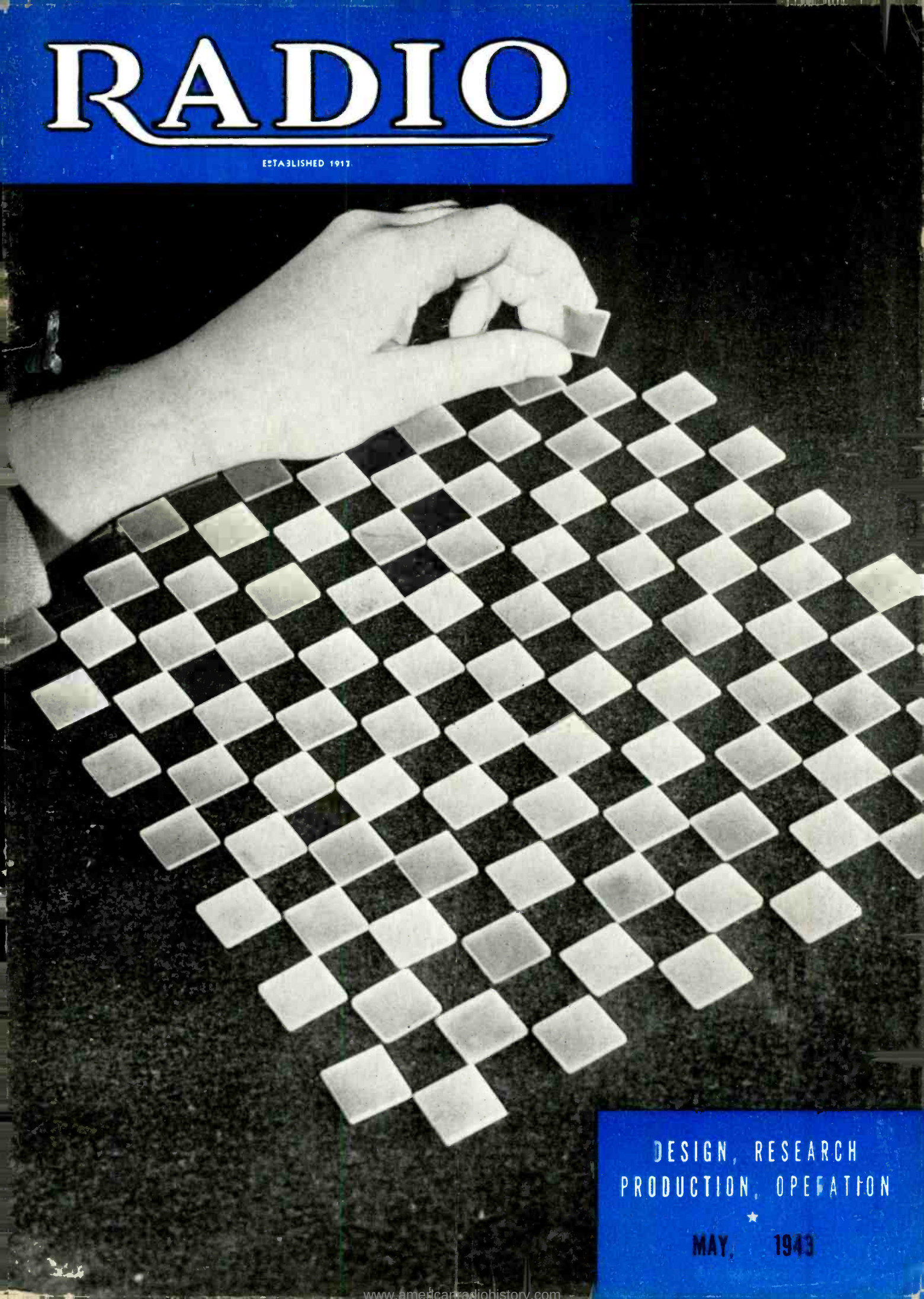
RADIO

ESTABLISHED 1917



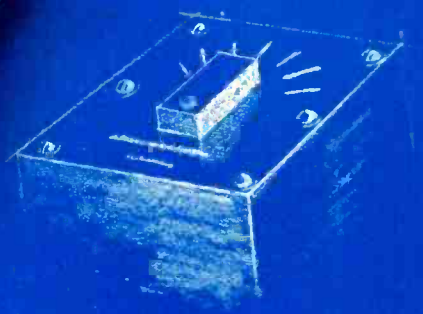
DESIGN, RESEARCH
PRODUCTION, OPERATION

★

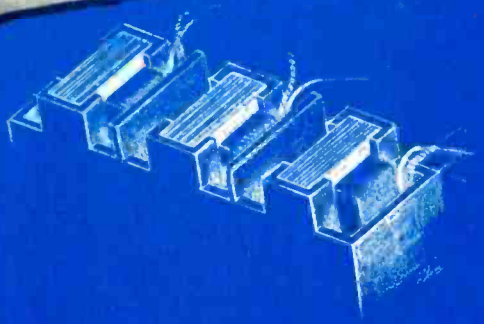
MAY, 1943

Combinations for Victory

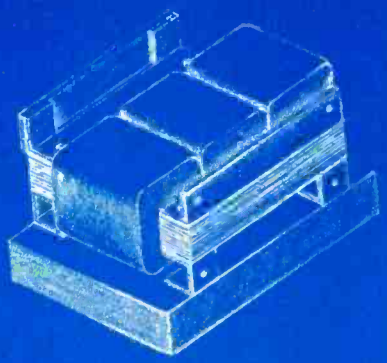
Savings in materials and machine time are vital to victory. Substantial savings can frequently be effected by combining elements. Typical UTC design refinements of this type are illustrated.



The design of this unit combines switch plate, name plate, and cover.



This unit employs a special die cast housing which combines the mounting of six units, eliminating twelve sets of brackets, twenty-four screws, and a special outer case.



UTC three phase to single phase transformers combine the mounting facilities of the transformer and condenser. This and electrical design reduced the volume and weight of the UTC design forty per cent compared to contemporary design.

Two reactors, four condensers, and two shielded transformers are combined in this hermetically sealed container. Separately cased, the volume and weight would be doubled.

May we design a Victory Unit to your application?

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

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. . . freedoms that are uppermost in the heart of every American. Workers in industry have toiled unceasingly to build peak production to enable their country to be the world's best equipped fighting forces to protect these freedoms.

The Hallicrafters employees have twice been cited by their country for excellence in production . . . once with the Army-Navy "E" Burgee . . . and now the addition of a star to this Burgee for continued excellence in producing communications equipment so vitally needed by our boys on all fronts.

This new honor will serve as an additional incentive to greater production.

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CHICAGO, U. S. A.

AN OVERWHELMING RESPONSE!

When Hallicrafters sent out an appeal for meters to meet an existing shortage we knew the appeal would be answered . . . and it was to the extent that we want to take this means . . . because we cannot thank each of you . . . of showing our sincere appreciation of your prompt aid to your country's effort toward winning this war in order that all of us may enjoy our freedom the real American Way!

BUY MORE BONDS!

BUY MORE BONDS!

hallicrafters

CHICAGO, U.S.A.

RADIO

Published by RADIO MAGAZINES, INC.

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◆

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MAY 1943 No. 280

Table of Contents

COVER

Finished quartz crystals, the size of postage stamps, spread out like a checker board at a General Electric Company plant. Crystals such as the ones illustrated, are the backbone of radio communications in the Armed Forces.

ARTICLES

MISCELLANEOUS

RADIO (title registered U.S. Pat. Off.) is published monthly at 34 N. Crystal Street, East Stroudsburg, Pa., by Radio Magazines, Inc., Executive and Editorial Offices at 132 West 43d Street, New York, N. Y. Subscription rates—United States and Possessions, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U.S.A.

Entered as Second Class Matter October 31, 1942, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879.

TECHNICANA

TRIGGER TUBE

SECONDARY EMISSION is utilized in a new vacuum tube for obtaining trigger or relay action similar to that obtained in a gas-filled tube, as reported in the April 1943 issue of the *Bell Laboratories Record.*

Trigger tubes have many possible applications in telephone switching, but their use has been limited largely because gas-filled types are noisy and their ionizing and deionizing times introduce a delay in the trigger action. With vacuum tubes there are no ionizing or deionizing times and the delay in the trigger action is reduced from around a thousandth of a second to something less than a millionth of a second. This thousandfold reduction in the time element is of great advantage in many applications. The reduction in noise, which is also obtained with the vacuum tube, is also an obvious advantage in telephone work.

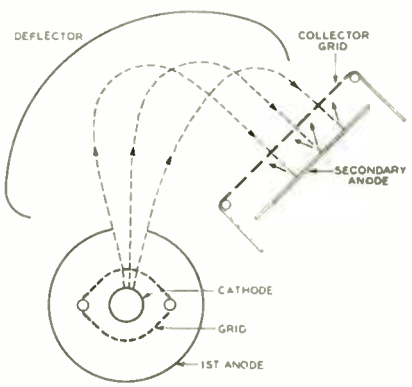


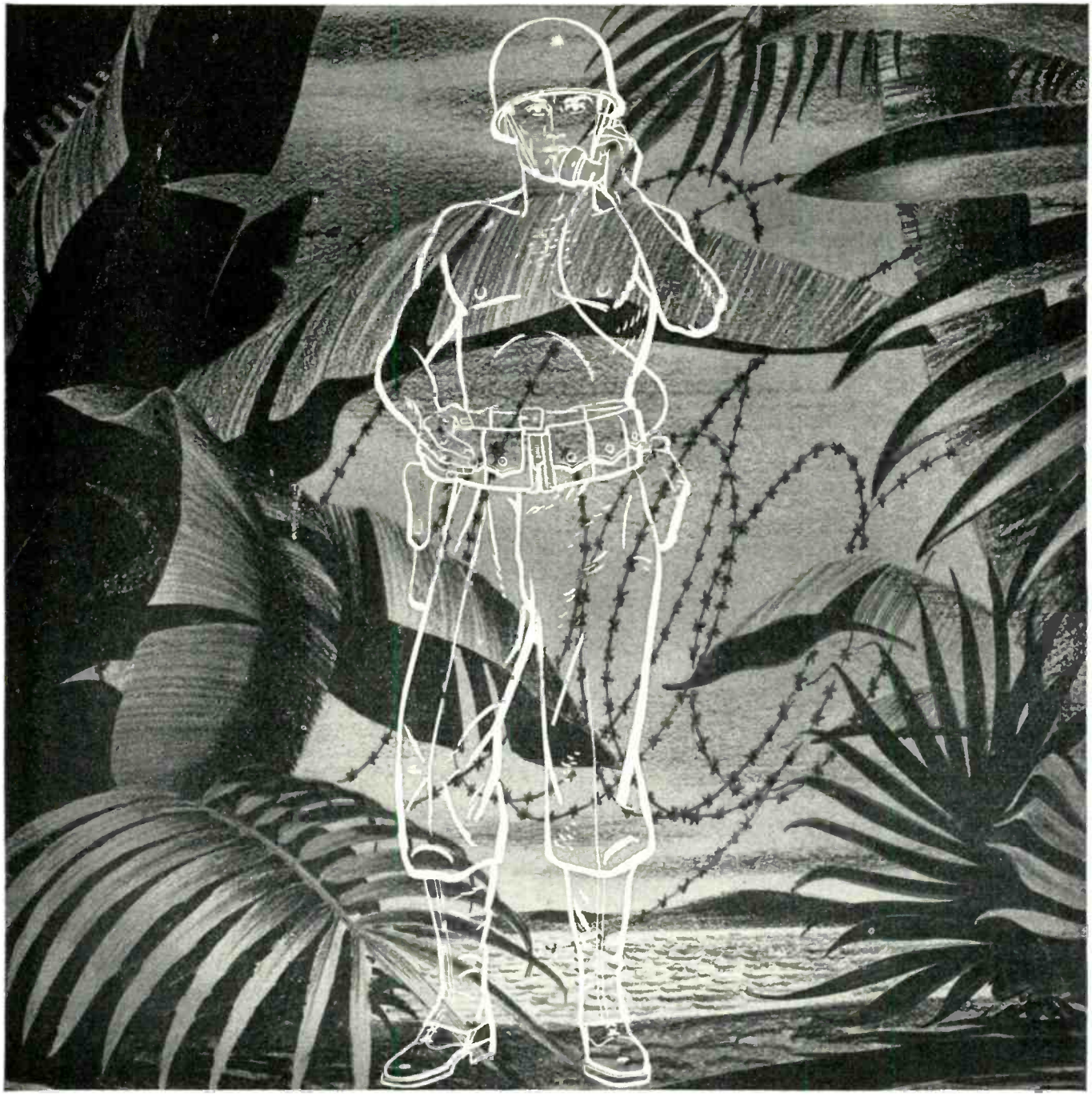
Fig. 1. Arrangement of elements of new secondary emission trigger tubes.

The layout of the elements in one of these trigger tubes is shown in *Fig. 1.* The cathode, grid, and first anode are like those in a W.E. 244A triode except that a slot in the plate, or first anode, allows about 10 percent of the electrons to pass through. These electrons follow the dotted paths to the secondary anode which has a good secondary emitting surface. The secondaries are collected by the collector grid.

A change in grid potential of a fraction of a volt is sufficient to trigger the tube on.

The amplifying characteristics of the triode section of the tube are not appreciably altered by the addition of

[*Continued on page 8*]



Wherever man goes . . . even when he's slashing through primeval jungle in some remote corner of the South Pacific, he is not alone, thanks to the existence of the two-way radiotelephone. In tomorrow's world, this new medium of communication will become an active part of your business and social life. And when hostilities cease you can look to Jefferson-Travis for the finest radiotelephone equipment made. As pioneers in this field we have developed new and exclusive improvements for this remarkable electronic achievement. Today they are employed by the United Nations everywhere — tomorrow they will be yours!

JEFFERSON-TRAVIS

RADIOTELEPHONE EQUIPMENT

NEW YORK · WASHINGTON · BOSTON

TECHNICANA

[*Continued from page 6*]

the trigger mechanism that puts it into action. The tube may be extinguished or returned to the off condition either by momentarily establishing a potential condition on the secondary anode that is just a little less in magnitude than the critical potential, or by swinging the grid sufficiently negative to cut off momentarily the electron stream. This is still another advantage of this new type of trigger tube. With gas-filled tubes, the grid loses control once the tube has fired, and the electron stream can be stopped only by reducing the plate voltage below a critical value.

★

MAGNETIC DISCRIMINATOR

To SEPARATE heat treated parts from those not heat treated but of identical appearance, a magnetic discriminator has been developed. It works on the principle that heat treating increases the permeability and thus gives a a stronger magnetic field. A system of balanced magnetic fields used with an oscilloscope provides easy visual determination of the difference.—*Ohmite News.*

★

ELECTRONIC TIMETER

A NEW ELECTRONIC time-interval meter for accurately measuring extremely short intervals—as low as 100 microseconds—has been developed by the Special Products section of the General Electric Company. Specifically,

Time-Interval Meter

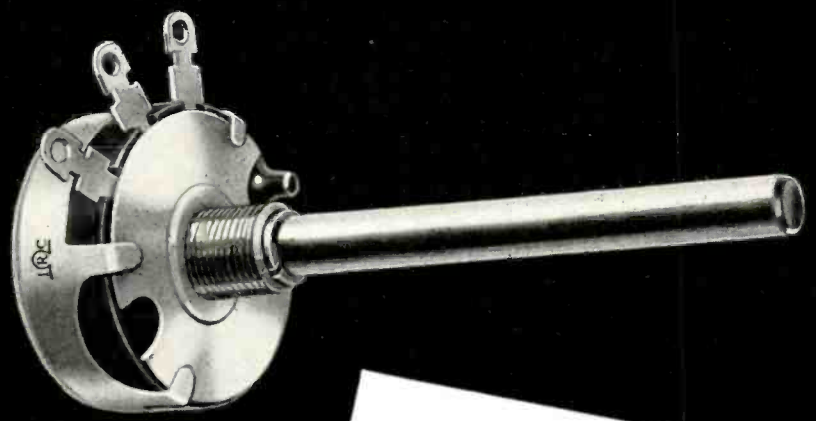
the meter is designed for measuring the time interval between two events which can be converted into electrical impulses, such as the elapsed time between the closing of two controls; between two impulses to a phototube;

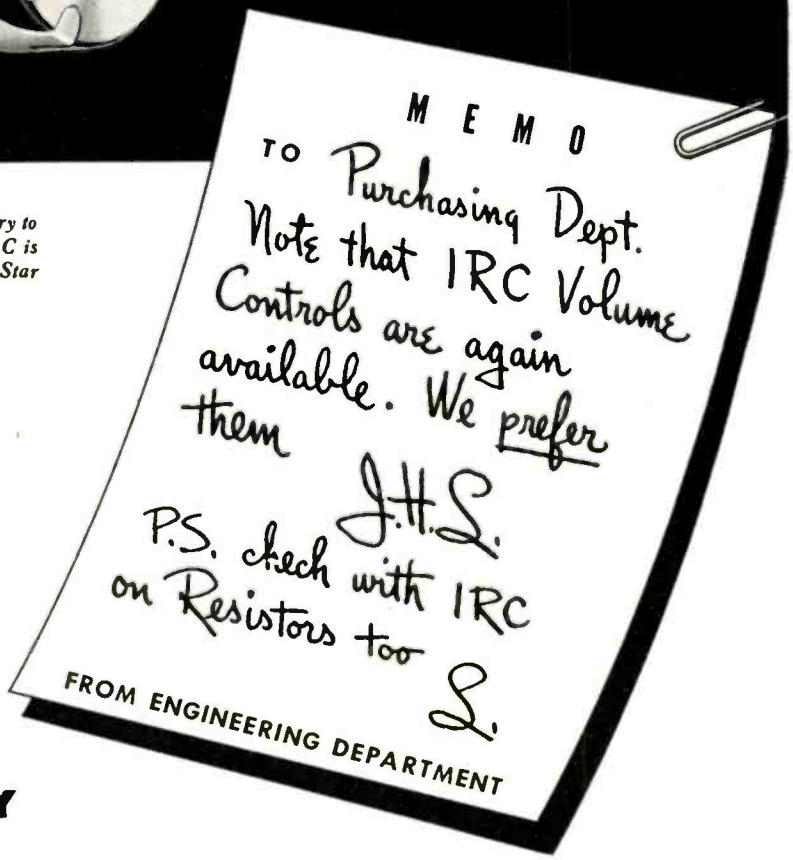
[*Continued on page 10*]

IRC VOLUME CONTROLS HAVE *All* THE FEATURES

No single attribute is responsible for the definite preference so often expressed by electronic engineers for IRC Volume Controls. Rather the fact that each unit embodies *all* the important factors which make for dependable operation has earned the regard of many of the largest users of potentiometers. . . . For preferred performance under severe conditions, for accuracy, stability and long life—specify IRC Volume Controls.

1—Metallized Element
2—Spiral Spring Connector
3—5 Finger Positive Contact
4—2 Sizes—1⅛" and 1¼" diam.
5—2 Ratings—½ and 1½ Watts
6—Available for Salt Spray, Sealed, and High Altitude Performance.





First in the industry to win an E flag, IRC is first also to win a Star for sustained production

PREFERRED FOR PERFORMANCE
IRC
FIXED & VARIABLE RESISTORS

INTERNATIONAL RESISTANCE COMPANY

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TECHNICANA

[*Continued from page 8*]

and between an electrical impulse and a light impulse.

Consisting of two units — an electronic panel and a phototube with its preamplifier stage—the meter has eight ranges, selected by means of a tap switch so that any time interval of a length between .0001 second and 3 seconds can be measured. A standard indicating instrument calibrated in milliseconds gives a direct reading of the time interval measured.

The normal input signals consist of changes of light intensity falling on the phototube or the making of external electrical contacts. In the former case, light values as low as 1/100 lumen, or an intensity of approximately 1.4 foot-candles, can be used on the photo-tube and still result in satisfactory performance.

★

USING HIGH CRYSTAL HARMONICS

By using a crystal in a lattice network, crystal harmonics at least as high as the 23rd may be used for the direct control of an oscillator circuit, thus dispensing with harmonic generators—an important consideration in the design of compact u.h.f. transmitters. Using this system, oscillators have been built for frequencies as high as 150 megacycles using crystals with fundamental frequencies below 10 megacycles.

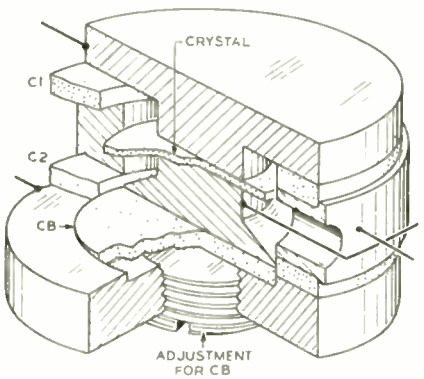


Fig. 1. Arrangement used to include crystal and three condensers in network

The theory and circuits are described by I. E. Fair in the April 1943 issue of the *Bell Laboratories Record.*

Of added interest is the fact that the capacitances of the crystal are very small, and those associated with it in the lattice are also very small. It is possible, therefore, to assemble the

[*Continued on page 13*]

E·L IS OUT THERE, TOO...

Out where the "fighting front" becomes grim reality instead of a glib phrase, E·L units are powering the "Walkie-Talkie" that serves as the voice and ears of our advance forces.

It's a marvelously efficient two-way radio, of course. But the Signal Corps knew that it couldn't be the useful, reliable instrument it is, unless it had a power supply that would keep it operating, under all conditions . . . whether in the destructive heat and grit of the desert, the paralyzing arctic cold, or the corroding humidity of the jungle.

Such a power supply did not exist until Electronic's engineers designed a special, high-voltage vibrator power supply, combined with storage battery, in a single, incredibly light and compact unit.

Behind this and other E·L power supply achievements are years of intensive development of the technique of *vibrator type* power supplies, and the most extensive research anywhere on power supply circuits. They have not only produced amazing advances for many military purposes, but promise revolutionary benefits for products of peace.

Wherever electric current must be changed, in voltage, frequency or type—for war or peace—E·L Vibrator Converters will give the same outstanding service that has singled them out for battle duty today.

Power Supply using rechargeable, non-spill storage battery for operation of "Walkie-Talkie" radio equipment. Input Voltage: 4 Volts; Output: Numerous Voltages, supplying plate and filament requirements of the equipment. Width, 3½"; Length, 6½"; Height, 4⅜".

