RADIO-ELECTRONIC *Engineering* SECTION

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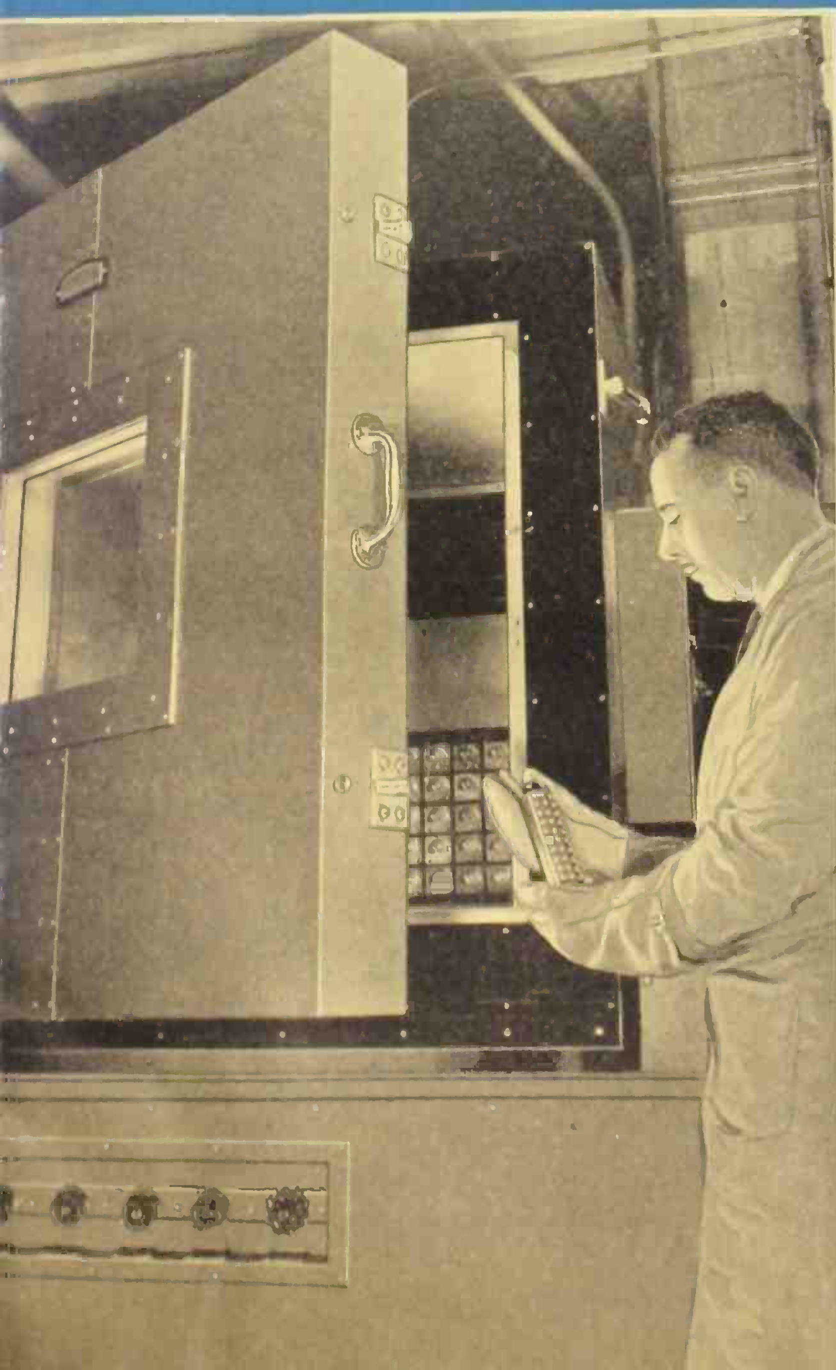


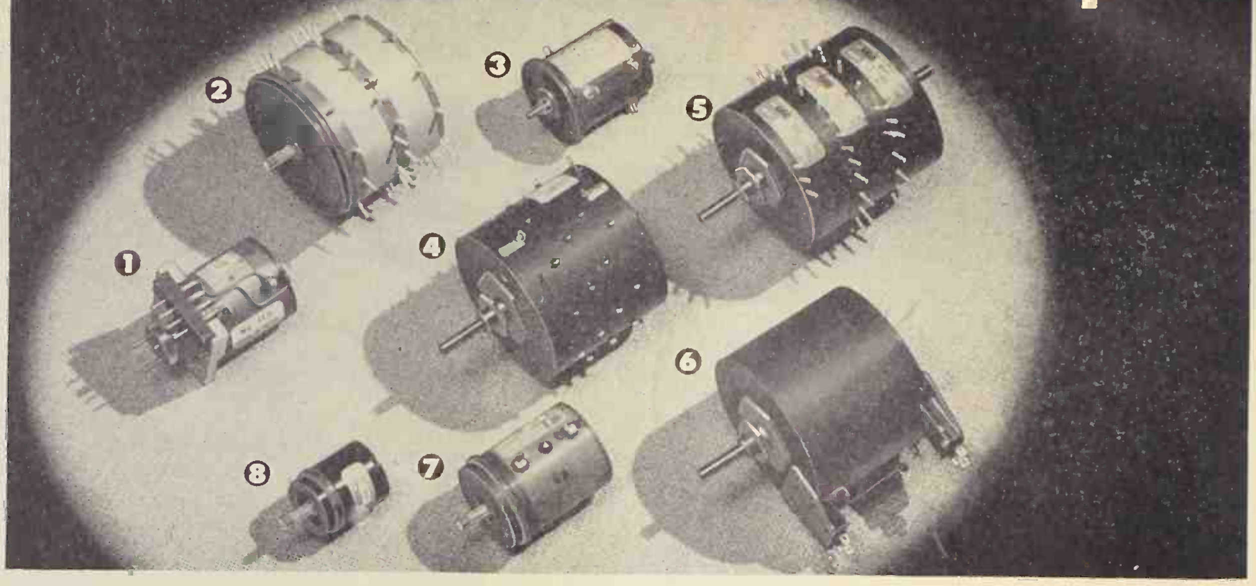
SEPTEMBER, 1951

DEPARTMENTS

RADIO-ELECTRONIC ENGINEERING is published each month as a special section in a limited number of copies of RADIO & TELEVISION NEWS, by the Ziff-Davis Publishing Company, 185 N. Wabash Avenue, Chicago 1, Illinois.

A bank of 1½" aircraft panel meters and a precision potentiometer are being checked in a Browser climatic test cabinet by a test engineer at DeJur Amsco Corporation. These instruments undergo rigorous tests over a wide range of temperature and humidity cycles.

Typical of the TOUGH POTENTIOMETER JOBS solved by Helipot



Precise Accuracy + Maximum Versatility + Space-saving Compactness

The potentiometers illustrated above are typical examples of the tough problems HELIPOT engineers are solving every day for modern electronic applications. If you have a problem calling for utmost precision in the design, construction and operation of potentiometer units—coupled with minimum space requirements and maximum adaptability to installation and operating limitations—bring your problems to HELIPOT. Here you will find advanced "know-how," coupled with manufacturing facilities unequaled in the industry!

The HELIPOTS above—now in production for various military and industrial applications—include the following unique features . . .

❶ This 10-turn HELIPOT combines highest electrical accuracies with extremes in mechanical precision. It features zero electrical and mechanical blacklash...a precision-supported shaft running on ball bearings at each end of the housing for low torque and long life . . . materials selected for greatest possible stability under aging and temperature extremes . . . special mounting and coupling for "plug-in" convenience . . . mechanical and electrical rotation held to a tolerance of ½° . . . resistance and linearity accuracies, ±1% and ±0.025%, or better, respectively.

❷ *This four-gang assembly of Model F single-turn potentiometers has a special machined aluminum front end for servo-type panel mounting, with shaft supported by precision ball bearings and having a splined and threaded front extension. Each of the four resistance elements contains 10 equi-spaced tap connections with terminals, and all parts are machined for greatest possible stability and accuracy.*

❸ This standard Model A, 10-turn HELIPOT has been modified to incorporate ball bearings on the shaft and a special flange (or ring-type) mounting surface in place of the customary threaded bushing. This HELIPOT also contains additional taps and terminals at the ¼- and 9¾-turn positions.

❹ *This standard Model B, 15-turn* HELIPOT *has a total of 40 special tap connections which are located in accordance with a schedule of positions required by the user to permit external resistance padding which changes the normally-linear resistance vs. rotation curve to one having predetermined non-linear characteristics. All taps are permanently spot-welded and short out only one or two turns on the resistance element—a unique* HELIPOT *feature!*

❺ This six-gang assembly of standard Model F single-turn potentiometers has the customary threaded bushing mountings, and has shaft extensions at each end. The two center potentiometers each have 19 equi-spaced, spot-welded tap connections brought out to terminals. *Each tap shorts only two turns of .009" diameter wire on the resistance element.*

❻ *This Model B, 15-turn* HELIPOT *has been modified to incorporate, at the extreme ends of mechanical and electrical rotation, switches which control circuits entirely separate from the* HELIPOT *coil or its slider contact.*

❼ This 10-turn HELIPOT has many design features similar to those described for unit No. 1, plus the following additional features . . . a servo-type front end mounting . . . splined and threaded shaft extension . . . and a center tap on the coil. All components are machined to the highest accuracy, with concentricities and alignments held in some places to a few *ten-thousandths* of an inch to conform to the precision of the mechanical systems in which this HELIPOT is used. *Linearity accuracies frequently run as high as ±0.010%!*

❽ *This single-turn Model G Potentiometer has been modified to incorporate a ball bearing shaft and a servo-type front end mounting. Special attention is given to contact designs and pressures to insure that starting torque does not exceed 0.2 inch-ounces under all conditions of temperature.*

The above precision potentiometers are only typical of the hundreds of specialized designs which have been developed and produced by HELIPOT to meet rigid customer specifications. *For the utmost in accuracy, dependability and adaptability, bring your potentiometer problems to HELIPOT!*

THE Helipot CORPORATION, SOUTH PASADENA 4, CALIFORNIA

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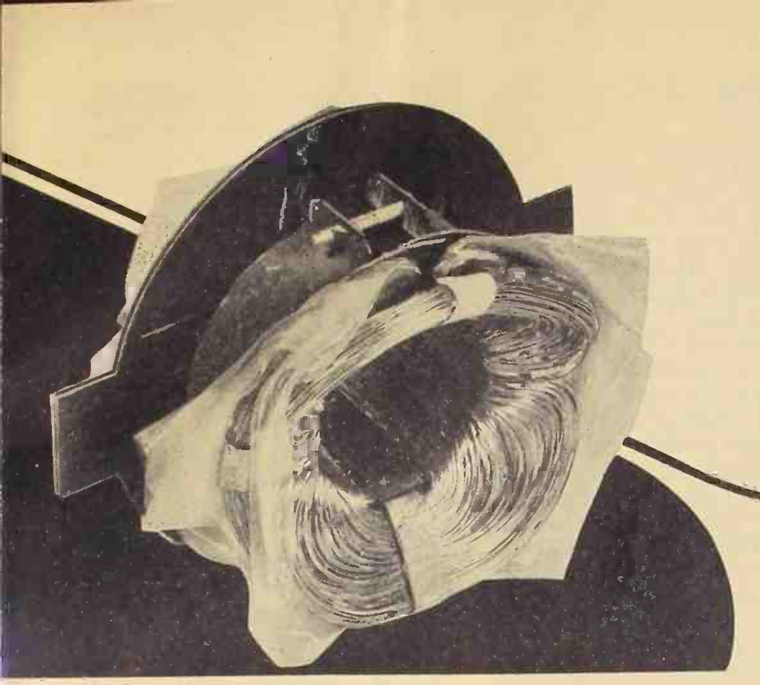


WIDE ANGLE DEFLECTION YOKES

Careful design permits yokes to be constructed having deflection angles as large as 90° with low distortion.

Completely assembled yoke, ready for placing on picture tube.

By HARRY E. THOMAS
Advance Development Laboratory
Electronic Parts Div.
Allen B. DuMont Laboratories, Inc.

DEFLECTION yoke design may at first appear to be a relatively simple procedure; the fundamental performance of the deflected spot has been described in electron optical theory and in many articles written on the subject. After all, current TV deflection yokes are nothing but four flat wound coils, bent up at the ends, assembled to fit around the neck of a cathode-ray tube, placed inside of two half rings of a permeable material, and fitted in a non-magnetic case with suitable terminals or leads. When actuated by a linear, sawtooth current such an arrangement will deflect the electron beam over the face of the cathode-ray tube.

Elements of the Yoke Structure

In general structure the two halves of a single horizontal or vertical yoke winding can be considered to form a short shallow solenoid of varying rectangular cross section with its forward edges so flared that it fits around the neck of a cathode-ray tube. Details of the yoke winding are shown in Fig. 3 since it is the key operating element of the yoke structure. Note the winding length, height, field length, and window dimensions, all of which enter into electrical and magnetic calculations. Fig. 1 shows a cross section view of these elements in assembled form.

The diameter is dictated by the neck diameter of the cathode-ray tube on which the yoke is to be used. In the television industry the dimension ranges between 1½" and 1⁹⁄₁₆" depending upon the tolerances to be accounted for in the tube and yoke structure. It is of course directly related to the inside neck diameter which, as described later, is a limiting boundary to the maximum deflection of the electron beam.

Three definitions govern the yoke length (Fig. 1):

(a) The *over-all length* "S" measured from the utmost edge of the front flare to the outside edge of the rear cover. This distance varies from 3" on older yokes down to 2½" for shorter modern designs.

(b) The *reference length* "T" to what is known as the reference line. This location on the figure is arbitrarily determined by RMA standard gauge #110 when slipped forward as far as possible over the tube's neck. It is useful in locating the position of other deflection items such as focus coils and ion traps with respect to the yoke and to the end of the tube.

(c) The *deflection length* or *winding length* determining boundary deflection again, is roughly distance "J" or "J'" between the centers of the front and rear flared sections of winding. Another approximation is the distance between the front and rear "corners" of the yoke. How this length determines deflection boundaries will follow under discussion of the magnetic dimensions. Note that the fundamental deflecting length of a vertical coil is less than that of a horizontal coil since it is inside of the latter.

The winding height "H" (Fig. 3), together with the length, determines the cross section of the yoke when it is considered as a short rectangular shaped solenoid; it is used in the calculation of inductance and in magnetic calculations.

Considering the winding a shallow flat solenoid, its depth "G" is something less than the inside diameter of the tube neck. This dimension is useful in magnetic and inductance calculations.

The window, a rectangular opening in the formed winding of length "D" and width "E" is in size a factor governing the winding distribution (and hence the flux). Window openings may not necessarily be rectangular; advantages in neck cut-off may be obtained with a triangular window and window shape may be used to control pattern distortion.

Those portions of the windings called flares have an effect on over-all performance and cannot be neglected. The degree of flaring, the angle, and the length all contribute to performance.

Circuit-wise the yoke consists of two pairs of poorly proportioned inductances placed at right angles to each other, each having resistance, distributed capacity, mutual inductive and capacity coupling plus circuit Q. Since each pair of coils operates at a different frequency, inductances are electrically fundamental.

Magnetically the yoke is a tilted magnetic field with a large air gap. Fig. 5A shows the classical representation of the magnetic structure; with flares the yoke becomes a tilted field with the flux bulging forward somewhat (Fig. 5B).

There are three magnetic constants, and one arbitrarily established quantity determining the physical limits and amount of deflection embodied in the conventional deflection yoke (Fig. 2).

(1) The deflection angle of the cathode-ray tube.

(2) The deflection length of the yoke.

(3) The peak-to-peak ampere turns necessary to meet requirements on (1) and (2).

(4) The center of deflection.

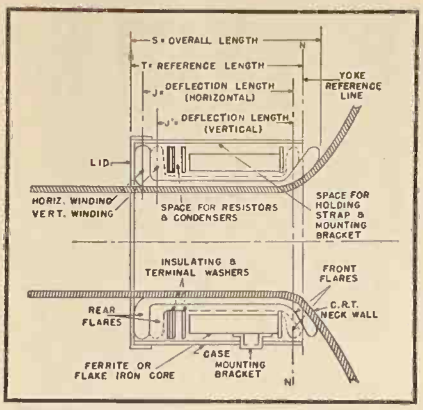


Fig. 1. Typical structure of a deflection yoke mounted on a picture tube.

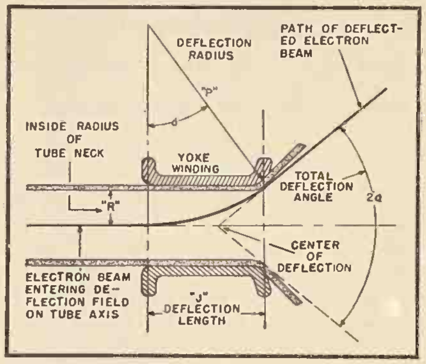


Fig. 2. Center of deflection in relation to deflection radius and yoke length.

The *deflection angle* of a cathode-ray tube is numerically equal to twice the angle at which its electron beam must leave the axis of the tube in order to reach the screen without striking the tube neck. Once the deflection angle is fixed, the diameter of the CRT screen is dependent on the length of the cone structure. This angle, as far as the tube's structure alone is considered, depends upon the angle and the contour of the outward flare of the cone. It also depends on the glass thickness at the very corner and, finally, upon the inside diameter of the glass in the straight portion of the neck.

The *deflection length* is the maximum distance that a magnetic field can be extended from a tube's neck toward the source of an electron beam without causing the beam to strike the glass at the start of flaring of the cone structure. This condition follows from the principles of magnetic deflection in Fig. 2 where a uniform field causes the electron beam to follow an arc of radius P which is restricted by the inside radius R of the tube neck. Thus it follows that the length is finally determined by R, the inside neck radius. The geometry of this yields:

$$L = R \left(\frac{1 - \cos \alpha}{\sin \alpha} \right) \qquad (1)$$

The *peak-to-peak ampere turns* required for deflection correlates the quantities in the magnetic circuit and the stiffness of the beam or, in other words, its second anode potential. It is calculated from the expression:

$$NI = \frac{8.4\, G \sqrt{E} \sin \alpha}{\mu J \sin (90^\circ - \alpha/2)} \qquad (2)$$

E = 2nd anode potential

G = field length

J = winding length

2α = total angular deflection

μ = permeability factor depending on contour of coils, iron core used and leakage paths.

