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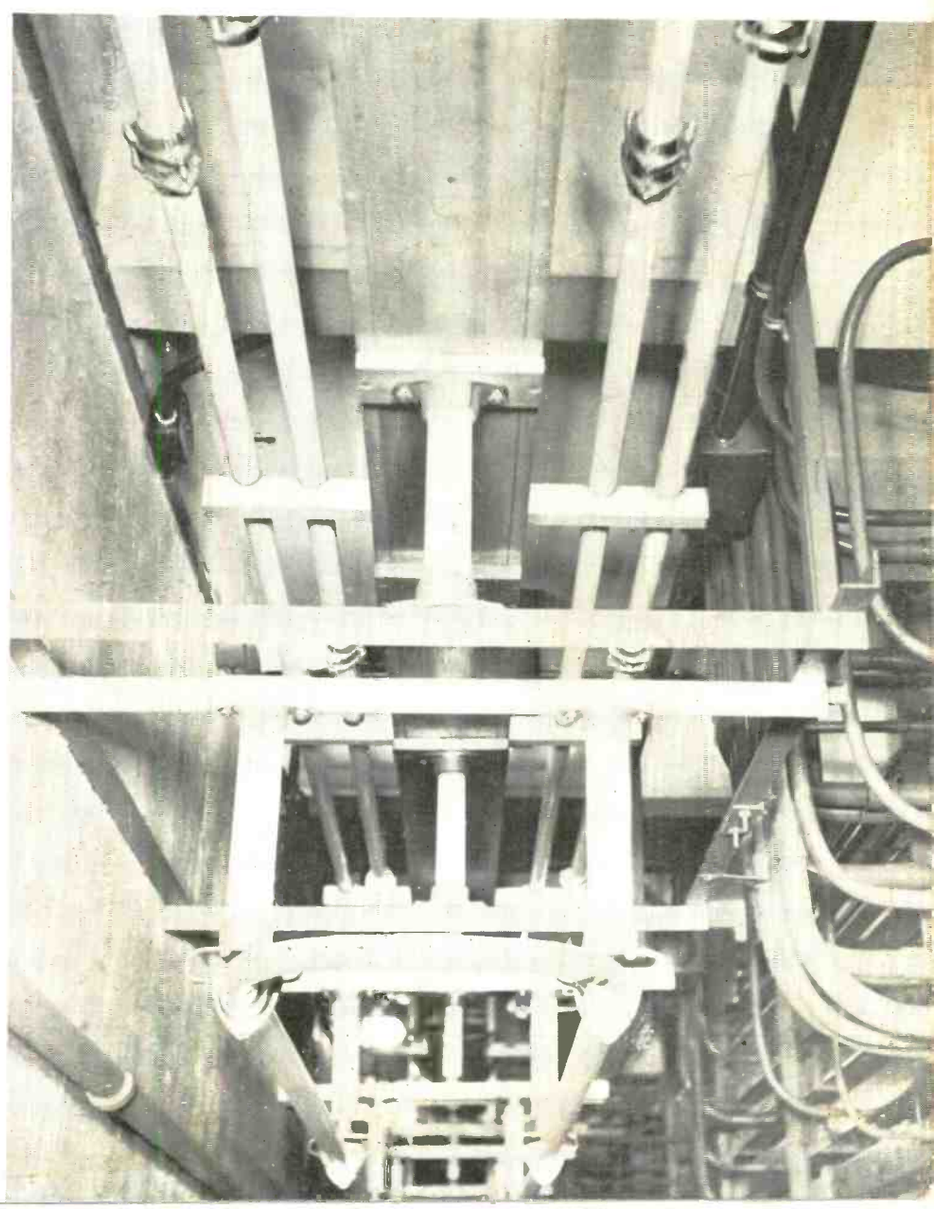
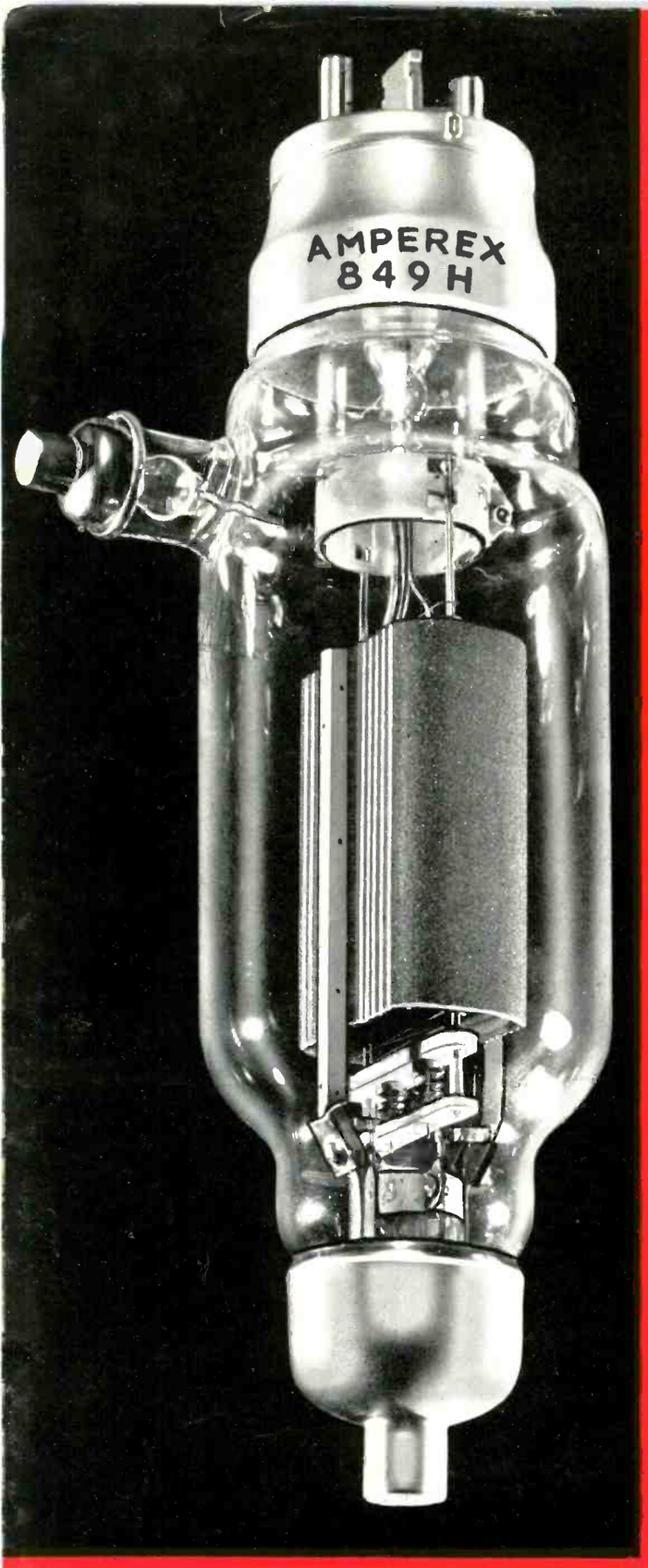


JUNE
1938



AMPEREX 849 H

A HIGH POWER—HIGH FREQUENCY TUBE

of Unusual Performance Capabilities

Can be operated at full ratings
UP TO 30 MEGACYCLES

Specialized research by the Amperex engineering staff in the field of Ultra High Frequency has resulted in a new concept of the space relationship of the electrodes in a vacuum tube as it affects the tube characteristics.

Based on this concept a series of Ultra High Frequency tubes (the HF-100, HF-200 and HF-300) were designed. Each of them has set a new standard of efficiency in its class and all of them have one dominant characteristic in common—

a remarkably high ratio of transconductance to interelectrode capacitance.

The Amperex 849-H, recently developed in answer to the demand for greater power at high frequency, also possesses this essential characteristic.

Other outstanding features are:

- LARGE FILAMENT AREA
- UNIFORM HEAT DISTRIBUTION BECAUSE OF BLACK BODY AND ROUGH SURFACE RADIATION OF GRAPHITE ANODE
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- VERY LOW INTERELECTRODE CAPACITANCE
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$135

AMPEREX ELECTRONIC PRODUCTS, Inc.
79 WASHINGTON STREET **BROOKLYN, NEW YORK**

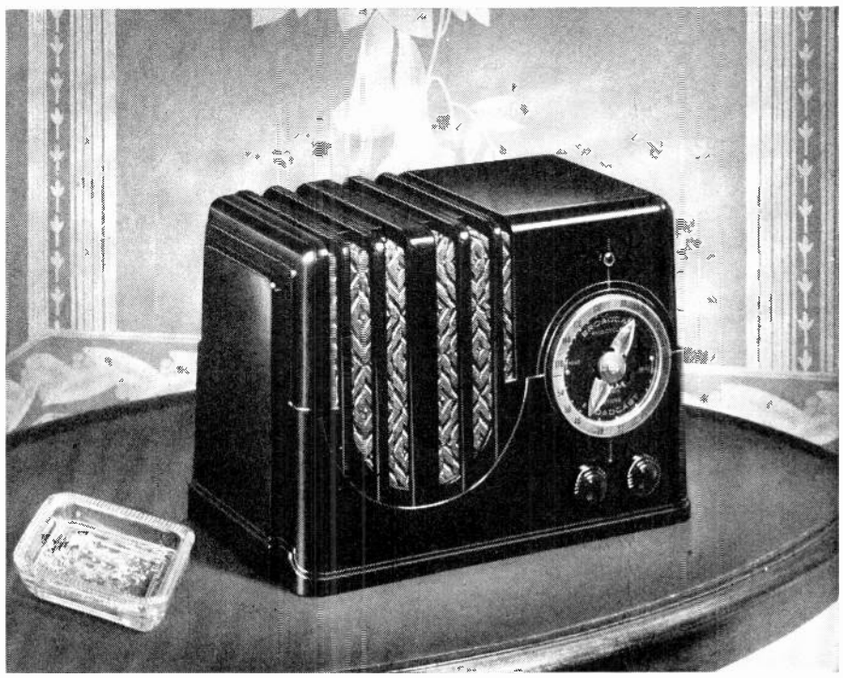
Profit from the Vogue

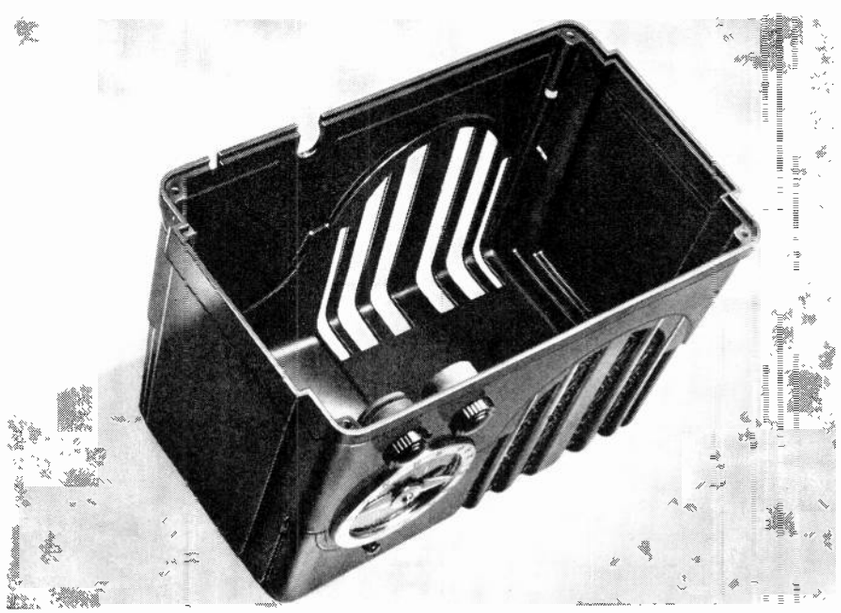
for Bakelite Molded Cabinets

IN THE past ten years, a growing number of radio manufacturers have included table models with Bakelite Molded cabinets in their annual styles. Thousands of purchasers of these sets have learned from personal experience the advantages in appearance, performance and durability which these cabinets provide.

Today, there is an active demand for table sets styled with Bakelite Molded. The use of this well-known material often aids manufacturers to secure immediate popular acceptance for new models.

An important factor in this trend is the economy with which quality cabinets may be produced in quantity from Bakelite Molded. Attractive designs like the Fada cabinet illustrated . . . and also large-size table models . . . are completely formed in a single molding operation.





Bakelite molding materials are now available in a wide variety of decorative effects . . . from opaque white to rich dark colors and mottles; and transparent and translucent colors of gem-like beauty. They include materials of phenolic, urea, acetate and polystyrene bases.

Write for Portfolio 50 containing valuable information on these versatile materials.

(Above) Fada Radio with conservative modern cabinet of lustrous Bakelite Molded.

(Left) Note one-piece construction 10" x 6" x 7" deep. Molder: Associated Attleboro Mfrs., Inc.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N.Y.

BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Canada — *West Coast:* Electrical Specialty Co., Inc., Los Angeles and San Francisco, Cal.

BAKELITE

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COMMUNICATIONS

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RAY D. RETTENMEYER • Editors • W. W. WALTZ

CONTENTS FOR JUNE

Cover Illustration: A bottom view of the porcelain pipe water-cooling system supplied by the Lapp Insulator Company for WHAM's 50-kilowatt Western Electric transmitter.

VOLUME 18 NUMBER 6

BRYAN S. DAVIS
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Published Monthly by the
BRYAN DAVIS PUBLISHING CO., INC.
19 East 47th Street
New York City
New York Telephone: PLaza 3-0483

SANFORD R. COWAN
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A. GOEBEL
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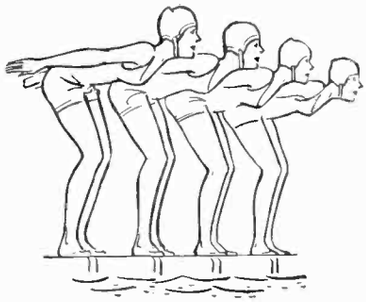
Chicago Office—608 S. Dearborn St.
Telephone: Wabash 1903.

Wellington, New Zealand—Te Aro Book Depot.
Melbourne, Australia—McGill's Agency.

Entered as second class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada, $3.00 in foreign countries. Single copies: twenty-five cents in United States and Canada, thirty-five cents in foreign countries.



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THE NEW 22 TYPE SPEECH INPUT

Here's what you've been asking for: high fidelity pick-up equipment at low cost—easily handled by one man—designed for fast set-up and easy operation, even in the dark.

These new Western Electric 22B and 22C equipments fill the bill. They're ideal for covering sports, outdoor concerts, political rallies, remote pick-ups of every kind.

They operate from AC supply or batteries—give you 4 mike mixers and main gain control. These new models are popular sellers—ask Graybar for all the facts and figures—and place your order now.

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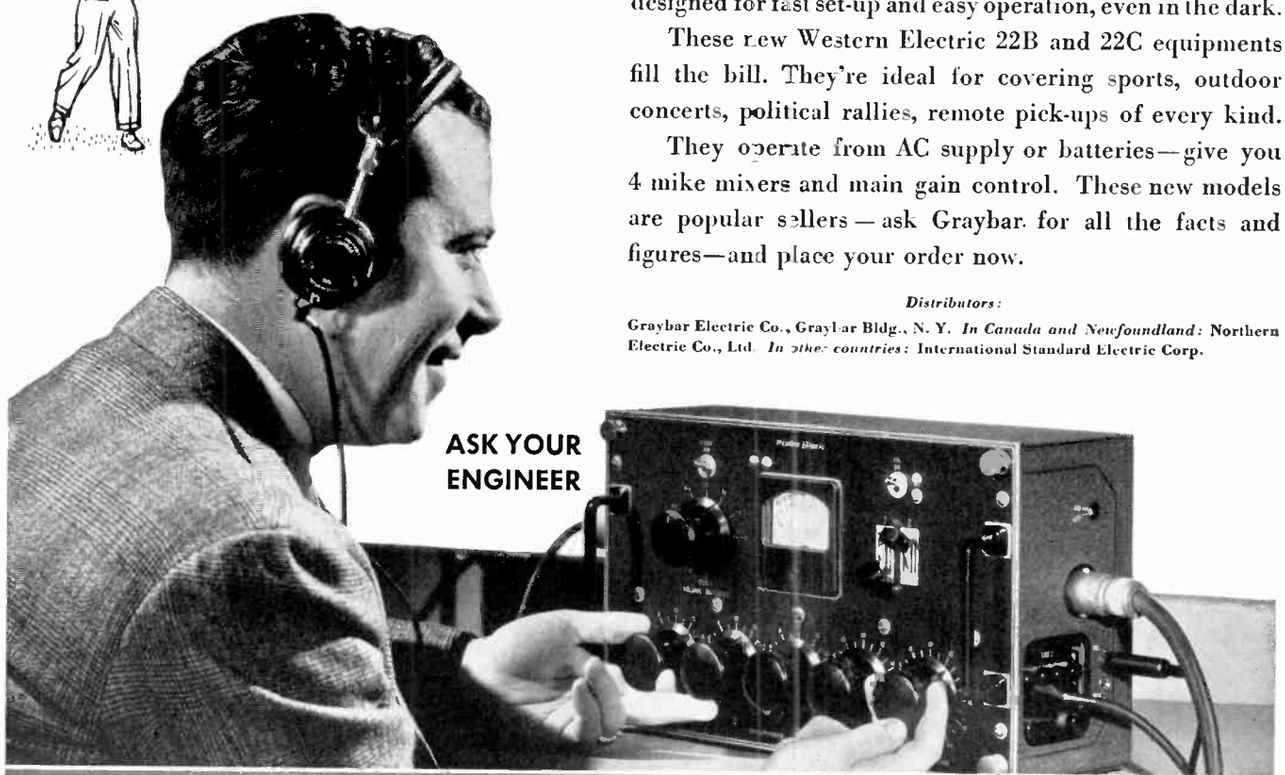


Western Electric

Distributed by Graybar Electric Company

RADIO TELEPHONE BROADCASTING EQUIPMENT

WITH THE EDITORS

RECEIVER TRENDS

THE LATTER part of May saw the introduction by most of the radio receiver manufacturers of their 1939 lines. While most of the features of last year's models have been retained, a number of unique developments have also been introduced.