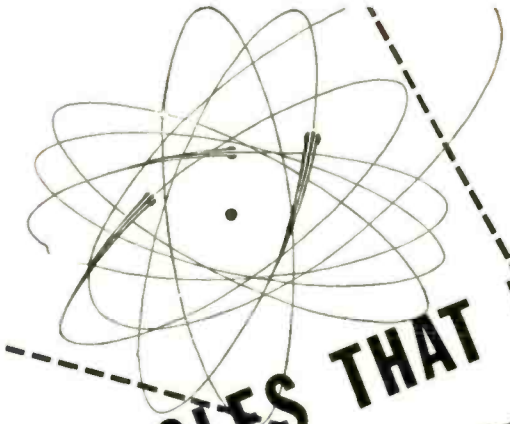
. . . AND E·L WILL BE HERE WHEN PEACE COMES!

● Mobile, two-way radio telephones will be at work in peace-time on big construction projects . . . on forms . . . in countless other places. E-L products will be on the job then, too, solving the power supply problem!

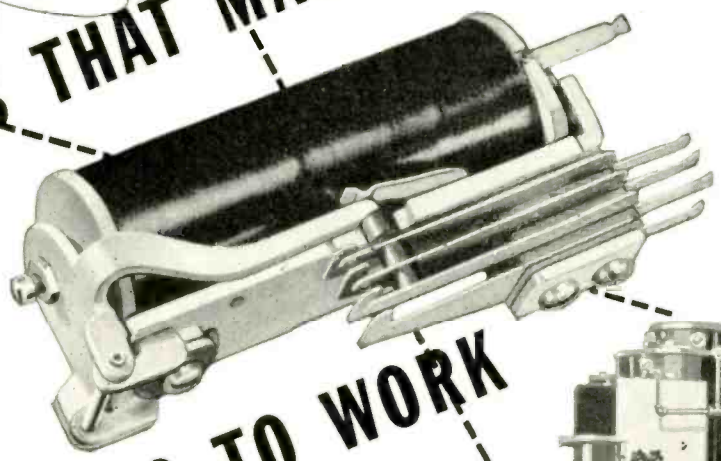
Electronic LABORATORIES, INC.

INDIANAPOLIS

E·L ELECTRICAL PRODUCTS—Vibrator Power Supplies for Communications . . . Lighting . . . Electric Motor Operation . . . Electric, Electronic and other Equipment . . . on Land, Sea or in the Air.



MUSCLES THAT MAKE ELECTRONS GO TO WORK



To capture the power of the electron—to make it behave and do a specific job—often requires control devices which must be carefully selected and precisely engineered to fit the conditions of the problem.

Automatic Electric relays and stepping switches, by bridging the gap between the electron tube and the job to be done, are helping to take new electronic ideas out of the laboratory and put them to practical use. They are the "muscles" that make electrons go to work.

Automatic Electric field engineers are today working with the makers of electronic devices of every kind, offering time-saving suggestions for the selection of the right control apparatus for each job—and extending the benefit of the technique which comes from fifty years of experience in electrical control applications. As a result, Automatic Electric controls are finding increasing use both in the implements of war, and in the plants where war products are made.

If you have an electrical control problem—whether electronic or not—first, be sure you get the Automatic Electric catalog. Then, if you would like competent help in selecting the right combination to meet your need, call in our field engineer. His recommendations will save time and money.

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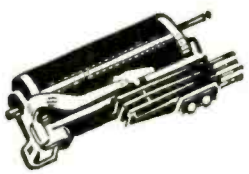
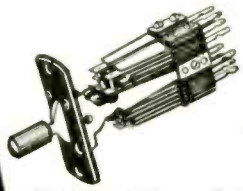
The Automatic Electric line of control devices includes:



RELAYS—A complete range of light and heavy duty types, for operation on a-c or d-c power, and with endless coil and contact combinations.

STEPPING SWITCHES—magnet driven selector switches for automatic or directed selection of circuit channels, in capacities of 10 to 100 circuits.



LEVER KEYS—Locking and non-locking types in any desired contact combination, for manual switching of control or communication circuits.

The Automatic Electric catalog of control apparatus includes also a complete listing of control accessories, such as solenoids, counters, jacks, plugs, impulse senders, lamp and target signals, etc. Write for your copy.

Relays AND OTHER CONTROL DEVICES *by* AUTOMATIC ELECTRIC

MUSCLES FOR  THE MIRACLES OF ELECTRONICS

EDITORIAL

ELECTROENCEPHALOGRAPHY

★ From an editorial in the April, 1943 issue of the British journal *Electronic Engineering*, we learn that the electroencephalogram was admitted as medico-legal evidence in a recent murder trial. Records of brain waves were examined by the jury and presumably aided them in reaching a verdict.

More to the point are two paragraphs supporting our own view with regard to the possibilities of employing radio equipment for the study of mental and nervous ailments, as expressed in our editorial in the March issue. Mr. Parr, the editor of *Electronic Engineering*, has this to say:

"We are all fundamentally composed of the same kind of electrons and whether they move in conductors or in nervous tissue they are subject to the same laws. Already electrical analogies have been made to explain certain phenomena in the human organism. Is it too much to hope that a complete analogue of the nervous system could be evolved, and with it the explanation of much that is still the subject of speculation?

"If the problems are attacked by the physiologist in close collaboration with the electron engineer it is probable that they will be solved in less time, and the viewing of many obscure phenomena from the electrical point of view may provide the clue that the physiologist is seeking."

Incidentally, for those who may wish to explore the subject of nerve action the following books are worth looking into: *The Mechanism of Nervous Action*, by Prof. A. D. Adrian (Oxford University Press, 1935); and the books *A Bi-Polar Theory of Living Processes* (1926) and *The Phenomena of Life* (1936), by Dr. George Crile.

TAILORED RADIO

★ Low- and medium-priced pre-fabricated or mass-produced houses, turned out on the scale of automobiles, are planned for the future. Advancements in many fields of science and the development of many new materials now produced in huge quantities for war equipment, contribute to the practicability of such a venture.

Architects and engineers have already designed a number of houses of this type which have conveniences and a durability not to be found in present-day homes. It is apparent that engineering has the upper hand in these designs, even to the point of having influenced the architect in his design concepts.

The manufacturing principle is predicated upon the complete fabrication of units that may later be assembled rather than built into a house. Thus, electrical wiring, plumbing, etc., are built into the walls or partitions at the factory and need only be joined to their sources when the house is erected. Bathrooms, kitchens and heating plants are complete units in themselves to which partitions are attached. And the primary lighting and heating fixtures are built right into the walls and ceilings. All in all, there is a disposition to incorporate into the various units all utilitarian devices that go to make up the complete home, leaving the matter of atmosphere to the furniture and decorations.

There is every indication that houses of this type will be produced not by the thousands but by the millions, in the post-war period. With a market of this size it is worth considering now whether a radio for home use should be classed in the manner of a piano, which has both utility and beauty, or whether it should be looked upon only as a utility in the same sense that a heating system is, and be built into the house along with the other utilities, just as radios have become an integral part of an auto.

Radio broadcast receivers have suffered from at least three limitations in the past. First, it has not been possible to provide audio quality at a reasonable price. Second, it has not been possible to house the receiver in a cabinet of a quality and taste comparable to other pieces of furniture without the price of the cabinet swamping the cost of the receiver chassis. Third, few receivers other than those in the high price brackets have had or can have the operating convenience that they should have, principally because a radio other than a midget is tied down to one spot.

All three of these drawbacks could be eliminated if a radio were made an integral part of the house. In the first instance, with loudspeakers built into the partitions, and with the proper acoustic qualities built into each room having a sound outlet, the nature of the sound projection and dispersal would surpass that of any present-day radio. In the second instance, the radio would cease to be a piece of furniture. In the third instance, operating convenience could be built into the system in a number of ways, with a plug-in remote-control unit probably being the most logical.

Since all of the units composing the built-in radio system would be removable for servicing, the door would be left open for the sale of new receiver models incorporating engineering improvements.—M.L.M.

SPACE-CHARGE FREQUENCY MODULATION

HAROLD E. ENNES
Technician, WIRE

★ The need for a highly simplified and extremely compact pack transmitter utilizing the important transmission characteristics of frequency modulation, resulted in the unique experiment described here. Advantages of the circuit are, the elimination of reactance tubes and a number of doublers, not only conserving vital space and weight, but also cutting the initial cost of manufacture by at least 50 percent.

Basic Principle

Referring to the original article on electron-coupled oscillators *(Dow, IRE Proceedings, Dec. 1931)*, it is noted that an increase of screen voltage will cause a decrease in resonant frequency, while an equal increase of plate voltage will cause an equal increase in resonant frequency, assuming the ratio of plate to screen voltage to be correct for this equal and opposite compensation. Although no explanation of this phenomena is given by Dow in his original paper, it is obvious that this shift of frequency is due to the effect of anode voltages on the dynamic input capacity of the tube circuit.

Fig. 1 shows the vector relationship of a properly designed electron-coupled oscillator or compensated Hartley circuit, when the voltage E_r is of the proper magnitude to draw E_p exactly 180° out of phase with E_g. E_r or "coupling voltage ratio" exists in an electron-coupled oscillator from plate to screen; the plate circuit considered in parallel with the triode oscillator consisting of cathode, grid and screen grid, and coupled by the space charge existing from screen to plate. Inspection of *Fig. 1* reveals that a change in transconductance due to $\Delta\mu$ or Δr_p will effect the *magnitude* of the vector, but will not affect the *phase*, thereby stabilizing the frequency. Thus, by properly proportioning the voltage ratio of screen and plate, the frequency is made independent of small changes in electrode voltages, *except* as these changes affect the dynamic input capacitance of the tube.

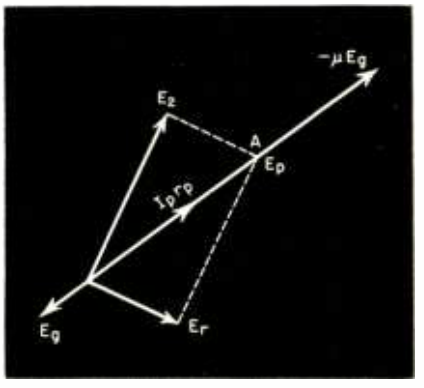


Fig. 1. Vector relationship of properly designed electron-coupled oscillator when the voltage Er is of the proper magnitude to draw Ep exactly 180° out of phase with Eg.

The dynamic input capacity C_i of a triode consists of the geometric or static capacity of grid to cathode, C_{gk}, plus the effect of the voltage amplification on the grid-to-plate capacity C_{gp}.

$$C_i = C_{gk} + (1 + A \cos\theta)\ C_{gp}^*$$

where C_i = "Hot" input capacity
C_{gk} = grid to cathode capacity
$A = E_p/E_g$ or ratio signal voltage developed in the plate to the original signal voltage E_g
θ = phase angle of signal voltage across load impedance to the equivalent voltage $-\mu e_g$

Since for all practical purposes we may consider $\theta = 0°$ when ratio of voltages is correct as in *Fig. 1*, we may omit cos θ from our formula since cos $0° = 1$. Thus

$$C_i = C_{gk} + (A + 1)\ C_{gp}$$

Electron Flow

For a clear explanation of the effect of space charge on the input capacity, it is necessary to consider the effect of electron flow between electrodes in a tube. It is customary under most static conditions to assume electron current flow in an electrode only when electrons actually contact the surface of the electrode under consideration. This conception must be modified under actual dynamic operations.

Considering the screen of an electron-coupled oscillator as the plate of a triode oscillator, it is found that each electron in the space between cathode and plate induces a charge on the screen; the magnitude of the charge being determined by the proximity of the electron to the screen, this in turn being dependent on the parameters of the tube itself. By using *Fig. 2*, and noting the direction of the electron motion as indicating arrows show, it becomes clear how the action of the suppressor on the space charge will affect the charge on the screen and plate, which in turn affects the transconductance of the tube, hence establishing a relationship between space charge and effective input capacity.

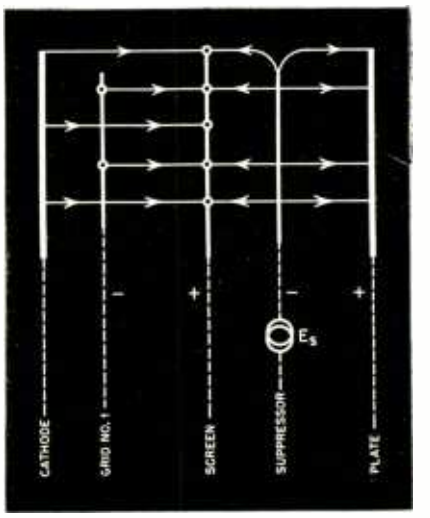


Fig. 2. How action of suppressor on space charge will affect charge on screen and plate, and in turn affect transconductance.

* For derivation of this formula, refer to Terman's *Radio Engineering*, second edition, page 232.

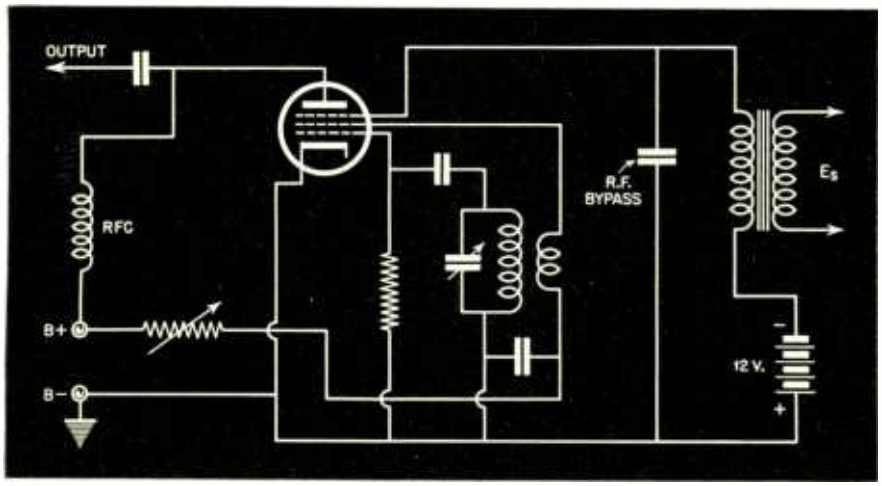


Fig. 3. Modification of the conventional electron-coupled oscillator, designed so as to eliminate operation of the cathode above ground.

Actually this change of C_i results from a change of the mutual conductance of the tube. A deviation of suppressor bias voltage results in changing the division of electrons between screen and plate, a retarding field near one electrode resulting in an increasing field near the other electrode. An increase in suppressor voltage (decreased bias) results in a lower f_o, equivalent to the screen voltage-frequency curve. Instability due to modulation of screen or plate is avoided by utilizing the suppressor as the transconductance control grid, upon which the signal voltage is superimposed.

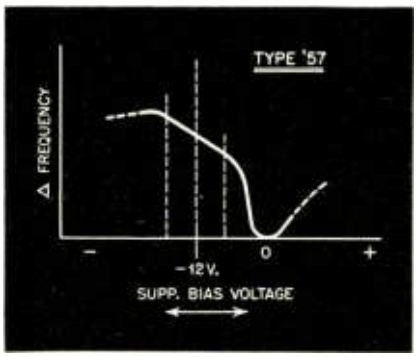


Fig. 4. Characteristic of type '57 tube used in space-charge f.m. transmitter.

The Circuit

The circuit of *Fig. 3* shows a modification of the conventional electron-coupled oscillator, designed so as to eliminate operation of the cathode above ground. This is an important point for space-charge control of frequency since inductance in the cathode lead would cause considerable instability so far as linear control of frequency is concerned. It may be shown that

$$C_i = C_{gk} + (A + 1)\ C_{gp} - g_m g_t L$$

where g_m = grid-cathode transconductance (concerned with the effect of cathode current through L)
g_t = conductive component of grid-cathode admittance
L = cathode inductance

Thus it is apparent that theoretically, if the term $g_m g_t L$ were made equal to $C_{gk} + C_{gp}$, the effective C_i would be zero. This, of course, is impossible in actual circuits since the effect of $g_m g_t L$ could not possibly be very large. However, when it is considered that g_m and g_t change with a change of electrode voltages, and g_t changes also with frequency, it becomes obvious that this cathode inductance should be held to an absolute minimum for stable operation.

The tube used in this experiment by the author was a type '57, and the dynamic operation point was determined by experiment. See *Fig. 4*. Extremely small signal voltage was necessary since a very slight change of suppressor bias proved sufficient for ±15-kc deviation at the output of two doublers. For practical field use, low drain battery-type tubes would be used, and this circuit should prove to be the cheapest and most compact f.m. transmitter yet devised. It should be highly satisfactory for narrow-band f.m. voice communication. It is obvious, of course, that the tube chosen for the oscillator must have the suppressor on a separate pin.

The basic design for an f.m. transmitter described in this article allows a higher fundamental frequency from which the first doubler works, and eliminates several doubler stages necessary in conventional reactance tube or phase modulators. Also, less trouble from vibration should be experienced, together with a more rigid construction of circuit elements.

USING THE SLIDE RULE IN VECTOR ALGEBRA

★ In the vector algebra solution of series-circuit equations the radio technician is often called upon to solve such equations as the following:

(1) $E = 20 + j30$
(2) $Z = 200 + j45$
(3) $50 = 15 + jX$ or, $50 = \sqrt{R^2 + X^2}$
(4) $Z = 200 + j150$

Equations (1), (2), (3), and (4) may be expressed in order as follows:

(5) $E = \sqrt{20^2 + 30^2}$
(6) $Z = \sqrt{200^2 + 745^2}$
(7) $X = \sqrt{50^2 - 15^2}$
(8) $Z = \sqrt{200^2 + 150^2}$

These are simple problems to solve even by the longhand methods. We can, however, greatly simplify such problems by the use of slide rule calculation. These and other such equations may be readily solved with an ordinary "Mannheim" slide rule.

Equations (1), (2), and (4) are the old familiar $a^2 = b^2 + c^2$ variety. Therefore, $a = \sqrt{b^2 + c^2}$. Consequently, assuming c to be larger than b:

$$\frac{a}{b} = \sqrt{\frac{c^2}{b^2} + 1}$$

$$= \sqrt{\left(\frac{c}{b}\right)^2 + 1}$$

$$\text{or, } a = b\sqrt{\left(\frac{c}{b}\right)^2 + 1} \qquad (9)$$

Then for equations of this category we can use formula (9) in place of (5), (6), and (8). Formula (9) is readily solved by the slide rule as follows:

Divide c by b and square the result. This is done by setting b on scale C over c on scale D. The result squared is read on the A scale above the left hand index on scale B. Add 1 to this by moving the left-hand index of B to the right by the amount of one on scale A. The square root of this then appears on D under the left-hand index on C. Adjust the slide to b on scale C and read the answer on D under that point. Thus we have with a minimum number of operations solved any typical vector equation of the nature:

[*Continued on page 65*]

A RECORDING

SOUND FREQUENCY ANALYZER

★ A sound frequency analyzer, one which will simultaneously measure and record frequencies over a wide range, designed by Western Electric Company for wide industrial use, is now standard equipment for many manufacturers. Most recently, however, the sound frequency analyzer has been appropriated by the medical profession for experimental purposes and is opening a new approach to the study of faulty heart action.

The Equipment

Designated the RA-281, the sound frequency analyzer consists of three units, a special filter, a special graphic level recorder and either a moving coil microphone or moving coil vibration pickup, and is the only instrument of its kind designed to meet the demonstrated industrial need of sound frequency analysis. The standard analyzer covers the frequency range from 10 to 9,500 cycles per second and can examine this entire range on consecutive bands as narrow as five cycles. Analysis is usually by the sweep method, using a heterodyne analyzer and a synchronous driving motor coupled to the dial so as to sweep through the frequency range in question at a definite rate.

This vibration pickup, which responds to the sub-sonic range of vibrations, is associated with the Recording Sound Frequency Analyzer. It works interchangeably with the 633A microphone and weighs but 6 ounces.

A special quartz crystal filter allows frequencies within the selected band to pass, rejecting energy of other frequencies. Four different band widths are available and any three of these can be built into the instrument. The output of the analyzer is connected to the graphic recorder which automatically traces on the chart the level of the particular frequency through which the analyzer dial is passing. With this permanent record to refer to, it is a simple matter to divide any sound into its frequency components. Compact and light weight, the equipment is readily portable and is intended for field testing as well as laboratory use.

The Frequency Analyzer

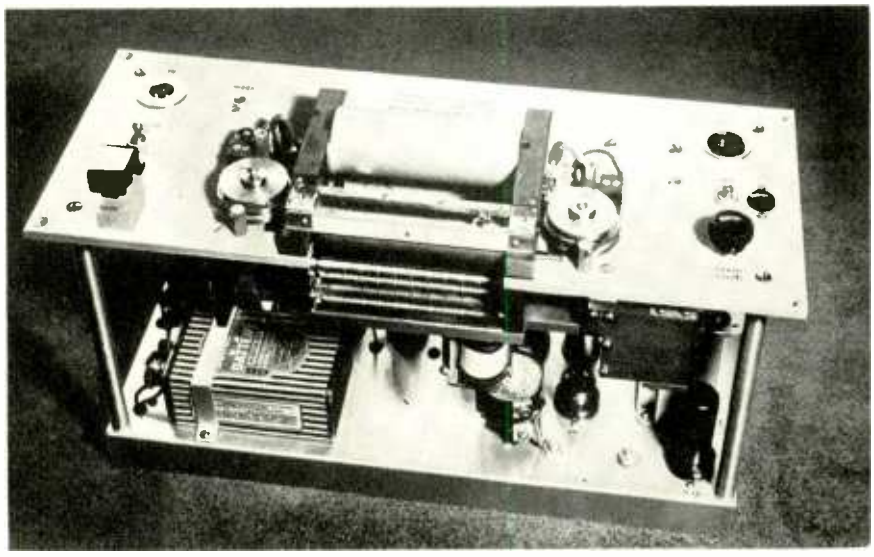
This unit does double duty in taking acoustic measurements. As part of the complete system it is a continuously variable sound frequency analyzer of narrow band width. Used alone, the turn of a switch converts it into a stabilized feedback sound level meter.

When used as an analyzer, frequency input is heterodyned to 50 kilocycles by a variable oscillator and the band-pass filter operates at that frequency. A demodulator reconverts the passed band to audio frequencies which are further amplified and rectified for measurement.