N = number of turns

I = amperes flowing in the yoke winding

The *center of deflection* is an imaginary point on the center line of the tube neck about which the deflected electron beam theoretically pivots in its maximum deflected position if its path is a straight line toward the viewing screen.

Its location on the tube's center line can be determined by the geometry of the funnel and neck structure (See Fig. 4 for this location on a 90° neck structure).

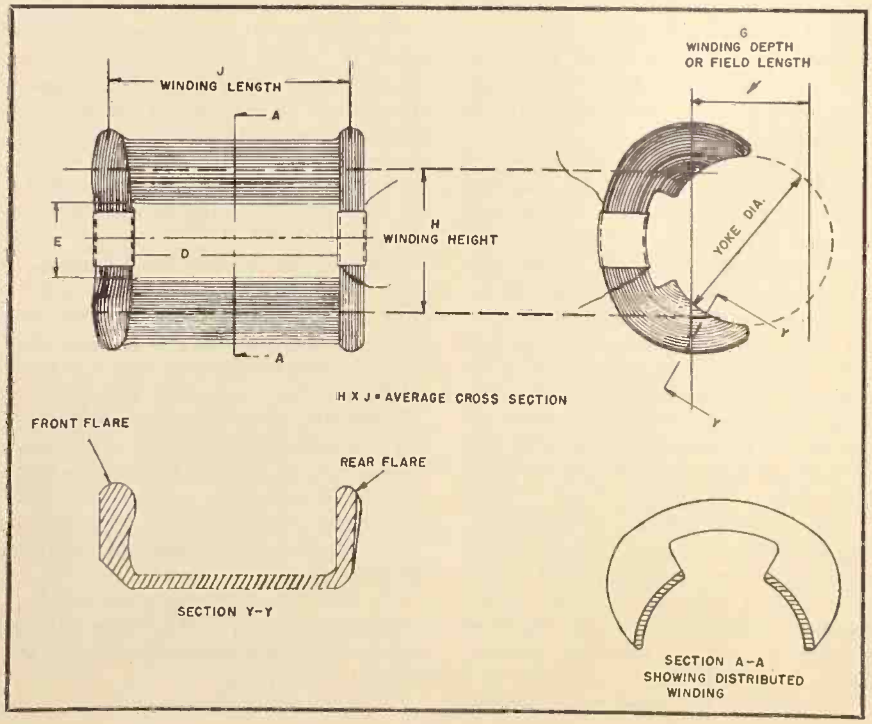
Determination of the location of the center of deflection with reference to the magnetic characteristics of the yoke alone may be closely approximated by several methods:

(a) Magnetically, we can calculate the effective magnetic center of the total flux by taking magnetic moments over an integrated flux intensity plot throughout the yoke structure. From these moments a single equivalent moment can be determined and its location fixed with respect to any point on the yoke structure. This point, at which the entire flux may be considered to be concentrated, is the center of deflection. From a number of these integrated flux diagrams it has been found that this point very closely coincides with the center as determined by geometric and other means (See Fig. 6).

(b) Measurement of the diameter of the circle caused by neck shadow allows one to locate the center of deflection from geometry of the yoke and tube outlines. Thus, using say a 90° tube and with a 70° yoke a neck shadow of a given diameter is obtained on the face of the tube. With this dimension referred to on the existing geometry of the tube, a line can be drawn on a cross-section drawing of the tube just grazing the glass of the neck so that an intersection is found with the main center line of the tube. This intersection when related back to the yoke itself is the center of deflection.

(c) By observing the electron beam path in a CRT with a specially designed internal structure which employs a cathode-ray tube with a partially phosphored face with a mica plate centered laterally in its neck. This plate is scribed into ¼" squares and is coated with a phosphor. In operation the electron beam is passed down the tube in the conventional manner with a slight vertical deflection so as to intersect the mica plate; direct current is then passed through the horizontal windings of the yoke and the fluorescent path of the beam observed through the unphosphored portion of the face plate.

Fig. 3. Typical yoke winding structure for a single coil.



From the curvature of the beam and its direction the center of deflection with respect to the yoke can be observed with a fair degree of accuracy.

Performance Characteristics

To evaluate a yoke's over-all performance the following characteristics must be investigated and measured:

Sensitivity

This characteristic could be called yoke output since it is quantitatively an index of performance efficiency. It is directly measured by the raster size and of course depends upon the magnetic and electrical circuits required to deflect a given electron beam a standard distance.

Spot Distortion

Aberration in spot size and shape, also known as deflection defocusing, is caused chiefly by two factors operating in deflection of the electron beam:

(a) The ratio of the radius of curvature of the face plate of a cathode-ray tube to the radius of the sector over which the beam may be considered to sweep.

(b) The unequal or curved field strength contours in the corners of the deflected area.

Degradation of the spot due to the first of these factors arises from the use of flat faced cathode-ray tube screens; a uniform deflecting field does not keep a center focused electron beam in focus over the entire raster unless the radius of the deflecting sector coincides with the radius of the viewing screen. With demands for the more realistic image reproduction that accompanies a flat faced tube the problem of compensating this type of defocusing becomes worse and results in a compromise since distortions in pattern and perfect spot focusing are incompatible.

The second factor causing corner spot defocusing is due to the curvature of deflecting fields contributed by the yoke flare. Since the flares consist of continuously curved portions of the windings, their fields are not at right angles to the main deflecting flux and consequently distort the spot in the corners of the raster.

Pattern Distortion

(a) The reproduction of a rectangular raster from a single scanning source on a flat faced tube leads to *pincushioning* or sagging inward of the sides of a normally rectangular raster. In other words, two dimensional deflection of the beam produces greater horizontal and vertical movement of the spot in the corners of a raster than at the sides

(b) *Barrelling* is the conjugate of pincushioning; it is manifested as bulging of the sides of the raster. With curved face tubes it is a natural geometric effect.

(c) A most pronounced example of the *trapezoidal pattern* defect is produced when one horizontal winding has shorted turns; losses, say in an upper winding, will produce a pattern tapering toward the top of a raster; unequal windings will produce the same effect.

(d) *Rhomboidal Pattern* distortion is produced by misalignment of the pairs of coils with respect to each other, although sometimes non-uniformity of the winding distribution can produce it. With a minimum of induced voltage from one winding to the other, rhomboidal distortion is minimized.

(e) Other factors independent of the yoke can produce what is known as *system distortion.* These include:

(1) Ion trap misadjustment which, in addition to deteriorating focus, can cause fuzzy corners, pincushioning or barrelling

(2) Focus coil misalignment affects the raster by barrelling or pincushioning along two adjacent sides. Correct a.c. focusing should always be made before accurate measurements are made on yoke characteristic.

(3) A misaligned electron gun structure will cause erroneous results chiefly because the focus coil must be misaligned to compensate and in this adjustment distorts the pattern.

(4) With metal cone tubes a magnetized cone will distort an otherwise normal pattern. The proximity of metal objects near a cathode-ray tube will distort the pattern; indeed pattern distortion has been compensated for by placing permanent magnets around the cone.

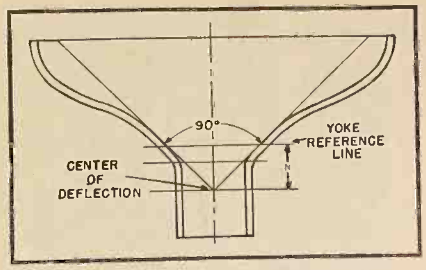


Fig. 4. Geometrical location of center of deflection in a 90° yoke.

Neck Shadow

If the deflected electron beam strikes the neck of the tube at any point when the yoke is in its normal position and a shadow occurs on the raster the yoke is not designed for its fullest capabilities. This in effect means that the center of deflection of the electron beam is too far back for the neck contour of this particular tube. Other factors entering this situation are:

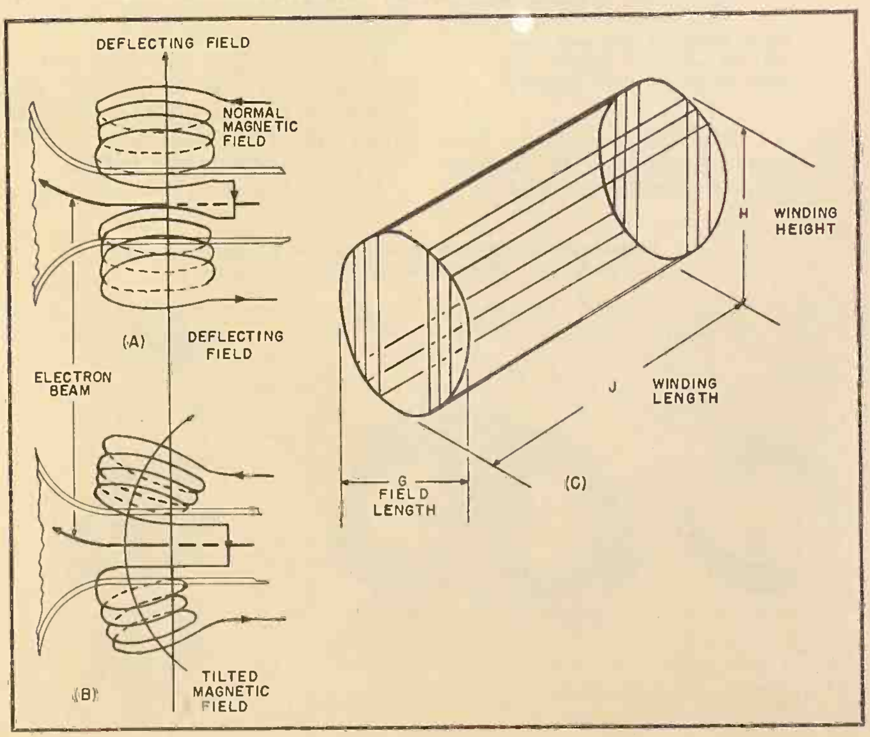
(a) The neck contour of the tube may not fit the yoke winding contour so that the yoke cannot be placed in its forwardmost position.

(b) The thickness of the glass in the neck of the tube can interfere with full swing of the beam.

(c) Misalignment of deflection elements—the gun, the focus coil, or the yoke—may produce a non-symmetrical neck shadow at less than the maximum angle of deflection.

(d) Anode voltage may affect the

Fig. 5. Basic magnetic structure and coil dimensions for a deflecting yoke.



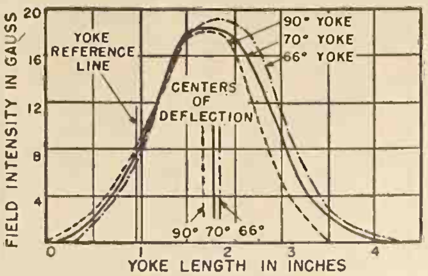


Fig. 6. Integrated flux plot for 66°, 70° and 90° yokes. Centers of deflection are indicated.

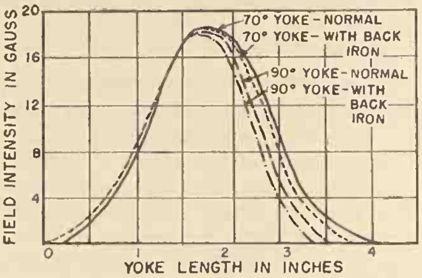


Fig. 7. Integrated flux plot showing the effect of back iron on both 70° and 90° yokes.

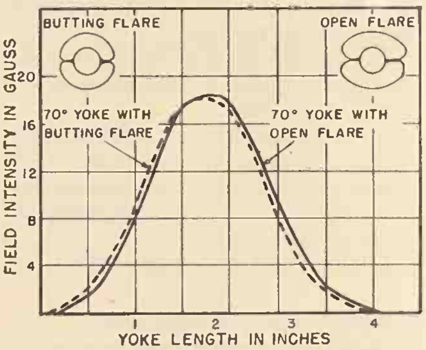


Fig. 8. Integrated flux plot showing the effect of butting and open flares on field intensity.

apparent neck shadow diameter since this voltage determines the diameter of the electron beam, and the edges of a large beam will strike the neck sooner than a very narrow beam.

Linearity

If the flux distribution throughout the sweep of a deflected beam is not uniform, a yoke may give a non-linear pattern. It is necessary to isolate the yoke performance from other non-linear circuit elements when measuring this characteristic, although this step is not usually employed in TV circuits since linearity controls can and usually do correct for what slight non-linearity there is in the yoke itself.

Design Considerations

After approximately proportioning the electrical, magnetic, and mechanical dimensions, two fundamental problems arise in improving performance.

First, there must be established a balance between sensitivity and neck shadow and second, an optimum of spot distortion versus a minimum of pattern distortion.

Sensitivity vs. Neck Shadow

Since yoke length and sensitivity are directly proportional, it also is corollary that neck shadow and wide angle deflection or sensitivity are incompatible. Referring to diagram, Fig. 2, it will be seen that the base line upon which the radius of curvature of the path of the electron beam is located is at the rear end of the yoke and is thus dependent on the length of the deflection field. If this radius is short and the field intensity is great the beam will turn abruptly, thus giving wide angle deflection. Also, in a short yoke, since the base line is nearer the front flare of the cathode-ray tube, there is an added advantage because the center of the deflection, too, is further forward.

Analysis of these conditions and the dimensions of the cathode-ray tube neck show that the center of deflection is an important controllable variable once the tube dimensions are fixed.

Fig. 6 analyzes the forward movement of the center of deflection and relates it to the yoke length on a 66° yoke, a 70° yoke, and a typical 90° yoke.

Several other devices producing improved neck shadow characteristics are:

(a) So called "back iron" consisting of a disk of permeable material placed next to and parallel with the back flare of the yoke windings, by magnetic shunting reduces the reluctance of the fringe fields and moves the net flux forward to improve neck shadow. (See Fig. 7.)

(b) The use of a tapered cylindrical liner between the yoke windings and the neck of the tube improves the neck shadow in a deflection system. By introducing a small tilt in the lengthwise, flux-producing turns of a yoke winding, the useful flux is bulged forward and relieves neck shadow.

(c) Using a specially shaped core by increasing the thickness of iron around and back of the flare decreases reluctance and restores sensitivity without affecting the position of the main flux; the center of deflection is thus moved forward and neck shadow relieved.

(d) The most obvious method to reduce neck shadow is to bring the butting edges of each coil winding as far forward as possible before making the turn for flaring. (See Fig. 8.)

Spot vs. Pattern Distortion

The fundamental consideration in deflection or spot defocusing is the relation between the deflecting sector radius and the curvature of the face of the cathode-ray tube. Yokes correcting for spot defocusing use a proper flux gradient depending upon the winding configuration (see Figs. 1 and 3). This means that the cone or bundle of electrons is deflected by a non-uniform field.

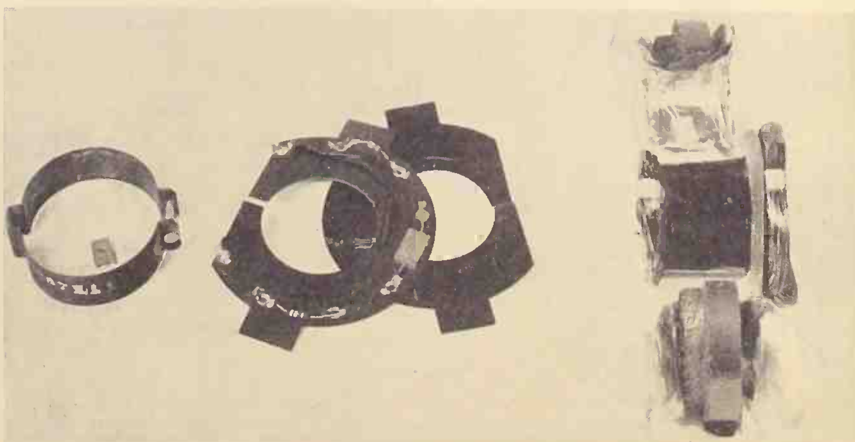
Perfect distribution, for ideal spot compensation, is not without disadvantages, however, because ideal flux distribution produces a pincushion field which in turn must be compensated for. Three devices act to produce such compensations.

(1) The natural geometric distortion caused by curvature of the face of the tube. A sharply curved tube face produces barrelling of the raster which compensates for pincushioning. This effect works out very well on tubes with face plate radii of less than 30".

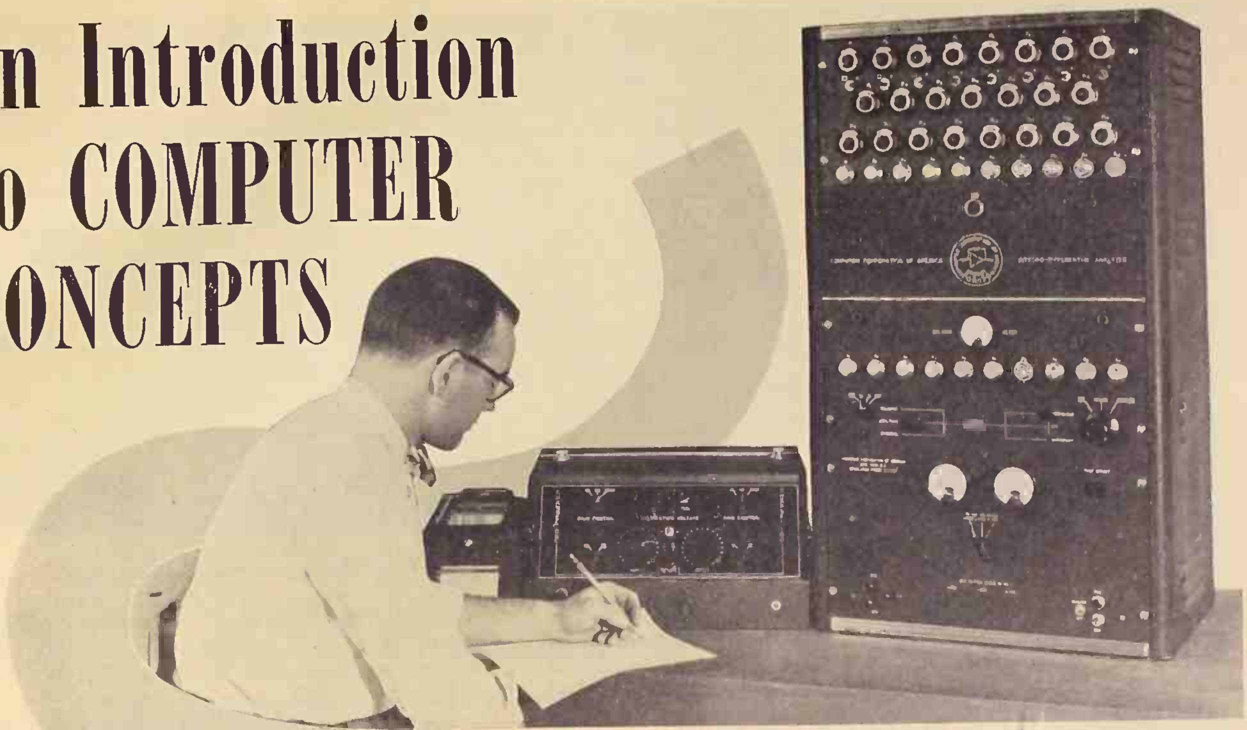
(2) By use of permanent magnets. A pincushioned raster may be simply distorted in proximity with a small adjustable permanent magnet. This device cannot, of course, be used with metal coned tubes.

