral distribution of radiation from airborne targets in the 1.5-25 micron region, to determine the total radiation from targets, and to record these measurements on a two channel recorder.

The illustrated booklet indicates that the monochromator is a valuable research tool for finding aircraft designs that are least susceptible to detection by enemy infrared instruments. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.

Bridge-Balance Units 280

Features and specifications of a complete line of bridge-balance and calibrating units are pointed out in Bulletin BBU 2-57. The four-page folder offers illustrations and descriptions of seven basic models. B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa.

Rectilinear Recorder 281

Bulletin R-502 introduces a 2-channel galvanometer rectilinear recorder. In a single page, the main advantages and features of the instrument are briefly outlined. Photographs show the unit and a sample recording. Texas Instruments, Inc., 3609 Buffalo Speedway, Houston 6, Tex.

Coils and Heaters 282

With text, photographs, charts, and graphs, a 12-page booklet describes coils and heaters manufactured for electronic and lighting applications. The booklet also contains illustrations of production facilities and processes. Sylvania Electric Products, Inc., Tungsten and Chemical Div., Towanda, Pa.

#2 in a series . . . on the new science of CABLE-TRONICS

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CIRCLE 284 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized Amplifier Design

SHOWN and described here is a three-stage, transistor audio amplifier. The amplifier employs RCA-2N109 alloy-junction transistors and, when driven by a medium-output crystal or ceramic pickup and operated from a 9 v supply, is capable of delivering 200 mw output at only 10 per cent distortion. The frequency response is compensated according to the Orthophonic recording curve now almost universally employed for 45 rpm and other long-play recordings. The operating parameters used for the 2N109 transistors assure satisfactory performance at ambient temperatures up to 50 C.

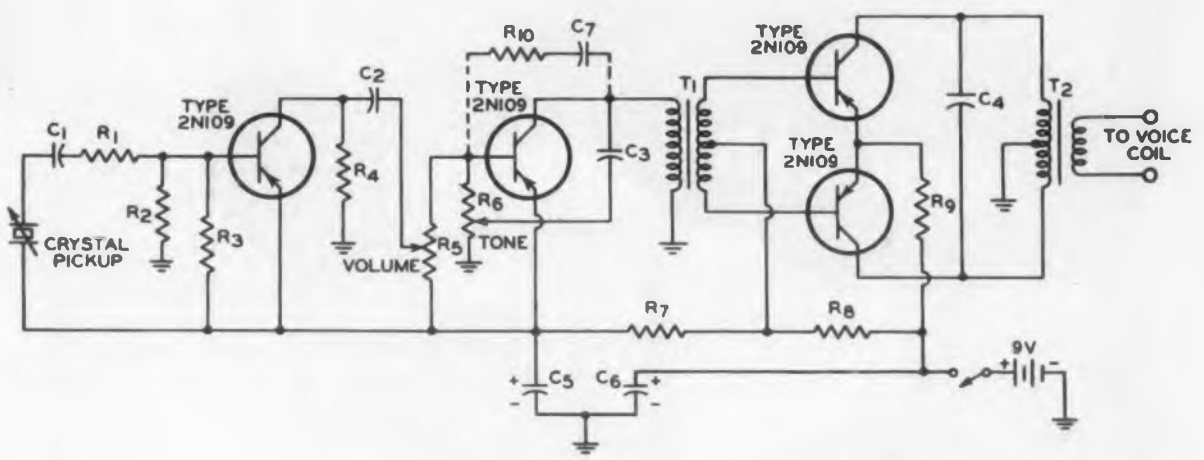
Circuit Description

The three stages—pre-amplifier, driver, and class B output stage—provide ample gain for use with crystal or ceramic pickups which deliver open-circuit output voltages of approximately 1 v, and have capacitances in the order of 1000 μμf. Commercial pickups of this type usually have hf characteristics which partially compensate for the "New Orthophonic" recording characteristic, and low-frequency characteristics which are easily corrected by the use of high-resistance terminations. Substantially flat frequency response from such pickups is obtained by the use of a 1 meg resistor R_1 in series with the input to the first transistor.

The volume and tone controls for the amplifier are placed in the second stage and also serve as bias resistors. A log-taper potentiometer is used for the volume control in order to reduce the sensitivity of the control at low-volume settings. The tone-control circuit is designed so that adjustment varies the hf roll-off point as well as the amount of hf attenuation. This control is a linear potentiometer.

In order to obtain the highest possible efficiency and power output, the output stage is operated under substantially class B. conditions. The driver transformer (T_1) has a primary-to-secondary impedance ratio of 3000 to 5000 ohms. Although a transformer having a higher primary impedance would provide more gain, the additional cost of such a transformer was considered unjustified because the available gain is more than adequate for the pickup used. Bias voltage for the ouput stage is obtained from a tap on the decoupling network for the first two stages. The 33-ohm resistor (R_9) in the common emitter circuit minimizes cross-over distortion and stabilizes the operating point for the output stage sufficiently to prevent thermal runaway at temperatures up to 50 C.

The output transformer (T_2), when connected to the speaker voice coil, provides an effective load resistance (collector-to-collector) of 550 ohms. This transformer should be a high-efficiency type having a dc primary resistance as low as is economically feasible, because the available undistorted power output is reduced in proportion to the square of the



C_1: 0.01 μf
C_2: 1.0 μf
C_3: 0.002 μf
C_4: 0.04 μf
C_5 C_6: 50 μf, 12 vdcw, electrolytic
C_7: 0.003 μf
R_1: 1 megohm, 0.5 watt
R_2 R_{10}: 220000 ohms, 0.5 watt
R_3: 4700 ohms, 0.5 watt
R_4: 1500 ohms, 0.5 watt
R_5: Potentiometer, 5000 ohms, logarithmic audio taper
R_6: Potentiometer, 100,000 ohms, linear taper
R_7: 680 ohms, 0.5 watt
R_8: 27 ohms, 0.5 watt
R_9: 33 ohms, 0.5 watt
T_1: Driver Transformer, primary impedance 3000 ohms, secondary impedance (base-to-base) 5000 ohms
T_2: Output Transformer, primary impedance (collector-to-collector) 550 ohms, secondary impedance to match speaker voice coil

Fig. 1. Circuit of the transistor battery-powered phonograph amplifier.

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dc voltage drop in the primary winding. The capacitor across the output-transformer primary (C_4) is used to minimize the "ringing" which tends to occur in a class B stage when the output current switches from one-half of the circuit to the other. The value of this capacitor is not critical and it may be made to serve a double purpose by the choice of a value which will reduce the effects of any hf resonances in the pickup.

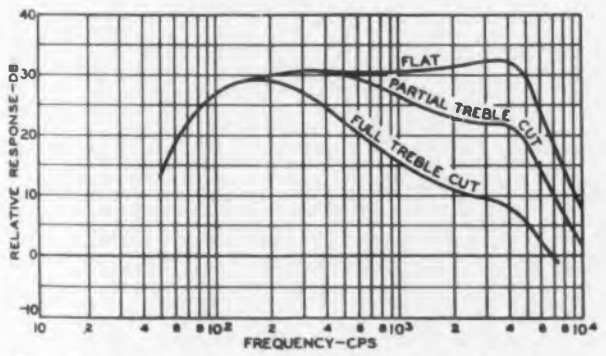


Fig. 2. Response of amplifier and crystal pickup.

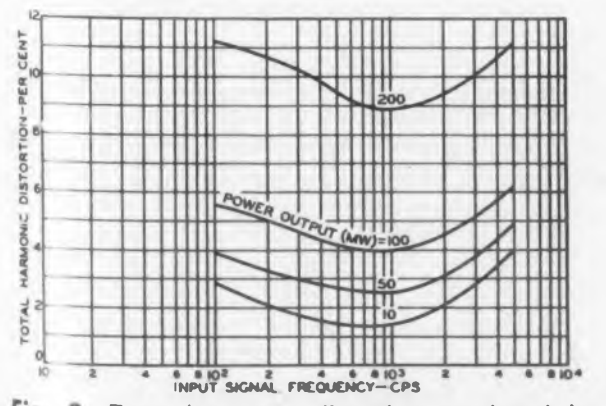
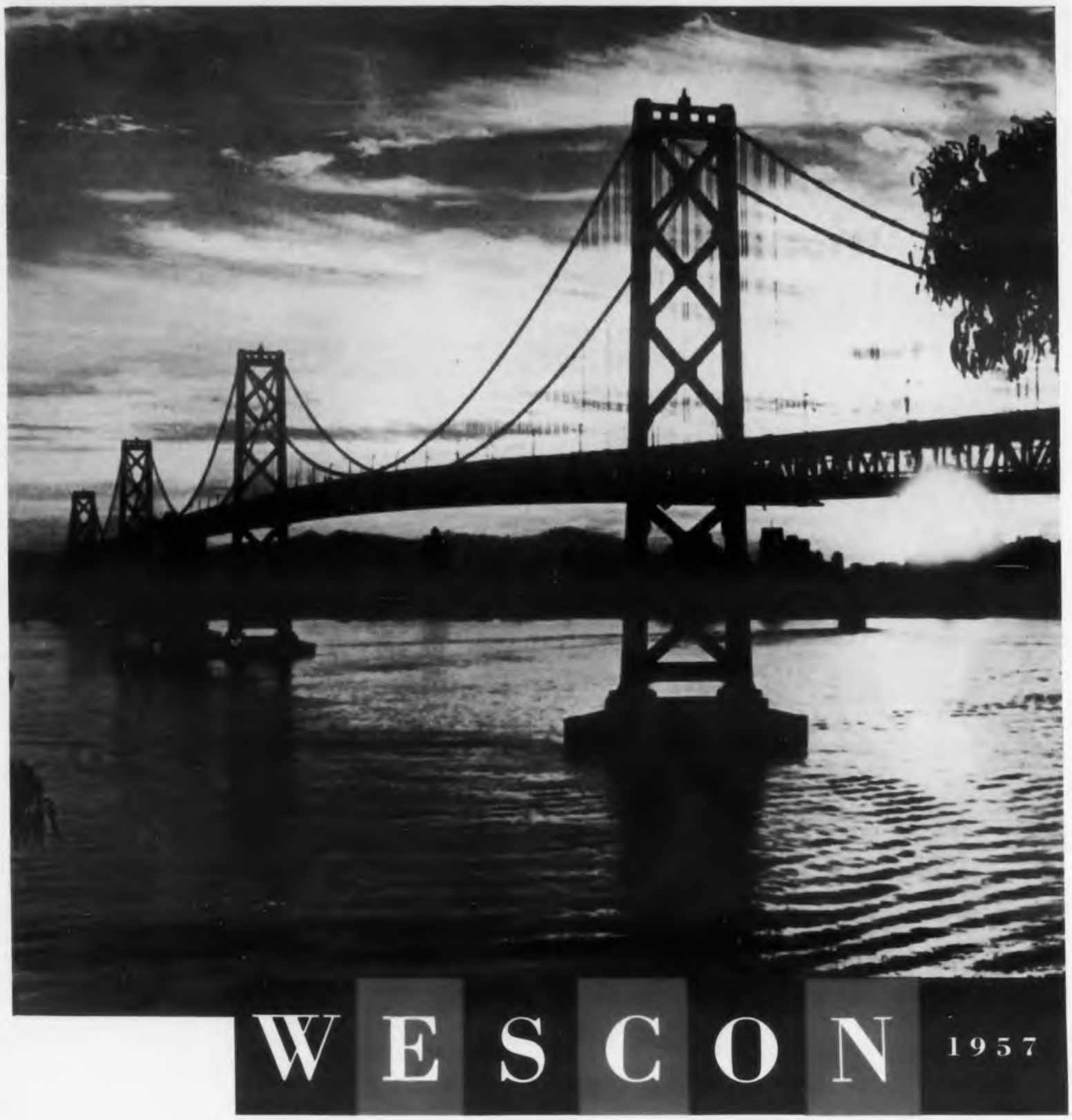


Fig. 3. Total harmonic distortion produced by the amplifier at various output power levels.