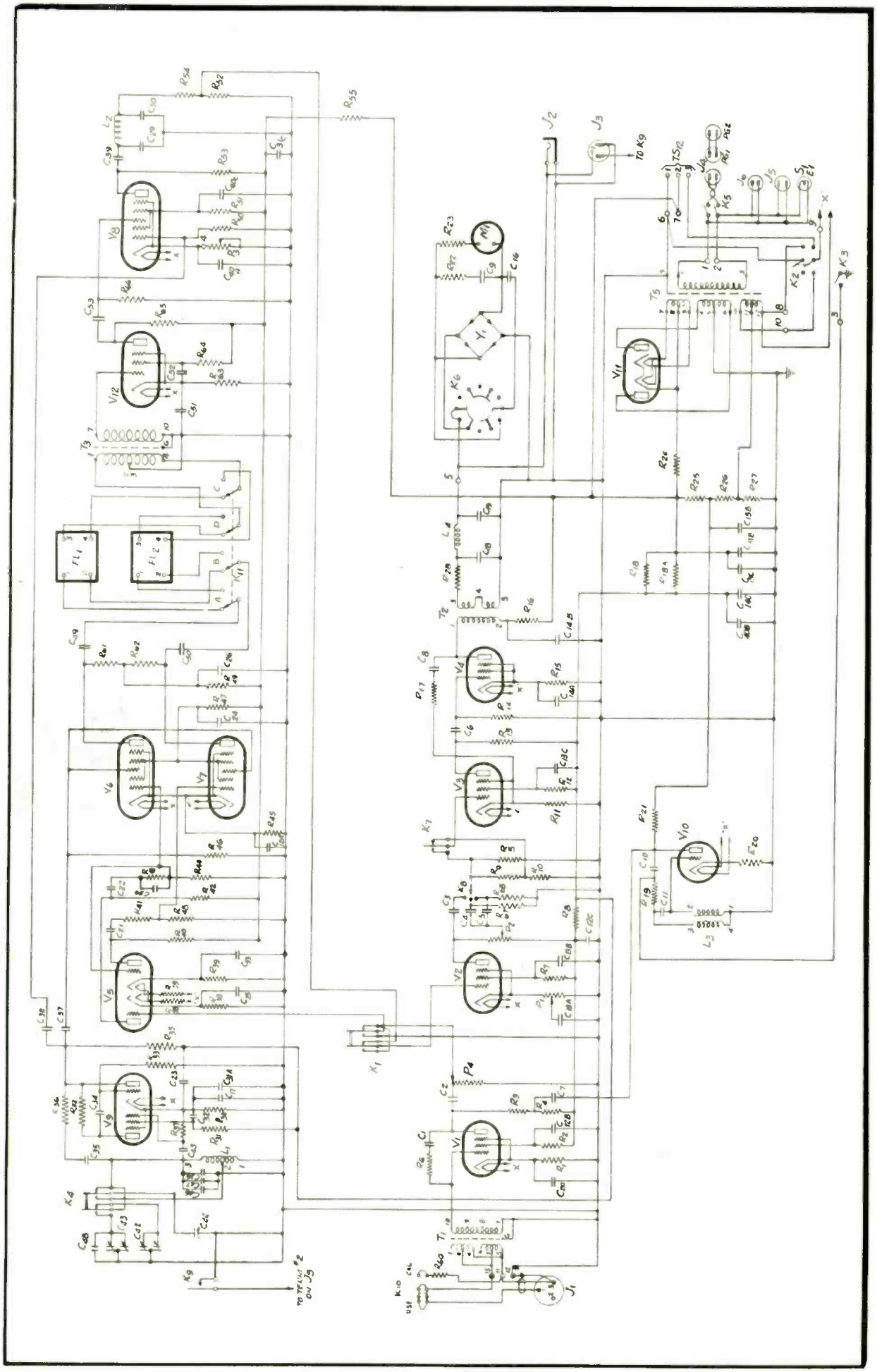
When the synchronous motor (in housing) swings into engagement with oscillator dial (center) it progressively sweeps the frequency band extending from 10 to 10,000 cycles in a period of two minutes. An alternate scale extends from 100 to 9,500 cycles.

The analyzer can be tuned to any frequency between 10 and 9500 cycles. The two ranges of 10 to 1000 and 100 to 9500 are spread over the 180-degree rotation of the tuning condenser.

The standard band width is 5 cycles. This has a substantially uniform re-



Exposed view of the recorder chassis. In it, a stylus moving in obedience to impulses picked up by a microphone, traces on a tape the volume or loudness of sound.



Schematic diagram of the RA-277-F Sound Frequency Analyzer as used in conjunction with the Graphic Level Recorder.

sponse, 5 cycles wide, centering at the frequency to which the dial is set and suppressing frequencies outside of that range at the rate of approximately 45 db in the first 55 cycles.

Band-Pass Filter

The perfect analyzer filter would pass all energy in a frequency band of specified width and completely reject energy of other frequencies. The filter used in this equipment approaches much nearer this ideal than previous designs. It is of the lattice-network type, hermetically sealed, using quartz crystals for elements. Response within the passed band is relatively uniform and the suppression of frequencies outside the band is not affected by temperature. Band widths of 5, 20, 50 and 200 cycles are available.

Recorder Unit

The recording unit traces on a chart the changes in frequency level applied to the input terminals. Levels are plotted on a linear decibel scale, with displacements proportional to the logarithms of the input voltage. The chart covers a range of 50 decibels on paper 4½ inches wide and changes in input level as high as 58 db per second are followed faithfully by the stylus. Several chart speeds, under control of a lever, take care of different operating requirements.

One unusual feature is the clutch system, developed and used by the Bell Telephone Laboratories. A very light moving system is used, consisting of stylus, attenuator wiper and drive cable and is engaged to the constantly moving drive system through a magnetic clutch only when motion is required. The clutches operate in sliding contact when not magnetically engaged, and when energized their action is almost instantaneous.

Simplicity of operation characterizes the RA-281 Recording Sound Frequency Analyzer. It can pick up, analyze and record a pattern of sound levels extending over a band from 10 to 10,000 cycles in a period of two minutes. The record so made is both accurate and permanent.

The Sweep System

In order to obtain a complete and accurate picture of the frequency components of any sound or vibration, the sweep method of analysis is used. By sweeping through the frequency spectrum under consideration and recording the exact level of each frequency, it is possible to obtain a detailed analysis without incurring errors due to frequency fluctuations in the sound or vibration under test. Since the sweep and paper drive motors are both of the synchronous type, displacements on the chart will correspond to fixed increments on the frequency dial, regardless of variations in frequency of the power supply.

The sweep method requires a recorder which can accurately follow very rapid changes in level—too rapid for the usual glass-pen type used in power plants and industrial practice. While the exact speed depends upon the sweep rate, filter suppression and other factors, a minimum recording rate of 50 db per second is generally used. This high speed is accomplished by the special stylus and driving system of the device without overshoot of the stylus which might be misinterpreted as a noise component or tend to confuse the true shape of the record.

Coverage of a wide decibel range on the chart is required for most analyses, a condition not readily met by voltage-operated recorders. A 50-decibel range is generally satisfactory and a uniform decibel scale is preferable in interpreting the records.

The record is made in from 30 seconds to 2 minutes, depending upon the frequency range covered—a small fraction of the time required when using an indicating meter. This time saving is of real value in tests in which it is impossible to maintain steady speed

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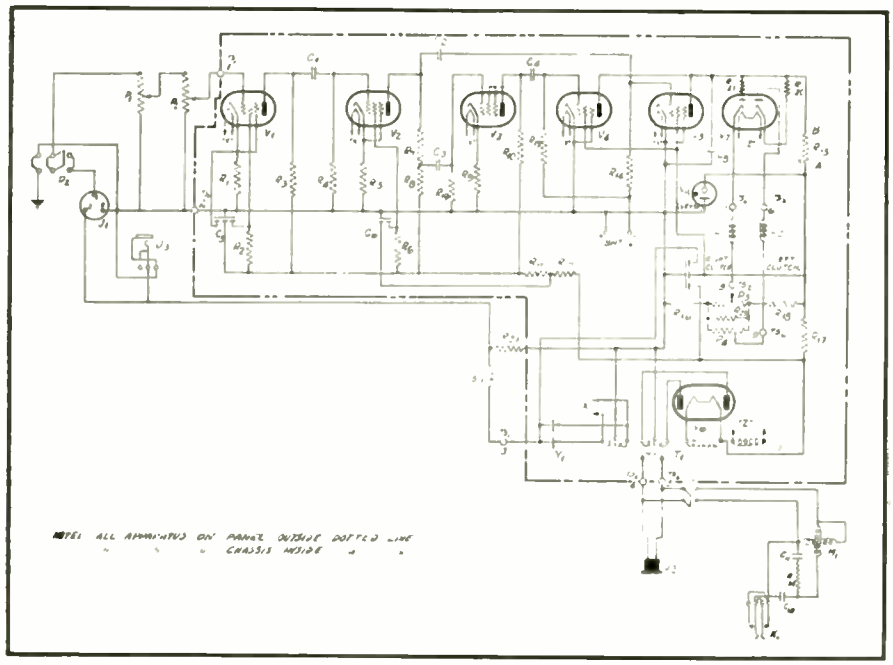

Schematic diagram of the RA-246 Graphic Level Recorder, a part of the Recording Sound Frequency Analyzer. Note magnetic clutch system associated with diode V7.

DETERMINING

VACUUM-TUBE CHARACTERISTICS

WITH AN OSCILLOSCOPE

OSCAR E. CARLSON

★ The response curve of a radio receiver as seen on an oscilloscope with a frequency-modulated input to the receiver is a graph of the output voltage versus frequency. The scope is measuring the output voltage over a period of time which is representative of the frequency deviations plus and minus the resonant frequency to which the receiver is tuned. This leads to the conclusion that a varying d.c. current can be viewed on the screen of an oscilloscope by allowing the varying current to flow through a resistor connected across the input to the vertical amplifier of the oscilloscope. The voltage produced by the *IR* drop across the resistor will be measured by the oscilloscope deflection. Hence, by an arrangement based on this conclusion, it is evident that the oscilloscope may be used for the determination of vacuum-tube characteristics.

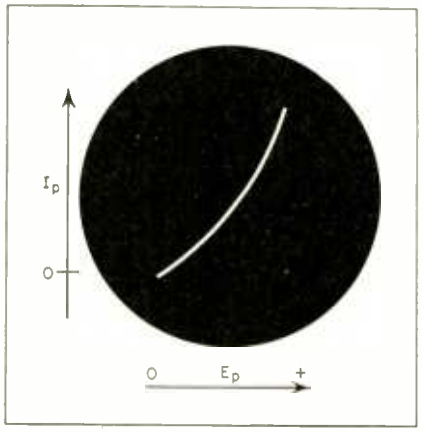

Fig. 2. Ep-Ip characteristic curve as seen on oscilloscope screen.

Such curves, when shown on a scope, prove an invaluable aid in the teaching of vacuum tube theory to radio students. However, a more practical reason for such curves is quite apparent; the engineer or technician may run actual curves on the tubes with which he is working. This eliminates the blind acceptance of the tube manual curves which are essentially a composite average of many tubes. It also provides a very efficient type of tube tester where a large number of the same type of tube is to be tested.

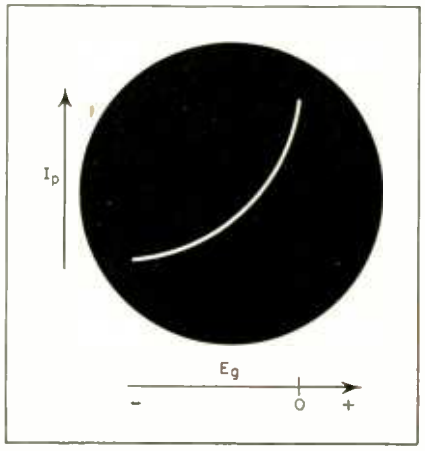

Fig. 3. Eg-Ip characteristic curve as seen on oscilloscope screen.

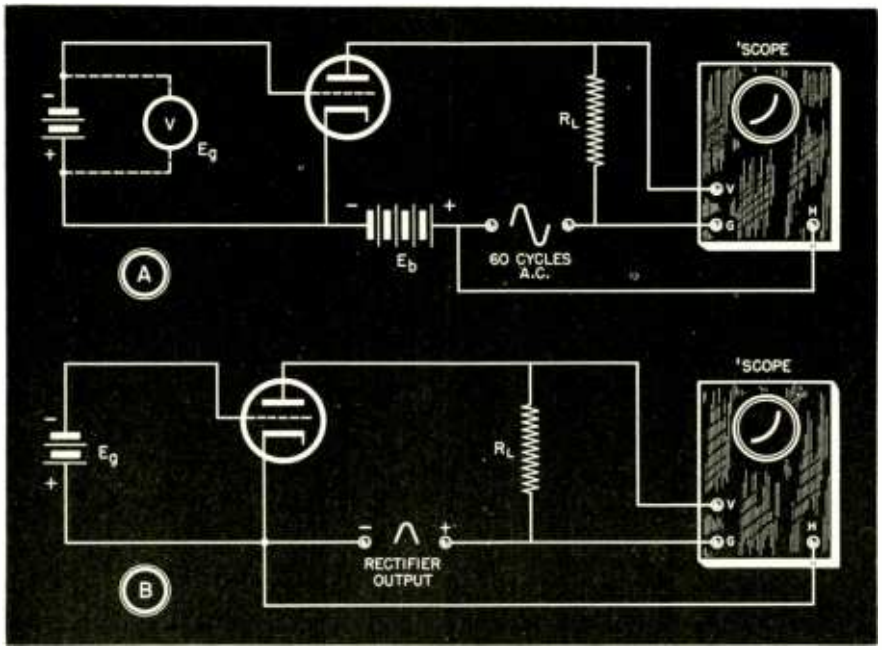

Fig. 1. Circuits for obtaining Ep-Ip characteristic curves. Circuit A uses a.c. to vary Ep, whereas circuit B uses rectified unfiltered d.c. to vary Ep.

Obtaining Plate Characteristic

Getting down to cases, let us assume that we vary the plate voltage of a triode vacuum tube from zero volts to plus 100 volts and back to zero volts at a rate of 60 cycles per second. With

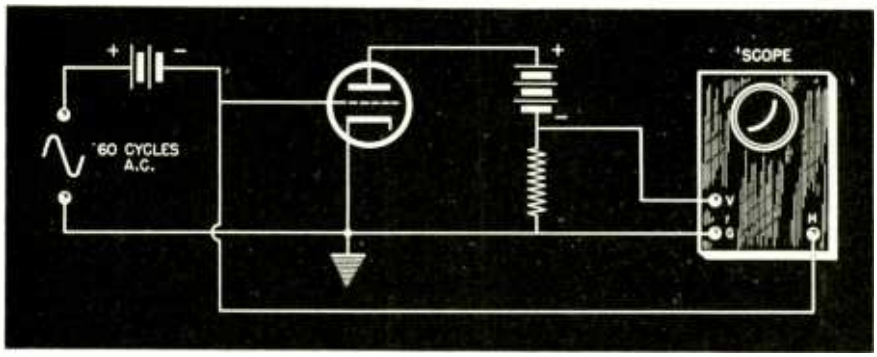

Fig. 4. Circuit for obtaining Eg-Ip characteristic curves.

a constant negative grid bias the plate current will vary from some minimum value to some maximum value at the same rate as the plate voltage is varied. The varying plate voltage can then be used to provide the horizontal sweep voltage for the oscilloscope. The resulting pattern would be the result of two identical frequency variations, in phase. As we know from the fundamental uses of an oscilloscope, two pure waveforms of zero phase difference when impressed across the two sets of deflection plates of an oscilloscope will produce a 45-degree straight line trace. In this application the slope of the trace will be a function of the gain of the vacuum tube whose characteristics are to be obtained. The plate current flowing would be represented by the amplitude of the trace along the Y axis and the plate voltage would be represented by the distance of the trace removed from the Y axis in the direction along the X axis. This would be the I_p-E_p characteristic curve, or plate characteristic curve, of the tube.

By using several values of grid bias and switching these values alternately in and out of the circuit at a high repetition rate by use of a commutator type switching arrangement, a family of these curves may be made to occur simultaneously on the screen of the oscilloscope. The schematics for two such arrangements using one fixed bias voltage are shown in *Fig. 1*.

The method of *Fig. 1-A* for varying the plate voltage through the desired range from zero to a high positive value uses a 60-cycle a.c. voltage to buck out and add to the battery voltage. This a.c. voltage may be obtained through a multi-tap transformer or by the use of a Variac. It must be remembered that the a.c. voltage will buck or add to the battery at continuously changing amounts over a period of time. Consequently the peak a.c. voltage must be considered. Thus, to buck 100 volts of battery voltage to zero we must use only 70.7 volts r.m.s. a.c. voltage. This would be the value measured on a regular a.c. voltmeter.

Fig. 1-B shows a schematic of a circuit employing the unfiltered output of either a half-wave or full-wave rectifier. The amount of plate voltage obtained will then vary from zero to the peak of the half-wave rectified voltage. Varying peak potentials may then be obtained by the simple expedient of using a high-resistance potentiometer

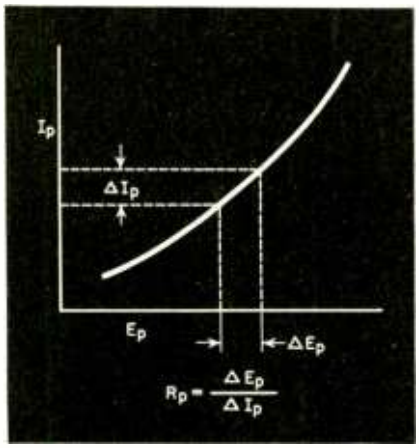

Fig. 5. Method of finding Rp.

as a bleeder across the rectifier output and taking the desired voltage from the tap of the potentiometer to the low side, or ground.

A typical E_p-I_p curve as obtained by this method is shown in *Fig. 2*.

Obtaining Mutual Characteristic

This process may be used to portray the E_g-I_p curves on the oscilloscope also, as shown in *Fig. 3*. This is accomplished by leaving the plate voltage constant and varying the grid bias voltage from some negative value to zero. This is easily accomplished by employing 60-cycle house current used in a circuit such as shown in *Fig. 4*. Here the a.c. voltage on the control grid may be supplied by a Variac or by a step-down transformer with a potentiometer connected across the secondary of the transformer and the voltage taken from the tap to one side of the potentiometer The a.c. voltage is used to aid the battery voltage so that the grid voltage will vary negative by an amount equal to twice the battery voltage and will buck the battery on the other half of the cycle so that the grid will operate at one instant at zero bias. The adjustment should be such that the grid does not swing positive unless that is specifically desired for some particular tube. The curve obtained is often called the "mutual" characteristic.

The value of these curves is greatly enhanced by simply calibrating the vertical amplifier in milliamperes for a given deflection on the cathode-ray tube and the horizontal amplifier in volts for a given deflection along the horizontal axis. These calibrations should be made for values commensurate with the values expected from examination of tube manual information of the tube under test.

To use the same methods for screen-grid and pentode tubes the other elements need only be provided with the necessary operating potentials. It is quite practical to construct a tube tester designed to operate in such manner as described herein. Such a unit would provide a much more positive indication of the worthiness of a tube than does the conventional "emission" type tube tester.

Other Tube Characteristics

With the oscilloscope calibrated for current on the vertical axis and for voltage on the horizontal axis we can determine the plate impedance, the mu, and the mutual conductance of the tube under test. The plate impedance, R_p, is equal to $\Delta E_p/\Delta I_p$. At any two points on the plate characteristic curve we can find the voltage between these points along the horizontal axis. This is done, as shown in *Fig. 5*, as follows: Drop two perpendicular lines from the curve to the axis line, draw two lines perpendicular to these lines from the same points on the curve to intersect the vertical axis. Remembering that E_p is in volts and that I_p is in milliamperes, we can then divide the E_p by

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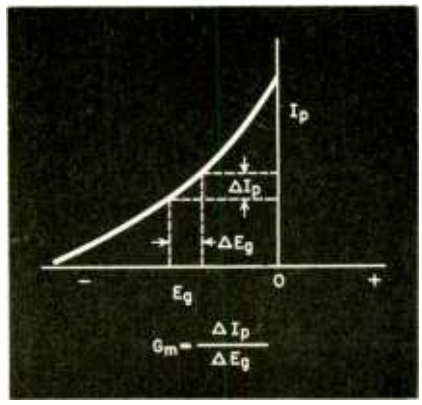
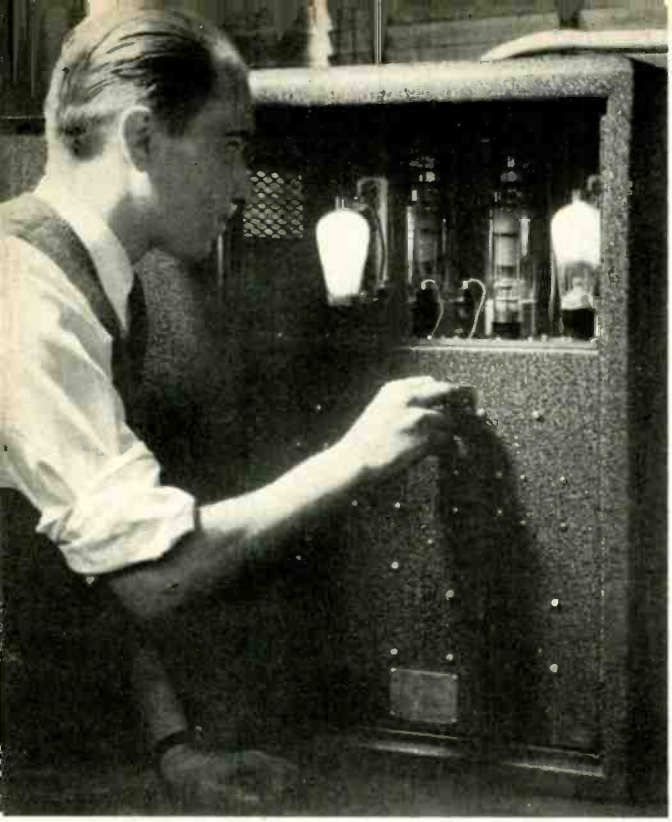


Fig. 6. Method of finding Gm.



Adjusting speed compensation on control cabinet of Mot-O-Trol. The glowing thyratron tubes control the current for the motor field.