(3) By utilizing the inter-field cross-coupling effects. Pincushioning is partly due to the effect of vertical fields on horizontal fields and vice versa.

Disassembled view of the yoke shown on P.3. showing back iron, clamp, and the coil construction.



An Introduction To COMPUTER CONCEPTS



This electronic analog computer, manufactured by the Computer Corporation of America, has been nicknamed "Ida" (for Integro-Differential Analyzer).

Part 2 includes a discussion of applications as well as basic systems and design considerations.

By
JOHN D. GOODELL
The Minnesota Electronics Corp.

IN PART I of this series broad comparisons were made between the characteristics of computing machinery and the human mind, the potentialities of future developments were indicated and a number of basic principles were discussed.

One method of classifying computing machinery is in terms of digital and analog presentation of the information. In the first case intelligence is represented by digital numbers, and in the second by quantities that vary over a continuum. The decision to design a computer for a specific application in digital or analog form is dictated by a variety of considerations, including the allowable error in the end result, the speed of operation required, the source of the information to be computed and other factors. In certain problems the intelligence originates from devices that can produce only an analog type of signal but this does not necessarily mean that the end results are most desirably obtained in analog form. Typical of this category are control or indicating systems where shaft rotations and angular motions are involved in the sensing structures. In some instances it may be desirable to transmit the information by wireless means between elements that are separated by substantial physical distances (*e.g.*, in certain types of servomechanisms). Analog presentations do not readily lend themselves to the requirements of wireless transmission. Systems requiring memory storage structures are difficult to design in terms of analog signals. It is clear that many problems would best be handled by combined analog and digital operations, and translating methods from one type of presentation to the other are very important. Several such systems now under development will be described in later articles

Actually, analog and digital systems represent the handling of information in accordance with different codes, the former being a continuous and the latter a discontinuous type of code. Where a large number of successive operations are necessary the analog methods tend to produce relatively large cumulative errors. On the other hand, the digital methods are often cumbersome and require an excessive number of operations to achieve an end result. A basic approach to the problem of translating an analog signal in the form of a continuous bounded function into digital representation is to integrate the area under, for example, a curve of voltage plotted against time. Such operations will ordinarily be in the form of the single Riemann integral. Many types of mechanical integrators are available but relatively few electrical systems.

A typical requirement for translation from one form to the other is in connection with problems where data is observed over interrupted periods of time and where it is desirable to store and accumulate such data for future manipulation. Analog data may, of course, be stored in the form of graphs of various types but it is difficult to regenerate it from this storage in a manner that lends itself to manipulation.

In connection with digital computers it has been pointed out that most large scale high speed machines operate in accordance with binary notation, so that no element in the machine is required to indicate more than two alternative conditions which may be notated as 1 and 0. There are many investigators who feel that this method of notation is the only satisfactory system for the operation of large scale high speed digital structures, but this concept is not accepted completely in all quarters. Many of the arguments presented involve practical limitations of available methods while others are related to concepts that are very much open to discussion. Obviously the existing practical difficulties may be overcome by current or future development work. One of these has been the lack of a satisfactory counting and storage device with a multiplicity of stable states. This limitation is no

General view of Univac (Remington Rand) with central door open, partly revealing the "mercury memory" assembly.

longer valid and several structures with a plurality of stable states will be described in a subsequent article.

In the history of mathematics improved methods of notation have led to increasing flexibility of manipulation. An obvious example of the importance of suitable coding is in the Roman versus Arabic representation of numbers. Even relatively simple arithmetical problems are incredibly cumbersome if handled with Roman numerals. It is equally difficult to attempt to work in binary notation with pencil and paper because the number of digits required to represent large numbers cannot be conveniently written or observed. Notation in the decimal system is considerably more convenient for manual working of problems in arithmetic and, until the advent of large scale high speed computers, all calculators of the desk type (*e.g.*, comptometers) operated on the decimal system. It may be that the current trend toward the design of digital computers in terms of binary notation should and will continue, but it is also possible that new techniques will make decimal, or some other coding, equally practical and more desirable.

It is not sufficient that a computing machine produce an answer; it is also necessary that the answer be produced in usable form. Somewhere along the line it is necessary that humans observe and use or evaluate the answer. This means that the final output signal should be in a form convenient to human observation and interpretation, and this usually means that it should be in decimal notation. Furthermore, it is necessary that the basic elements and data relating to any problem must be fed into the machine by human operators, and this again implies the desirability of some convenient coding such as the decimal system. Thus such machines should be, and usually are, equipped with input and output devices capable of translating between binary and decimal coding. Internal operation on a decimal basis would eliminate translation.

There are many methods of coding electrical signals in accordance with numbers. In the binary system the codes consist of pulse trains of 1 and 0. Decimal digits may be represented by pulse groups, by the amplitude or time duration of pulses, and in many other ways.

It is of some interest to recognize that the human nervous system responds to stimulation by generating signals that are transmitted in binary form along nerve fibres, *i.e.*, on/off, go/no-go, 1 or 0. The magnitude of the stimulus is indicated by the pulse repetition rate as well as the number of nerve fibres that respond. This is sometimes thought of as an indication of binary operation in "thinking" functions, but this deduction is not necessarily correct. There is considerable statistical evidence that the memory storage capacity of the mind is too large to explain on the basis of binary nerve cells. Some form of quantization of molecular structures seems more likely.

It is not unreasonable to suggest that the more compact the code the less complex are the machine requirements. For present purposes the speed of operation is such that binary notation imposes no limitation of consequence, but future formulation of problems may re-emphasize this point. In one sense the giant machines are relatively unimportant because they will be few in number. In mass applications of smaller computers efficiency of input and output systems and simplicity of design will be increasingly important.

Most computing machine design work today has emphasized systems for solving statistical and complex mathematical problems. Of more currently dramatic interest are designs for solving problems involving logical thought. Logic forms the foundation for mathematics and it is a subject that has not received the widespread attention that it deserves. Many mathematical systems, designed without sufficient understanding of logical foundations, have led to unnecessary contradictory results and erroneous conclusions. Mathematical logic is the most valuable rigorous discipline possible in the field of human reasoning because it is the foundation of all reasoning. There is a great deal of contemporary emphasis on the "scientific approach" to widely varying types of problems, but there is far too little understanding of the advances that have been made in the science of developing systems for thinking processes. It is indeed unfortunate that scientific progress has periodically been obscured and slowed by a lack of interest and understanding in the foundations of reason It would be still more unfortunate if machines were developed that led to unrecognized fallacious results. Systems of arithmetic and the algebra of numbers have existed for at least four thousand years, yet no such system has been developed that does not lead to contradictions. Recognition of such limitations helps greatly to vitiate their dangers.

In the field of logical thought the problem of coding the information is of no less importance than in the field of mathematics. Similarly, the inadequacy of various codes has greatly limited progress in the past. Human verbal languages are extremely unsatisfactory codes from the standpoint of rigorous expression and also with respect to compactness. Contemporary systems of logic use internal languages in the form of codes that permit compact and rigorous presentation of problems that would be incredibly involved and subject to semantic confusion in verbal form. There are many such systems and many different symbolizations. Boolean Algebra is perhaps the most familiar. These are the forms in which machines handle problems of logical thought.

It is interesting that in symbolic logic, as well as in the field of mathematics, there is posed a problem of binary versus other basic codes. Human reason is inclined, either by inherent characteristics or by environmental influences, in the direction of bi-valued thinking. Propositions are true or false, a man is guilty or not guilty, an act is wrong or right. The foundations of logic are built on such bi-valued systems, but a considerable variety of many-valued logical systems has been proposed and developed. In this case the problem involves more than simply a system of notation, but there are a number of inductive conclusions that may be drawn from the analogy.

The question of applications for machines operating on principles of symbolic logic is an interesting one and the possibilities considerably more specific as well as broader than might first be assumed. Almost any type of problem susceptible of solution by means of symbolic logic is a potential subject for machine design. Berkeley has applied these principles in connection with actuarial problems, others have applied them to the solution of various types of electrical networks.

Of perhaps greater interest is their application to the making of business decisions that are now handled intuitively on a relatively high level but actually involve manipulations that should be considered as relatively low level thinking. An example might be in connection with a firm engaged in fabricating end products from raw materials traded on the futures market. Such a firm purchases an inventory distributed for delivery in future time, to be used in the fabrication of end products also to be delivered in future time. If the end products may be fabricated from a variety of raw materials the optimum inventory distributed in time from the standpoint of maximum profit changes daily with changes in raw material quotations. Such a problem may become so complex that it is not practical of absolute solution by ordinary accounting methods in the time during which action on the solution is necessary. Decisions are handled by men with years of experience speculating in these markets. A suitable machine could eliminate most of the speculation and at the same time insure a maximum profit factor. The construction and operation of such a machine is well within the realm of known techniques.

The Calculus of Propositions considers only declarative propositions that may be categorized as true or false. Using only two rules it is possible to generate from three simple relationships all possible true propositions in this calculus. Using a simple matrix system it is possible to prove rapidly the truth or falsity of all such propositions. In this calculus there is no concern with the internal meanings of the propositions. Thus it is a relatively easy task to design a machine that will generate all true propositions in this calculus or which will examine any proposition and determine whether it is true or false. Such a machine would have little real importance. But a machine designed to operate in terms of more complex systems could be used to determine rapidly whether a legal document involving complex linkages between intricately related conditions was properly written. A machine might be designed that would make medical diagnoses on the basis of properly determining the possible sources of particular combinations of clinical measurements.

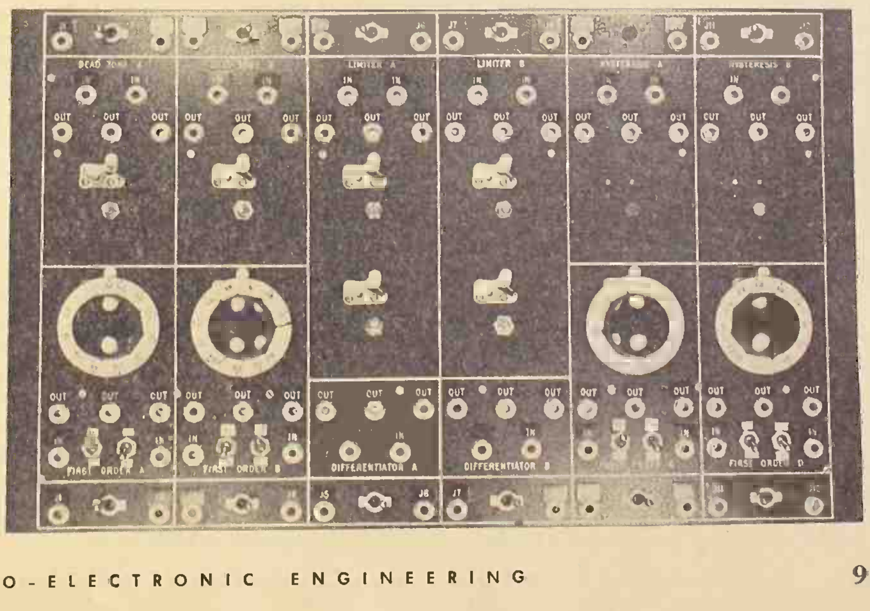
In the latter machine there would be involved many decisions of degree where multi-valued possible measurements must be considered. In most instances of this kind it is possible to treat each level of measurement as a special case, thus effectively transforming the terms into bi-valued expressions. It is only because the amount of information necessary to relate all possible clinical observations with all known sources of malady is so vast and the relations so complex that diagnosis involves high level decisions.

It is quite possible that Church and others who have presented proofs that it is impossible to design a machine that will duplicate all of the processes of the human mind are right in their conclusions. But there is no doubt that machines may be designed to take over all of the drudgery, all of the straight reasoning processes, and release the mind for the accomplishment of truly creative thought—truly creative concepts in the design of still more useful machines.

(To be continued)

Model 153 computer-plotter manufactured by Electronic Associates, Incorporated.

Front view of the non-linear unit of an analog computer developed and manufactured by Laboratory for Electronics, Inc.



A PULSE MIXING UNIT

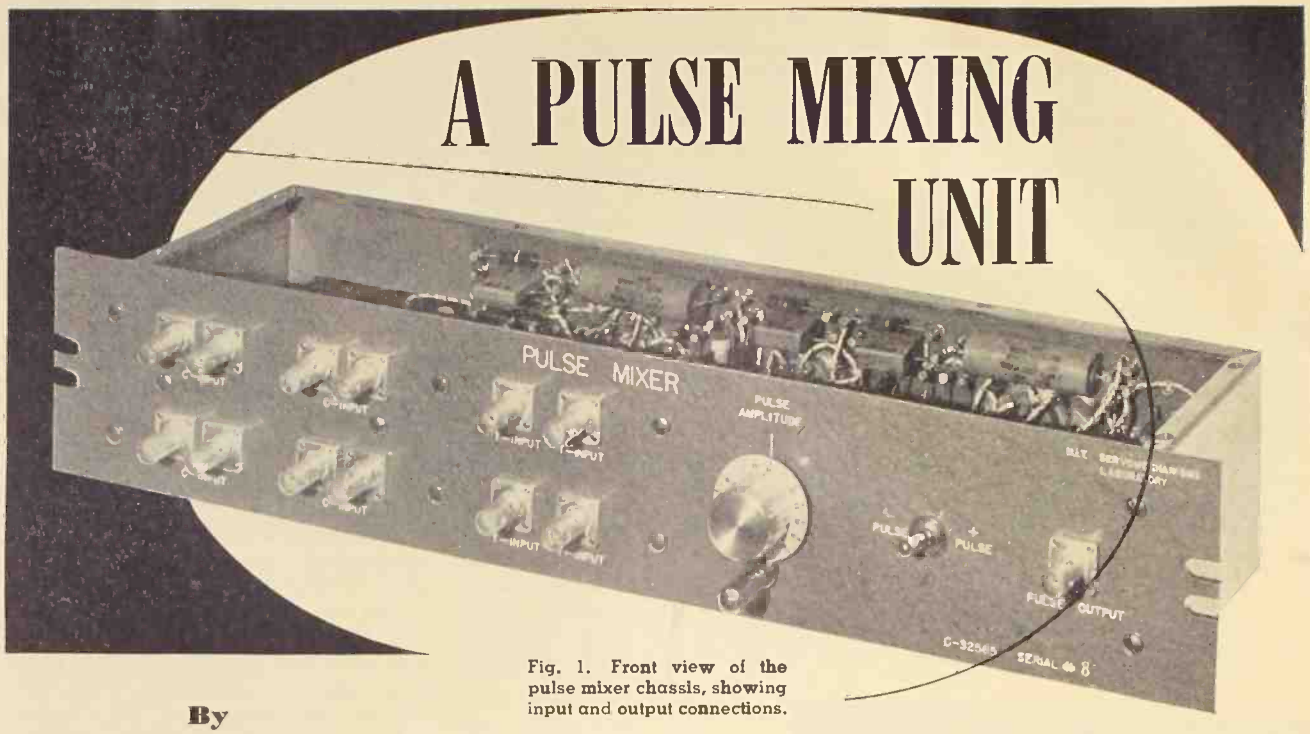


Fig. 1. Front view of the pulse mixer chassis, showing input and output connections.

By
ROBERT R. RATHBONE
Servomechanisms Laboratory
Massachusetts Institute of Technology

Input from up to 8 external lines may be mixed, producing a chain of pulses at a single output.

IN TESTING pulsed circuits or simulating large pulsed systems, the engineer frequently needs to mix the outputs from a number of pulse lines onto a single line. For example, he may wish to trigger an electronic counter with a certain sequence of pulses, each from a different source. If he can assume that the pulses will have the same polarity, his problem then is to prevent a pulse on one line from feeding back onto another line (a time-consuming task when line impedances differ), and to standardize pulse amplitudes and lengths so that the triggering action of each pulse is optimum.

The "Pulse Mixer"

The pulse mixer shown in Fig. 1 is a compact, convenient unit which can take pulses from as many as 8 external lines, mix them at the input, and produce a chain of pulses 0.08 microseconds later at a single output. It incorporates a pulse-standardizing circuit which allows nonstandard, or random, positive input pulses to be used, converting them into standard 0.1 μsec half-sine-wave pulses at the output.

The mixer is constructed on a panel and chassis for standard 19 inch rack mounting. The chassis measures 3½ x 4½ x 17 inches and is completely shielded (the photograph, Fig. 1, was taken with the cover removed). Input and output jacks, and controls are located on the front panel; vacuum tube sockets are mounted on the rear of the chassis so that tubes may be replaced without removing the unit from the rack.

At the Servomechanisms Laboratory, power for the test units is furnished by central power supplies, with remote outlet boxes at each laboratory bench. Voltages can then be fed by cable directly to the equipment, connecting into a Jones 400 series 6 pin plug on the rear of the chassis, or can be fed to rack power strips if several units are mounted together. The laboratory supplies are regulated because of the heavy loads; smaller supplies should be made as stable as possible in order to prevent marginal operation.

The power requirements of the pulse mixer are as follows:

Voltage	Current	
	No signal	1 mc. signal
+250	0.4 ma.	16 ma.
+150	47 ma.	44 ma.
+120	13 ma.	12 ma.
— 15	16 ma.	16 ma.
6.3 a.c.	1.9 amp	

The input circuit of the unit (Fig. 3) consists of four high-impedance inputs (C-IN) which utilize paired jacks (J1-J8), and four transformer-coupled inputs (T-IN) having single jacks (J9-J12). Input pulses must be positive, and if the pulse amplitude is less than 13 volts, T-IN should be used. The paired jacks of the C-IN permit continuance of the incoming lines or termination with external terminating resistors, which can be soldered to BNC coaxial connectors. The top waveform in Fig. 2 shows input pulses from three different sources.