Considerable improvement has been made in push-button tuning systems during the last year, and this convenience will be found on all classes of home receivers from the most expensive to the cheapest, as well as on certain models of auto sets. Also of interest is the distinct trend towards higher fidelity by the more progressive manufacturers. Increased use of spread-band tuning of short waves, one of last year's more important developments, is also evident in the new models.

Among the new developments introduced during the last month is an automatic program pre-selector, a device which permits the pre-selection of programs over a twenty-four hour period. This pre-selector is divided into ninety-six 15-minute time intervals.

Some models of the 1939 line will come equipped with a built-in antenna employing a Faraday type shield. This antenna is said by the manufacturer to operate on the electromagnetic portion of the radio signal, and to discriminate against noise interference ordinarily carried to the receiver by the electrostatic portion of the signal.

Also a new system of remote-control has been introduced. The small remote-control box of this system may be placed at any convenient point. The control box provides an off switch, means for selecting stations and a method for controlling volume.

NAB PRESIDENT

AT A MEETING held on June 6, the Board of Directors of the National Association of Broadcasters elected Neville Miller, of Louisville, Kentucky, as President of the organization. Mr. Miller will be remembered as the 1937 "flood mayor" of Louisville.

Miller succeeds Mark Ethridge who has been doing excellent service in a temporary capacity since the Association was reorganized last March. Miller is now assisting Harold W. Dodds, President of Princeton University, in administrative reorganization. He will take over his radio post about July 1.

TELEVISION DEVELOPMENTS

CONSIDERABLE attention has been given to television during the past month. Not only have several demonstrations been staged, but television receivers have been placed on the market.

Recent developments in the RCA all-electronic system were shown on May 17 by the Radio Corporation of America and the National Broadcasting Company at Radio City. The demonstration was given to show the progress made by the two companies during the past seven months. While no startling innovations have been introduced, it was evident that considerable improvement has been made in the RCA system.

A demonstration was also held by Kolorama Laboratories in Irvington, N. J. Television pictures transmitted by wire from standard motion picture film were shown in sizes of 3 feet by 4 feet and 4 feet by 5 feet. The Kolorama pictures are scanned with 225 lines, interlaced 2 to 1. The field frequency is 24 and the frame frequency is 12 per second.

As we go to press, we learn that both Allen B. DuMont Laboratories and Television Corporation of America have placed television receivers on sale in the larger New York department stores. The prices of the latter have been rumored to range from $125 to $275, while the DuMont receivers will probably be priced between $350 and $700. The DuMont television-sound receivers have black and white images.

INTERMEDIATE-FREQUENCY PROBLEM

MEASURES to maintain the 455-kc intermediate frequency for radio receivers, involved in the recent North American treaty negotiated at Havana, have been taken by RMA. Resolutions have been sent to the FCC by RMA requesting that the 455-kc intermediate frequency be retained and that changes be made regarding the 900-kc and 910-kc frequencies. There will be problems for radio manufacturers if the second harmonic interferes with the 455-kc frequency.

COMMUNICATIONS

FOR JUNE, 1938

AN INSTRUMENT LANDING SYSTEM

By EDWARD NELSON DINGLEY, Jr.

Radio Engineer, Bureau of Engineering

NAVY DEPARTMENT

THE *Air Commerce Bulletin,* Volume 9, Number 6, issued on December 15, 1937, by the Bureau of Air Commerce, Department of Commerce, summarizes the present status of instrument landing systems and sets forth the desired characteristics of what would be considered "the most satisfactory system."

The system described below does not require the use of radio frequencies, a probable advantage, and with this exception it appears to possess all of the above referenced desired characteristics as follows:

(a) No runway localizer is required for the reason that the glide path provides both vertical and lateral indications.

(b) No marker beacons are required for the reason that the glide path is horizontal until the airplane reaches the point where the normal landing glide begins.

(c) The landing glide path is not only smooth but it is also straight, thus providing a constant glide angle.

(d) The glide path is fixed in space regardless of weather and ground conditions.

(e) A crossed-pointer instrument in the airplane continuously indicates the vertical and lateral position of the airplane relative to the glide path and indicates the rate of approach or departure from the glide path. The point of intersection of the crossed pointers moves 8 percent over the face of the instrument for a deviation of approximately 0.6° from the glide path in any direction.

(f) No equipment adjustments are required to enable the pilot to choose the glide angle most suitable for each particular landing.

(g) Monitoring equipment consists solely of a few alternating-current ammeters.

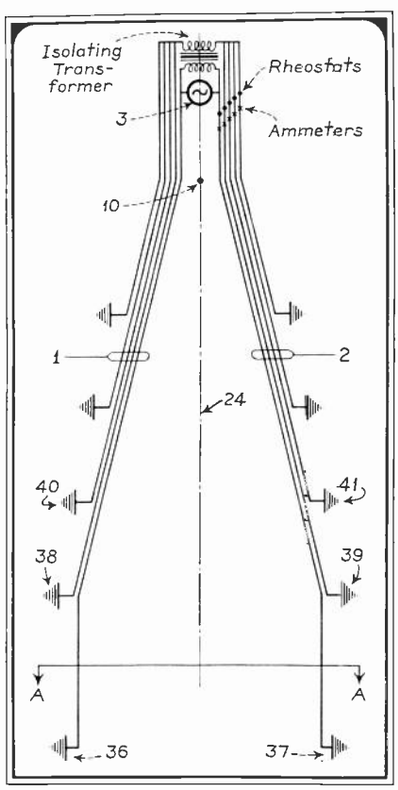
(h) All ground equipment of the system may be underground and does not constitute an obstruction on the field.

(i) The airplane equipment is simple, inexpensive, easily maintained in calibration and is ideally suited for connection to a gyro-pilot, thus providing a fully automatic landing facility.

(j) The system is not affected by atmospherics.

(k) The ground equipment is relatively inexpensive and its operating and maintenance costs are negligible. It does not utilize vacuum tubes or other items representing replacement costs.

Fig. 1. Showing ground equipment for instrument landing system.



This instrument landing system utilizes the magnetic field surrounding two horizontal multi-conductor cables to establish in space a path of constant electromagnetic field intensity. This is shown diagrammatically in Fig. 1 wherein the horizontal cables 1 and 2 are laid on, under or above the surface of the earth on each side of and equally spaced from a landing runway 24 and the graphical extension thereof. One conductor of cable 1 is grounded at the point 36 and one conductor of cable 2 is grounded at point 37. These two conductors are connected to an alternator 3 through a rheostat and ammeter as shown and thus form a horizontal loop.

Another conductor of cable 1 is grounded at point 38 and another conductor of cable 2 is grounded at point 39. These two conductors are connected to the secondary of the isolating transformer, as shown, through a rheostat and an ammeter and thus form a second horizontal loop smaller than the first mentioned horizontal loop. The current in this second loop is caused to flow in the opposite direction (phase opposition) to that of the current in the first mentioned loop by proper connection to the isolating transformer.

The magnitude of the current flowing in the second loop is adjusted by means of the rheostat and ammeter as shown, to a value equal to a definite fraction of the current flowing in the largest loop and, in consequence, the magnetic flux surrounding the portions of the cables 1 and 2 wherein the conductors of the first and second loops are parallel is less than the flux surrounding cables 1 and 2 at distances beyond the limits of the second loop.

In the same manner, a third loop is formed by grounding two conductors at points 40 and 41 and the magnitude of the current through this loop is adjusted to a definite fraction of the current in the largest loop and in phase opposition thereto. Other loops of gradually diminishing dimensions are similarly formed as shown in Fig. 1 and the magnitude of the current in each of these is adjusted to a definite fraction of the current in the largest loop and in phase opposition to it.

In this manner, by properly choosing the grounding points for each horizontal loop and by adjusting the current in each loop to the proper value, the rate of diminution of the magnetic flux surrounding cables 1 and 2 may be caused to be any desired function of the distance along the cables toward the landing point 10 or conversely, the altitude above the cables to a point of constant field intensity may be caused to diminish as any desired function of the distance along the cables.

Fig. 2 represents a section taken through A-A of Fig. 1. The aircraft carrying loops 28 and 29 is represented as being at the height h above the runway 24 and the cables 1 and 2 are represented as being spaced from the runway by the distance d. It is desirable but not mandatory that the distance h and d should be equal throughout the length of the runway. It is for this reason that Fig. 1 shows cables 1 and 2 converging toward the landing point 10.

Fig. 3 shows a side elevation of Fig. 2 taken through the runway 24. A section B-B of Fig. 3 is represented by Fig. 2.

In operation, the voltage of the alternating source 3 is adjusted to produce a current flow through cables 1 and 2 at section A-A of sufficient value to produce an alternating field having the value F at a radial distance X from the cables 1 and 2; the value F being such that the maximum potential induced in a loop collector mounted in the aircraft will be considerably in excess of the potentials induced in the same loop by locally generated fields surrounding the aircraft, and the distance X being the hypotenuse of the triangle d-h-X of Fig. 2 where h is the desired height of the aircraft at start of glide path.

In order to establish the desired constant-angle glide path 9, Fig. 3, the grounding points of the smaller horizontal loops are spaced at constant intervals and the current in each smaller loop is adjusted to equal the value of the current in the largest loop divided by the number of smaller loops. In this manner, the radial distance X from cables 1 and 2 to the point of field strength F is caused to diminish as a linear function of the distance along the cables from the start of the downward glide path.

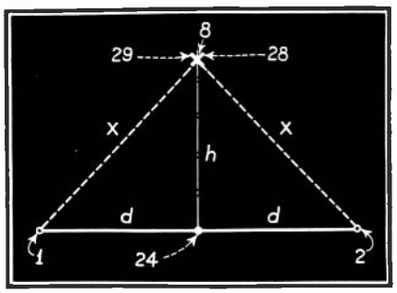
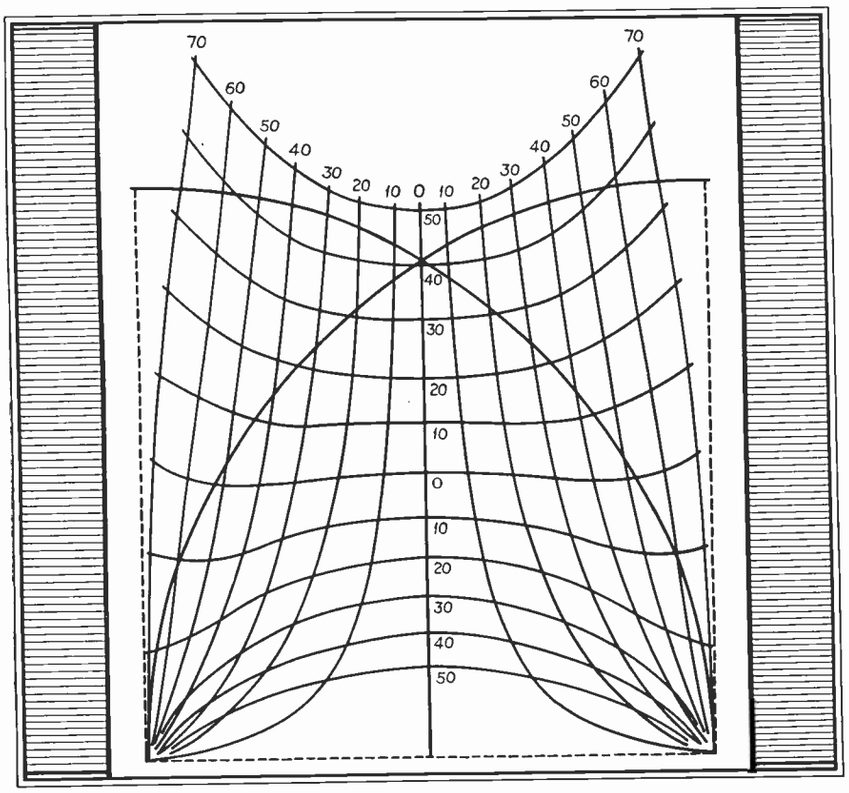


Fig. 2. A section taken through A-A of Fig. 1.

Having thus established in space a glide path represented by the locus of the points of constant field strength F, it is only necessary to provide in the aircraft 8, means to indicate the position of the aircraft relative to this locus in order to make possible the guidance of the aircraft along the predetermined glide path.

The above referenced loops, 28 and 29, are mounted on the aircraft in such a manner that the plane of each loop is perpendicular to the plane of the other loop and so that the plane of each loop lies at an angle of 45 degrees to the horizontal when the aircraft is in normal flight. One simple and effective way to install these loops consists of utilizing a small diameter, light weight, multiconductor, fabric covered, waterproof cable containing twenty to thirty small gauge insulated conductors. One end of this cable may be secured to the inside or outside of the fuselage near the forward end of the aircraft at a point 45 degrees above the lateral centerline of the aircraft. The cable may be then extended aft along the fuselage to a point near the tail which is 45 degrees above the lateral centerline of the aircraft. The cable may be then passed over the fuselage to a point diametrically opposite the last mentioned point, thence forward along the fuselage to a point diametrically opposite the first mentioned point, thence under the fuselage and return to the first mentioned point where the various conductors may be interconnected to form a multi-turn loop having its plane lying at an angle of 45 degrees to the horizontal for a position of normal flight. A second loop having its plane perpendicular to the first may be secured to the fuselage

Fig. 5. Showing departure from glide path in percentage.



in a like manner. A non-ferrous metallic fuselage will not adversely affect the operation of these loops.

Each of the loops mounted in the aircraft is connected to a simple tuned audio-frequency amplifier and each of the amplifiers has in its output circuit a substantially linear rectifier capable of supplying to a suitable load circuit a direct current, the amplitude of which is directly proportional to the amplitude of the voltage induced in the loop to which it is connected.

The load circuit of each linear rectifier consists of a direct current d'Arsonval type milliammeter. These two milliammeters are mounted within one instrument case as shown in Fig. 4. Both pointers are vertical for zero deflection and the two pointers cross at the center of the instrument when each is deflected an amount equal to half scale deflection.

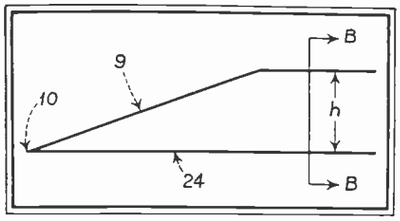
With reference to Fig. 2, it will be noted that when the aircraft is flying along and centered on the established glide path, one of each of the loop collectors will lie in a plane producing a maximum of induced voltage from one of the ground cables 1 and 2 and zero induced voltage from the other cable. If the aircraft is flying parallel to the established glide path but above, below or to either side of it the voltages induced in the two loops will assume different values and cause the two pointers of the instrument to intersect at the points shown in Fig. 5 wherein the vertical and horizontal lines are marked in terms of percentage off the glide path. In this figure, 100 percent below or above the glide path is taken to be at a point on the ground and at a point twice as high as the glide path, respectively. Similarly, 100 percent to the left or right of the glide path is taken to be at a point directly above the left hand or right hand cable, respectively.

The points of intersection of the pointers as shown in Fig. 5 were calculated from the formula:

$$V = 384\ f\ I\ N\ b\ 10^{-3} \log_e \frac{X_b\ X_c}{X_a\ X_d}$$

V = microvolts induced in one airplane loop.
f = cycles per second frequency of source 3.
I = effective amperes flowing in cables 1 and 2 at the point below the aircraft.
N = number of turns in each aircraft loop.
b = length in feet of aircraft loop sides parallel to earth.
X_a = radial distance in feet from cable 1 to first limb of aircraft loop.
X_b = radial distance in feet from cable 1 to second limb of aircraft loop.
X_c = radial distance in feet from cable 2 to first limb of aircraft loop.
X_d = radial distance in feet from cable 2 to second limb of aircraft loop.

Fig. 3. Illustrating glide path. See Fig. 2.



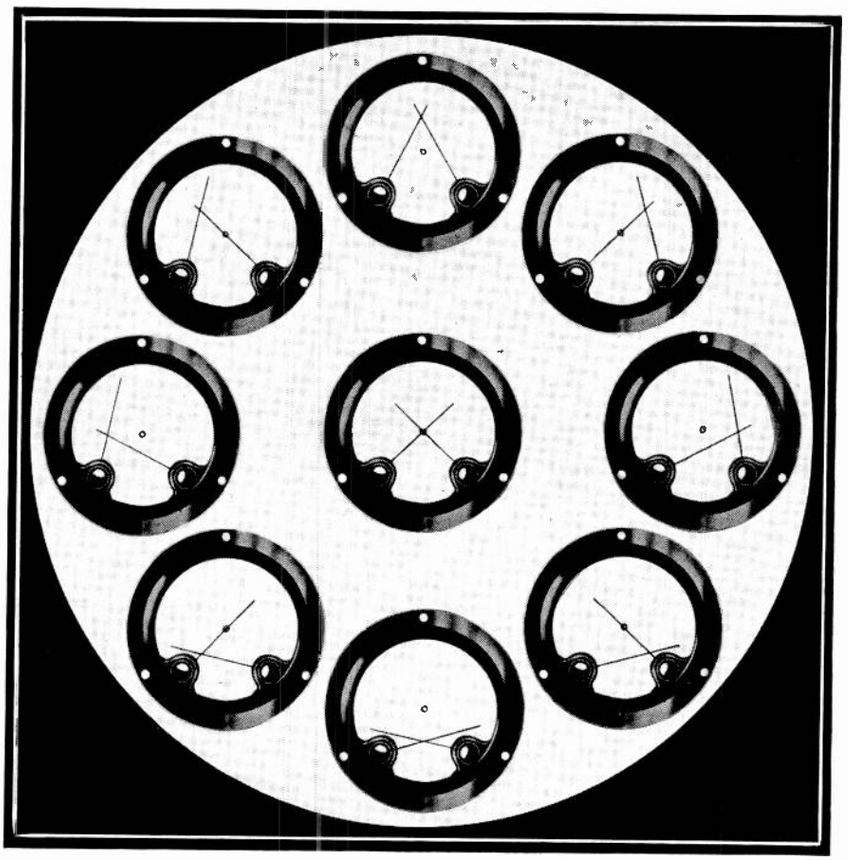


Fig. 4. Crossed pointers indicate position of plane with respect to glide path.