ADJUSTABLE-SPEED A-C ELECTRONIC MOTOR DRIVE

T. R. LAWSON
Application Engineer, Electronic Section
Westinghouse Electric & Mfg. Co.

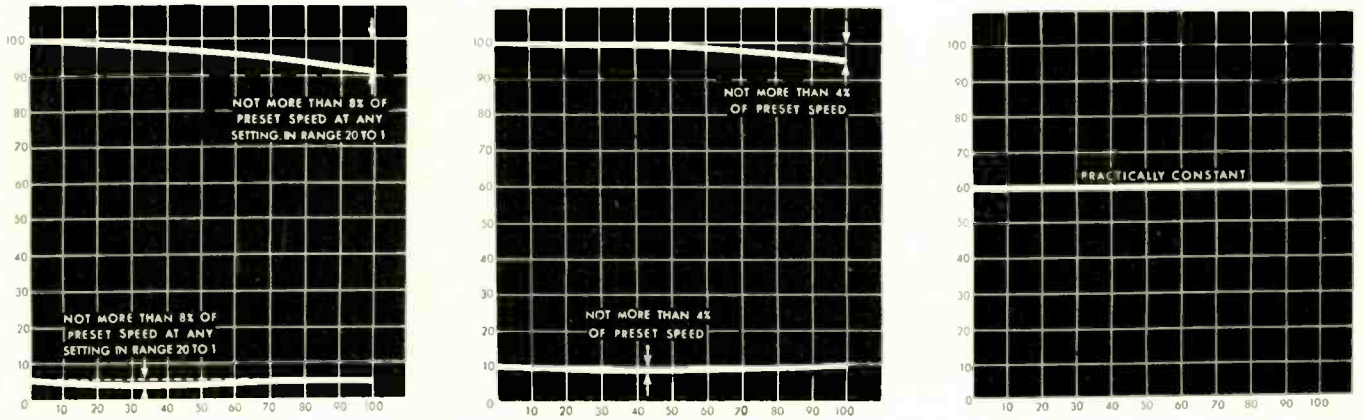
★ An adjustable-speed electronic motor drive has been developed by Westinghouse that can be used in any industry on applications that require constant preset speed at varying loads over a 20 to 1 speed range and smooth, automatic acceleration and deceleration. Flexibility of a direct-current motor drive with an alternating-current supply is obtained, as the incoming a.c. power is converted by grid-controlled rectifier tubes and supplied to the armature and field of the d.c. motor. This electronic drive provides constant torque for all speeds up to the base speed of the motor and constant horsepower above base speed.

The search for a satisfactory motor with exceptionally wide adjustable-speed range to operate from alternating current has continued ever since alternating current itself was first commercially used. Many solutions have been offered with some degree of success, for instance, numerous mechanical drives using a constant speed a.c. motor and variable speed output shaft, modifications of the wound-rotor induction motor and slip clutch arrangements. Some industrial machinery is supplied by a separate source of d.c. power, even if it means individual a.c., d.c. motor-generator sets, so that a direct-current motor with its desirable characteristics might be used.

None of the special adjustable-speed, alternating-current drives for general purpose use are without some undesirable feature, whether it be speed range obtainable, speed torque characteristics, first cost, maintenance or mounting difficulties. In many instances where direct-current power is available, the standard direct-current motor does not completely fulfill all requirements; such as, extremely wide stable speed range, good speed regulation and smoother automatic acceleration.

Electronic Control System

This electronic motor drive, known as the Mot-O-Trol, was designed to fulfill the desired requirements of an a.c., adjustable-speed motor. The basic idea is not new. Westinghouse has furnished such motor drives on special applications for some years, but recent refinements eliminate many of the earlier handicaps and make the new



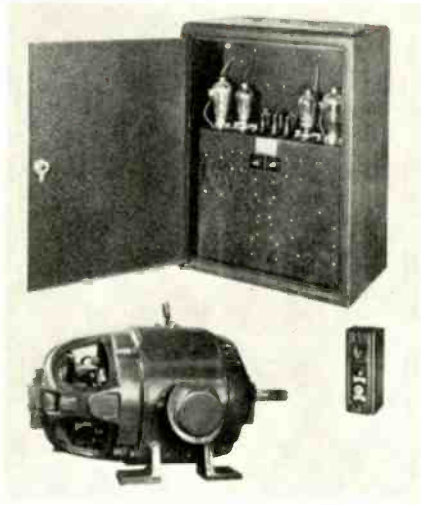
Speed torque curves showing control characteristics of the electronic motor drive under three operating conditions. In each case percent of base speed is plotted against percent of full load torque. Left graph covers a 20-to-1 speed range; center graph a 10-to-1 speed range. Right graph shows constant speed, from zero to maximum torque, is obtained at any speed within the operating range.

electronic system comparable or better than other existing solutions.

Thyratron tubes supply a shunt-wound d.c. motor with rectified a.c. power. In general, the system consists of a single or polyphase grid controlled, thyratron tube rectifier, that takes power from an a.c. line and rectifies it into direct-current output. The rectified d.c. voltage is applied to a regular shunt-wound, d.c. motor and may be varied from zero to motor rated voltage (or above) for d.c. armature control. Smaller thyratron tubes used in the control provide rectified d.c. field current for the motor. The field voltage is held constant throughout the range of armature voltage and then is reduced to provide greater speed range by field weakening above the base speed of the motor.

This electronic control, shown schematically in *Fig. 1*, for motors 1 hp and smaller, uses single-phase, full-wave rectification on both field and armature. For motors of larger horsepower rating a two phase full-wave or three phase half-wave rectifier may be used depending upon the most economical application of tubes. Four pieces of equipment are involved. These are the power transformer, the electronic control, the control station and the d.c. motor.

When mercury-vapor tubes are used, an initial five minute time delay period is required for tube warm-up. However, this time delay need occur only once after the line switch is closed.



Motor, control cabinet and control box make up the complete Mot-O-Trol system.

The control is designed to maintain continuous heating of the tubes at all times, even when the motor is stopped, unless the line switch is opened or the low-voltage protection feature operates. The time delay relay contacts are in the field control and armature control circuits so that the "forward" and "reverse" push buttons are not effective until the initial warm-up period is over.

Speeds may be preset, within the design range. With two speed-control potentiometers and reversing contactors, different forward and reverse speeds may be preset so that only the operation of the forward or reverse push buttons is necessary to obtain a predetermined speed in either direction. Speed adjustment may be made at any time while the motor is running. Speed control potentiometers are tandem type to cover the entire range of armature and field adjustment on a single dial. Adjustment of the potentiometer changes the firing point on the a.c. line voltage wave at which the tubes fire and thereby varies the output d.c. voltage as required.

Speed Regulation

The normal speed range by armature control is 20 to 1, below the base speed of the motor, though a much wider range, such as 100 to 1 can be obtained. Field control is used above basic speeds for standard motors. This is normally 2 to 1, but the top speed is limited by the mechanical limitations of the motor.

The standard electronic control automatically regulates the motor speed so as to maintain essentially constant speed at any setting regardless of load. Through other small control tubes, the d.c. voltage output of the main rectifier tubes is controlled to compensate for speed changes. In a properly adjusted system, the speed over a 10 to 1 range will not vary more than 4 percent from a presestting, with torque varying from no load to full load. Nor will it vary more than 8 percent for any speed within the speed range of

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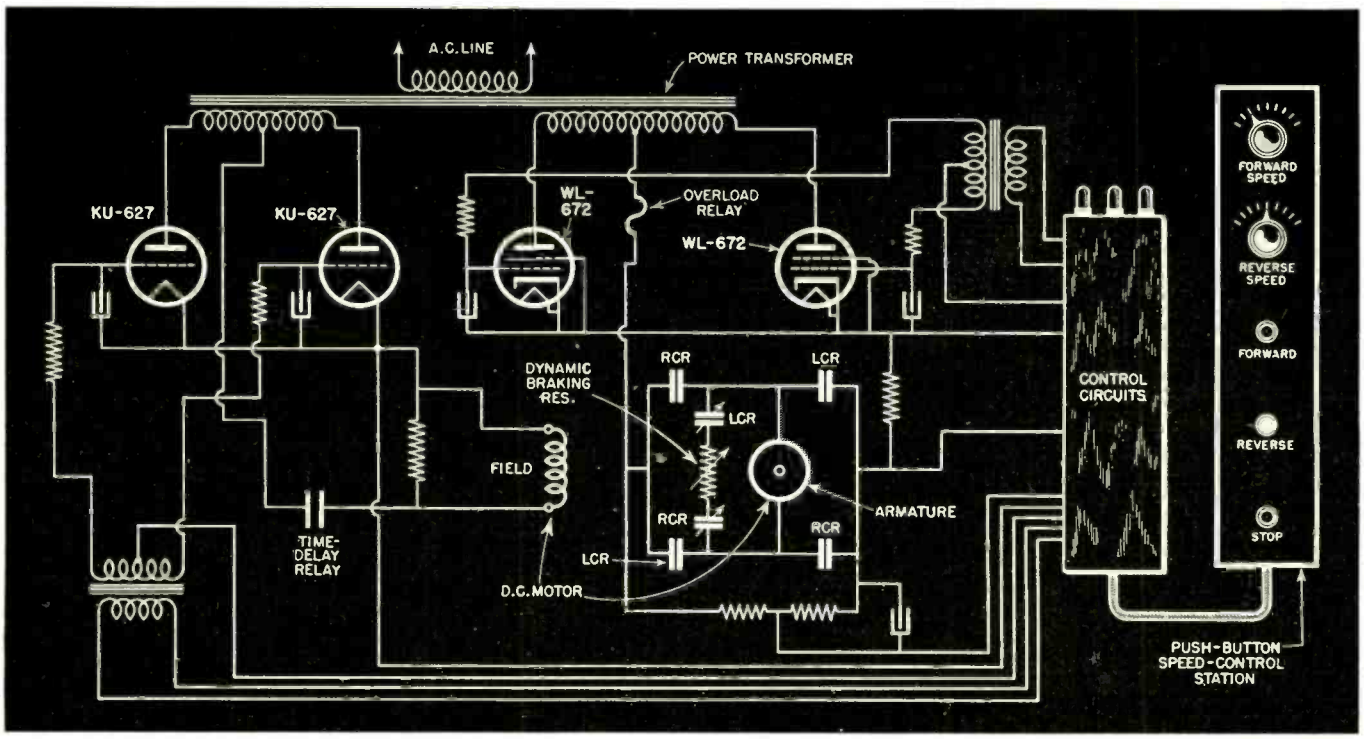


Fig. 1. Schematic of Mot-O-Trol power circuit. Power taken from the a.c. line is rectified by two 672 tubes and supplied to the motor armature through a reversing contactor. Two 627 thyratrons supply rectified voltage to the field of the motor.

Photo by U.S. Army Signal Corps.

STANDARDIZATION OF RADIO PARTS

S. K. WOLF*

Chief, Resources Branch,
Radio and Radar Division, WPB

★ Standardization and simplification of component parts of radio and electronic equipment is more important today than ever before. This equipment is now being produced in a dollar volume some 1500 percent greater than that in the month before Pearl Harbor.

Only a limited additional amount of plant expansion can be provided to meet the tremendous needs of the Army and Navy for equipment ranging from tiny handie-talkies to complicated and bulky electronic apparatus. Some of this equipment had not even existed in the wildest dreams before American industry set to with a will and produced today's miracles in electronic research and development.

It is necessary, therefore, because of this limited plant expansion, to take the utmost advantage of our present production lines and tooling, as well as to stretch our available supply of labor by every possible means.

The use of standard components in equipment radically reduces the possibility of assembly-line stoppages due to shortages of special parts, tailor-made for individual equipment. It will also reduce the number of separate assembly lines necessary for practically identical equipment built for various purchasers but which differs chiefly in the minor details of the various components and sub-assemblies.

Likewise, the use of standard components means the elimination of small runs in the case of the parts manufacturers because of small orders for special parts. It also makes possible more extensive use of labor-saving automatic machinery by the various parts manufacturers because of the increased runs.

Whims Abolished

With the use of American War Standard parts in radio and electronic equipment, component manufacturers will no longer have to comply with the whims of any designer who may have his own ideas of the specifications which should apply for parts used in equipment bought by the Armed Forces on the so-called "performance basis." Sometimes such whims have meant that constructions, tolerances, etc., have been insisted upon which have been unnecessary or have not been applicable for the required use in which the equipment was to be placed. In others it has meant that inadequate tests and designs have been called for which

*Chairman, War Committee on Radio (C75).

could not be quickly detected in the short time military necessity has sometimes allowed for equipment type approval tests in the government laboratories. This has resulted in failures and in necessary field modifications of equipment when the inadequacies have been discovered in actual military usage. That this has been a serious problem cannot be denied, since as a chain is no stronger than its weakest link so a radio equipment is no better than its least reliable component part.

The actual work of establishing the necessary standards for the component parts of military radio and electronic equipment is now being conducted by the War Committee on Radio of the American Standards Association. The membership of this committee comprises representatives of the U. S. Navy Bureau of Ships, the Signal Corps Standards Agency, the Headquarters of the Army Service Forces, the War Production Board, the Institute of Radio Engineers, and prime contractors for radio equipment.

How Standards Evolve

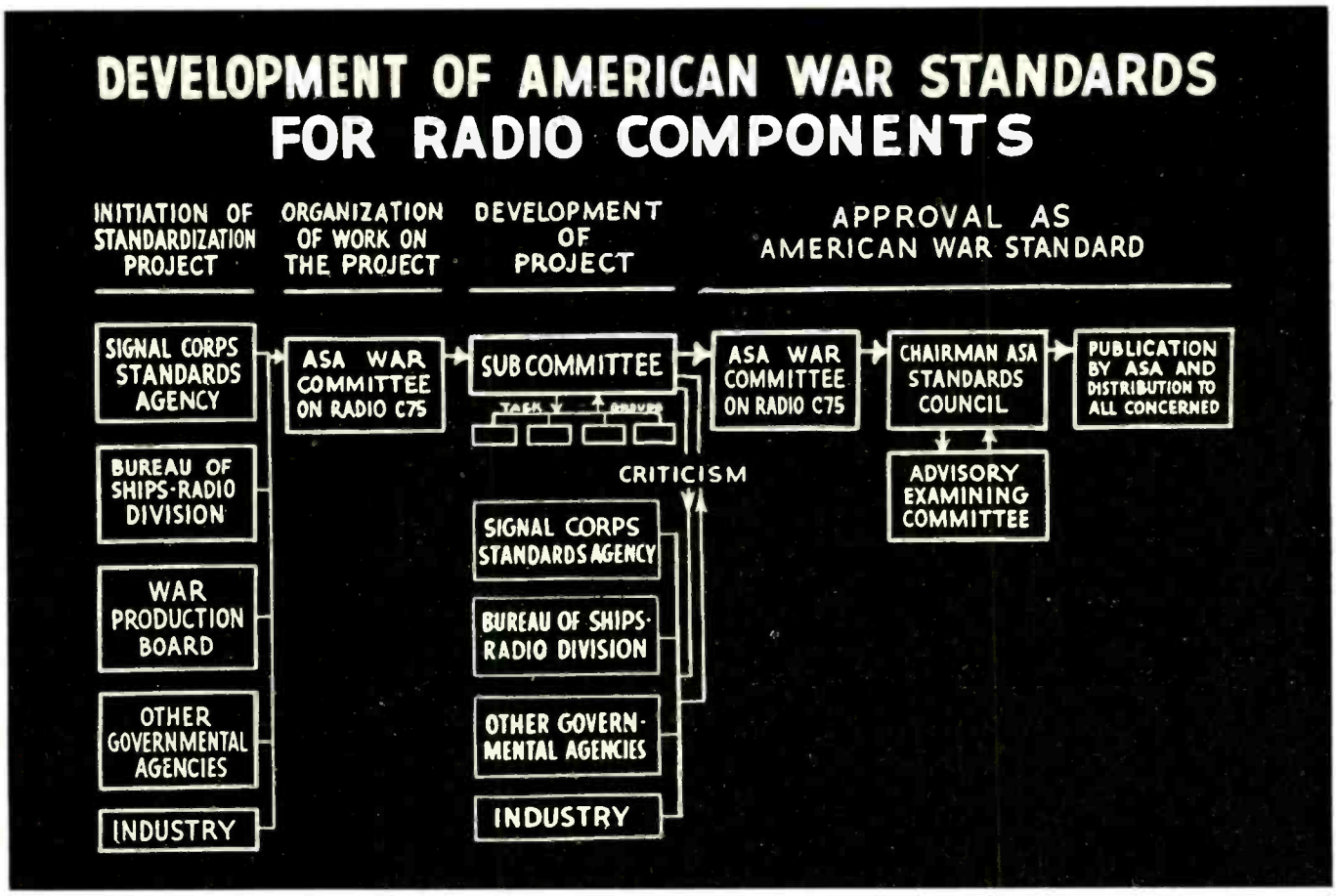
Under the supervision of this committee, subcommittees and task groups, representing both the Armed Forces and industry, meet jointly around the table to draw up American War Standards. In these standards are included the minimum number of necessary electrical characteristics for each item chosen on the basis of preferred numbers; requirements for physical characteristics which use a minimum of strategic and critical materials; a test specification setting forth the tests and requirements necessary to insure satisfactory performance of the component under the terrifically severe conditions of temperature, humidity, vibration, and shock encountered in equipment used by the Armed Forces; and a type designation or part number for all standard parts. This number identifies all the essential physical and mechanical characteristics of the particular part as well as designating that they have been produced to conform with the particular American War Standard in which they are listed.

When the work of these task groups and subcommittees is finished, all important individual and radio components will be American War Standard components interchangeable between various equipment used by the Air Forces, the Ground Forces, and the Navy.

The advantages to both the Armed Forces and Industry of having these American War Standards, on which all interested parties have agreed as to the essential requirements for any individual component, cannot be counted in terms of dollars alone. On the fighting front the interchangeability of standard parts means that equipment which would otherwise have to be discarded because of lack of spare parts can be speedily repaired and returned to service. It means also a great improvement in the "spare parts problem," because no longer will the Armed Forces have to maintain large and diversified stocks of all spare components in field repair depots scattered from Iceland to Australia. Accompanying the lessening of demand for these special spare parts is a consequent freeing of component fabrication facilities for standard parts and a reduction in the amount of critical materials and parts destined for storage against possible use.

Easy Interchangeability

The standard type designation given to all standard component parts means that these part numbers can be used for re-ordering, instruction books, circuit diagrams, etc., where in a few letters they identify the essential mechanical and electrical characteristics of a given part. It means also that the various Armed Services can obtain parts from each others' warehouses with but little trouble, since the parts will be identical even unto the numbers stamped thereon.



Vital link between battle headquarters and the fighting mechanized units is supplied by radio equipment such as this. Dan Veglia is lining up completed units prior to final tests and shipment at the RCA Victor Division plant in Camden, N. J.

Another advantage of these American War Standards has already been realized. Standard component parts can now be and are being reallocated, as the need arises, from one equipment to another in order to keep production schedules in balance and to relieve sudden needs which arise as production schedules are altered because of changes in the military situation.

The work of the War Committee on Radio has evoked international interest among our Allies and its four American War Standards already approved are being used for lend-lease supplies and as a guide to the tooling up of production lines abroad. It seems probable that component parts of American equipment will in the not too distant future be directly interchangeable with those used and manufactured by our Allies. These four American War Standards are already in use in lieu of former specifications in the procurement of components and materials for radio and electronic equipment by both the Signal Corps and the Bureau of Ships.

Material Conservation

An instance of how far-reaching the recommendations for simplifications made by an ASA committee can be is the case of small panel-type electrical indicating instruments, such as voltmeters and ammeters where a reduction to 386 basic instruments in two case sizes was accomplished. The permissible variations of these instruments are only 4586, less than 5 percent of the varieties previously furnished regularly by one large manufacturer. This American War Standard on Electrical Indicating Instruments, developed by an ASA committee headed by R. B. Shepard, Chief of the WPB Simplification Branch, has already seen use as a guide to WPB-sponsored plant expansion and tooling in the American instrument industry.

In the case of American War Standard on Fixed Mica-Dielectric Capacitors (C75.3-1942), the number of case sizes available was more than halved to 18. The standard ranges and characteristics were simplified to conserve huge amounts of strategic mica, much of which has had to be imported by air from abroad, and of critical low-loss molding material.

The other American War Standards already approved include one on Ceramic Radio Insulating Materials, Class L (C75.1-1943) and another on Ceramic Radio Dielectric Materials, Class H (C75.4-1943). The first of these will allow the use of a far greater number of materials than in present specifications used by the Armed Forces and thus contribute greatly to the opening up of the bottlenecks in the production of various ceramic insulato. . The second specification is the first ever written for the materials used in ceramic dielectric capacitors which are coming into greater and greater use today both in precision frequency-determining circuits and as an alternate for mica capacitors.

The work of other subcommittees of the War Committee on Radio is progressing smoothly and efficiently. The draft standards for Fixed Ceramic Dielectric Capacitors and for Vibrators are in editorial preparation for printing for general canvass of the radio and electronic industry as are similar standards for fixed wire-wound resistors and for wire-wound potentiometers and rheostats.

A draft standard for external meter-type resistors is now circulating in printed form for comment and criticism from industry.

A standard for steatite radio insulators will be finally approved and ready for use about May 15, it is expected.

Proposed standards for glass, glass-bonded mica, and porcelain radio insulators will be printed for general canvass after compeltion of the pilot work on steatite insulators.

A draft standard on high stability fixed wire-wound resistors is being revised and will be recirculated for comment from resistor and test instrument manufacturers before general canvass of the radio industry is taken.

Volume Control Work Halted

Work on the draft standard for composition potentiometers and rheostats—the familiar volume controls of civilian radio—is temporarily halted as a result of lack of sufficient information as to the performance of these controls both on the part of the Armed Forces and the manufacturers. The work of the drafting group on this standard has revealed that the type of controls furnished in peacetime are not at all suitable for military usage. Manufacturers have undertaken an immediate research and development program on these controls and at the same time government laboratories are conducting tests on samples of various manufacturers, so that the limits set in the proposed standard will not interfere with production.

Various task groups are also working on drafts of proposed standards for crystals and crystal holders and on reference test circuits for testing these vital quartz frequency standards which are used today by the million where they were used by the hundred before the war.

A draft of a war standard radically simplifying the dynamotor situation, which was first prepared by an Army-Navy subgroup, is being reviewed and revised by a joint Industry-Army-Navy task group to bring it in accord with the situation as seen by the industrial representatives from a production standpoint.

Because of the special characteristics needed in communications and electronic equipment, new specifications for both thermo-setting molded, thermo-molding, and laminated-plate plastic materials are now being drawn up by another task group comprising representatives of the plastics industry, the Institute of Radio Engineers, the American Society for Testing Materials, and the Armed Forces.