The series crystals (CR_1-CR_8) in each input line (Fig. 3) are used principally to prevent a pulse on one line from feeding back onto another line and secondly to damp out ringing. CR_9 is used as a precautionary measure to further damp oscillations if necessary.

The mixed pulses are condenser coupled (C_1) to the grid of the inverter V_1; CR_{10} is used as a clamping crystal. The second waveform in Fig. 2 shows the pulses on a single line at pin 6 of V_1.

The 7AD7 inverter V_1 and the 6AG7 *R-L-C* peaker V_2 form a pulse standardizing circuit which converts the nonstandard input pulses into positive pulses with the same shape and amplitude. (See Fig. 2, waveforms 3 and 4.)

The inverter changes positive pulses fed to its input into negative pulses in its output. Each negative pulse has a steep negative-going edge which is used to cut off the *R-L-C* peaker tube V_2. The *R-C* coupling circuit (C_5, R_{20}) has a short time constant so that the small capacitance of C_5 charges quickly through the forward resistance of the crystal CR_{12}. When the signal voltage goes from negative towards positive, the charge on the condenser discharges through the resistance. The crystal tends to clamp the top of each pulse as close to ground potential as its forward resistance permits (waveform 3, Fig. 2).

The *R-C-L* peaker has a natural period determined by the value of the inductance L_2 and the total capacitance C of the circuit. V_2 is normally on, so that current flows steadily through L_2 and no signal voltage is produced. The arrival of a negative pulse from the inverter cuts the tube off rapidly and the voltage across L_2 rises. Plate current then flows into the stray capacitance of the circuit and the peaker begins to oscillate. As the voltage across L_2 goes from positive to negative, CR_{11} conducts and R_7, in series with it, critically damps the oscillations so that a single positive half-sine wave and negative overshoot are formed (waveform 4, Fig. 2). Thus the peaker is the pulse-forming portion of the standardizing circuit, the length and amplitude of the pulses in its output being determined by the *L-C* constants, and the length of the negative overshoot by the value of R_7.

The output circuit of the pulse mixer contains a 6AG7 buffer amplifier V_3, with a pulse-amplitude control R_{13} in the cathode circuit and a 3:1 pulse transformer T_5 in the plate. The latter has a bus-driver crystal CR_{15} and polarity switch in the secondary. The output of the peaker is *R-C* coupled (C_8 and R_{11}) to the buffer because no d.c. component exists across L_2, and *R-C* coupling is entirely adequate for passing aperiodic pulses. R_{12} is the grid resistor for V_3, providing a —15 volt no-signal bias. Since cut-off occurs at —11 volts, the tops of the peaker pulses turn the tube on. Due to the 6AG7's characteristics, the output pulses are narrowed to approximately 0.1 μsec (see bottom waveform, Fig. 2). The output transformer must be able to see a 93 ohm *terminated* line at the output jack J_{13}.

After power is applied to the unit, the operator should select the proper input jacks for the incoming lines (C-IN for high impedances, T-IN for low impedances).

Although input pulses must be positive, they may vary in shape and amplitude. The amount of variation which can be tolerated is usually determined by the frequency at which pulses are fed to the input; but since we must anticipate pulses occurring at random, we can better express input requirements in terms of recovery times. The recovery time of the *R-L-C* peaker is in effect that of the whole unit because it determines how close together two input pulses can be without merging as a single pulse in the output or in some other manner losing their identity. Fig. 2 shows the complete recovery time of the peaker to be about 0.3 μsec. This value is a safe minimum pulse interval (trailing edge to leading edge) which will guarantee a standard 0.1 μsec output pulse for every nonstandard positive input pulse. Actually, it is possible to use shorter intervals and still have good results, but the equipment becomes increasingly sensitive to input variations as the interval decreases. For example, a low-amplitude pulse may not get through to the output if the peaker has not completely recovered from a previous pulse; whereas a high-amplitude pulse has a good chance of doing so.

In actual tests with the pulse mixer, chains of positive pulses, roughly 0.1 μsec at the base line, separated by 0.3 μsec intervals, and vastly different in

(*Continued on page 27*)

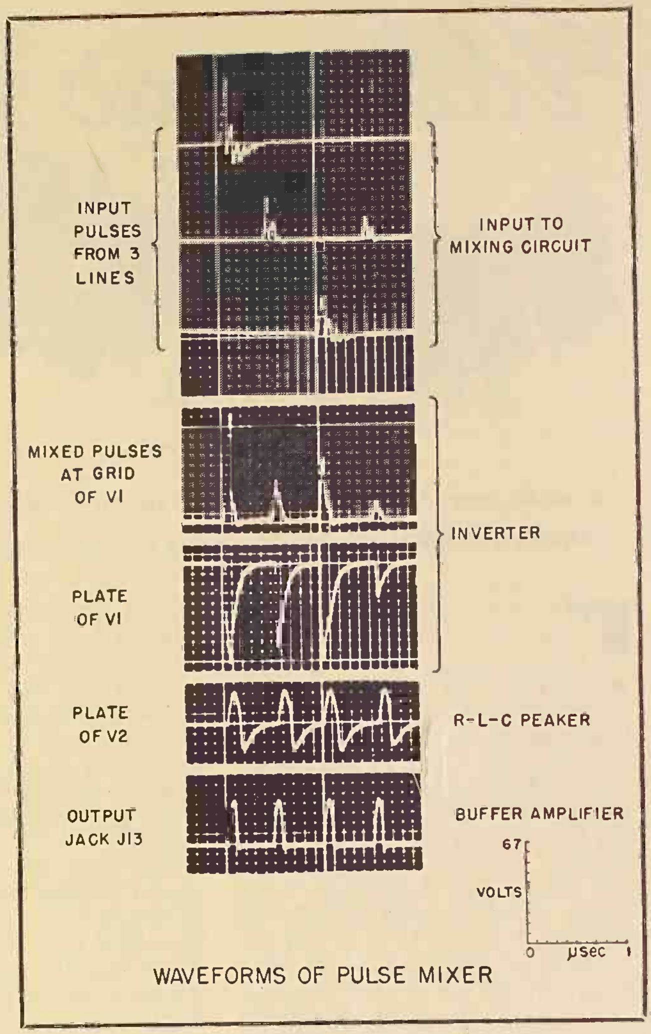
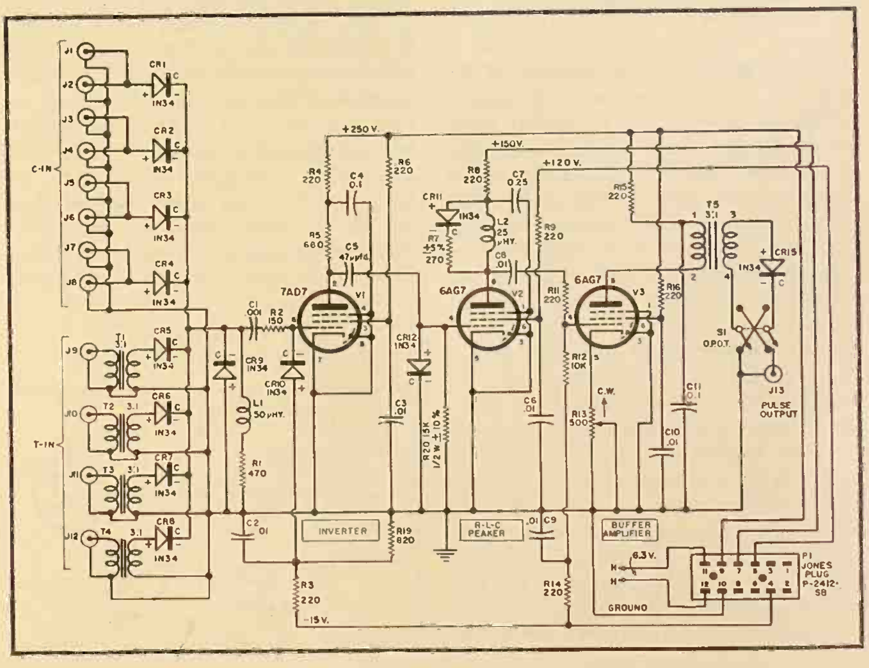


Fig. 2. Waveforms at various points in the pulse mixer. The scale in the lower right corner permits both the amplitude and duration of the various waveforms to be determined accurately.

Fig. 3. Complete circuit diagram and parts values for the pulse mixer.



Ultrasonic WAVE ANALYZER

By
T. A. BENHAM
Haverford College

A new crystal filter is used in this analyzer which covers 10-300 kilocycles with a 200-cycle pass band.

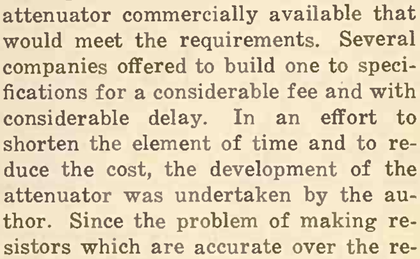
THE ANALYZER herein described was one of several built for the Acoustics Laboratories at Pennsylvania State College. The laboratory is carrying on basic research in ultrasonics under the sponsorship of the U. S. Signal Corps. It was thought that considerable knowledge of the phenomena observed could be had if more were known about the spectrum of the ultrasonic generator used to obtain a given phenomenon. Accordingly, in the summer of 1947, the first analyzer was developed. It proved to be of considerable value in spite of its several shortcomings. In the fall of 1948, therefore, the second analyzer was begun with the hope that the experience obtained in developing the first would yield a superior instrument. Results to date seem to indicate that the hope was well-founded.

The instrument is similar to the common wave analyzer such as the *Hewlett-Packard* or the *General Radio* wave analyzer. The principal difference is that this unit operates between 10 kc. and 300 kc., the lower part of the ultrasonic spectrum. The signal from a microphone, for example, is applied to the input where it passes through a two-stage attenuator, then through a stage of broad-band amplification and a phase inverter to the grids of a balanced modulator. The output of the modulator continues through a special narrow-band filter and then into three stages of intermediate frequency amplification, 325 kc. The output of this amplifier then passes through a cathode follower whose purpose is to match the high impedance output of the i. f. amplifier to the relatively low impedance detector circuit. The detector which this stage feeds is a simple diode rectifier, type 1N34, and a resistor in series with a microammeter as the d.c. output indicator.

Of course, the incoming signal at the input terminals is a spectrum of frequencies lying between 10 and 300 kc. At the balanced modulator, this signal is mixed with that from a local oscillator whose frequency is adjustable between 325 plus 10 kc. to 325 plus 300 kc., thus producing a 325 kc. beat frequency when the oscillator is 325 kc. above a given component of the input signal.

The input attenuator presented a special problem since at the time the development was begun, there was no attenuator commercially available that would meet the requirements. Several companies offered to build one to specifications for a considerable fee and with considerable delay. In an effort to shorten the element of time and to reduce the cost, the development of the attenuator was undertaken by the author. Since the problem of making resistors which are accurate over the required frequency range, 10 to 300 kc., is a difficult one, a circuit was devised which reduced the number of resistors required to the minimum. The final result is shown in Fig. 5, in the section marked "input attenuator." The first attenuator is designed for a 20 db attenuation per step while the second is 2.0 db per step. Since the individual attenuators consist merely of a string of resistors arranged in a simple voltage divider network, they may not be placed in direct cascade as the attenuation of the first step would depend on the setting of the second. To circumvent this difficulty, and also reduce "capacitance feed thru", the attenuators were made up of low value resistors and placed in the cathodes of two cathode follower stages. Since the total gain of the analyzer was to be as high as possible, consistent with good performance, it was thought desirable to introduce this broad-band amplifier ahead of the balanced modulator to make up for the loss introduced by the two cathode-follower stages, about 6 db. It was appreciated that a broad-band amplifier would present an augmented noise signal to the balanced modulator, but it was thought that the very selective filter which follows the modulator would render this noise spectrum of little importance. So long as this was the case, it was desirable to make up the gain in the "preamplifier" rather than in the i.f. stages since the greater the gain of this section, the greater likelihood of troublesome oscillations and instability. Furthermore, if the instrument manifested a nonlinear frequency response, that is, gave a better performance at one end of the range than the other, compensation could be introduced in this broad-band amplifier. Such compensation did not prove necessary since there is another means of obtaining slight compensation through the adjustment of the output characteristic of the local oscillator.

Fig. 1. Circuit diagram of a typical single crystal filter.



The balanced modulator is of typical design but has minor changes. The output of the oscillator was coupled to the modulator through a cathode follower because it was desired to vary the magnitude of the r.f. voltage fed into the cathode circuit. This variable feature could be accomplished with the least fuss through the use of this isolating stage. The output of the balanced modulator is somewhat different in that "link coupling" was employed. The balanced output coil in the plate circuit of the modulator is coupled to the coil which feeds the filter through two small inductances and a short line. In this way, good balance between the modulator output coil and the small secondary could be easily realized and in addition the effect of capacitive unbalance in the coils was reduced. Furthermore, the coil feeding the filter could be more advantageously placed than one transformer which had to serve both as the output of the modulator and the input of the filter. Each of the coils in the final arrangement are slug tuned for ease of balancing. Details of this system are shown in Fig. 5 in the section marked "band pass".

The local oscillator is conventional, but presented the progress of the development with a special problem. The circuit of this oscillator was, at the outset, the same as that used in the first model of the analyzer. However, the second oscillator proved to be most unstable. Practically everything in the book, and a few ideas that were not, were tried in an effort to bring about the desired stability. Finally the coils were baked and then boiled in paraffin, which solved the problem.

The alignment of this oscillator is rather critical. It will be noticed that the coils are slug-tuned and that variable trimming condensors are connected across them together with the proper zero temperature coefficient fixed condensors. The main tuning condenser has a range of 30 to 300 micromicrofarads which is to cover the desired frequency ranges: 334-426, 424-526, 524-626 kc. The three ranges, it wil be seen, provide one kc. overlap at each end of the dial. This required that the inductance of the coil and total capacitance tuning it to be exactly correct. Some practice is necessary in order to properly align the ranges. At best it is rather a tedious operation.

The proper theoretical value of inductance and total capacitance may be determined by solving two simultaneous equations. In this case, the tuning condenser had a range of 270 $\mu\mu$fd.

The shape of the tuning condenser plates is of some importance. Fig. 3 shows the ideal capacitance versus angle of rotation, capacitance versus angle for the symmetrical semicircular rotor plates, and capacitance versus angle for the so called midline capacity condenser, *Hammarlund* Mc 325 M. It is clear that short of making a special condenser, the semicircular symmetrical condenser fits the ideal most closely. If this condenser is used, the frequency markings on the dial will be uniformly spaced. The "midline" curve will result in spreading at the high frequency end of the range.

The filter section presented the most difficult problem in the entire development. The specification called for a flat-top response 200 cycles wide falling off to 60 db voltage-wise at 1000 cycles above and below the middle of the response. These requirements could be met through the use of a four crystal lattice network. However, the rather high frequency of 325 kc. makes the dimensions of the crystals so small that considerable difficulty would be encountered in their manufacture. In addition the lapse of time required to get the crystals prepared would have held up the project longer than desired, so another method was sought.

Fig. 1 shows the circuit for the conventional single crystal filter while Fig. 2 (dotted curve) shows the type of response to be expected. Now suppose a second similar filter were introduced whose peak response occurred at a frequency of about 100 cycles different from the first. Fig. 2 (solid curve) shows what would happen. By properly adjusting the circuits the dip in response between individual peaks could be eliminated, giving a reasonably flat top with steep sides. This was tried, putting the two filter stages in the output of two i.f. amplifiers. The result was not satisfactory, however, because the crystals showed different characteristics at the two different signal levels, one peak always larger than the other and the skirts were different.

Fig. 4 shows a better circuit arrangement and is the one finally used, as may be seen by comparing with Fig. 5. This configuration is symmetrical, the crystals witness equal amplitude of signal voltage. The tuned circuit in the output filter together with its associated selectivity resistor is the same as in the simple single crystal circuit. By manipulating the Q of this tuned circuit, the dip between peaks may be completely eliminated, producing the response shown in Fig. 6 (dotted curve). It may be seen that the specifications have been met to a sufficiently close degree. The cost of such an arrangement is very low, the major expense being the two crystals, about $60.

The instrument was to have two response characteristics, one as described above, the other to be a broad-band response for preliminary investigation.

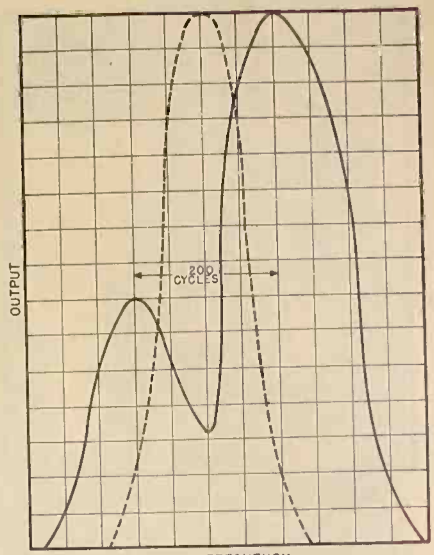
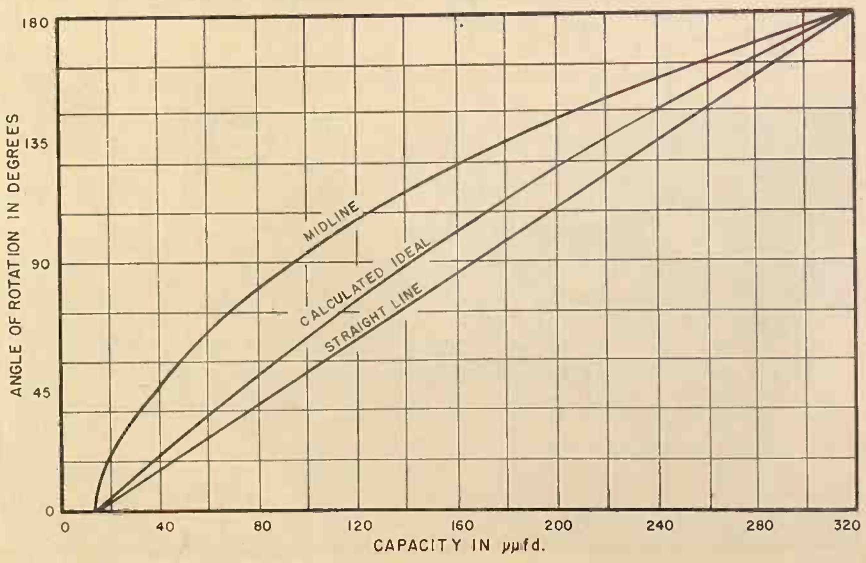


Fig. 2. Response of a single crystal filter (dotted) and of two crystal filters in cascade (solid).

