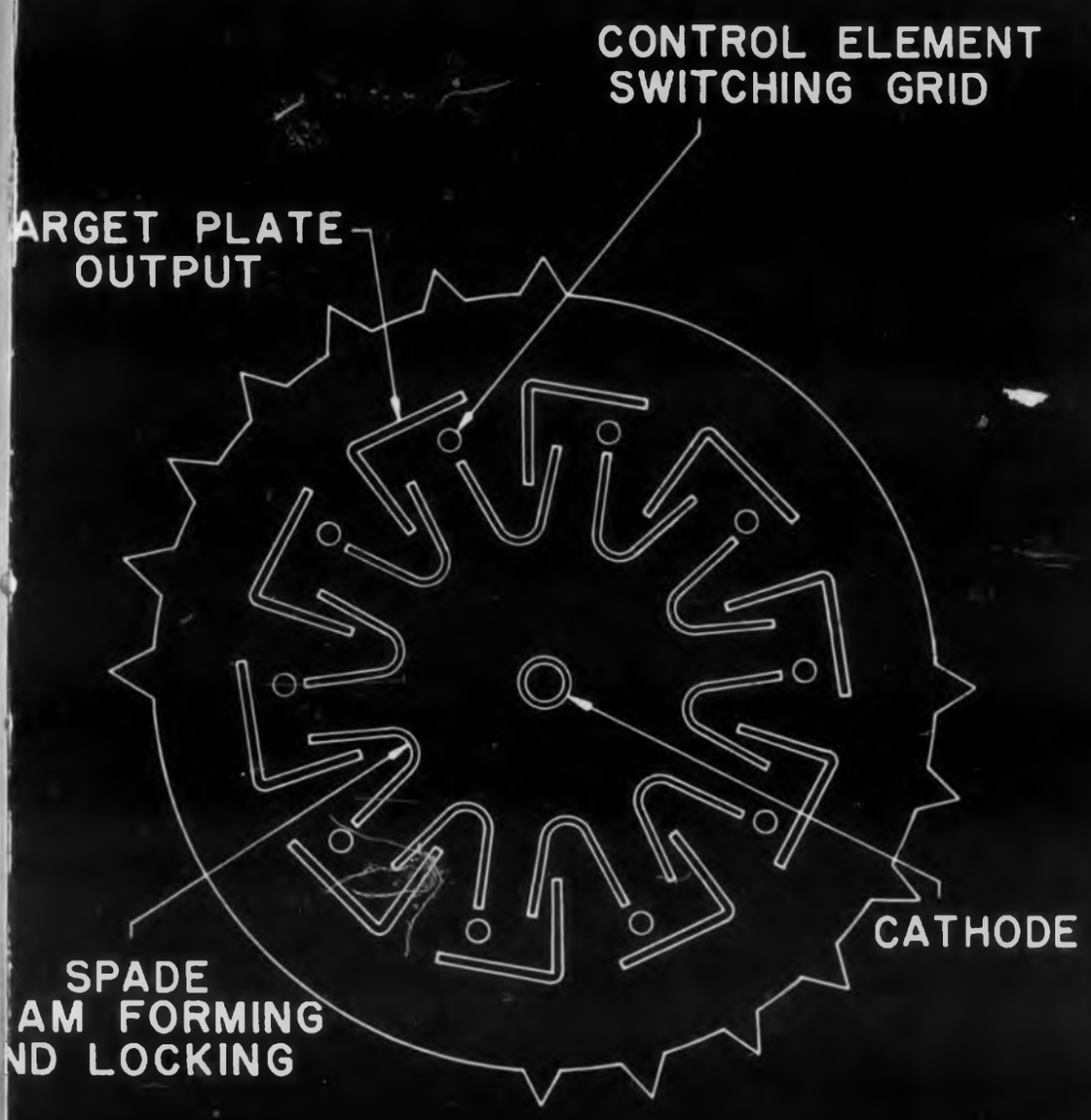
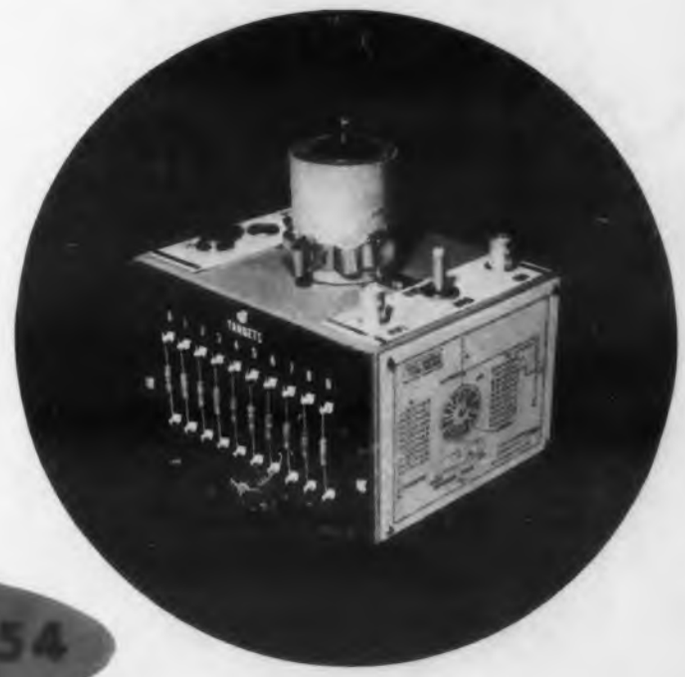
ELECTRONIC design



Symbolic representation of a new beam switching tube with its various internal elements is shown at the left. This tube has the characteristics of 10 pentode-like tubes in one envelope, and it has a potential reliability and life greater than that of a diode. Below is a universal test chassis which permits electronic designers to quickly evaluate the tube or any circuitry associated with the tube. A magnetic field, provided by a cylindrical permanent magnet which surrounds the tube, and electric fields are used to effect beam forming and switching to 10 discrete, automatically locked positions consecutively or at random.



January 1954

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CIRCLE ED-1 ON READER-SERVICE CARD

ELECTRONIC design

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Contents

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113

CIRCLE ED-2 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial . . .

Service to the Reader

MUCH time and effort goes into the preparation of material for each issue of Electronic Design. "Service to the reader" is our aim. Besides distributing the magazine without cost to qualified electronic engineers (a pretty valuable service in itself), we try to make it a working tool for designers.

The articles contain ideas or describe techniques which the reader can use directly in his work or extrapolate to suit his requirements. Some of the articles describe products of unusual design interest. For more information on these the reader can write directly to the manufacturer mentioning the issue and page on which the article appeared; or he can request it on the blank lines at the bottom of the Readers Service Card provided at the rear of the magazine.

Key "ED" numbers appear at the bottom of or alongside ads, at the bottom of product descriptions, and alongside titles of new literature reviews. For more data or a copy of the literature offered, the reader need only circle the proper number on the Readers Service Card. These requests are promptly sent to the manufacturers who in turn send the appropriate information to the reader. When an item has no "ED" number, the reader can write directly to the manufacturer, giving the issue date and page on which the item appears.

The best source for more information on items in the Engineering Review section of the magazine are given right in the items themselves. This is also true of the reviews in the Books section where each review includes the address of the publisher. Copies of the patents described in the Patents section can be obtained from the U. S. Patent Office, Washington 25, D. C., at 25 cents each.

By following the few simple suggestions mentioned above readers can make more effective and efficient use of Electronic Design.

◀ CIRCLE ED-3 ON READER-SERVICE CARD

Engineering Review . . .

Submicrosecond Electronic Camera

A Kerr cell of unusual design acts as the shutter for a submicrosecond camera being produced by Hycon Manufacturing Co., 2961 East Colorado St., Pasadena, Calif. Shown above is a platform-mounted 8″ explosive stick caught in partial detonation at 1/10 of 1 μsec with the new camera operated by an electronic circuit. There are no moving parts, and the power to take a picture is about that required to light a Christmas tree bulb.

Continuous Color TV Signal Standards Proposed . . . A proposal for broadcasting continuous color TV signal standards has been made to the FCC by J. Raymond Popkin-Churman, president of Telechrome, Inc., 88 Merrick Road, Amityville, L. I., N. Y.

Pending FCC approval, the proposal would make available nation-wide, day-long color TV signal standards to which all television broadcasting facilities and home receivers could be set correctly. Its most unique feature is that color or black and white programs would continue uninterrupted during the time these signal standards were being broadcast—an important contribution to the orderly growth of color TV broadcasting. The text of the proposal follows:

"It is proposed that continuous color standard test signals be broadcast during normal transmitting periods without interference to regular monochrome or color programming. These signals would be presented as follows:

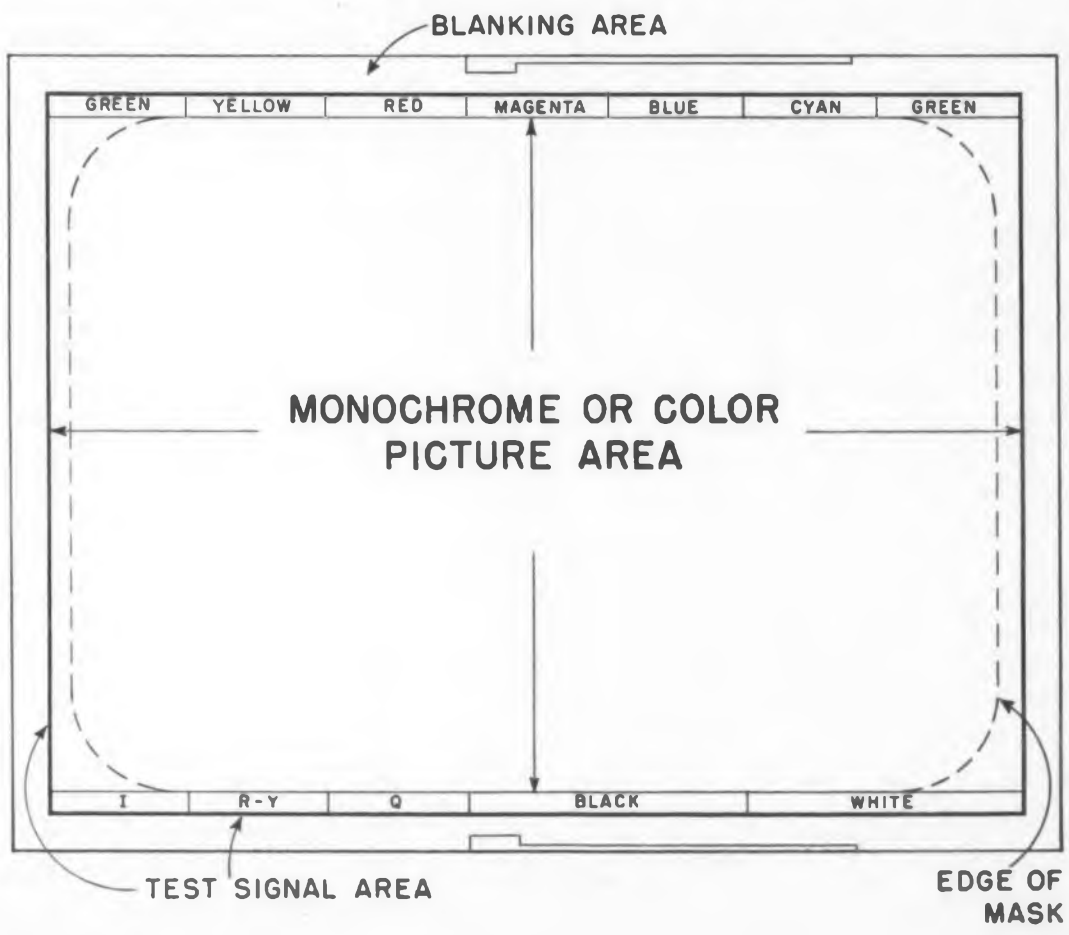
As shown in the . . . illustration, 10 or 12 lines at the top of the video picture would show bars of the major saturated colors and their complementaries; i.e., green, yellow, red, magenta, blue, and cyan. The 10 or 12 lines at the bottom would show I, R-Y, Q, black, and white. In addition, color burst and possibly one line of gray scale would be sent.

Inclusion of these signals would be consistent with the standards of the NTSC proposal presently submitted to the FCC and would introduce no degradation of monochrome or color signals. A survey of television receivers indicates that the 12 lines on the top and bottom of the picture generally lie outside the picture mask and would, therefore, not be visible. In the few cases where the test signals would be visible, it is felt that the subdued nature of these signals would not constitute an annoyance to the viewer.

Since the networks will be the first to broadcast color, this proposal would make available nation-wide color standards so that all receivers, transmitters, common carriers, and network facilities might be adjusted and checked by the same standard signals. Such a proposal would increase the time available for adjusting color receivers from the present few "off time" hours to the entire broadcast period; thus a standard of comparison for color would be available whenever needed.

The optional one line gray scale would allow checking of amplitude and linearity. Frequency burst signals from 500kc to 4.2Mc might also be sent to check frequency response instead of gray scale.

The instrumentation necessary to generate these signals can be easily accomplished with the equipment now available at the FCC field laboratory at Laurel, Maryland."



The sketch at the left illustrates how proposed standard color TV test signals would be received on monochrome or color picture tubes. These signals, appearing outside of the normal picture area, could be used for making adjustments of the color sections of the receiver even though a color TV program was not on the air.

Radioactive Tubing Gage . . . A gage utilizing beta rays from a radioactive source to measure the wall thickness and roundness of tubing has been developed by Tracerlab, Inc., 130 High Street, Boston, Mass. The new gage provides a means of gaging small diameter, thin walled tubing with extreme accuracy. It will be especially useful where uniform thickness of the tube walls is important and concentricity must be accurate.

Heart of the device is a source of beta radiation moved inside the tube in relation to a sensitive means of detecting radiation on the outside of the tube. Changes in the thickness of the tube's wall affect the amount of radiation passing through the wall. These changes are easily translated into thickness readings and recorded by a pen tracer on a recorder chart.

Engineering Review . . .

Automatic Insulation Inspector . . . A new automatic inspection device to speed production and insure uniform quality of sheet electrical insulating materials has been designed and built at the General Engineering Laboratory of General Electric Co., Schenectady 5, N. Y. The device measures and marks voids in insulating materials faster and more accurately than the most highly trained human inspector.

Mica tape is made from splittings about the size of a half-dollar. These are blown into a chamber and fall onto a steel drum which, in turn, deposits the flakes onto a moving web of varnish-soaked paper.

Since the flakes do not fall uniformly in this process, open spaces are hand-patched as the tape moves past a group of operators. It then passes through the inspection device which gives a continuous indication of the quality as determined by the number and size of voids remaining. If quality falls below an established level, the device gives a signal and corrections are made.

A permanent record of quality is kept by means of a photoelectric recorder, and all voids exceeding a permissible size are marked with a drop of dye. Detection elements scan the entire sheet as it moves past the point of inspection and, when a void goes through the detection elements, current flows. Inspection is accomplished by automatic measurement of the flow of current which is limited to low value.

In a year's test at General Electric's laboratory, the instrument created a 260% boost in the production of mica tape, which is in great demand as an insulating material for motors and generators. An estimated $100 per eight-hour shift in material costs is also saved as the result of the constant check on quality.

NBS Radio Disturbance Warnings . . . Beginning January 5, 1954, The National Bureau of Standards, Washington 25, D. C., will broadcast short term propagation forecasts for the North Pacific area from its standard frequency broadcasting station, WWVH, the Hawaiian counterpart of the Bureau's Washington station. The disturbance notices will tell users of radio transmission paths over the North Pacific the condition of the ionosphere at the time of the announcement and anticipate communication conditions for the next 12 hours. Forecasts are prepared three times daily by the Bureau's North Pacific Radio Warning Service at Anchorage, Alaska. Currently only those forecasts

issued at 8AM and 4PM (Alaskan and Hawaiian time) are to be relayed to the Hawaiian station.

The North Pacific broadcasts are transmitted twice an hour (at 9 and 39 minutes past the hour on standard frequencies of 5, 10, and 15Mc.). The North Atlantic broadcasts, in contrast, are broadcast on the same frequencies at 19-1/2 and 49-1/2 minutes past the hour.

The announcement consists of a letter and a digit. The letter identifies the radio quality at the time of the forecast from the station in Anchorage—*N*, *U*, and *W* signifying radio propagation conditions as normal, unsettled, and disturbed, respectively. The digit is the forecast of the radio propagation quality on typical North Pacific transmission paths during the 12 hours after the forecast is made. The numbering system is based on a scale of one (useless) through five (fair) to nine (excellent). The announcement is repeated every half-hour until the next forecast is issued. If, for example, propagation conditions are good at the time of the forecast, but an important disturbance is expected during the next 12 hours, the forecast would be broadcast in Morse Code as *N3* repeated three times, i.e., *"N3, N3, N3"*.

Ultrasonic Machine Tools Expand . . . The recent announcement that Cavitron machine tools will now be designed, manufactured, and marketed by the Sheffield Corp., Dayton 1, Ohio, promises an expansion in the application of ultrasonics to industrial needs. According to the report, the Cavitron Corp., Long Island City, N. Y., holder of the basic patent rights, will continue to purchase the ultrasonic transducers and generators, and will issue licenses for the process through Sheffield.

The Cavitron machine tool utilizes an ultrasonic vibrating head and an inexpensive tool, such as soft steel, for the precision cutting of hard and brittle materials. These may be either ferrous or non-ferrous, such as the carbides, germanium, hardened tool steels, sintered aluminum oxide, quartz, industrial crystals, ferrites, various types of glass, ceramics, sapphire, and other materials difficult to machine.

The ultrasonic machine tool may be used for extremely precise external or internal machining including cutting, drilling, and grinding of holes, cavities, slots, and recesses of any shape, as well as precision forming of external profiles. Very fine surface finish is obtained and there is no local heating of the work surface. No chemical or physical change takes place in the work piece.

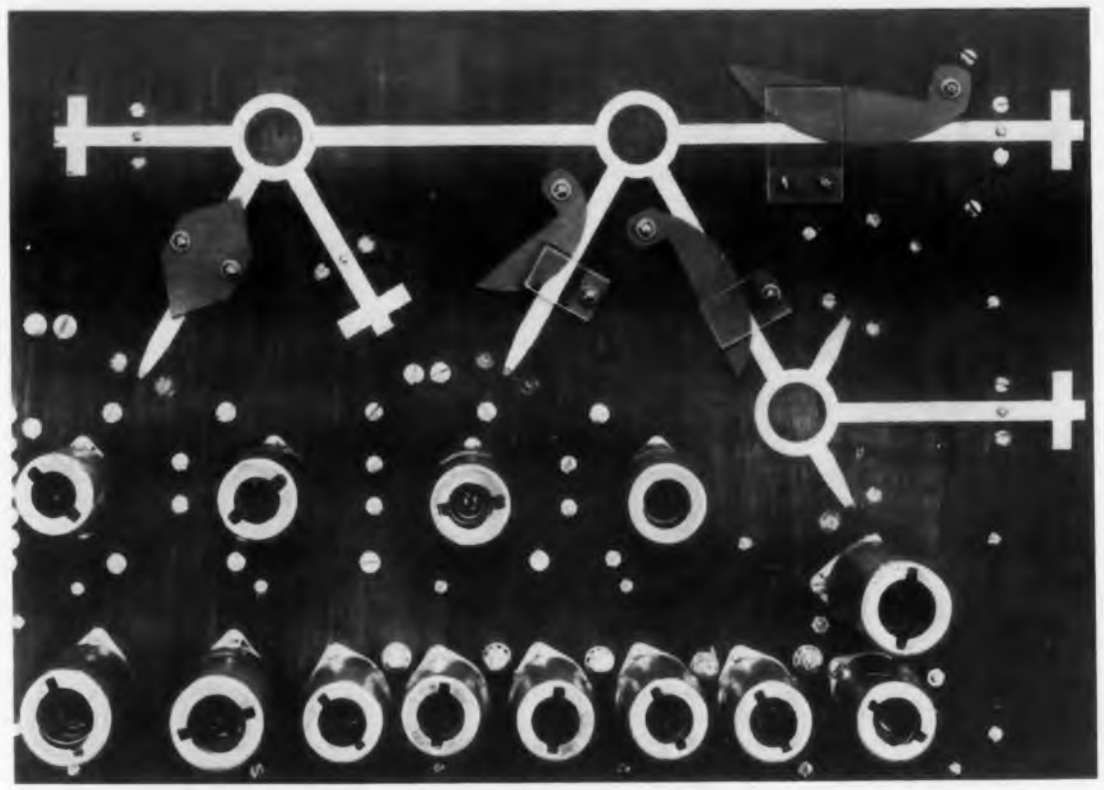
The tool accomplishes its high cutting speeds and precision by the use of an ultrasonic tool head vibrating from 18,000 to 30,000cy.

Engineering Review . . .

Circuit Stories Wanted . . . Certain portions of an electronic design project often are very interesting from a design point of view. Because these design innovations or circuit tricks are only part of a larger device they rarely get the attention they deserve, usually being buried in a complex circuit diagram or often tagged on the end of a long article as an afterthought. A number of readers have expressed an interest in this type of editorial material, and in keeping with their wishes such "circuit stories" are being solicited for early publication in ELECTRONIC DESIGN.

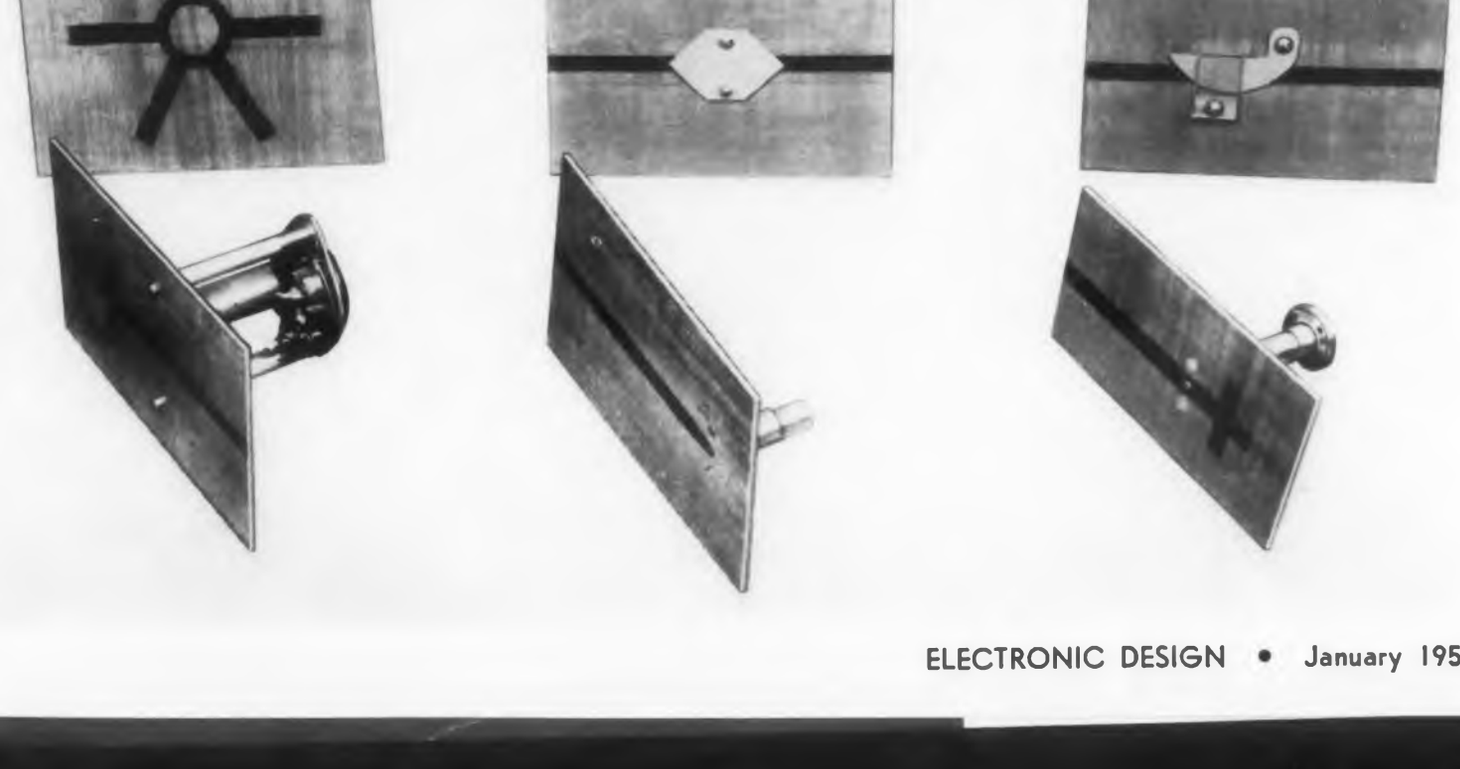
Specifications for this kind of article are simple. The article should be brief, from 200 to 400 words long, and should tell the reader (1) what the circuit is, (2) how it works, and (3) where it can be used. The circuit diagram should be neatly drawn with all component values properly labeled so that the reader can try out the idea if he so desires. The drawing should be in black ink on 8-1/2" x 11" white paper or tracing cloth, with Leroy or standard engineering lettering large enough to permit reduction. A glossy photograph of the diagram is also acceptable. In any case, a "finished" drawing is required.