In the offing to be activated as soon as possible are committees or task

[*Continued on page 66*]

RADIO DESIGN WORKSHEET

NO. 13—PERCENTAGE MODULATION; MULTIPLE ANGLES; LATTICE NETWORK

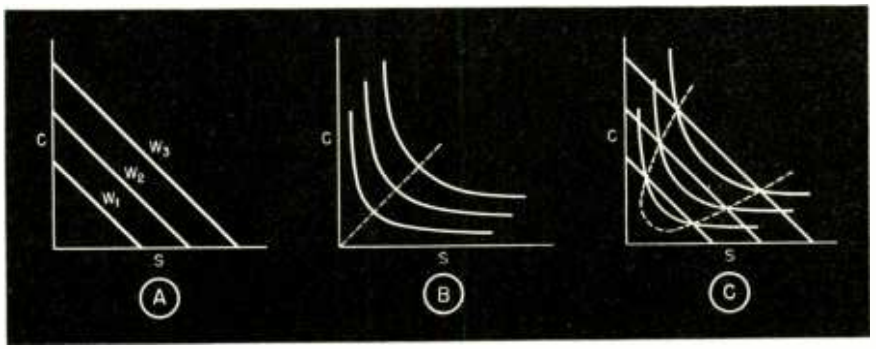


FIG. 1

DETERMINING PERCENTAGE MODULATION

Problem: *Show that a measurement of peak voltage and audio voltage can be used to determine percentage modulation of an amplitude-modulated wave.*

Solution: An amplitude-modulated wave may contain one or two sidebands. For our purpose let us consider a single sideband carrier transmitted radio communication.

Let the carrier be:

$$C \sin \omega t$$

Let the sideband be:

$$S \cos (\omega - p)t$$

The output of a peak volumeter will register:

$$C + S = W$$

The output of a square-law detector would register an a.c. voltage of:

$$CS = Y$$

Now, for different ratios of carrier amplitude to sideband amplitude we have:

$$C + S = W_1, W_2, W_3, \text{ etc.} \quad (1)$$
$$CS = Y_1, Y_2, Y_3, \text{ etc.} \quad (2)$$

If (1) is plotted with C as ordinate and S as abscissa, we have a family of curves as shown in *Fig. 1-A*. And if (2) is plotted we have a family of curves as shown in *Fig. 1-B*. If these two figures are superimposed we have *Fig. 1-C*. Obviously the intersections represent the percentage modulation or ratio of carrier amplitude to sideband amplitude. If we solve (1) and (2) for C and S we find:

$$C = \frac{W \pm \sqrt{W^2 - 4Y}}{2}$$

$$\text{and } S = \frac{W \pm \sqrt{W^2 - 4Y}}{2}$$

Since both C and S are given by the same two valued equations it is obvious that the carrier will be represented by one root and sideband amplitude by the other. Moreover, we know that: $C > S$.

Whence, if we plot C or S as a function of Y with W as a parameter, we have a family of curves such as shown by the one in *Fig. 2*. The upper half

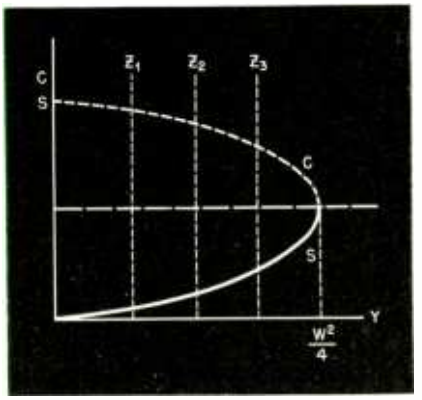


FIG. 2

of this curve will represent $C = f(Y)$ for a given value of W, and the lower half will represent $S = f(Y)$ for the same value of W. Then vertical lines parallel to the C or S axis will represent $C/S = Z_1, Z_2, Z_3$ etc.

A similar set of curves should be drawn if a measure of r.m.s. value of C and S were substituted for the peak voltage, as shown in *Fig. 3*.

While the problem has been based on a single sideband, it can easily be shown that similar results can be obtained for the conventional double sideband system.

A somewhat more satisfactory arrangement and one more generally used consists of a linear detector. In this case the change in direct current and the audio voltage are measured and compared. The solution of the linear detector for a double sideband amplitude-modulated radio wave is given in Problem 5, Radio Design Worksheet No. 11, page 30, March 1943 issue.

Let the radio wave be:

$$A \cos \omega t + \frac{AK}{2} \cos (\omega + p)t + \frac{AK}{2} \cos (\omega - p)t$$

Applying this to a linear detector yields:

$$\frac{MA}{\pi} \text{ — change in direct current}$$

$$\frac{MAK}{2\pi} \cos pt \text{ — audio term}$$

There are in addition a number of higher order modulation products which must be filtered out. It is evident that the change in direct current is proportional to the carrier amplitude A, the ratio being M/π where M is a loss factor determined by the constants of the detector.

It is also evident that the amplitude of the audio term $M/\pi \times AK/2$ is proportional to sideband amplitude, the ratio again being M/π. Whence, the ratio of d.c. to maximum instantaneous audio current is proportional to the ratio of carrier to sideband amplitude, which in turn is proportional to percent modulation K.

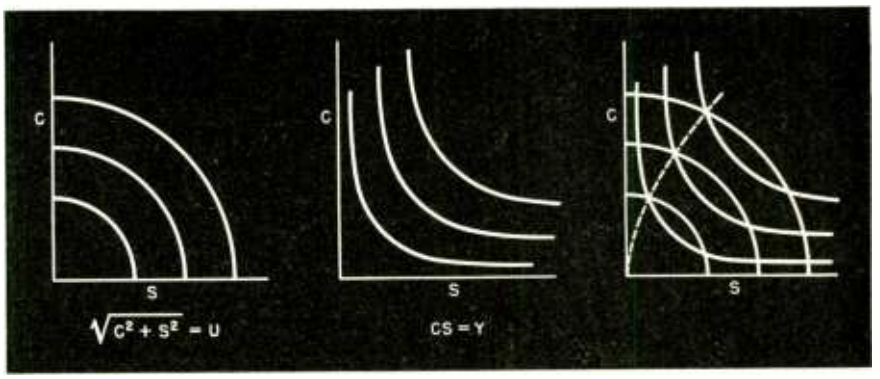


FIG. 3

EXPRESSION FOR $\sin^N\theta$

Problem: *Derive an expression for $\sin^N\theta$ in terms of multiple angles, that is harmonics of θ.*

Solution: From Euler's Theorem we have:

$$\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j} = \frac{1}{2j}\left[e^{j\theta} - e^{-j\theta}\right]$$

where $j = \sqrt{-1}$

and $e = 2.7183$ which is the base of Naperian logarithms.

Whence:

$$\sin^N\theta = \frac{1}{(2j)^N}\left[e^{j\theta} - e^{-j\theta}\right]^N$$

Expanding by the binomial theorem, we have:

$$\sin^N\theta = \frac{1}{(2j)^N}\left[e^{Nj\theta} - Ne^{(N-2)j\theta} + \frac{N(N-1)}{2}e^{(N-4)j\theta} - \frac{N(N-1)(N-2)e^{(N-6)j\theta}}{2\times 3} \ldots e^{-Nj\theta}\right] (1)$$

$j = \sqrt{-1}$; $j^2 = -1$; $j^3 = -j$; $j^4 = 1$

If $N = 2$ we have:

$$\sin^2\theta = \frac{1}{(-4)}\left[e^{2j\theta} - 2e^0 + e^{-2j\theta}\right]$$

$e^0 = 1$

Whence:

$$\sin^2\theta = \frac{1}{(-2)}\left[\frac{e^{2j\theta} + e^{-2j\theta}}{2} - e^0\right] = -\frac{1}{2}\cos 2\theta + \frac{1}{2}$$

If $N = 3$ we have:

$$\sin^3\theta = \frac{1}{(-8j)}\left[e^{3j\theta} - 3e^{j\theta} + 3e^{-j\theta} - e^{-3j\theta}\right] = \frac{1}{(-8j)}\left[(e^{3j\theta} - e^{-3j\theta}) + (3e^{-j\theta} - 3e^{j\theta})\right]$$

$$= -\frac{1}{4}\left[\frac{e^{3j\theta} - e^{-3j\theta}}{2j} - 3\frac{e^{j\theta} - e^{-j\theta}}{2j}\right] = -\frac{1}{4}\sin 3\theta + \frac{3}{4}\sin\theta$$

Likewise, we have:

$$\sin^2\theta = \frac{1}{2} - \frac{1}{2}\cos 2\theta$$

$$\sin^3\theta = \frac{3}{4}\sin\theta - \frac{1}{4}\sin 3\theta$$

$$\sin^4\theta = \frac{1}{8}\cos 4\theta - \frac{4}{8}\cos 2\theta + \frac{3}{8}$$

$$\sin^5\theta = \frac{1}{16}\sin 5\theta - \frac{5}{16}\sin 3\theta + \frac{10}{16}\sin\theta$$

$$\sin^6\theta = -\frac{1}{32}\cos 6\theta + \frac{6}{32}\cos 4\theta - \frac{15}{32}\cos 2\theta + \frac{10}{32}$$

$$\sin^7\theta = -\frac{1}{64}\sin 7\theta + \frac{7}{64}\sin 5\theta - \frac{21}{64}\sin 3\theta + \frac{35}{64}\sin\theta$$

$$\sin^8\theta = \frac{1}{128}\cos 8\theta - \frac{8}{128}\cos 6\theta + \frac{35}{128}\cos 4\theta - \frac{56}{128}\cos 2\theta + \frac{70}{128}$$

$$\sin^9\theta = \frac{1}{256}\sin 9\theta - \frac{9}{256}\sin 7\theta + \frac{36}{256}\sin 5\theta - \frac{84}{256}\sin 3\theta + \frac{126}{256}\sin\theta$$

$$\sin^{10}\theta = -\frac{1}{512}\cos 10\theta + \frac{10}{512}\cos 8\theta - \frac{45}{512}\cos 6\theta + \frac{120}{512}\cos 4\theta - \frac{210}{512}\cos 2\theta + \frac{126}{512}$$

In similar fashion it may be shown that:

$$\sin 3\theta = 3\sin\theta - 4\sin^3\theta$$

$$\sin 5\theta = 5\sin\theta - 20\sin^3\theta + 16\sin^5\theta$$

$$\sin 7\theta = 7\sin\theta - 56\sin^3\theta + 112\sin^5\theta - 64\sin^7\theta$$

$$\sin 9\theta = 9\sin\theta - 120\sin^3\theta + 432\sin^5\theta - 576\sin^7\theta + 256\sin^9\theta$$

LATTICE NETWORK CURRENT

Problem: *Apply Thevenin's Theorem to determine current that will flow through Z_1 (Fig. 1) if it terminates a lattice network when voltage E is applied to input terminals.*

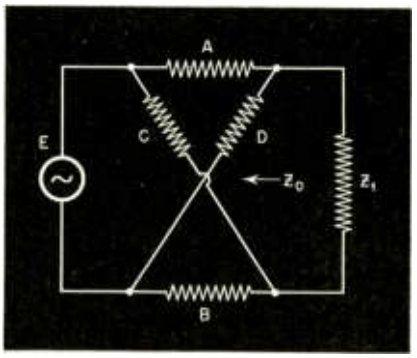


FIG. 1

Solution: Thevenin's Theorem was stated in Radio Design Worksheet No. 6, October 1942 issue.

The impedance Z_0 looking into the output terminals of lattice network with E short circuited is from *Fig. 2.*

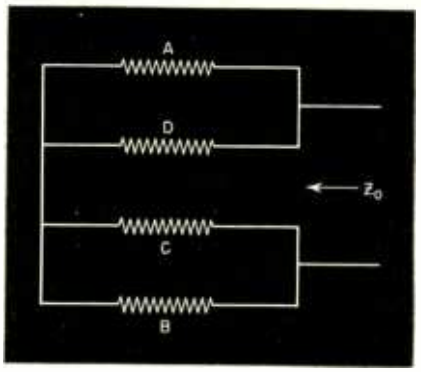


FIG. 2

$$Z_0 = \frac{AD}{A+D} + \frac{BC}{B+C} = \frac{AD(B+C)+BC(A+D)}{(A+D)\ (B+C)}$$

The voltage appearing across the output terminals of the lattice network with Z_1 removed is from *Fig. 3.*

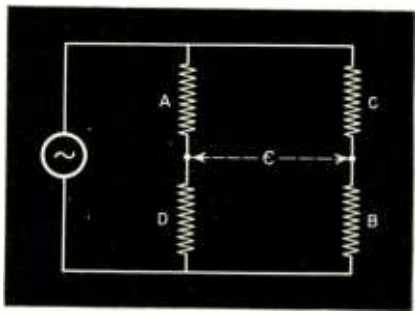


FIG. 3

$$\epsilon = \frac{DE}{(A+D)} - \frac{BE}{(B+C)} = \frac{ED(B+C) - EB(A+D)}{(A+D)\ (B+C)}$$

The current which would flow through Z_1 terminating the network is:

$$I = \frac{\epsilon}{Z_0+Z_1} = \frac{ED(B+C)-EB(A+D)}{(A+D)\ (B+C)} \times \frac{(A+D)\ (B+C)}{Z_1(A+D)(B+C)+AD(B+C)+BC(A+D)} = \frac{D(B+C)-B(A+D)}{Z_1(A+D)(B+C)+AD(B+C)+BC(A+D)} E \quad (1)$$

Which is the current required. Obviously if E were applied through an impedance, the solution would have been identical. Likewise, by comparing the square of equation (1) times the resistance Z_1 with E^2/Z_1, we could determine the loss caused by the lattice network. Lattice networks are of great importance in communications, appearing in filter, tube, and bridge computations. Also, Thevenin's Theorem is a most convenient tool in their solutions.

REVISED LIST OF

ARMY-NAVY PREFERRED TUBES

★ The accompanying Army-Navy Preferred List of Vacuum Tubes, issued March 1, 1943, supersedes the former list, dated September 28, 1942 (page 11, October 1942 RADIO).

To those concerned with the design and manufacture of Army or Navy equipment utilizing vacuum tubes. the following data is pertinent:

1) The accompanying Army - Navy Preferred List of Vacuum Tubes sets up a group of unclassified general-purpose tubes selected jointly by the Signal Corps and the Bureau of Ships. The purpose of this list is to effect an eventual reduction in the variety of tubes used in Service Equipment.

2) *It is mandatory that all unclassified tubes to be used in all future designs of new equipment under the jurisdiction of the Signal Corps Laboratories or the Radio and Sound Branch* of the Bureau of Ships be chosen from this list. Exceptions to this rule are hereinafter noted.*

3) The term "new equipments," as mentioned in Paragraph 2 above, is taken to include:

a. Equipments basically new in electrical design, with no similar prototypes.

b. Equipments having a similar prototype but completely redesigned as to electrical characteristics.

c. New test equipment for operational field use.

* Attention is invited to the fact that the Radio Division, (formerly Radio and Sound Branch) Bureau of Ships, has cognizance over all radio electron tubes (vacuum tubes) used by the Navy Department.

4) The term "new equipments," as mentioned in Paragraph 2 above, *does not* include:

a. Equipments either basically new or redesigned, that are likely to be manufactured in very small quantity, such as laboratory measuring instruments.

b. Equipments that are solely mechanical redesigns of existing prototypes.

c. Equipments that are reorders without change of existing models.

d. Equipments in the design stage before the effective date of adoption of this Preferred List.

The foregoing statements in Paragraphs 3 and 4 above are explanatory in nature and are not intended to be all-inclusive.

[*Continued on page 63*]

RECEIVING

FILAMENT VOLTS	DIODES	DIODE TRIODES	TRIODES	TWIN TRIODES	PENTODES		RECTIFIERS	CONVERTERS	POWER	INDICATORS
					REMOTE	SHARP				
1.4	1A3	1LH4	1G4GT	3A5 1291	1T4	1L4 1LN5 1S5		1LC6 1R5	3A4 3Q4 3Q5GT 1299	991
5.0							5U4G 5Y3-GT			
6.3	6H6* 9006	6SQ7* 6SR7*	2C22 2C26 6C4 6J5* 1201 9002	6J6 6SL7GT 6SN7GT	6AG5 6AK5 6SG7* 6SK7* 9003	6AC7* 6AG7* 6SH7* 6SJ7* 9001	6X5GT 1005	6SA7*	6B4G 6G6G 6L6G 6N7GT 6V6GT 6Y6G	6E5
12.6	12H6*	12SQ7* 12SR7*	12J5-GT	12SL7GT 12SN7GT	12SG7* 12SK7*	12SH7* 12SJ7*		12SA7*	12A6*	1629

TRANSMITTING

TRIODES	TETRODES	TWIN TETRODES	PENTODES	RECTIFIERS	
				VACUUM	GAS
304TH 801-A 811 826 833-A 838 1626 8005 8025	807 813 814 1625	815 829 832	2E22 803 837	2X2 3B24 5R4GY 73R 371A 705A 836 1616 8020	4B25 83 866A 872A

MISCELLANEOUS

GRID CONT. RECTIFIERS	VOLTAGE REG.	PHOTOTUBES	CATHODE RAY
394-A 884 2050 C1B C5B	VR-90-30 VR-105-30 VR-150-30	918 927	2API 3BPI 5CPI 9EPI

* Where direct interchangeability is assured "GT" and "L" counterparts of the preferred metal tubes may be used.

Q. & A. STUDY GUIDE

C. RADIUS
RCA Institutes

A-F AMPLIFICATION—I

Equivalent Generator Circuits

1. What is the most desirable factor in the choice of a vacuum tube to be used as a voltage amplifier? (II-148)

The tube constant which must be considered in the selection of a vacuum tube to be used as a voltage amplifier depends on the type of tube: i. e., triode or pentode. In general triodes may be treated as constant-voltage generators and compared on the basis of the amplification constant, while pentodes are treated as constant-current generators and compared on the basis of the transconductance.

A. Constant-voltage Generator:

From the definition of the amplification factor μ, it is known that a small change, e_g, in the grid voltage will cause the same change in plate current as a change of μe_g in the plate voltage. The space charge between the cathode and the plate offers opposition, r_p, to the flow of this current. The triode can then be thought of as a generator with internal resistance r_p. See *Fig. 1-B*. This is known as the constant-voltage equivalent circuit, since μe_g is independent of the load R_L.

If we assume that the tube is a linear device in which the i_b-e_b curves are straight lines, then μ and r_p of the equivalent generator are constants. The tube is then a distortionless amplifier. This assumption is justified in practice if the signal is maintained within certain limits.

Since amplification is the ratio of the a.c. output voltage, E_o, to the a.c. input voltage, e_g, the amplification becomes $\mu \dfrac{R_L}{r_p + R_L}$. See *Fig. 1-B*. It is apparent from this expression that the gain of a stage is directly proportional to μ and can never exceed this value. See *Fig. 2*.

B. Constant-current Generator:

Because of the high plate resistance of pentodes, it is difficult to evaluate the amplification factor. Since the tube's transconductance specifies the change in plate current with respect to grid voltage, it is possible to consider the tube as a current generator. A change, e_g, in the grid voltage will cause a change, $g_m \times e_g$, in the plate current. This current flows from plate to cathode through an impedance formed by r_p and R_L in parallel. R_L being very much smaller than r_p, the output voltage is equal to the current $g_m e_g$ multiplied by the load R_L. See *Fig. 3*. This is known as the constant current equivalent circuit since $g_m e_g$ is independent of the plate load resistor R_L. In this case the amplification is directly proportional to g_m.

It must be noted that there is a 180-degree phase displacement between e_g and E_o since plate voltage decreases as grid voltage increases (becomes less negative).

Fig. 2. Pertinent characteristics of two triodes and a pentode.

TUBE	μ	g_m	r_p	AVERAGE AMPLIFICATION		db
TRIODE 6C5	20	2000	10,000	$\mu \dfrac{R_L}{r_p + R_L}$	10	20
TRIODE 6SF5	100	1500	66,000		50	34
PENTODE 6SJ7	—	1650	—	$g_m R_L$	100	40

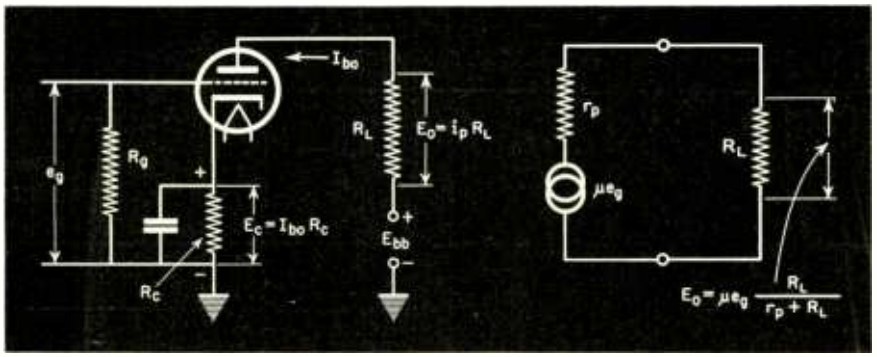


Fig. 1. A—Actual triode circuit. B—Constant voltage equivalent circuit.

Class A Amplification

2. Describe the characteristics of a vacuum tube operating as a Class A amplifier. (II-136)

3. What are the characteristics of a Class A audio amplifier? (II-166)

4. Describe what is meant by a Class A amplifier. (II-165)

A Class A amplifier is one in which there is a continuous (360 degrees of each cycle) flow of plate current, normally without any flow of grid current. The grid bias, plate-load resistor, and signal are adjusted so as to cause the output voltage to be a linear reproduction of the signal. See *Fig. 4*.

Since plate current flows continuously, plate dissipation is relatively higher than in other modes of operation. This results in low efficiency and is a factor which must be considered in Class A power amplifiers.