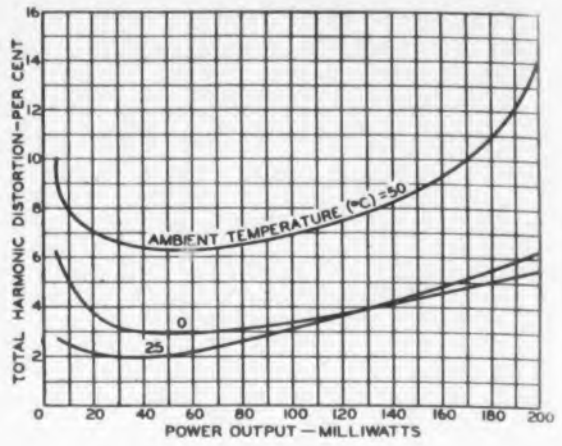


Fig. 4. Total harmonic distortion produced by the amplifier as function of power output.

Circuit Performance

The over-all frequency response of the system (including an RCA Stock No. 75476 Crystal Pickup) is shown in Fig. 2. The drop in high-frequency response in the vicinity of 500 cps is due partly to the decrease in pickup output in this region and partly to the bypassing effect of the capacitor across the output-transformer primary. The low-frequency response is determined by the time constant of the pickup capacitance and the terminating resistance (R_1), and by the characteristics of the driver and output transformers.

The total harmonic distortion contributed by the amplifier versus input-signal frequency at various output-power levels is shown in Fig. 3. Total harmonic distortion versus power output for different ambient temperatures is shown in Fig. 4.

The signal-to-noise ratio of the system is in the order of 55 to 60 db. The total current drawn by the amplifier from a 9 v battery versus power output at an ambient temperature of 25 C is shown in Fig. 5. At the maximum rated output of 200 mw the current drain for sinusoidal signal waveforms is approximately 41 ma, representing a power consumption of 0.639 w. At normal listening levels for

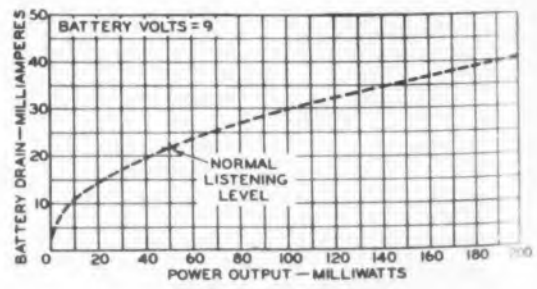


Fig. 5. Total current drawn by the amplifier as a function of power output.

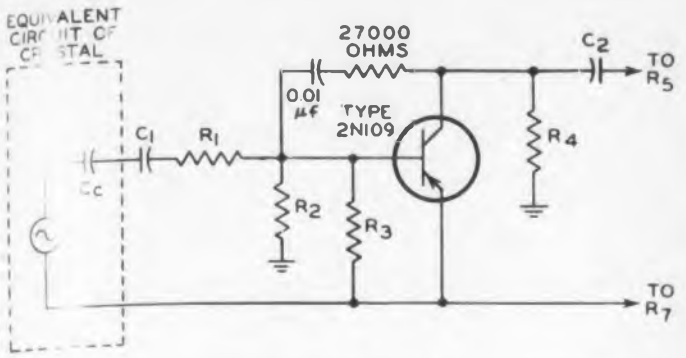


Fig. 6. Alternative input circuit for use with pickups having flat frequency-response characteristics.

speech and music (approximately 50 mw) the amplifier draws only about 22 ma, representing a power consumption of 0.198 w. The amplifier will operate satisfactorily, although with reduced output, at reduced battery voltage. The total battery drain will, of course, depend upon the current drawn by the turntable motor. A typical 45 rpm, 6 v motor draws 30 ma.

Circuit Modifications

If the amplifier is to be used with a pickup which faithfully follows the recording characteristic, correction for the "New Orthophonic" recording characteristic may be obtained without an appreciable reduction in over-all gain by the use of the alternative input circuit shown in Fig. 6. The value of R_1 will depend on the pickup capacitance and should be selected so that the time constant, $R_1 C_c$, is 75 μsec. When this alternative input circuit is used, the functions of the volume and tone controls in Fig. 1 should be reversed in order to minimize changes in over-all frequency response with changes in the setting of the volume control. In this case the 100,000 ohm potentiometer should have a logarithmic audio taper.

The low-frequency response of the amplifier may be improved by the addition of the 220,000 ohm resistor (R_{10}) and 0.003 μsec capacitor (C_7) shown connected by dashed lines across the second transistor in Fig. 1.

The amplifier can readily be modified for operation at ambient temperatures above 50 C by a reduction in the base-to-emitter forward bias of each stage. The reduction should be at the rate of 0.002 v for each degree by which the desired operating temperature exceeds 50 C, and may be obtained by 1. insertion of suitably bypassed resistors in the emitter leads of the first two stages; 2. a change in the bias circuit for the output stage so that the driver transformer center tap is connected to a suitable point on a voltage divider directly across the 9 v supply instead of a tap on the decoupling network.

Ideas for Design

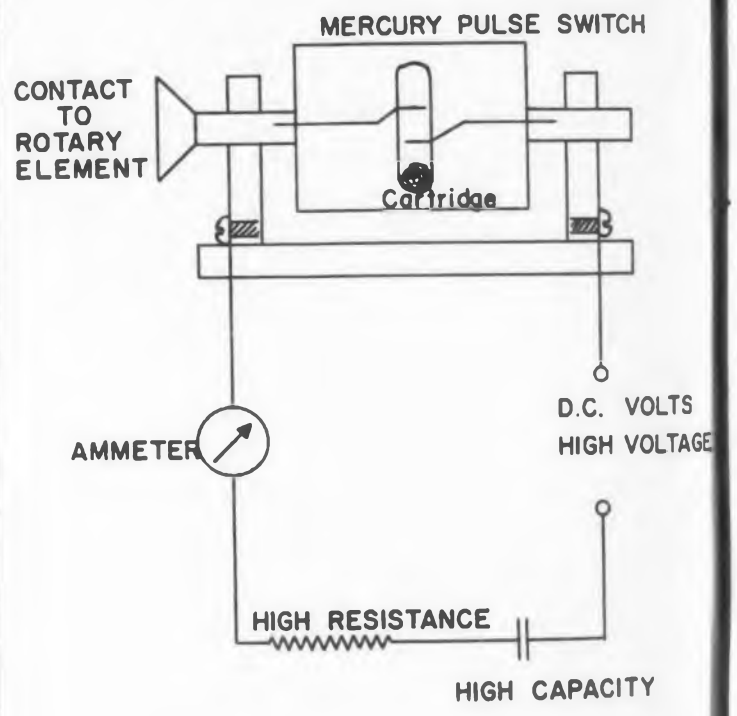
Low Speed Indicator

Present tachometers work effectively only for comparatively high revolution speeds. When checking extreme speeds, only measurements over a prolonged time interval are presently used. The design described here bridges the gap between the standard types of tachometers and the motions measured by timing only.

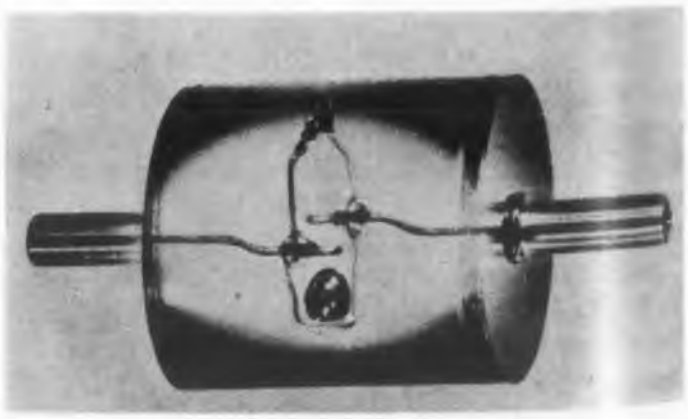
Problem Solution

This design makes effective use of a mercury pulse switch (U.S. Patent #2,687,453). The essential element of the device is shown in the photo.

The glass element contains a drop of mercury. When the cartridge rotates, the mercury fall past the two electrodes, establishing intermediate contact only and passing past the electrodes into the



Schematic of Low Speed Indicator



Mercury Pulse Switch

non-conductive part of the tube. Hence every 180 deg of revolutions a contact between the electrodes is established. According to the schematic diagram the contact is used for charging a large capacitor. The discharge of the capacity takes place through a high-resistance ammeter.

With the discharge rate essentially uniform, the rate of indication stays in a direct relation to the charging rate of the condenser; hence it is a function of the dc voltage impressed and the number of discharges (which are in direct relation to speed).

Dr. Erwin J. Saxl, Chief Engineer, Tensitron, Inc., Harvard, Mass.

10-Minute Etching and Anodizing Process

A "do-it-yourself" 'Fotofoil' kit solves short-run problems for nameplates, panels, schematics and templates. Using the equipment shown, no darkroom or photographic equipment is required. The kit is especially designed for research and development departments. It contains all necessary chemicals and equipment to produce top quality etched, anodized nameplates and panels in about seven minutes.

Fotofoil is a metal, coated with a light sensitive ink which, after processing, becomes alkali, acid and waterproof. It is available in a wide variety of colors and in standard thicknesses from .003. The kit contains a photo lamp, print frame, three porcelain trays, chemicals, Triac adhesive in pressurized container, and 10 sheets of Fotofoil, at a cost of about $40. Fotofoil and chemicals can be purchased separately. The kits are available from Miller Dial & Name Plate Co., 4400 N. Temple City Blvd., El Monte, Calif.

Dials, panels or nameplates can be produced in less than 10 minutes with the do-it-yourself kit. The kit is especially useful for "crash" programs, research & development departments, and for experimental work where savings in time and cost are equally important.

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To encourage two-way communication between electronic designer and manufacturer.

Now, almost five years later, *Electronic Design*, alone among all other electronic publications, remains unchanged in policy, in concept, and in its pledge to both reader and advertiser.

T. Richard Gascoigne

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Ideas for Design

Felt Lubrication Seals

The use of motors and mechanical drives under wide temperature extremes, particularly in aircraft, points up some important properties of felt. Prelubricated and sealed bearings and drives under extreme conditions places a severe burden on lubricating materials used.

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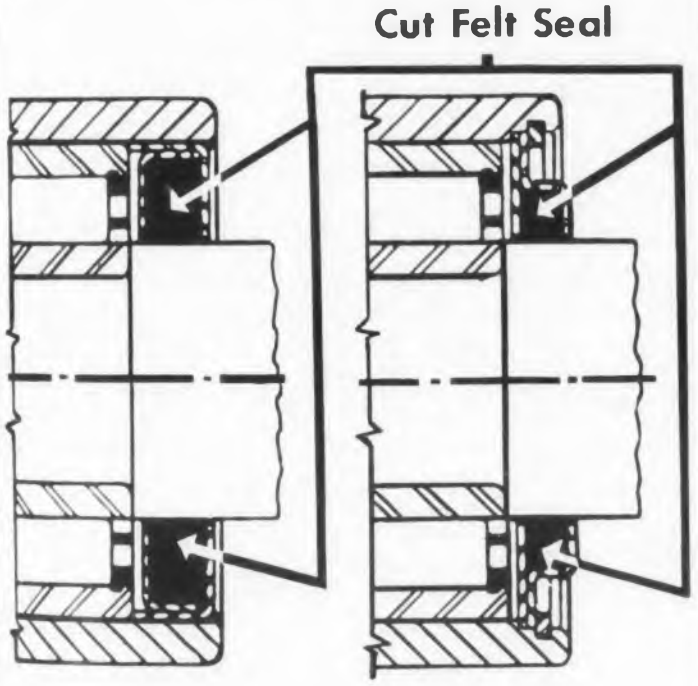

Suggested Application of Felt for Use in Metal Stamping Seals for Pre-Lubricating Ball Bearings

Correction

Purchase Specifications for Pulse-Forming Networks, published in the April 15 issue of ELECTRONIC DESIGN was written by John Trinkaus, Standards Engineer at Sperry Gyroscope Company. We apologize sincerely for the omission of a byline.