Payment of $10.00 will be made upon publication for each "circuit story" accepted. Manuscripts should be sent to the Editor, ELECTRONIC DESIGN, 127 East 55th Street, New York 22, N. Y.



"Microstrip" Offered For Licensing

"Printed" microwave wiring known as "Microstrip" is being offered to prospective users under a licensing arrangement with International Telephone and Telegraph Co., 67 Broad Street, New York 4, N. Y. Below are typical "Microstrip" components: a hybrid junction and a tube mount below (left); a fixed attenuator and a crystal holder below (center); and a variable attenuator and a transducer below (right). At the left is a microwave receiver using "Microstrip" units.



RR Electronic Temperature Controls . . . Electronic temperature controls will be installed in ten new chair cars to be put in service on the Southern Pacific Railroad. The conventional heating of the cars will also be replaced by hot water radiation floor heating systems.

The advantage of the controls, manufactured by Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., lies in the use of a simple, single-valve electronic control which reduces the chance of system failure while providing fully automatic heating and cooling.

The new Pullman coach will use three electronic thermostats, eight times more sensitive than other types, to regulate heat and air conditioning with outside air, indoor temperature, and the heat of the discharge air taken into account.

Honeywell electronic temperature controls are now used on at least 24 major railroads. The company has also developed an electronic control system that can be adapted to existing steamheated cars.

Color Tube Availability . . . Color TV picture tubes will be available to set manufacturers in limited quantities during the first three months of 1954 according to General Electric's Tube Department, Electronics Park, Syracuse, N. Y. Pilot production of the tubes, which will be the 15″ round, all glass type, producing approximately a 12″ picture, will begin in January.

The color tubes will cost manufacturers about 10 times the price of comparable black and white tubes. Manufacturing processes for the color tubes are being tested in a new color tube development laboratory in the GE Syracuse plant. The production models will be the type using three electron guns and a planar shadow mask for color selection.

Meetings . . .

January 18-24, 1954: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

January 26-27, 1954: Scintillation Counters Conference, Washington, D. C.

February 3-5, 1954: Society of the Plastics Ind., Reinforced Plastics Division Conference, Chicago, Ill.

February 4, 1954: Instrument Society of America, Ninth Annual Regional Conference. Statler Hotel. New York, N. Y.

February 4-6, 1954: Sixth Annual IRE Conference and Electronics Show, Hotel Tulsa, Tulsa, Okla.

February 10-12, 1954: AIEE-IRE-ACM West Coast Computer Conference. Ambassador Hotel. Los Angeles, Calif.

February 18-19, 1954: IRE-AIEE Conference on Transistor Circuits, Philadelphia, Pa.

March 22-25, 1954: IRE National Convention. Waldorf Astoria Hotel and Kingsbridge Armory, New York, N. Y.

Engineering Review . . .

Remote Helicopter Autopilot . . . A completely automatic method for maintaining a helicopter in a hovering position directly above a given point on the ground and at a given altitude was demonstrated recently at Patrick Henry Airport, Warwick, Va. The method employed is entirely automatic and does not require operators at any point in the system to enable the helicopter to maintain its horizontal position directly above a selected point to an accuracy of better than five feet.

The new system, jointly demonstrated by the Hastings Instrument Corp., Raydist Navigation Corp., both of Hampton, Va., and the Piasecki Helicopter Corp., Morton, Pa., comprises a closed-link system consisting of "Raydist" (a continuous wave radio location system), an autopilot, and a Piasecki built HUP-2 twin rotor helicopter. The plane was controlled in flight with equal accuracy at low and high altitudes.

Taking off first on automatic position, the helicopter then ascended to an altitude of 1100 feet. At this height, it maintained a stable hover for about seven minutes, according to the strip chart records of the operation.

The helicopter also descended by means of the Raydist-controlled automatic pilot and was landed within one or two feet of the central point, demonstrating the repetitive capacity of the system.

The operation utilized a small transmitter installed in the helicopter. Signals from two Raydist relay stations on the ground were compared in one phase meter to indicate longitudinal movements of the helicopter. Simultaneously, signals from two other relay stations were compared in a second phase meter to indicate the transverse movement.

The transducer unit employed for each of these error indications was a small low-torque potentiometer attached to the shaft of the respective phase meters.

Whenever the helicopter drifted to the right or left of the reference point, the transverse phase meter indicated the movement as rotation. This actuated the arm of the potentiometer and introduced positive or negative signals to the autopilot.

Reacting to these signals, the autopilot then adjusted the cyclic pitch of the rotor blades to reposition the helicopter and bring the phase meters back to the null position. Fore and aft digressions were handled in a similar manner.

This Raydist controlled autopilot combination promises to make automatic helicopter navigation and landing extremely practical.

Color TV in '53 . . . An announcement from the Radio Corporation of America, Camden, N. J., indicates that stations throughout the United States will have received RCA's compatible color television equipment before the end of 1953. The news projects

Water Saving Ignitron

The thermostatic unit being adjusted by the workman above is a feature of a new temperature-controlled thyratron manufactured by General Electric Co., Syracuse, N. Y. It makes possible the saving of up to 95% of the cooling water needs for the tube, and protects the tube from overheating in case of water supply failure. The tubes are interchangeable with standard ignitrons and are made in sizes B, C, and D.

an early start for color TV broadcasts now that the Federal Communications Commission has approved standards for a compatible color system.

The first items, to be delivered this month, will include color monitors and terminal apparatus to be added to existing TV transmission equipment, and will enable stations to telecast programs received over telephone circuits. RCA color cameras, slide and film equipment, and other accessories for live broadcasts will be ready for delivery in March 1954. RCA plans to schedule deliveries for color broadcasting of network programs so that stations may make full use of telephone circuits adapted to handle the transmission of color signals when they become available.

Empirical Techniques for Microwave Component Design

By Sam Levine

John Gombos Co., Inc., Irvington, N. J.

Empirical techniques play an important role in microwave component design, for the geometries encountered in most microwave components seldom lend themselves to simple mathematical manipulations. Many design problems, especially those of a broadband nature, can be solved by empirical or "cut-and-try" means long before the mathematical formulations can be set up. Most of the time, the ideal approach is a coordinated program of analysis and practical work. Study of the performance of an elementary physical model suggested by simple analysis reduces the number of design factors to be considered and permits any desired mathematical analysis to continue unhampered by factors of minor importance. In this manner, the designer avoids worrying about second, third, and n-th order effects when he should have been considering the first-order effects.

Even problems that are mathematically solvable and whose formulations yield practical design factors require final physical adjustments to compensate for approximations made during the analysis. It is evident, therefore, that the microwave designer must be thoroughly conversant with physical techniques to solve his problems. He will benefit greatly if he approaches empirical designing with the same discipline he employs in mathematics.

Experimental Development Model

The empirical design of a broadband coaxial-to-waveguide transition (adaptor) will be presented as an example of practical design techniques.

The large body of literature on this subject indicates that this transition can take on a considerable number of practical forms. There are transitions with bead-supported probes and dielectric-supported probes as well as doorknob, hemisphere, resonant-slot, and others. After the choice has been narrowed down to the inherently broadband types, a helpful concept in selecting a type is to pick one whose physical dimensions can be readily changed. Such a transition is the bead-supported probe type. It is a relatively broadband adaptor, and has a simple form.

Fig. 1 shows an experimental model of a bead-supported transition with most of its pertinent dimensions. It is designed for convenient variation of dimensions A and B. Location of the flange (dimension D) is purely a mechanical consideration, and has no electrical effect on the performance of the transition. To conserve space, therefore, the flange is located as close to the probe as possible without interfering with the ease of coupling the instrument to other components.

Dimension A is classically one-quarter of a guide wavelength (at mid-band) from the center line of the probe. Since the shunt is to be moved towards the probe, a 20% larger initial dimension A is chosen. The bead location (dimension C) is at least one-half a wavelength (at mid-band) from the inside wall of the waveguide. This position is arbitrarily chosen to keep the bead well away from the transitory region near the end of the coaxial line.

Dimension R is a radius of about 1/10 of a wavelength (free space) that provides a smooth transition from the coaxial line to the waveguide. The end of the outer coaxial conductor is made flush with the waveguide wall because it is a convenient way to maintain control in production over the positioning of the coaxial line. Slight penetration of the coaxial outer conductor into the waveguide can be used as a trimming adjustment, but this complicates the production of these units far out of keeping with the resulting benefits.

The probe is connected to a conventional type N female connector. The bead is a broadband type made of polystyrene, and the probe is pinned to the bead by a nylon pin. Polystyrene is used instead of teflon chiefly because teflon has the tendency to flow under pressure and chips easily. Since the probe assembly is frequently removed to change dimensions of the probe, the more stable polystyrene is preferable.

The end of the probe is not rounded as it usually is in classical designs because it is time consuming to perform this operation after each cut in the length of the probe. This step can be left for final touching up. If design requirements can be met without this additional operation, then it is omitted altogether. It is advantageous to make the probe out of coin silver instead of brass so that frequent silver plating of the tested probe is unnecessary. Initially, the probe length is dimensioned so that dimension B is 1/8 of the inside height of the waveguide.

Although changes in dimension E can be used to trim the results obtained by experimentation with the other dimensions, design is simplified by centering the probe. This results in dimension E being zero.

Experimental Techniques

Changes in A and B depend on one another and require concurrent optimization. The technique is analogous to the mathematical treatment of two or more dependent variables; that is, each variable in turn is varied while the others are held constant.

The procedure is as follows: VSWR readings are taken over the desired band on the fully assembled experimental model and plotted. The probe assembly is carefully removed and 0.005″ is milled off the tip of the probe. The unit is reassembled, and VSWR readings are again taken over the band. This set of readings is compared with the first set. Several additional cuts are made and evaluated. If the trend between adjacent cuts is small, material may be removed in larger increments of 0.010″. This procedure is continued until the probe penetration is negligible.

From the resulting family of curves (see Fig. 2), the range of probe penetrations that indicates where an optimum probe penetration lies may be evident. In this event, future probe penetrations need only be within this region; and the shunt position may now be changed in 0.010″ increments. This entails unsoldering the shunt, milling 0.010″ of material off the rear of the waveguide, and soft soldering the shunt back to the waveguide.

If optimum probe penetration is not evident after the first run, the probe is replaced by one whose penetration is the same as the first probe used; that is, dimension B is about 1/8 of the inside height of the waveguide, and the shunt position is changed by 0.010″. Probe penetration is again made progressively smaller, and the resulting curves are studied. Much time can be saved in this process of obtaining an optimum probe penetration and shunt position if a

graduated set of probes is used rather than one probe, which is shortened after each run.

Use of Curves

The simplified family of curves in Fig. 2 shows the effect of reducing probe penetration (increasing dimension *B*, Fig. 1) with the shunt fixed at its initial position. The curves are lettered in order of decreasing probe penetration starting with curve *A*, which shows the effect of maximum penetration, and ending with curve *E*, which shows the effect of minimum penetration. It can be seen that curve *C* is the curve of minimum VSWR over the band. The probe penetration corresponding to this curve is therefore used when determining another family of curves that shows the effect of reducing the shunt-to-probe distance (dimension *A*, Fig. 1).

This new family of curves will start with Curve *C* and show displacements and mutations of the curve as the shunt dimension is shortened. The optimum curve in this second family indicates the near-optimum shunt position. Probe penetration may now be changed slightly from its first optimum value (penetration corresponding to curve *C*) as a trimming adjustment with the shunt fixed at its near-optimum position. After this second probe optimization, the shunt position is trimmed with the probe at its second probe optimum penetration. This process is continued until the true optimum shunt and optimum probe dimensions are found.

It might be questioned why an adjustable sliding probe is not used along with a movable plunger-type shunt instead of the cut-and-try methods outlined. The answer lies in the fact that sliding probes and shorts are relatively indeterminate devices. First, the probe and its sheath introduces a step. Second, the sheath must either be slitted or crimped to hold the probe securely, thus introducing indeterminate mechanical configurations. Third, the conductance between the probe and the sheath is variable. Finally, probe penetration becomes difficult to measure, for the measuring device is liable to shift the probe.

A sliding plunger is not desirable because of the uncertain electrical and mechanical parameters it presents. Although an adjustable device can be made to function satisfactorily, equal performance by its nonadjustable prototype is seldom the case. It is imperative that a model closely resembling the final product be employed in the advanced stages of the experimental design. In this example, it was propitious to employ such a model in the early design stages.

Probe Width Determination

Investigation of probe width can now be undertaken. Here the technique is as before: mechanical changes are correlated with the electrical results they produce. Experimentation with a stepped probe whose tip has a reduced diameter is very profitable. A starting point is to reduce the diameter of the probe by 0.010″ to 0.025″ with a step width of 1/16″. The width of the step may then be increased in increments of 1/16″ until the performance of the transition is optimized. An additional step may be added in the same manner.

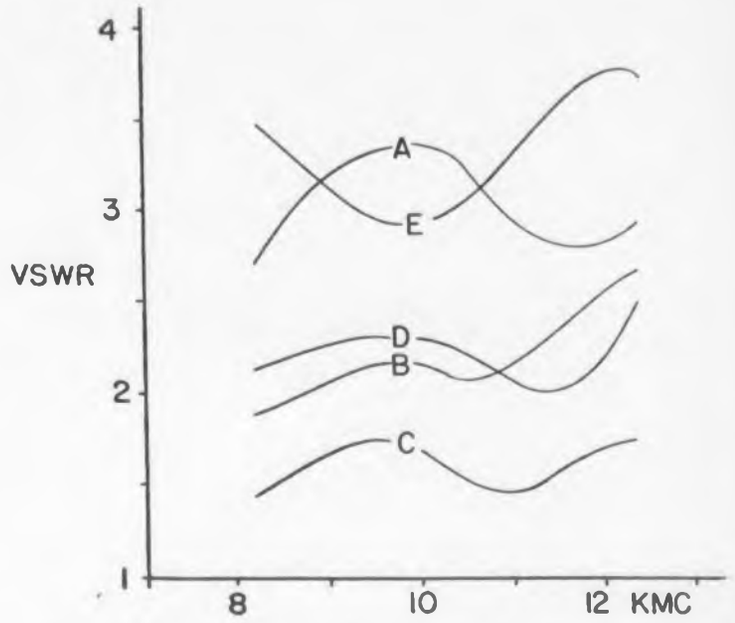


Fig. 2. Curves showing the effect of reducing probe penetration (dimension B in Fig. 1).

Implicit in the above discussion is the necessity for careful measurement techniques. All points of discontinuity between the impedance meter, the transition under test, and the termination must be minimized. The impedance meter and termination must have inherent VSWR's better than 1.01 over the desired band. Such instruments are commercially available.

Production Considerations

The basic concept of practical microwave component design is that the experimental model should always represent a device that is capable of being duplicated with relatively minor changes by existing production techniques. Standard parts and components should be used wherever possible. A 100% mechanical inspection with emphasis on concentricity requirements should be made on all early production models to further correlate electrical results with mechanical characteristics. A sufficient number of pilot production models should be tested so that a full range of mechanical tolerances can be evaluated and close tolerances eliminated where possible.

Excellent results have been achieved by using empirical design techniques to broadband simple microwave components. In the small X-Band, a coaxial-to-waveguide transition has been designed with a VSWR of better than 1.20 from 8.2 to 12.4 kMc. In the large X-Band, similar results have been obtained over an extended range from 5.3 to 8.2 kMc. Over the same bands, broadband loads with VSWR's less than 1.01 have also been designed empirically.

The use of careful physical design techniques along with qualitative analytical thinking quickly leads to the solution of broadband microwave problems of inherently simple configurations.

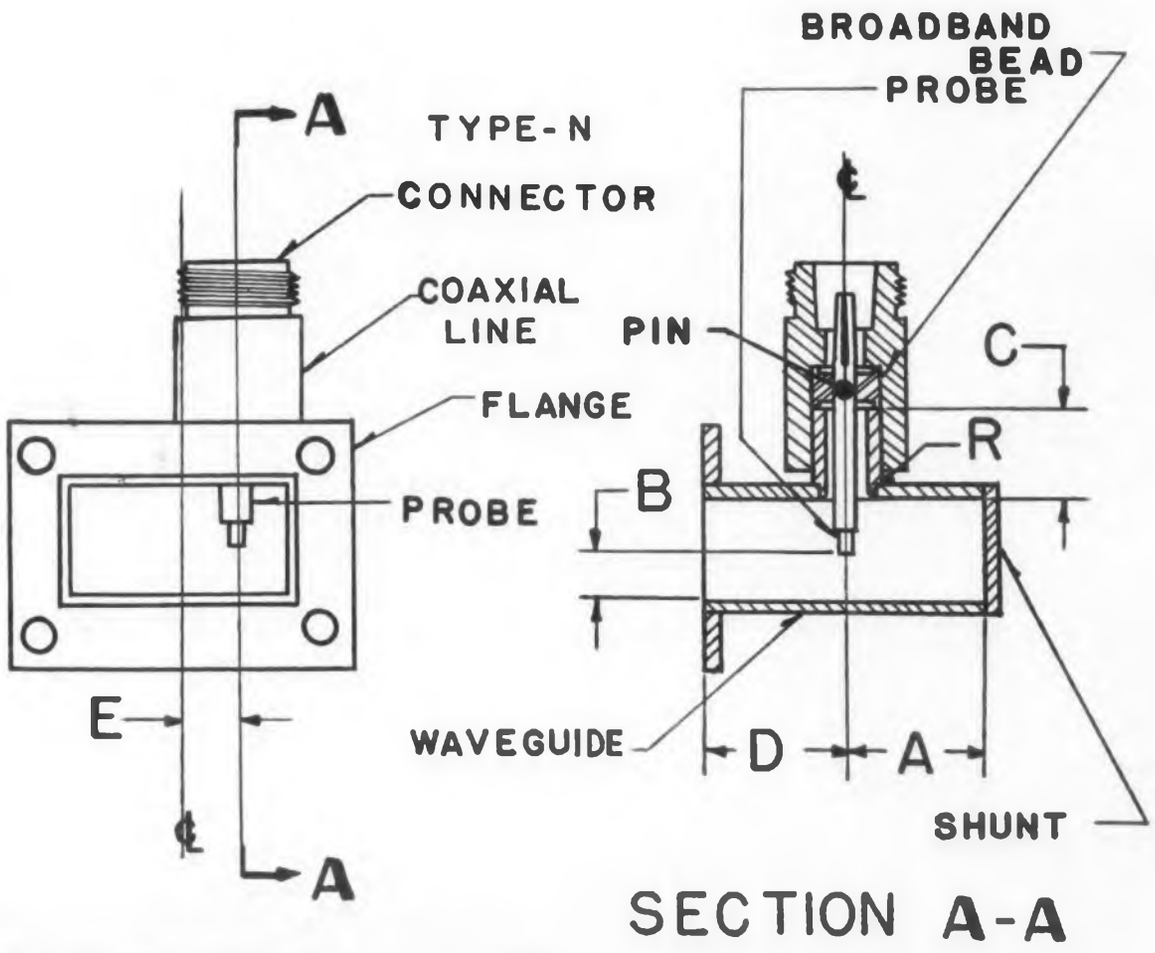
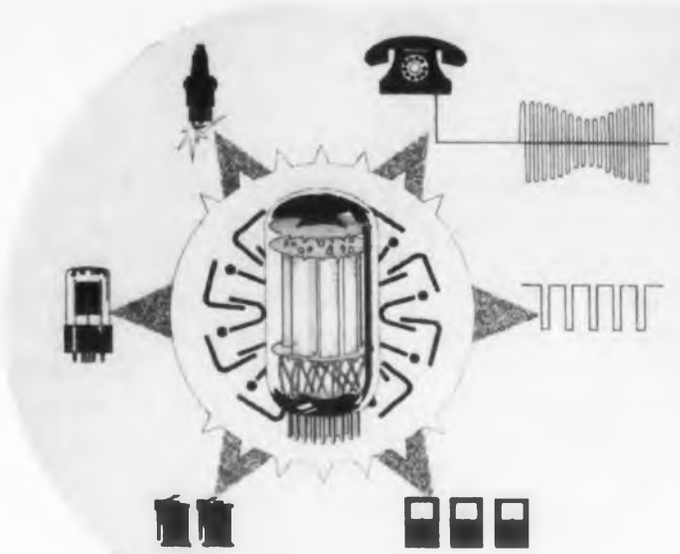


Fig. 1. Experimental model of a bead-supported transition which is used to explain the empirical design techniques described in the article.

A New Beam Switching Tube



SIMPLICITY, reliability, and high efficiency are features of a new beam switching tube which has a wide range of application possibilities. Shown symbolicly in Fig. 1, the tube has the characteristics of 10 pentode-like tubes in one envelope, and potential reliability and life greater than that of a diode.

Utilizing the combined effects of a magnetic field (provided by a cylindrical permanent magnet which surrounds the tube) and electric fields (formed by potentials on the various internal elements of the tube), an electron beam is formed, switched, and modulated in 10 discrete automatically locked positions consecutively or at random. The tube has a simple structure consisting of three basic elements for each position as shown in Fig. 1. The beam forming and locking element called a "spade" is positioned to utilize the beam current to control the electric field component so that each position is automatically stable without adjustment.