Bias Voltage

5. What is the purpose of a bias voltage on the grid of an audio-frequency amplifier tube? (II-144)

6. What is the maximum permissible r.m.s. value of audio voltage which can be applied to the grid of a Class A au-

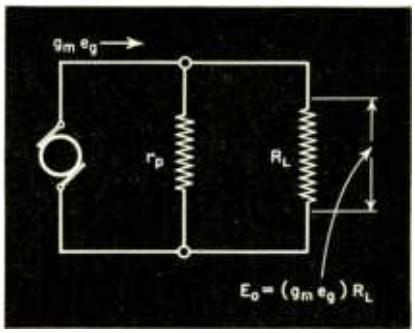


Fig. 3. Constant current equivalent circuit for pentodes.

dio amplifier which has a grid bias of 10 volts? (VI-131)

Class A audio amplifiers operate with negative bias voltage, E_c, to prevent the flow of grid current. The peak value of the signal voltage should never exceed the bias voltage. Since the r.m.s. voltage is 0.707 × peak voltage, a tube biased at —10 volts should not operate with a signal greater than 7.07 volts. In power amplifiers, particularly, this limiting value of signal voltage should never be applied if distortion is to be kept at a minimum since the grid will draw current when its potential is still negative with respect to the cathode. This is a result of several factors which involve contact potential, gas current and electron velocity.

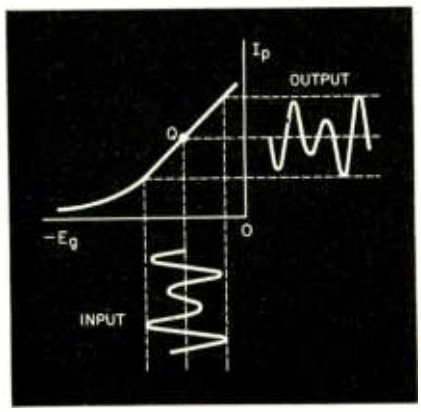


Fig. 4. Graphical illustration of Class A amplification where output is linear reproduction of input.

Audio amplifiers commonly use cathode bias as indicated in *Fig. 1-A*. The d.c. plate current I_{bo}, flowing to ground through the cathode bias resistor R_c develops a d.c. potential $E_c = I_{bo} \times R_c$. This places the grid at ground potential and the cathode above ground potential. The value of the bias voltage is so adjusted that the operating point is the midpoint of the linear (straight line) portion of the I_p-E_g curve. See *Fig. 4*.

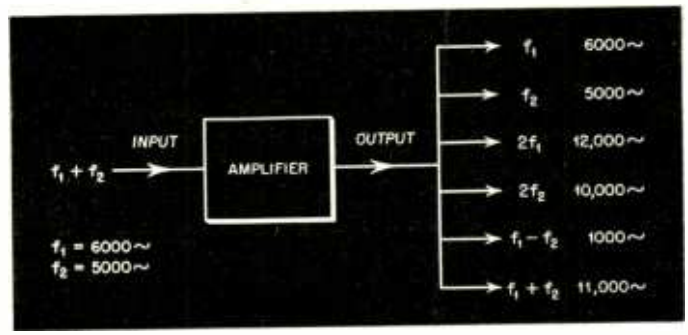


Fig. 6. Indicating the frequency components present in the output wave when the dynamic characteristic is a second - degree function.

Distortion

7. Does a properly operated Class A audio amplifier produce serious modification of the input waveform? (II-139)

8. When a signal is impressed on the grid of a properly adjusted and operated Class A audio amplifier, what change in the average value of the plate current will take place? (III-167)

Fig. 5 indicates the actual operation of a 6C5 triode voltage amplifier with normal bias, plate voltage, and load resistance. It is immediately apparent that if the maximum permissible signal is applied, the output voltage wave is very unsymmetrical. The dynamic characteristic which is plotted from the load line indicates how the output (plate current) varies with the input (grid voltage). If this tube were operating as a distortionless amplifier, the dynamic characteristic would be a straight line. The curvature in the dynamic characteristic will determine the distortion components present in the output wave. In this example the dynamic characteristic has second degree curvature and the output wave contains approximately 5 percent harmonic distortion. The average value of the plate current has also increased approximately 0.05 ma. This d.c. component is a result of the signal and hence represents rectification. When the d.c. plate current of a Class A amplifier changes with the application of a signal on the grid, second harmonic distortion is always present. The peak value of the second harmonic is equal in magnitude to the rectified plate current.

If the signal voltage wave were made up of two frequencies, say 5000 cycles and 6000 cycles, the output wave would contain a 1000 - cycle (6000 — 5000) component and a 11,000-cycle (6000 + 5000) component. In this case the 1000 - cycle component would be decidedly objectionable. It is these combinations or sum - and - difference components which are generated by the tube operating as a non-linear device, that are truly responsible for the distortion. *Fig. 6* indicates the frequency components present in the output wave when the dynamic characteristic is a second degree function:

$$i_b = a + bc_g + cc_g^2.$$

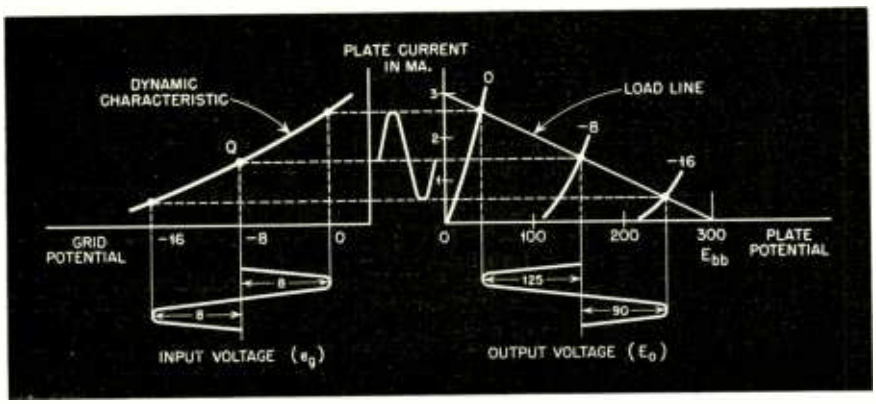


Fig. 5. Graphical illustration of the operation of a 6C5 as a Class A voltage amplifier, with Ebb 300 volts, Ec —8 volts and R1 100,000 ohms.

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METER STANDARDIZATION

Many small electrical instruments used in radio and radar, such as voltmeters and ammeters, can be reduced by standardization from sixty varieties to one or two, it was said at a meeting of the Electrical Indicating Instrument Industry Advisory Committee with the Radio and Radar Division of the War Production Board.

The adoption of American War Standards will facilitate the production of instruments, many of which will become interchangeable. It also will simplify depot stocking and replacements.

Manufacturers said that simplification should not include the elimination of special scale markings. Because switchboard and portable instruments are produced in small numbers, special scale markings do not disrupt the routines of manufacture. Such markings are functional rather than decorative, it was said.

The Production Consultant to the Instrument Unit was asked to work out methods for comparing the demand on industry with scheduled production. The data will be used in scheduling deliveries of various companies.

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FREQUENCY MEASUREMENTS AT R. F.

(INCLUDING U. H. F.)

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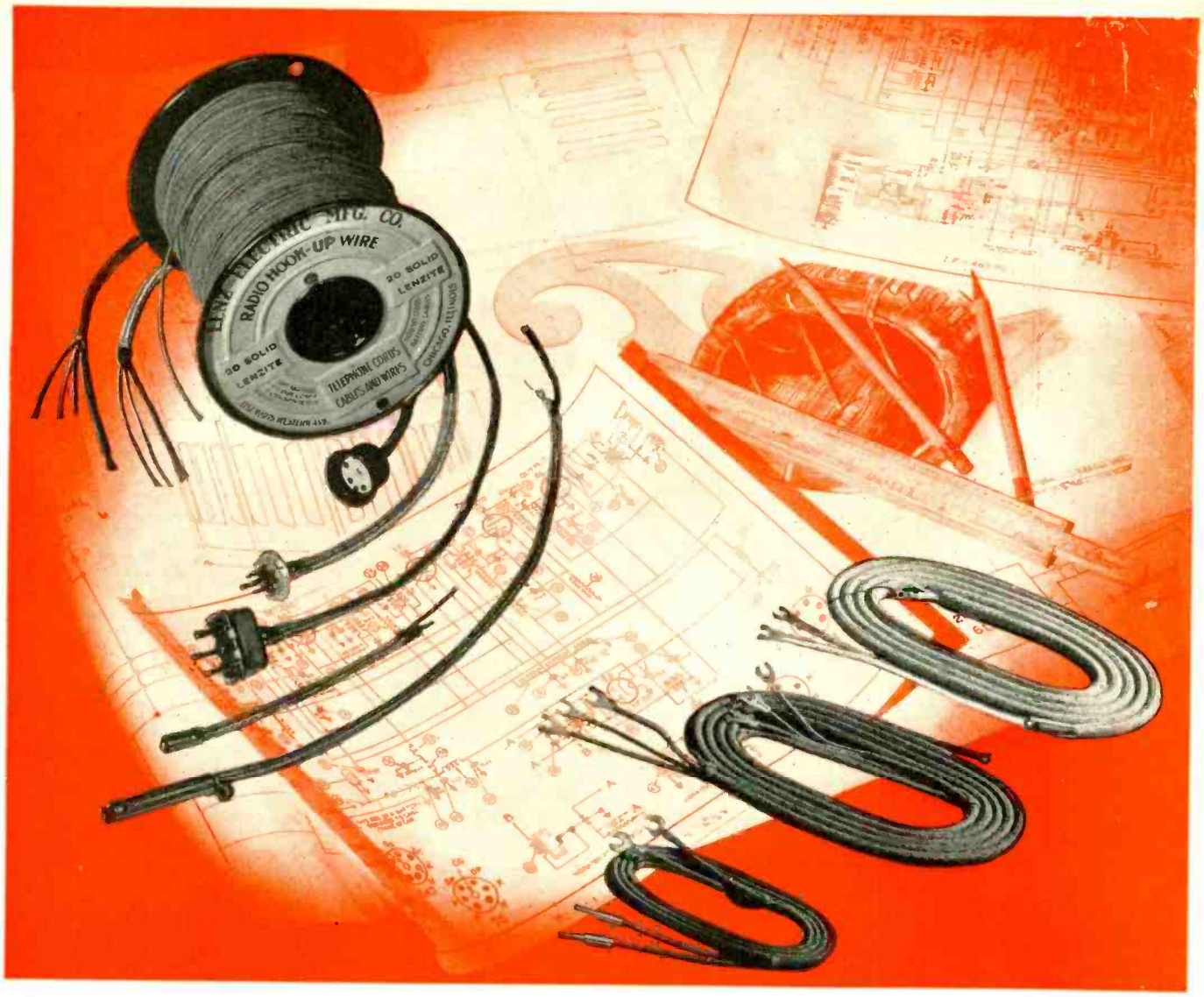

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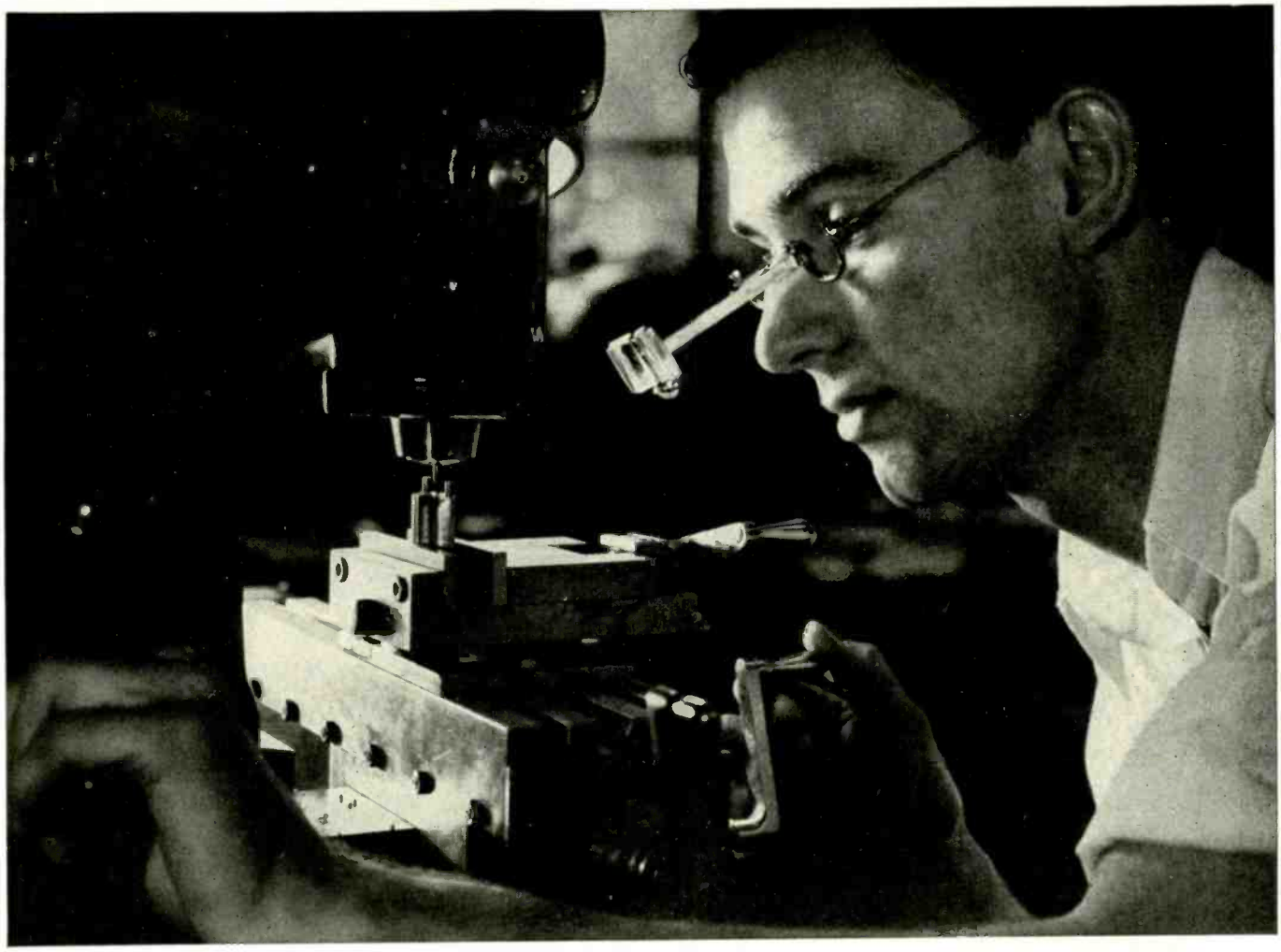

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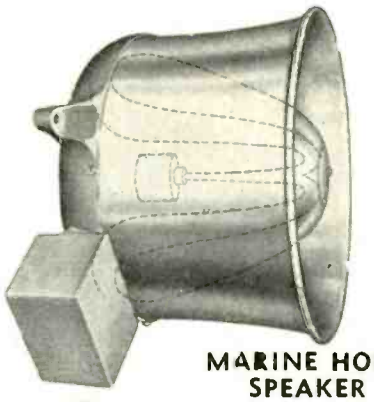

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[*Continued on page 52*]

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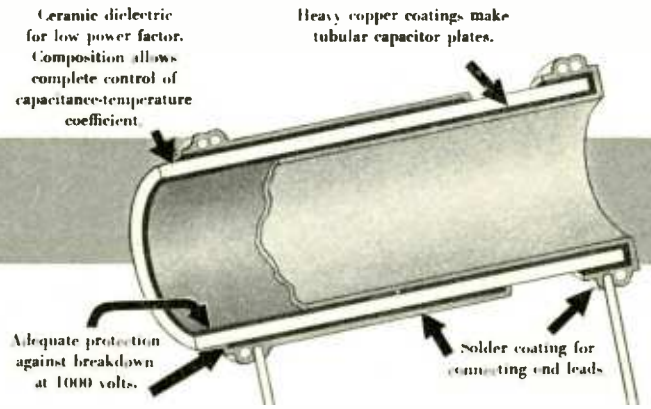

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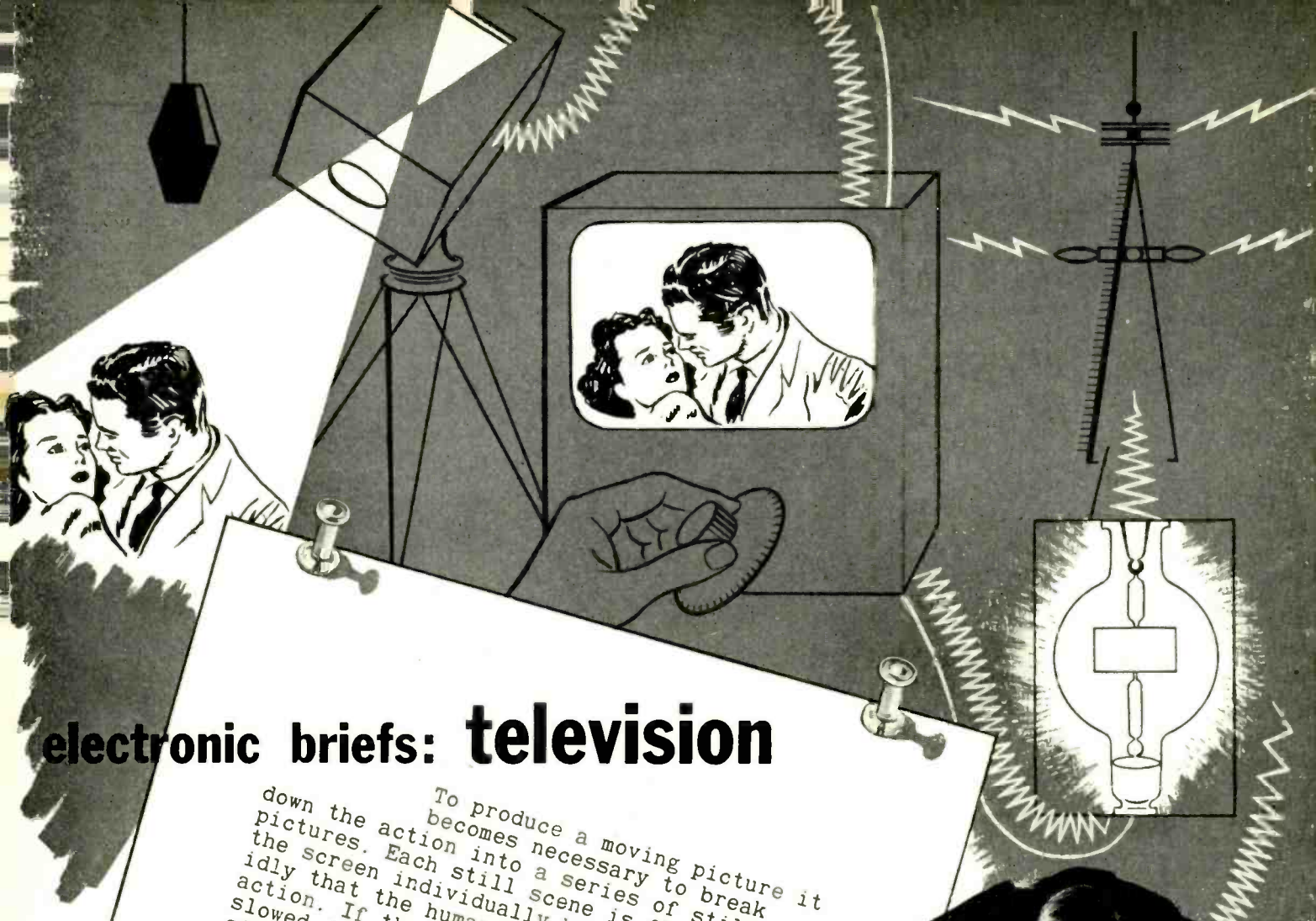

electronic briefs: television

To produce a moving picture it becomes necessary to break down the action into a series of still pictures. Each still scene is flashed on the screen individually but done so rapidly that the human eye sees a smooth action. If the motion picture projector is slowed down the action becomes jerky. Each still picture is called a frame. The conventional movie projector flashes between 24 and 30 frames per second on the screen. Television is based upon the same principle but the problems involved are much more complex.

Television, using the same basis for creating picture action as the movies, breaks down the picture or scene to be broadcast into a series of still pictures called frames. But each frame must also be broken down into approximately 200,000 tiny segments, each segment being broadcast separately and reassembled at the receiving end so rapidly that 30 frames can be flashed on the screen every second. Thus some 6,000,000 separate signals must be transmitted per second. Furthermore each of these signals starts as light, is converted into an electrical impulse, broadcast and then reconverted to light again. To make television talk, a conventional sound transmitter must be coordinated and synchronized with the picture broadcast.

As with all things in the field of electronics, vacuum tubes are what make television possible. Remember; Eimac tubes enjoy the enviable distinction of being first choice among leading electronic engineers throughout the world.

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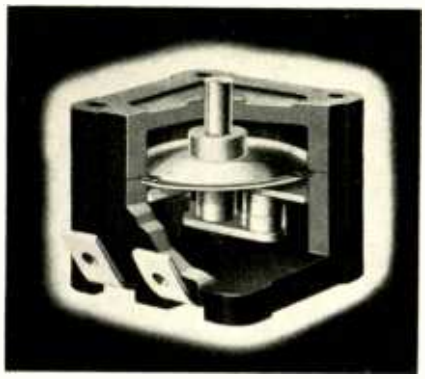

Operating characteristics of Allied A3 and A5 Sealed Switches are: *Contact Arrangements:* Single pole, single throw. A3—normally closed, double break. A5—normally open, double break. *Contact Ratings:* Non-inductive, 50 amperes at 12 and 24 volts d.c. and 110 volts a.c. *Operating Pressure:* 1½ to 3½ pounds. *Plunger Travel:* Travel differential 0.006 to 0.012 of an inch. *Over Travel:* 0.050 to 0.070 of an inch at maximum pressure. *Vibration:* 10 G for either horizontal or vertical positions. *Weight:* 5 ounces. *Dimensions:* 1 15/16 by 1 15/16 by 1 19/32 inches. The Allied Control Company, 2 East End Ave., (at 79th St.) New York.

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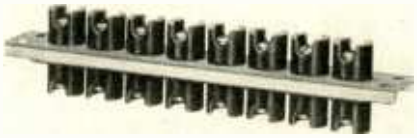
A new multiple terminal block, for sub-panel and chassis construction, with feed-thru terminals, has just been announced. This new terminal block is designed to meet present-day demands of electronic and electrical design, which require external terminals, because of their wiring simplicity and other advantages.



The terminal block consists of individual feed-thru terminals, mounted in bakelite, which are permanently held in a metal strip in any combination desired. Factory production now includes blocks having any number of units between 1 and 10, but, because of their unique sectional design, blocks can be supplied with any number of terminals needed.