As may be readily appreciated, a point-by-point method for aligning the analyzer would be an extremely tedious task and perhaps would never yield the desired result. Therefore, time was taken to develop a special oscilloscope for a dynamic alignment procedure. This oscilloscope is of rather interesting appeal but there is not sufficient space here for a complete description. The principle is basically simple. A frequency modulated oscillator is incorporated whose operating frequency is within the range of the analyzer, such as 50 kc. The amount of the sweep was adjusted to 500 cycles per inch. The sweep oscillator which was designed for particularly linear sweep supplied the horizontal sweep of the beam in the

Fig. 3. A plot of capacitance vs. angle for the main tuning condenser.



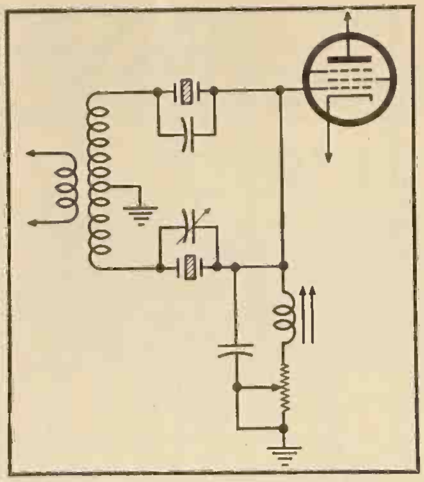


Fig. 4. Circuit of dual crystal filter.

CR tube and the frequency swing of the oscillator. The output of the analyzer was then fed into the vertical deflecting system of the oscilloscope. In this way, the response of the filter could be seen at a glance and changes became immediately apparent.

The rest of the i.f. amplifier, the cathode follower which follows, and the detector and meter circuit are quite conventional. The d.c. output of the diode rectifier is brought out to a jack and the main tuning condenser shaft is extended front and rear to be connected to a recorder for obtaining permanent graphs of spectra under study.

Some feedback is used in the i.f. amplifier in order to provide greater gain stability and to compress the output and input characteristics so that a range of 20 db may be covered with one setting of the input attenuator.

The cathode follower follows the last i.f. stage and feeds the detector which is a 1N34 diode. In the initial analyzer the cathode follower was not necessary because the input of the rectifier and meter circuit was sufficiently high to be connected directly to an *R-C* amplifier. Since the instrument is to be used with an *Esterline-Angus* 1 milliampere recorder, the impedance had to be lowered in order to get the necessary current from the available voltage output. The detector was therefore designed to operate into an impedance of 1200 ohms. The residual noise of the instrument (input shorted) is about 5% full scale on the output meter, 5 microvolts at the input terminals giving about 10% of the full scale. As is shown in Fig. 5, the output meter was provided with a "back current" circuit so as to be able to balance out the residual noise reading. Under these conditions, a 5 microvolt signal provides about 6% full scale deflection and 50 microvolts provide full scale deflection.

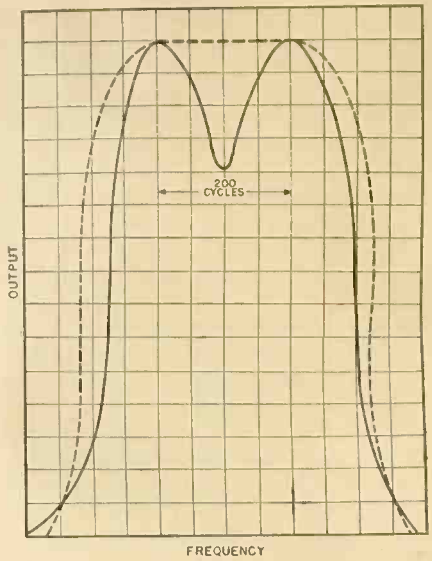
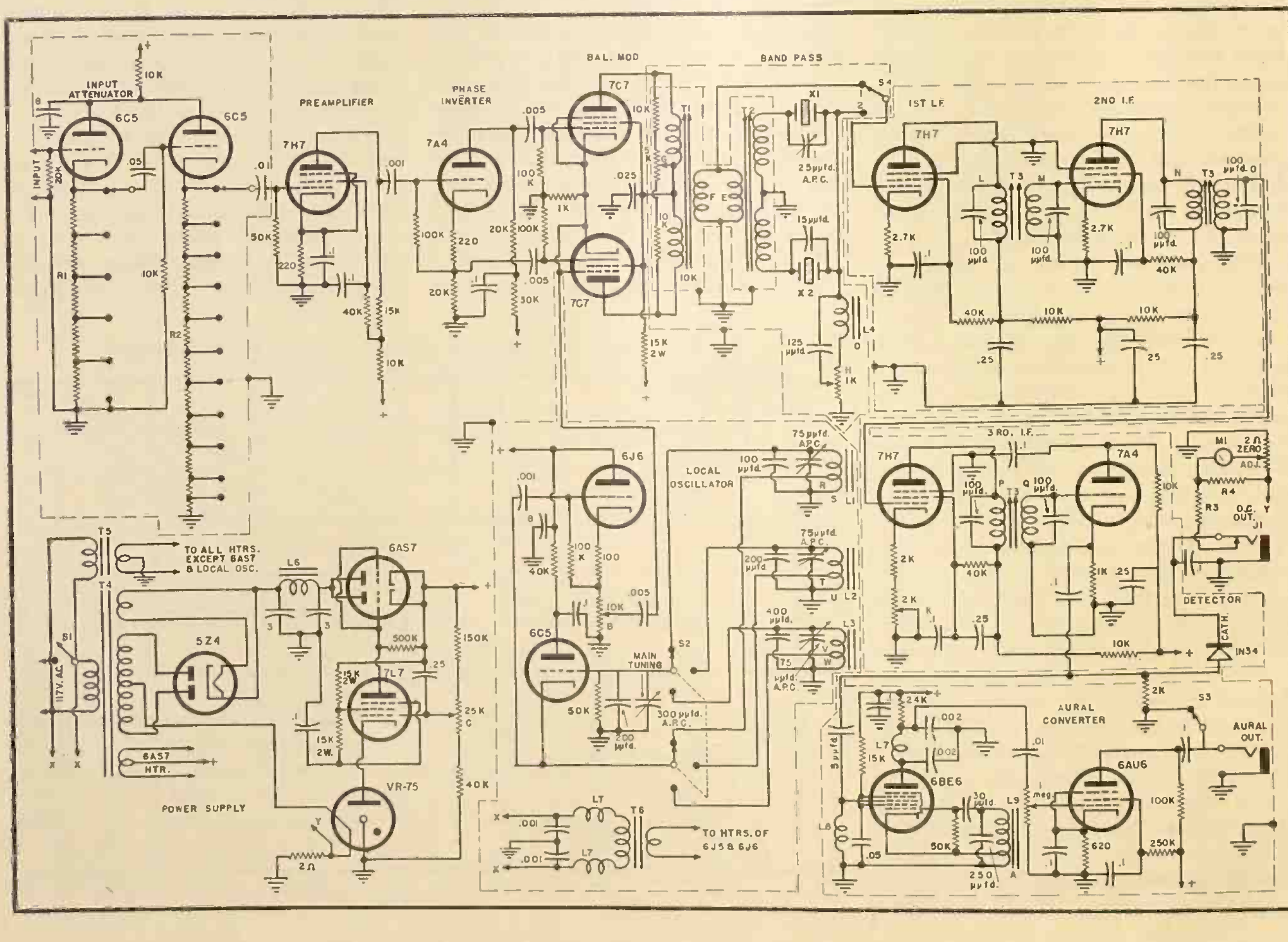


Fig. 6. Double peak response (solid) and flat top response (dotted).

The author wishes to acknowledge the assistance of Mr. William Newlin and Mr. Fred Davis whose ideas and patience contributed materially to the success of the project.

Fig. 5. Complete circuit diagram of the ultrasonic analyzer, showing shielded sections.



R. F. Dielectric Standards

Calibration services have been set up at NBS for solid, liquid, and gaseous dielectric materials.

Equipment for measuring dielectric constant and power factor at NBS. The NBS electrode systems are designed so that they may be conveniently plugged into most commercial bridges.

TO AID IN DETERMINING the properties of dielectrics and their dependence on frequency, temperature, and humidity, the National Bureau of Standards has established radio-frequency standards for dielectric measurements. For solid dielectric specimens, dielectric constant and power factor calibration services are now available in the frequency range from 10 kc. to approximately 600 mc. Somewhat more limited calibration services are also offered for gases and liquids.

In recent years information on the properties of dielectric materials has become increasingly important not only to designers and manufacturers of electronic equipment but also to the scientist who is studying molecular structure. The new standards and services provided by the Bureau are expected to be of material assistance in these fields.

The NBS technique for evaluating dielectric properties employs a disk-shaped capacitor made from the material to be investigated. The complex dielectric constant of this capacitor is conveniently measured by bridge or resonance methods. Special micrometer electrode systems are used consisting essentially of two plates which form a variable capacitor. They are precision instruments constructed so that the circular electrodes are plane parallel and near optical flatness. One electrode is insulated by a quartz disk while the movable or grounded electrode is attached to a holder by metal bellows arranged so that there are no sliding contacts. The position of the movable electrode is accurately controlled by a micrometer, and the capacitance of the entire system is calibrated against an incremental precision capacitor. The structure supporting the movable electrode forms an effective shield for the electrode system.

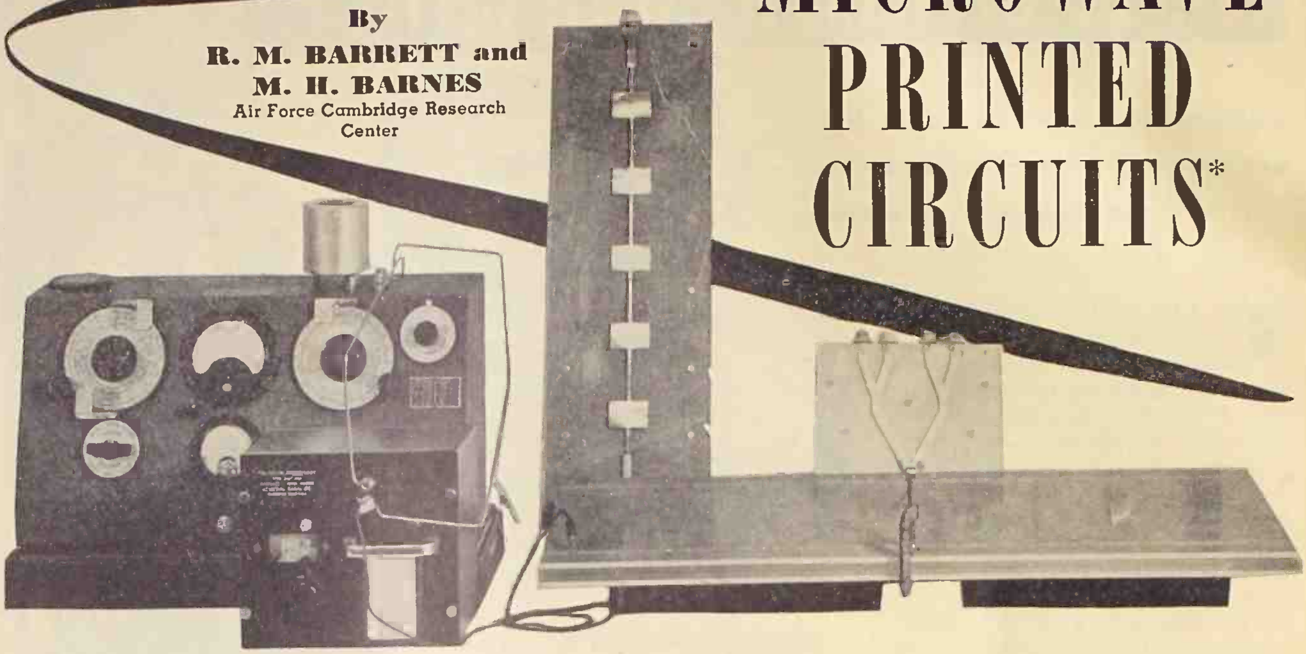
The NBS micrometer electrode system is used in conjunction with conventional bridges or resonance indicating devices. The dielectric specimen is inserted between the electrodes, and the bridge is balanced or the circuit resonated. The specimen is then removed and the spacing between the electrodes is reduced until the bridge rebalances or the circuit re-resonates. The dielectric constant is determined from the capacitance corresponding to this reading on the micrometer dial and the capacitance corresponding to the micrometer dial when set to the known thickness of the specimen. This technique for determining the dielectric constant circumvents fringing errors and is known as the susceptance variation method. It is valid with commercially available bridges for frequencies up to approximately 300 mc. Errors due to series inductance are reduced, becoming a function only of the change in length of the movable electrode, which is negligible for most values of capacitance.

At frequencies above 500 kc., the power factor and dielectric constant are usually determined most accurately by a resonance method. In this technique, the circuit including the electrode system and the specimen is resonated, and the voltage across the unknown is recorded. The specimen is then removed, the circuit re-resonated, and the voltage across the air capacitor is recorded. From these voltages and the known Q of the electrode system, the loss properties of the specimen are evaluated. Again, the dielectric constant is simply determined from the dial reading of the micrometer at the re-resonant point and the corresponding calibrated capacitance. (*Continued on page* 31)

Resonant cavity apparatus for determining dielectric constant and power factor.

MICROWAVE PRINTED CIRCUITS*

By
R. M. BARRETT and
M. H. BARNES
Air Force Cambridge Research Center



Setup for measuring the capacity of various transmission systems.

Hybrid junctions, directional couplers, filters, etc. can be fabricated easily and cheaply by this method.

THE MICROWAVE PRINTED CIRCUIT is an extension of the well-known technique which is of such importance in the lower frequency regions. This newer circuit possesses all of the virtues of other printed circuits, such as light weight, cheapness, ease of manufacture, miniaturization, etc. The basis of the new technique is the planar or "flat strip" transmission system which was developed during World War II but which has remained unpublished and relatively unknown in the postwar period. All of the conventional microwave components, such as hybrid junctions, directional couplers, power division networks, filters, etc., can be readily fabricated by this technique.

The planar transmission system out of which the microwave printed circuits are assembled is, fundamentally, an adaptation of the coaxial transmission system.

If the side walls of a rectangular coaxial system are allowed to approach infinity, the resultant flat strip transmission system, while possessing all of the advantages of the coaxial system, now has a form factor which is adaptable to the printed circuit technique.

All of the field is concentrated in the region of the strip and, since no potential difference exists between the outside plates, no energy is propagated in the lateral dimension, the isolation in this dimension being about 80 db per inch. A cursory examination of the system would lead one to believe that the capacity of the system, which determines the characteristic impedance of the line, could be calculated readily from the parallel plate capacity formula. For wide, low-impedance strips this is true, but for strips which have characteristic impedances in the order of 50 ohms, fringing effects at the edge of the center conductor produce a noticeable effect. As the strip is narrowed for higher impedances, another effect becomes apparent, *i.e.*, interaction between the fringing effect at the two edges which must be taken into account.

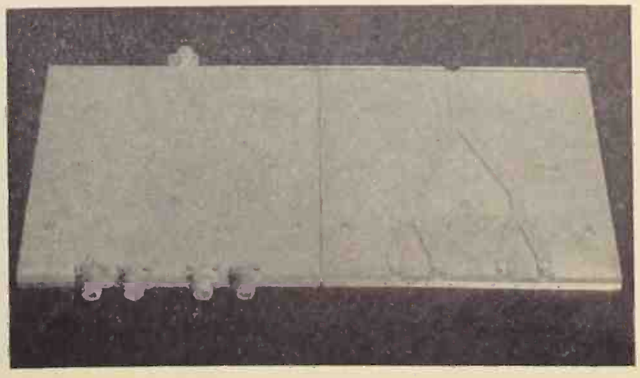
Accurate analysis of the capacity of these strips is somewhat difficult and tedious and will not be described here. An experimental evaluation of the flat strip transmission system made by the authors checks the theoretical values very closely. This measurement which was made, for convenience, at low radio frequencies, utilizes simple readily available equipment.

The method of measurement consisted of connecting a Q-meter and a precision

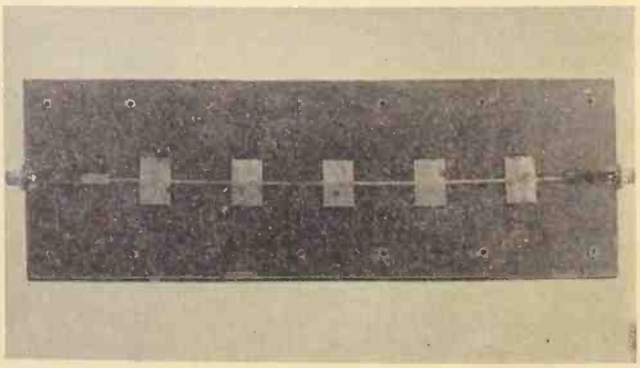
(*Continued on page* 31)

Abstract of a paper presented at the Dayton Airborne Electronics Conference, May 23-25, 1951.

Microwave power division network.



A five-section microwave filter.