The associated target is so shaped and placed that it receives the entire remaining beam current. The ratio of output current to cathode current is usually greater than 90% (less than 10% intercepted by the spade in forming its stable locked-in position). The tube's constant current, "pentode-like" target characteristics are obtained without suppression, and with negligible crosstalk over a wide range of supply voltages and load resistors. By taking advantage of the particular path of the electron beam in this tube, the switching grid is located so as not to receive current and yet be effective in shifting the beam from one position to the next with a low input voltage.

The switching grid is designed to affect only the beam in its individual position. By connecting odd and even grids in common, a d-c voltage can be used to switch the beam only one position at a time. The elimination of critical pulse width requirements for this type of operation represents a great improvement in reliability.

The tubes, which are a product of Burroughs Electronic Instruments Division, 1209 Vine Street, Philadelphia 7, Pa., have been operated from the company's standard Pulse Control Equipment, supplying 20v at rates from pushbutton inputs to frequencies above 4Mc. For the higher rates, tubes with internal vacuum mounted spade load resistors were used. The tubes operate equally well at all speeds.

Because of the many variables possible in tube applications and testing, the universal test chassis shown in Fig. 2, was developed. This unit permits easy access to all tube terminals, control of inputs and outputs, load resistors, and supply voltages so that electronic designers can quickly evaluate the tube or an associated circuit. One valuable test is to monitor the beam switching waveform dynamically while modulating the supply voltage with a-c to check upper and lower operating limits. Tube operation under normal conditions can withstand greater than 50% variations.

The tubes utilize standard low operating voltages and require a minimum of power. They have been operated with an overall tube voltage of less than 20v. Typical operation is at 100v with an output of 10ma. The tube can operate in circuits with from one to 10 controls to produce from one to 10 outputs. The constant current outputs can be made virtually independent of their common supply voltage as indicated in the curves shown in Fig. 3.

Four versions of the basic design are available. Type MO-10 has 10 stable positions, 10 individual target outputs, provisions for presetting at any position, and may be operated by either d-c or pulsed inputs. It has a 26-pin base and can operate at speeds to above 1Mc. Type MO-10R is the same as the MO-10 except that it has internal vacuum-mounted resistors, and provisions for presetting to zero only. As a result the operating frequency is extended to above 5Mc and the number of pin connections is reduced to 20.

Type DC-1 is a decade counter with 10 stable positions but only one target output, provisions for pre-

Fig. 1 (below). Symbolic representation of the new beam switching tube showing the basic elements in the structure.

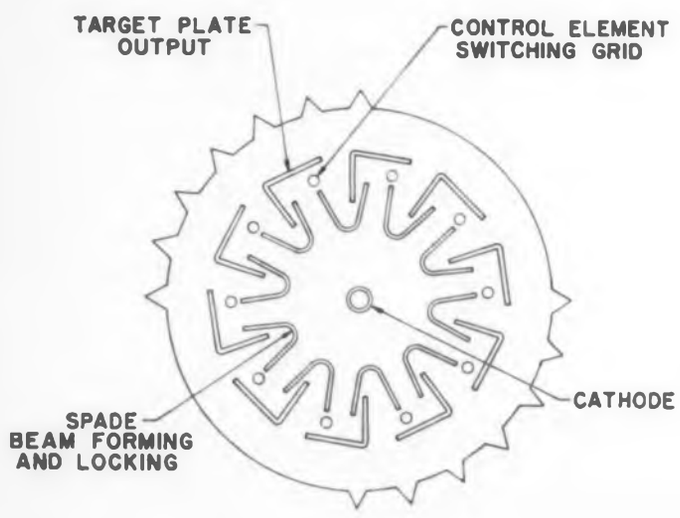


Fig. 2 (right). Universal test chassis which permits quick evaluation of the tube or an associated circuit.

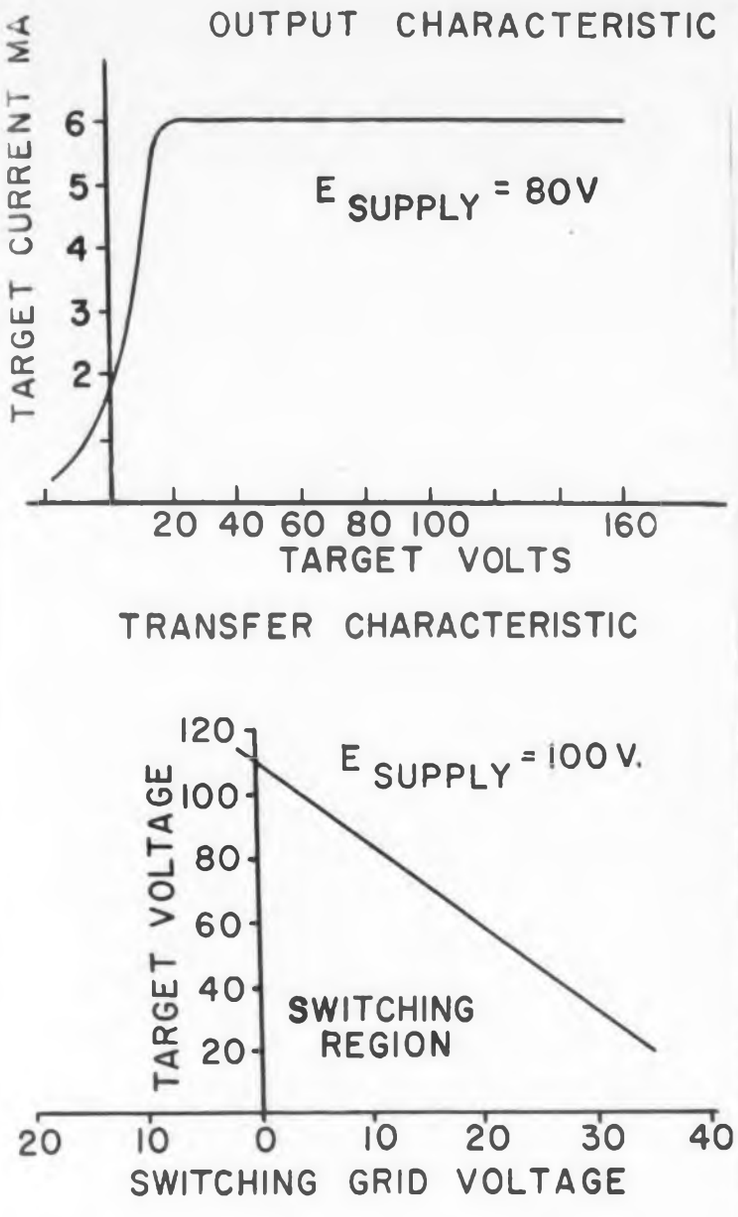


Fig. 3. Output and transfer characteristic curves for the new beam switching tube. Note the low operating voltages, and how the constant current outputs can be made virtually independent of their common supply voltage.

setting at any position, and can be operated by d-c or pulsed inputs at operating speeds to above 1Mc. Type DC-1R is the same as the DC-1 except that it has internal resistors and provisions for presetting to zero only. Its operating frequency is higher than 5Mc and it has only nine external pins.

This unusual tube can be used for a wide range of applications including fractional microsecond switching; for dial telephony; for measuring, sampling, and statistical tabulating for quality control; pulse generation; communications switching and modulation; gating; counting and registering; telemetering; and for combining low speed mechanical information with high speed electronic inputs. Sensing elements which convert size, weight, temperature, pressure, rpm, etc. into proportional voltage outputs can be used to control switching, forming, or modulation of the beam. Conversely, the beam can be used to sample multi-element phenomena to a common information point.

High Current D-C Supply Design

Frank A. MacPherson
Electrons, Inc., Newark, N. J.

EQUIPMENT designers requiring high current d-c power frequently use modern inert-gas rectifiers and thyratrons because of their independence of ambient temperature, high efficiency and small size. When automatic regulation of output voltage is desired, gas thyratrons make possible very fast response circuits for power supplies of many kilowatts. Thyratron applications follow the same basic power circuit design procedure to be outlined here for gas rectifier tubes, but have the added consideration of a grid circuit[1]. Automatic correction for line voltage variations and load changes are easily obtained.

The single-phase full wave rectifier circuit employing a single inert-gas rectifier tube with two anodes, two half wave rectifier tubes, or a pair of thyratrons is often useful. The design procedure for this circuit is typical, and will be described. The basic considerations are as follows:

1. Approximate anode transformer design.
2. Choice of tube type.
3. Specification of anode transformer.
4. D-c output filter design.
5. Filament supply considerations.
6. Overcurrent protection.
7. Mechanical design.

An approximate design of the anode transformer for the circuit shown in Fig. 1 is determined from the required output d-c voltage and current. An ideal transformer is assumed and the secondary winding voltage to center tap is $E' = (\text{Form Factor})\ (V_{\text{d-c}} + V_{\text{Tube Drop}})$. The form factor for this circuit is 1.11. Other form factors for common rectifier circuits are listed in Table 1. An average tube drop of 10v may be taken as representative for a modern inert-gas filled rectifier or thyratron tube.

Choice of Tube Type

The first consideration in selecting the proper tube type is the required maximum peak inverse voltage rating. This is the greatest instantaneous negative voltage that may be applied between plate and cathode without danger of passing current in a reverse direction. A full wave circuit imposes a maximum peak inverse voltage equal to the maximum instantaneous anode-to-anode transformer voltage plus allowances for transformer regulation and high line voltage.

For a first approximation, a 10% transformer drop and 10% maximum variation for high line voltage may be assumed.

Peak Inverse Voltage $= 1.2 \times 2 \times \sqrt{2} \times E'$.

Tube current duty may be determined by reference to Table 1. The greatest continuous average anode current that a tube can safely pass is stated as the average anode current rating. For the single phase full wave circuit, the average current per anode is one-half the d-c output current. The maximum continuously recurring peak current duty is equal to the d-c output current for a purely inductive load, and for a resistive load it is 1.57 x the d-c output current. A suitable tube type may now be selected from the manufacturer's catalog, and this establishes the tube voltage drop. The final design of the anode transformer may now be made.

Specifications of Anode Transformer

Voltage regulation depends on the circuit and transformer characteristics rather than on the tube, and is considered in the final transformer design. It is the arithmetic sum of three voltage drops: transformer resistance drop, commutation drop, and reactance drop due to leakage flux in the primary windings.

The resistance drop (D_R) in d-c volts is:

$D_R = A(N^2R_1 + R_2)$

where A = total d-c current
R_1 = resistance of primary winding
R_2 = resistance of 1/2 secondary winding
N = (turns in 1/2 secondary) ÷ (turns in primary)

If a filter choke is used, its resistance R_C causes an additional drop equal to $A \times R_C$.

Transformer leakage flux between successive secondary windings tends to prolong the time required for the current to transfer from one anode to the next. During this short period of transfer, both anodes conduct, and the instantaneous output voltage is the average of the two anode voltages rather than the highest. This period of commutation of the current from anode to anode lowers the d-c voltage by

$D_C = KAX_1$, (d-c volts)

where K = regulation constant given in Table 1.
A = total d-c current
X_1 = effective reactance at supply frequency measured between two successive anode connections with the primary shorted

The reactance drop D_L in d-c volts, appears on resistive loads only and is usually insignificant. It may be estimated with sufficient accuracy as

$$D_L = V\left[1 - \sqrt{1 - \left(\frac{AX_2}{E'}\right)^2}\right]$$

where X_2 = transformer reactance measured across one half of secondary winding with primary shorted.
V = no load d-c output voltage
A = total d-c current
E' = secondary winding voltage to center tap (assuming an ideal transformer)

In low voltage power supplies the reduction in output voltage caused by starting voltage of the rectifier tubes may be significant, but if the d-c output is 100v or more it can usually be neglected[2].

The true secondary winding voltage to center tap of the anode transformer (E) is:

$E = 1.11\ (V_{\text{d-c output}} + V_{\text{tube drop}} + D_R + D_C + D_L)$

The wave shape of the current in the anode circuit is such that d-c and a-c ammeters give quite different readings. Copper losses and transformer heating depend on the rms value of current flowing in the various windings. Consequently, factors in the table should be used to compute the a-c currents. For common rectifier circuits, the kva rating of the anode transformer must be higher than the desired output d-c kw. For example, in the circuit being described, the kva of the primary for 1 kw d-c output is:

1.11 x 1.11 = 1.23 kva for resistive load
1.11 x 1.0 = 1.11 kva for pure inductive load,

and the secondary is:

1.11 x 2 x 0.785 = 1.74 kva for resistive loads
1.11 x 2 x 0.707 = 1.57 kva for pure inductive loads

D-c Output Filter Design

The output voltage of a rectifier may be filtered by inductance, capacitance or both. If a single inductor is to be used next to the tube, its size may be estimated from the following formula:

$$L = \frac{E_h}{2\pi\ f_h\ I_h}$$

where L = inductance in henries
E_h = a-c value of the major ripple voltage of the rectifier output (see table 1)
f_h = frequency of the major output voltage (see table 1)
I_h = permissible a-c current in the output.

The detailed design of composite sectional filters is covered extensively in most electrical engineering handbooks and will not be considered here.

Operation of the rectifier will shift from inductive

input to crest rectifier operation if the d-c load current drops below approximately three times the a-c ripple current through the first inductor of a composite filter. If the load on a composite filter is suddenly removed, the energy stored in the inductances flows into the capacitance. If the I^2R loss and the energy already present in the capacitor are neglected, an overvoltage V, which may be many times normal voltage, will be impressed across the shunt capacitance. The approximate value of this overvoltage may be derived from the general energy equation $CV^2/2 = LI^2/2$, where $V = I\sqrt{L/C}$. The circuit constants should be such that this will not cause equipment failure, or increase the peak inverse voltage on the tubes to a dangerous value.

Filament Supply Consideations

The filament supply may be obtained from a separate transformer or an additional winding may be placed on the anode transformer. Filament windings of full-wave tubes should be center-tapped for the d-c positive lead to eliminate line frequency components of voltage from the output, and to properly distribute the load over the filament. Full wave tubes used in polyphase circuits should have polyphase filament-heating circuits, with the correct phase applied to each filament. For most half-wave tubes, a center-tapped filament transformer winding is recommended for the positive lead to the load.

Careful adherence to recommended filament voltages will pay dividends in the form of increased tube life. If the filament voltage is greatly in excess of the manufacturer's recommendations, cathode coating may boil off and shorten tube life. Should the filament voltage be much less than the manufacturer suggests, the tube voltage drop will be increased with resulting destruction of the cathode by excessive ion bombardment. It is essential to observe the filament minimum heating time (usually 60 sec or less) for inert-gas tubes as suggested by the manufacturer before d-c load is applied. Dependable time delay relays are usually specified in the load circuit to automatically switch in the load after the proper filament heating time has elapsed. The anode and filament voltages may be switched on together however, if the d-c load is disconnected. Where thyratrons are used, a negative grid voltage may be used to prevent tube conduction until after the filament heating time has elapsed to permit simultaneous application of anode and filament voltages.

Provision for Overcurrent Protection

As in any electrical network, provision for overload and short circuit protection should be made. Inert gas-filled rectifiers are not seriously damaged by a short circuit if the current is interrupted promptly, but they tend to overheat rapidly because of their high efficiency. Both fuses and circuit breakers operate in response to the rms value of current flowing, whereas tube heating is dependent on the average current. If a short circuit occurs, the average current increases proportionately more than the rms current, and tube heating is greatly accelerated. A circuit breaker with a tripping current of not more than four times the full load current should be specified for the source impedance to be found in the usual power supply. Interruption may be made either by opening the anode circuits or, if energy storage in the load is small, by opening the supply side of the anode transformer. If circuit breakers are used in the supply side, the trip coils must have enough time delay to allow transformer magnetizing inrush current to flow without tripping.

Mechanical Design

The opportunity for long trouble-free life of the unit can be greatly enhanced if properly constructed tube sockets are specified[3]. One important function of the socket is to carry away and radiate heat which is conducted down the filament leads. If large heavy wiring is used in the filament circuit, much of the heat will be radiated and the temperature of the socket contacts thereby limited to a safe value. Bracket mounted tubes with flexible leads and lugs are now available in the higher current ratings to avoid this difficulty.

Obviously, consideration should be given to determine the optimum physical placement of components to give accessibility for maintenance and adequate ventilation consistent with a minimum overall volume. Vibration and shock mountings may be indicated if severe mechanical abuse is expected.

A typical 250 volt d-c regulated power supply of 35amp utilizes two C16J thyratrons. Excluding output filter the unit has a volume of 2.2 cu ft, and a weight of 175 lb, or 0.25 cu ft/kw and 20 lb/kw.

Table 1. Rectifier Circuit Constants, assuming ideal transformers and rectifiers.

	Symbol	Single Phase Half Wave	Single Phase Full Wave	Single Phase Full Wave Bridge	Delta Wye 3 phase Star	4 phase Star	Delta Star 6 phase	3 phase Full Wave Bridge
A-c Plate Volts	E	2.22V	1.11V	1.11V	0.854V	0.785V	0.740V	0.427V
A-c Secondary Current	I_s							
Resistive load		1.57A	0.785A	1.11A	0.587A	0.503A	0.409A	0.817A
Inductive load		—	0.707A	A	0.577A	0.500A	0.408A	0.815A
A-c Primary Current	I_p							
Resistive load		*1.21AN	1.11AN	1.11AN	0.480AN	0.711AN	0.579AN	0.817AN
Inductive load		—	AN	AN	0.472AN	0.707AN	0.577AN	0.815AN
Peak Inverse Volts	PIV	3.14V	3.14V	1.57V	2.09V	2.22V	2.09V	1.05V
Average D-c. Anode Current		A	0.5A	0.5A	0.333A	0.25A	0.167A	0.333A
Peak Anode Current								
Resistive load		3.14A	1.57A	1.57A	1.21A	1.11A	1.04A	1.04A
Inductive load		—	A	A	A	A	A	A
Effective phases	p	1	2	2	3	4	6	6
Commutation Regulation Coef.	K							
Resistive load		—	0.000	0.000	0.286	0.500	0.866	0.866
Inductive load		—	0.318	0.636	0.477	0.637	0.954	0.954
Major Ripple Frequency	f_h	f	2f	2f	3f	4f	6f	6f
A-c Ripple Voltage	E_h	1.11V	0.47V	0.47V	0.18V	0.094V	0.040V	0.040V

*Transformer magnetizing current and core losses are important and must be added to the primary current in this circuit.

Where V = d-c output volts
A = total d-c output amperes
f = supply frequency

$$N = \frac{\text{turns in secondary winding to center-tap}}{\text{turns in primary winding}}$$

A-c voltages and currents are rms—d-c voltages and currents are average

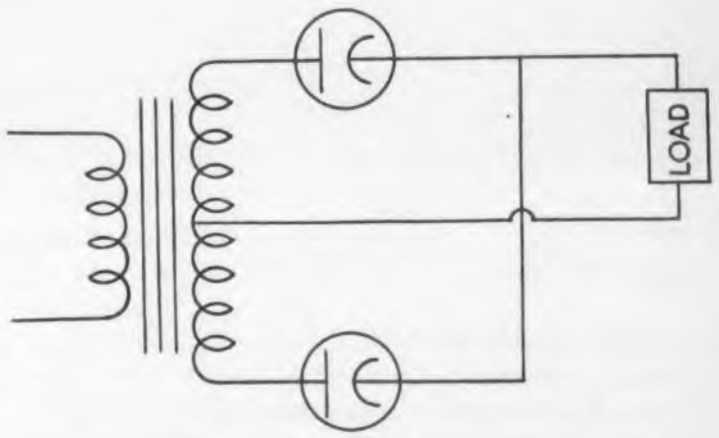


Fig. 1. Single-phase full wave rectifier circuit.

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1. Thyratron Grid Circuit Design, J. H. Burnett; *Electronics*, March 1951, p 106. Corrections, *Electronics*, April, 1951 pp 304-5.
   Improving Gas Tube Grid Circuit Reliability, J. H. Burnett; *Electrical Engineering*, April 1953, p 341.
2. *Engineering Manual and Catalog;* Electrons, Inc., p 7.
3. Gas Tube Filament Connections, Morris Brenner and H. G. Schmitt; AIEE Tech. Paper, Sept. 1953, Transactions No. 53-357.

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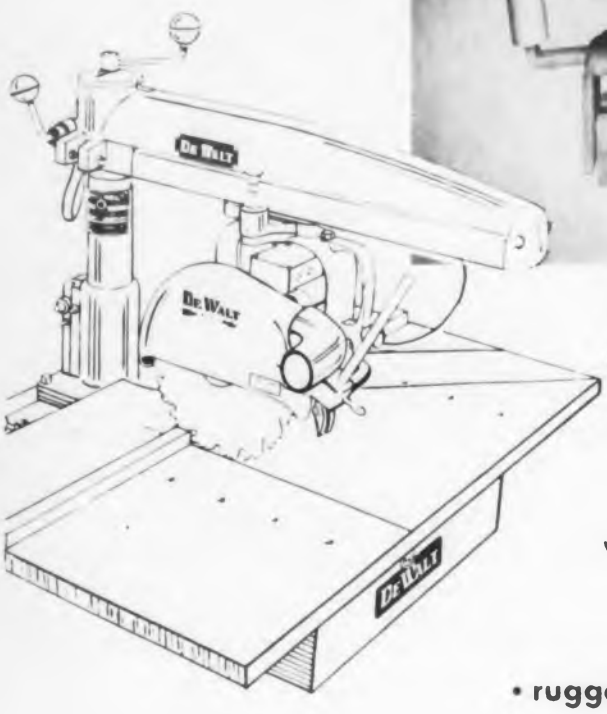

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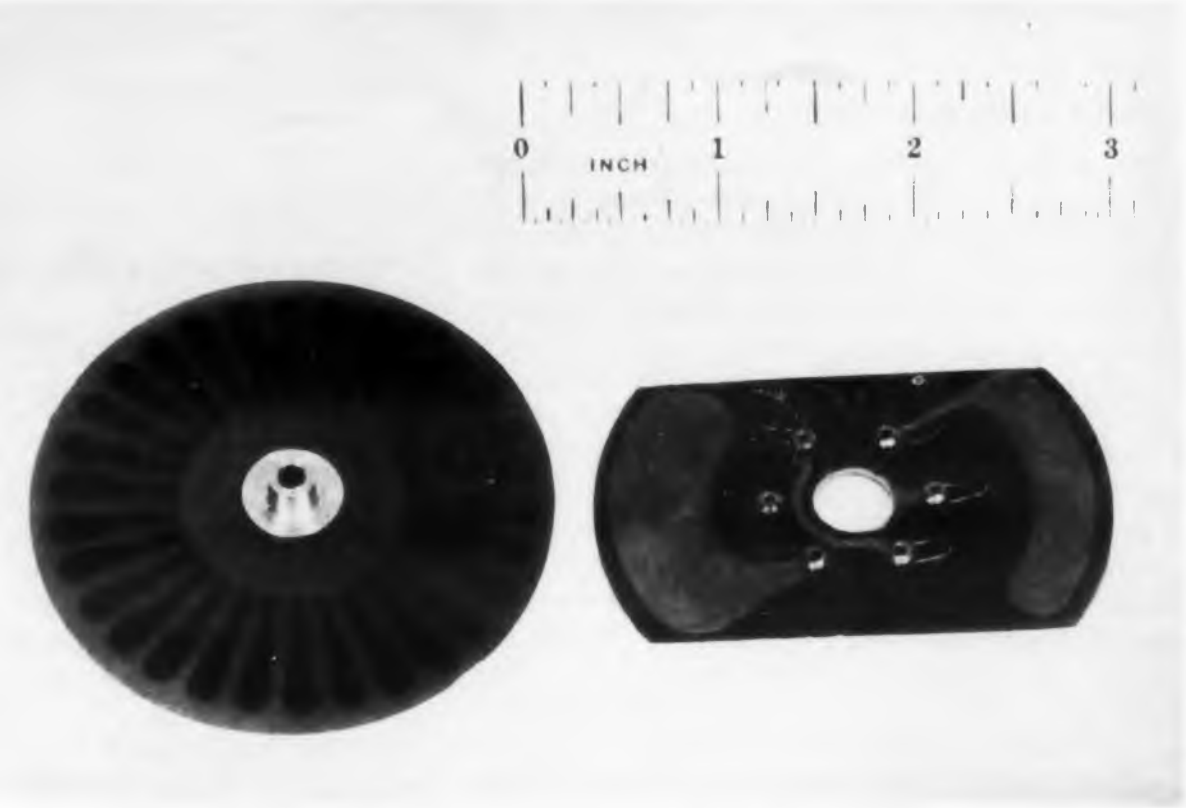


Fig. 1. Rotor (left) and stator (right) of the NBS electrostatic generator. They are made by printed circuit techniques.