Report Briefs

Fused-Junction Transistors

An investigation of certain of the physical characteristics of transistors, derived from measurements of a group of 100 fused-junction transistors is made for the purpose of determining the empirical relations that exist among them. Significant departure from the theoretical relations derived from the one-dimensional transistor is discovered. An approximate relation based on the measurements of the group of transistors is presented, together with some discussion of the possible reason for the discrepancy between the theoretical and empirical relations. In addition, it is shown that for this group of transistors, the low-frequency circuit parameters may be expressed as functions of but two basic physical quantities. *PB 123988 Variability of some characteristics of a group of fused-junction transistors, G. H. Scithers, Stanford University Electronics Research Lab., Stanford, Calif. L.C. Washington 25, D.C. Sept. 1955. 34 pp. Mi $3.00, ph $6.30.*

Status of Noise Analysis

This report deals largely with investigation of discrete oscillations and excess noise noted in a low voltage beam tube employing an axial focusing magnetic field. A diagram of the experimental tube used thus far for most of the noise studies is here reproduced. *PB 123057 Interaction of electrons and R-F fields. Current Status of the Noise Analysis, Technical Report No. 4, J. C. Twombly. Colorado Eng. Experiment Station, Boulder, Colo., July 1955, Library of Congress, Washington 25, D.C., 52 pp, Microfilm $3.60, Photostat $9.30.*

Transistor Amplifier Design

A method was devised for design of a multistage wideband transistor incorporating constant resistance ladder networks in the external feedback path. The method allows synthesis of the feedback amplifier without use of equivalent circuits for the transistors. This is accomplished by approximating the measured amplifier gain function without feedback with a rational function of frequency, then applying unilateral feedback theory in design of the feedback path. Interaction effects are eliminated by use of constant resistance ladder networks in the feedback path. Among other advantages, the method is said to considerably reduce design time through use of equipment such as a complex plane analyzer or Spirule, and applying root locus techniques. *PB 121556, Transistor Feedback Amplifier Design, G. L. Benning, University of California OTS, U. S. Department of Commerce, Washington 25, D.C. Oct. 1955. 29 pp. $.75.*

580-600 Mc

Antenna pattern measurements for the 580-600 mc 3-slot array antenna were made on a section of the Aerobee rocket. Measurements were made in the principal planes through the center of each slot. Measurements of the transmission loss and phase characteristics of the 3-slot array antenna feed harness were made. Transmission loss was found to be 0.5 db, ±0.2 db per section, and the relative phase difference at the output of each section was found to be not greater than ±2 degrees. Voltage standing wave ratio measurements were taken on each slot and its associated feed harness, as well as on the complete 3-slot array. *PB 123163 Performance of the 580-600 megacycle slot antenna for the Aerobee rocket, Howard J. Jackson, Harold D. Smith and Cecil C. Post, New Mexico College of Agriculture and Mechanic Arts, Physical Science Laboratory, State College, New Mex. LC. Washington 25, D.C. Feb. 1956. 20 pp. Microfilm $2.40, photostat $3.30.*

Evaluation of Low-Dielectric

A glass composition called 6-6-4 glass was developed which has better electrical properties than the standard "E" (for electrical) glass when used in glass-fabric-base plastic laminates. Fabric woven from yarns of the new glass fibers is called a low-dielectric glass fabric. In this research, comparative tests were run on laminates reinforced with fabric made with the new fibers and with the "E" fibers. Data showed that laminates made with the low-dielectric fabric were superior in electrical properties but inferior in strength and elastic properties. *PB 121859 Evaluation of Low-Dielectric Glass Fabric, F. Werren and B. G. Heebink, Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, OTS, U. S. Department of Commerce, Washington 25, D.C. Oct. 1956. 24 pp. $.75.*

Design of RF Transformers

Part 1 of the report deals with theory of equivalent circuits, element calculations, and transformer terminology. Part 2 deals with transformer design, with examples covering two frequency ranges. Part 3 describes physical studies made in conjunction with the program, behavior of ferrite materials, coil losses and core losses. Part 4 illustrates a few applications of ferrite materials to transformers which handle more than 1 kw of rf energy and to other matching devices which also handle large amounts of power. *PB 124088, Principles of design for miniaturized broadband, high power RF transformers. H. Rosander, D. Cherry, W. Jakubowski and E. Smith, Sierra Electronic Corporation, San Carlos, Calif. LC. Washington 25, D. C. 182 pp. Mi $8.40, pl $28.80.*

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Patents

Electric Trigger Circuits

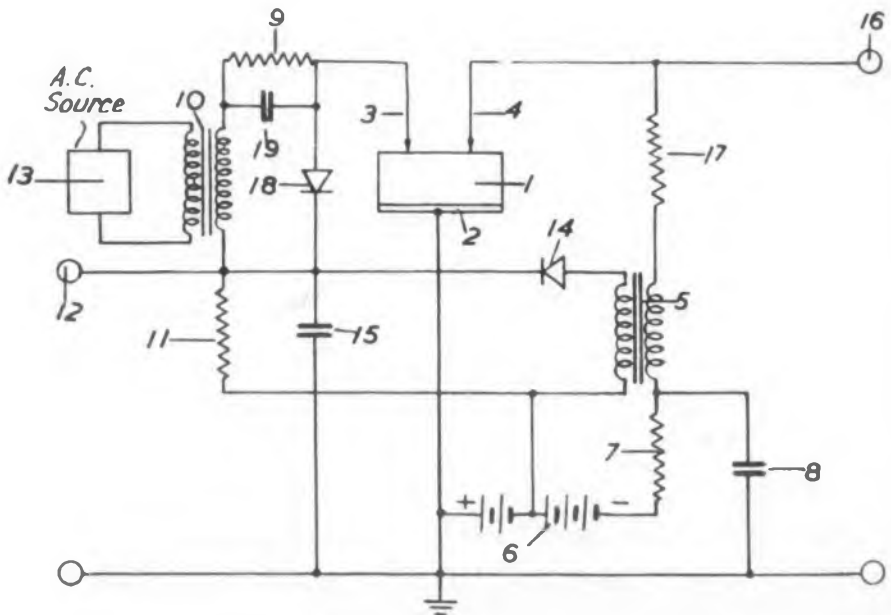
Patent No. 2,764,688. H. Grayson et al (Assigned to International Standard Electric Corp.)

There are many uses for trigger circuits although they find their more common uses in counting circuits and pulse amplifiers. Trigger circuits have two conditions of stability and are triggered from one condition to the other upon application of a triggering pulse. The circuit of the patent is a transistor crystal triode amplifier. The transistor is a power gain type although transistors of the current gain type, which also have a power gain, may be used.

The transistor *1* of the circuit has the usual base *2*, emitter *3* and collector *4* electrodes. An oscillator *13* of any suitable kind is coupled to the emitter *3* through a transformer *10* and current limiting resistor *9*. The frequency of this ac source should be considerably higher than the trigger circuit frequency and a relationship of 1 mc to 10 kc is set forth as a suitable frequency relationship. The control pulse for the circuit is applied at the input terminal *12* across a resistor *11* of relatively high value. The collector circuit includes a load resistor *17*, and the primary winding of a transformer *5* having its secondary connected across the resistor *11* through a rectifier *14*. Proper potentials are applied to the electrodes from a source of potential *6*.

So long as a trigger pulse is not applied at the input terminal *12*, the transistor is at its blocked or "off" condition. Upon the application of a positive pulse to the terminal *12*, the transistor is triggered to "on" condition and conducts. The high frequency current now flows in the emitter circuit and is amplified in the collector circuit. A short trigger pulse will accomplish this and hold the transistor in its conducting condition through the feedback provided by the transformer *5*. In order to restore the transistor *1* to its "off" or non-conducting condition, a negative pulse of relatively short duration is supplied to the input terminal *12*. The transistor remains in its non-conducting or "off" condition until the next positive input pulse is applied. The output signal may be taken from any suitable point such as an output terminal *16* in the collector circuit.

The circuit may be somewhat uncertain in operation if there is sufficient variation in the amplitude of the high frequency current. The transistor may be triggered to "on" condition if this current becomes too great. Operation of the circuit may be made by using a rectifier *18* between the emitter *3* and the input terminal *12* and a capacitor connected across the current limiting resistor *9*. Several modified circuits are illustrated in the patent which operate substantially in the manner described. One such modified circuit uses the transistor not only as an amplifier but also as an element of the high frequency oscillator.



Distributed Amplifiers

Patent No. 2,778,888. E. H. Bradley. (Assigned to Melpar, Inc.)

The distributed amplifier described uses a first and a second phase delay transmission line each terminated in its characteristic impedance. Pairs of vacuum tubes, each pair consisting of a first and a second tube are connected to the transmission lines as will be described. These tubes usually have sufficient capacitive feed-back between anode and grid such that unstable operation results when amplifying at ultra high frequencies. The anodes of the first tubes of each pair are connected to distributed points along the first transmission line and the control grids of these tubes are connected to a point of fixed ac reference potential. A positive potential applied to the first transmission line supplies the potential for the anodes of the first tubes. A load impedance is provided between the cathode of these tubes and the same point of fixed reference potential. The control grid of each of the second tubes of each pair is connected to like distributed points along the second transmission line. The anode or cathode of each second tube is also connected to the point of reference potential, and the other electrode is connected to the cathode of the first tube of its pair. The input signal is applied to one of the transmission lines and the output signal is derived from one or both of the transmission lines.

Magnetic Gating Circuit For Controlling A Plurality of Loads

Patent No. 2,774,956. Theodore H. Bonn. (Assigned to Sperry Rand Corporation)

A new system of magnetic gating is disclosed for controlling spaced power pulses from a suitable source to two different loads. Two magnetic amplifiers are shunted across the one load and is in series with both the second load and the source of power pulses and controls the flow of current from the source to the loads. Each of the magnetic amplifiers have a control winding and a power winding with the power windings being connected to the pulse source and to the loads so that they determine the flow of current to the loads. Each control winding is energized by a signal source during the spaces between the power pulses.