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Sylvania Electric Products Inc. 1901–1951 Five Decades of Progress 50th Anniversary

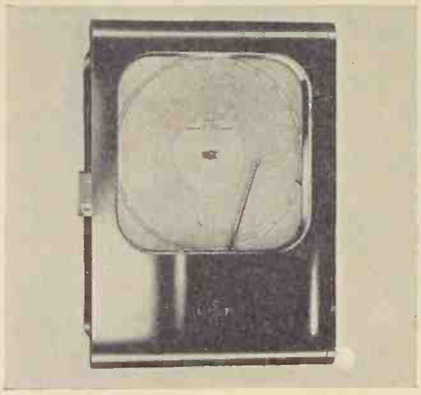
SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

NEW PRODUCTS

RUNNING-TIME RECORDER

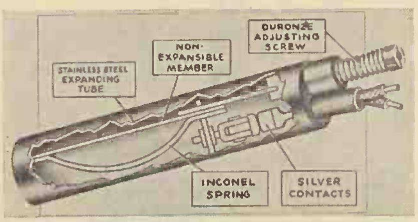
A new line of recorders has been announced by *The Bristol Company*, Waterbury 20, Conn. *Bristol* Running-



Time Recorders record on a chart the operating or "on" time of production machinery and other similar equipment. The chart record gives the total "on" time in hours, minutes, and seconds for a given period. "Time off" periods are also shown on the chart as well as the time at which they occurred. The recorder magnifies the running-time readings in such a way that the total operating time of a machine can be easily and accurately determined to within a few seconds. Three types of models are available for wall, flush-panel or portable use. Complete information on models, ranges, specifications, and uses are given in Bulletin OP1504, which is available from *The Bristol Company*.

THERMOSTAT

An entirely new design, originated by the *Smith Control & Instrument Corp.*, Palmyra, N. J., eliminates many difficulties which have been character-



istic of expanding tube thermostats. The new Scaico model utilizes a stainless steel tube as the expanding member and an Invar strip as the non-expanding member. An Inconel spring gives fast make and break action. An adjusting screw permits quick and easy setting of the control point at any temperature up to 600 degrees F. and no heating or cooling procedure is required to stabilize it. Scaico thermostats are made in three types for conduction, convection or immersion. Series 12 is ½ inch in diameter, 2³⁄₃₂ inches long for 600 watt loads at 110 or 230 volts a.c. or d.c., senstivity is .2 degrees F. on 1 ampere load. Series 58 is ⅝ inch diameter, 3 inches long for 1000 watt loads at 110 or 230 volts a.c. or d.c., sensitivity is 1 degree F. on 1 ampere load.

OSCILLOSCOPE

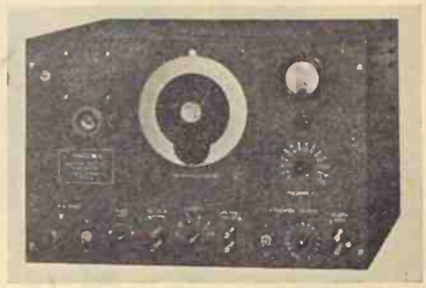
A new five-inch oscilloscope designed especially for use in microwave installations has been announced by *General*

Electric's Commercial Equipment Division at Electronics Park, Syracuse, N. Y. The new scope, type ST-2C has a high sensitivity and wide frequency response. The vertical sensitivity is 0.075 rms volts per inch; the vertical amplifier frequency response is 20 cycles to 3 megacycles. Also useful for television stations and general laboratory work, the new oscilloscope is of small weight (43 lbs.) and size to permit portability. All frequently used controls are located on the front panel and are grouped conveniently according to their function. The panel is simplified by the use of concentric controls in the sweep oscillator. The cathode-ray tube is cradled in rubber and is provided with a ¼ inch thick green-colored safety window.

Wide frequency response is obtained without recourse to peaked amplifier coupling circuits, resulting in excellent transient response. The entire vertical amplifier, sweep, and low level horizontal stages are supplied with d.c. operating potentials from an electronically-regulated power supply which allows the oscilloscope to be used under unusually severe power line fluctuations. To aid in amplitude measurements of voltages under test, a voltage calibrator is included which may be varied in seven steps, from .3 volts to 300 peak-to-peak volts.

SIGNAL SOURCE

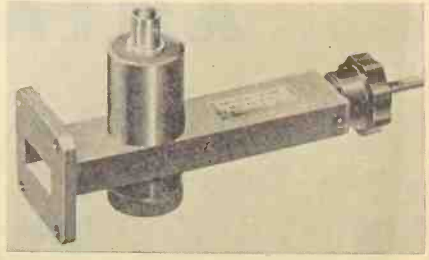
A new signal source of high accuracy in the ultrasonic frequency range has



been announced by *Kay Electric*, Maple Avenue, Pinebrook, N. J. This new instrument is called the Sonaligner. It is a very stable and accurate oscillator in the ultrasonic range suitable for use in determining the pass band of narrow band ultrasonic filters and other accurate work in this range. Outputs are developed at fundamental frequency —no beat oscillators. Crystal check points accurate to 0.01 per-cent are included, or the unit may be externally calibrated. A timing comb may be used for accurate alignment of radar range circuits. Output level meter and attenuators are included.

DETECTOR MOUNTS

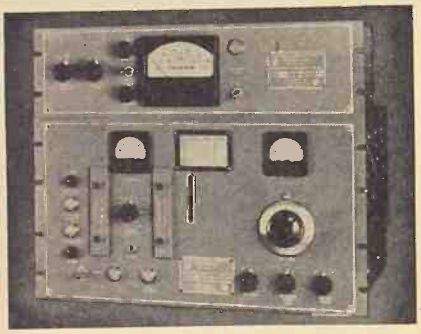
The *Hewlett-Packard Co.*, 395 Page Mill Road, Palo Alto, Calif. announces their -hp- 485 Detector Mounts which are designed to facilitate measurements of power at any frequency, 2.6 kmc. to



18.0 kmc., in conjunction with the -hp- 430A Power Meter and a Sperry 821 barretter. The equipment may also be employed to measure relative level or detect r.f. energy using a Type 1N21 silicon crystal. The mount is semi-tuned by means of a movable short. Additional tuning may be provided by addition of -hp- 870A Slide Screw Tuner or -hp- 880A E-H Tuner. The 485A Detector Mount is available in waveguide size 3 x 1½ inches for use with barretter only; 485B, for use with crystal, is available in sizes 2 x 1 inches; 1½ x ¾ inches, 1¼ x ⅝ inches; 1 x 1½ inches and .702 x .391 inch.

MONITOR SYSTEM

Designed as a secondary standard to monitor the frequency and shift of transmitter carrier outputs, the Frequency and Shift Monitor System announced by *Northern Radio Company, Inc.*, 143 W. 22nd Street, New York 11, N. Y., features the ability to measure the frequency shift of a mark and space (FS) signal, both during setting up for



traffic and under normal keying conditions. This system consists of a Type 106 Frequency & Shift Monitor and a Type 127 Electronic Frequency Meter. The stability of this unit is better than 2 cycles per megacycle over an ambient temperature range of 0-50 degrees C. It requires crystals having a temperature coefficient of only 3 parts per million per degree C. Its range is 2.5 — 30 mc. with 10 crystal-controlled frequencies; there are separate panel trimmers for each. In addition, the use of an external oscillator is provided for. The shift range is 10-10,000 C.P.S. Less than 100 millivolts r.f. input is required.

COUNTER

The Post Machinery Co., a subsidiary of *Reid Bros.* of Beverly, Mass., in collaboration with the *General Control Co.*, Boston 34, Mass., has adapted the Post Promatic Electronic Counter for general-purpose counting in several variations, including total count, rate of count, and predetermined count. The high-speed count is obtained through the use of photocell and electronic circuits. Miniature parts, as well as large

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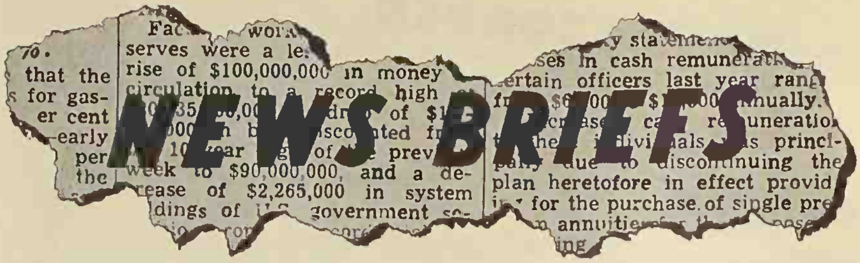


NEW PRODUCTION ORGANIZATION

Related to the established developmental company, *Sierra Electronic*

Corporation, a new production organization under the name of *Sierra Electronic Manufacturing Company* has been established in San Carlos, California. The new company has a similar roster of officers including Willard Feldscher, President; Paul F. Byrne, Engineering Vice President; and Leonard V. Bedell, General Manager.

Electronic Engineering Associates, Ltd., formerly *Electronic Associates, Ltd.,* is exclusive distributor of *Sierra's* principal products. All three companies are housed in a newly-completed building at 1050 Brittan Avenue, San Carlos, California.

PUSHBUTTON TEST

General Electric's universal "pushbutton" test set replaces four other test units in testing lighthouse tubes used widely for radar and communication applications. Merely by pushing individual buttons, the operator can test a tube for filament current; plate current; heater-cathode leakage; gas; mutual conductance; and pulse emission.

Prior to this new operation, the tubes had to run the gamut of four separate test units. In contrast to this new method, whereby the tubes are pre-heated only once, the former method of testing necessitated pre-heating the tubes prior to each test.

The set was developed by H. L. Woodcock, shown in the illustration, and is located in *GE's* Industrial and Transmitting Tube Division building at Schenectady.

IONOSPHERE

The propagation of radio waves over long distances depends on their reflections from the ionosphere, a series of electrically conducting layers in the earth's atmosphere. Because these layers are continuously changing, knowledge of their characteristics is necessary for regular and reliable radio

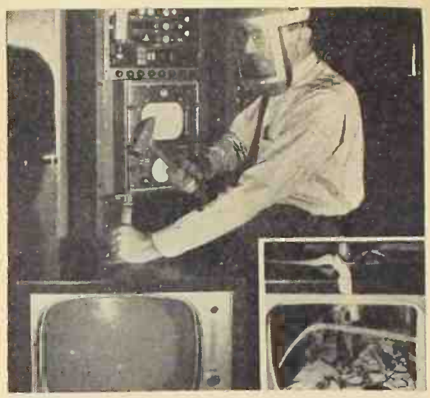
communications. The Central Radio Propagation Laboratory of the National Bureau of Standards collects and analyzes ionospheric data from stations all over the world. From the data, the Bureau makes and publishes predictions of useable frequencies for communications between any two places at any hour.

In an effort to obtain more comprehensive data on the ionosphere, the Bureau has incorporated a mobile ionospheric research unit into the existing chain of 60 world-wide ionosphere stations. The NBS mobile unit is made up of two prime movers and two trailers. Equipment includes two gasoline-powered motor-generators which provide 10,000 watts each of electrical power for transmitting, receiving, and recording components in the event commercial power is unavailable. One of the trailers has been converted into living quarters for the two-man operating crew for use in regions where living accommodations cannot be obtained.

The illustration shows the transmitting-receiving-recording equipment of the new mobile ionospheric station.

DESTRUCTIVE TESTING

One way to be sure that the protective glass panel in front of the cathode-ray tube of the *Westinghouse* television



set protects the viewer in case of tube failure is to break the tube. The illustration shows engineer Albert Bubb of the Television-Radio Division executing a hard blow to the picture tube. The tube breaks like an ordinary light bulb, except the explosion is more powerful and the pieces of flying glass are larger. Inset shows that the front glass did its part in this laboratory safety test.

CORONA LABORATORIES

The establishment of a new National Bureau of Standards laboratory center at Corona, Calif., to be devoted to various phases of electronic research, development, and engineering was announced by Dr. E. U. Condon, Director of NBS. The Corona Laboratories will be primarily concerned with the technical problems of importance to the Department of Defense. The site was transferred to NBS by the Dept. of the Navy because of the Bureau's urgent need for new facilities. About 22 buildings are being renovated to accommo-

date research and development activities. Dr. R. D. Huntoon, formerly chief of the NBS Atomic and Radiation Physics Division, has been named associate director to head the new laboratories. The most important activity at Corona will be the development of guided missles. Every phase of missle development will be covered from theoretical and applied research to construction of experimental parts and units.

The illustration shows an aerial view of the new laboratories.

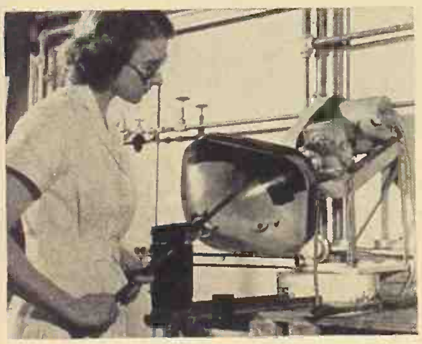
WANTED

Technical writers, to prepare reports on projects involving electronics, chemistry, mathematics, mechanics and similar scientific subjects are required immediately in the Ordnance Development Division of the National Bureau of Standards.

For full information, write to Personnel Officer, Ordnance Development Division, National Bureau of Standards, Washington 25, D. C. Applicants will save time by submitting immediately a Civil Service Form 57 obtainable from local postoffices, or from the Civil Service Commission.

PAINTING TELEVISION PICTURE TUBES

All sizes and shapes of television picture tubes are painted at *General*



Electric's picture tube laboratory at Electronics Park, Syracuse, N. Y. The illustration shows a lab technician painting the inside of a 20-in. glass TV picture tube, which will be used for developmental testing work at the lab.

POWER GENERATOR

Westinghouse electrical equipment, specially designed to power the two billion electron-volt Cosmotron, has successfully passed its first test at *Brookhaven National Laboratory*, Upton, N. Y. The 2200 ton magnet, key component of the accelerator, has been tested at its full power of 40,000 kilowatts.

Called the "Cosmotron" because it will give atomic particles energies equal to some cosmic rays, the giant

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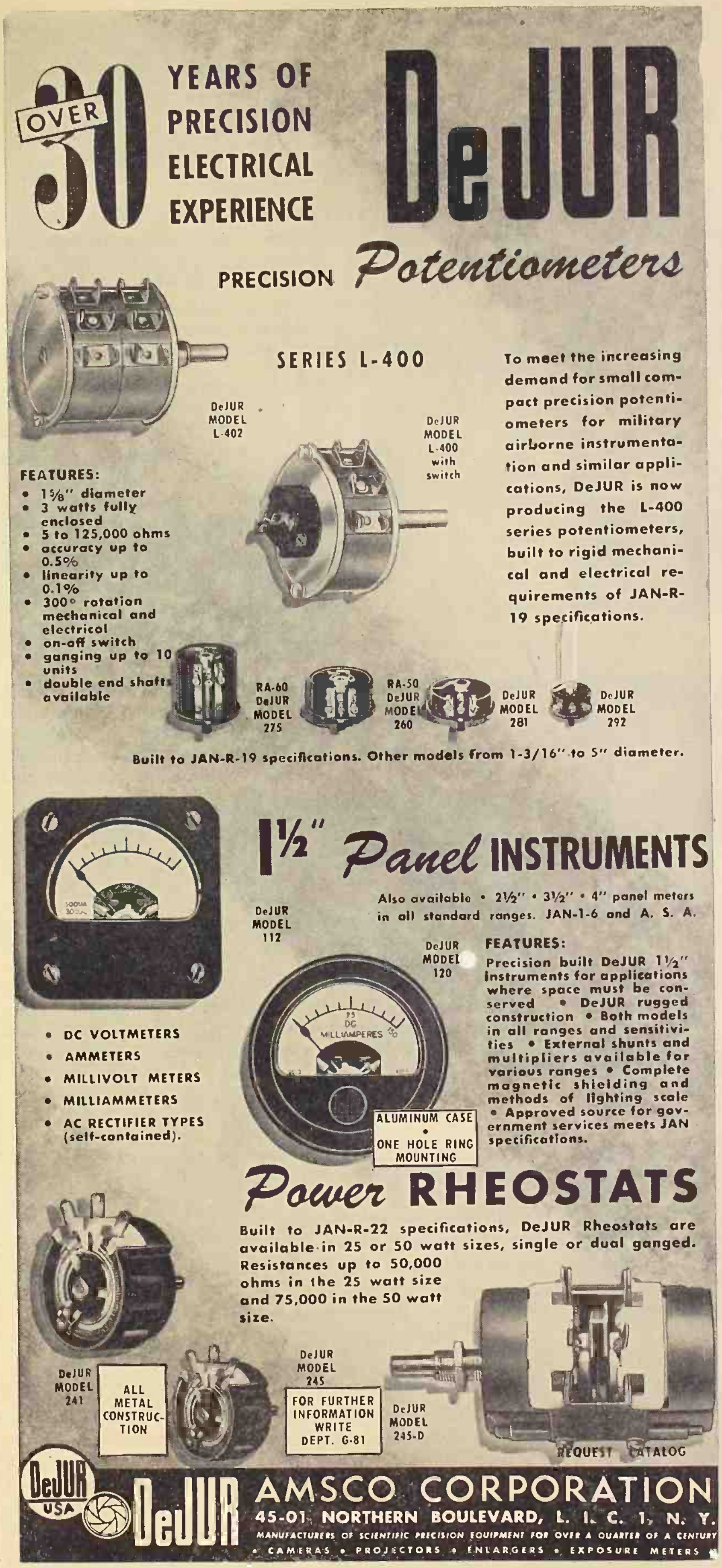


Personals

DR. C. J. BREITWIESER has been named executive assistant to Dr. F. R. Hensel, vice-president in charge of engineering at *P. R. Mallory & Co., Inc.* Dr. Breitwieser came to Indianapolis from California where he was chief of electronics and head of the engineering laboratories at *Consolidated Vultee Aircraft Corporation.* He holds a Master of Science degree from the University of North Dakota.

E. V. HUGGINS has been elected executive vice-president of *Westinghouse Electrical International Co.*, the foreign trades subsidiary of *Westinghouse.* He had been secretary for the company for three years and also headed the Law Dept. Mr. Huggins is a native of Wisconsin and attended Yale University, from which he was graduated in 1929 and from Yale Law School in 1932. He then joined *Westinghouse* Law Department in 1943.

DR. R. D. HUNTOON has been appointed associate director of NBS's new Corona Laboratories, near Corona, Calif. He has received wide recognition for research on atomic-beam measurements, special amplifiers, atomic particle counting, study of deuteron-deuteron nuclear reactions, and the phasing of oscillators. Dr. Huntoon was born in Waterloo, Iowa and received his B.A. from Iowa State Teachers College in 1932.

DR. SAUL ROSEN has joined the Research Div. of *Burroughs Adding Machine Co.* Dr. Rosen received his B.S. degree at City College of N. Y. in 1941, his M.A. from Univ. of Cincinnati in 1942, and his Ph.D. from the Univ. of Pennsylvania in 1950. He has been an instructor of mathematics at several universities, and is a member of Phi Beta Kappa, Sigma Xi, Mathematical Assoc. of America, and the American Mathematical Society.