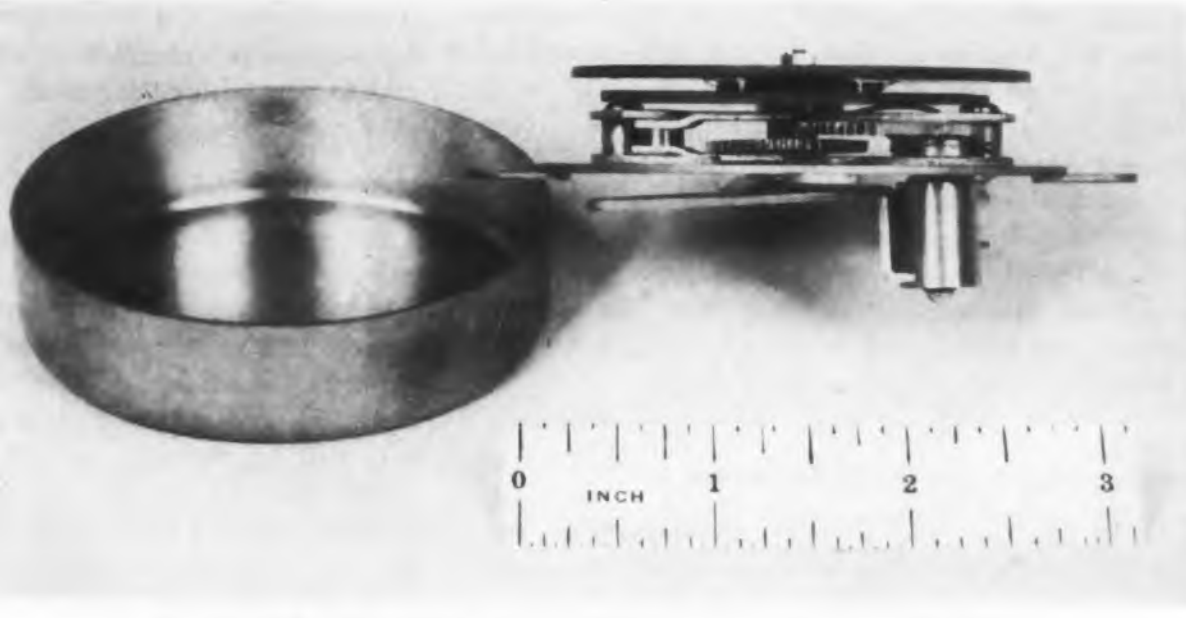


Fig. 2. Side view of the assembled generator showing its drive mechanism. The entire unit can be hermetically sealed.

PRINTED circuit techniques are employed in a miniature electrostatic generator developed by S. R. Gilford, S. Saito, and J. L. Herson of the National Bureau of Standards, Washington 25, D. C. The device is an adaptation of the work of Holz and Wommelsdorf (U.S. Patent No. 1,071,196, August 26, 1913), but it uses modern printed circuit and miniaturization ideas. The unit serves as a source of high voltage for radiation survey instruments, and is one result of a program sponsored by the Navy Bureau of Ships for the investigation and application of techniques adaptable to low-cost mass production of radiation survey instruments.

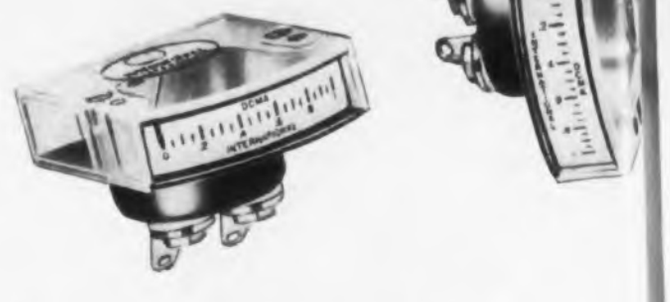
Many radiation detection devices require high voltage low current sources to supply polarization potentials for ionization chambers. This voltage is usually obtained from miniature high voltage batteries used directly or in combination with capacitors charged in parallel and then connected in series, from a vacuum tube oscillator in combination with a high-ratio transformer and rectifier, or from a vibrator power supply. The NBS generator which replaces these sources, is simpler to fabricate, is potentially less expensive, has fewer components, and avoids the use of special batteries.

The generator consists basically of a stator of two field plate conductors, and a rotor with a number of conducting sectors. Printed circuit techniques are used to apply the conducting areas to the flat insulating plates of the rotor and stator. Several sets of brushes transfer electrical charge between the components of the system and the storage capacitor. The attached driving system enables the rotor to be driven at speeds as high as 6000rpm by a reciprocating drive mechanism operated by an external lever. Although simpler drive systems were devised, the reciprocating type was chosen for its convenience, small size, and the ease with which it can be adapted to a hermetically sealed generator.

An important design problem in the project was devising a method to establish a unique polarity of output voltage. Of the several ways in which this can be accomplished, the use of a small external bias voltage to precharge the generator was adopted because it is the most reliable and because the polarizing potential is already available in the associated electronic equipment.

Practical printed circuit generator units as small as 1-5/8″diam have been constructed. As the size decreases, however, the output current decreases correspondingly, and a longer time is needed to charge the storage capacitor.

Experience with the generator shows that a 0.02mfd capacitor can be charged to 2kv in about 15sec. A typical application of the generator is in an alpha survey meter using the air proportional counter. The probe requires 2000v at 10^{-12} to 10^{-14}amp which is obtained from a storage capacitor recharged periodically by the new generator



Space Saving Panel Meters

DESIGNED to provide maximum instrument scale length in a minimum panel area, the miniature Side Indicating Panel Meters shown above afford greater legibility for complex instrument panels. They are available in a wide variety of ranges with flanges for single and back-to-back mounting, and can be grouped in both horizontal and vertical arrangements as shown below. Mounted side by side, they afford quick and easy comparative readings and reduce the size and weight of equipment.

Accuracy of the instruments is ±3% of full scale deflection for d-c readings, and ±5% for a-c measurements. They employ a lance type pointer and have a scale length of 1.322". The mechanism in enclosed in a dustproof anodized case with a clear plastic cover. Mounting is accomplished by means of a

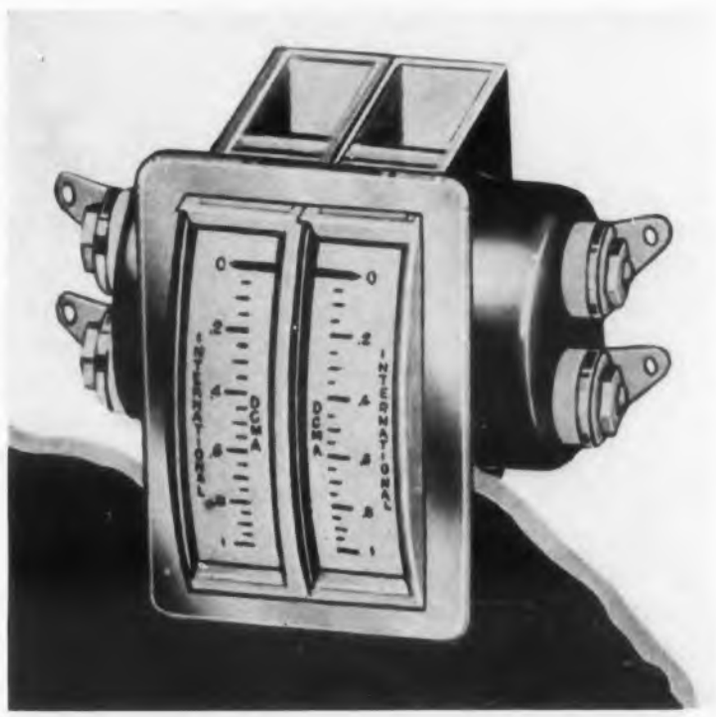


Fig. 1. Two of the new panel meters mounted back-to-back to save space.

mounting flange and a bracket. The single meter mounting flange requires a panel cutout size of 1.687″ x 0.531″, and the double meter mounting flange panel cutout measures 1.687″ x 1.040″. The instruments also can be mounted without the use of flange or bracket by means of two mounting holes on the side of the meter. The unit weighs 1-3/4 oz.

Standard ranges available include three microampere ranges from 0-100 to 0-500μamp; 11 milliampere ranges from 0-1 to 0-500ma; four ampere ranges from 0-1 to 0-15amp; a 0-50mv range; eight d-c voltage ranges from 0-1v to 0-150v (with 1000 ohms/v sensitivity); and eight a-c voltage ranges, rectifier type, self-contained, from 0-1 to 0-150v (with sensitivities of 10,000 ohms/v to 1000 ohms/v).

In addition to the instruments for measuring currents and voltages as outlined above, VU, db, and other meters are available in zero center, left, and right models. Special ranges, scales, sensitivities, resistances, etc., can be provided to suit individual requirements. The instruments are a product of International Instruments, Inc., P. O. Box 2954, New Haven, Conn. Using these meters, the electronic designer can effect a neat appearance for his instrument panel. Two instruments can be placed in the space normally occupied by a larger meter.

Because of their small size, legible markings, and long scales, the instruments should find wide application in complex electronic instrument panels. The zero center models are adaptable for use as null indicating instruments in tuning circuits, and the long scale of the units suggest their use for position indicating applications. Because the instruments employ a plastic cover, it should not be difficult to mount a small pilot light within the case or directly above or at the side to illuminate the scale, if desired.

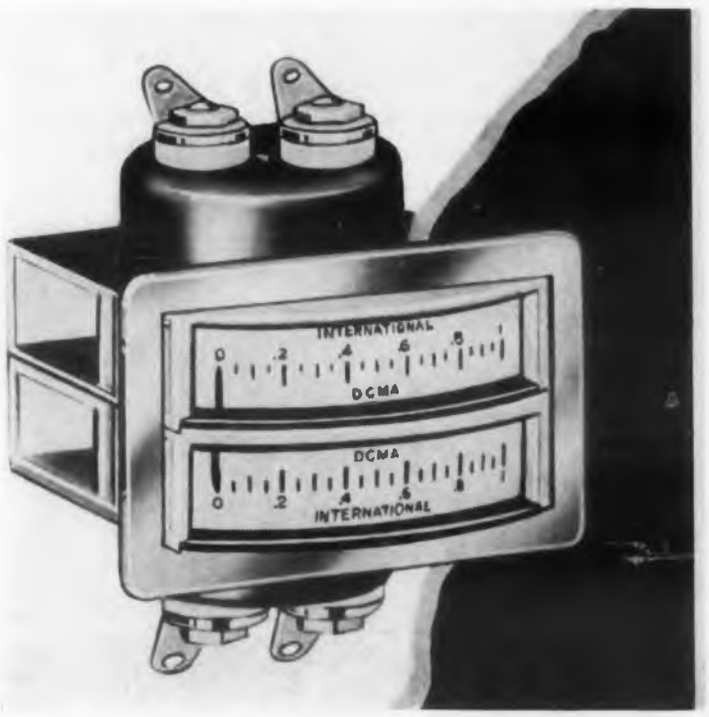
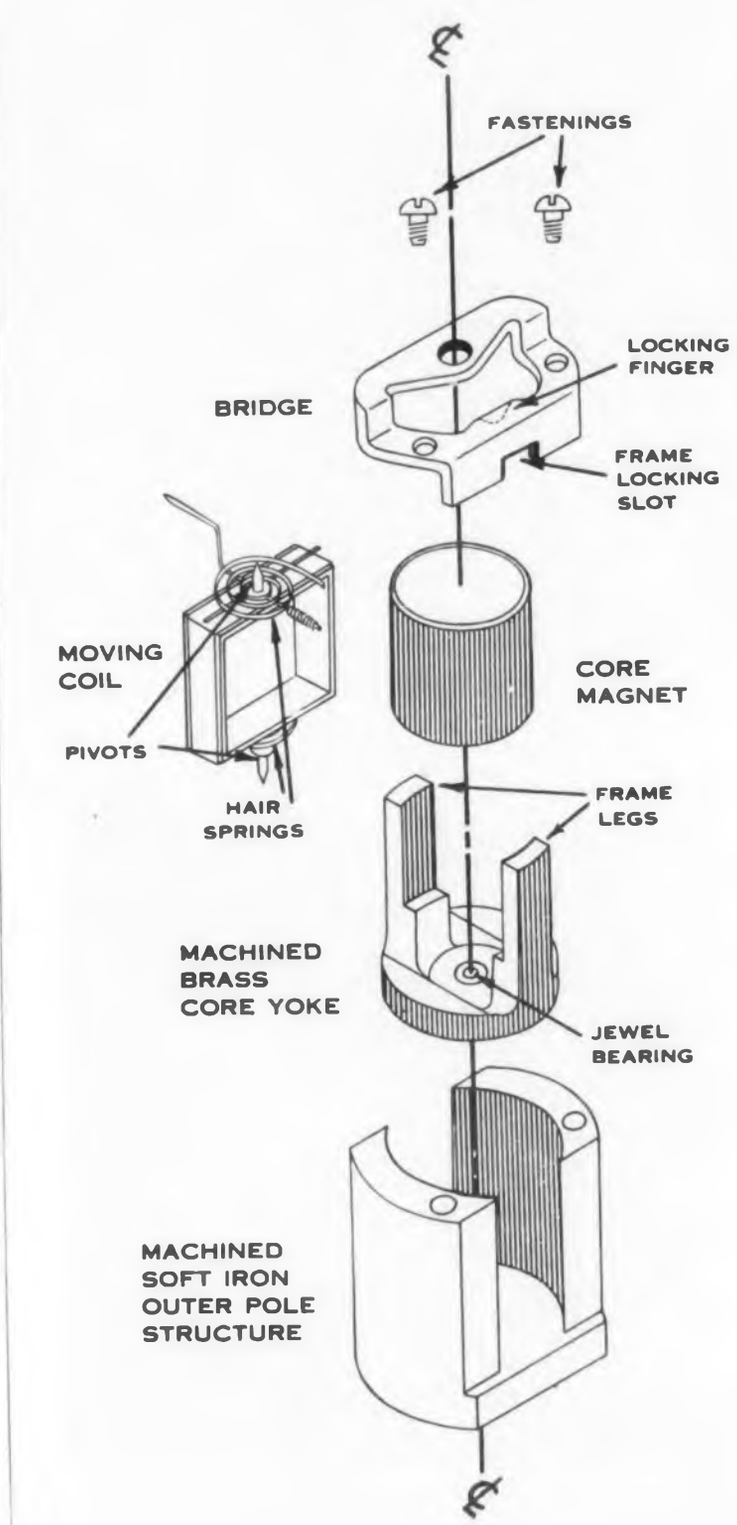


Fig. 2. Mounted in this manner, the instruments afford easy comparative readings.

Coaxial Galvanometer Mechanism



PERFORMANCE characteristics and durability surpassing those of existing ruggedized panel instrument movements of much greater size and weight are outstanding features of the coaxial galvanometer mechanism shown in Fig. 1. These features make practical the use of the moving coil mechanism as a component of many electronic instruments and devices, especially where ruggedness is needed.

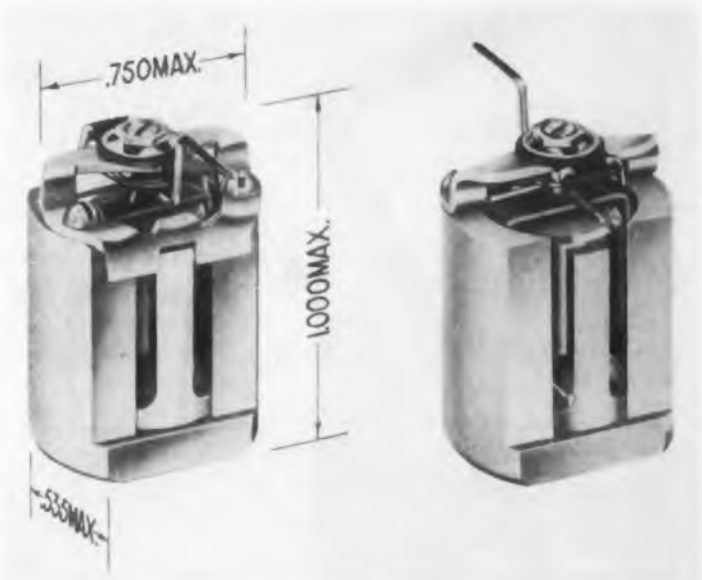
The assembly consists of a soft iron outer pole structure, a nonmagnetic yoke, and a magnetized core, all having diameters such that the yoke fits snugly in the pole structure, and the core within the yoke. A bridge, attached by two screws (the only fastenings in the entire assembly) locks the assembly. A locking finger on the bridge holds the core and frame in position. Rotation of the core yoke is prevented by a slot in the bridge flange which engages one of the legs in the frame. The moving coil is contained by its pivots, and bearings located in the bridge and base of the frame. (See Fig. 1).

A product of Marion Electrical Instrument Co., Manchester, N. H., this standard D'Arsonval movement mechanism can be used in ammeters, voltmeters, ohmmeters, etc. Its sensitivity compares with that of ordinary type meters. The movement is adaptable to all normal ranges of panel instruments of the 90° deflection type.

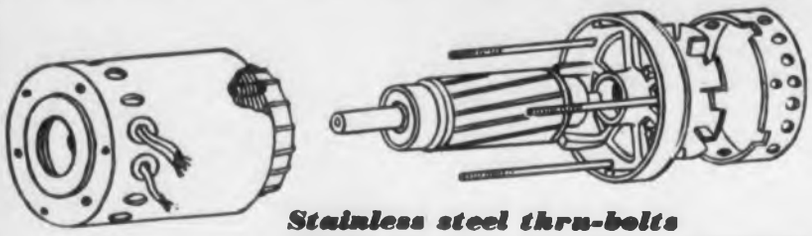
The unit weighs 0.8 oz as compared to 4-1/2 oz minimum for movements in other ruggedized types, and its ruggedness is equal to or better than that of the company's ruggedized instruments.

Because of its small size and weight, and its ruggedness and high accuracy characteristics, the mechanism is especially applicable in aircraft instruments. These features also make the unit useful for portable instrument application where accuracy is desired and rough handling is often encountered.

Fig. 1. At the left is an exploded view of the coaxial galvanometer mechanism shown below. It features small size and weight, accuracy and durability.



EXTRA-RIGID CONSTRUCTION IN MINIATURE MOTORS



Stainless steel thru-bolts
Rigid die-cast aluminum housing
Riveted stator

These construction features, incorporated in *all* Air Marine sub-fractional horsepower motors, result in extra-rigid design that assures positive bearing alignment and uniform air gap. Even after repeated impact shock and vibration tests, motor performance remains unchanged. Motors are protected against humidity and fungus growth — can be mounted in any position — are equipped with ball bearings using suitable lubricants for high and low ambient temperatures—meet all AN specifications.

A NEW ENGINEERING DEVELOPMENT

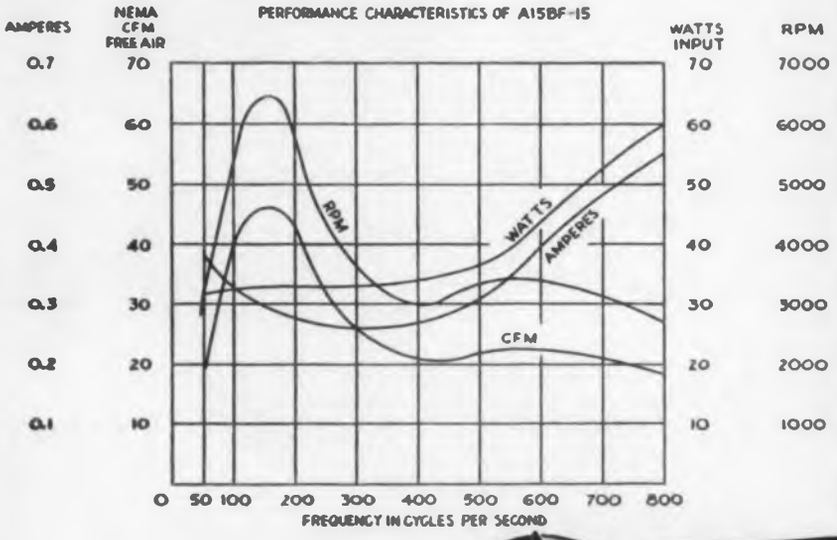
The 50-800 cycle Type A15BF-15 Motor

Latest result of Air Marine design skill is the Type A15BF-15 motor, the first ever manufactured for operation over the entire frequency range from 50 to 800 cycles.

Motor is designed for operation on 115 volt variable frequency supply—has single winding, four leads, reversible.

Totally enclosed—available with or without fan or blower.

Type A15BF-15 is designed for single phase operation—available for 2 and 3 phase operation also.



AIR MARINE MOTORS INC.
369 BAYVIEW AVE. AMITYVILLE, L.I.

Phone Amityville 4-6122

Send for Sub-Fractional Horsepower and Application Folder and Engineering Assistance Form Number ED-104

CIRCLE ED-16 ON READER-SERVICE CARD FOR MORE INFORMATION

Portable Plastic Drawing Board

MOLDED of clear, durable, polystyrene plastic, the portable drawing board shown in Fig. 1 measures 9-3/4″ x 12-1/4″ and weighs only 8 oz. It can be slipped easily into a brief case or be kept in a drawer for making design drawings in the field or at the desk.

The board is provided with four corner clamps that hold 8-1/2″ x 11″ paper without thumb tacks or adhesive tape. The clamps are recessed into the plastic so that a ruler or triangle can ride freely over them without interference. In use, they are pushed up from underneath the board, the paper corner is slipped under the head, and when released, a spring causes the clamp head to hold the paper firmly.

Two recessed metal straight edges, one along the bottom edge, and the other along the left edge of the board, make it possible to make precision drawings without a T-square. By pushing the lower end of the vertical straight edge slightly upward, the entire metal strip snaps up above the level of the drawing board from its recessed position. The horizontal straight edge is raised by pushing one end slightly to the right.

In the raised position, the strips serve as guides for a triangle in drawing parallel lines, for cross-hatching, etc. When the drawing is finished, the straight edges are quickly lowered, and by pressing up on the clamps from the bottom, the paper is released from the drawing board.