As an example of the large values of induced aircraft loop voltage which are obtainable, assume that the aircraft loops are 12 feet long and average 4 feet wide, that they have 40 turns each, that the current in cables 1 and 2 is 5 amperes at 500 cycles and that the aircraft is flying on the glide path at an altitude of 1,000 feet (1,414 feet distant from each cable), then the voltage induced in each loop will be 1,300 microvolts.

The effect of the currents flowing between ground points of cables 1 and 2 will be negligible because of their divergent distribution and because the number of lines of flux linking them with the aircraft loops is negligible compared to the number of lines which link cables 1 and 2 with aircraft loops.

Should the aircraft be flying across the glide path at a small angle, its instantaneous position as indicated by the crossed-pointer instrument will be in error by only a very small amount. If the angle flown across the glide path is larger, the error will be larger but the instrument will show, by the very rapid movement of the pointers, that the aircraft is crossing the glide path and will show whether the movement is to the right or left. Whenever the aircraft is flying parallel to the glide path, the instrument will indicate its exact position relative to the glide path. The length of *horizontal* glide path provided by this system is of great assistance to the pilot in orienting his airplane on the glide path prior to reaching the beginning of the downward path. It is an improvement over the parabolic glide paths provided by the radio systems wherein the start of the glide path is quite steep.

It is interesting to note that the instrument of Fig. 5 indicates departure from the glide path in percentage. At a glide path altitude of 1,000 feet, an indication of 10 percent low represents a distance of 100 feet below the glide path but when the plane is about to land and the altitude of the glide path is only 10 feet, an indication of 10 percent low represents a distance of

(*Continued on page* 30)

CHARACTERISTIC IMPEDANCE OF GROUNDED & UNGROUNDED

OPEN-WIRE TRANSMISSION LINES

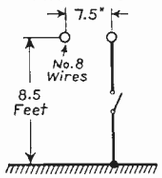
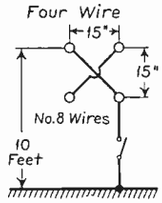
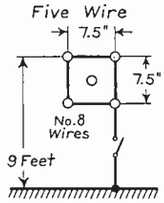
By R. D. DUNCAN, Jr.
RCA MANUFACTURING CO., INC.

TRANSMISSION LINES are universally employed in radio for connecting antennas with remotely located transmitting and receiving apparatus. They are of two general types, the concentric tubular and the open wire. It is with the latter that this paper is concerned. Open-wire lines may consist either of a pair of conductors carrying the going and return currents, or of a multiplicity of conductors interconnected in different manners. One of the important line properties with which the engineer has to do is its characteristic impedance. A requirement for efficient operation is that the impedance of the antenna which connects with one terminal of the line and of the transmitting or receiving apparatus which connects with the other terminal, be matched with the line characteristic impedance.

In transmitter practice it is desirable to ground one conductor, or in the case of a multiple-wire line, one set of conductors, as this arrangement permits of employing less complicated and expensive impedance-matching equipment at both the antenna and transmitter line terminals than would be required if the line were operated ungrounded. This immediately raises the question . . . to what extent does grounding of a line affect its characteristic impedance? Formulas are available for calculating the characteristic impedance of lines when ungrounded and when the going and return currents are balanced, but so far as the writer is aware no such formulas have hitherto been available for grounded lines.

The effect of grounding upon the characteristic impedance of a line has been investigated experimentally and theoretically, as it applies to *open-wire* lines of the type employed in transmitter operation and in the normal broadcast-frequency range of 500-1500 kilocycles. Formulas have been derived for calculating the characteristic impedance of different types of lines for both grounded and ungrounded conditions. A brief discussion of the results of this investigation together with formulas and curves showing the manner of impedance variation with the line dimensions, is presented in the following:

Table I

Line	Characteristic Impedance (Ungrounded - Grounded)	Characteristic Capacity (Ungrounded - Grounded)
Two Wire 	Ohms: 570 403 Decrease - 29.3% Ungrounded / Grounded = 1.41	Mmfd.: 715 1090 Increase - 52.5% Grounded / Ungrounded = 1.52
Four Wire 	290 231 Decrease - 20.3% Ungrounded / Grounded = 1.25	1350 1780 Increase - 31.8% Grounded / Ungrounded = 1.32
Five Wire 	355 346 Decrease - 2.5% Ungrounded / Grounded = 1.025	1100 1132 Increase - 2.91% Grounded / Ungrounded = 1.03

The characteristic impedance of a transmission line is given by the expression

$$Z_o = \sqrt{\frac{R + j \cdot 2\pi fL}{G + j \cdot 2\pi fC}}$$

where R, L, G and C are respectively the resistance, inductance, leakage conductance and capacity, per unit length of line effective at the frequency..... f. At radio frequencies and with reasonably well insulated lines the resistance R and leakage conductance G may be neglected for most practical purposes and the expression for the characteristic impedance written in the usual simplified form

$$Z_o = \sqrt{\frac{L}{C}}$$

If the inductance is in henrys and the capacity in farads the characteristic impedance will be in ohms. These expressions hold whether a line is grounded or ungrounded; it is merely required to know the value of inductance or capacity effective for the condition in question.

The effect of grounding an open-wire line may be best understood from consideration of a simple two-wire line. Connecting one of the wires to ground will increase the capacity effective between the wires and, as it destroys the current balance between wires, the earth carrying a

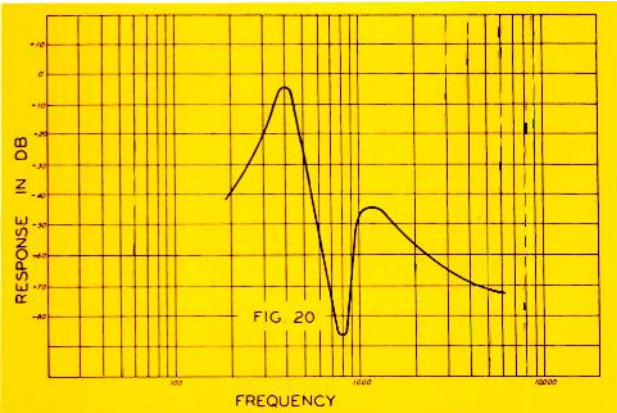


Fig. 20—Typical response curve of the HE-818 band pass filter.

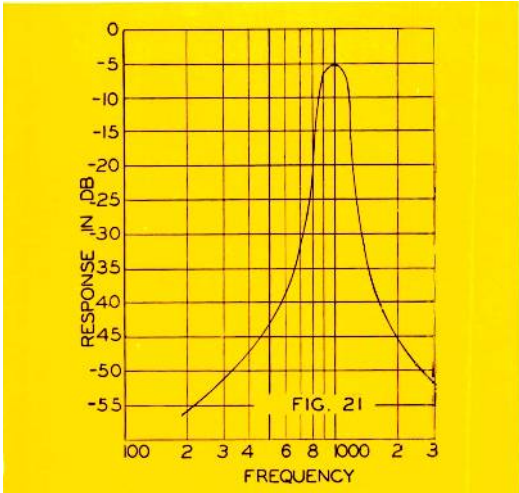


Fig. 21—Typical response curve of the HE-819 band pass filter.

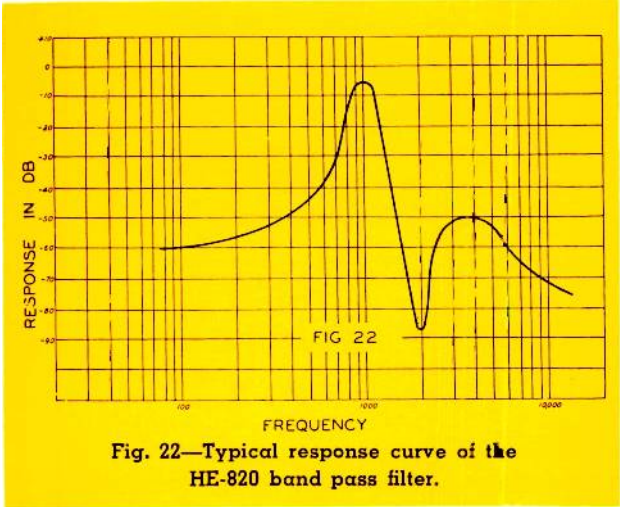
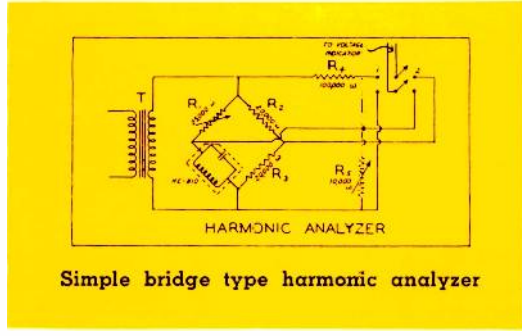


Fig. 22—Typical response curve of the HE-820 band pass filter.

HARMONIC ANALYSIS

In the continual progress toward higher fidelity, a means of measuring harmonic content is becoming more and more important. Most devices of this type are relatively expensive. A simple type of harmonic analyzer is illustrated in Fig. 23. This unit is comparatively inexpensive and easily constructed. The operation of this analyzer functions in the following manner:

The resonant circuit shown in the figure is the UTC type HE-810 harmonic analyzer unit. This is resonated at 400 cycles. A 400 cycle signal is fed into the amplification equipment to be measured and the output of this equipment is in turn fed into the primary of the isolating transformer T. The secondary of this transformer operates into the bridge circuit consisting of two fixed arms R_2 and R_3, the HE-810 parallel resonant circuit, and a variable resistor R_1. R_1 is used originally to balance the bridge. In operation, the D P D T



Simple bridge type harmonic analyzer

switch is thrown into position 2 thus enabling the external voltage indicator to show when a balance has been reached. This balance is indicated by the minimum reading. Examining this bridge circuit, it is apparent that the only frequency which is balanced by the bridge is 400 cycles, as at this frequency the LC combination acts as a pure resistance and consequently, can be balanced by pure resistance. At balance, anything which reaches the voltage indicator must be harmonics. The reading obtained from these harmonics is noted and the switch is then thrown to position 1. In this position, R_5 is adjusted until the same meter reading is obtained as in switch position 2. The harmonic content is then determined from the formula $\% H = 2 \frac{(R_5)}{(R_4 + R_5)} 100$. It is obvious that R_5 may be calibrated to read percentage of harmonics directly.

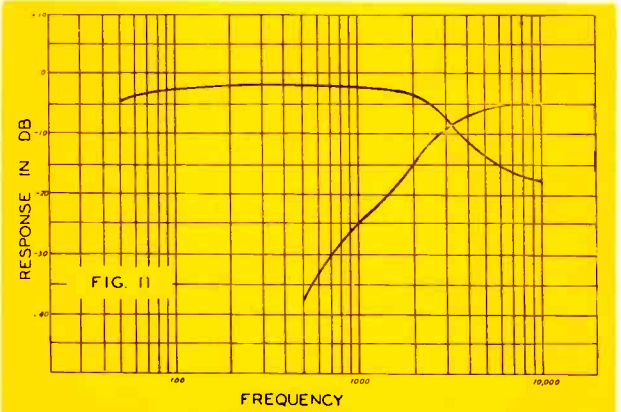


Fig. 11—Response curves of a two way dividing network.

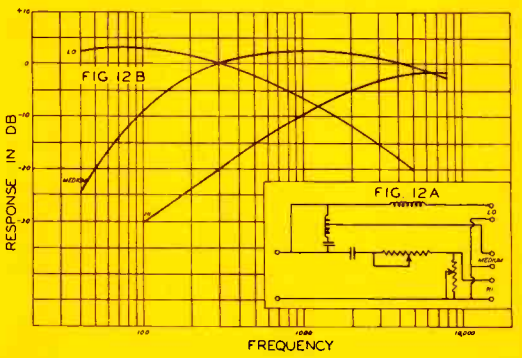


Fig. 12 (a and b)—Schematic and response curves of a three way dividing network.

WAVE FILTERS

In communication work it is often necessary to exclude certain bands of frequencies and permit others to pass and vice versa. There is an infinite variety of variations and combinations possible depending upon the use to which such a device is put. These units are known as wave filters and may generally be classified as high pass, low pass, band pass, or band eliminators. Unless otherwise specified the filters designated are for insertion in a 500 ohm line. Fig. 16 illustrates the frequency response of the HE-813 which is tapped to pass all low frequencies (thus known as low pass) up to 4000, 6000 or 8000 cycles; and to exclude all other frequencies. The HE-814 is a modified type known as an "M" derived wave filter, whose purpose is to provide a sharp attenuation at certain frequencies. The response curves for this unit are shown in Fig. 17. The HE-815 is a high pass wave filter designed to exclude low frequencies as illustrated in Fig. 18.

It is often necessary in certain devices to pass only a given frequency under test and exclude all others. These wave filters, designated as band pass filters, are illustrated in Figs. 19, 20, 21 and 22. The attenuation curves for the HE-817 and 819 are for a pure sine wave. If any considerable amount of second harmonic is present, this unwanted frequency will be present in the output. The HE-818 and HE-820 incorporate an additional filter to exclude the second harmonic present in the original wave form.

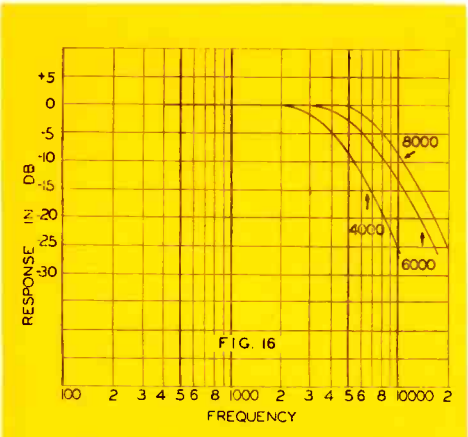


Fig. 16—Reponse curves of the HE-813 low pass filter.

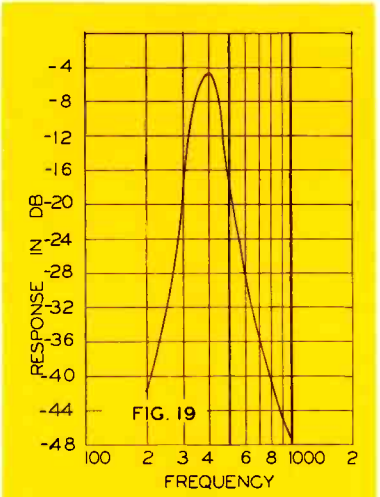


Fig. 19—Typical response curve of the HE-817 band pass filter.

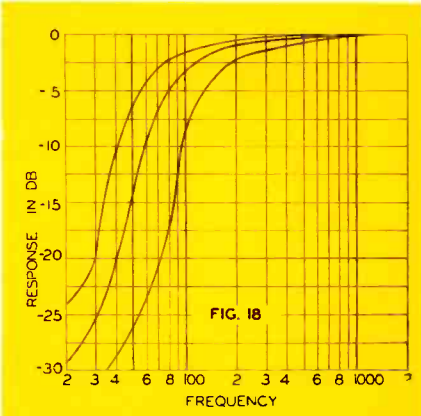


Fig. 18—Response curves of the HE-815 high pass filter.

large portion of the current of the grounded wire or wires will decrease the inductance. Since the characteristic impedance varies inversely as the capacity and directly as the inductance it will decrease in value from that holding for the ungrounded line. The same conditions prevail for the more complex line structures.

Measured values of characteristic impedance and capacity, of three types of open-wire lines, ungrounded and grounded are given in Table I. The characteristic impedance is an average value for the frequency range, 500 to 1,500 kilocycles. Capacities were measured at 1,000 cycles.

It is observed that the characteristic impedance of the grounded line decreased to a lesser degree than the capacity increased. The impedance decrease was of the order of 30% for the two-wire line, 20% for the four-wire line and 2.5% for the five-wire line. Theoretically the ratio of ungrounded to grounded impedance should equal the ratio of grounded-to-ungrounded capacity. This is seen to be true within the error of measurement from the table. The five-wire line very closely approaches a true concentric line and it is not to be expected that grounding of the outer conductors will materially affect its capacity or impedance.

Expressions for the capacity and inductance of ungrounded open-wire lines, from which expressions for the characteristic impedance are immediately obtainable, may be derived without difficulty. However, when one conductor of a line, or in the case of a multiple-wire line, when a number of its conductors are grounded, the theoretical problem becomes more difficult, the complexity increasing quite rapidly as the number of conductors is increased. Specifically, its solution requires the determination of the distribution of charges between the conductors resulting from grounding one or a number of them. It involves the use of Maxwell's coefficients of capacity or potential, a discussion of which is to be found in most textbooks on advanced electricity.[1]

In Table II are given expressions for calculating the characteristic impedance in terms of the line dimensions, for four different types of open-wire lines, for both grounded and ungrounded conditions. These have been checked experimentally with an agreement between calculated and measured values sufficiently exact for all practical purposes. The accuracy of the expressions for the grounded condition become less, the greater the spacing is between conductors, with respect to the height.

The expressions show the effect of grounding in decreasing the characteristic impedance. For example in the case of the two-wire line, comparing the expressions for the ungrounded and grounded conditions it is seen that,

$$Z_{o(\text{Grounded})} = Z_{o(\text{Ungrounded})} \left\{ \frac{1}{1 + \dfrac{\log_{10} \dfrac{2D}{d}}{\log_{10} \dfrac{8h^2}{Dd}}} \right\}$$

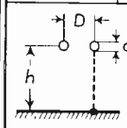
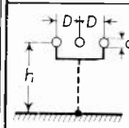
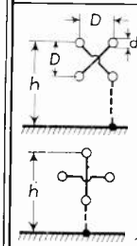
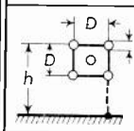
Since the logarithm terms are both positive, the characteristic impedance of the line when grounded is less than when ungrounded. The same is true for the other lines as will be evident from comparison of the expressions.

In using the expressions of Table II it is to be noted

[1]For an explanation and illustration of use as applied to a two-wire line, see "Electrical Engineering—Advanced Course" by E. J. Berg—first edition, Chapt. XX. See also. "The Calculation of Capacity Coefficients for Parallel Suspended Wires" by Frank F. Fowle, *Elec. World*, Vol. 28, 1911. Page 386, etc.