S. FLOYD STEWART has been elected executive vice-president of the *Arma Corporation* of Brooklyn, N. Y., subsidiary of *American Bosch Corp.* Mr. Stewart joined *Arma* from the *Leece-Neville Co.* of Cleveland, where he was successively chief engineer, vice-president and executive vice-president. He was graduated from Washington University, St. Louis, and Massachusetts Institute of Technology, where he received a Master's Degree in 1925.

CARL WASMANSDORFF has been appointed director of engineering for the *Hoffman Radio Corp.*, Los Angeles. He has been with the *Hoffman* organization since 1943. Mr. Wasmansdorff is one of the leading authorities on code communication and noise reduction in the country, and holds several patents. He is a member of various engineering and scientific groups and has prepared technical papers for many conventions.

News Briefs

(*Continued from page 23*)

machine is designed to accelerate protons to energies exceeding two billion electron-volts, five times greater than those provided by the largest existing cyclotron.

The energy is supplied by a large motor-generator set, equipped with a 45 ton flywheel, that delivers alternating current to a battery of 24 ignitron rectifiers. These rectifiers convert the alternating current into 40,000 kw. direct-current pulses. Twelve pulses per minute are sent into the Cosmotron magnet to guide the sub-atomic particles around the acceleration chamber.

MEETING

The first Fall joint meeting of the U.S.A. National Committee of URSI and IRE Professional Group on Antennas and Propagation at Ithaca, N. Y. will be held on October 8, 9, and 10, 1951. The School of Electrical Engineering of Cornell University will be hosts and the meetings will be held on the University Campus.

A program of titles and abstracts will be printed for distribution at the time of the meeting, and a mimeographed tentative program of titles and sessions will be circulated prior to the meeting. Advance registration fee will be $2.00, while the registration fee at the meeting will be $2.50. Registration may be made in advance directly to Dr. A. H. Waynick, Secretary, U.S.A. National Committee of URSI, The Pennsylvania State College, State College, Pa.

POLYMERIZATION

The possibility of making solid plastics from raw materials by bombarding them with high-voltage electron beams, or cathode rays, is foreseen as a result of experiments reported by two scientists of the *General Electric Research Laboratory*, Schenectady 5, N. Y.

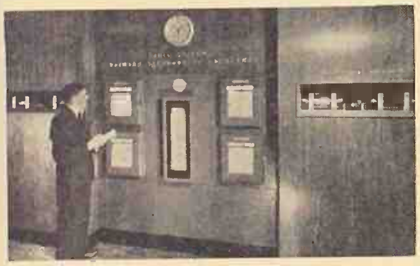
An essential part of the manufacture of plastics, Dr. John V. Schmitz and Elliott J. Lawton explained, is a process called "polymerization," in which small groups of atoms are linked together to form long chains. The individual groups can move around freely, so that they form a liquid, but the chains make a rigid, solid structure. They found that a beam of electrons with energies of 800,000 volts, brought into open air, is able to cause polymerization. Most of their experiments were performed with a compound known as TEGMA (Tetraethyleneglycol dimethacrylate) but they found that various other compounds could similarly be polymerized.

TIMEKEEPER

A new and extremely precise "master timekeeper" has been placed in operation at the *Bell Telephone Laboratories* at Murray Hill, N. J. It is expected to vary less than one ten-thousandth of a second per day; this corresponds to a precision of one second in 30 years. The secret of this split-second precision lies in four stable quartz crystals which vibrate constantly at a frequency of 100,000 cycles per second. The vibrations of the crystals control the frequency of a special electric current with a precision of one part in a billion.

The apparatus is used by the telephone companies to monitor or regulate equipment for the coaxial cable and radio relay television and telephone networks, as well as overseas, ship-to-shore and mobile radiotelephone service. Power is derived from storage batteries.

The equipment is housed in air-conditioned rooms where the temperature



never varies more than two degrees. The crystals . . . each about the size of a paper matchbook . . . are enclosed in containers from which all the air has been pumped out, and these in turn are surrounded by thermostatically controlled ovens to maintain the temperature of the quartz crystals constant to within a hundredth of a degree.

STORAGE SYSTEM

International Business Machines Corp. has introduced the cathode-ray tube storage system developed by Prof. F. C. Williams, noted English radar expert. *IBM* will use the Williams system under a licensing agreement with the *National Research Development Corp.* of London. The agreement gives *IBM* full use throughout the world of *NRDC* patents in the computing field, including many involved in the new Manchester machine, of which Dr. Tom Kilburn is co-inventor with Prof. Williams.

In the cathode-ray storage system, information required in a calculation is stored in the form of dots and dashes on the face of the tube in a manner similar to the projection of a picture on a home television tube. The information is read back from the tube to the electronic computer in a few millionths of a second, by passing the cathode-ray beam over the same area. As many as 2048 items of information have been stored on a cathode-ray tube with a 24 square inch screen.

TV TUBE TESTING

Each tube tested at *General Electric's* tube manufacturing building at Electronics Park, Syracuse, New York, undergoes a complete series of electrical tests, including screen conditions and

electrical operating characteristics.

Shown is a 24 inch metal picture tube being tested, although the test is capable of testing tubes ranging in size from the 8½ inch to 24 inch. Tubes shown on the rack are 19 inch metal picture tubes.

HOOVER MEDAL AWARD

Dr. Karl T. Compton, Chairman of the Board, Massachusetts Institute of

Technology, is shown receiving the Hoover Medal from Dr. Scott Turner. The Medal is awarded jointly by the electrical engineering group, The American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining and Metallurgical Engineers.

Dr. Compton is the twelfth engineer to receive the medal since it was first

(*Continued on page* 27)

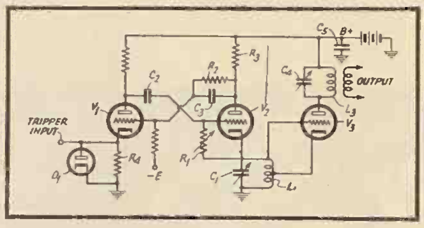
PATENT REVIEW

Printed copies of these or any other patents may be obtained from the U. S. Patent Office for 25c each. Address the Commissioner of Patents, Washington 25, D. C.

TRIGGER CONTROLLED OSCILLATOR

Trigger controlled oscillators have numerous applications where it is desired to produce a source of standard frequency which may be started and stopped easily. This invention provides such a system wherein the time delay or phase between the triggering pulse and the start of oscillations remains constant, regardless of the random character of the triggering pulses.

The tank circuit of a conventional oscillator is shunted by a normally conducting triode, preventing operation of the oscillator. This triode is in turn con-



trolled by another triode normally cutoff, actuated by the triggering pulse. This pulse causes the first triode to conduct, cutting off the second triode and permitting oscillations to start. Oscillations will continue until the second tube returns to a conducting condition, the time required for this return being controlled by the condenser and resistor in the grid circuit.

A modification of this circuit utilizes a crystal-controlled oscillator. A further modification permits oscillations to continue until a second pulse is received.

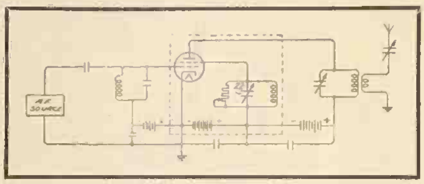
Patent No. 2,554,308 was issued May 22, 1951, in the name of William A. Miller.

CLASS C AMPLIFIER OUTPUT

The efficiency of a Class C amplifier may be increased by causing a rectangular waveform of anode current to flow while the anode voltage is at a minimum. It is the purpose of this invention to provide a means for approaching this desired rectangular waveform.

The introduction of a third harmonic signal in the screen circuit, properly phased, will reduce the peak anode current, and if the amplitude is correct, will result in a considerable squaring-off of the anode pulses. This signal may be introduced by inserting a tuned circuit in the screen grid of the amplifier, resonant at the third harmonic. A variable resistor connected across this tuned circuit provides the necessary amplitude control.

Further squaring may be accom-

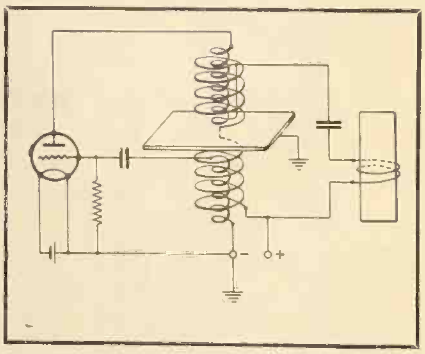


plished by introducing other harmonics, such as the second, in the same manner. The system may also be applied to push-pull Class C amplifiers.

Patent No. 2,554,457 was issued on May 22, 1951, in the name of Robert B. Dome.

HIGH FREQUENCY OSCILLATOR

The purpose of this invention is to provide a further increase in efficiency over that provided by a conventional



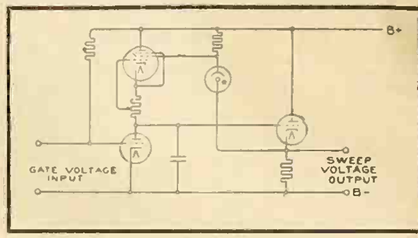
back-coupled oscillator such as that used for high-frequency heating. This is accomplished by providing an auxiliary coil in the anode circuit which, together with the load circuit coil, provides a step-up of the resonant resistance of the oscillator circuit.

There are limitations in the above circuit due primarily to parasitic oscillations. According to this invention, the efficiency may be further increased by the mechanical arrangement shown in the drawing, and by the insertion of a shield to prevent direct inductive coupling.

Patent No. 2,554,087 was issued May 22, 1951 in the name of Syste Breimer.

LINEAR SWEEP GENERATOR

A saw-tooth waveform is essential to the operation of most cathode-ray tube



devices. In general, such a waveform is produced by charging a condenser slowly and then discharging it suddenly. Only the relatively linear portion of the charging curve is used.

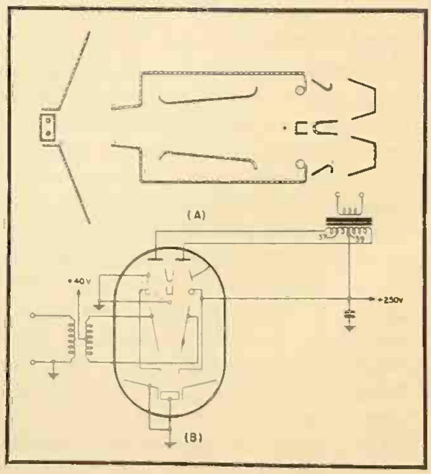
By charging the condenser through a constant current device and then discharging it through an auxiliary tube, a great improvement in linearity may be obtained. In this invention, the constant current device is a pentode with constant screen-to-cathode voltage. Several circuit arrangements are possible, one of which is shown.

Patent No. 2,554,172 was issued May 22, 1951 in the name of Thomas G. Custin.

PUSH-PULL OUTPUT TUBE

This invention describes a deflection-controlled output tube which permits much greater than normal efficiencies for Class A operation, with distortion and output characteristics somewhat similar to present-day pentodes.

In the illustration, (A) shows a cross-section of the element structure, and (B) shows a schematic of the device. A sheet of electrons, perpendicular to the plane of the paper, is formed and ac-



celerated in a conventional manner. This sheet passes between a pair of deflection electrodes on which the signal is impressed. The signal deflects this sheet up or down, (A), so the electrons are divided and flow to the upper, lower, or neutral electrode, depending upon the signal. Thus, push-pull action is provided.

In an experimental model, a power output of 1.6 watts was obtained from a single-ended rms output of 11 volts at 1000 cycles with 5% distortion. Beam current was 13 ma. at 290 volts.

Patent No. 2,553,735 was issued May 22, 1951 in the name of Robert Adler.

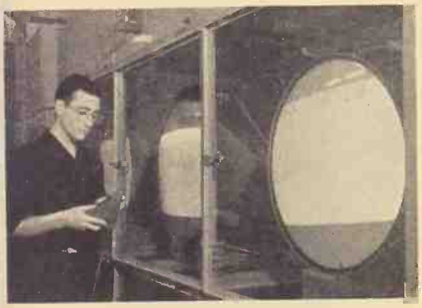
News Briefs

(*Continued from page* 25)

awarded to Herbert Hoover in 1930. It is presented "for distinguished public service."

LIFE-TESTING

A group of 24-in. television picture tubes being life-tested at *General Electric's* television picture tube plant at Electronics Park, Syracuse. This life-test is one in a series of quality control tests which the tubes go through before being shipped from the factory.



GENERAL MANAGER

Mr. Earl E. Bradway has been named general manager of *DeJur-Amsco Corporation*, Long Island City, N. Y., manufacturer of industrial meters, precision potentiometers and rheostats. Mr. Bradway spent several years as a consulting engineer and recently resigned as president of the *Colgate Manufacturing Corp.* to accept his present position.

PROMOTION

Harvey J. Finison, assistant chairman of electrical engineering research at Armour Research Foundation of Illinois Institute of Technology has been promoted to chairman of the department at the Foundation.

Virgil H. Disney, James L. Murphy, and Raymond E. Zenner will be assistant chairmen of electrical engineering research. All were supervisors of operating sections of the department.

Finison was an application engineer for *GE* from 1944 to 1949, when he joined the Foundation. He was an electrical engineer for the Air Materiel Command from 1940 to 1944.

Disney became supervisor of electronics at the Foundation in 1949, and Murphy supervised electronics research since 1946.

NEW LITERATURE

Microfilming Booklet

A 12-page illustrated booklet "Facts and Figures on Microfilming Engineering Drawings" is available from *Micro Photo Service Bureau*, 4614 Prospect Avenue, Cleveland 3, Ohio.

This booklet presents pertinent information on the importance of microfilming, costs, equipment, film storage, film processing, and many other related subjects.

Pulse Mixer

(*Continued from page* 11)

amplitude (6 to 60 volts), appeared as 0.1 μsec output pulses with individual amplitude variations not exceeding 5%. A chain of 60 volt pulses produced no noticeable variation on the output amplitude, nor did a single 100 volt pulse. However, 50 volts maximum is recommended so as to keep well within the rated maximum voltage for the 1N34 crystals.

The pulse-amplitude control (see Fig. 1) varies the amplitude of the output pulses up to 35 volts. The scale is not calibrated, but if precise readings are required a vacuum-tube voltmeter can be used. The pulse-polarity switch is provided so that positive or negative output pulses are available. Although the new M.I.T. test units all operate with positive pulses, the polarity switch is included on each so that the equipment will be compatible with other test instruments.

One operational difficulty which is most likely to necessitate maintenance work is unequal amplitude of the output pulses. This fault is usually due to a defective bus-driver crystal in series with the output transformer, or a defective crystal diode and/or damping resistor across the *R-L-C* peaker inductance, and these components should be checked regularly.

Another worthwhile precaution is to make sure that the noise level of input pulses is not more than 2 volts positive; otherwise the noise will be amplified by the unit and appear at the output. If the noise level is too high (6 volts or more) it will be converted into standard pulses at the output.

TECHNICAL BOOKS

"THEORY AND DESIGN OF TELEVISION RECEIVERS" by Sid Deutsch. Published by *McGraw-Hill Book Company, Inc.*, 330 West 42nd St., New York 18, N. Y. 536 pages. $6.50.

This new book presents a physical explanation for the behavior of various television receiver circuits, develops related mathematical theory, and discusses the practical design of television receiver circuits. The standards governing television transmission are reviewed first, followed by two chapters outlining the mathematical background necessary for an understanding of subsequent topics and nine chapters treating the basic sections of a receiver. Three succeeding chapters deal with special circuits and systems, and a final chapter discusses receiver servicing techniques.

The particular treatment provided in this book offers to the engineer a considerably improved approach to the study of television receivers by considering the various sections in a logical order from antenna to the picture tube, giving numerous illustrations of all topics considered, and by concentrating solely on the study of receivers. All recent developments in the field of television receivers are included.

"ULTRASONICS" by P. Vigoureux. Published by *John Wiley & Sons, Inc.*, 440 Fourth Avenue, New York 16, N. Y. 163 pages. $4.00.

The object of Vigoureux' book is to introduce the scientist or student to the technique and to the simpler aspects of the theory of propagation of ultrasonics in fluids. Regarding technique, the author stresses the principles used, rather than detailed descriptions of apparatus or of experimental procedure. The theoretical treatment is as simple as possible, consistent with the explanations of phenomena available to date.

In recent years, the interest in waves above the limits of audible sound has grown tremendously. And with this interest, scientists have discovered a myriad of uses for waves of ultrasonic frequencies. The chapters in this book on propagation, gases, and liquids deal with theory and results; those on generation and observation mostly with apparatus and methods. The latter chapters, therefore, may be skipped by those who are not concerned with experimental details.

New Products

(*Continued from page 21*)

bulky units, may be easily and accurately counted. The counter automatically energizes an external circuit for

the purpose of segregating batches at the end of the predetermined count. A visual six-digit totalizer indicates the exact count, while a rate meter shows at all times the rate of count per hour. The counter is housed in a gray cabinet, and may be located as far as 75 feet away from the photocell head. Industrial type tubes and rugged components are used in its construction. The unit operates from a 115 volt, 60 cycle unit, and is capable of counting in excess of 10,000 units per second, either accumulative or predetermined.

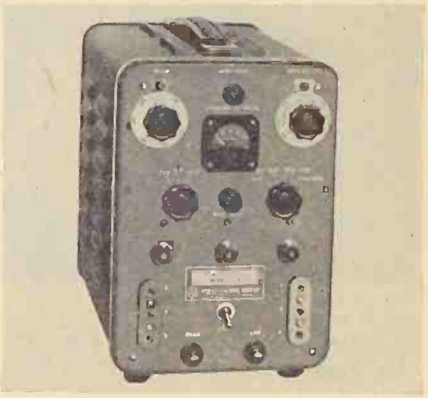
LABMARKERS

The *Berkshire* Labmarker is a wave-shaping device for producing time marks in cathode-ray oscillography. A sinusoidal input is converted by the Labmarker into a series of sharp unidirectional pulses. Timing marks consisting of short breaks in the oscilloscope trace are obtained by connecting the output of the labmarker to the "Z" input terminals of the oscilloscope. Model 1-U1 differs from previously announced Model 1-U in that it gives shorter pulses of less amplitude. The pulse duration is approximately one-tenth of a cycle. Peak amplitude of the output pulse is approximately one-

twentieth of the rms input voltage, which may be up to 36 volts. Frequency range is from 25 cycles to one megacycle. Overall length is 5½ inches, and diameters are 1¾ inches for the 1-U1 and 1½ inches for the 1-N1 and 1-P1. For further information write to *Berkshire Laboratories*, 504 Lexington Road, Concord, Mass.