Tension clips on the under side of the board are provided for securely storing two 8″ triangles. The compact size and light weight of the board make it especially useful as a lap drawing board. It is also equipped with rubber feet in each corner to prevent slipping or marring when used on a desk.

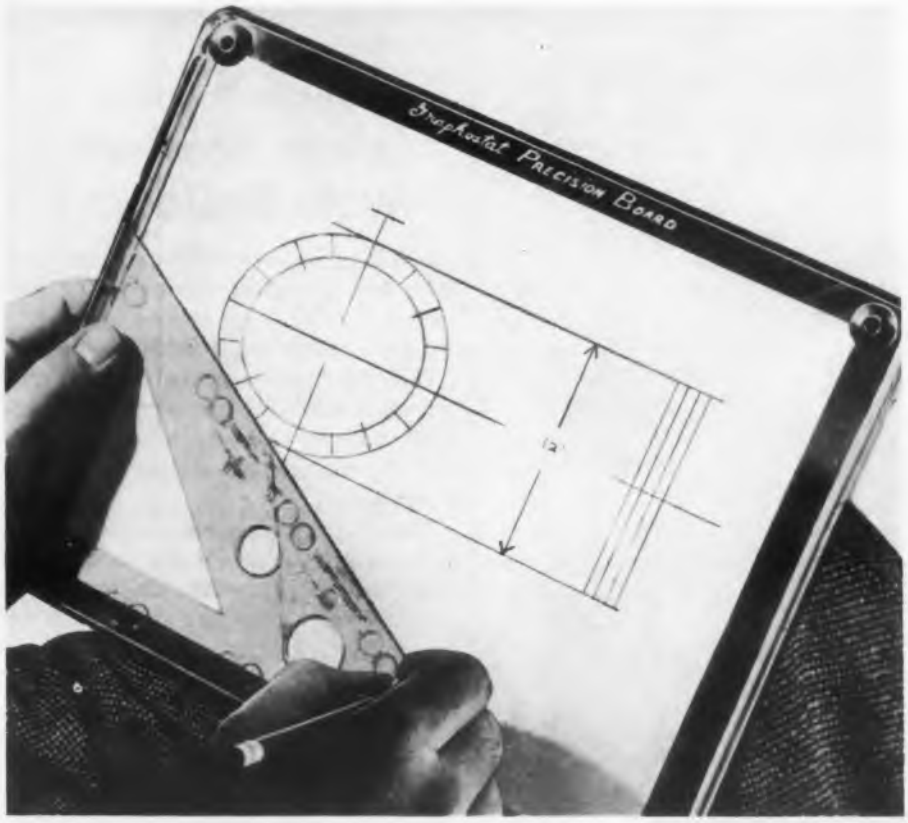


Fig. 1. Versatile, portable, transparent plastic drawing board which can be carried in a brief case for use in the field or at the desk.

New Permanent Magnet Alloy

GREAT possibilities for weight and space reductions in electronic products are afforded by "Alnico 5Cb", a new permanent magnet alloy. It is similar in physical characteristics to "Alnico 5", but offers considerably higher external energy and residual reduction. Its energy product is 5.70 x 10^6Bd Hd, the highest energy product of any "Alnico".

A product of Thomas & Skinner Steel Products Co., Inc., 1157 E. 23rd St., Indianapolis, Ind., the alloy is composed of aluminum, nickel, cobalt, copper, iron, and specially added columbium which makes possible the improved magnetic characteristics. It is hard and brittle, and must be fabricated by casting or grinding, or by shell molding. Holes must be cored in casting, or steel inserts must be used to be drilled and tapped for mounting. Considerable savings can be made by the shell molding process where tolerances can be held to $\pm 0.005''$ without additional grinding being necessary.

Operating conditions are an extremely important design consideration when using the alloy. A closed circuit assembly or one which is magnetized after the pole pieces, etc., are assembled, operates more efficiently than an open circuit assembly where the pole pieces are added after magnetization. Another important consideration is the ratio of the length to the diameter, and the physical shape of the magnet has a direct bearing on the efficiency.

Microphones, meters, klystrons, radar, magnetic pickups, and loudspeakers are a few of the many applications for the new alloy. Electronic designers will be able to make these products smaller and lighter and while maintaining a given energy product for the particular application.

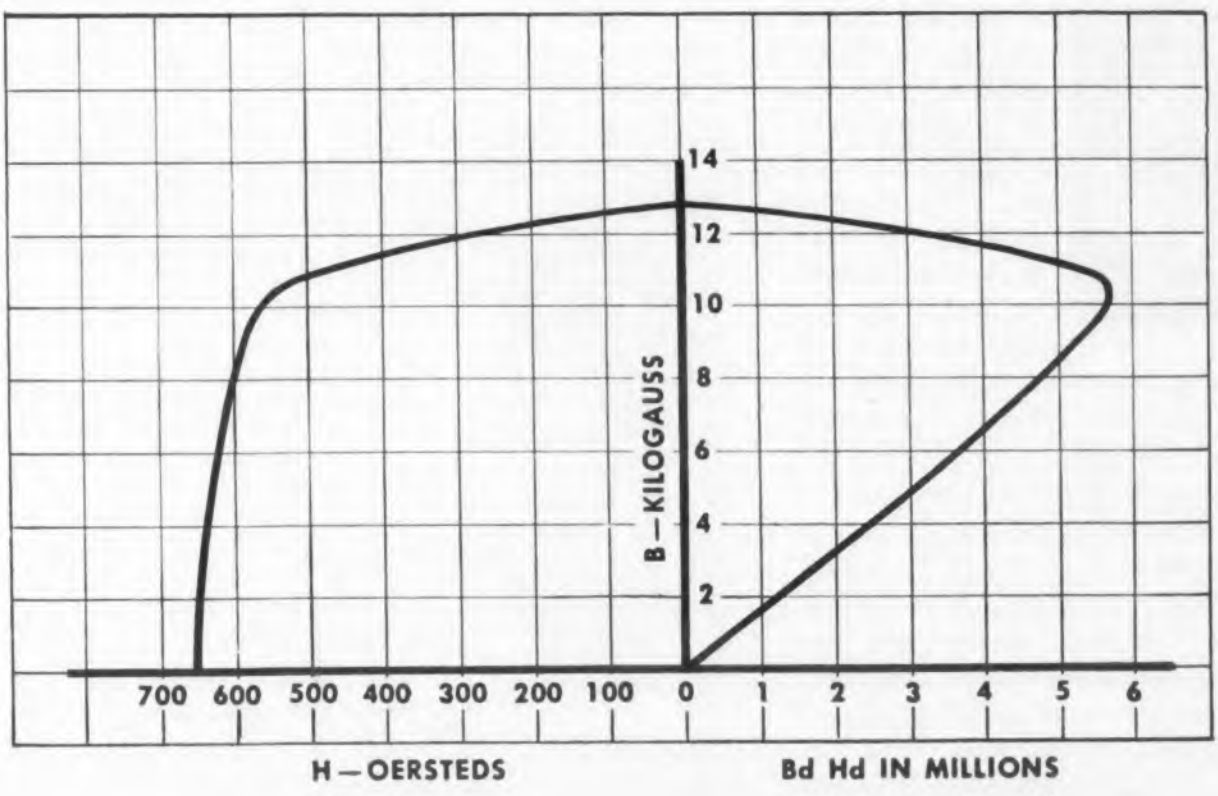


Fig. 1. Typical demagnetization and energy product curve for "Alnico 5Cb".

convert SELF-BALANCING POTENTIOMETERS TO digital read-out

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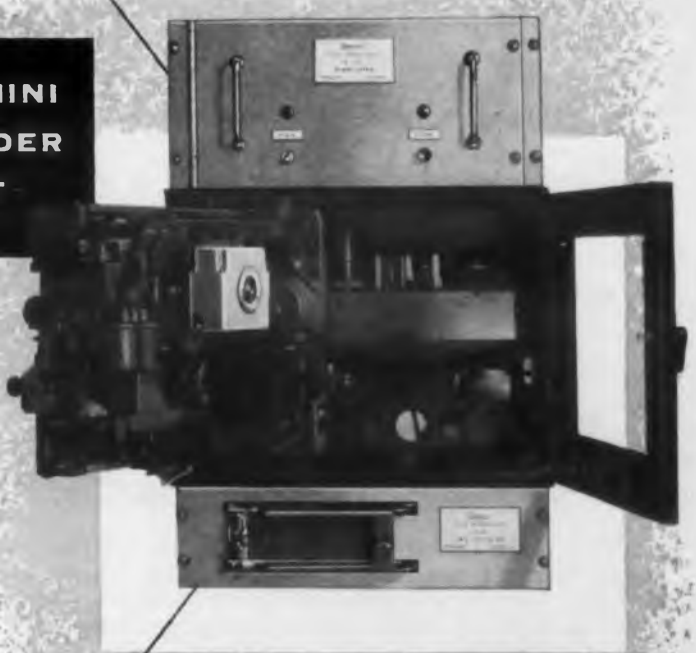
COMPLETE...EASY TO INSTALL...READS FROM 0—1000; ACCURACY ±0.1%—Here is a complete system kit for obtaining digital information from standard self-balancing potentiometers. Easy to install, complete with all necessary hardware, this conversion does not affect the accuracy of the recording instrument, and no modification of the potentiometer is required. Readings can be taken while the recording pen is moving, and because no gears are used, inertia effects are very low.

Non-linear calibrations available for use with thermocouple applications.

GIANNINI ENCODER KIT



CODED COMMUTATOR:

Digitizes shaft position. Used for Analog to Digital Conversion.

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CIRCLE ED-17 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Oil-Filled Capacitors

Small, Single-Stud-Mounted Units

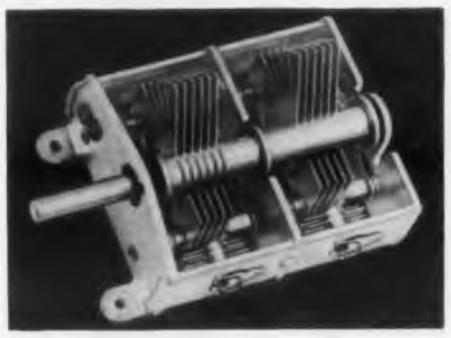
These small case size, inverted, single-stud-mounting, tubular, oil-filled capacitors are available in ratings of 8mfd and dual 4mfd at 600v d-c; 4mfd and dual 2mfd at 1000v d-c; and 2mfd at 1500v d-c. Similar units in the same case size are also available.

Case sizes range from 1-½"diam x 2-⅞", to 2"diam x 4-1/2". Hermetically sealed, they are oil-impregnated and filled with Indco Oil "A". Pyroteen filled capacitors are also available. Temperature range for the Indco Oil type is —40° to +70°C; for the Pyroteen, —70° to +90°C. Industrial Condenser Corp., Dept. E-15, 3243 N. California Ave., Chicago 18, Ill.

CIRCLE ED-19 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Air Capacitors

In Single to Four Gang Sections



This line of variable air capacitors is for all u-h-f and r-f applications. Small in size and of instrument quality, standard units are available in single to four gang sections.

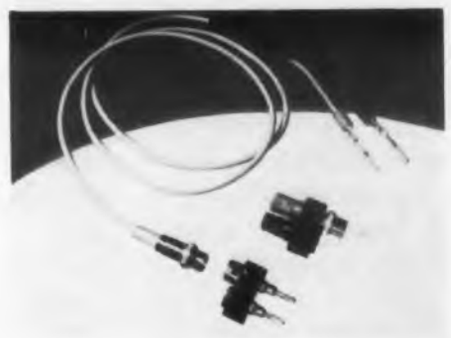
Each capacitor has a compact, swaged and soldered, lightweight frame. Each has a 3-point mounting. The units are provided with stainless steel ball bearings, and all rotors and stators are soldered. Units are constructed of silver-plated brass (or invar) for low surface resistance.

The compression-loaded ceramic rod stator suspension of each capacitor gives it an exceptionally long dielectric path and mechanical reliability. A variable air trimmer is an integral part of each section. All capacitors have high Q and low minimum capacities. Johanson Mfg. Corp., Dept. ED, Boonton, N. J.

CIRCLE ED-20 ON READER-SERVICE CARD FOR MORE INFORMATION

Conversion Plugs

Join Different Style Instruments



Two new plugs simplify interconnection of measuring instruments and other electronic laboratory equipment having old-style 3/4"-spaced banana plugs, or the corresponding jack type terminals, with other instruments having new-style concentric amphenol terminals and plugs.

These "Conversion Plugs" are the CP-122 (amphenol to spaced jacks) and the CP-221 (spaced plugs to amphenol). They enable users to plug old equipment into new meters and scopes or to use the shielded Millivac clip lead, CL-101, (see illustration) for older equipment having spaced terminals. Millivac Instrument Corp., Dept. ED, 444 Second St., Schenectady, N. Y.

CIRCLE ED-21 ON READER-SERVICE CARD FOR MORE INFORMATION

Audio Pentode

Low Noise, High Gain Unit

The "Genelex Z729" is a low hum, low noise, low microphonic, voltage amplifying, audio pentode which will fit a standard 9-pin miniature socket. Especially designed for use in high quality, high gain audio preamplifier and equalizer stages, it features an internal shield completely surrounding the tube elements.

General characteristics include: 6.3v heater voltage; 0.2amp heater current; 250v anode voltage; 6ma total current; and a hum level below 1.5mv. British Industries Corp., Dept. ED, 164 Duane St., New York 13, N. Y.

CIRCLE ED-22 ON READER-SERVICE CARD FOR MORE INFORMATION

Hermetic Terminals

Of Glazed Alumina Ceramics

Metalized Solderseal Hermetic Terminals are made of glazed Alumina Ceramics and they are available in a wide range of standard sizes. The material conforms to the requirements of Grade L-5A, in accordance with JAN-1-10. Lugs and eyelets are hot-tinned brass with metalized areas silver fired on ceramic. Both lugs and eyelets are copper electroplated and tin fused for soft soldering. Immersion in 60/40 solder at 450°F for 1-1/2min for dip soldering will not injure the metallic coating.

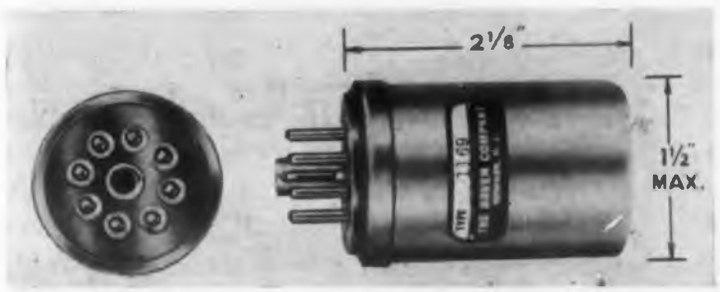
The terminals feature high mechanical strength, high resistance to thermal shock, and permanent hermetic sealing. Installation can be made quickly and easily. Dimensional tolerance is ±1.5%, but not less than ±0.010". RMS voltage ratings range from 3000v to 15,000v. General Ceramics and Steatite Corp., Dept. ED, Keasbey, N. J.

CIRCLE ED-23 ON READER-SERVICE CARD FOR MORE INFORMATION

Resistor Network

Plugs into Octal Sockets

The Type 1169 hermetically sealed resistor network is designed to be pluged into standard octal sockets. It is available in completely matched sets of resistors, interconnected as desired. All parts are securely



mounted internally to resist the most severe military shock and vibration tests. The unit will withstand the JAN-R-93, characteristic A, salt water immersion test and, in addition, temperature cycling from −65° to +125°C.

The network can be supplied with up to five 1 meg resistors, or up to ten 1/2 meg resistors in any desired internal circuit. Resistors can be matched to ±0.02%, with temperature coefficients matched up to ±10 parts per million per degree centigrade, if desired. The Daven Co., Dept. SU, 191 Central Ave., Newark 4, N. J.

CIRCLE ED-24 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Miniature D-C Gear Motors

Output Speeds Down to 1rpm

This series of miniature, permanent magnet d-c motors and gear motors can be supplied with overload torque limiting clutches. The motors measure 1-3/16"diam x 4" long. Their output speeds can be varied, by changing the gear set, to as little as 1rpm. They are designed in conformance with military specifications. Mission-Western Engineers, Inc., Dept. ED, 132 W. Colorado Blvd., Pasadena 1, Calif.

CIRCLE ED-30 ON READER-SERVICE CARD FOR MORE INFORMATION

Proximity Meter

Compares & Measures Dimensions

The "Proximity Meter — Capacitance Guage" compares, measures, or monitors dimensions and distortions. It is applicable to both static and dynamic (0-4000cps) measurements. Sensitive to 0.05mmfd or closer, it operates on changes in the capacity of the specimen under test.

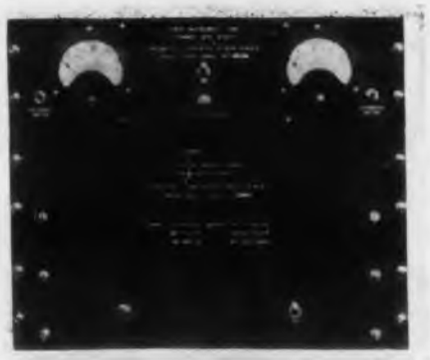
The extreme sensitivity of the instrument on either metallic or insulating materials offers a great number of uses, ranging from research and laboratory work to production line quality control. Some uses are: Measuring concentricity of shafts, rotors, etc.; readings may be obtained on the meter or viewed through an oscilloscope. Use as a micrometer to measure very small diameters; measurements are made without physical contact to the specimen. Use as a dielectric comparator to measure the composition or quality of conducting or non-conducting materials, whether solid, liquid, or gas. Measuring thickness of paint of insulating materials bonded to metal surfaces.

In mechanical measurements, variations are reflected by a change in position of test surfaces of the specimen with respect to a fixed measuring electrode. Fielden Instrument Div., Robertshaw-Fulton Controls Co., Dept. ED, 2920 N. 4th St., Philadelphia, Pa.

CIRCLE ED-31 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Converter

Delivers 60va, 2500cy Power



Especially suited for work on computers, guided missiles instrumentation, and similar applications requiring adequate power coupled with precision voltage and frequency regulation, the Model 2500 Frequency Converter delivers 60va of regulated, 2500cy power. It operates on a 110-120v 60cy line at a maximum dissipation of 365w, and delivers a monitored output, adjustable between 90v and 115v, 2500cy, at 60va maximum. The frequency regulated output is accurately controlled by a tuning fork. An output cutoff relay protects against frequency change due to component failure.

Within the specified input voltage limits, voltage regulation, frequency regulation, and harmonic distortion are independent of the power factor between 0.5 lagging and 0.5 leading. Voltage is regulated to better than ±0.5%, frequency to better than ±0.04%, and total harmonic distortion is less than ±1%. Mounted on a standard 19″ rack, the unit is 16″ high and weighs 63 lbs. Avion Instrument Corp., Div. of American Car and Foundry Co., Dept. ED, 293 State Highway No. 17, Paramus, N. J.

CIRCLE ED-34 ON READER-SERVICE CARD FOR MORE INFORMATION

Junction Transistors

With 40% Smaller Cases

The cases of the n-p-n grown junction transistors produced by this firm have been reduced 40% by changing the length dimension from 0.500″ to 0.300″. Connections are made to the case through three leads, supplied already tinned and 1-1/2″ long, suitable for soldering into the circuit or clipping to desired length and plugging into a subminiature socket.

The cut in case size affects only the case length. No other change was made in materials or fabrication methods; the moisture-proof, glass-to-metal hermetic sealing and electrically insulating finish remain unchanged. The transistors are available in three types, differing principally in collector resistance and amplification factor. Alpha (current amplification factor) is a guaranteed minimum of 0.90 in Type 200, 0.95 in Type 201, and 0.98 in Type 202 transistors. Texas Instruments, Inc., Dept. ED, 6000 Lemmon Ave., Dallas 9, Texas.

CIRCLE ED-35 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Resin-Glass Laminate
For Printed Circuits

"Epoglas" is a laminate of epoxy-resin and glass-cloth with a low water absorption (0.016%) and high dielectric constant, surface resistivity, and arc resistance. Service temperature is 175°C. It is especially valuable for printed circuits and other electronic applications.

The material is available copper-clad on one or both sides, ready for etching; or unclad, for use in terminal boards or as a base for plated and printed circuits. Sheets are 24″ x 36″, and thicknesses are from 0.003″ through 0.500″.

The epoxy-resin has a high bond strength to copper when laminated under heat and pressure. Because it requires no adhesive, both it and the copper retain their electrical and mechanical properties unimpaired in the completed circuit. "Epoglas" is ideally suited to dip-soldering and will not delaminate. It is readily workable by all conventional fabricating processes. Plastilight, Inc., Dept. ED, 481 Canal St., Stamford, Conn.

CIRCLE ED-38 ON READER-SERVICE CARD

Printed Circuits
Available in Four Kits

The Printed Electronic Circuits of this firm are now being furnished in four handy kit assortments. They permit industrial or components laboratories to have the most often used printed circuits always available. The smallest kit of 18 circuits will replace 42 resistors and 52 capacitors.

The four kits are known as the PCK-18, PCK-45, PCK-110, and PCK-1220. They include, respectively, 18 circuits in a plastic box, 45 circuits in a plastic box, 110 circuits in a metal cabinet, and a complete assortment of 220 circuits in a large metal cabinet. Centralab, Division of Globe Union, Inc., Dept. H-31, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE ED-39 ON READER-SERVICE CARD

◀ CIRCLE ED-37 ON READER-SERVICE CARD

Titanium

In Very Thin Gages

Commercially pure titanium, precision rolled to very close tolerances and to thin gages and foils, is available for use in the manufacture of electronic, electrical, and communications equipment components. The lightweight metal, which compares favorably in strength to many steels, possesses excellent corrosion resistance and the ability to withstand high temperatures.

The metal is rolled in strip up to 8″ wide and down to 0.0005″ thick, to tolerances as close as ±0.0001″. It is available in any quantity from 1 pound to thousands of pounds. American Silver Co., Dept. ED, 36-07 Prince St., Flushing 54, N. Y.

CIRCLE ED-40 ON READER-SERVICE CARD

Plastic Materials

Have Adjusted Dielectric Constants

"Stycast Hi-K" is a series of plastic materials having adjusted dielectric constants. Available in various sheet and rod forms, the materials are intended for r-f and microwave applications and possess dielectric constants of 3, 4, 5, 6, 7, or 8. Standard rod sizes of 1″, 2″ and 3″, and sheets with thicknesses of 1/2″ and 1″, are carried in stock. Other constants and sizes are available on special order.

The materials have a maximum variation of dielectric constant of only ±0.15 from 10^6cy to 10^{10}cy, while the dissipation factor is below 0.001. Volume resistivity is greater than 10^{14} ohm-cm³; dielectric strength is greater than 500v/mil.

Machinability of the plastics is excellent with carbide tools. Physical properties vary with the dielectric constant, but some average values are: tensile strength, 8000psi; flexural strength, 13,000psi; linear expansion coefficient, 50 x 10^{-6}/°C; water absorption, 0.1% gain at 25°C; for 24 hrs; temperature range —70° to +125°C. Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE ED-41 ON READER-SERVICE CARD

CIRCLE ED-42 ON READER-SERVICE CARD ➤

New Products . . .