Table II

Characteristic Impedance in Ohms

Line	Ungrounded	Grounded
	$Z_0 = 276 \log_{10} \frac{2D}{d}$;	$Z_0 = 276 \frac{\left(\log_{10} \frac{8h^2}{Dd}\right)\left(\log_{10} \frac{2D}{d}\right)}{\log_{10} \frac{8h^2}{Dd} + \log_{10} \frac{2D}{d}}$
	$Z_0 = 69 \log_{10} \frac{4D^3}{D^3}$;	$Z_0 = 69 \frac{\left(\log_{10} \frac{16h^3}{dD^2}\right)\left(\log_{10} \frac{4D^3}{d^3}\right)}{\log_{10} \frac{16h^3}{dD^2} + \frac{1}{6} \log_{10} \frac{4D^3}{d^3}}$
	$Z_0 = 138 \log_{10} \frac{\sqrt{2}D}{d}$; *	$Z_0 = 138 \frac{\left(\log_{10} \frac{8h^2(2h-D)^2}{\sqrt{2}dD^3}\right)\left(\log_{10} \frac{\sqrt{2}D}{d}\right)}{\log_{10} \frac{8h^2(2h-D)^2}{\sqrt{2}dD^3} + \frac{1}{2} \log_{10} \frac{\sqrt{2}D}{d}}$
	$Z_0 = 69 \log_{10} \frac{\sqrt{2}D^3}{d^2\sqrt{dD}}$;	$Z_0 = 69 \frac{\left(\log_{10} \frac{256h^5}{dD^4}\right)\left(\log_{10} \frac{\sqrt{2}D^3}{d^2\sqrt{dD}}\right)}{\log_{10} \frac{256h^5}{dD^4} + \frac{1}{10} \log_{10} \frac{\sqrt{2}D^3}{d^2\sqrt{dD}}}$

All dimensions in same units

* Derived by P.S. Carter, of RCA Communications, Inc

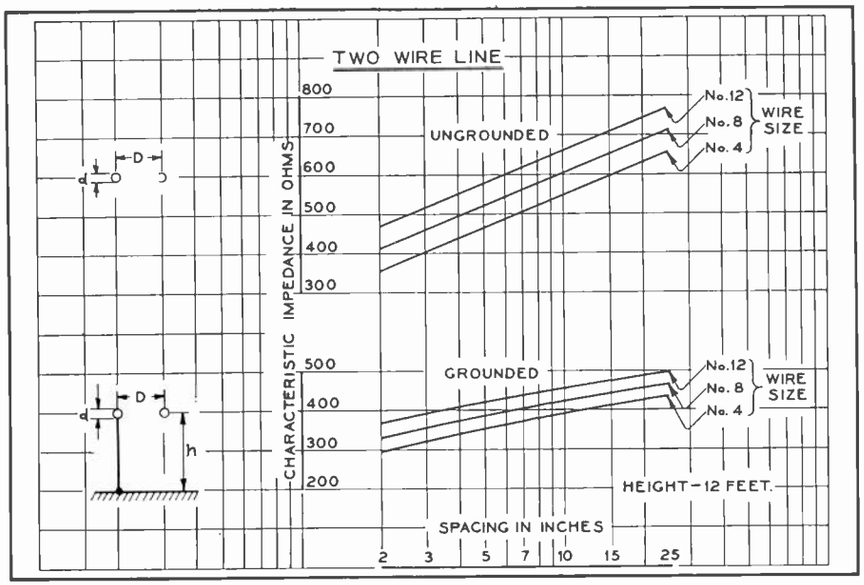
that all dimensions are in the same units, viz., inches, or centimeters, etc., and the logarithms are to the base 10. The impedances are in ohms.

The manner of variation of the characteristic impedance with conductor size and spacing is illustrated in the chart, which shows curves giving the calculated impedance values for four different types of lines, for three conductor sizes, viz., Nos. 4, 8 and 12 B. & S., and spacing between conductors varying from 2 to 25 inches. A single height of 12 feet was taken for the grounded condition. A variation of ± 4 feet in height from this value will produce a change in the calculated impedance not exceeding 5% for the 25-inch spacing with a lower percentage difference for smaller spacings.

For transmission lines of appreciable length grounds should be made at several intermediate points along the line as well as at the two ends. Measurement has shown that with ground connections at only the transmitter and antenna-line terminals there may be a substantial variation in characteristic impedance with changing frequency. However, with the line grounded at several points a uniform value of impedance is obtained over the broadcast-frequency range. Grounds made every seventy feet have been found adequate. A metal stake or pipe driven in the earth to a depth of several feet will usually suffice for the ground contact.

Another result of grounding an open-wire line is an increase in its radiation field. This is due to the fact that the "going" and "return" circuits are unbalanced, the earth carrying most of the current of the grounded conductors, with the result that the radiated field strength is increased above that which would exist if the line were ungrounded. However, even for the grounded condition, the line field is of a low order compared to the field of the antenna and except possibly in the case of highly directional antenna systems, its effect is negligible in transmitter practice.

It is desired to acknowledge the cooperation of Mr. Dale Pollack in this investigation.



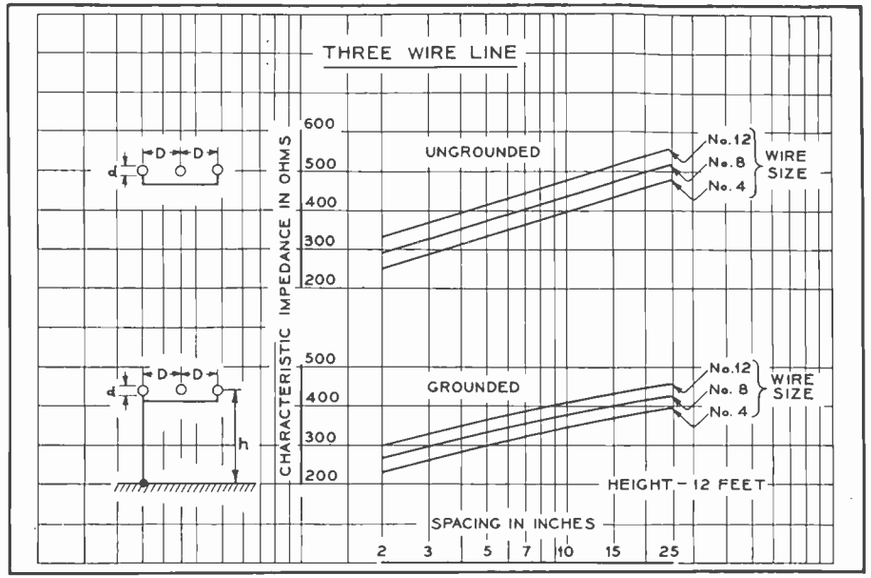
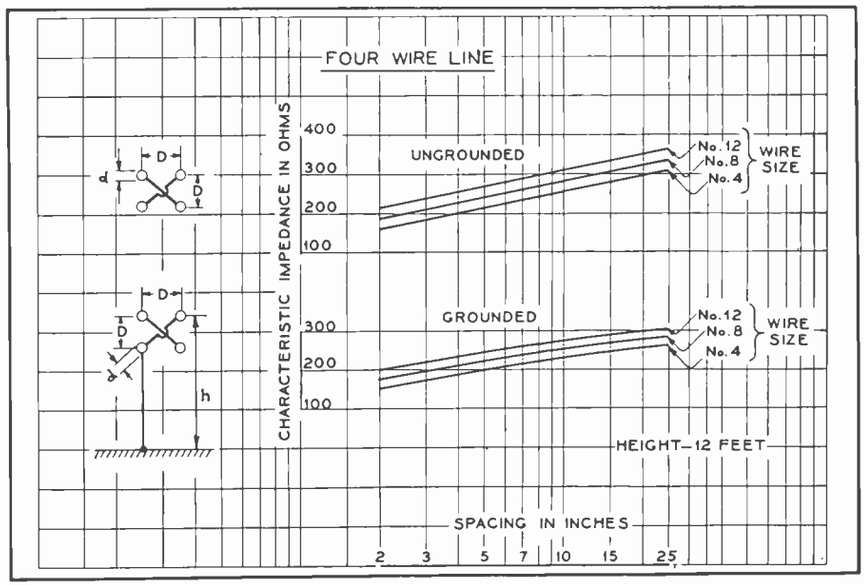
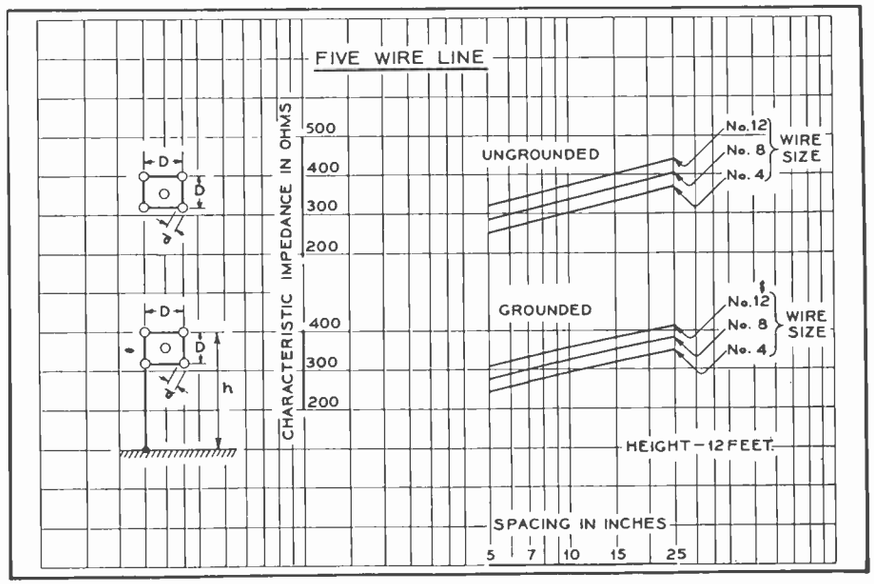


Chart of Characteristic Impedance of Open-Wire Transmission Lines





VIDEO AMPLIFIER DESIGN

By ALFRED W. BARBER
Consulting Engineer

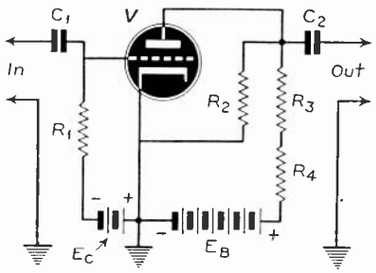


Fig. 1

Essential elements of one type of amplifier.

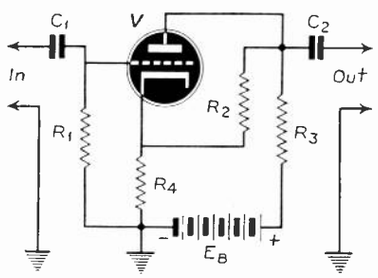


Fig. 2

A circuit providing automatic cathode bias.

TELEVISION amplifier requirements are by comparison rather severe. They include wider frequency range, higher gain and less distortion than conventional amplifiers hitherto available. Early resistance-coupled amplifiers suffered from low-frequency instability often called "motor-boating" because of the characteristic sounds produced. While this difficulty was satisfactorily met in audio-range amplifiers, the problem has arisen with renewed intensity in video amplifiers due to the greatly extended low-frequency response required. In addition to the increased low-frequency instability new aspects of the problem such as trouble from line-voltage impulses introduced into the amplifier have arisen. The circuit to be shown and discussed here shows a means of overcoming these difficulties.

Fig. 1 shows the essential elements of one form of the amplifier to be discussed. The plate-load resistor R_2 is connected between the tube plate and ground and the plate voltage is supplied through the decoupling resistor R_3. If the plate-voltage source is assumed to have an equivalent impedance at very low frequencies of value R_4, then, signal or other voltages produced across plate-load R_2 will be attenuated before reaching R_4 by a factor $R_4/R_3 + R_4$ by the action of the decoupling resistor. Also signal and undesired voltages appearing across R_4 will be attenuated by a factor $R_2/R_2 + R_3 + R_4$ at the plate of the tube. Since this filter action is due to a resistance network it is effective down to zero frequency, whereas filters depending on condensers become less and less effective as the frequency is reduced.

Fig. 2 shows the essential circuit of a modification which provides automatic cathode bias without harmful effects on frequency response and with little loss in gain. Since the current flowing in R_4 is essentially the same as the current flowing in R_3, if R_3 is made large enough to keep the current drawn from the plate-voltage supply essentially constant, the bias drop across R_4 will be constant. Thus little or no degeneration results from the lack of by-pass capacity across R_4 and equal response is obtained down to zero frequency.

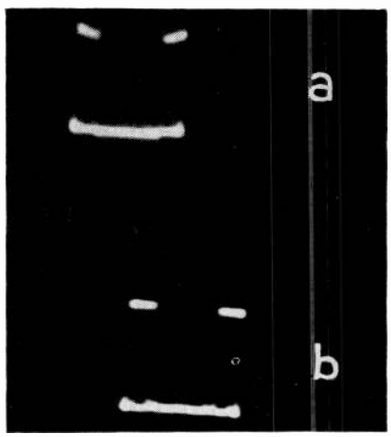


Fig. 3. (a) Output of conventional amplifier. (b) Output using circuit of Fig. 2.

One of the most serious difficulties encountered in video amplifiers, which is overcome by these circuits, is that of distortion due to power-supply regulation. For instance, if a flat-topped wave is impressed on one or more stages of a conventional amplifier, the steady current flowing from condensers in the power supply or decoupling system, due to the flat-top part of the wave, starts to discharge these condensers. As the condensers discharge, the flat-topped voltage appearing at the tube plate falls exponentially. Even in a generously designed system it is difficult to pass a flat-topped wave of any frequency below 100 cycles without encountering enough of this type of distortion to be serious. The circuits shown in Figs. 1 and 2, however, are essentially constant-current systems and, as such, flat-topped waves of even very low frequencies are passed with little distortion due to charging condensers.

Fig. 3 shows photographs of oscillographs showing at "a" a distorted 60-cycle flat-topped wave as passed by a conventional amplifier stage while at "b" is shown the great improvement obtained at the same stage gain with an amplifier using the circuit shown in Fig. 2.

Since these circuits effectively decouple the tube circuits from the power supply for even the lowest frequencies, stability is greatly improved and line-voltage fluctuations are kept out of the amplifying system. The tendency to "motor-boat" may be reduced by almost any desired amount. The improved stability was shown when the oscillograms of Fig. 3 were made. The pattern "a" jumped constantly due to line-voltage fluctuations passed on by the power supply while pattern "b" showed practically no fluctuation even when large line-voltage changes were artificially introduced.

There are many applications which suggest themselves where the improved stability of these circuits is useful. In video-signal amplifiers it is evident. It is almost as evident in sweep or scan-

(Continued on page 30)

A practical circuit using pentodes.

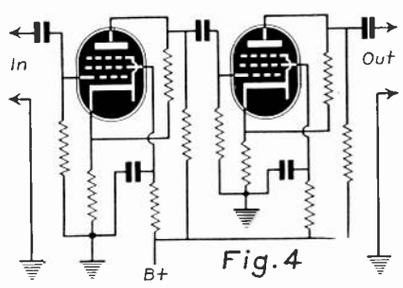


Fig. 4

Another circuit similar to Fig. 4.

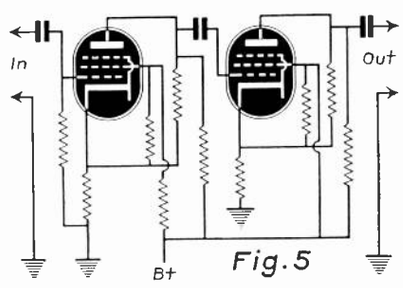


Fig. 5

IRE CONVENTION PROGRAM

THE THIRTEENTH ANNUAL Convention of the Institute of Radio Engineers, which is to be held at the Hotel Pennsylvania on June 16, 17 and 18, promises to be an outstanding gathering. In all 49 papers will be presented at the technical sessions, covering the most recent developments in nearly every phase of radio. In brief, the program for the convention is as follows:

THURSDAY, JUNE 16

9:00 A.M.

Registration and opening of exhibition.

11:00 A.M.-12:30 P.M.—Ballroom

Official welcome by Haraden Pratt, President of the Institute.

"KDKA Low-Angle Antenna Array," by Ralph N. Harmon, Westinghouse Electric and Manufacturing Company, Chicopee Falls, Mass.

"A Short-Wave Single-Side-Band Radiotelephone System," by A. A. Oswald, Bell Telephone Laboratories, Inc., New York, N. Y.

"A Single-Side-Band Receiver for Short-Wave Telephone Service," by A. A. Roetken, Bell Telephone Laboratories, Inc., New York, N. Y.

"A New Antenna System for Noise Reduction," by V. D. Landon and J. Reid, RCA Manufacturing Company, Inc., Camden, N. J.

1:30 P.M.-4:30 P.M.

Trip No. 1. Women's trip to the Jules Bache and Frick Art Collections.

2:30 P.M.-4:30 P.M.—Ballroom

"A 50 Kilowatt Broadcast Station Utilizing the Doherty Amplifier and Designed for Expansion to 500 Kilowatts," by W. H. Doherty, Bell Telephone Laboratories, Inc., New York, N. Y., and O. W. Towner, The Louisville Times Company, Inc., Louisville, Ky.

"Recent Developments in Radio Transmitters," by J. B. Coleman, and V. E. Trouant, RCA Manufacturing Company, Inc., Camden, N. J.

"A High Efficiency Modulating System," by A. W. Vance, RCA Manufacturing Company, Inc., Camden, N. J.

"Technical Equipment of the New KYW Studios," by Arthur G. Goodnow, Westinghouse Electric and Manufacturing Company, Chicopee Falls, Mass.

"Design Requirements for Broadcast Studio Audio-Frequency Systems," by H. A. Chinn, Columbia Broadcasting System, Inc., New York, N. Y.

2:30 P.M.-4:30 P.M.—Parlor 1

"Application of Quartz Crystals to a Wave Analyzer," by L. B. Arguimbau, General Radio Company, Cambridge, Mass. (Demonstration.)

"Bridged-T and Parallel-T Null Circuits for Measurements at Radio Frequencies," by W. N. Tuttle, General Radio Company, Cambridge, Mass.

"Some Applications of Negative Feedback with Particular Reference to Laboratory Equipment," by F. E. Terman, R. R. Buss, W. R. Hewlett and F. C. Cahill, Stanford University, Calif.