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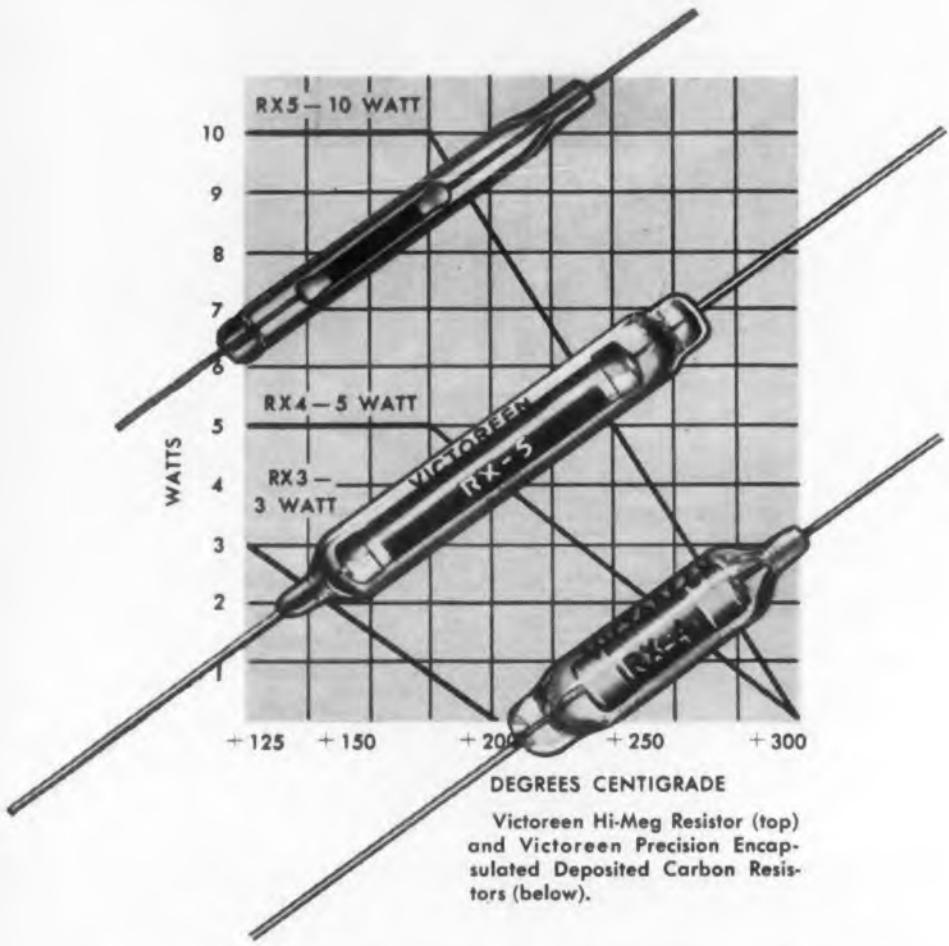

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Patents

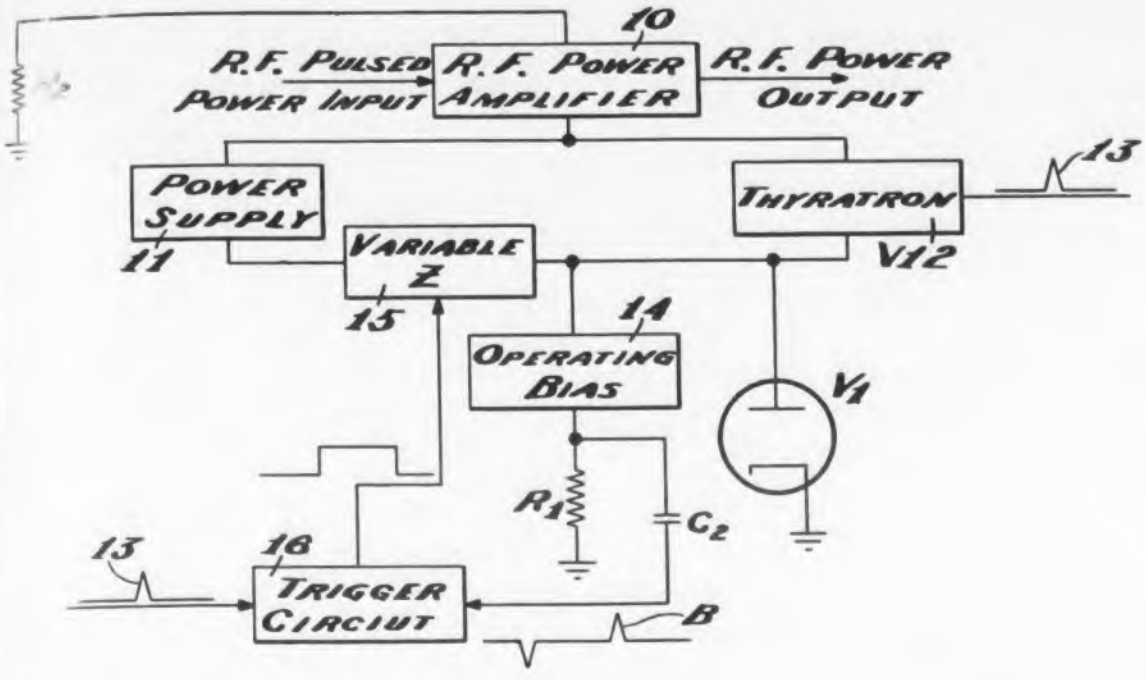
R-F Pulsed Amplifier

Patent No. 2,755,379, N. W. Hancock. (Assigned to Collins Radio Company)

High power amplifier tubes are used which have a peak power output of as much as eight megawatts. Such tubes require the application of a negative bias in the neighborhood of 10,000 v in order to cut it off. Another difficulty in control of these tubes is that the grid current may be as high as 10 amps. The diagrammatic circuit illustrated shows a circuit which supplies the high negative voltage necessary for cut-off of the amplifier but does not supply the grid current which flows during conduction.

The negative bias grid potential for cut-off of the high power tube *10* is secured from a power supply *11* which can be relatively small. This power supply may be a full wave rectifier including a transformer, a pair of diodes and filter. A thyratron is in parallel with the power supply and is non-conductive. When the thyratron is con-cut-off. A trigger pulse *13* renders the thyratron conductive and substantially short-circuits the power supply. This removes the bias from the power tube and it becomes conductive. When the thyratron is conducting it provides, in conjunction with the operating bias tube *14* and resistor *R1*, a current path for the grid current of the amplifier.

A variable impedance *15* is included in the circuit between the plate of the thyratron *V12* and the power supply. This variable impedance may be a discharge tube having a grid which is controlled by a trigger circuit *16*. When a trigger pulse *13* is applied to the control grid of the thyratron, the same control pulse is applied to the trigger circuit which generates a negative pulse and biases the variable impedance tube *15* to its high impedance value. This substantially limits current from the power supply through the thyratron when the amplifier is conducting. When the amplifier is not conducting, a grid circuit is provided by the diode *V1*, impedance *15*, the power supply and resistance *R2* provided by the water path which is used to cool the grid of the amplifier. The operating bias *14* for the grid of the amplifier may be secured by



using a discharge tube and resistor *R1*. This impedance controls the operating point of the amplifier during conduction. By controlling the bias on its grid the shape of the output wave may be altered.

A trigger pulse to cut-off the amplifier is derived by differentiating the potential across the resistor *R1* through the capacitor *C2* and a resistor (not shown) which is applied to the trigger circuit and a positive potential is developed which is applied to the control grid of the variable impedance *15* so that it is restored to its low impedance condition and the thyratron is extinguished. The high negative potential of the power supply is then applied to the control grid of the power amplifier *10* to cut off this tube.

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Patents

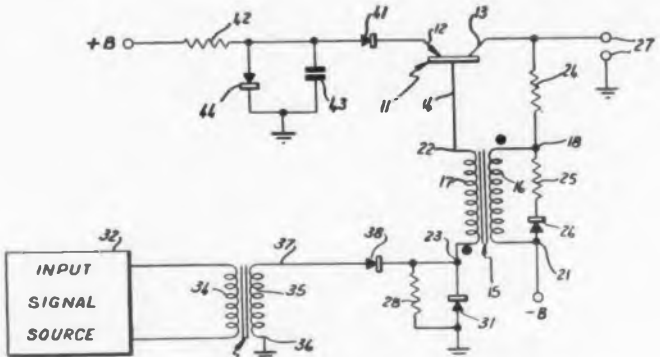
Transistor Pulse Generator

Patent No. 2,758,206. D. J. Hamilton. (Assigned to Hughes Aircraft Company)

A stable pulse generator has many applications and finds extensive use in digital computers. A common form of circuit generates a sine wave which is amplified and then clipped to secure a square wave. This square wave is differentiated which gives a pip of voltage at the leading and trailing edges of the wave. Because of the sensitivity of this circuit to the amplitude of the input it lacks a desired degree of reliability. Another pulse generator is the multiar circuit which is reasonably reliable but since conduction through the tube is continuous except at pulse time, this circuit is inefficient. Also the output is in the form of sharply defined pips which must be clipped in order to secure a square wave.

The circuit illustrated uses a transistor *11* and circuit elements which results in the direct generation of a square wave time pulse from a sine wave input. These output pulses are unaffected by any expected variation in the amplitude of the input wave. The pulses are generated when the input wave crosses the zero reference point which gives accurate timing of the pulse.

The input signal or wave is applied across a resistor *28* through a transformer *33* and diode rectifier *38*. The potential at terminal



23 is applied to the base *14* of the transistor through the secondary winding *17* of a feedback transformer *15*. During one half wave of the input signal, the potential at connection *37* is positive so that with the rectifier *38* properly poled, current flow is established through the resistor *28* and a positive potential exists at terminal *23* and on the base *14*. With this potential condition the diode *31* is non-conducting. The positive potential appearing at the emitter *12* is relatively low since it corresponds with the potential drop across the diode *44*. Under these conditions there is no current flow through the emitter circuit and therefore no output in the collector circuit *13* nor at terminal *27*. The resistor *28* is shunted by a rectifier *31* poled so that when the potential *37* is positive, this rectifier is poled for non-conduction.

As the input wave passes through zero potential, the diode *38* becomes non-conducting and ground potential is applied to the base electrode *14* so that current begins to flow through the emitter circuit and hence through the collector circuit which includes resistor *26* and the primary winding *16* of a regeneration transformer *15* so that a negative going potential is induced at *22* of the secondary winding and at the base. Increased current flow through the emitter results and by such regeneration a substantial pulse is generated. When the emitter current reaches saturation, reverse regenerative action occurs to restore the potential on the base *14* to a potential which cuts off current flow. The pulse generated is a square form.

The capacitor *43* which shunts the diode *44* is charged negatively with respect to ground during current flow through the emitter circuit. Upon termination of emitter current, the charge on the capacitor biases the diode *44* to non-conducting condition so that the charge on the capacitor is discharged through resistor *42* and the B+ power source. This capacitor and resistor therefore controls the time interval when the diode *44* again becomes conducting and hence the recovery time of the circuit. The cycle then repeats.

If it should be desired to balance impedances this can be accomplished with resistor *25* and diode *26* across the primary winding *16*. The patent also describes a more complex circuit using two transistors for use primarily in a computor using the Ferranti or Manchester system.

Patents

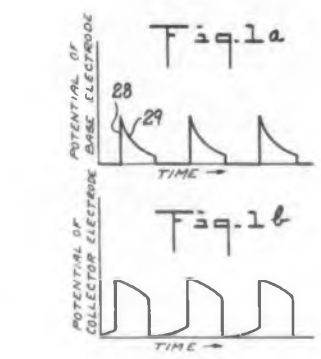
Multivibrator Oscillator Generator

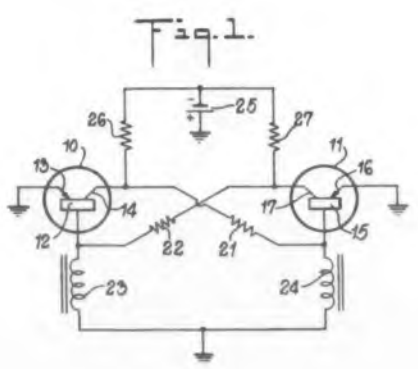
Patent No. 2,759,104. A. M. Skellett. (Assigned to National Union Electric Corp.)

A multivibrator oscillator using a pair of transistors instead of tubes has been devised by the patentee. The transistors *10* and *11* can be any well known brand. Particular attention is directed to the fact that the emitter electrodes are directly grounded, the base electrodes are grounded through their respective inductors *23* and *24* and the collectors are supplied with a negative potential from a power source *25*, the positive terminal of which is grounded. It is desirable, though not necessary, to provide resistors *26* and *27* in series between the collector and the power source.