Junction Transistor

Low Noise, p-n-p Type

A low noise Junction Transistor Type CK727, has been added to the company's line of p-n-p transistors.

This new unit has an average noise factor of 13db, and average alpha of 0.97, and an average power amplification of 37db. Raytheon Manufacturing Company, Dept. ED, 55 Chapel Street, Newton 58, Mass.

CIRCLE ED-47 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Generator

Wide Range, Versatile Instrument

The Model 2120A Pulse Generator is constructed on the block-unitized principle. It generates a positive or negative main pulse whose width, amplitude, and delay from trigger are continuously variable over a wide range. Using no gas tubes in pulse forming circuits, operation from either internal or external frequency sources at repetition rates up to 100,000cy is provided, along with single pulse and gated operation.

Amplitude of the main pulse is 80v max across an internal 93 ohm resistor and may be continuously varied within 10db steps. Pulse width is variable from 0.1μsec to 1000μsec in four ranges, and flatness of the pulse top may be adjusted within 2% on all ranges.

Rise time of the main pulse is 0.02μsec on all ranges, and fall time is 0.03μsec. Delays from synchronizing pulse from 0-10,000μsec are provided in five ranges. Other waveforms available include blocking oscillator pulses at the synchronizing pulse, at 1μsec before and at the main pulse leading edge, and at the main pulse trailing edge, along with positive and negative gates and negative triangles corresponding to both delay and width of the main pulse. Electro-Pulse, Inc., Dept. ED, 11811 Major St., Culver City, Calif.

CIRCLE ED-48 ON READER-SERVICE CARD FOR MORE INFORMATION

New Wide-Range Capacitor

C.T.C.'s new CST-50 capacitor surpasses the range of others many times larger in physical size. This is due to a new and unusual tunable* element that practically eliminates losses due to air dielectric. As a result, a large minimum to maximum capacity range (1.5 to 12 $\mu\mu$fd) is realized. Yet the CST-50 stands only 19/32″ high when mounted, is less than ¼″ in diameter, and has an 8-32 threaded mounting stud. The mounting stud is split so that the tuning sleeve* can be securely locked without causing an unwanted change in capacity.

The CST-50 is provided with a ring terminal having two soldering spaces. The tuning sleeve* is at ground potential. All C.T.C. materials, methods and processes meet applicable government specifications. Send for details. Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Mass.

*Patent Applied For

CIRCLE ED-52 ON READER-SERVICE CARD FOR MORE INFORMATION

Modular Design Kit

For "Project Tinkertoy" Designs

The PT-1000 Kit includes all the hand tools, materials, chemicals, module parts, and standard accessories necessary for the design and construction of "Project Tinkertoy" modules and subassemblies, or complete end equipment using modular designs. All the user needs is bench space, the test equipment normally available in an equipment development laboratory, and the PT-1000 Kit.

The items provided include among many others; 14 standard tools peculiar to the process, such as a silver firing furnace, a drying oven, and an etched circuit solder pot; 12 specially designed hand tools, such as ceramic setters, a socket press, notch painters, and a pattern printer; enough assorted wafers, 7-pin and 9-pin socket bodies, socket connectors, and hardware to make over 200 modules; an assortment of 1200 pre-cured tape resistors and 1200 ceramic capacity bodies; all necessary chemicals; and standard screens to print capacitor and resistor patterns, plus blank screens for making specialized patterns. Communication Measurements Laboratory, Inc., Dept. ED, 350 Leland Ave., Plainfield, N. J.

CIRCLE ED-53 ON READER-SERVICE CARD FOR MORE INFORMATION

Test Chambers

Multi-Range, All-Purpose Units

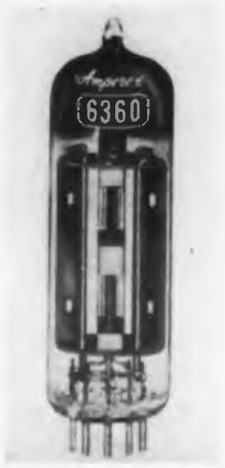
This Test Chamber design can produce temperatures from —130°F to +200°F, with a standard humidity cycle of 20% to 95%, within the range of 35°F to 185°F. Five sizes are available, with test capacity space from 4 to 36cu ft.

The heavily insulated chambers incorporate many useful features, including a high capacity, low velocity, forced air circulation system; sleeved openings in test spaces for the introduction of leads, hydraulic lines, etc.; an electric defrost system, and simple water and drain connections. Many optional features such as program control, recorder-controller, hand hole ports, and electrical terminal pads are available. Murphy & Miller, Inc., Dept. ED, 1326 S. Michigan Ave., Chicago, Ill.

CIRCLE ED-54 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Miniature Twin Tetrode
For Frequencies Up to 200Mc



The Type 6360 is especially valuable for use in low drain, mobile transmitters and multiplier chains, where its ability to increase the power level quickly, and deliver a balanced output, make it ideal for driving higher power and higher frequency push-pull stages.

The unit is designed for use as a Class C amplifier and oscillator, frequency multiplier, and modulator for frequencies up to 200Mc at maximum ratings. It is capable of delivering 16w at 200Mc under I.C.A.S. conditions. As a frequency tripler from 67Mc to 200Mc, it can deliver 5w out under I.C.A.S. conditions.

The cathode is of the oxide-coated, indirectly heated type. Dimensions of the Type 6360 are 3-1/16" overall length x 7/8"diam. Amperex Corp., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

CIRCLE ED-58 ON READER-SERVICE CARD FOR MORE INFORMATION

A "PEN" MICROSCOPE at work in quality control at Bridgeport-Lycoming

Quality control work at the Bridgeport-Lycoming Division of Avco, manufacturers of aircraft engines and jet engine components, is one of the many applications which leading industrial companies have found for the Pike Model V "Pen" Microscope — the instrument that's no larger than a fountain pen — yet gives magnifications of 40x, 50x or 60x. Ruggedly made and easy to use — yet built with the optical precision of a laboratory microscope.

Ideal for on-the-spot examination of specimens — eliminates time-consuming techniques. Self-illuminating by means of mirror that reflects external light source. Price $15.75.

Write for literature on Pike "Pen" Microscopes and FLASH-O-LENS models combining magnifiers and self-contained light sources

E. W. PIKE & COMPANY

492 NORTH AVENUE ELIZABETH 3, NEW JERSEY

CIRCLE ED-62 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Frequency Inverter

With Voltage Regulation of ±0.5%

The Model B401-15 Behlman Invertron is an electronic power oscillator featuring continuously variable frequency from 300cy to 500cy. Power output is single phase, and two continuously variable voltage ranges of 0-130v and 0-32v are provided. A large, easy-to-read dial, calibrated in 2cy increments, permits frequency settings accurate to within one cycle. Power output capability is 160va continuous and 180va intermittent.

Total distortion at full load is less than 2%. Output voltage regulation is ±0.5% from zero to full load. Total frequency shift caused by changing output voltage and/or load is ±1/4cy. The unit operates directly from 115v, 60cy power and is housed in a standard gray cabinet rack.

Other models are available to cover various frequency, voltage, and power ranges. Multi-phase outputs are also available. Bon Air-Behlman, Dept. ED, 711 S. Victory Blvd., Burbank, Calif.

CIRCLE ED-64 ON READER-SERVICE CARD FOR MORE INFORMATION

Better Performance...

WITH THIS NEW HERMETICALLY SEALED RELAY

Developed to meet exacting specifications for a current aircraft equipment application, this hermetically sealed, solenoid-type relay combines high contact rating and large contact area in a lightweight, compact envelope.

No. A-53-110

CHARACTERISTICS

DESCRIPTION: SPST, NO., bracket mounted.
COIL DATA: Nominal voltage 24-28 VDC; maximum operating voltage 29 VDC; maximum pick-up voltage 18 VDC; drop-out voltage 7 VDC, plus 0, minus 5.5 VDC; standard coil 160 ohms, maximum coil current .180 amps.
CONTACT RATING: 25 amp. resistive; 20 amp. inductive; 15 amp. motor.
RATED DUTY: Continuous.
WEIGHT: 6.25 ounces.
MAXIMUM DIMENSIONS: Width 1 15/32"; length 1 13/16"; height 2 3/4".

Brochure and specifications available upon request.

RELAY DIVISION
Electrical Products CORP.
1100 North Main Street, Los Angeles 12, California

CIRCLE ED-66 ON READER-SERVICE CARD FOR MORE INFORMATION

CANNON PLUGS *for hermetic sealing*

SUB-MINIATURE U Series plugs for miniature switches, relays, transformers, amplifiers and other sealed components have steel shells and Silcan insulation, cable relief and moisture resistant sleeve. Bayonet-lock coupling method. Rated 1700 v. D.C.; 5 a.—Have 3, 6, and 12 contacts—one plug style and two receptacles. Refer to U-2 Bulletin.

GS TYPES (Top, right) and RKH Types (Bottom, right) have fused vitreous insulation providing a true hermetic seal for relays, position indicators, etc. Cadmium finish steel and bleached Iridite shells with Dural coupling nut. Resist thermal shock—300°F. to 600°F.; pressures 200 to 900 psi—specials to 7500 psi. See GS-3 section in AN-8 Bulletin and KH-1 section in K Bulletin.

CANNON ELECTRIC

Since 1915

FACTORIES IN LOS ANGELES, TORONTO, NEW HAVEN
Representatives in principal cities. Address inquiries to Cannon Electric Co., Dept. K143, Los Angeles 31, California.

CIRCLE ED-63 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRO-MECHANICAL ASSEMBLIES *to your specs*

DESIGN • DEVELOPMENT • PRODUCTION

Top project engineers seeking a contract designer and manufacturer for electro-mechanical assemblies have been turning to PM Industries for the past twelve years. Our accomplishments include slip ring assemblies ranging from heavy duty to instrument grade, operator control grips, potentiometer linkages, high speed rotary switches, aircraft winches, square wave generators, and many others. We are organized to design or re-design as necessary, develop, and manufacture.

Your request for full information will get prompt attention. Write PM Industries, Inc., Stamford, Connecticut.

PMI Industries Inc., Stamford, Conn.

CIRCLE ED-65 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature ELASTIC STOP® nuts down to 0.109" across flats

NOW, miniature ELASTIC STOP nuts are available in sizes #0 through #4 in both SAE fine thread and USS coarse series—for special applications, such as electronics equipment and instruments. Smaller than any other self-locking nut they maintain a precise adjustment whether tightened against a seating surface or positioned at any point on a threaded member.

Nylon inserts make them self-locking, vibration-proof and re-usable, like all ELASTIC STOP nuts. They are simpler and less expensive to assemble than double nuts or soldered units.

WRITE FOR design information on Miniature Nuts and other special and standard ESNA fasteners. Address Dept. N38-162.

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, N. J.

DESIGN HEADQUARTERS FOR SELF-LOCKING FASTENERS

CIRCLE ED-67 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Toroids
In Wide Range of Sizes

A line of toroidal coils is offered in a wide range of sizes from units having a hole size of 5/16", to coils with an 8" hole size using cores of small cross section. An outstanding feature is their close electrical tolerances: units can be wound to ±5% inductance, matched to a standard to 0.1% inductance or —1 turn.

The finished toroids are available as uncased units, hermetically sealed or embedded to meet applicable MIL specifications. If desired, the coil can be incorporated into complete wave filters or networks designed to performance specifications or the customer's own design. F. W. Sickles Division, General Instrument Corp., Dept. ED, Chickapee, Mass.

CIRCLE ED-70 ON READER-SERVICE CARD FOR MORE INFORMATION

provides control for machine tools

This compact lightweight potentiometer provides accurate electronic control for cutting tool, winder, processing machine drives, and similar applications.

The precision metal alloy contact fully traverses the special resistance element with ½" plunger movement. Oil-tight enclosure, permanent calibration, 10,000 ohms resistance value on standard, up to 25,000 ohms on custom-made potentiometers. Write for Bulletin 68, Ward Leonard Electric Company, 77 South St., Mount Vernon, N. Y.

WARD LEONARD ELECTRIC CO.

Result-Engineered Controls Since 1892

RESISTORS • RELAYS • MOTOR CONTROLS • CHROMASTER

CIRCLE ED-74 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Diodes

Optimum Performance at 6750Mc

Four cartridge-type silicon diodes have been developed for mixer use in microwave systems utilizing RG 50/U wave guides. The diodes are interchangeable with the standard 1N23B and 1N21B, but are designed for optimum performance at 6750Mc in the company's Type P-570 mixer. In the mixer, the 1N150 diode presents a match of better than 1.5 to 1 at 1mv level.

The 1N150 and its reversed polarity counterpart are manufactured to such narrow limits that they can be used in balanced mixers without selection. In such mixers, noise figures of approximately 10db are obtainable over broader bandwidths than possible with 1N23C diodes at this wavelength.

The 1N160 (SD7000) and 1N160R (SD7000R) are similar to the 1N150, but are designed to slightly higher test limits. Microwave Associates, Inc., Dept. ED, 22 Cummington St., Boston 15, Mass.

CIRCLE ED-76 ON READER-SERVICE CARD FOR MORE INFORMATION

COMPRESSION TERMINALS and LINKS

All types, all sizes quickly, easily installed with wide variety of matched tooling

All sizes of solderless lugs and links for all conductors and all applications in manufacturing and plant wiring can be rapidly, economically installed by means of Burndy tooling, coordinated with specific manufacturing methods and production requirements.

Burndy Hylugs and Hylinks are of one-piece, pure copper construction, so they can be indented on any side of the barrel and they can't split. There are no intermediate contact surfaces — current is carried by the entire cross-section. Plated to resist corrosion. Listed by Underwriters' for #22 through 2000 Mcm.

Intimate high-pressure contact between conductor and connector is assured by Burndy matched installation tools. Manual, hydraulic, and pneumatic tools are designed for portable, on-the-job use and for production bench operation.

For complete details and catalogs, write

Dept. H, BURNDY, Norwalk, Connect.

CIRCLE ED-78 ON READER-SERVICE CARD FOR MORE INFORMATION

Multi-Purpose

LABORATORY

POLI-SCALER

Versatile
Compact
Precise
Low-Cost

The Detectron DS-606 Poli-Scaler is a complete laboratory scaler of exceptional versatility. Adaptable to GM and scintillation counting and frequency checks. Power supply may be used for either GM input or to operate accessory equipment.

PULSE HEIGHT DISCRIMINATOR INPUT – 2 to 100 V

POSITIVE or NEGATIVE PULSES – 2-100V Pos-2-50V Neg.

RESOLUTION TIME – 5 Microseconds per pulse pair or less

HIGH VOLTAGE POWER – Variable in 1-step from 0 to 2.5 kv.

COUNTING RATE – 1,000 per sec. max.

ACCESSORY SOCKETS –for count rate meter and speaker

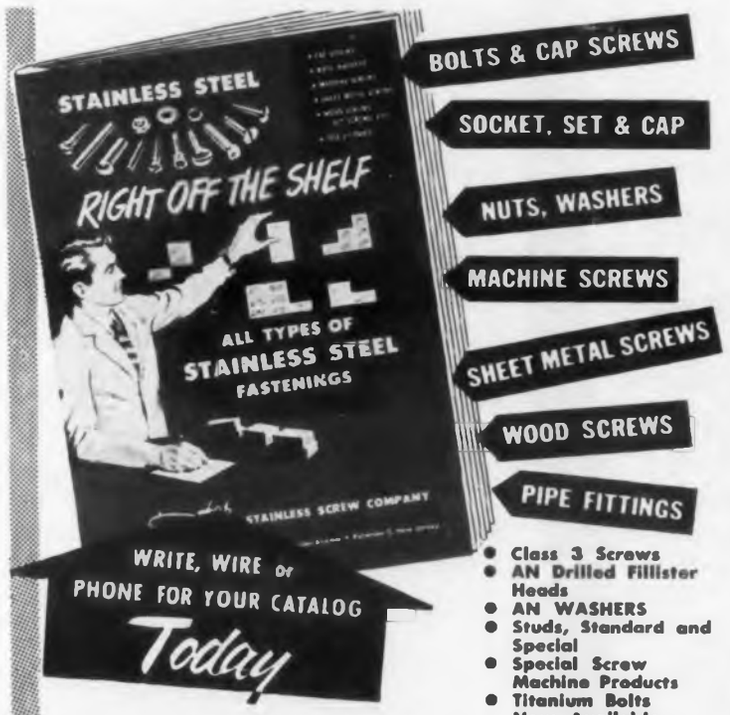
DIRECT READING – to 99,999,999

Write for FREE folder
Dept. 76

THE Detectron CORPORATION

5420 VINELAND AVE., NO. HOLLYWOOD, CALIF.

CIRCLE ED-75 ON READER-SERVICE CARD FOR MORE INFORMATION



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CIRCLE ED-77 ON READER-SERVICE CARD FOR MORE INFORMATION

High speed, direct reading. Indicates increment of measurement in radar navigation instruments.

"Y" Rotary Counter used in navigating instruments.

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Special counter for Tape Recorder to indicate position of tape passing through recorder.

Special high speed Y-type for Goniometer application.

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PRODUCTIMETERS *Count Everything*

75th ANNIVERSARY

CIRCLE ED-79 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Low Inertia Servomotor

Combined With Damping Generator

This 2-phase servomotor and integral damping generator combination weighs only 7.6 oz and measures 1.062″diam x 3″ overall length. Stator assemblies of both units are integrally cast in a thermosetting plastic material, permitting straight through rotor bores, thus making possible minimum air gap with a resultant increase in efficiency and performance. Stainless steel housings and cast stators provide protection against environmental effects of high temperature, humidity, vibration, and shock. The combination features extremely low rotor inertia and high stall torque.

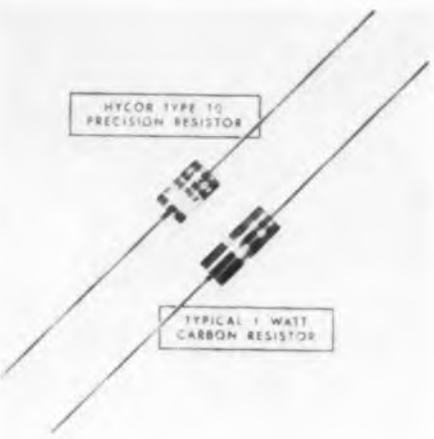
Servomotor rotor inertia is 1.3gm-cm^2; stall torque is 0.65 in-oz. No load speed is 5900rpm. Theoretical acceleration at stall is 34,200rad/sec^2. The motor draws 3.5w for 115v 400cy fixed phase, and 57.5v 400cy center-tapped control phase; and, for plate-to-plate operation, 3.7w for 180v 400cy fixed phase, and 90v 400cy center-tapped control phase.

Generator excitation is 115v 400cy. Output is 0.500v per 1000rpm minimum; the unit has 600 ohms output impedance, and a null voltage of 19mv. Maximum speed for linear output is 5500rpm. The generator is available also as a separate unit or with other servomotors. Kearfott Co., Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

CIRCLE ED-81 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire-Wound Resistor

Values From 0.1-300,000 ohms



The Type 10 precision wire-wound, plastic molded resistor is the first of this firm's "H" group of hermetically sealed resistors. It has a conservative rating of 1/4w at ambient temperatures up to 125°C. Dimensions are 1/4″diam x 13/32″ long. It is supplied in resistances from 0.1 ohm to 300,000 ohms, at tolerances as close as 0.05%. Hycor Co., Inc., Dept. ED, 11423 Vanowen St., North Hollywood, Calif.

CIRCLE ED-82 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnet Wire

Insulated With Teflon

This line of magnet wire is recommended for high-temperature and high-frequency applications, especially where miniaturization is a design factor, or where solvents or chemicals are encountered. Available in a wide range of sizes, it is insulated with Teflon and has a low loss factor, low dielectric constant (2.0-2.05 from 60cy to 30,000Mc), and excellent dielectric strength. The insulation is nonflammable, completely inert to moisture and all known commercial solvents and chemicals.

The solid conductor may be either soft or annealed copper, on which the Teflon enamel is dip-coated. Sizes range from 14-50 AWG, in six colors. Every lot is tested for abrasion, scrape resistance, continuity, dielectric strength, and thermoplastic flow before shipping. Single, heavy, triple, or quad thicknesses are available. Hitemp Wires, Inc., Dept. ED, 26 Windsor Rd., Mineola, L. I., N. Y.

CIRCLE ED-84 ON READER-SERVICE CARD

Sleeves for Resistors

Fit Standard Sizes

Transparent protective sleeves for tubular carbon resistors are now being extruded from "Kel-F" plastic by this firm. The sleeves are nonflammable and non-carbonizing even at elevated temperatures. The plastic has high impact and compressive strength and resists abrasion and cracking indefinitely. They remain transparent even after long periods of service to permit easy identification of the resistor rating without removal of the sleeve.

The sleeves are non-porous, have zero water absorption, and have excellent resistance to aging and most chemicals and lubricants. Sizes currently being produced range from 1/8" to 3/8" ID, and to any length required. Tolerances are carefully maintained to assure correct fit over standard sizes of tubular resistors. The Garrison Co., Dept. ED, 1 Columbus Ave., Kenilworth, N. J.

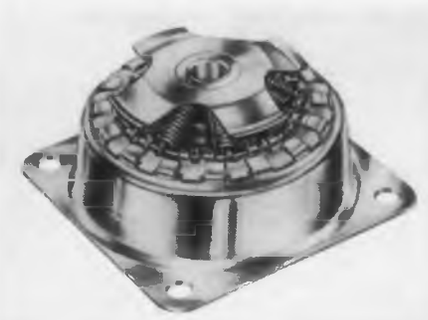
CIRCLE ED-85 ON READER-SERVICE CARD

CIRCLE ED-86 ON READER-SERVICE CARD ➤

New Products . . .

Vibration Isolators

Withstand 15G's Shock



"Equiflex" all-metal vibration isolators are designed to absorb vibrations both vertically and horizontally. They are offered in circular cup (illustrated) and square plate mountings, with both types available in three load ranges: up to 6 lb, 14 lb, and 35 lb. Performance is not affected by temperature extremes, and the mountings withstand 100hr salt spray tests. Shocks of 15G's can be sustained without damage, and equipment is kept captive up to 30G's. Ucinite Co., Dept. ED, Newtonville, Mass.

CIRCLE ED-90 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Pick-Up

Can Operate at 500°F

The Model 3010-HT Pick-Up is a small, low-cost, rugged, electrical impulse generating device that converts mechanical motion to electrical energy while operating at temperatures as high as 500°F. It generates usable voltages from 0-28v at frequencies up to 75,000cps.

The pick-up operates without physical contact or "loading" when mounted near any moving magnetic material and generates a voltage proportional to the rate of motion or speed of any metal object with magnetic properties. It may be actuated by the keyway in a shaft, the teeth of a gear, the spokes of a wheel, a slot in the rim of a wheel or shaft, a screwhead or pin on moving part, or by any vibration or displacement of magnetic material in its field. It is self-energized by means of a built-in permanent "Alnico V" magnet. "Teflon" insulation is used throughout.