Terminals have ample clearances and leakage distances for circuits carrying up to 300 volts, 20 amperes. Center to center distance between terminal units is ⅝". No. 8 screws are used on each side of the terminal units for securing connection. The two mounting holes at each end of the terminal base take No. 8 machine screws. These new blocks, known as Curtis Feed-Thru Terminal Blocks are offered by Curtis Development and Mfg. Co., 1 N. Crawford Ave., Chicago, Ill. Descriptive literature is available upon request.

★

NEW GARNER FREQUENCY METERS

The Fred E. Garner Company has just announced production of four new models of their "Telrad" line of frequency meters. All models are crystal-controlled and, by means of a Class C harmonic amplifier circuit embodied in the units, accurate frequency carrier signals are provided every 10 kc and every 100 kc from 100 cycles to 45 megacycles. A carrier signal is also produced every 1000 kc from one megacycle to 120 megacycles. A convenient panel-mounted "on-off" switch permits use of a 1000-cycle modulated note.

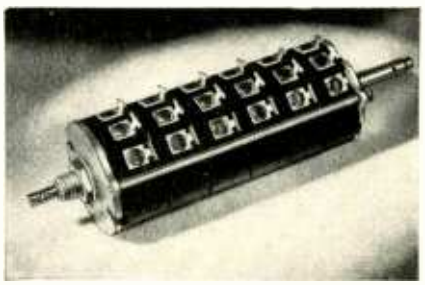
Special models designed for use under adverse conditions are available, equipped with two precision crystals that have been ground to produce exact frequencies of 100 and 1000 kc and tested for efficient operation at temperatures from —35° to 55° Centigrade and have temperature co-efficients of maximum drift of only 2 and 3 cycles per megacycle per degree Centigrade respectively.

Models are available for either a.c. or portable battery operation. Additional information may be obtained from Fred E. Garner Co., 43 East Ohio St., Chicago, Ill.

★

CLAROSTAT TANDEM CONTROLS

A plurality of circuits—up to two dozen if desired—can be controlled by the single shaft of the "42" Series Control developed by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y.



This new control was developed to meet certain radio and electronic requirements calling for the single control of several circuits. To produce maximum rigidity in such tandem assemblies, as well as positive rotation of all units without the slightest backlash, the "42" Series construction has been worked out.

The new design of case for each unit permits the nesting and locking of all units into a compact stack. The metal

[*Continued on page 76*]

THIS MONTH

RMA NAME CONTINUED

Continuation of "Radio Manufacturers Association" as the name of the industry trade organization, was decided upon by its Board of Directors at its meeting in New York on April 15. There had been discussion of including "electronics," "radionics," or some other term connected with the new technical developments and possibly changing the name of RMA, which was organized in 1924.

The Organization Committee of RMA, of which Mr. Leslie F. Muter, past president of the Association, is chairman, presented a unanimous report to the Board of Directors recommending that for the present the name of RMA be continued. The Zenith Radio Corporation offered RMA unrestricted use of its copyrighted word "radionics." Members of the committee which recommended continuation of the Association's present name include H. C. Bonfig, Glenn W. Thompson, A. S. Wells and Fred D. Williams.

★

HALLICRAFTERS AGAIN RECEIVES PRODUCTION MERIT AWARD

The Hallicrafters Company, Chicago, who were awarded their Army-Navy "E" Burgee on September 9, 1942 have again been cited for continued excellence in the production of communications equipment by the addition of stars to their Army-Navy "E" Burgee.

This coveted award was accepted for the Hallicrafters Company by W. J. Halligan and R. W. Durst.

★

"E" AWARD TO SPRAGUE

The presentation on April 2nd of the Army-Navy "E" Award to the Sprague Specialties Company, manufacturers of condensers, resistors and many other pieces of electronic equipment for the war effort, took the form of a double ceremony under one roof. Two "E" Flags were received, one by the Beaver Street Plant and one by the Brown Street Plant. Employing over half the industrial population of North Adams, Mass., "Sprague Day" became a celebration in which the entire city assisted.

Following a buffet luncheon to out-of-town military and civilian guests, the program was held at the Brown Street Plant, a band and color guard from Westover Field opening the ceremonies at 3 P. M. by raising the American Flag and playing the National Anthem. Governor Leverett Saltonstall brought greetings from Massachusetts and Mayor C. E. O'Brien congratulated the employees on behalf of the city.

Brigadier-General A. A. Farmer, U. S. Signal Corps, presented the two "E" Flags to President R. C. Sprague and two of the employees. Following Mr. Sprague's speech of acceptance, Captain J. S. Evans, U.S.N., presented the emblem pins to James F. X. Shea, President of the Independent Condenser Workers' Union, Local No. 2, and to four other employees representing all the workers. Mr. Shea then accepted for both plants.

President R. C. Sprague interrupts his speech of acceptance of the Army-Navy "E" to observe it is first time he has stood before all the employees of the Sprague Specialties Co.

★

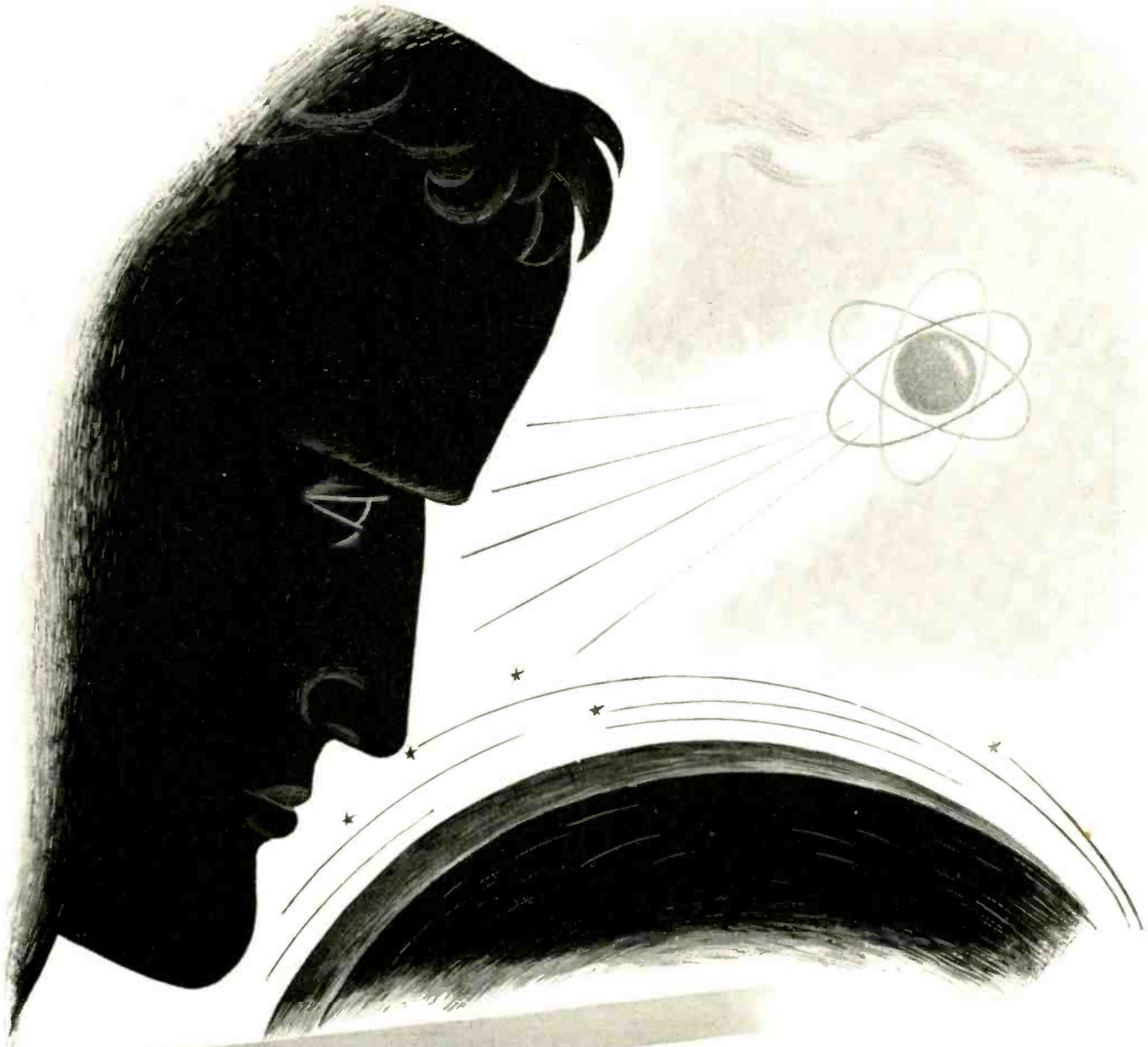
SHURE BROTHERS AWARDED ARMY-NAVY "E"

The Men and Women of Shure Brothers, Chicago, were awarded the Army-Navy "E" for high achievement in the production of war materials. The "E" Burgee was presented to Mr. S. N. Shure, General Manager of Shure Brothers, by Lt. Col. Nathan Boruszak. The presentation was made at Thorne Hall, Northwestern University. Other Army and Navy men and women on the rostrum were: Lt. Col. John M. Niehaus, Lt. Comdr. George C. Norwood, Lt. Comdr. T. M. Brautigam, Major Eldon A. Koerner, Lt. Robert D. Morgan, Lt. Barbara Rode, Ensign Miriam Fullbright, S. I. Neiman. Presentation of the "E" Pin was made by Lt. Comdr. George C. Norwood. Acceptance of the "E" Pin was made by Marion De Block.

Master of Ceremonies was Jack Berman, Shure Sales Manager. Over 800 Shure workers and guests filled Thorne Hall to overflowing and participated in the presentation. It was the first "E" awarded to an exclusive microphone manufacturer.

[*Continued on page 60*]

R. W. Durst, Marcia Davis, and W. J. Halligan displaying Hallicrafters' "E" Burgee with Star added.



NOSE TO THE GRINDSTONE

"Our noses are held to the grindstone of war production . . . but our eyes are fixed on the future." This is how one Stancor engineer described our present operating policy.

War problems are urgent, challenging, and stimulating. To solve them calls for midnight oil; but the lessons learned and discoveries made apply also to the problems of peace. When the war is won, industry will be confronted by a revolutionary development of electronic engineering . . . and Stancor engineers, seasoned by war demands, will be ready to serve you.

STANCOR

STANDARD TRANSFORMER CORPORATION
1500 NORTH HALSTED STREET · CHICAGO

SICKLES GETS "E" AWARD

For excellence in the production of radio equipment, the F. W. Sickles Company and its employees were presented with the Army-Navy "E" by Lieut. Col. Kenneth D. Johnson of the Army Signal Corps. Col. Johnson told the large audience of Sickles workers that they had won the award "because of the high quality and quantity of your production." One Sickles item, Col. Johnson said, leaped upward in production some 350% after Pearl Harbor, under the employee-management impetus to provide the fighting forces with radio parts. Production was increased 450% on another item, the Colonel revealed.

The award was accepted on behalf of the Sickles management by Roy F. Sickles, company president and son of the founder F. W. Sickles, and on behalf of the employees by William Meserve, president of the Mutual Benefit Association.

★

MOTOROLA EARNS STAR ON "E" FLAG

One of the first Chicago firms to be awarded a star on their Army-Navy "E" Flag, for continued excellence in production, is the Galvin Mfg. Corporation, 4545 Augusta Boulevard.

Ever since the original ceremony of September 8, 1942, at which Lt. Col. Paul F. Hannah presented the "E" Flag and emblems to Mr. P. V. Galvin, President, representing the Motorola management, and Mr. P. J. Maloney, representing the Galvin employees, the Motorola factory has kept abreast of and ahead of its production quota. It is this record which led to the recently awarded star.

S. N. Shure (left) shaking hands with J. J. Kahn.

S. N. SHURE HONORED

At its April meeting the Association of Electronic Parts and Equipment Manufacturers (formerly the Sales Managers Club, Western Group) formally presented to one of its charter members and past presidents, Mr. S. N. Shure, General Manager of Shure Brothers, a large decorated cake commemorating the recent Army-Navy "E" production award to that company. The presentation was made to Mr. Shure by Jerome J. Kahn, Chairman of the Association.

★

RMA, WITH IRE, ORGANIZING TECHNICAL PLANNING BOARD

Plans of RMA, with participation of IRE and cooperation of the Federal Communications Commission, to establish a "Radio Technical Planning Board" for the study of postwar services to the public, including FM and television, were announced by Chairman James L. Fly of FCC on Wednesday, April 28, at the annual meeting of the National Association of Broadcasters in Chicago. The FCC and other government agencies will cooperate in extensive postwar technical studies planned of the use of ultra-high frequencies in the radio spectrum.

The RMA, through its Engineering Department under Director W. R. G. Baker, initiated the plans for the Radio Technical Planning Board, following suggestions made by Chairman Fly last November at the RMA-IRE fall meeting in Rochester, N. Y. The scope of RTPB organization and technical studies is similar to that of the National Television System Committee, which was organized by RMA with FCC cooperation, and which Chairman Fly said at Chicago "did a monumental work for the industry and the government."

Preliminary organization of RTPB now is being completed and its operations will be financed entirely by RMA. The tentative organization plan, after revision, was approved by the RMA Board of Directors at New York on April 15 and later by FCC. It awaits final action by the IRE Board of Directors. An initial appropriation of $10,000 for RTPB operations was made by the RMA governing board.

President Paul V. Galvin of RMA and Dr. L. P. Wheeler, President of IRE are to appoint the RTPB chairman, with the approval of Chairman Fly of FCC. The RTPB board mem-

[Continued on page 66]

Representing Galvin employees here are June Bauer and P. J. Maloney.

ELECTRONIC MOTOR DRIVE

[*Continued from page 25*]

20 to 1. Normal variations in a.c. line voltage have only a small effect on the speed regulation.

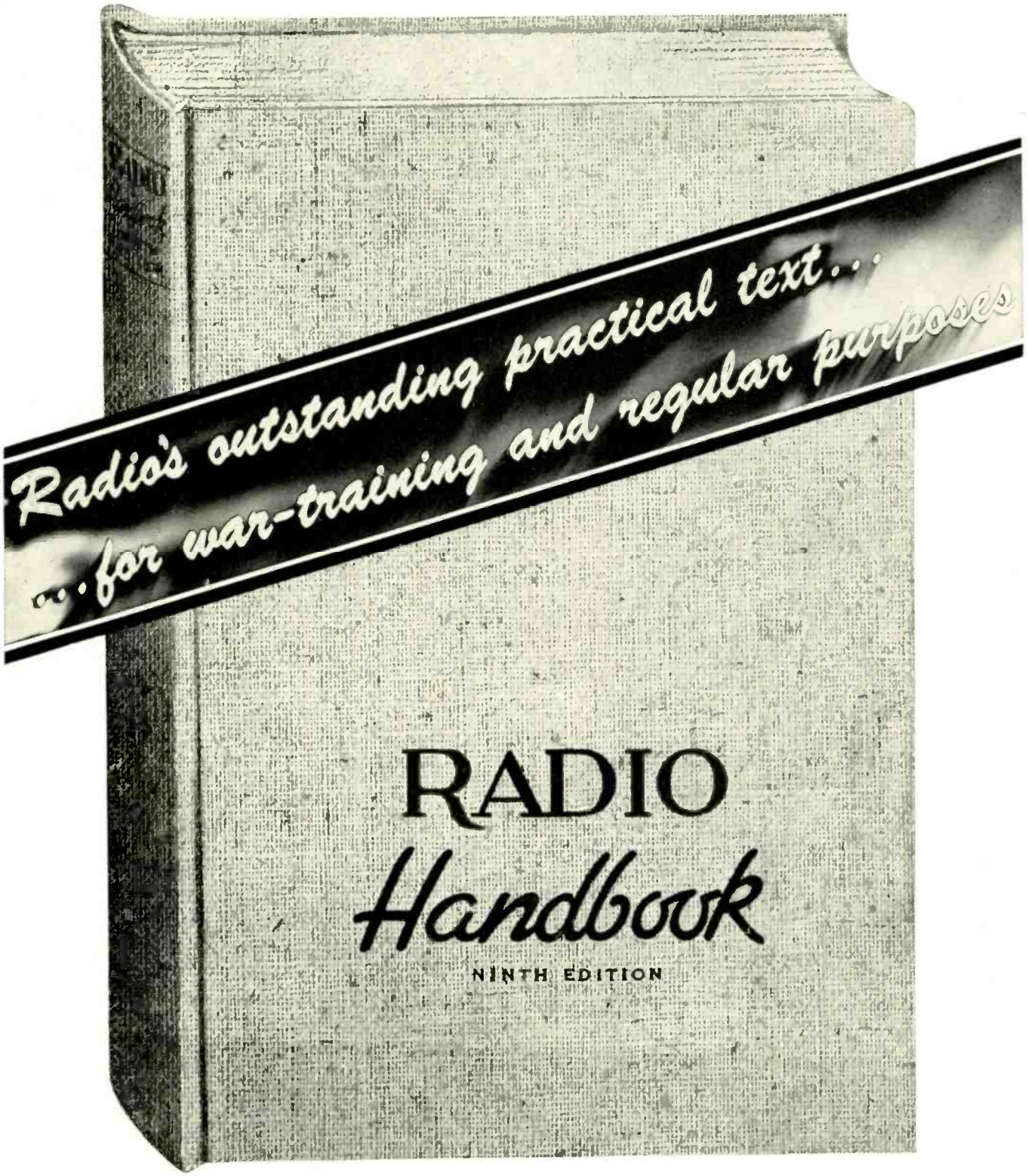
Motors furnished with this electronic control are selected to handle constant torque load over the entire armature control speed range (or up to the base speed of the motor) and constant horsepower over the field control range continuously without exceeding safe temperature limits. The frame size of the motor will depend upon the base speed rating and other operating characteristics. In most ratings it will be somewhat larger than the standard d.c. motor frame of the same horsepower and basic speed rating. The reason for a larger motor frame in most cases is because of the high form factor of pulsating current obtained from the rectifier when the firing angle is phased back to obtain low output voltage and consequently low motor speeds.

The control is arranged so that the motor is always started at full field regardless of the setting of the speed potentiometer. If the speed is set above base speed, with weakened field, the speed control does not become effective and the field is not weakened until the motor reaches base speed. Fast, smooth acceleration is automatically obtained through a special current-limiting device built as part of the standard unit. The current-limiting device also works from a small auxiliary control tube that in turn controls the firing of the main rectifier tubes. Thus, the voltage output of the rectifier will be such that a preset current limit will not be exceeded. For general applications, the current-limiting device may be set over a wide range up to 200 percent of rated full-load motor current, so that accelerating characteristics may be varied to suit load conditions. If unusually high starting currents are required the rectifier tubes must be carefully chosen for their peak ampere rating, even though the running load conditions do not exceed the average ampere tube rating.

The motor is quickly stopped with a dynamic braking resistor that is not in the motor circuit during running conditions. The amount of braking resistance is adjustable.

Vibration difficulties sometimes encountered with adjustable-speed drives have been minimized, as the d.c. motor is the only rotating part. No separate line starter or field rheostat is required. The electronic control may be mounted in its own cabinet or installed directly into the driven machine.

★



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Revisions in this edition adapt it even better than ever before for war-training and general use; contains added and simplified theory in the simplest possible language; added test equipment which can be home- or field-constructed; and a review of mathematics for solving simple radio problems.

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Editors and Engineers, **1422 North Highland Avenue, Los Angeles**

To the trade: Radio parts stores, schools, and governmental units may order direct from us; all other trade outlets should order through the nearest branch of the American News Co., Inc.

ARMY-NAVY TUBES

[*Continued from page 31*]

5) In the event that it is believed that a tube other than one of those included in this Preferred List should be used in the design of new equipments for either the Signal Corps or Navy, specific approval of the Service concerned, is to be requested from the Signal Corps Laboratory concerned with such equipment; the said Laboratory will then make known its recommendations in the matter to the Office of the Chief Signal Officer where the final decision will be made and returned to the laboratory for transmittal to the party requesting the exception. When Navy equipment is concerned, the request for exception shall be addressed to the Bureau of Ships, Navy Department.

6) The publication of this list is in no way intended to hamper or restrict development work in the field of vacuum tubes or vacuum tube applications.

7) This list is to take effect immediately.

Office of the Chief Signal Officer, Headquarters, Services of Supply, War Department.
Chief of the Bureau of Ships, Navy Department.

TUBE CHARACTERISTICS

[*Continued from page 23*]

the I_p and multiply the quotient by 1000. This will be the numerical value of the plate impedance in ohms.

The mutual conductance, G_m, is equal to $\triangle I_p/\triangle E_g \times 10^3$ and may be easily computed from the E_g-I_p curve when that curve is traced on the oscilloscope screen by the same methods as for finding R_p. The graphical analysis is shown in *Fig. 6*.

The gain, or mu, of the tube equals $\triangle E_p/\triangle E_g$ which equals $G_m R_p/10^6$. The mu may therefore be computed from the G_m and R_p values which are found from the curves as shown above. By these methods we can ascertain all of the pertinent facts concerning the tube, and whether or not any particular tube is within the specified tolerances for proper operation. In the above calculations I_p is in milliamperes and G_m is in micromhos.

For other information on measurements of this type and the data attainable by such methods, the following texts are worth consulting: *RCA Receiving Tube Manual; Electronics* — Millman and Seely; *Principles of Electron Tubes*—Reich; *Radiotron Designers' Handbook*—RCA.

SOUND FREQUENCY ANALYZER

[*Continued from page 21*]

and load conditions for more than a short period, such as in moving vehicles.

War Use

The Medical profession became interested in the RA-281 after plant physicians at one of the country's largest explosives manufacturing companies turned to it as a possible method of accurately determining the degree of heart muscle fatigue on the part of workers in a particular section of the chemical works.

Employees in this department were unavoidably exposed to chemical fumes which caused fatigue of the heart muscles. When that fatigue reached a certain point it induced fainting. The medical problem: to devise a positive method of determining the point at which fatigue of the heart muscles would bring about fainting; circumvent a possible explosion that might injure a number of men and wreck the plant if a worker fainted while handling explosive elements. The use of stethoscopes was highly unsatisfactory as the human element—the doctor's interpretation of the sounds heard—was too great. The sounds of a normal or unfatigued heart differed only minutely from those of a heart reaching the danger point of fatigue.

By using three filters, plant physicians found that they could chart the heart sounds of a worker before his exposure to the chemical fumes. These charts were compared with similar charts taken of the heart sounds of workers who had fainted from the fumes. By a regular check-up on all workers in the department and comparison of their charts with those showing the characteristics associated with fainting, the company physicians have been able to prevent further fainting. Workers whose charts show muscular fatigue are immediately transferred to other departments.