The circuit operates as a feedback amplifier which provides an unstable circuit. The frequency is determined by the respective values of the inductors and resistors used. The circuit generates a pulse as shown in Fig. 1a at the base electrode of either transistor and Fig. 1b shows the wave form at either collector electrode.

The form of the output wave of the multivibrator may be varied by providing a shunting capacitor for the resistors *21* and *22* in which event the steepness of the rise of the pulse is increased. This also increases the maximum potential by a substantial amount. Furthermore these capacitors speed up the transition of the circuit from one state to the other. By using shunting capacitors for the inductors the wave form output of the multivibrator may approximate a sine wave. The patent also discloses circuits having a transformer winding connecting the collector electrodes with the secondary winding providing an output circuit having a square wave output of long duration. A transformer connection with the base electrodes may be used with which circuit a modified square wave output is obtained.





Pulse System

Patent No. 2,776,375. F. P. Keiper, Jr. (Assigned to Philco Corporation)

The pulse system uses transistors. An operating potential is applied to the collector through an inductive element. The emitter circuit is coupled to the inductive element so that a voltage pulse developed across this element increases the current through the emitter to the saturation level—at least during a portion of the pulse. A resistance in the path of principal emitter current flow determines the magnitude of this current flow.

Oscillators

Patent No. 2,774,878. James Lee Jensen. (Assigned to Minneapolis-Honeywell Regulator Company)

The oscillator uses an amplifier tube having control elements for controling the current through the tube. An output circuit connects the amplifier tube to a direct current source and a connection is made from the output circuit to the load. A second connection is made from the output circuit to inductive coupling means which provides feedback to the control elements of the amplifier. Initially the feedback tends to increase the current through the output circuit of the amplifier and hence to further increase the signal applied to the control elements. The inductive coupling includes a saturable core for limiting the signal transmitted to the control elements so that when the limiting value is reached, the inductive coupling is effective to decrease the signal transmitted to the control elements. The amplifier then becomes nonconductive which cycle is repeated.

One Shot Multivibrator

Patent No. 2,778,,936. R. B. Trousdale. (Assigned to General Dynamics Corp.)

The multivibrator is designed to control the switching of a potential supply circuit to a utilization circuit. The electronic switch includes a first tube of the gas type which is used for actual connection of the supply circuit to the utilization circuit. A signal source applies a signal to the control grid of the tube so that the switch becomes effective to interconnect the supply and utilization circuits. The multivibrator includes a second tube of the gas type with its plate connected to the cathode of the first tube. A capacitor is used for firing the second tube. Upon a discharge through the second tube, the discharge through the first tube is extinguished whereupon current flow through the second tube ceases due to removal of potential from the plate of this tube.

Millivolt Gating Circuit

Patent No. 2,775,696. R. E. Thomas. (Assigned to the United States of America)

A gating circuit is disclosed which has a pair of like gating tubes having a common plate resistor. The signal to be gated is applied to the grid of one of the pair of gating tubes. A positive gating signal is applied to a screen grid of this same tube. Simultaneously a negative gating signal is applied to the screen grid of the other of the pair of tubes while the control grid has a signal proportional to the anode potential applied to it. As a consequence any voltage variation across the common plate resistor is minimized.

Quasi-Regenerative Pulse Gating Circuit

Patent No. 2,773,982. Robert B. Trousdale. (Assigned to General Dynamics Corp.)

A pulse gating circuit is described having a control tube and a gating rectifier in series. The rectifier has two electrodes, one of which has control pulses applied thereto in the correct polarity to cause the rectifier to become conductive. A condenser is connected to this same electrode of the rectifier which biases the rectifier to cut off. By controlling the conductivity of the control tube a predetermined minimum value of current flow through the rectifier is secured. The pulses applied to the first electrode of the rectifier are deriving from the other electrode of the gating rectifier when the control tube is conductive.

Books

Acoustical Engineering

Harry F. Olson. D. Van Nostrand Co. Inc., Princeton, N.J., 718 pages, $13.50.

An outgrowth of an earlier text of Mr. Olson's entitled "Elements of Acoustical Engineering" this book covers the entire field of acoustical engineering from fundamentals to practical applications. Throughout the text consistent and logical use of analogies between electrical, mechanical and acoustical systems are made. This reduction of a vibrating system to the analogous electrical network is a valuable tool and should prove particularly interesting to the electronic engineer. Detailed presentations of theory and practice are given for all important transducers. The material, on speech, music and hearing correlates objective and subjective acoustics. A large number of useful formulas, tables and graphs are included.

In addition to bringing his material "up to date" Mr. Olson has added two chapters dealing with complete sound reproducing systems and communications systems. The most recent developments in underwater acoustics, systems for detecting and locating crafts and obstacles, and depth soundings are discussed. In the field of ultrasonics, industrial techniques for cleaning machined parts, drilling and the detection of flaws are analyzed. Because of its depth of coverage, the book deserves a spot in the electronic engineer's reference library.

Radio Aids to Air Navigation

J. H. H. Grover. Philosophical Library, 15 East 40 Street, New York, N.Y., 138 pages, $6.00.

The design engineer interested in *technical data* on radio aids to air navigation will find little of interest to him in this text. He may, however, find the material very interesting as a descriptive survey on present day systems. In writing this volume the author stressed performance, capabilities and methods of operation of the different types of navigational radio equipment. Obsolete and purely military types of equipment have been excluded, but the most important civil systems in current use in Europe and America have been fully covered.

After an introductory chapter on General Principles, medium frequency and VHF systems are described. Two chapters are devoted to the particularly important hyperbolic aids. There follow chapters on pulse systems, aids to traffic control and aids to approach and landing. In chapter 10 Mr. Grover discusses future aids and trends in air navigation. The volume is well illustrated and indexed.

Automation: Its Purpose and Future

Magnus Pyke, Philosophical Library, 15 East 40 Street, New York 16, N.Y. 191 pages, $10.00.

Dr. Pyke begins by reviewing some of the new things that are already being done automatically. He describes the principles of the digital computer and the way in which it was developed. An account of "automation" in the mass-production industries is included showing how the new computors can be used to make special machine tools or the precisely constructed parts of aircraft.

The rapid onrush of automatic systems in offices, banks and insurance companies, their present importance in the petroleum industry, and their appearance in chemical manufacturing are also discussed. Factors effecting the speed with which "automation" is likely to spread in different countries are discussed.

Dr. Pyke is optimistic about the social effects of the new revolution. He sees signs that where "automation" is furthest advanced, the intelligent use of leisure is growing.

What the Russians Are Writing

J. George Adashko

RADIO ENGINEERING

(Contents of RadiotekhnikaNo. 9, 1956)

TRANSISTORS

Feedback in Transistor Circuits, Ia. K. Trokhimenko, (8 pp, 4 figs, 1 table).

The conditions under which transistor circuits can or cannot be approximated by equivalent vacuum tube circuits has been a recurrent topic in recent Russian literature, and several articles on the subject were already mentioned in "What the Russians are Writing."

The use of external feedback in transistor amplifiers improves stability and counteracts the frequently-harmful effects of transistor internal feedback. It should be noted that many problems related to the use of feedback in transistor circuits (particularly stability and phase relationships) have not yet been thoroughly studied. A development of a rigorous engineering theory for the application of feedback transistor circuits would inevitably lead to better transistor amplifiers, particularly mass-produced ones.

Reduction of Wavefront Distortion in Junction-Transistor Video-Pulse Amplifiers, T. M. Agakhanian, (5 pp, 5 figs).

A method is given for reducing the distortion due to velocity dispersion of the minority carriers near the base of a junction transistor. Wavefront distortion in video amplifiers employing junction transistors is due principally to parasitic capacitances, which can be minimized by methods well known from the theory of vacuum-tube amplifiers, and to processes occurring near the base of a junction transistor, namely diffusion and the disturbed thermodynamic equilibrium between the recombined and thermally formed current carriers. These processes introduce a temporary time shift and increase the buildup time of the wavefront.

Fig. 1 shows how the buildup time of the wavefront can be reduced by so choosing the parameters

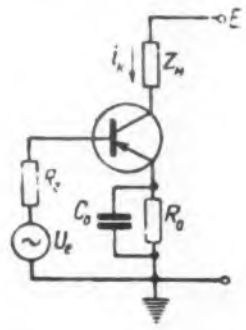


Fig. 1. A sharp drop in the input pulse increases the influx of carriers at the output of the circuit, thereby decreasing the buildup time of the wavefront.

as to increase the number of carriers with the steepness of the wavefront. The steeper the input pulse, the lower the input impedance of this circuit, and the less effective the feedback loop R_0C_0.

The article gives a thorough analysis of such a network in terms of its equivalent circuit. It is pointed out that current carriers can be redistributed also by other types of networks, but the circuit described is shown to be the most promising. Reference is made to articles by Chow, Suran, and Schaffner (Journ. App. Phys, *24*, pp 1355 ff, 1953, and Proc. IRE, *41*, p 1125, 1953).

ANTENNAS

Influence of Precipitation on the Electric Properties of Wire-Mesh Surfaces, V. K. Paramonov, (9 pp, 5 figs).

This rigorous treatment is valuable in UHF antenna design, since screen material and expanded metal are frequently used as antenna elements. The effect of icing on the reflecting properties of wire-mesh surfaces is analyzed and equations are derived for the transmission coefficient of a mesh in which each wire is coated by a uniform layer of ice. The discussion covers both direct and oblique incidence of the electromagnetic wave. Experimental verification of the theoretical data is also presented.

Receiving Antennas and Industrial Static, V. V. Roditi, M. S. Gartsenshtein (7 pp, 3 figs, 4 tables).

Statistical theory is used to calculate the effective height of indoor antennas used for medium- and long-wave reception in several Russian cities,

and to determine the interference transfer coefficient. The latter are treated as basic parameters which affect the reception quality under urban broadcasting conditions in the presence of industrial static. An attempt is made to analyze the data measured in several cities.

INFORMATION THEORY

Mutual Correlation of Fluctuation Noise at the Output of Bandpass Filters, M. V. Maksimov, (11 pp, 3 figs).

Statistical analysis of the output noise in a typical system, where a detected signal is resolved by means of narrowband filters into several components which are subsequently compared or combined. In view of their common source the noise factors of the individual channels are obviously interdependent, and their correlation is studied for systems with and without detectors.

PROPAGATION

On the Possible Transmission Bandwidth in Long-Distance Tropospheric Propagation, V. N. Troitski (5 pp, 3 figs).

Discussion of the anistropy effects in long-distance tropospheric propagation, under the assumption that the horizontal irregularities of the dielectric constant are smaller than the vertical ones. Equations are derived for the maximum bandwidth that can be transmitted without distortion. The influence of antenna directivity on the possible transmission band is also analyzed.

A Possible Method of Calculating the Propagation Constant of Waveguides with Walls of Finite Conductivity, L. N. Loshakov, (4 pp, 1 table).

Equations for wave propagation in waveguides with walls of finite conductivity can be derived from Maxwell's equations, subject to certain boundary conditions. These equations are valid at relatively high conductivity, but not for rectangular waveguides. Using a different approach, based essentially on energy-balance considerations, the author derives an approximate method and verifies his premises with illustrative examples.

CIRCUIT THEORY

Investigation of Shock Excitation and of Forced Quenching of Quartz Oscillations, T. N. Iastrebtseva, I. G. Akopian, (7 pp, 11 figs).