"The Bridge-Stabilized Oscillator," by L. A. Meacham, Bell Telephone Laboratories, Inc., New York, N. Y. (Demonstration.)

"Evacuated-type Crystal Oscillator Holder," by C. F. Baldwin, General Electric Company, Schenectady, N. Y.

7:30 P.M.-10:00 P.M.—Ballroom

Presentation of Institute Awards.

"Input Impedance of Converter Tubes," by J. R. Nelson, Raytheon Production Corporation, Newton, Mass.

"A Push-Pull Ultra - High - Frequency Beam Tetrode," by A. K. Wing, RCA Manufacturing Company, Inc., Harrison, N. J. (Demonstration.)

Haraden Pratt, President of IRE.

"Control of the Effective Internal Impedance of Amplifiers by Means of Feedback," by H. F. Mayer, General Electric Company, Schenectady, N. Y.

"Use of Feedback to Compensate for Vacuum-Tube Input-Capacitance Variations with Grid Bias," by R. L. Freeman, Hazeltine Service Corporation, New York, N. Y.

"Automatic Selectivity Control Responsive to Interference," by J. F. Farrington, formerly of Hazeltine Service Corporation, New York, N. Y.

11:00 P.M.

Exhibition closes.

FRIDAY, JUNE 17

9:00 A.M.

Exhibition opens.

10:00 A.M.-3:00 P.M.

Trip No. 2. Women's trip to Good Housekeeping Institute, Castleholm Restaurant and Sky Gardens at Rockefeller Center.

10:30 A.M.-12:30 P.M.—Ballroom

"Development of an Ultra-High-Frequency Transmitter for Aircraft Instrument Landing," by P. J. Kibler, Washington Institute of Technology, Washington, D. C.

"Air-Track System of Aircraft Instrument Landing," by G. L. Davies, F. G. Kear, and G. H. Wintermute, Washington Institute of Technology, Washington, D. C.

"Further Developments in the Design and Technique of Operation of Mobile Field-Intensity-Measuring Equipment," by W. A. Fitch, National Broadcasting Company, Inc., New York, N. Y.

"Lateral Disc Recording for Immediate Playback with Extended Frequency and Volume Range," by H. J. Hasbrouck, RCA Manufacturing Company, Inc., Camden, N. J. (Demonstration.)

"A New High-Fidelity Reproducer for Lateral Disc Records," by H. J. Hasbrouck, RCA Manufacturing Company, Inc., Camden, N. J. (Demonstration.)

10:30 A.M.-12:30 P.M.—Parlor 1

"A Consideration of the Radio-Frequency Voltages Encountered by the Insulating Material of Broadcast Tower Antennas," by G. H. Brown, RCA Manufacturing Company, Inc., Camden, N. J. Demonstration.)

"The Operating Characteristics of Radio-Frequency Transmission Lines as Used with Radio Broadcasting Antennas," by C. G. Dietsch, National Broadcasting Company, Inc., New York, N. Y.

"Design and Tests of Coaxial Transmission-Line Insulators," by W. S. Duttera, National Broadcasting Company, Inc., New York, N. Y.

"Coupled Transmission-Line Networks," by A. Alford, Mackay Radio and Telegraph Company, New York, N. Y.

"Communication by Phase Modulation," by M. G. Crosby, RCA Communications, Inc., Riverhead, L. I., N. Y.

"Oscillograph Design Considerations," by G. R. Mezger, Allen B. DuMont Laboratories, Passaic, N. J. (Demonstration.)

2:00 P.M.-4:00 P.M.—Ballroom

"Contrast in Kinescopes," by R. R. Law, RCA Manufacturing Company, Inc., Harrison, N. J.

"Recent Improvements in the Design and Characteristics of Iconoscopes," by R. B. Janes, and W. H. Hickok, RCA Manufacturing Company, Inc., Harrison, N. J.

"The Image Iconoscope," by H. Iams, G. A. Morton and V. K. Zworykin, RCA Manufacturing Company, Inc, Harrison, N. J.

"Electrostatic Electron Multiplier," by V. K. Zworykin, and J. A. Rajchman, RCA Manufacturing Company, Inc., Harrison, N. J.

5:30 P.M.

Exhibition closes.

8:30 P.M.-1:00 A.M.

Boat trip on the Hudson River.

(Continued on page 33)

FEATURES OF 1939 RECEIVERS

By D. D. COLE, G. G. GERLACH & W. P. SHORT

RCA MANUFACTURING CO., INC.

THIS YEAR'S radio season will see wide application of the three most significant developments of the past year. There is no doubt that the foremost of these developments has been push-button tuning and all classes of receivers from the cheapest to the most expensive will offer this convenience; in some cases even to the exclusion of conventional tuning methods. The second of these significant developments has been that made in the field of higher fidelity of reproduction and certain receivers have been developed to a point where they may now be called high-fidelity receivers. The third development to receive wide attention during the past year has been the spread-band tuning as applied to short waves. The recent improvements in quality of foreign broadcasts received in this country have put a premium on good short-wave performance and convenience in tuning so that this year's line will find increased use of the spread-band feature.

PUSH-BUTTON TUNING

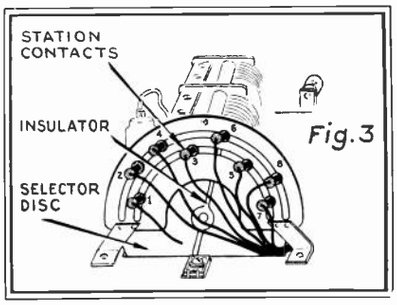
The development of automatic-frequency-control circuits made possible the practical application of push buttons to receivers. Since that time much development has been done in the way of stabilizing oscillator circuits with respect to temperature and humidity variations to retain the practicability of the push button tuning and yet eliminate the cost and space requirements of the afc circuits. The development of fixed condensers with practically a zero-temperature coefficient of capacitance variation has been an important factor. These condensers in conjunction with permeability-tuned coils in the oscillator and intermediate-frequency circuits make it possible to produce pre-set circuits with negligible drift.

The circuit used in the RCA receivers using pre-tuned circuits is shown in Fig. 1. Separate oscillator coils are used for each push button and they are adjusted by moving the magnetite core in the field of the coil. Each coil covers a range of about 500 kilocycles and three coil groups are used to cover the band of 550 to 1,550 kilocycles with sufficient overlapping of the ranges to meet any ordinary requirements. The coils parallel the conventional oscillator coil to simplify the winding and switching arrangements. The stability of the circuits is such that oscillator drift is less than 1,500 cycles for a temperature rise of 50° F. at a signal frequency of 1,500 kilocycles.

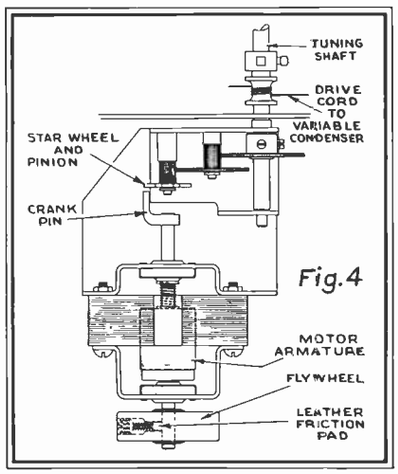
The antenna circuits, which are not so critical to capacity variation, use conventional compression mica trimmers switched across the normal antenna coil. The intermediate-frequency amplifier stability is assured by use of permeability-tuned coils with stabilized fixed tuning condensers.

MOTOR TUNING

Motor-tuned receivers offer certain advantages that are lacking in the pre-

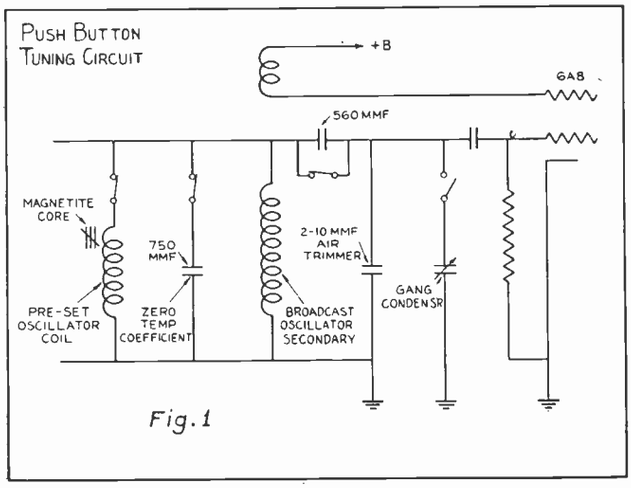


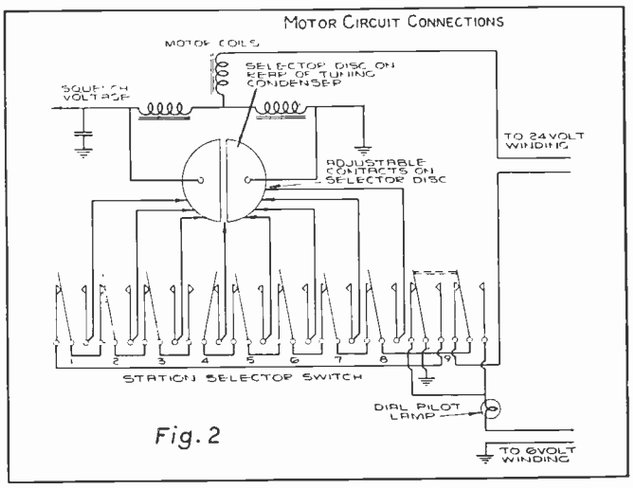
Selector and contact arrangement for push-button tuning.



Motor drive assembly.

Left: Push-button tuning circuit. Right: Motor circuit connections.





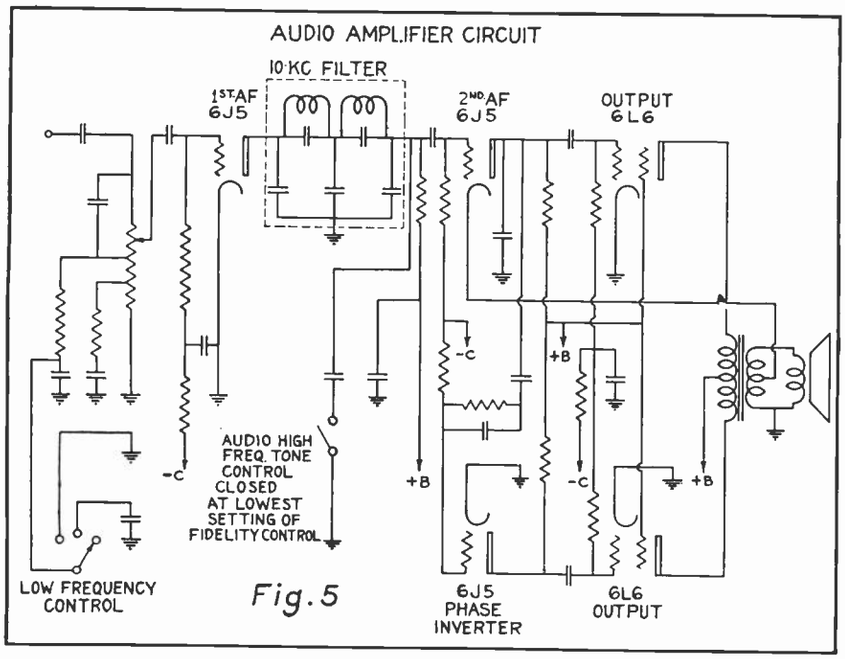


Fig. 5

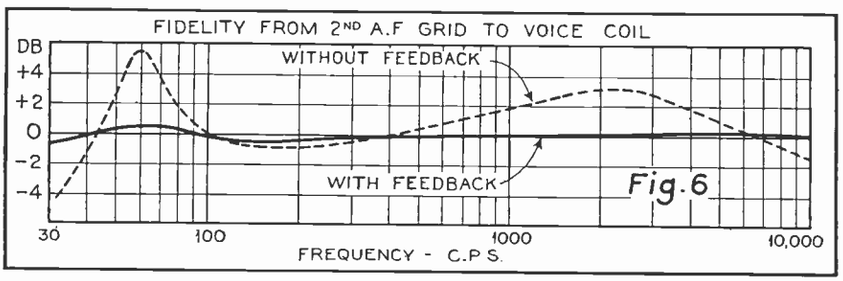


Fig. 6

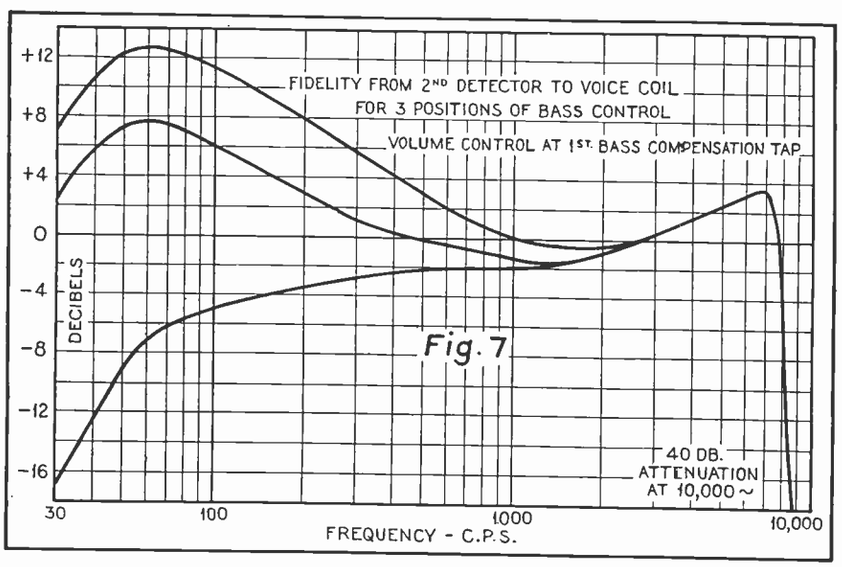


Fig. 7

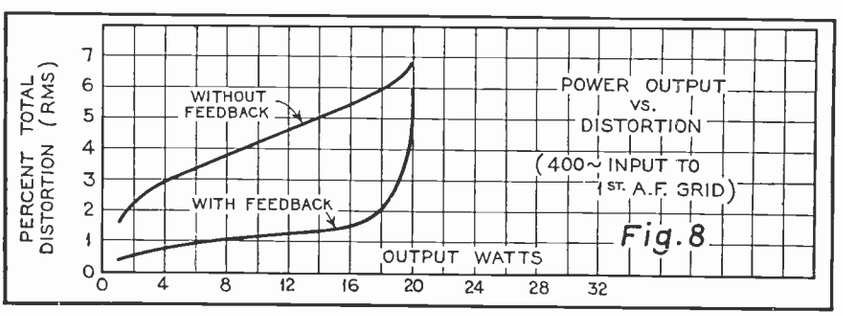


Fig. 8

set electrical systems. The main advantages are in greater ease in setting up stations for push-button operation, particularly with receivers using 3-gang condensers, and provides the possibility of attachment of a remote-tuning device if so desired. The motor-tuning system used in the RCA receivers is greatly improved over previous types and is of the "homing" type, that is, the motor seeks the station directly without the necessity of throwing a reversing switch at the end of the condenser travel. Fig. 2 shows the schematic diagram of the system. The station-selector switch is of the latch-in series type which eliminates the possibility of overheating the motor in case more than one station button is pressed in at the same time. Contact positions 1 to 8 inclusive represent push buttons for 8 different stations. Position No. 9 is for "dial tuning" and removes the motor voltage from the 8 station buttons. The dial pilot lamp, shown in Fig. 2, is also controlled by position No. 9, and is used as a visual aid in setting up stations.

Fig. 3 shows the arrangement of the selector disc and station contacts mounted on the rear of the variable condenser. The station contacts are held in place by spring-loaded friction washers but can be easily moved in the slots when setting up stations.

When a station is to be set up, the desired station button is latched in with the "dial-tuning" button. The station is then tuned in by means of the tuning knob. The station contact on the selector unit corresponding to the latched-in button is then slid along the slot in the direction of the insulator until the pilot lamp goes out and the contact is centered on the insulator. The station is now set up for push-button operation.

Reference to Fig. 2 indicates that when the "dial-tuning" button is pressed in, all of the station buttons are energized through the pilot lamp from the 6-volt transformer winding. The return circuit for the pilot lamp is through the selector and motor windings to ground. When the station button and "dial-tuning" buttons are both latched in, the pilot light will go out only when the station contact is directly over the insulator thus indicating proper set up.

Motor tuning has been applied to the majority of the present line of RCA receivers without the use of automatic frequency control. The high-fidelity chassis in the line are provided with afc. Accuracy of tuning is obtained through the use of frequency-stabilized components and an accurate motor drive and stopping system.