POWER SUPPLY

A new precision instrument for greater convenience and accuracy in waveguide measurement has been added to the *Hewlett-Packard Company's* line of waveguide test equipment. The new -hp- 715A Klystron Power Supply is designed for test-bench operation of all types of low-power Klystron oscillators. The instrument provides a beam voltage continuously variable from 250 to 400 volts at 50 milliamperes maximum. Reflector voltage is variable from 10 to 900 volts at 5 microamperes. The unit also provides for square wave modulation at 1000 c.p.s. or may be modulated from an external source. In addition, the new power supply gives a filament supply of 6.3 volts at 1.5 amperes. -hp- 715A Klystron Power Supply is mounted in a sturdy, compact,



steel case equipped with carrying handle. For further information write to *Hewlett-Packard* at 395 Page Mill Road, Palo Alto, Calif.

SAMPLING MONITOR

To aid quality control engineers in continuous sampling, *General Electric's* Special Products Division, Schenectady 5, N. Y., announces the development of a "continuous sampling monitor," an electrical device which automatically keeps track of the sampling procedure. Briefly, the monitor works in this way: An electric counter, set to any predetermined number from 1 to 400, automatically keeps track of the clearance number. When the counter reaches the set number, contact is broken, and the white sampling light goes on indicating that the predetermined number of acceptable units has been inspected, and that sampling can resume. Percentage inspection or sampling may vary from 1 per-cent to 50 per-cent depending on the desired average outgoing quality evel. The monitor requires 110 volts and has a maximum counting speed of 500 units per minute. The unit is housed in a small 12 x 6 x 6" cabinet.

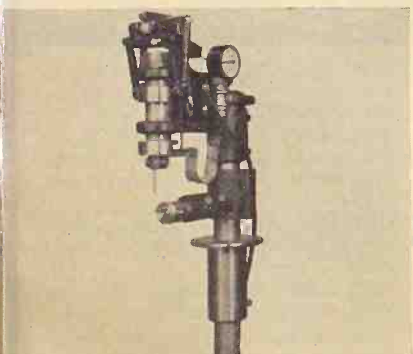
SURGE DAMPING VALVES

The *Denison Engineering Co.* of Columbus, Ohio has developed new surge damping valves which eliminate excessive shock in high pressure hydraulic

systems. Small and compactly designed, they are individual units universally adaptable to any hydraulic circuit, can be installed as easily as any ordinary fitting, and do not interfere with other functions of the circuit. Test setups over many months proved that the valve will prevent shock from occurring, rather than simply absorbing hydraulic surge and consequent shock. The valve adjusts itself automatically to any working pressure, requires only a fraction of a second to act, and cannot slow down cycle time.

WELDING HEAD

The *Raytheon Manufacturing Company*, Waltham 54, Mass., announces the design of a new welding head to be used for welding dissimilar metals in the assembly of radio and other electronic tubes, as well as for the assembly of other small metal parts. The new Model I-S Weldpower is extremely small

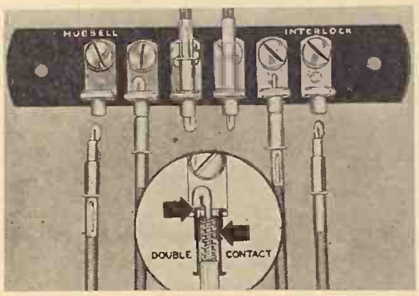


and compact, 3½ x 9½ x 8½ inches, is a bench-mounted, press-type unit with single post mounting. Accurate electrode pressure is made possible through the use of a closed air system using a metal bellows, and instantaneous electrode follow-up is achieved by keeping the mass of the moving parts of the upper electrode assembly extremely low. Either ⅛ or ¼ inch electrodes can be used interchangeably. The lower electrode mounts either horizontally or vertically.

ELECTRONIC CONNECTOR

Harvey Hubbell, Inc., Bridgeport 2, Conn., manufacturers of electrical wiring devices and machine screws, announce a new type of electronic connector. The "Hubbell-Interlock" connectors feature new locking and contact characteristics. Straight insertion at the terminal locks the plug securely in its outlet, without the necessity of screws, clips or tools. The contact parts form the lock, and the locking engagement is positive as well as shock and vibration proof. A slight pull on the flanged sleeve releases the locking mechanism and the plug for facilitating removal.

The special electrical features of the connectors are the frictional contact, as in other types of connectors and the knife-edge contact, effected by the lock-



ing contacts in plug and outlet, and held under constant coil spring pressure, providing constant contact pressure of approximately 20 oz. The connector is rated at 10 amps., 110 volts. Terminals and wiring tools can be supplied to suit all wiring conditions. Data sheets, test reports, and samples are available upon request from Department X.

NEW PYRANOL

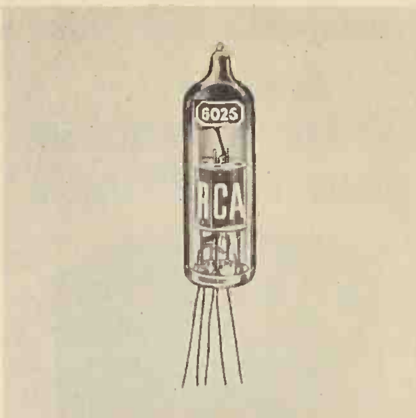
The development of a new, low-temperature Pyranol, which greatly extends the useful range of specialty Pyranol capacitors, has been announced by the Transformer and Allied Product Division of the *General Electric Company*, Schenectady 5, N. Y. The former Pyranol, which made possible a one-third reduction in physical size of specialty capacitors, had its application limited in a few cases by its low-temperature characteristics. The new, low-temperature Pyranol has no loss in capacity down to —32 degrees C. The use of this development in capacitors for such applications as capacitor motors, fluorescent ballasts, etc., means that the cold-weather uses of these units will be greatly extended.

NEW TUBES

RCA TUBES

Oscillator Triode

This new, flexible-lead, subminiature tube type 6026 is an oscillator triode designed especially for transmitting serv-



ice at 400 mc. in radiosonde and similar applications. In such service, it can deliver a useful power output of 1¼ watts. The subminiature structure of the 6026 features very short transit time and low interelectrode capacitance, and is useful in equipment requiring extreme compactness because of its very small size and very light weight.

Picture Tube

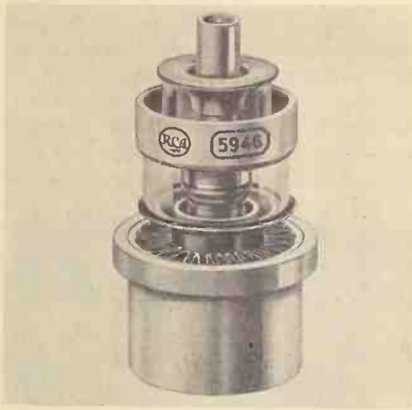
The Tube Department of *Radio Corporation of America*, Harrison, N. J., announces their new short, directly viewed, 21AP4 rectangular picture tube of the metal-shell type for use in tele-

vision receivers. It has a picture size of 18⅜x13^15^/16 inches with slightly curved sides and rounded corners. Its design incorporates a white fluorescent screen on a high-quality faceplate made of frosted Filterglass to prevent reflection of bright objects in the room and to provide increased picture contrast. Employing magnetic focus and deflection, the 21AP4 has a maximum high-voltage rating of 18,000 volts; an ion-trap gun for use with an external single-field magnet for eliminating ion-spot blemish; a diagonal-deflection angle of 70°; a horizontal-deflection angle of 66°.

Power Triode

Also announced by *RCA* is a compact, forced-air-cooled power triode designed for u.h.f. plate-pulsed oscillator and amplifier service. In such service, the 5946 has a maximum rated plate dissipation of 250 watts, and can be operated with full plate voltage at frequencies up to 1300 megacycles.

A special feature in the design of the 5946 is a coaxial-electrode struc-



ture for use with circuits of the coaxial-cylinder type, providing low-inductance, large-area, r.f. electrode terminals for insertion into the cylinders. Effective isolation of the plate from the cathode makes this triode particularly suitable for grounded-grid circuits.

Picture Tubes

Three new rectangular picture tubes featuring electrostatic focusing have been announced by *RCA*. The 14GP4, 17GP4, and 20GP4 require no focusing coil or focusing magnet, and each uses an improved electron gun to provide uniformity of focus over the entire picture area.

The 14GP4 is of the all-glass type with external conductive bulb coating, has a maximum high-voltage rating of 14 kilovolts, and produces 12⅜" x 8½" pictures on a face of Filterglass. The 17GP4 is of the metal-shell type, has a maximum high-voltage rating of 16 kilovolts, and produces 14⅝" x 11" pictures on a relatively flat, frosted Filterglass. The 20GP4 is of the all-glass type with external conductive bulb coating, has a maximum high-voltage rating of 18 kilovolts, and produces 17¼" x 13¼" pictures on a Filterglass face.

Employing magnetic deflection, each of the three types has a diagonal deflection angle of 70° and a horizontal deflection angle of 66°.

GE THYRATRON

General Electric's Tube Divisions announce a new heavy-duty thyratron tube for control applications. Designed especially for the exacting requirements of airborne electronic-control equipment, the GL-6044 has a basing ar-

rangement which provides both electrical connection and mechanical support. Instead of the prong-type base for insertion into a socket, the tube has contact terminals extending at right angles from heavy support rods at the bottom on the tube. With these terminals the tube can be bolted securely to a control panel without any possibility of the tube working loose through vibration of the equipment.

GL-6044 will operate efficiently from temperatures as low as —55° C. up to 120° C. at normal atmospheric pressure.

CALENDAR of Coming Events

SEPT. 10-13 — NEDA Second Annual Electronic Parts Distributor Show, Cleveland, Ohio.

OCT. 8-10 — Fall Meeting of U.S.A. National Committee of URSI and IRE Professional Group on Antennas and Propagation, Ithaca, N.Y.

OCT. 22-24—7th Annual National Electronics Conference, Edgewater Beach Hotel, Chicago.

OCT. 22-26 — Fall General Meeting, AIEE, Cleveland, Ohio.

OCT. 23-25—Forty-second meeting of the Acoustical Society of America, Sherman Hotel, Chicago, Ill.

OCT. 25—Twentieth anniversary of the American Institute of Physics, Sherman Hotel, Chicago, Ill.

OCT. 29-31—Radio Fall Meeting, King Edward Hotel, Toronto, Ont., Canada.

NOV. 1-3 — Audio Fair, Hotel New Yorker, New York City.

Dielectric Standards

(*Continued from page* 15)

This resonance technique is used over a wide frequency range and is particularly applicable at frequencies above 100 mc. At these frequencies the inductor becomes a single turn; therefore a doubly reentrant resonant cavity (essentially a coaxial structure shorted at both ends with a variable gap in the center conductor) of either fixed or variable length is utilized. The test specimen occupies the gap between the reentrant posts. The frequency of operation of the fixed-length cavity is governed by the constants of the specimen inserted between the reentrant posts as well as by the geometry of the cavity. Consequently, the operating frequency cannot be specified in advance. The variable electrode, similar in structure to the movable electrode of the micrometer electrode system described previously, is also micrometer-controlled and is calibrated at the lower frequency in terms of the capacitance between the reentrant posts. This again permits measurements without appreciable corrections for lead inductance. The techniques used in the resonance method are equally applicable to reentrant-cavity measurements. Resonant cavities are advantageous because Q's of the order of 1000 to 3000 are readily obtainable, thus providing convenient voltage ratios even in the case of very low-loss specimens such as polystyrene or quartz.

In this region, resonant circuits with Q's of this magnitude are not common at frequencies below 50 mc. Therefore, it is necessary to resort to special circuitry in order to obtain low-loss measurements at these frequencies. A suitable circuit can be achieved using a linear, stable negative resistance. When this resistance is connected in series with an inductor and a conventional micrometer electrode, it can be adjusted to very nearly cancel the resistance of the rest of the system, thus producing a resonant measuring system of extremely high Q. As a result, the losses in the system are primarily due to the specimen, thus enabling an accurate evaluation of its dielectric properties.

The circuit used is effectively a cathode follower with a capacitive load and increased grid-to-cathode capacitance. Under these conditions the real component of the input impedance has a large negative magnitude and can be adjusted by varying one of the circuit parameters. The large amount of negative feedback makes the circuit extremely stable and yields excellent linearity because only very low amplitude signals are applied. Q's of 100,000 have been obtained with an instability of only a few per-cent over a period of ten minutes, with no detectable deviation from the normal resonance curve resulting from non-linearity. These conditions make it possible to measure dissipation factors of the order of 10^{-5} to an accuracy of about 10 per-cent and, of course, lower losses (less than 10^{-5}) with less accuracy.

Studies are continuing in an effort to extend the frequency range of the negative-resistance system so that it may be used at any frequency up to those at which cavity methods become practical. Other work in progress is directed toward the adaptation of the system for measuring the dielectric constants of gases.

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Printed Circuits

(*Continued from page* 16)

standard capacitor across the transmission system. The transmission system was connected and the standard capacitor was set at 100; the Q-meter was then balanced. The transmission system was disconnected and the standard capacitor adjusted to rebalance the Q-meter. The difference in standard capacitor readings was then taken to be the capacity of the transmission system. From this, Z_0 (the characteristic impedance) can be calculated.

The planar transmission system can be adapted to printed circuit techniques by using two sheets of solid dielectric as spacers between the outer conductors, the center conductor being supported between these sheets. This center conductor can then be printed on one of the dielectric sheets in conducting paint by the silk screen printing process. Experimental work can also be accomplished by using a metal foil center conductor which can be cut with scissors.

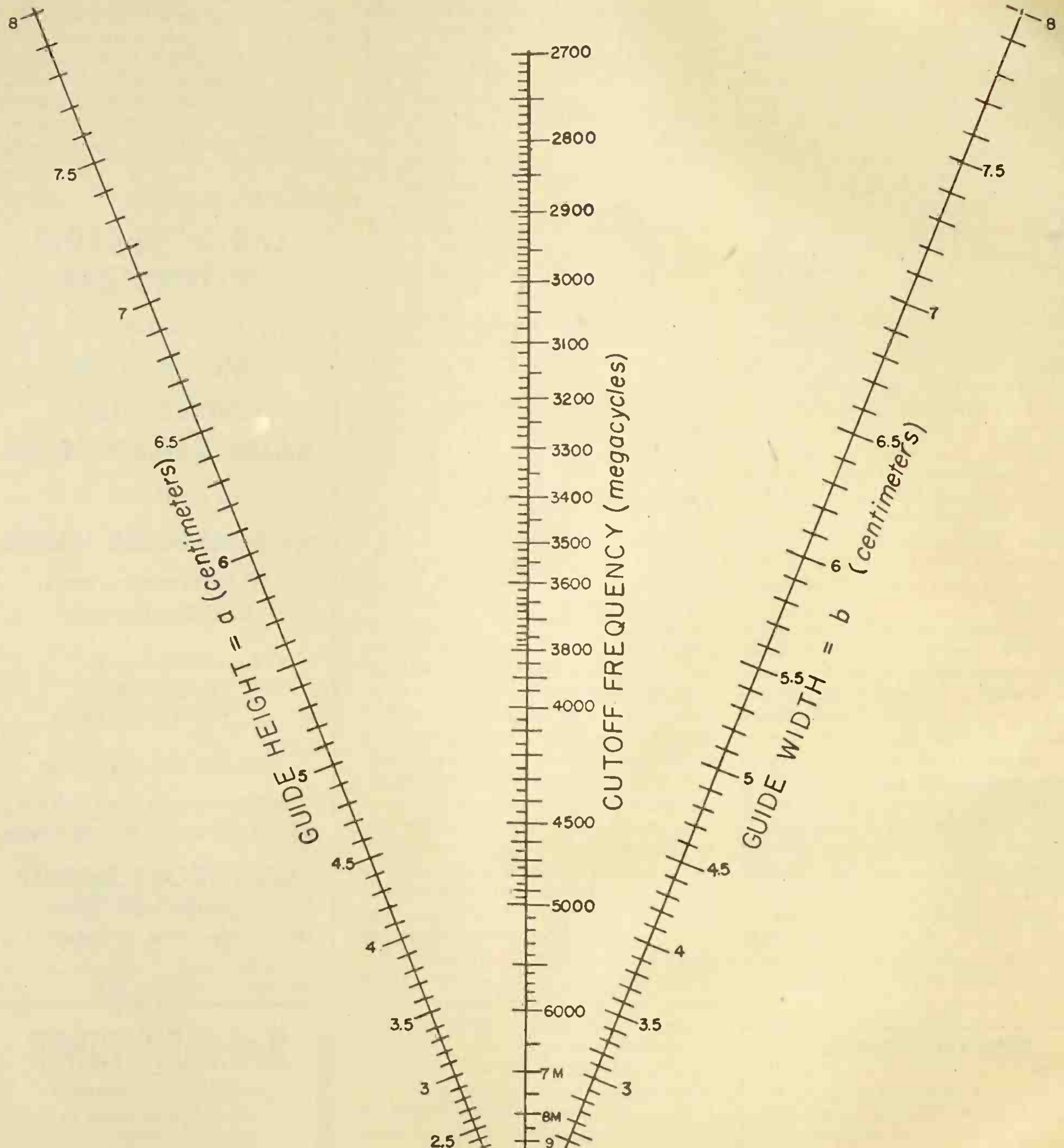
Since the characteristic impedance of the system is a function of strip width, it is readily adaptable to circuits requiring impedance changes. This principle was used in the design of a series of power dividing networks for a special problem being worked on in the Air Force Cambridge Research Center. The two-to-one power splitter is typical of these devices. Similar devices

Microwave printed circuit matched load.

in coaxial or waveguide systems are more bulky and much more difficult to construct. Low-pass microwave filters made by this method have been designed, constructed, and tested in half a day — a process which by standard methods would take a great deal more work and would result in a much heavier filter.

$TM_{1,1}$ WAVES IN RECTANGULAR WAVE GUIDES

This nomograph permits the determination of the cut-off frequency when the dimensions of the guide are given.



Courtesy of Federal Telephone and Radio Corporation