Straightforward circuit analysis is used to determine the response of a quartz crystal to a step function or to a rectangular pulse. The inverse phenomenon, forced quenching, is also analyzed. The optimum pulse duration for maximum response

Russian Translations

amplitude and for minimum harmonic content is determined. Four methods of forced quenching are studied; shunting the quartz with a resistor, use of a negative-feedback loop, quenching with the aid of a balancing circuit, and shock quenching.

The article contains a discussion of the various methods and a description of some experimental circuitry developed at the Moscow State University.

Fundamental Properties and Characteristics of Synchronous Filters, N. K. Ignat'ev (13 pp, 6 figs).

The synchronous filter is a natural extension of the tuned filter, but unlike an ordinary tuned filter, the effect of the synchronous filter is not limited to sinusoidal oscillations, but to oscillations of any form that repeat at a given frequency to which the filter is "tuned."

This article examines the operation of such a filter and derives relationships for its frequency, phase, and transient characteristics. The concept of filtration coefficients as related to the noise voltage is introduced, and the dependence of this coefficient on the filter parameters is determined.

An essential part of such a filter is a storage device, which, in this case, is merely a long open-circuited line.

Reference is made to several American articles on the subject.

Use of Harmonics to Calculate Envelopes of Curves, A. A. Kulikovski, (3 pp, 2 figs).

In non-linear radar analysis one frequently deals with the response of a tuned circuit (and the response of the linear tuned stages that follow it) to a hf pulse "filled" with oscillations that are made non-sinusoidal by non-linearities in the preceding stage. (A typical example is the determination of the time variation of the voltage across the tuned plate circuit of a non-linear tuned amplifier or of the output voltage of a following linear stage.) This is claimed to be one of the first attacks on this problem by direct transient analysis.

RADIO ENGINEERING AND ELECTRONICS

(Contents of Radiotekhnika i Elektronika No. 10 1956)

RADIO INTERFERENCE

On Certain Statistical Properties of Atmospheric Radio Interference, Ia. I. Likhter, (8 pp, 6 figs).

Shows that radio interference does not obey the normal distribution law, and that the distribution function depends on several parameters.

TRANSMISSION LINES

Waveguides used as Resonators at Subcritical Frequencies, I. V. Lebedev, A. M. Guttsait, (6 pp, 5 figs).

A cavity can be synthesized from a waveguide operating below critical frequency and a capacitative diaphragm. Such a cavity has a low loaded Q and is simple to construct. It can be tuned as readily as an ordinary cavity, although it does have a narrower frequency band. Fig. 2 shows an 18 mm cavity used with a 10 x 23 mm rectangular waveguide, and Fig. 3 shows the experimental input-reactance vs. frequency curves, which agree well with the theoretically-calculated data.

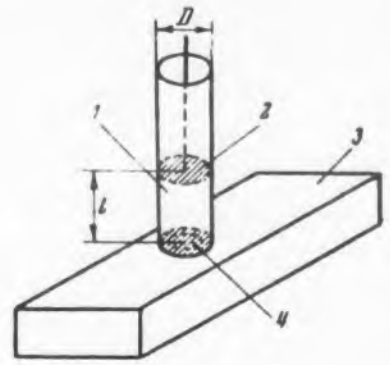


Fig. 2. Subcritical cavity arrangement: 1. Subcritical waveguide; 2. Piston; 3. Main line; 4. Capacitive diaphragm (window).

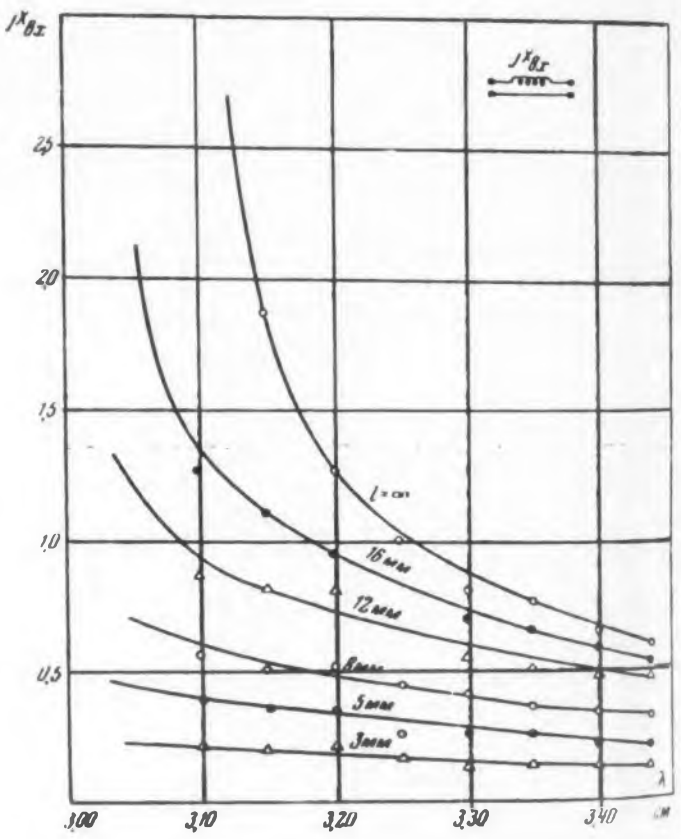


Fig. 3. Experimentally measured input impedance of round subcritical 18mm waveguide. The ordinate, jX_{in}, is the impedance relative to that without the piston. At upper right is the simplified equivalent diagram.

A New Diaphragm-Type Waveguide, R. G. Mirimanov, G. I. Zhileiko (4 pp, 1 fig).

A new diaphragm type waveguide which can be successfully used in travelling-wave tubes and particle accelerators is discussed. Equations are derived for the field components of the propagating wave.

Concerning the Theory of the Double-Helix Coaxial Line, V. S. Mikhalevskii, (8 pp, 3 figs).

Discusses the dispersion properties of double-helix coaxial lines for simple axially-symmetrical waves. Equations are derived for the dispersion as a function of the geometry of the helices, which may be wound in the same direction or in opposite directions. Refers to article by S. Sensiper, "Electromagnetic Wave Propagation on Helical Structures," Proc. IRE, 1955, *43*, 149-161.

FERRITES

Ferrite Thermomagnetic Materials, L. I. Rabkin, B. Sh. Epshtein (7 pp, 11 figs).

The permeability of a thermomagnetic material varies considerably with temperatures, and this property can be used to compensate, say, for temperature variations of the inductance of an iron-core coil. The article discusses the properties of such materials and various compensation methods.

PHOTO-ELECTRICITY

Certain Results of an Investigation of the Energy Distribution of Photo-Electrons from an Antimony-Cesium Cathode, N. M. Molitova (9 pp, 8 figs, 1 table).

Although the antimony-cesium cathode has been known for 20 years, studies of its electron-emission mechanism have been far from exhausted. This study was made for incident light ranging from 4000 to 6300 Angstroms.

Semiconducting Photosensitive Layers for Photoconductive Television Tubes, Ia. A. Oksman, (4 pp, 2 figs).

Discusses in particular the procedure, measurement setup, and experimental results of an investigation of Sb_2S_3 films used as photoconductive coatings in vidicon tubes.

CIRCUIT THEORY

On the Theory of Synchronization of Non-Sinusoidal Self-Oscillations, I. I. Minakova, K. F. Teodorchik, (8 pp).

The energy-balance method is used to analyze the synchronization of a self-oscillating system in response to an external periodic force. A general expression is obtained for the synchronous frequency as a function of the spectral contents of the self-excited oscillations and of the external force.

Russian Translations

On the Theory of Non-Linear Phenomena in Travelling Wave Amplifiers, A. A. Vedenov, 1 p.

Another explanation of the amplitude limitation of travelling wave tubes based on the integration of the Poynting vector inside the tube strucure.

Other Articles in This Issue

"Commercial Types of Multistage Photomultipliers," I. Ia. Broido, B. M. Glukhovskoy, and L. G. Leiteizen (13 pp, 17 figs, 4 tables). (Gives extensive data on the latest types of the most modern Russian photomultipliers.); "Effect of Vapors and Gases on the Internal Photoeffect of Oxide Semiconductors and the Sensitization of Oxide Semiconductors with Chlorophyll," E. K. Putseiko (10 pp, 7 figs); "External Photoeffect from Lead Sulfide and Copper Selenide," P. S. Popov, (6 pp, 5 figs, 1 table).

AUTOMATION AND TELEMECHANICS

(Contents of Avtomatika i Telemekhanika No. 10 1956)

SERVO SYSTEMS

Evaluation of Performance of Automatic-Regulation System from Stability Margin, from the Modulus and Phase, and from the Value of *M*, M. V. Meerov, (6 pp, 11 figs).

A critical review of a proposed method in which the modulus and phase of the open-loop complex gain, the stability margin, and the value of the peak *M* of the closed-loop gain are used to predict the performance of an automatic-regulation system. Other frequency-analysis methods are compared and the limits within which this method is valid are indicated.

Vibrator Amplifiers and their Use in Servomechanisms, Ia. E. Gukailo, S. M. Fedorov, (8 pp, 6 figs).

Describes the operating principles of several versions of vibrator (chopper) amplifiers employing polarized relays. Both self-excited and externally excited vibrations are covered. Typical output vs. input curves are shown for all types and are approximately derived for the externally-excited versions. The use of such amplifiers in servomechanism is discussed.

CIRCUITS

Effect of External Feedback Loop on Multi-Stage Magnetic Amplifiers, N. P. Vasilieva, M. A. Boiarchenkov, (7 pp, 4 figs).

The most effective method of increasing the gain to time-constant ratio in a magnetic amplifier is to

increase the bias frequency; this calls for a special power supply. The next best method is to use several low-time-constant stages in cascade, and to use a feedback loop from the output to the input. The overall feedback can be either electric or magnetic; the article discusses the merits of the two types and shows that electric feedback is preferable.

Synchronous Filter-Oscillator for Remote-Control Frequency Installations, V. L. Inosov, A. M. Luchuk, (5 pp, 2 figs).

Essentially a combination of narrow-band filter, relay, and local oscillator. The relay operates when a remote signal of the same frequency as the local oscillator is received. Synchronism is detected by a phase-sensitive network with an integrating element. The operation can be readily followed from the diagram.

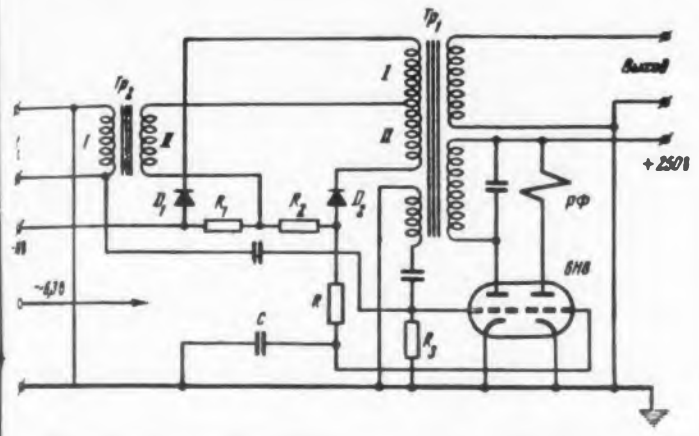


Fig. 4. Narrow-band frequency relay (filter) combined with oscillator. In the absence of a signal (f_c) the double diode is blocked by the 16v bias.

Simple Circuit for Producing a Voltage Proportional to the Square of Speed, V. V. Gorski, (2 pp, 4 figs).

A Russian patent application was made for the circuit shown in Figs. 5 and 6. If the reactance of C is much greater than the load resistance, the voltage is nearly proportional to the square of the frequency, for the current in the load is

$$I = \frac{E_{TG}}{(R^2 + 1/\omega^2 C^2)^{1/2}}$$

and E_{TG} is proportional to the frequency.