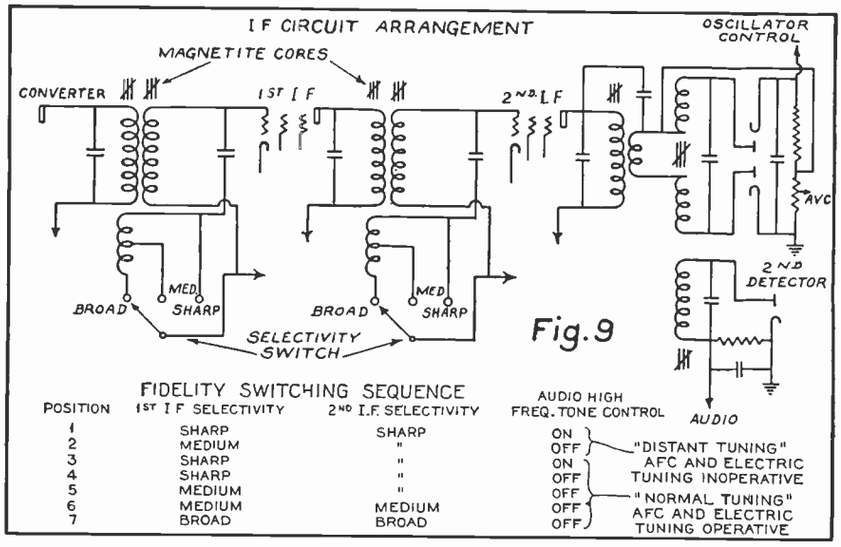
The accuracy of stopping depends on the width of the insulator in the selector disc and the diameter of the station contacts shown in Fig. 3. The width of the insulator has been set at .075 inch and

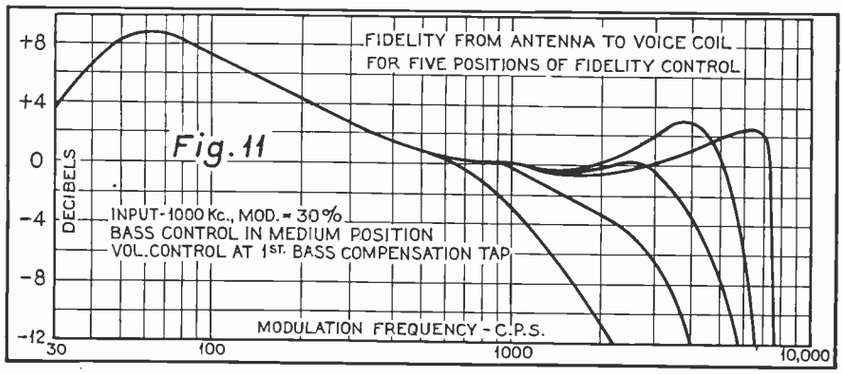
the diameter of the contact has been set at .059 inch which leaves .008 inch either side of the contact when the contact is centered on the insulator by correct set-up. (Production tolerances on these dimensions are permitted to vary somewhat, but the action of a flywheel to be discussed later can be made to take care of these tolerances). At the radius at which the contacts operate, .001 inch corresponds to about 200 cycles on the broadcast band. In order to tune accurately, to within 1 kc, which is satisfactory, the overtravel of the motor may be anywhere from .003 inch to .013 inch approaching the insulator from either direction. This small amount of overtravel with the ordinary motor drive, even with an armature of low inertia, would be very difficult to control without excessive oscillation or hunting. A special type of drive with very little overtravel has been developed and is shown in Fig. 4.

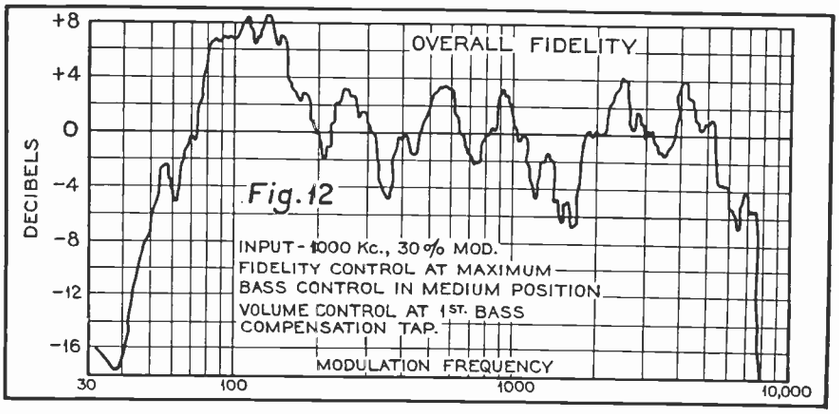
When the motor armature is energized it engages the star wheel and pinion by means of the crank pin and drives the gear train which in turn drives the tuning shaft. The tuning shaft is connected to the variable condenser through a conventional cord drive. The reduction ratio from the motor shaft to the tuning shaft is 25:1 and from the tuning shaft to the variable condenser is 17:1. The time required to tune from one end of the broadcast band to the other is approximately 3 seconds. The motor armature when de-energized is thrown clear of the star wheel and pinion and by means of a spring, the armature itself having axial movement.

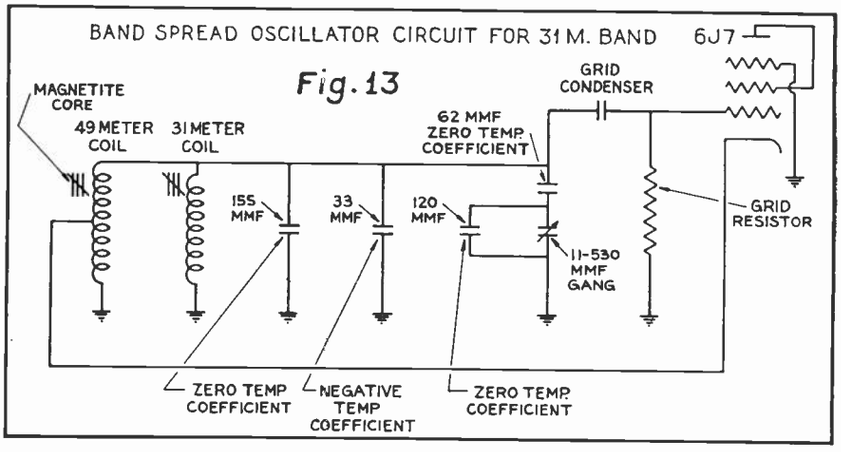
A flywheel is mounted on the motor shaft but is not rigidly connected to it. The torque is transmitted to the flywheel through an adjustable leather friction pad. It is the action of this flywheel which controls the overtravel of the motor and the accuracy of the system.

When a station button is pressed, the motor tends to pick up speed and rotate the selector disc in the direction of the corresponding station contact. The motor cannot come up to speed immediately due to the friction load of the slipping flywheel. When the insulator on the selector disc has reached the station contact both the motor and flywheel are rotating at the same speed and their combined inertia carry the insulator beyond the station contact and the motor reverses. Because of the momentum of the flywheel which is still rotating in the original direction, the motor speed in reverse is reduced. While the motor is rotating at low speed in the reverse direction the station contact is again reached at which time the motor current is broken and the condenser stops within the limits of the insulator. Adjustment of the set screw on the flywheel friction pad con-









trols the amount of overtravel and the accuracy of tuning. In order to insure that the motor will accomplish final tuning while rotating very slowly, the drive pinion has been equipped with a six-bladed star wheel which permits the motor to start reversing the condenser immediately before the motor attains speed which would cause the selector to overtravel the station contact and "hunt" the second time. In actual operation, the system hunts only once, returning to the proper setting after one overtravel. The receiver is silenced during the period of motor tuning by biasing off the audio tubes by means of a muting circuit.

HIGH FIDELITY

With the present trend of transmitters towards high power, wide frequency range and low distortion, and with the advent of superior programs which are producing a more critical group of listeners; the need for higher fidelity receivers has made itself felt. The approval of our higher fidelity receiver, the HF-1, introduced early this year,[1] confirmed this need and resulted in the continuation of high-fidelity design in several new models. The HF-8 described here represents the best of these models.

AUDIO AMPLIFIER

Inverse feedback is used over the last two stages, the feedback loop including the output transformer as shown in Fig. 5. The 1st a-f tube is operated outside of the feedback loop and the 10-kc filter and audio tone control are inserted in this circuit. Fig. 6 shows the frequency characteristic with and without feedback measured from the grid of the 2nd a-f tube to the speaker voice coil. The curves of Fig. 7 show the frequency characteristic measured from the diode when the volume control is set at the 1st bass-compensation tap. Harmonic distortion from the 1st a-f grid to the output is given in Fig. 8.

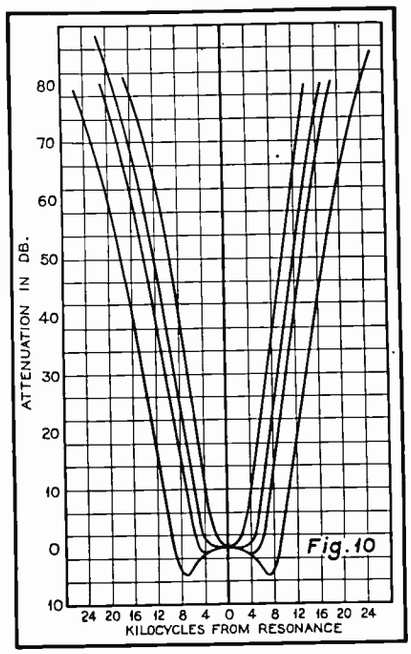
SELECTIVITY

A flexible control of fidelity in the form of variable selectivity is used to provide optimum performance over the wide range of operating conditions encountered in the field. Selectivity is varied by switching coupling coils in the 1st and 2nd i-f stages. The selectivity from the 2nd i-f tube to the 2nd detector is relatively sharp and flattens out the valley of the double-humped selectivity characteristic of the 1st two i-f transformers in the broader selectivity positions. Fig. 9 shows the essentials of the i-f switching circuits and also the switching sequence employed. Overall selectivity curves for the four steps of selectivity are given in Fig. 10. The use of magnetite core adjusted i-f transformers tuned with zero-temperature-coefficient mica condensers assures constancy of i-f alignment and afc assures correct tuning to the center of the pass band.

[1] "A High-Fidelity Local Receiver," p. 28, COMMUNICATIONS, April, 1938.

FIDELITY AND TUNING CONTROLS

The tuning control is arranged with a push action for manual operation on the high-fidelity chassis. Pushing in the knob while tuning removes afc and narrows selectivity. Releasing the knob automatically reconnects afc and returns the selectivity to that for which the fidelity control was set. The fidelity control is a seven-point switch. It was not considered desirable to use afc on weak distant stations subject to fading; therefore, the first two positions of the fidelity control are labeled "Distance" and in these positions afc and electric tuning are made inoperative. In the remaining five positions afc and electric tuning are reconnected. Fig. 11 shows fidelity measured from the antenna to voice coil for the various fidelity-control positions.



Overall selectivity curves for four steps of selectivity.

SPEAKER

In order to realize the full capabilities of the HF-8 receiver a new speaker was required. Accordingly a speaker was designed having substantially flat response from 50 cycles to 7,500 cycles but with high attenuation of 10,000 cycles. An interesting solution to the problem of obtaining both high input power-handling capacity and good high-frequency response was reached in this design. To handle high-power input a relatively heavy cone was necessary but this inherently limited the high-frequency response. To overcome this difficulty a smaller and lighter auxiliary diaphragm was placed inside the large cone and fastened to it by a flexible base support at about half way out. Compliant coupling in the large cone allows the small cone to be driven independently at high a-f frequencies by the voice coil to which it is attached at its small end. While this resulted in a substantial improvement, the response from 4,000 to 7,500 cycles was still insufficient. Loading the apex of the inner diaphragm with sufficient mass to resonate with the stiffness between the apex and the voice coil increased this response still further without increasing the 10,000-cycle response. This required mass was furnished by a small inverted metal dome which by its motion also contributes to the high-frequency radiation. A sound-pressure curve showing the overall fidelity of the receiver and speaker is shown in Fig. 12.

SPREAD-BAND SHORT WAVES

The four principal entertainment bands on short waves are each spread across the entire tuning scale on those receivers using the overseas dial. The actual spread is such that the 300-kilocycle band covers the 8-inch scale with 10-kilocycle calibration points almost 3/16 inch apart.

The oscillator circuit used to accomplish this is shown in Fig. 13. The oscillator is tuned by means of a standard 11 to 530-micromicrofarad variable capacitor but the circuit constants are such that the effective change across the inductance is from 44 to 58-micromicrofarads. The method of temperature compensation is indicated in Fig. 13. The compensating capacitor is a titanium-dioxide unit with a negative temperature of -6.8×10^{-4} mmfd per mmfd per degree C. The oscillator drift with temperature is less than 4 kilocycles at 15 megacycles for a temperature rise of 50° F.

The oscillator coils are trimmed by means of magnetite cores to exact calibration and separate coils are used for each band. The antenna and radio-frequency amplifier stage are fixed tuned to the middle of each of the spread bands.

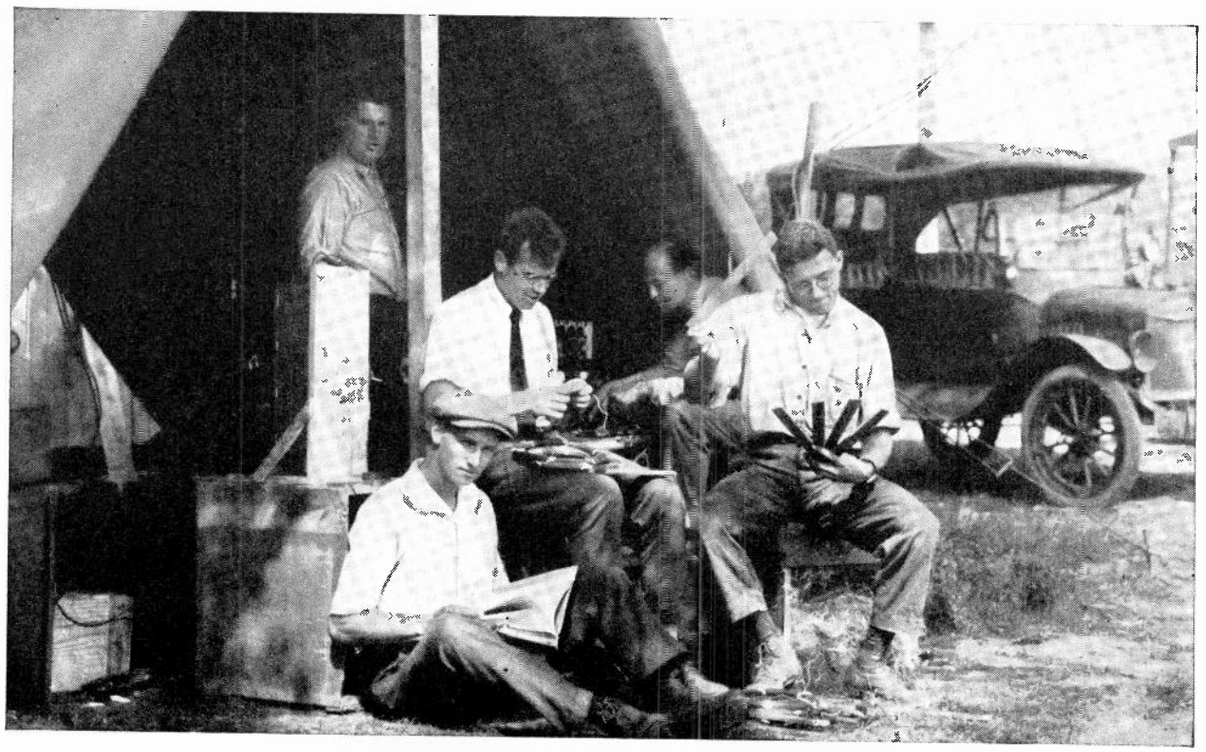
Switching of the antenna and r-f stage circuits is accomplished by means of tapped coils connected to the band switch. Since the band coverage is only 300 kilocycles, the loss experienced by not tracking the radio-frequency circuits with the oscillator is small.

•

SWARTLEY HEADS WOWO-WGL

W. C. Swartley has been appointed manager of radio stations WOWO and WGL at Fort Wayne, Indiana. He comes to his new duties from the office of the President of the Westinghouse Electric & Manufacturing Company at Pittsburgh, Pennsylvania.

First Use of Radio: Communications. First in Radio Communications: RCA



First RCA Experimental Laboratory at Riverhead, Long Island—1919

THE Radio Age began with radio communications. Practically all present day developments of radio, not only in broadcasting, but in every other direction, have grown out of communications research.

Each advance in one branch of radio knowledge has contributed to the progress of other branches. Broadcasting, because of its widespread appeal, has been the most conspicuous radio service for a number of years, yet its success has not caused any lessening in the advance of older radio services, marine and international communications.

From its very beginning, RCA has been a research organization. The men who organized this company, and have since conducted it, have always been fully aware of the necessity for unceasing exploration in the vast field opened up by radio's pioneers.

The radio research which RCA has sponsored within a period of nearly 20 years is the foundation for the many ways in which RCA serves millions of people.