Clinical Use

How effectively and to what extent the RA-281 may be applied to the study of "heart cases" remains to be determined. At present, however, it has been learned that the RA-281 may be used in conjunction with the cardiograph. The electric cardiograph, as it is used, reveals irregularity of heart action by graphically registering the comparative duration and intensity of the heart's movements. The degree to which duration and intensity of the heart cycle vary from the established normal help to ascertain the serious-

ness of the irregularity. By using the RA-281 in conjunction with the cardiograph, physicians can now determine what part of the heart cycle is responsible for any abnormal heart action charted by the cardiograph.

USING SLIDE RULE

[*Continued from page 18*]

$Z = \sqrt{R^2 + X^2}$, or $Z = R + jX$

If the unknown is the reactance X as shown in equation (3) and expressed as in equation (7), our simplified formula for slide rule operation becomes:

$$X = R\sqrt{\left(\frac{Z}{R}\right)^2 - 1}$$

Note that we now subtract 1 where formerly we added 1.

Let us take a few examples and solve them.

Example 1:

If $Z = R + j$, then when $R = 47$ and $j = 15$, $Z = \sqrt{47^2 + 15^2}$

To follow our outlined slide rule procedure we set 15 on scale C to 47 on scale D. The square of that division is then read on scale A above the left-hand index of B, and is 19.8. We add one to 19.8 and so set the left-hand index of scale B to 10.8 on scale A. Move slide to 15 on scale C and read answer on D. This answer is 49.5 ohms.

The phase angle is the angle whose tangent $= X/R$ or 47/15. The tangent as found on the rule is then 3.2. The angle is readily found by placing the right-hand index of scale C over 3.2 on scale D and reading the angle on tangent scale on the reverse side of the slide. The angle found is subtracted from 90 degrees to give the phase angle, since the tangent is over 1. We find the angle to be 17° 25′ so the phase angle is 72° 35′.

Example 2:

If $Z = 50$ ohms
$R = 15$ ohms

and we wish to solve for X, we set 15 on scale C to 50 on scale D. Read result squared above the left-hand index of B on A as 11.2. Subtract one from this and set left-hand index of B to 10.2 on A. Adjust slide to 15 on C and read answer under that on D. The answer is then 47.6 ohms. The phase angle is the angle whose tangent is X/R or 47.6/15. The tangent is then 3.17 and the angle found by the same procedure, as in Example 1, is 73 degrees.

From the above the technician should be able to greatly facilitate solutions of vector analysis as applied to series circuits and their use in series-parallel arrangements.

PARTS STANDARDIZATION

[*Continued from page 28*]

groups to set up standards for dry electrolytic capacitors, air dielectric cappacitors, transformers, tube sockets, plugs and connectors, batteries, hookup wire, and solder and methods of soldering.

In all the standardization work of the War Committee on Radio, the cooperation between representatives of the War and Navy Departments and of industry has been whole hearted and unceasing. Standards established on such a basis are not only sound from an engineering standpoint but also from a production standpoint, since both aspects have been considered during the progress of the standardization and simplification work and a satisfactory balance struck.

Inspection Made Easy

Not the least advantage to both industry and the Armed Forces of these new American War Standards is the clear, concise instruction for sampling and inspection given in each standard, which should do much to end unnecessary controversies between inspectors and manufacturers.

Also important to both the engineers of the Armed Forces and the equipment manufacturers is the assembling for the first time in each standard of all the important design and usage data for the particular component under consideration. This information has only been available to a very limited number of engineers in the Armed Forces and in the laboratories of the largest equipment manufacturers. Now it is available to everyone who can properly make use of the information.

With the adoption of these recognized standards, design laboratories will be able to build preliminary shop models using standard parts from the start, thus saving much time on the part of production engineers when they find it necessary to redesign such early models for production purposes.

THIS MONTH

[*Continued from page 60*]

bers and numerous panels and committees of technical experts are to be appointed by the RTPB Chairman. Dr. Baker is scheduled for the appointment to the chairmanship.

The scope provides for technical studies of radio spectrum frequency allocations over which the FCC has jurisdiction of assignment, and RTPB primarily will formulate recommendations to the Commission for such allocations. Radio services now are virtually limited to frequencies under 100 megacycles, but experimental work is being done up to 3,000 megacycles.

Many technical experts and scientists will be drafted for the RTPB work, on its panels and committees, provided in the organization draft. The Board itself will be composed of representatives of industry groups, such as Interdepartmental Radio Advisory Committee (IRAC), of government officials, including Army and Navy; National Association of Broadcasters, American Radio Relay League, and other regularly constituted radio groups and including all chairmen of the RTPB panels.

★

TEST EQUIPMENT DELIVERIES

After May 1, deliveries of radio and radar test equipment will be made in accordance with schedules determined under M-293 instead of preference ratings, it was stated at a recent meeting of the Test Equipment Industry Advisory Committee with the Radio and Radar Division of the War Production Board.

Buyers of test equipment will fill in Form 556, on the basis of which the placement and delivery of new orders

will be determined. These forms, available at WPB regional offices, will be submitted to the WPB Radio and Radar Division for approval, and the approved forms will be attached to purchase orders.

While it is expected that buyers no longer will be able to trump each other's bids for equipment with triple A ratings, they will be able, under restrictions, to obtain directives for prompt delivery. However, requests for such directives will be scrutinized more closely, leading to a swift reduction in the number of them in force, it was said.

Elmer Crane, Chief of the Components Section, said that while deliveries of test equipment no longer would be subject to the competition of priority ratings, production would continue to be expedited by the use of ratings to purchase components and materials. Since supplies of these components, consisting of resistors, condensers and other equipment, are not as tight as those of test apparatus, schedules of the component producers will not be upset.

Since test equipment purchase orders hereafter are to carry WPB approval on Form 556, manufacturers receiving purchase orders without such approval should return them to their customers, it was stated. Jobbers, like manufacturers, are to see to it that their customers receive approval on Form 556, and that the approved form is sent with the purchase order to the producer.

★

ONSTAD APPOINTED PRESIDENT OF THORDARSON

R. E. Onstad, formerly Vice President and General Manager of Thordarson Electric Manufacturing Company of Chicago has been elevated to the post of President and General Manager, following the resignation of C. H. Thordarson as President. Mr. Thordarson, who founded the Company nearly a half century ago, and who is now nearly 76 years of age, will continue to lend his talents to the organization as technical consultant.

At the same time the Board of Directors announced the above changes, L. G. Winney, former Treasurer, was named Vice President and Treasurer, and W. R. Mahoney, formerly connected with Arthur Anderson and Company, was elected Assistant Treasurer.

★

ZENITH ANNOUNCES NEW OFFICERS

Four new officers of the Zenith Radio Corporation were elected at the last meeting of the board of directors, it was announced by Commander E. F. McDonald, Jr., Zenith president.

G. E. Gustafson, who has been with the company since 1925, has held the post of chief engineer since 1933, and has been assistant vice president since 1940, was elected vice president in charge of engineering.

R. D. Burnet, who joined the company in 1924 and has been controller and assistant treasurer since 1929, was also elected secretary, replacing Lieutenant-Colonel John R. Howland who resigned to enter the Army.

Karl E. Hassel, engineering executive, who with Commander McDonald and Ralph Mathews was an original founder of the company and who has been a director of the corporation since 1932, was elected assistant vice president.

J. E. Brown, Zenith's engineer specialist in television and frequency modulation since 1937, was elected assistant vice president.

★

PECK TO COLUMBIA UNIVERSITY

Arthur G. Peck, studio engineer for Columbia Broadcasting System, at WCCO, Minneapolis-St. Paul, has resigned to become a member of the staff of the Airborne Instruments Laboratories of Columbia University on Long Island.

Mr. Peck has been on the staff at WCCO for the past six years. During that time he had also acted as technical supervisor for Beck Recording Studios of Minneapolis. He was educated at the University of Minnesota, majoring in communications.

For the past year Art has been Secretary-Treasurer of the Twin City Chapter of the Institute of Radio Engineers. He will assume his new duties about May 10th.

★

ROSE HILLIARD APPOINTED PRIORITY DIRECTOR

Victor J. Andrew, president of the Victor J. Andrew Company, has announced the appointment of Rose Hilliard as Priority Director.

Victor J. Andrew and Rose Hilliard

Rose Hilliard is well known in industry and comes to the Victor J. Andrew Company from the Columbia Broadcasting System where she served as a technician in the engineering department.

★

OXFORD-TARTAK ELECTS TWO VICE PRESIDENTS

Paul H. Tartak, President of Oxford-Tartak Radio Corporation, of 3911-3929 South Michigan Avenue, Chicago, Illinois, announces the election of Alexander M. Arnt and Karl A. Kopetzky as Vice-Presidents.

Mr. Arnt is in charge of production, while Mr. Kopetzky, besides continuing his executive duties, will take charge of electronic developments occasioned by the firm's war conversion and expansion.

The corporation in peace times was one of the foremost manufacturers of loud-speakers. With war conversion, it branched out into electronic devices, range filters and transmitters.

★

ALLEN APPOINTED ERIE WORKS MANAGER

Erie Resistor Corporation, Erie, Pa., announces the appointment of Mr. J. M. Allen as Works Manager.

Mr. Allen is well known in the radio industry, having been actively connected with many phases of radio work

since 1923, when he joined Fansteel Products Corporation at North Chicago, Ill. He was superintendent of radio receiver manufacturing for Fansteel during the latter part of his connection there.

In 1930 he went to Stewart Warner Corporation as superintendent of radio receivers and component parts.

J. M. Allen

In 1934 he joined Fairbanks-Morse in Chicago as manager of radio manufacturing.

A year later Mr. Allen went to R.C.A. at Camden where he was successively coordinator of inspection and test laboratories and in charge of purchasing of all radio receiver production materials.

When R.C.A. created its Bloomington, Indiana works in 1940, Mr. Allen was in charge of organizing the manufacturing facilities, and served as works manager until shortly after the first of the year, when he resigned to come to Erie Resistor.

★

JACK HORNER JOINS BURTON BROWNE

Jack Horner, well known in advertising art circles, has joined the art department of Burton Browne Advertising, Chicago. Mr. Horner resigned a similar position with a Muncie, Indiana organization.

★

RADIOMARINE PROMOTES MACKENTY

John Gilman MacKenty, for many years Assistant to the Vice President of Radio Corporation of America in charge of RCA Laboratories, has been elected Vice President and General Manager, and Director, of Radiomarine Corporation of America, Charles J. Pannill, President of Radiomarine Corporation, has announced.

Mr. MacKenty, who has been a member of the staff of Radio Corporation of America for twenty-one years, has been in charge of foreign license contracts of RCA since 1930. After attending Sheffield Scientific School of

Yale University, he became associated with the Sales Department of RCA in 1922.

★

W. G. WAGENER NOW CHIEF ENGINEER OF HEINTZ AND KAUFMAN

The appointment of Winfield G. Wagener as chief engineer of Heintz and Kaufman, Ltd., has just been announced by the company. Mr. Wagener has been associated with the firm for five years, during which time he has been working out practical applications of vacuum tubes in UHF circuits, and has headed up the development of two new tubes for military service.

Wagener graduated from the University of California in 1928 with honors in electrical engineering, and obtained his master's degree while on a John W. Mackay scholarship at that university. He later did postgraduate work under Dr. F. E. Terman at Stanford.

★

HAZELTINE ENGINEER ACCEPTS NAVY POST

John Kelly Johnson for many years engineer in charge of the Hazeltine laboratories in Chicago has resigned his position as senior engineer in Hazeltine Electronics Corporation in order to accept the position of Special Representative assigned to the Office of Procurement and Material of the Office of the Under-Secretary of the Navy. He will assume his new duties with headquarters in Washington, D. C. immediately.

★

NON-FACTORY SET PRICE CEILINGS

To provide a precise method of determining maximum prices on radios and phonographs assembled by retailers and distributors the Office of Price Administration will issue shortly a new

regulation controlling the price ceilings for such sets.

Coming under the new regulations will be a scattered number of radio distributors, retailers and brokers who, since the summer of 1942, have become assemblers of household phonograph and radio receiving sets. By comparison with full-fledged manufacturing procedures, their operations are relatively simple, consisting of the mounting of a fully-assembled chassis with a speaker, and frequently with a phonograph pickup mechanism into a finished cabinet.

Specifically excluded from the new regulation will be regular manufacturers of radios. They will continue under Revised Price Schedule No. 83 (Radio Receivers and Phonographs). Manufacturers are practically removed from production of such sets, by Limitation Orders L-44A and L-183 issued by the War Production Board. However, these WPB orders do not prevent placing a chassis manufactured in accordance with the terms of the orders, into a cabinet.

★

NEW LITERATURE

CRYSTAL ACCESSORIES BULLETIN

Engineering Bulletin No. 201 describing a line of new fixtures and accessories has been made available by the Philips Metalix Corporation. These Philips accessories and fixtures will greatly extend the usefulness and versatility of the Philips X-Ray Quartz Analysis Apparatus. A few of the fixtures listed in this bulletin are Crystal Blank Holders, Rotating Wafer and Rotating Crystal Blank Holders, Edge Correction Holder, Angle Correction Holder and Bragg Angle Scale. Copies of Bulletin No. 201 can be obtained by writing to the Philips Metalix Corporation, 419 Fourth Avenue, New York City.

★

"PREFERRED TYPE CAPACITORS"

Solar Capacitor Sales Corporation, Bayonne, N. J., announce the adoption of a new policy of capacitor standardization, in anticipation of inevitable Government-enforced standardization.

New Catalogs V-1 and V-2 have been issued, illustrating a minimum number of types specifically designed for a maximum number of applications.

★

ALLIED'S RADIO CIRCUIT HANDBOOK

Published by Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois. Price, 10c.

A new publication containing radio and electronic circuits with analyses,

comparisons, and discussions. The method of presentation was especially planned to make this book a useful text for the classroom and for home study as well as a reliable guide for experimenters and builders. Fundamental principles of radio are illustrated and explained in sixteen basic circuits. The application of these principles to various components of receivers, transmitters, and other electronic units is shown in twenty-five additional circuits of conventional radio and electronic units. A schematic and pictorial diagram is shown for each unit, ranging from simple one-tube sets to superheterodynes.

This well-prepared booklet should prove to be very useful as a supplementary text for radio classes. Forty pages, 8½"x11".

★

GENERAL ELECTRIC ELECTRIC GAGES

"21 Electric Gages to Aid Production" is the subject of a new 8-page article reprint (GEA-3991) recently issued by the General Electric Company. The leaflet describes the functions of the twenty-one gages, and contains a chart showing schematic representations of electric gage circuit applications.

Included among the gages described and illustrated in the leaflet are thickness, magnetic, electrolimit, pressure, strain, and eccentricity gages. These are some of the most important gage types in use today. They perform a variety of unique gaging functions and represent, in many cases, the practical solutions to many gaging problems.

★

G-E AIRCRAFT POWER PACKAGE

The G-E power package for aircraft is described in a new, illustrated 4-page bulletin (GEA-3968) recently issued by the General Electric Company. The bulletin illustrates and describes the three types in which the compact power package is furnished and explains the use for which each type is desirable.

The bulletin also describes in detail the unusual number of functions incorporated in each power package—motor, brake, gears, clutch, limit switch, and load release.

BULLETIN ON "DIEFLEX"

Insulation Manufacturers Corp., 565 West Washington Blvd., Chicago, Ill., have issued a 4-page bulletin on "Dieflex" varnished tubing products and "Fiberglas" base sleeving and tubing. Data is also included on Dieflex wire identification markers. Copies of the bulletin are available on request to the manufacturer.

★

NEW CALLITE CATALOG

In their attractive new 36-page, illustrated, two-color catalog, Callite Tungsten Corporation discusses the design, manufacture and application of electrical contacts of silver, platinum, tungsten, molybdenum and a variety of other metals and alloys. Covering types of contacts, their physical size and shape, and the particular applications to which each metal and alloy is best suited, this new catalog offers the design and production engineer a complete story on electrical contacts. The book also illustrates and gives specifications of typical standard contacts designed and manufactured by Callite. Catalog No. 152 is available on request at the main office of the Callite Tungsten Corporation, Union City, New Jersey.

★

NEW RCA WAR-EDITION TUBE GUIDE

A new and completely revised edition of the RCA Guide for Transmitting Tubes, designed especially for radio engineers and technicians in the armed service and war industries, has just been published and is available through all RCA power tube distributors.

Written originally and carried through in the three earlier editions as a catalog for tube users, the present or fourth edition of the Guide transforms the booklet into an effective instrument of war. In 72 pages of circuit designs, photographs and technical details it supplies a wealth of information invaluable to every engineer and experimenter.

★

AMPERITE AUTOMATIC BALLAST TUBE

Amperite Company, 561 Broadway, New York, N. Y., have issued a 4-page folder covering the specifications, characteristics and applications of their new Automatic Ballast-Regulating Tube, an automatic rheostat designed to keep the current in a circuit at a definite value, regardless of supply voltage. Copies on request to manufacturer.

★

NEW V. J. ANDREW CATALOG

The Victor J. Andrew Co., 363 East 75th St., Chicago, Ill., have issued for distribution to manufacturers, engineers, etc., an 18-page catalog covering the company's complete line of Coaxial

Cables and Accessories, such as Terminals, Gas Equipment, and Fittings, as well as the Andrew Direct Reading Phase Monitor, Remote Indicating Antenna Ammeter, and Andrew Tower Lighting Equipment. Copies of the catalog may be obtained from the manufacturer.

★

NEW R.C.P. BULLETIN

Bulletin No. 127 describing new additions to the R.C.P. line of electrical and electronic instruments has been released by the Radio City Products Co., Inc.

This bulletin describes the new model 703 Signal Generator, Model 419 Master Multi-tester in three models, Models 416 and 418 Pocket Multitesters and the Model 446 A A.C.-D.C. Multitester.

Copy of Bulletin No. 127 may be had on application to the Radio City Products Co., Inc., 127 W. 26 Street, New York City.

★

TELECAST ADVERTISING PREVIEWS

How will television programs be paid for? The answer to that question is now being prepared even though television is necessarily a war casualty. Allen B. Du Mont Laboratories, Inc., operating television station W2XWV at 515 Madison Avenue in New York City, are inviting broadcasters, advertisers and advertising agencies to take part in studying and experimenting with telecasting technique without cost for studio and station facilities so that the sponsorship angle can round out the engineering and programing angles already worked out to a high degree. With the signing of the peace, therefore, telecasting will be all set to go on a truly commercial basis.

For months past Station W2XWV has been on the air each Sunday evening with a scheduled program of pro-

fessional entertainment. Now in addition to the Sunday evening program which is serving to formulate the studio technique and to train a telecast personnel under the direction of Program Director Will Baltin, the Du Mont organization aims to study and formulate a satisfactory advertising or sponsorship practice in collaboration with those seeking to be identified with the business end of future television.

To broadcasters, Du Mont extends an invitation to come to W2XWV and survey at first hand the operations of a telecasting station.

★

UNIVERSAL ERECTS ANNEX

Universal Microphone Co., Inglewood, Cal., in April erected a two story annex adjacent to Building No. 2 that will enlarge the floor space by one half. Extension of the war production department will be made for the first story with lathes and other equipment, while the second story will be devoted to the administrative force, including a newly installed cost accounting department.

TECHNICANA

[*Continued from page 13*]

the material along. At the same time, they act as plates which set up a small electromagnetic field of radio-frequency current. As this current passes through the material, heat is generated by dielectric loss, or, in other words, by the struggle of the current to get through the closely packed molecules of matter which compose the material. The heat causes thermoplastics to fuse, or weld, in a tight bond.

Somewhat similar in appearance and operation to the conventional sewing machine, the radio device derives its current from a low-power radio-electronic oscillator. A small electric motor drives the roller wheels. Controls are in a foot pedal.

NEW PRODUCTS

[*Continued from page 56*]

end discs and tie rods hold the cases together and provide further rigidity. The single shaft passes through and locks with each rotor in the stack. The finished assembly is to all mechanical intents and purposes a single control with a plurality of independent sections for as many independent circuits. All units of the control of course pass through the same degree of rotation as the single shaft is rotated. Individual units can be of any standard resistance, taper, taps and hop-offs to meet individual circuit requirements.

"42" Series Controls are necessarily made on special order only, since the number of sections and the values vary from one application to another. Units with as many as 20 sections are being produced for critical applications.

★

"POLECTRON" SYNTHETIC

Recent announcement of the development of "Polectron" Synthetic by the Americanized General Aniline & Film Corp., as the basic substance in mica replacement materials, has sharply focused attention on the important place strategic mica, now largely imported from India, is playing in the war.

The original patent and technical research records from which "Polectron" Synthetic was developed became a military secret when the control of General Aniline, formerly enemy-owned, was invested in the Alien Property Custodian. Facilities of the company were immediately directed toward increased war production, and an expanded program of research and development was instituted by the new board of managing directors under the chairmanship of Robert E. McConnell. One of the first war projects undertaken was the industrial production of a synthetic replacement material for high grade mica to reduce the drain from our supply on hand.

ADVERTISING INDEX

with but a Single thought

Gertrude Fontaine, mount operator at Hytron's Salem plant, and soldier in the Army of Production.

Miss Fontaine concentrates her nimble fingers and keen young eyes (assisted by a microscope) upon spot-welding and assembling minute parts of a 954.

On another floor, a Hytron engineer is giving lavishly, night and day, of his long training and experience as he designs and develops a new War tube in record time. The driving force urging them — and all of us at Hytron — on to superhuman effort, stems from a single thought, a single purpose: to supply our courageous fighting men with tools to win. Hytron employees have but one goal — a mounting flood of top-quality tubes to serve as the "hearts" of electronic and radio equipment helping our boys to blast the way to speedy and permanent Victory.

Oldest Exclusive Manufacturer of Radio Receiving Tubes

Hytron ELECTRONIC AND RADIO TUBES **Corporation**

SALEM AND NEWBURYPORT, MASS.

CRYSTALS

Any TYPE OF CUT AND FREQUENCY

We have facilities for producing crystals to all temperature co-efficient and absolute frequency specifications. Our engineers have wide experience with all crystal types. In our Special Crystal Division we are ready to undertake NOW the development and production of any special and exacting crystal types that may assist you in the war effort. If it's "Rush" phone!

Phone **CRYSTAL SERVICE DIVISION**
PLYMOUTH THREE THREE

JOHN MECK INDUSTRIES
PLYMOUTH, INDIANA

EXCELLENCE IN MUSIC AND VOICE RECREATING INSTRUMENTS