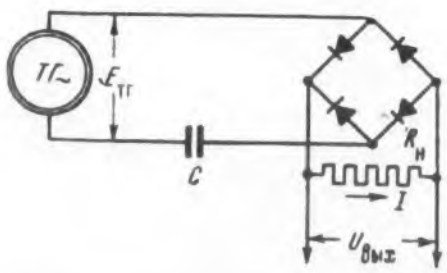


Fig. 5. The bridge and capacitor convert the output into a dc signal proportional to the tach-generator speed.

Russian Translations

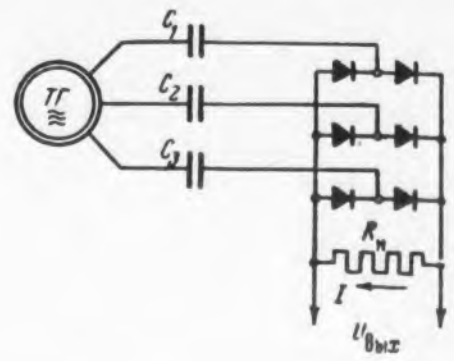


Fig. 6 A similar arrangement can be obtained for a three-phase tach-generator, which is more common.

Other non-linear outputs, for example $U_{out} = k(1-\varepsilon^{-a\omega})$ can be obtained by using a choke and resistor combination in lieu of the capacitor.

INFORMATION THEORY

Pulse-Width Modulation Element for Electronic Simulator of Pulse-Type Regulation Systems, M. A. Shnaidman, (11 pp, 19 figs).

Another article dealing with the new electronic computer of the USSR Academy of Science, described in the January 1956 Avtomatika i Telemekhanika (See *ED* June 1, 1956).

Analysis of control systems in which error or control signals are supplied in the form of pulses involves laborious computations even in the cases of the simplest systems. An analogue computer capable of handling non-linear differential equations, used in conjunction with a pulse-width modulation circuit, can simplify the work considerably. The element described here can produce output pulses that range from 0.01 to 20 cycles in frequency, with a pulse duty factor ranging from 1.05 to infinity, and with an accuracy of 2-3 per cent of the computer full scale. The performance of the pulse-width modulation element is thoroughly described, although no numerical data are given. Reference is made to an article by Morrill and Baum, "Diode Limiters Simulate Mechanical Phenomena," Electronics, Nov. 1952.

Other Articles in This Issue

"Selection of Dimensions and Structural Scheme of Electrodynamic Clutches," I. M. Makarov (13 pp, 22 figs); "Design and Analysis of the Dynamic Behavior of Throttle-Type Hydraulic Amplifiers," V. A. Khokhlov, (9 pp, 3 figs.); "Regulating the Feed of a Cutting Engine in Well Drilling," D. I. Marjanovsky, (10 pp, 6 figs.).

[Concerning Approximate Solution of Partial Differential Equations by Electric Models, E. S. Kozlov, N. S. Nikolaev, (7 pp, 11 figs.)]

ELECTRICAL COMMUNICATIONS

(Contents of Elektrosvyaz' No. 10, 1956)

MODULATION

Single-Sideband Modulation with Division of Low-Frequency Spectrum, B. B. Shtein, (9 pp, 11 figs).

This is a continuation of work described in the June 1956 issue of "Radiotekhnika" (*ED* Jan. 1, 1957), where the use of three-phase modulation to produce single sideband signals is discussed, with the phase shift kept within the required accuracy limit by using wideband phase-shifting networks. This article shows how the phase shift can be maintained constant by dividing the low-frequency spectrum in two parts. A new two-phase modulation method, analogous to the previously described three-phase method, is discussed in some detail.

NETWORKS

Analysis of Linear and Non-Linear Electric Network by Tabular Methods, V. A. Govorkov, (11 pp, 4 figs, 7 tables).

Relaxation methods, such as described by Scarborough and Southwell, are used to eliminate much of the drudgery of solving the simultaneous linear equations involved in rigorous Kirchhoff's-law calculations. The accuracy of the method is discussed.

INTERFERENCE

Analysis and Comparison of Principal Circuits for Suppressing Interference from Stations Operating at the Intermediate Frequency of a Receiver, I. M. Simontov, (10 pp, 6 figs, 1 table).

Discusses the most widely used suppression circuits—the band elimination filter, a bridged-T blocking filter used in the receiver input, and a cathode-circuit blocking filter invented by the author. The three circuits are compared with respect to the attainable intermediate-frequency selectivity and with respect to the insertion loss produced by the filtering network.

Other Articles in This Issue

"On Noise Rejection of Long-Distance Communication Channels," Iu. D. Farber, (10 pp, 3 figs). (Mostly concerns telephone communication at voice frequencies); "Modern Ideas on the Propagation of Meter Waves by Ionospheric Scattering," E. L. Cherenkova, (7 pp, 4 figs). (Survey of American literature on the subject); "Long Distance Dialing System," V. N. Roginski (10 pp. 5 figs, 1 table); "Automatized Relaying of Telegrams with Code Switching," G. F. Pramnek, (8 pp, 3 figs); and "Theory of Design of Broadcast Distribution Networks," E. K. Iodko, (6 pp, 6 figs).

Abstracts

Specialized industrial tubes manufactured in small numbers are evacuated in special ovens. Operator is checking temperature of tube (WL-5936 triode) as it is evacuated.

Status of Special Purpose Tubes

A major trend in special purpose tubes has been in the direction of achieving greater power densities from smaller tube generators. Reliability has been an important consideration too, as has been the assembly of multitube units in one envelope. Some of the techniques and advances in special purpose tubes are reviewed briefly here.

■ **Envelopes.** New glasses and improved ceramics have made possible tube designs that will stand high-frequency operation, high voltage, high temperatures and operation in a strong rf field. "Custard cup" base structure provides a contour to which metal thimbles are easily attached, and forms part of the vacuum envelope. Kovar, with an expansion characteristics which matches 7052 glass, allows rugged metal-to-glass seals in very large sizes.

In the multiform process, powdered glass is mixed with a binder and dry pressed into a toroid shape. The ring is next heated in an oven which sinters the glass particles into one solid piece. The glass ring can be sealed on both its inside and outside edges to metal cylinders, which form part of the electrical lead-in system. Furnace sealing of the glass ring and tube parts results in a tube with concentric input and output electrode leads that are most suitable for high-frequency operation. A new 10 kw tube for frequencies up to 30 mc uses this concentric lead-in system.

■ **Leads.** Tungsten wire is often used as a lead-in conductor for power tubes since it can be sealed

readily to glass, particularly in the smaller sizes. Although the expansion of tungsten does not exactly match glass, proper annealing results in satisfactory seals. Dumet, a nickel-iron wire with a sheath of copper, seals readily to many types of glass and is widely used, particularly for receiving tubes. "Flying leads,"—long flexible copper ribbons permanently attached to the pins in the base of the tube—make efficient connections with external circuit elements.

▪ **Insulation.** A newly designed spider insulator can support long filament wires at critical points and operate at 2000 C inside the filament cage. Sometimes the need for even higher operating bulb temperatures and higher frequencies requires ceramic parts to support and insulate the electrodes, and simultaneously form part of the vacuum envelope. High purity alumina is useful. Usually it is coated with a surface layer of metal at the electrode seals. Alumina can be brazed to metal parts and forms a vacuum-tight joint of high strength.

The material can be made either non-porous or porous, the latter being preferable when efficient out-gassing is a consideration, such as for internal insulation. Non-porous ceramics are used for vacuum-type envelopes. The parts can be made in sizes from a fraction of an inch to ten inches. Alumina windows have been made as thin as 0.010 in. although flat pieces are usually somewhat thicker.

▪ **Cathodes.** If the ratio of peak available electron emission demanded by the circuit is kept above a ratio of about 3 to 1, and if a high degree of vacuum is maintained, thoriated-tungsten filaments prove satisfactory under relatively severe and continuous operating conditions. Electron emission is a key factor and must be maintained at a high level.

Cermet cathode can stand high temperatures caused by back positive ion bombardment, and have been used where particularly severe operating conditions prevail, such as in a high-powered magnetron.

▪ **Grids.** To keep power tube grid thermionic emission from becoming too high, an emission-inhibiting grid material such as a platinum-clad wire of molybdenum or tungsten is used. The oxide-coated cathode of a typical receiving tube tends to deposit a layer of barium on the grid; here, gold plating prevents the unwanted primary emission.

▪ **Anodes.** In air-cooled tubes, an internal anode radiates most of its heat directly through the envelope walls. The solid anode X-ray rectifier tube operates particularly well under the high peak power loads which are often encountered. Some electronic tube anodes are external, forming part of the envelope and resulting in a relatively compact tube. A metal-to-glass seal is required. The anode portion of the tube is mounted in a water jacket and water cooling is quite effective. A new rectifier has been built with an external anode that includes a

radiator portion for either air- or oil-cooled operation. Another has been designed particularly for oil-immersed installation, and can be mounted inside the ac power transformer tank. Such installation provides high voltage and current ratings, and minimized tendency to arc over.

▪ **Gas Filling.** The thryatron grid prevents current from passing between the cathode and anode until a desired time, after which the amount of current flow depends solely upon the electrical values of the external circuit. The grid cannot regain control until the current flow is stopped, when anode potential goes negative. Thus the grid in a gas-filled tube controls the power handled in the tube by determining the portion of the ac cycle that current can flow; it cannot determine the magnitude of the current through direct and continuous control of the amount of electron flow.

Mercury vapor has been the traditional filling for thyratrons and works efficiently. Objections to its use are its sensitivity to extremes in both high and low ambient temperatures. But the control grid has been redesigned and shield grids added to restrict the spread of ionization during operation so that the deionization occurs more rapidly, resulting in better control.

Inert gases, such as argon, neon and xenon remain in the gas phase throughout the normal operating temperature range. Advantageous operating characteristics are sometimes obtained by using a combination filling of an inert gas and mercury.

When extremely rapid ionization and deionization is desired, such as for modulating radar equipment, thyratrons are filled with hydrogen. Since hydrogen is also an inert gas, the hydrogen thyratron is not influenced by ambient temperature conditions over the usual operating range.

▪ **Ultrasonic Cleaning.** Improvement of techniques has achieved outstanding results in removing residues remaining from the compounds used on metal surfaces during buffing, polishing, and drawing. Ultrasonic cleaning equipment has been developed to the point where it can be placed on production lines.

Ultrasonics has been found useful also in assisting chemical action in plating operations. The mechanical vibrations knock loose any small bubbles formed during plating and thus shorten plating time.

▪ **Non-Destructive Inspection.** Important advances have been made with chemical, ultrasonic, high-frequency, magnetic, fluorescent penetration and X-ray methods to check the quality of materials and parts. The polariscope for examination of many forms of glass and glass-to-metal seals is another non-destructive testing technique.

Refinement of an old method can be used for inspection of steel parts. The material to be inspected is first dipped in an acid bath to produce an insoluble coating of material that leaves a matte-back-

ground surface. The parts are next placed in a penetrant, such as an acid mixture, after which they are removed, washed and dried. The penetrant bleeds out of any cracks or fissures and leaves a permanent indication of flaws, easily observed under natural light.

In ultrasonic testing, high-frequency sound waves are sent into a material and their travel pattern noted. A fissure will reflect these mechanical vibrations, and by careful measurement, location of a flaw can be accurately determined. X-ray pictures will reveal hidden cracks or voids and are also used to check internal spacing, such as the distance between the grids and anodes in large water-cooled power tubes.

▪ **Ignitrons.** The ignitron switch requires a small amount of water flow for cooling purposes to maintain rated temperature. Usually the operator will not turn off the water flow when the welder equipment is not in operation, and thus much water is wasted. An important ignitron improvement is a thermal control device that performs this function. The tube is interchangeable with the previous version, so that a new tube can be easily installed and the thermal control features added.