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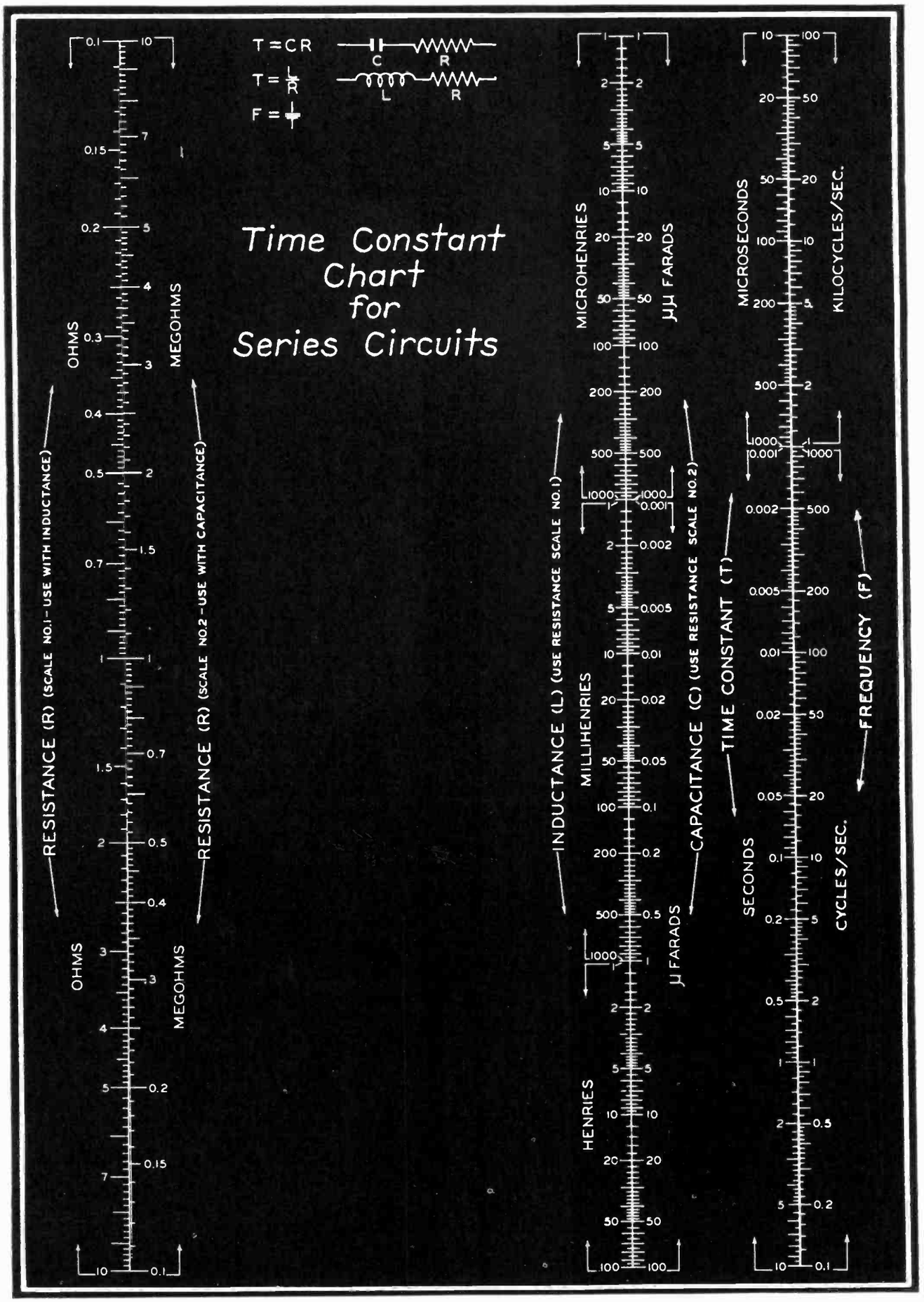
Time Constant Chart for Series Circuits
T = CR
T = L/R
F = 1/T
C
R
L
R
RESISTANCE (R) (SCALE NO.1 - USE WITH INDUCTANCE)
OHMS
MEGOHMS
RESISTANCE (R) (SCALE NO.2 - USE WITH CAPACITANCE)
OHMS
MEGOHMS
INDUCTANCE (L) (USE RESISTANCE SCALE NO.1)
MICROHENRIES
MILLIHENRIES
HENRIES
CAPACITANCE (C) (USE RESISTANCE SCALE NO.2)
μμ FARADS
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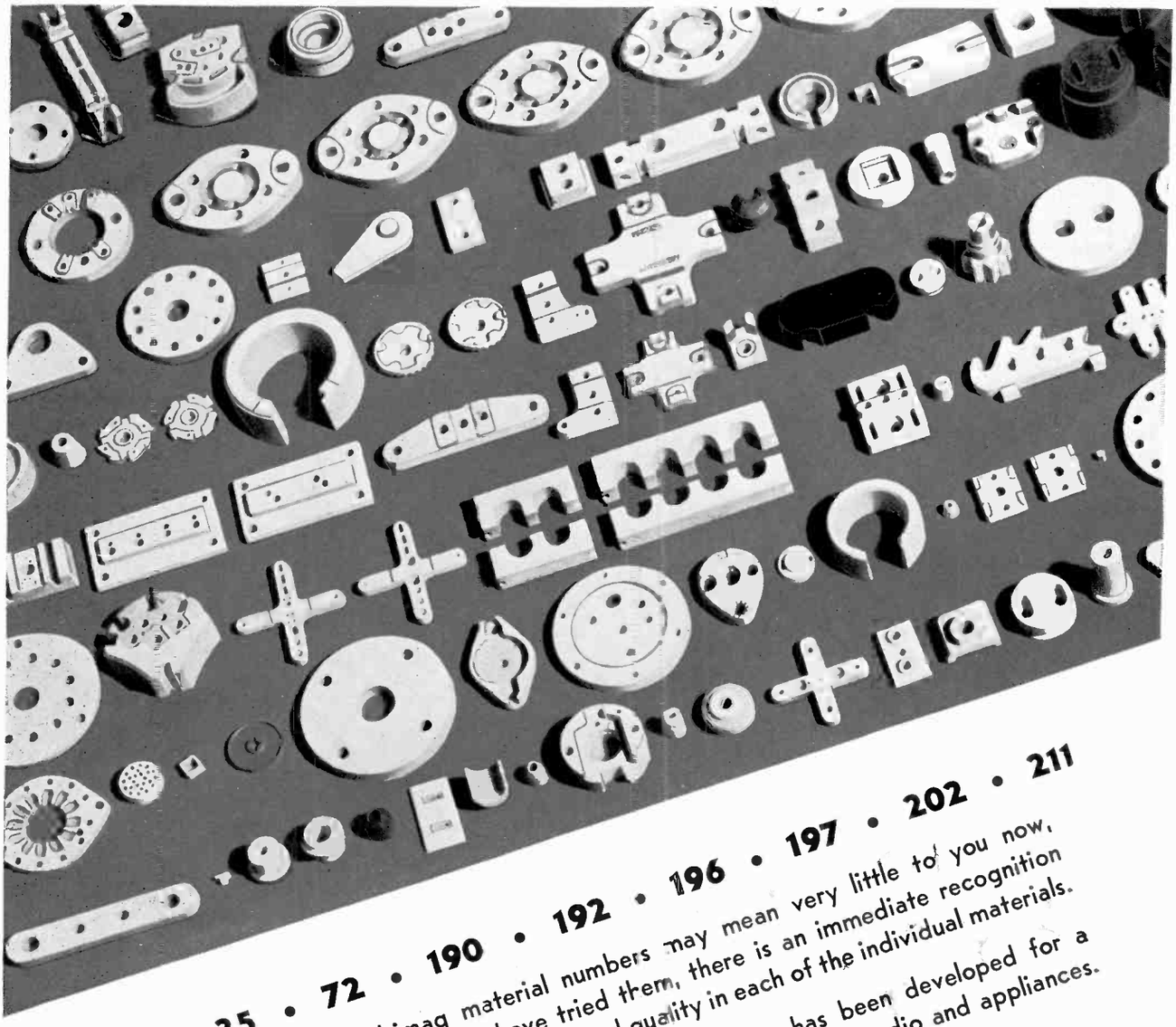
MICROSECONDS
SECONDS
FREQUENCY (F)
KILOCYCLES/SEC.
CYCLES/SEC.



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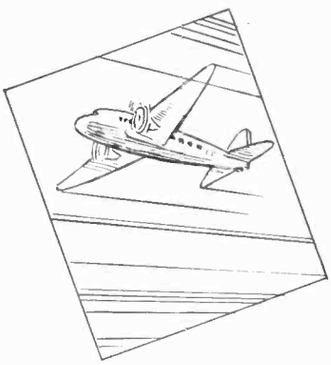
Why not avail yourself of our experience of 36 years in the ceramic field? Helpful suggestions and designs can be furnished by our engineers. Use these high quality materials on your next job.



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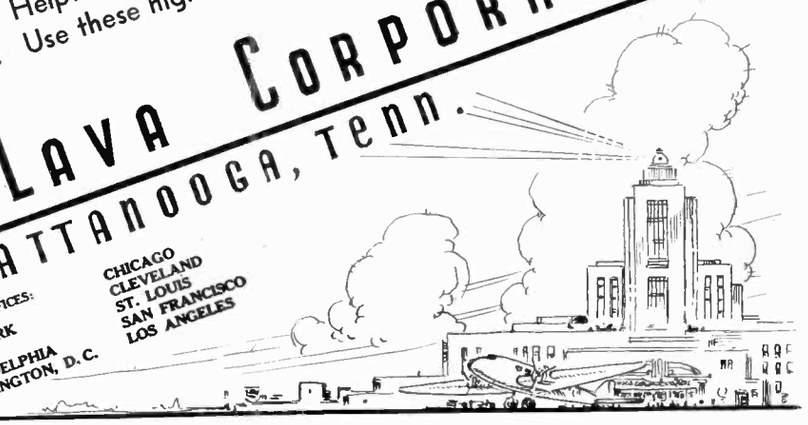

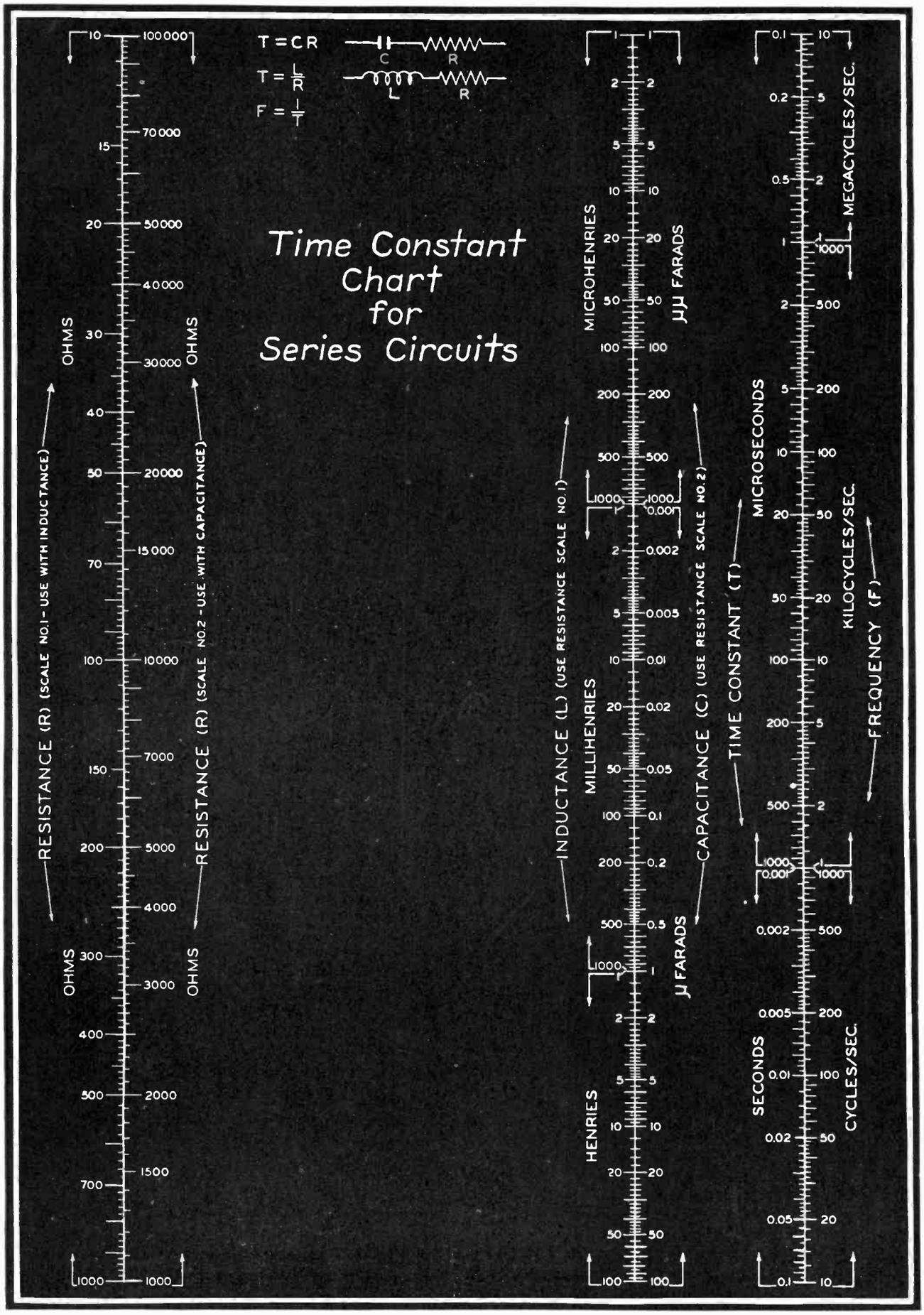
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TIME CONSTANT (T)
MICROSECONDS
SECONDS
FREQUENCY (F)
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KILOCYCLES/SEC.
CYCLES/SEC.

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- Now provided with adjustable mounting ring. Upright or inverted mounting. Any height above or below chassis platform.
- 1, 2 and 4 mfd. in 600, 1000, 1500 and 2000 v. D.C. working. 1 and 2 mfd. in 2500 and 3000 v.

Series 610 HYVOL units in inverted screw-mounting aluminum cans. Can normally grounded. Can be insulated from chassis with insulating washer. Hermetically sealed. Extensively used for amplifier and transreceiver filters. 2, 3 and 4 mfd. in 600 v., 1 and 2 mfd. in 1000 v., .5 and 1 mfd. in 1500 v.

Series 605 HYVOL units. Adjustable mounting ring. Round aluminum can. High-tension pillar terminals. Hermetically sealed. Conservatively rated, therefore larger than Series 610 units. 1, 2 and 4 mfd. in 600 v., 1000 v. and 1500 v., 1 and 2 mfd. in 2000 v. and 2500 v., 1 mfd. in 3000 v.

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NOTES AND COMMENT

Design

TIME CONSTANT CHARTS FOR SERIES CIRCUITS*

(*See pages 20 and 22.*)

THE TIME CONSTANTS of the load and coupling elements in amplifiers and of the pass or rejection elements in filter networks are important factors in the design work on radio and television equipment. In a resistance-capacitance series network the time constant is defined by:

T (seconds) = R (ohms) × C (farads)

The expression for an inductance-resistance series network is:

$$T \text{ (seconds)} = \frac{L \text{ (henrys)}}{R \text{ (ohms)}}$$

These equations give the time required for the current to rise, or decay, to within 1/e of the steady-state value (approximately 63% of its final value). During each successive interval the current rise or decay will progress towards its steady-state value a like percentage of what remains. Thus, at the end of the second, third and fourth intervals the respective values of the current will be approximately 86.5%, 95.5%, 98.5% of the final value.

The charts on pages 20 and 22 provide a rapid means for evaulating time constants. To facilitate greater accuracy the chart is furnished in two sections. Each chart contains resistance, inductance, capacitance, time constant and frequency scales. The resistance scales on each are numbered 1 and 2, No. 1 to be used with an inductance and No. 2 with a capacitance.

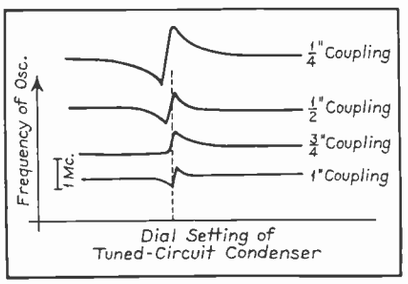
A simple example will serve to illustrate how to use the charts. The time constant of a network consisting of a resistance of 0.1 megohm in series with a capacitance of 0.25 mfd is desired. Lay a straight-edge from the point 0.1 megohm on the resistance scale No. 2 to the point 0.25 mfd on the capacitance scale. The straight-edge intersects the time constant scale at 0.025 second. The frequency 40 cps, corresponding to this time constant, represents the highest frequency at which 63.2% of the exciting voltage can be developed across the R-C network in 0.025 second. Thus, higher frequencies would suffer discrimination, particularly as regards amplitude distortion and phase displacement if the waveform is not sinusoidal. The frequency scales are also useful in determining whether or not an R-C network can follow frequencies impressed across it as, for example, in cases of diode loads with shunting capacitances, or grid leak and condenser combinations.

In a similar manner a straight-edge connecting a given value on resistance scale No. 1 with the proper inductance value will indicate the correct time constant of such a series circuit.

*Reprinted through the courtesy of Hygrade Sylvania Corporation.

INDUCTIVE COUPLING AT ULTRA-SHORT WAVELENGTHS

THE USE of improper coupling values is one of the important reasons why some obtain poor results from their transmitters and receivers at ultra-short waves. The comparatively high frequency and the effect of small stray-circuit constants make for radically new conditions. Pioneers in this field know that a large part of the trouble in the past was due to the use of tubes which were not designed for use at very high frequencies. Today, with the better tubes, there are still important points that are easily overlooked. One of the most important of these is the use of correct coupling values. This note discusses some measurements made by this writer and shows how important it is to properly design these high-frequency coupling systems and their associated equipment.



Curves showing change in frequency for various coupling conditions.

Because inductive coupling has always associated with it capacitive coupling also, and because this capacitive effect is very pronounced at the ultra-short wavelengths, capacitive coupling is in many cases to be preferred; nevertheless there are many places where inductive coupling is required. But, under the usual conditions, it is "combined" coupling that results—a combination of inductive and capacitive, where shields are not employed. We shall consider inductive coupling at this time, but capacitive coupling is present at the same time.

One of the first errors made at ultra-short waves is the employment of coils which are much too large in diameter. Such coils have large fields, consequently increased losses and in many cases give erratic results.

It was possible in some of the early regenerative receivers constructed by this writer to greatly change the regeneration by moving the body or a hand near the front of the set. The remedy was to set the coils at the rear of the set, or to redesign for coils of a smaller diameter.

In the investigation considered here, coils only ⅜ inch in diameter were employed with entirely satisfactory results. It is with coils of this small diameter that proper coupling values were investigated.

The results of these tests reveal that very often improper coupling values make it impossible to tune an ultra-short-wave circuit without shifting the frequency entirely out of the range of the usual wavemeter or receiver. This applies also to the oscillator or receiver that is inductively coupled to its necessary antenna; and perhaps the greatest number of oscillators and receivers are of the simple type.