The pick-up has many applications, including counting, serving as a tachometer (when used with a voltmeter), precision ignition timing, controlling electrical devices (when used with amplifiers and relays), providing synchronizing voltage for oscillographs, and marking angular or linear positions in measuring displacement. Impedance of the unit is 500 ohms at 1000cy. Resonant frequency is 50,000-60,000cy. Dimensions are 2″ x 3/4″ overall. Weight is 2oz. Electro Products Laboratories, Inc., Dept. ED. 4501 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE ED-92 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Q-Standard

Permits Precise Measurements

The Type 513-A Q-Standard provides an accurately known Q and reactance for precise measurements; it also offers a convenient means for checking overall Q-Meter performance.

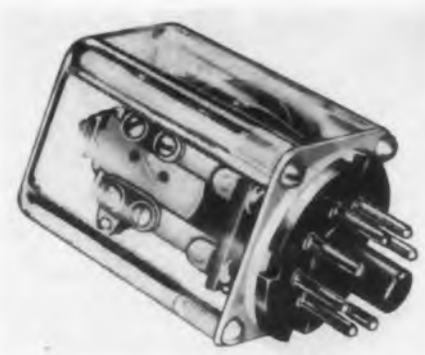
The unit has a special winding of Litz wire on a low-loss, stable steatite coil form which is mounted in a hermetically sealed copper shield can filled with dry helium. A convenient carrying and storage case is provided.

Nominal inductance (L) is 250μohms and is specified to +1%. Distributed capacitance (Cd), when mounted on either the Type 160-A or 260-A Q-Meter, is approximately 9.0mmfd and is specified to +2%. Each inductor will be individually calibrated to an accuracy of +3% in terms of effective Q (Qe) at frequencies of 0.5meg, 1.0meg and 1.5meg, and at a temperature of 22 C; nominal circuit Q (Qc) readings for the 160-A and 260-A will also be provided. Boonton Radio Corp., Dept. ED, Boonton, N. J.

CIRCLE ED-101 ON READER-SERVICE CARD FOR MORE INFORMATION

Plug-In Relay

For Photoelectric Circuits



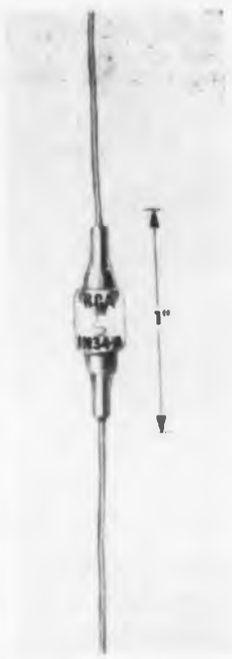
The "KCP" is a plate circuit, current actuated, plug-in relay enclosed in a clear polystyrene dust cover. It is intended for use in original equipment using photoelectric cell control or similar electronically operated circuitry. Contact rating is 2amp, 115v, a-c non-inductive load. Operating coil power is 125mw per movable pole, with a contact pressure of approximately 10 grams.

The relay is available in a variety of spst, spdt, dpst, and dpdt contact combinations, with 2500 ohm, 5000 ohm, and 10,000 ohm coils available for each combination type. Potter & Brumfield, Dept. ED, Princeton, Ind.

CIRCLE ED-102 ON READER-SERVICE CARD FOR MORE INFORMATION

Crystal Diodes

Geranium Point-Contact Type



Six types of crystal diodes, each of the germanium point-contact type and utilizing sealed-in-glass construction, are offered with identical dimensions.

RCA-1N34-A is a general-purpose type intended for low-power rectification in applications such as isolating, clipping, and switching circuits. RCA-1N38-A is a large-signal type especially useful in electronic computers and clamping circuits. RCA-1N54-A is a high-back-resistance type intended for use in clipping circuits, high-impedance high voltage probes, and d-c restorer circuits.

RCA-1N55-A is a large-signal type having a high peak inverse voltage rating; this type has the same uses as the 1N34-A, as well as d-c restorer circuits and high voltage probes.

The RCA-1N56-A is a high-conduction type featuring exceptionally low dynamic impedance; it is especially useful for limited service in frequency-modulation receivers. RCA-1N58-A is a similar to 1N55-A, but has a somewhat lower peak inverse voltage rating. Radio Corporation of America, Dept. ED, Harrison, N. J.

CIRCLE ED-107 ON READER-SERVICE CARD FOR MORE INFORMATION

Electrolytic Capacitor

For Transistor Applications

The "Silverlytic" is a sub-miniature electrolytic capacitor for hearing aids, miniaturized radios, personal page radios, and other transistor applications requiring high capacity in a small container at low voltage. It is available in type ALA in ratings of 0.1mfd, 0.2mfd, 0.3mfd, and 1.0mfd at 10v, d-c; 2.0mfd at 5v, d-c; and 4.0mfd at 4v, d-c.

Operating temperature range of the capacitor is −30° to +65°C. Maximum leakage current measured in laboratory tests was 2μamp after 5 minutes application of rated voltage. Size is 3/8" long x 7/32"diam. The capacitor may be mounted by its own leads, each of which is 1-1/2" long No. 26 bare, tinned copper. Capacitor Division, P. R. Mallory & Co., Inc., Dept. ED, 3029 W. Washington St., Indianapolis 6, Ind.

CIRCLE ED-108 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Resolver

Highly Accurate Computing Unit

The size 15 "Telesyn" Resolver continuously performs trigonometric operations involving resolution of input voltages into sine and cosine components. An extremely accurate computing unit of miniature size and lightweight, it is available in three models with transformation ratios of 1:1, 4:1, and 8:1, making it adaptable to numerous applications in analog computers, angle data transmission systems, automatic control systems, and similar equipment. It may also be used to perform such operations as synthesis of two voltages, and rotation of coordinates.

Rated at 1-24v, 400cy input, the resolver weighs only 5 oz and measures 1.6″ long x 1.4″diam. Ford Instrument Co., Division of The Sperry Corp., Dept. ED, 31-10 Thomson Ave., Long Island City 1, N. Y.

CIRCLE ED-111 ON READER-SERVICE CARD FOR MORE INFORMATION

Stabilized D-C Amplifier

Subminiature, Wide Range Unit

The Model 55A Subminiature-Stabilized D-C Amplifier is designed for telemetering or recording the outputs of thermocouples and d-c excited strain gages. Its frequency response is ±2% from d-c to 10kc. Gain is 1000. Noise is less than 25mv rms equivalent input signal at normal ambient temperatures. At an 85°C ambient temperature and 10G's vibration along the equipment's major axis, in the vicinity of 300cy, a maximum noise of 100mv is obtained.

Drift is an output zero offset which does not exceed ±25mv equivalent input signal. Nominal input range is 0 to ±mv. Output impedance is less than 50 ohms. An external power supply, non-critical as to regulation, is required.

The complete amplifier, including stabilizing components, weighs 10 oz. Including a 9-pin octal plug, overall dimensions are 5-1/8″ x 1-7/16″ x 1-7/8″. Electro-Mechanical Research, Inc., Dept. ED, P. O. Box 307, Ridgefield, Conn.

CIRCLE ED-112 ON READER-SERVICE CARD FOR MORE INFORMATION

Instrument Rectifiers

Completely Sealed in Plastic

This series of rectifiers is conservatively rated up to 6v a-c, 4.5v d-c, and 5ma d-c. A universal, all-purpose type has four plates, five leads. Two other have two plates, three leads, and one plate, two leads, respectively. The rectifiers are packaged individually, along with characteristic curves and installation instructions. They measure 7/16" x 1/4" x 5/8" and have two 7/64"diam mounting holes.

Built to rigid military standards, the rectifiers feature vacuum processed pellets with gold contacts. They are completely sealed in moisture and fungusrsistant plastic. The design also features minimum temperature errors.

Some additional uses of these instrument rectifiers are in wave clippers and slicers, frequency multipliers, for static drain, temperature compensators, temperature indicators, current regulators, computer diodes, and surge suppressors and varistors. Bradley Laboratories, Inc., Dept. ED, New Haven, Conn.

CIRCLE ED-115 ON READER-SERVICE CARD FOR MORE INFORMATION

Voltmeter Inverter

Has Two Independent Channels

The Model 214 Voltmeter Inverter extends the usefulness of conventional a-c vacuum tube voltmeters to d-c measurements. It can be used wherever small d-c voltages are measured, as with transistors, null detection, servomechinisms, temperature measurement, and photometery. Two independent channels facilitate ratio measurements.

For each channel the injected d-c signal is transformed into a symmetical a-c square wave by pericdic clamping and filtering. Gain controls are provided for each channel. The normal gain is less than unity.

Range is 100mv to 100v. D-c input resistance is approximately 0.5meg, and a-c output impedance is approximately 30,000 ohms max Power supply is 100-130v, 60cy, 5w. Dimensions are only 6" x 5" x 4". Weight is 3 lbs. Brunswick Instruments, Dept. ED, P. O. Box 813, New Brunswick, N. J.

CIRCLE ED-116 ON READER-SERVICE CARD FOR MORE INFORMATION

2 NEW ACHIEVEMENTS

in precise *wire-wound* trimmer potentiometers

Aerohm Micro-miniature Series AP ½

Series AP ½

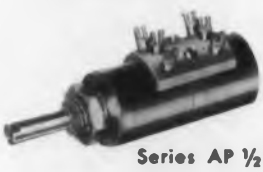
- Two watts continuous at 80 degrees C.
- Resistances from 10 ohms to 20,000 ohms.
- Diameter ½ inch, depth ½ inch.
- Temperature coefficient 0.00002 part per degree C.
- Weight ¼ ounce.
- Sealed well enough to permit potting.

Aerohm Series AP 1 ⅛

Series AP 1 ⅛

- Four watts continuous at 80 degrees C.
- Resistances from 10 ohms to 100,000 ohms.
- Diameter 1⅛ inch, depth ½ inch.
- Temperature coefficient 0.00002 part per degree C.
- Weight less than ¾ ounce.

Available also as ganged units.



Series AP ½-2

Series AP 1⅛-2

These new potentiometers embody many features that are usually found only in much more costly units. They are precision machined throughout, with bodies of anodized aluminum, line-reamed phosphor bronze bushings, centerless-ground stainless steel shafts, and gold-plated fork-type terminals. All electrical connections are soldered, except for precious metal sliders and slip rings. All units are fully sealed, and treated with Service-approved moisture-proofing and fungicidal materials.

In addition, *all Aerohm potentiometers are individually checked through a quality-control system that guarantees you full performance from every unit in your order.*

Write for full technical information and prices.

Aerohm CORPORATION

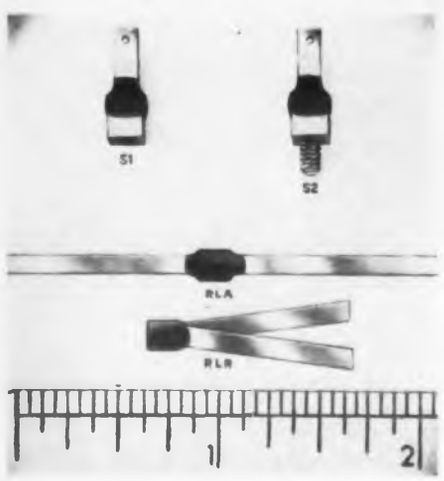
282 MOODY STREET, WALTHAM, MASSACHUSETTS

CIRCLE ED-117 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products . . .

Ceramic Capacitors

Subminiature, 2-10,000mmfd Units



This series of u-h-f subminiature ceramic capacitors is designed to reduce inherent series inductance to a minimum. They may be had in bodies ranging in dielectric constant from 16 to 6000, depending on the properties and capacitance required.

Style S1 is a standoff unit with 4-40 x 1/8″ female thread. Sizes are approximately 3/16″, 5/16″, or 7/16″ square x 9/16″ high. Capacitances range from 2mmfd to 10,000mmfd.

Style S2 is a standoff unit with male thread 4-40 x 3/16″. Size is approximately 3/16″ square x 9/16″ above chassis. Capacitances range from 2mmfd to 2000mmfd.

Style RLR and Style RLA with radial or axial lead ribbon leads have body sizes from 1/8″ to 3/8″ square. They range from 4mmfd to 7500mmfd. Mucon Corp., Dept. ED, 9 St. Francis St., Newark 5, N. J.

CIRCLE ED-119 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Capacitors

Rated for 35,000v Peak, 100amp

These vacuum capacitors are offered in five different capacitance values, each with the same overall dimensions: nominal 5-1/4″ length x 2-3/4″ diam. Capacitances are 250, 200, 150, 100, and 50mmfd. Each type is rated for 35,000v peak; 100amp rms.

The capacitors have wide circumference, low resistance contact provisions. Oxygen free, high conductivity copper is used for all internal active areas, as well as for external terminals. Mounting and contact are accomplished by the use of 2″ diam phosphor bronze rings supplied with the capacitors.

Temperature coefficient is extremely low. The exhaust tube seal of tip is not exposed. United Electronics Co., Dept. ED, 42 Spruce St., Newark 2, N. J.

CIRCLE ED-120 ON READER-SERVICE CARD FOR MORE INFORMATION

G-E Quick-Disconnect "AN" type Connectors

No Unscrewing

The General Electric M-8500 Series Quick-Disconnect Connector makes an electrical connection that can be separated quickly with *a simple, straight-line motion.*

How Connector Works

To connect, pull coupling ring back, engage plug with receptacle, release. Coupling ring springs forward to lock connection—no safety wiring required. **To disconnect,** simply pull on the knurled coupling ring.

Applications

Intended for use in all low tension connector applications, M-8500 Connectors are particularly suited to equipment which requires frequent removing, repairing or replacement. Also, since no tools or safety wiring is required, Quick-Disconnect Connectors are ideal for applications in cramped or normally inaccessible quarters.

Now Available

G-E Quick-Disconnect Connectors are currently available in both 12S and 18 shell sizes, in straight plug and through-wall mounting receptacle types, with standard "AN" insert arrangements. The line is being expanded to include additional mounting arrangements and shell sizes . . . 14S, 20, and 24 shell sizes will be available soon. Write us concerning your applications and Quick-Disconnect Connector requirements.

New "AN" Connector Guide Offered

Mail coupon below for complete information, including shell styles and insert arrangements, on all "AN" Connectors in the General Electric line.

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Wiring Device Department N-1
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Please send me the new *General Electric "AN" Connector Guide and Selection Table.*

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Magnetic D-C Amplifier

Produces 0 to 5v for Telemetering

Model MM-421 is a low level, magnetic d-c amplifier which permits drift-free amplification of d-c signals in the millivolt range. It is primarily intended for amplification of signals from resistance type transducers such as strain gauges, resistance thermometers, chemical pick-ups, and current measuring shunts; it also amplifies signals from self-generating devices such as thermocouples and photocells.

The unit requires a supply of 6.3v, 0.001amp, 400cy. No bias supply is required. It has a d-c voltage gain in excess of 1500. A d-c input signal of less than 3mv produces an output signal of 5v d-c. Output voltage ripple is less than 25mv. Change of gain is less than 1% from −20° to +80°C. Linearity is better than 2%. Bandwidth is up to 5cy. Smallest detectable signal power is 10^{-12}w. Hermetically sealed in thermosetting plastic, the amplifier is housed in a GP-3 deep drawn steel can with an 8-pin phenolic header. Weight is less than 7 oz. Magnetic Research Corp., Dept. EW, 318 Kansas St., El Segundo, Calif.

CIRCLE ED-123 ON READER-SERVICE CARD FOR MORE INFORMATION

Electric Motor

Provides High Starting Torque

This small motor provides low speed, high starting torque, of value in such applications as aircraft actuators, remote-controlled rheostats and power switches, and indexing devices of all types.

Present models operate on 115v a-c, but the motor can be provided with different coils for other operating voltages. It operates efficiently over a wide range of frequencies, as well as pulsating d-c. It combines the feature of a starting torque equal to running torque, with instantaneous stopping when power is turned off.

Motors are available delivering over 6 in-lbs of torque at 30rpm, and operating satisfactorily over a −60° to +500°F temperature range. The Viking Tool & Machine Corp., Dept. ED, 2 Main St., Belleville 9, N. J.

CIRCLE ED-124 ON READER-SERVICE CARD FOR MORE INFORMATION

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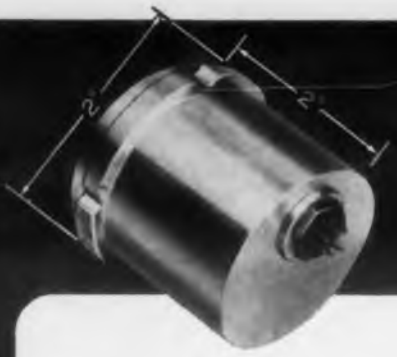


RATE GYRO

Type No. 15814-1-A

MOTOR: 26 volts, 400 cps, 3 phase with rated speed of 22,000 rpm and a rotor moment of inertia of 175 gram-cm².

PICKOFF: 26 volts, 400 cps, single phase with "E" type variable coupling. With resistive load of 10,000 ohms, tuned output is 6 to 7 volts at maximum rate. Null is 30 millivolts with an armature travel of 2½° to 3° either side of null.

DAMPING: Accomplished by fluid flotation of gimbal. Damping factor is 0.5 to 0.7 of critical, but values up to and including 1.0 of critical can be provided.

NATURAL FREQUENCY: 50-55 cps (undamped).

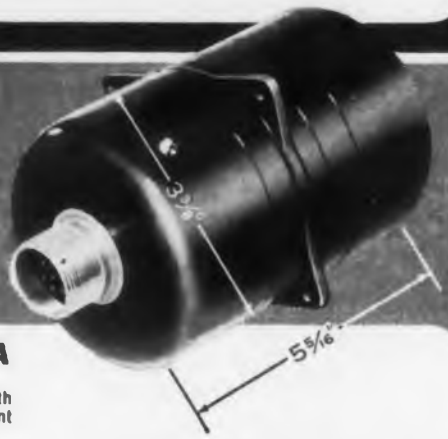
WARM-UP TIME: One minute.

RANGE: Maximum rate is 450 ± 20°/ second. Minimum detectable rate is less than 1.5°/ second. Other maximums and minimums are available.

ENVIRONMENTAL CHARACTERISTICS: —20°F. to 140°F. temperature operating range. Maximum shock is 60 g. Vibration operating range of 5 g. from 20 to 300 cps. Positive hermetic seal.

WEIGHT: 13.5 ounces complete with mounting bracket and electrical connector.

FREE GYRO



Type No. 14108-1-A

MOTOR: 26 volts, 400 cps, 3 phase with rated speed of 22,000 rpm and a rotor moment of inertia of 1260 gram-cm².

DRIFT RATE: Will not exceed 1° per minute when subjected to Scorsby test at amplitude of ± 15° and rate of approximately 6 cpm (corrected for earth's rotation).

PICKOFF: Autosyn* type with peak value of 20 volts. Initial slope of output voltage curve about null position is 0.35 volts per degree ± ten per cent. Phase shift is less than 20 degrees. Residual voltage is less than 50 mv.

WARM-UP TIME: Within two minutes.

OPERATING LIFE: Rated at 500 hours.

ENVIRONMENTAL CHARACTERISTICS: Maximum operating temperature of 195°F. and a minimum of —20°F. Maximum allowable shock is 60 g. with maximum operating vibration of 7 g. (from 10 to 500 cps). Maximum excursion not to exceed 0.5 inches. Positive hermetic seal.

WEIGHT: Approximately 4.2 lbs.

CAGING AND UNCAGING: Can be caged remotely by applying 26 volts, 400 cps, single phase and 28 volts DC power. Will cage from any position of gimbals within 30 seconds with gyro rotor at full speed. Application of 28 volts DC will uncage within 0.1 seconds.

*REGISTERED TRADE-MARK BENDIX AVIATION CORPORATION.

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West Coast Office: 117 E. Providencia, Burbank, Calif.
Export Sales: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

CIRCLE ED-126 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature . . .

Panel Instruments 127

Two 2-page color bulletins provide technical data on 1-1/2″ round (Model 120) and 1-1/2″ square (Model 112) panel instruments. Included are illustrations, schematic drawings, general specifications, tables of standard ranges, etc. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

TV Calculator 128

The "TV Calculator" contains a scale for instant conversion of decibels to voltage gains, charts and diagrams describing various strengths of attenuator pads, a convenient channel-megacycle scale, and a table to compute TV transmission line losses. Blonder-Tongue Laboratories, Inc., 526-536 North Ave., Westfield, N. J.

Transistors 130

Four specification sheets cover four types of N-P-N Grown Junction Transistors: a super Alpha type, a high collector resistance type, a medium Alpha type, and a general-purpose type. Also available is a data sheet with curves on variation of collector current cutoff with temperature, and rise and fall time measurements. Federated Semi-Conductor Co., 66 Dey St., New York 7, N. Y.

Coils, Toroids, Filters 131

This 12-page, 2-color catalog (No. 101-A) presents detailed information on toroids, high quality coils, and various audio filter networks. It includes complete descriptions, attenuation and Q curves, etc. Burnell & Co., Yonkers 2, N. Y.

Socket Screw Products 132

A 4-page, 2-color folder describes the company's "Unbrako" socket screw products, including socket head cap screws, self-locking socket set screws, shoulder screws, flat head socket cap screws, and button head socket screws. Also included are descriptions of socket screw keys, square head set screws, and pressure plugs and dowel pins. Each item is illustrated. Standard Pressed Steel Co., Box 935, Jenkintown, Pa.

Microwave Nomograms 133

A 20-page booklet of waveguide engineering data and curves, "Microwave Nomograms and Charts", represents practical techniques and approaches developed over the years by this firm in designing and using waveguide components such as mixers, duplexers, flexible and rigid waveguides, directional couplers, and allied accessories. The charts should be of value in the handling a wide variety of microwave problems. Airtron, Inc., Dept. H, Linden, N. J.

Electronic Components 135

A 56-page, 2-color catalog (RC-9) describes, illustrates, and provides specifications and dimension drawings for a wide variety of standard components. It covers fixed and variable composition resistors, line switches, slide switches, powdered iron cores, "Ceramag" ferromagnetic cores, and molded coil forms. Tables of general information, such as wire sizes, weights of materials, and temperature conversion, are included. Electronic Components Division, Stackpole Carbon Co., St. Marys, Pa.

Symbol Stamps 136

Transparent "Symb-O-Stamps" are described and illustrated in a 4-page bulletin (B-124). The stamps bear electrical and electronic symbols and serve as a valuable aid in reducing drafting time. Being transparent, they permit accurate registration. There are 124 typical symbol imprints contained in the bulletin. John Griffin Co., Dept. H, 2157 James Ave., St. Paul 5, Minn.

Relay contacts last longer when protected by

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New Westinghouse Capacitor Control uses two EDISON Time Delay Relays to prolong the life of the auxiliary switching relay.

THIS NEW Westinghouse Capacitor Control senses the need of a utility power system for reactive kilovolt amperes and energizes circuits to connect the capacitor bank to the bus. The reverse function is performed when the capacitor bank is no longer required.

THE FUNCTION of the Edison Time Delay Relay is to hold off energization of the auxiliary relay until the change in the system is of a permanent nature. Any intermittent operation of the sensing relay is ignored until enough accumulated energy is stored in the bimetal of the time delay relay to close its contacts.

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CIRCLE ED-137 ON READER-SERVICE CARD FOR MORE INFORMATION

Here's your authoritative guide to Button Mica Capacitors

THIS NEW BUTTON MICA CAPACITOR CATALOG gives you full information on Sangamo Button Micas — *the most complete line in the industry*

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CIRCLE ED-138 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature . . .

Power Supplies 139

This 4-page bulletin gives complete details on "Absolute D-C Power Supplies", with 0.01% stability. Specifications for a variety of models, illustrations, data on operating principles, and prices are included. Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diego 10, Calif.

Automatic Controls 140

This 64-page catalog (700B) is divided into sections on controls for industrial applications, magnetic and motorized valves, and controls for domestic applications. All automatic controls are mercury switch equipped. The catalog includes a wide variety of pressure controls, temperature controls, liquid level controls, transformer-relays, mercury switches, a full line of valves, and numerous other types of equipment. Hundreds of items are covered. The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.

Electronic Components 142

This 300-page handbook, "Ideas-Techniques-Designs", is packed with descriptions of new standard components for unitizing electronic equipment. It provides many data, plus planning sheets on plug-in packages and basic chasses. It is divided into sections on: components for plug-in construction; plugs and connectors; miniature plugs and sockets; cathode tube and tuning eye sockets; dial lights and sockets; tube cap connectors; components for test equipment; quality electrical components; components for government specifications; Alden services; computer components; and production aids and machinery. Alden Products Co., Dept. HB, Brockton, Mass.

Key Switches 143

Illustrated with many photographs and diagrams, this 32-page catalog contains specifications and general data on key switches, impulsing devices, switchboard lamps, jacks and caps, and other control devices. Specification tables are designed for easy ordering. Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.

Tube Characteristics 144

This 166-page book is the 19th edition of the "Tung-Sol Tube Characteristics Manual". The first 166 pages contain all the technical data on receiving and cathode ray tubes required by engineers. A special 20-page section contains basic marketing information. The manual is available at 75¢, directly from Tung-Sol Electric Co., 95 8th Ave., Newark 4, N. J.

Microwave, TV Equipment 145

A 44-page catalog (No. 530) covers this firm's latest developments in microwave and TV instrumentation. The first section deals with microwave test equipment covering frequencies from 10Mc to 31,000Mc; it includes signal sources and generators, spectrum analyzers, microwave receivers, and wide band video amplifiers. The second section covers TV equipment for the laboratory, manufacturer, and studio; it includes synchronizing generators, picture monitors, transmitters, and a complete line of regulated power supplies. Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.

Cord Sets 147

Bulletin CS-1, a 12-page "Design Guide for Custom-Built Cord Sets", illustrates standard molded parts available, including male plugs, female connectors, strain reliefs, junction boxes, and the types of flexible cord on which they can be molded by this company. Cord sets can be sketched by the customer by tracing the illustrated components without the necessity for having a blueprint made. Whitney Blake Co., New Haven 14, Conn.

Carbon Specialties 148

A 44-page, 2-color catalog (40A) describes standard and special carbon and graphite components and materials for chemical, electrical, and mechanical applications. Designed more as a guide to the many uses of carbon and graphite than as a restrictive listing of standard products, the catalog contains considerable engineering information on the physical and electrical properties of these materials as compared to metals and other refractory materials. Stackpole Carbon Co., St. Marys, Pa.

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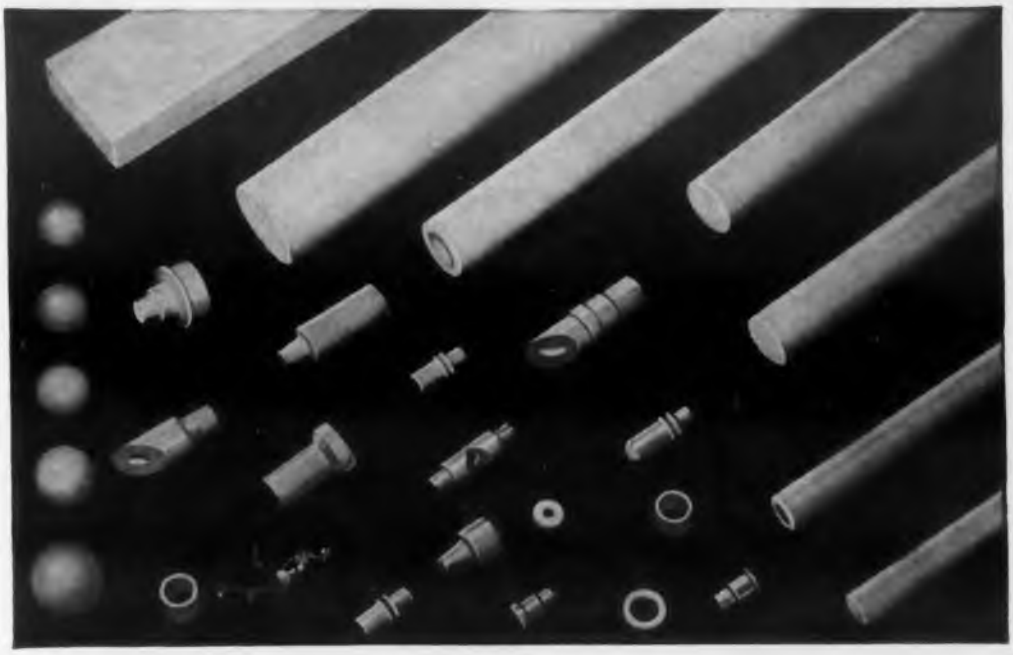

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CIRCLE ED-149 ON READER-SERVICE CARD FOR MORE INFORMATION

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they're Sealed-in-Steel they're True-to-Ratings

H-TYPE. Steel base cover is deep-seal soldered into case. Terminals hermetically sealed. Stud-mounted unit. Meets all MIL-T-27 specs.

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CIRCLE ED-150 ON READER-SERVICE CARD FOR MORE INFORMATION

Patents . . . By John Montstream

Ultrahigh-Frequency Generator . . . *Patent No. 2,653,272. Simon Ramo, Schenectady, N. Y. (Assigned to General Electric Co.).*

Oscillators for generating extremely short waves of the order of one or two millimeters customarily use as a resonator a closed chamber with holes for the passage of electrons. The principal problem with generators of this kind is that they require about as much current to excite a resonator to generate waves of one millimeter length as for those of one centimeter. With the usual type of resonator, this current is too great for the space allowed for passage of the required current to excite the resonator.

The generator shown in Fig. 1. has a cathode *(1)*, cathode heater *(2)*, focusing grid *(3)* at a negative potential, a multiple resonator structure *(5, 6,* and *7)*, and reflector collector *(4)* which be negative with respect to the cathode as well as to the resonator. It is the construction of the multiple resonator which is unique in that it comprises layers of fine parallel wires *5* and *6*. These are separated by transverse parallel wires *7*, which also short circuit the parallel wires so that each pair of parallel wires *5* and *6* between wires *7* forms a single half wave length open wire line resonator. The wires *5* and *6* provide a nearly rectangular cross section wave guide resonator and the transverse wires *7* form the sides of the guide. The transverse wires are spaced apart a multiple of,

or an integer number times a half wave length, at the desired operating frequency of the oscillator.

The electron beam from the cathode established by the potential on the resonator structure passes on both sides of each resonator. Because the wires are closely spaced, a more effective coupling is secured with the individual resonators. The electrons pass through parallel wires *5* and *6* and excite the individual resonators to set them into oscillation and establish across each gap of the wires *5* and *6* an alternating high frequency potential. The electrons then proceed into the region of the field of the reflector collector *4*, are reversed by the negative potential there, and reenter the resonator structure to deliver additional energy to the resonator.

The advantages of the generator include greater utilization of the space between the cathode and collector electrode for the space charge whereby larger currents of extremely short wave lengths are generated. The particular arrangement of the resonator eliminates the generation of oscillations having a wave length longer than the distance between the short circuiting transverse wires *7*. The multiple resonators also are simply joined by the wires *7*, which function as connectors and as short circuits for lower frequencies.

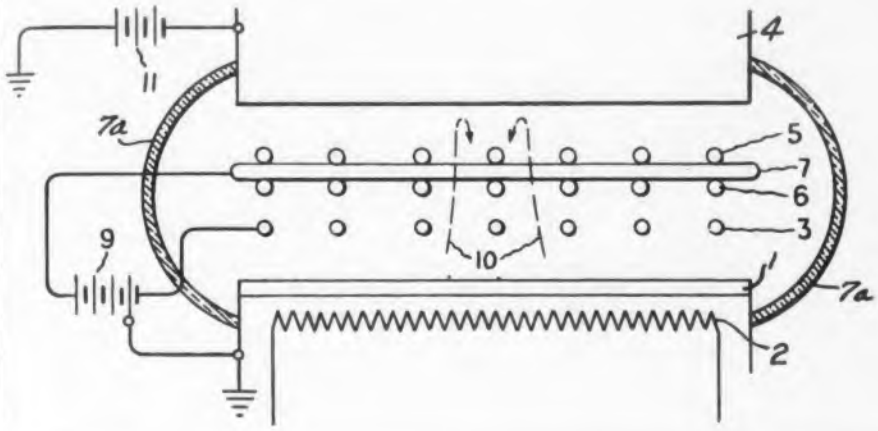

Fig. 1. Schematic diagram of an ultrahigh frequency oscillator which can generate millimeter waves.

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Do audio attenuator problems cost you money? Chances are Shallcross has a model to match your specifications exactly—and at moderate cost.

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A complete description of all Shallcross attenuators — mountings, characteristics, and circuits is yours for the asking in Bulletin L-4A. SHALLCROSS MFG. CO., 526 Pusey Avenue, Collingdale, Penna.

QUICK DELIVERIES! Small quantities of popular 20 step Shallcross composition resistor potentiometers and wire-wound ladders without detents are immediately available.

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CIRCLE ED-153 ON READER-SERVICE CARD FOR MORE INFORMATION

(Advertisement)

Heavy Duty Industrial Triode, ML-5668

Obsoletes Type-892 Tube in Industrial Service

Machlett Laboratories offers the designer and equipment user a heavy duty industrial replacement for the broadcast type-892. Incorporating the most advanced design features and construction techniques, the Machlett ML-5668 provides: 20kW plate dissipation rating which is equivalent to normal input in radio frequency heating service; sturdy terminals sealed to glass with Kovar metal giving 10 times torsional and 5 times bending strength of typical copper feather-edge seal; self-supporting, stress-free filament; half-inch thick copper anode which practically eliminates hot spotting and permits, with Machlett automatic seal water jacket, one-half the water-flow required for type-892 for equivalent anode dissipation. Extended oscillation at plate voltage and power considerably beyond ratings in industrial equipments contributes to stable and trouble-free service.

Conversion to ML-5668 involves only two minor equipment modifications: 1) enlargement of mounting holes to accommodate Machlett water jacket; 2) installation of mounting clamp to hold jacket. On dual tube installations conversion may be made one tube at a time, as the ML-5668 and type-892 run side by side.

Machlett Laboratories, Inc., 1063 Hope Street, Springdale, Connecticut

CIRCLE ED-155 ON READER-SERVICE CARD FOR MORE INFORMATION

Patents . . .

Germanium Photocell . . . *Patent No. 2,644,852. William C. Dunlap, Jr., Schenectady, N. Y. (Assigned to General Electric Co.).*

Germanium has been used as the photoelectric sensitive element of photocells. The photocells comprise two types, a point contact element and a p-n junction type element. The point contact type makes use of the photoelectric effect secured between a point engaging the germanium, but the area of contact is so small that the photoelectric effect is minute. The p-n junction type of photocell uses germanium having a region of p type, an adjacent region of n type, and the joining layer forms the p-n junction exhibiting the photoelectric effect.

Since germanium has low transparency to light, particularly to visible light and ultra violet rays, it has been customary to direct the light upon an edge of the p-n junction. Although the p-n junction type photocell provides a much greater photosensitive area than that provided by a point contact photocell, there is a substantial area of the p-n junction which does not contribute to the photoelectric effect.

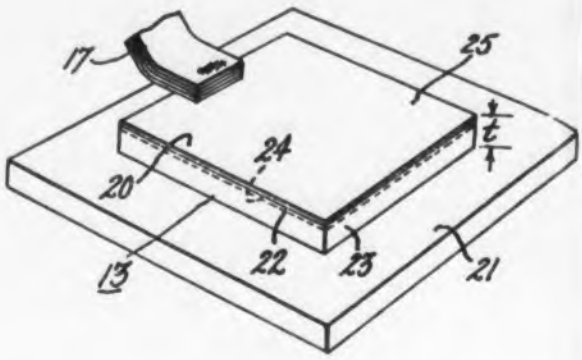


Fig. 2. Diagram of the germanium photocell.

The photocell of the patent provides a p-n junction type of cell which utilizes all or most of the junction area and hence has a much greater active photosensitive area. The cell is also responsive to light throughout the infra red, visible, and ultra violet spectrums even though the light must pass through a portion of the germanium. The photocell can also be constructed so that it

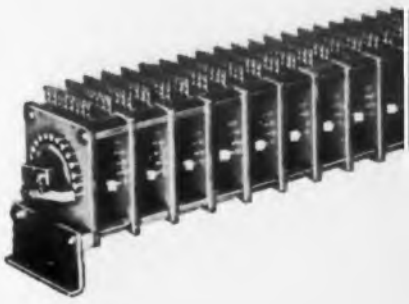
responds to a narrower band of light.

While several forms of the new p-n junction type photocell are described, the basic concept is shown in the Fig. 2. A germanium wafer *(25)* having a thickness no greater than 0.050" and preferably no less than 0.005" has a polished, etched surface upon which an impurity film *(20)* is deposited by evaporation or sputtering. The film thickness should not be greater than 4000 angstroms and best results are secured if it is only 1000 angstroms. The type of impurity deposited depends upon the conduction characteristics of the germanium; if the wafer is extremely pure or impurity balanced "intrinsic germanium", the film may be of either type.

The wafer with its deposited film is heated for about one half hour, to secure diffusion of the impurity into the germanium to a depth preferably less than 0.001" and not extending through the entire thickness of the wafer. The boundary *(22)* of the diffused impurity penetration forms the p-n junction. The temperature to which the wafer is heated for diffusion of the impurities into the germanium depends upon the impurity used. The wafer is soldered to a conduction plug, not shown, to which one electrode is connected and another electrode *(17)* is electrically connected with the light receiving surface.

It is desirable that the other face of the germanium be in conductive relation with an impurity element of opposite sign to the film such as a plate *(21)*. If the germanium is "intrinsic germanium", an impurity film of one type is formed on the surface of the wafer and diffused as described above, it is esential that an impurity element of an opposite sign, such as plate *21*, be brought into contact with the opposite surface of the wafer.

The photocell has the light directed vertically on the surface of the wafer upon which the film has been deposited so that a large area of the junction is exposed to the light. The p-n junction lies very close to the light exposed surface and very little, if any, of the film remains on the surface so that the junction receives the full light spectrum. By constructing the wafer so that the light passes through a selected thickness of germanium to impinge upon the p-n junction, the width of the band of light to which the cell is sensitive may be selected.



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C1A	Make before break	31	1	1¾"
C2B	Break before make	15	1	1¾"
D1A	Make before break	47	1	2¼"
D7A	Make before break	14	4	2¼"
D8B	Break before make	7	4	2¼"
D9A	Make before break	9	5	2¼"
E3A	Make before break	47	2	2¾"
E8B	Make before break	12	4	2¾"
E11A	Make before break	15	6	2¾"
F1A	Make before break	60	1	3"

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Books...

Speech and Hearing in Communication . . . *By Harvey Fletcher. Second edition, 461 pages. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. $9.75.*

Thoroughly revised and extensively rewritten, this new edition of this classical work brings every phase of the technical aspects of speech and hearing up to date. It contains a wealth of useful information for those designers concerned with communicating systems involving speech and hearing.

The first five chapters deal with speech and include such topics as the speech sounds of English, the speaking mechanism, characteristics of speech waves, acoustical speech powers, and frequency of occurrence of the different speech sounds. Chapter 6 deals with noise, describes methods of representing noises, and gives typical levels encountered in communication.

Chapters 7 through 14 cover the various aspects of hearing, including the mechanism of hearing, hearing acuity, minimum perceptible changes in frequency and sound pressure level, masking effects, loudness, binaural hearing effects, auditory perspective, and the space-time pattern theory of hearing.

The next four chapters summarize about 30 years of work done with the Bell Telephone Laboratories by various groups on the perception of speech sounds by listeners having normal hearing. This information is presented in the form of a method of calculating the articulation score expected by any talker-listener pair, using any kind of system, which may be immersed in any kind of noise. In Chapter 19, this is extended to the case of deafened listeners. Here is shown what the fundamental criteria must be for designing a hearing aid to be used by a deafened person having any kind and degree of deafness.

The last chapter is concerned with compensation cases due to injured hearing. A simple method for computing the percent hearing loss in compensation cases is presented.

Transistors and Their Applications in Television-Radio-Electronics . . . *By Louis E. Garner Jr. Paper bound, approximately 100 pages. Published by Coyne Electrical School, distributed by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 5, Ind. $1.50.*

This book is designed to provide technicians, servicemen, and experimenters with a practical explanation of transistors in simple, nonmathematical terms.

A brief history of transistor development is pre-

sented first, followed by a nonmathematical explanation of how transistors work and a description of the basic types of transistors. This is followed by a discussion of transistor characteristics, amplifier circuits, oscillator circuits, and special circuits such as d-c amplifiers, r-f detectors, clippers, phase inverters, push-pull circuits, and multivibrators.

The latter part of the book covers transistor components, servicing transistorized equipment, and practical circuits; and a list of several commercially available transistors.

Instrument Engineering, Vol. 2 . . . *By C. S. Draper, W. McKay, and S. Lees, 827 pages, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. $15.00.*

This is the second volume of a three-volume work intended to provide a comprehensive background of theory for the teaching and practice of measurement and control. Vol. 1 (reviewed in the Feb. '53 issue on page 22) deals with the descriptions of physical situations by means of mathematical and graphical forms. The present volume which is sub-titled "Methods for Associating Mathematical Solutions with Common Forms", is a comprehensive source of information on effective methods and techniques for solving the integro-differential equations that commonly appear in descriptions of the behavior of physical systems with "lumped coefficients". The third volume, is yet to be published.

In Volume 2, the information is presented in a way that makes a maximum of useful knowledge easily available to practicing engineers who may not wish to review mathematical theory in order to carry out detailed derivations. Typical results are developed with enough detail to save much routine effort for readers, and each example shows the general procedures for finding solutions of typical equations.

The book begins with a discussion of the generalized integro-differential equation and the procedure for reducing it to a specified standard nondimensional form. Three generalized procedures for solving the basic equation are then presented: the classical method; operational methods; and the relating function, the weighting function, and the transfer function. These are followed by detailed solutions for first-order and second-order equations. Equations and nondimensional curve families for a number of forcing functions and initial conditions are included to illustrate typical results and to provide quantitative information for engineering uses.

Discussions of stability for higher order equations are followed by descriptions of several techniques for handling higher order equations of arbitrary order. The book ends with the development of procedures for handling the basic equation when nonlinear terms are present.

Advertising Index

January 1954

Inquiry No.	Advertiser	Page
50	General Radio Company Agency: K. E. Morang Company	32
17	Giannini, G. M., & Co., Inc. Agency: Western Advertising Agency, Inc.	25
32	Green Instrument Co., Inc. Agency: Tippett, Jackson & Nolan, Inc	29
93	Gries Reproducer Corp. Agency: Harold Marshall Advertising Company, Inc.	41
105	Hart Mfg. Company, The Agency: Wilson, Haight, Welch & Grover, Inc.	43
97	Haydon, The, A. W., Company, Inc. Agency: Cory Snow, Inc.	41
94	Helipot Corporation Agency: Darwin H. Clark Co.	41
163	Hermetic Seal Products Co. Agency: Art-Copy Advertising Agency	59
7	Hughes Aircraft Company Agency: Foote, Cone & Belding	10
	Hughes Research & Development Laboratories Agency: Foote, Cone & Belding	22
33	Industrial Test Equipment Co. Agency: Mac Berman	29
	International Business Machines Agency: Cecil & Presbrey, Inc.	48
99	Joyal Products, Inc. Agency: Art-Copy Advertising Agency	42
29	Kester Solder Company Agency: Paul J. Steffen Co.	28
69	Kulka Electric Mfg. Co., Inc. Agency: L. D. Blehart Company	36
155	Machlett Laboratories, Inc. Agency: E. Scott Brown Advertising	54
159	Mallory, P. R., & Co., Inc. Agency: The Aitkin-Kynett Co.	56
109	Metron Instrument Company Agency: Wayne Welch, Inc.	43
151	NRK Mfg. & Engineering Co. Agency: Kreicker & Meloan, Inc.	52
98	New Hermes Engraving Machine Corp. Agency: Lester Harrison, Inc.	41
65	PM Industries, Inc. Agency: Moore & Company, Inc.	35
49	Phalo Plastics Corporation Agency: George T. Metcalf Co.	32
62	Pike, E. W., & Company Agency: The Franklin Fader Company	35
88	Plastic Capacitors, Inc. Agency: Sander Rodkin Advertising	40
2	Potter Instrument Company, Inc. Agency: J. B. Roberts, Inc.	3
164	Radio Corporation of America Agency: J. Walter Thompson Company	60
12	Radio Corporation of America Agency: Al Paul Lefton Company, Inc.	20
8	Raytheon Manufacturing Company Agency: Walter B. Snow and Staff, Inc.	11
146	Refrigeration Systems, Inc., Hudson Bay Div. Agency: Julian Frank & Associates	51
59	Resinite Corporation, Div. of Precision Paper Tube Agency: Symonds, MacKenzie & Company, Inc.	34
104	Rotron Manufacturing Company, Inc. Agency: G. B. Woodin Co.	42
138	Sangamo Electric Company Agency: Arthur R. Mogge, Inc.	50
80	Servomechanisms, Inc. Agency: Sanger-Funnell, Inc.	38
57	Shakeproof Div. of Illinois Tool Works Agency: Waldie & Briggs, Inc.	34
153	Shallcross Manufacturing Co. Agency: The Harry P. Bridge Company	53
	Sigma Instruments, Inc. Agency: Meissner & Culver, Inc.	44
60	Speer Carbon Company, Jeffers Electronics Div. Agency: Hazard Advertising Company	34
77	Star Stainless Screw Co. Agency: Harold Marshall Advertising Co., Inc.	37
10	Sterling Engineering Co. Agency: Fletcher D. Richards, Inc.	18
25	Sylvania Electric Products, Inc., Tungsten & Chemical Div. Agency: Cecil & Presbrey, Inc.	27
6	Sylvania Electric Products, Inc., Parts Div. Agency: Cecil & Presbrey, Inc.	9
154	Tensolite Insulated Wire Company Agency: George Homer Martin Associates	54
100	Tobe Deutschmann Corp. Agency: Engineered Advertising	42
72	Uniform Tubes, Inc. Agency: Benham Advertising	36
73	United Catalog Publishers, Inc. Agency: Burton Browne Advertising	36
37	United Electronics Agency: Lewin, Williams & Saylor, Inc.	30
96	Vector Electronic Co.	41
74	Ward Leonard Electric Co. Agency: James Thomas Chirurg Company	37
113	Waters Manufacturing, Inc. Agency: Engineered Advertising	44
114	Waters Manufacturing, Inc. Agency: Engineered Advertising	45
71	Weckesser Company	36
134	Western Gold & Platinum Works Agency: Norton M. Jacobs	49
162	Westinghouse Electric Corp., Electronic Tube Div. Agency: Fuller & Smith & Ross, Inc.	58

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