▪ **Magnetrons.** An x-band magnetron can be tuned by pushing a set of pins into, or removing them from, the anode cavities. This magnetron, mechanically tunable over a frequency range of 8500 to 9600 mc, is an improved model over World War II designs that were not tunable.

A new magnetron has a peak-power rating of 10 Mw and enables radar to see a plane at a distance of 400 miles. This tube has obtained the highest power-duty product for any magnetron using pulse widths up to 10 μsec and 0.0018 duty. The cermet cathode power is 4 kw for starting, and reduces during oscillation to between 1 and 3 kw, depending upon average anode input power. Rated plate voltage is up to 70 kw, and the peak anode current is 350 amp. The magnetron delivers its power into a 6-1/2 in. diam waveguide with no pressurizing or gas insulation required. The anode and end covers are water cooled, and forced-air cooling is required for the output glass window. The efficiency varies from 46 to 50 per cent depending upon the operating point.

▪ **Counter Tubes.** In the atomic energy field, neutron detection tubes have been developed to monitor and control atomic reactors while in use. Neutron detection tubes have been designed with sturdy integral structures to withstand any normal operating conditions of temperature and vibrations to which equipment using these tubes may be subjected. A complete line of tubes can cover a neutron flux range of at least 12 decades.

Abstracted from An Age of Refinement for Special Purpose Tubes *by Harry F. Dart, in the* Westinghouse Engineer, *May, 1957.*

Standards and Specs

Sherman H. Hubelbank

Guided Missile Electronic

MIL-E-25366(USAF), Electric and Electronic Equipment, and Systems, Guided Missiles, Installation of, General Specification for, 21 December 1956

The general requirements for the installation of electric and electronic equipment and systems in guided missiles are established by this spec. The design and installation of the electric and electronic systems and the selection and installation of the electric and electronic equipment is based on reliability; simplicity of operation; long-storage life with minimum reconditioning for operational use; minimum resources cost; minimized need for new, unique, or complex operational support facilities; minimum vulnerability to enemy countermeasures; minimum size and weight; and maximum safety of personnel and equipment. This spec supersedes MIL-E-9156 (USAF) 20 November 1953 and MIL-E-9483(USAF) 26 January 1955. This spec is intended for use with development and production models of all types of guided missiles.

Knobs

MIL-K-25049A(ASG), Knobs, Control, Equipment, Aircraft, 12 December, 1956

Control knobs, as defined by this spec, are furnished in two sizes, with and without skirts, large and small. Control knobs furnished under this spec shall be a product which has been tested and has passed the qualification tests specified. The aircraft control knobs covered by this spec are intended for use on controls used as a part of airborne equipment.

Marking

MIL-P-15024B, Plates, Identification—Information and Marking for Identification of Electrical, Electronic and Mechanical Equipment, 11 March 1957

This spec covers the material requirements for identification plates and information plates and the marking information for identification plates mounted on units, assemblies, and equipment of BuShips material. Identification plates and information plates are classified by this spec as: etched, engraved, stamped, cast, stenciled, laminated, decalcomanias or adhesive-backed metal foil, photographic, and embossed. The term information plates as used by this spec means instruction, warning or safety plates, wiring diagrams, graphic charts, and other designation plates. Dimensions showing typical proportions and spacing for electronic equipment identification plates are given.

National Bureau of Standards

NBS Miscellaneous Publication 220, National Bureau of Standards Annual Report 1956

The research and development activities of the National Bureau of Standards in the physical sciences during the fiscal year 1956 are summarized in this report. This 158-page publication gives brief descriptions of representative accomplishments in each area of the Bureau's responsibilities, which include maintenance of basic standards, determination of physical constants and properties of matter, development of methods and instruments of measurement, and the provision of calibration, testing, and scientific advisory services. Copies of this publication may be obtained for 60 cents each from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

Electronic Equipment

MIL-E-16400B (Ships), General Specification for Naval Ship and Shore Electronic Equipment, 8 January 1956

General requirements are established which are applicable to the design and construction of electronic equipment and associated and auxiliary apparatus furnished as part of a complete system intended for Naval ship or shore installations. The intent of this spec is to set forth the ambient conditions within which equipment must operate satisfactorily and reliably; the general material, the process for selection and application of parts, and to detail the means by which equipment as a whole will be tested to determine whether it will so operate.

Transistors

MIL-T-19500A, General Specification for Transistors, Notice 1, 3 January 1957

Notice 1 states that reference to the superseding document "MIL-T-25830(USAF)" is corrected to read "MIL-T-25380(USFA)". For Air Force procurement, the subject spec does not supersede MIL-T-25380(USAF) until such time as all detail specs written against MIL-T-25380 are covered by MIL-T-19500A.

Resistors

MIL-R-8781(USAF), Resistors, Fixed, Wirewound, Power Type, Chassis Mounted, 31 December 1956

This spec covers power type, wirewound, fixed resistors, which may utilize the principles of heat dissipation through a metal mounting surface. These resistors are not suitable for applications where alternating current is of critical importance. A typical type designation for a resistor meeting this spec follows: AFRI02J1000. These resistors are intended to be used where semi-precision at high temperatures, high power, wirewound resistors are needed.

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SO. NORWALK, CONN.

Mechanical Engineers (graduates BS and MS levels), Design Engineers, with or without formal degree, if qualified. Send complete resumé to Mr. Robert Martin, Dept. NJ-3, Wilson Ave., South Norwalk, Conn.

ST. PAUL, MINN.

Electronics Engineers, Mechanical Engineers, Electronic Design Engineers, Engineering Writers, Physicists, Mathematicians. Send complete resumé to Mr. R. K. Patterson, Dept. SJ-3, Univac Park, St. Paul 16, Minn.

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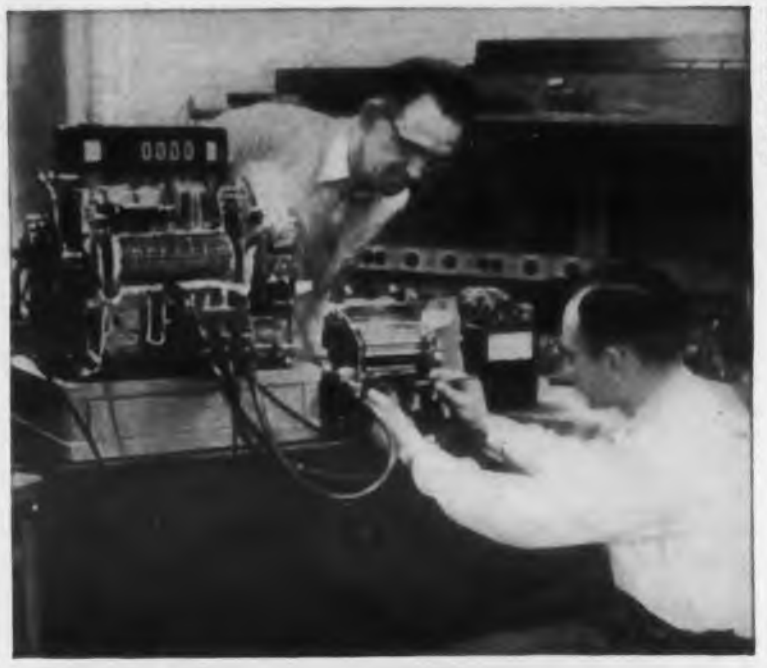

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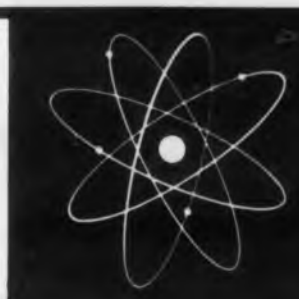

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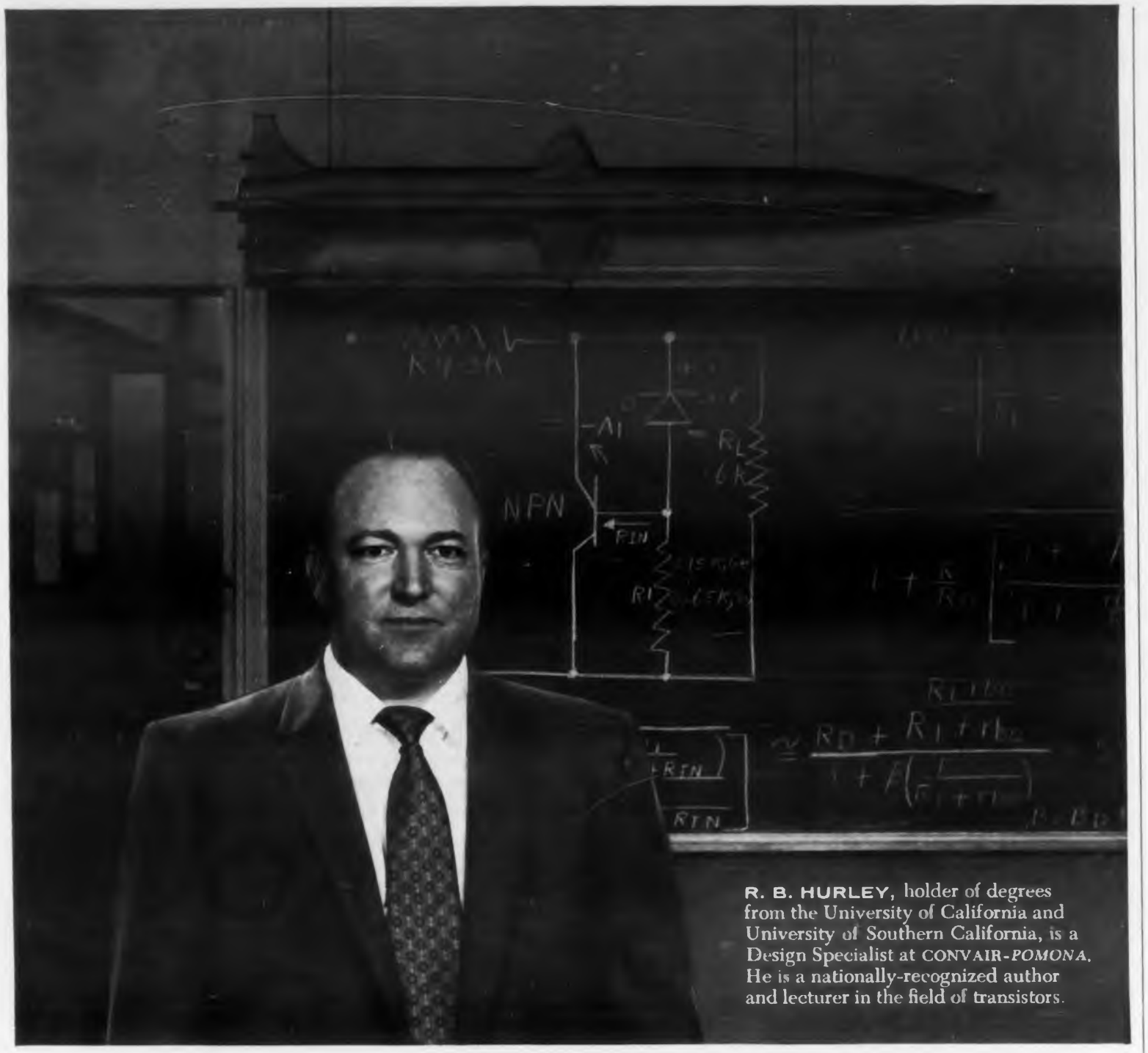

R. B. HURLEY, holder of degrees from the University of California and University of Southern California, is a Design Specialist at CONVAIR-*POMONA*. He is a nationally-recognized author and lecturer in the field of transistors.

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