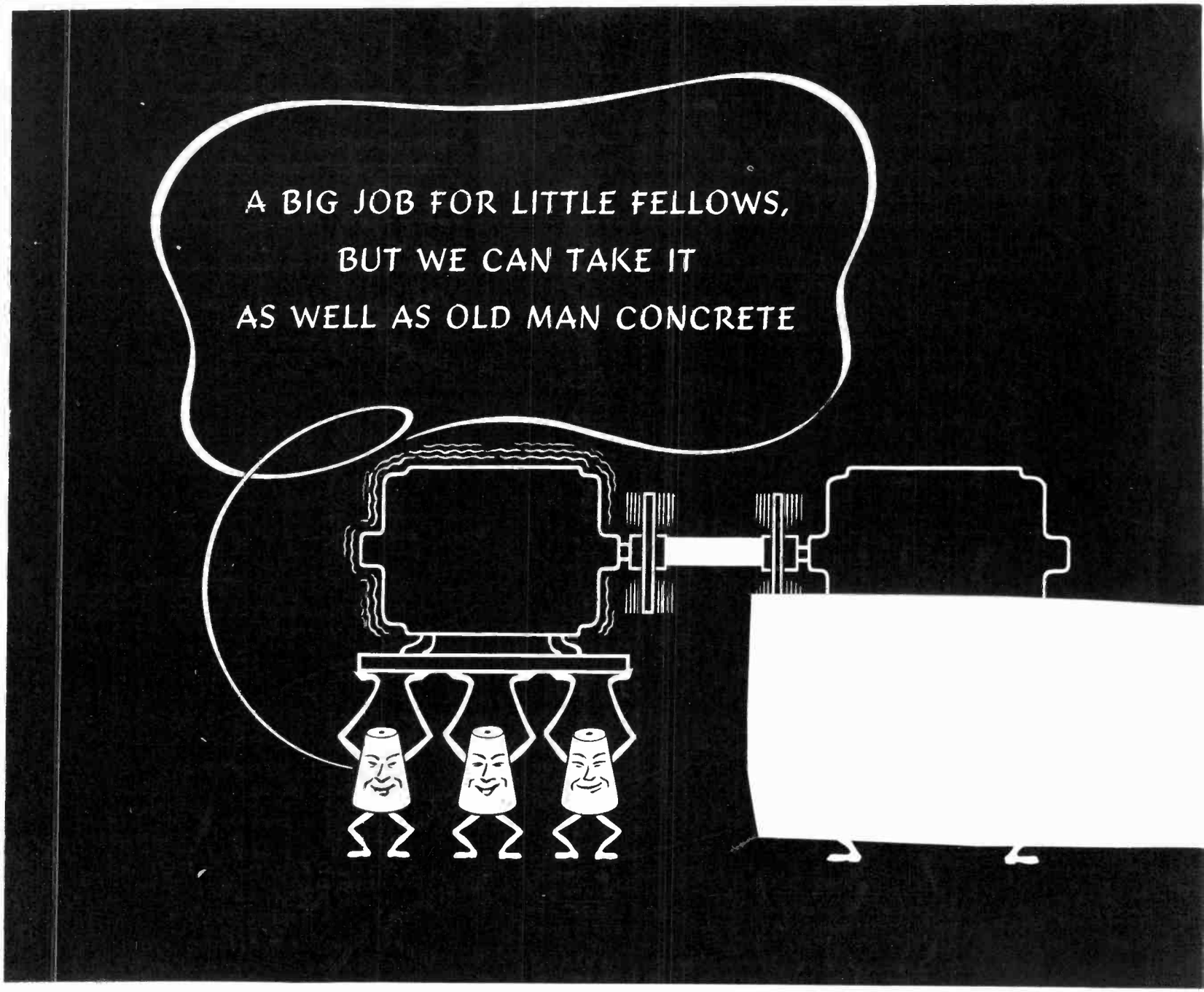
In the results referred to later, it is discovered that tuning two circuits to resonance, when the coupling is too close, may shift the frequency entirely out of the range of the usual wavemeter or receiver, as much as 4 mc or more. The ordinary broadcast band is 1-mc wide, but it is found that with proper design this change in frequency can be greatly reduced. Imagine what would take place in an ultra-short-wave simple regenerative receiver closely coupled to its aerial, if the aerial swayed, as aerials do, or imagine what takes place when a cw set is closely coupled to its aerial.

Few realize that 60 mc is really a very high frequency. Even with coils only ⅜ inch in diameter, sufficient coupling may be obtained by separating them an inch or so.

The curves in the accompanying illustration show the change in frequency that takes place when a tuned circuit is

(*Continued on page* 35)

Production



THE three Isolantite* cones — relatively small but husky—are living up to the family traditions. They are supporting the generator of a tower lighting M-G set; and it takes a big block of solid concrete to do the same job for the motor. A big job, but not too big—for high mechanical strength is a trait common to all Isolantite insulators.

Strength is very important; it permits the use of smaller insulator sections, reducing dielectric volume and losses. Low power factor also aids in minimizing losses. In all high frequency circuits in the radio and communications fields Isolantite is recognized as the standard insulation for efficient, dependable operation. Vitrified at high temperatures and resistant to moisture, it is equally suitable for indoor or outdoor applications.

Isolantite is manufactured in standard forms for many radio applications, or in other forms to meet special requirements. Isolantite engineers will cooperate in the economical design of special insulators.

**Registered Trade-name for the products of Isolantite Inc.*

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CERAMIC INSULATORS

Factory: Belleville, N. J. • Sales Office: 233 Broadway, New York, N. Y.

OVER THE TAPE . . .

NEWS OF THE COMMUNICATIONS FIELD

PHILCO APPOINTMENTS

Two new members of the Board of Directors and a new Vice-President have just been named by Philco Radio and Television Corporation. William H. Grimditch, who has been in charge of the Engineering Department, has been made Vice-President in Charge of Engineering, and a member of the Board of Directors. Thomas A. Kennally, Sales Manager of the organization, also has been chosen a member of the Board. The full Board now consists of President Larry E. Gubb; Vice-Presidents, Sayre M. Ramsdell, William H. Grimditch, and Russell L. Heberling; John Ballantyne, Treasurer; H. S. McDaniel, Secretary; C. E. Carpenter, Thomas A. Kennally.

MIKE-STAND CATALOG

Eastern Mike-Stand Co., 56 Christopher Ave., Brooklyn, N. Y., have just released two new catalog sheets covering their line of microphone stands and accessories. One measures 17″ x 22″ long and is intended for wall mounting, in the sound room. The other is a four-page catalog of standard 8½″ x 11″ size intended for the jobber's file. The larger sheet shows the various sizes of floor and table stands available and has a listing showing the various weights, base diameters, etc., so that the desired stand may be readily chosen.

UTC BULLETIN

"Broadcast Developments" is the title of a new 4-page bulletin which is available from United Transformer Corporation, 72 Spring Street, New York City. Data is given on transformer components, equalizers, remote amplifiers, and Varitran control units. To secure a copy, write to the above organization.

"ELECTROLYTIC CAPACITORS"

A new book, entitled "Electrolytic Capacitors," in which both radio and electrical men will find information on the theory, construction, characteristics and applications of electrolytic capacitors of all types, has just been published. Its author, Paul McKnight Deeley, is Chief Engineer of the Electrolytic Division, Cornell-Dubilier Corporation. "Electrolytic Capacitors" is available through the Cornell-Dubilier Electric Corporation, South Plainfield, N. J. The price: $3.00.

PIONEER LITERATURE

Pioneer Gen-E-Motor Corporation, 466 W. Superior St., Chicago, Illinois, have recently issued bulletins covering their line of "Pincor" Silver-Band dynamotors and the "Pincor" Gold Crown heavy-duty power plants. The bulletin covering the dynamotors includes a set of data sheets comprised of performance characteristics, capacities, ratings, etc. These bulletins are available from the above organization.

AMPEREX DATA SHEETS

Amperex Electronic Products, Inc., 79 Washington St., Brooklyn, N. Y., have recently released a number of data sheets. Two of the sheets discuss the uses and ratings of water-cooled tubes, while the other sheets contain complete engineering data for the following Amperex type water-cooled and air-cooled tubes: 220C, 849A, 228A, 849H, 212E and 892. These sheets are available from the above organization.

RADIOTONE PLANT

Ground has been broken for a new manufacturing plant designed for Radiotone, Inc., which will be located at 7356 Melrose Ave., Hollywood, California. In addition to manufacturing space, the building will contain general and private offices, a large display room and laboratories. Construction is expected to be completed by June 30.

WESTON POINTER

The first issue of the *Weston Pointer*, an illustrated journal featuring new developments and technical aid for the radio service man, has just been published by the Weston Electrical Instrument Corporation, Newark, N. J. The publication is to be issued at intervals throughout the year, and will be sent without charge to men actually engaged in radio service work.

KIRKLAND DATA SHEET

The H. R. Kirkland Company, 75 West Street, New York City, manufacturers of signalling apparatus, have recently issued a data sheet describing a new neon indicating lamp of interest, and lamp annunciator units. Specifications and prices are given. Copies of the data sheet may be secured from the above organization.

SHORT-WAVE MANUAL

The 1938 edition of the well-known "Hammarlund Short-Wave Manual" contains much interesting material for the short-wave experimenter. Included in its 32 pages are a number of one, two, and three-tube, a-c and battery-type short-wave receivers. short-wave converter; two-stage preselector, an ultra-high-frequency superheterodyne and complete power-supply data. There is also a three-stage crystal-controlled transmitter and a five-meter transmitter with appropriate receivers and power supplies for the ham, etc.

Copies are available from Hammarlund Mfg. Co., 424 W. 33 St., New York City. The price is 10 cents.

BULLARD RECEIVES APPOINTMENT

Clarence O. Bullard, former news reporter and Copy Chief for the 4A Andrew H. Cone Advertising Agency, in New York City, has just been appointed Continuity Chief for Station WTOL, Toledo's new 100-watter.

COMMUNICATION PRODUCTS BULLETIN

Communication Products, Inc., 245 Custer Ave., Jersey City, N. J., have issued an interesting 8-page bulletin covering their line of coaxial transmission line (for numerous powers and purposes) and impedance-matching apparatus for both transmission and reception. Complete data and specifications are given. A copy may be secured from the above organization.

CAPACITOR WALL CHART

The required capacitor for any standard type of capacity-starting motor may be readily found on the new wall chart just issued by Aerovox Corporation, 70 Washington St., Brooklyn, N. Y. Different types of motors are alphabetically listed. The required capacitor is indicated. Copies of this wall chart may be obtained on request.

NEUSCH ADVANCES AT CISE

Mr. Hubert L. Shortt, President of Transformer Corporation of America, announces the advancement of Mr. Roy Neusch to the post of General Sales Manager in charge of the Clarion Institute of Sound Engineers. Mr. Neusch has been associated with T.C.A. from its inception and has been active in the sound reinforcement field for many years.

AMPLIFIER CATALOG

A new free amplifier catalog, No. 600-C, has just been released by Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago. Six models with outputs ranging from 8 to 60 watts are shown. The catalog contains technical data with regard to each of the models, general information about the line, illustrations and prices of speaker and portable cases, etc.

NATIONAL UNION OFFICES

Sales headquarters of the National Union Radio Corporation, which have been located at 570 Lexington Avenue, New York, have been consolidated with the Research and Engineering headquarters of the company at 57 State Street, Newark, New Jersey.

The following executives of National Union will be located at the new Newark office: S. W. Muldowny, R. H. Van Dusen, J. H. Robinson, G. E. De Nike, F. M. Paret, J. J. Clune, Le Roy Schenck.

New offices have also been developed for additional National Union executives at 45 Spring Street, Newark, N. J. Among those located at this address will be: H. R. Peters, President, H. G. Butterfield, Andrew A. Priest and R. E. Booth.

National Union also conducts extensive manufacturing operations at 1181 McCarter Highway in Newark.

(Continued on page 40)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President | RCA Building, 30 Rockefeller Plaza, New York, N. Y. | H. H. PARKER, Secretary

GREETINGS

OUR CORDIAL good wishes and heartiest greetings to the members of the Institute of Radio Engineers assembling in New York for their Annual Convention, June 16, 17 and 18th, 1938. VWOA members from out of town attending this Convention are invited to contact us while in New York. We trust that the efforts of Harold P. Westman, Institute Secretary and VWOA Member, in arranging the details of the Convention will be amply rewarded by a most successful gathering. Good luck, HPW.

MEETINGS

AFTER THE JUNE MEETING there will be no further meetings until either September or October. A pleasant summer and a most enjoyable vacation for each of you is our earnest wish. During the summer we will continue to greet you through this page. We look forward to the Fall for a rebirth of VWOA activities in all the Chapters and an ever increasing interest in our affairs by all our members. It is not too soon to mention that the Fourteenth Annual Dinner Cruise of our Association will be held on Saturday evening, February 11th, 1939, in New York, and simultaneously in cities and places throughout the country and the world where Chapters already exist or will be formed before then. More of that later. Again we say, Happy Vacation.

ARRL CONVENTION

THE HUDSON DIVISION ARRL Convention will be held on Friday and Saturday, June 17 and 18, 1938, at the Hotel Astor, New York City. Contests and lectures will feature the informal part of the Convention during Friday and Saturday afternoons and Friday evening. The Banquet will be held Saturday evening, tickets for which are priced at $3.00 per person. Valuable prizes will be awarded for the various contests and numerous Door prizes will be given out Saturday evening with one Grand Prize which should prove most interesting to all. Our prexy is Chairman of the Publicity and Advertising Committee. We hope to see some of you there.

TRIBUTE

AN ARTICLE in the New York *World-Telegram* of Monday, April 11, 1938, headed "Hero, Too Busy to Get Lifebelt, Dies as 29 Are Saved at Sea." The article continues: "From the sea that is his grave today came a wireless message that is probably all the monument there will ever be to Papas Theodorou, who gave his life that twenty-nine men might live.

"He was the wireless operator on the Greek freighter *Kyllene,* which was 200 miles off the Azores, headed for Gulf ports from Amsterdam, Saturday, when an explosion tore the ship in half.

"Three men were killed in the explosion or washed overboard, and the wireless transmitter smashed. While fourteen men clung to the after part of the ship and seventeen waited for death on the sinking forward part, Theodorou rigged up an emergency wireless set.

"On that makeshift set, with the wreckage foundering under him, he tapped out calls for help hour after hour through the day. Just as dark three tankers reached the spot in answer to his wireless call.

"The forward half of the *Kyllene* was slowly turning over as the tankers' lifeboats took off all the men except Theodorou. He stuck to his emergency set until the last man had been rescued. He had been too busy to get a lifebelt for himself. So, when he jumped for a lifeboat in the dark, he was drowned.

"The after half of the *Kyllene* remained afloat through the night with the rest of the men huddled on it. A tanker's boat was smashed, so the rescue vessels hove to until daylight and then took them off. With the twenty-nine rescued men aboard, the tankers *Inverlee, Athelfoam* and *Kaia Knudsen* proceeded on their ways."

Another case where the wirelessman lived up to the highest traditions of his profession. We turn the name of heroic Papas Theodorou over to our Awards Committee and to the Monument Committee. It is fitting and proper that his name be placed in company with those other heroes of our profession on the Monument in Battery Park.

The Titanic Memorial Program being broadcast over WOR. Left to right: Lieut. D. F. de Otte, of the Coast Guard; Rev. W. P. Doty, VWOA Chaplain; Theodore D. Haubner, who sent the first SOS, and William J. McGonigle, President of the VWOA.

Wide World photo.

PERSONALS

J. R. POPPELE, Chairman of our Scholarship Committee, is touring Europe studying broadcasting in the major centers of the Continent. . . . A. J. Costigan, Director, recently returned from Cairo where for several months he was in attendance at the Telecommunications Conference. Welcome home AJC. . . . George H. Clark, our Historian, was recently interviewed by Mr. Mullen, of RCA, on the "Farm and Home" hour. He gave an interesting account of some of the more interesting phases of early day wireless communication. Incidentally, GHC was the first Expert Radio Aid in the United States Navy. . . . Glad to see A. F. Parkhurst, an early wireless man, who was Superintendent of Tropical Radio some twenty years back, at the last meeting. . . . H. A. Steinberg is leaving for Chicago to attend the Radio Trade Show there this month. . . . E. J. Girard, formerly Marine Superintendent of Mackay Radio and more recently in charge of the Washington office of Mackay Radio, is now with the Federal Telegraph Company at Newark, N. J. . . . A. F. (Steve) Wallis did a fine job of lining up details of Monu-

ment exercises on the Titantic Anniversary. . . . Bill Simon has been kept busy traveling to and from Baltimore & Philadelphia in his work as Chief Inspector of Tropical Radio in New York.

A long and interesting communication from Gilson Willets, Acting Chairman of the San Francisco Chapter, on the recent broadcast and association matters in general. Prospective members may communicate with Mr. Willets at 1434 26th Avenue, San Francisco, Calif., or with Mr. Stanley W. Fenton, Acting Secretary at Mackay Radio, in San Francisco. . . George Clark helped immeasurably with the details of the cruise and the broadcast and is doing a very efficient job as Executive Secretary of the Marconi Memorial Fund—for which, many thanks, G. H. C. . . The Reception Committee, R. H. Frey, Chairman, rates commendation for the grand job at the Thirteenth Annual. . . J. R. Poppele, Scholarship Committee Chairman, spoke briefly on the details of the Marconi Memorial Scholarship at the Cruise on the 11th of February. . . Plenty of news regarding our Association's activities in the RCA Family Circle—thanks to George Clark and Company.

Wm. O. Glessner sends in the necessary for '38. . . . Carl L. Jones, who was with the United Wireless Telegraph Company in 1910, returns to the fold. Welcome CLJ. . . . Carl O. Petersen has signed up some real old timers as Veteran members recently. Keep up the good work Carl. . . . Incidentally, "Young America—The National News Weekly for Youth," recently carried a large picture of Lieut. Carl Petersen with an item about his awards and particularly about his receiving the Marconi Memorial Medal of Valor from the VWOA.

"HELP THY NEIGHBOR"

WE QUOTE from the column of Ed Wheeler: "Hal Styles' 'Help Thy Neighbor' program, which picks jobs out of the KHJ air on Sundays at 4 PM, is still a one-station vehicle after nearly a year of broadcasting, but very few programs — even network colossals — have been accorded as many honors for outstanding accomplishment.

"The program has been cited by the National Association of Broadcasters; memorialized by the Board of Supervisors of Los Angeles County; publicly credited by Mayor Frank L. Shaw of Los Angeles City, as inspiration for his proclamation of 'Human Kindness Week,' and for Governor Merriam's nomination of January First as 'Good Neighbor' day; named as best Pacific Coast program of Human Interest by Harrison Holliway's 'Listener-Inner' selection of the Ten Best Programs of 1937; and—most recently—its originator and conductor, Hal Styles, has been invited by the national 'Happy New Year Dinner Club' to inscribe his name alongside those of a score of state governors and a number of America's most eminent personalities upon its roster of Honorary Vice-Presidents.

"According to authentic information a plan of operation has been perfected that may soon take this program to nationwide release. Its sponsorship on such a scale is being considered by several of Radio's heaviest time buyers."

We learn too, that this program, "Help Thy Neighbor," has placed 4,000 persons in jobs in one year on the air. Hal Styles is a Veteran member of our Association. Our congratulations, Hal Styles, on a splendid job of helping thy neighbor.

VIDEO AMPLIFIER DESIGN

(*Continued from page* 13)

ning-voltage amplifiers where stability and the preservation of low-frequency waveform is of great importance. There are also many applications in the field of electronic apparatus such as electrocardiograph and photoelectric-control systems where this same improved stability is helpful.

Figs. 4 and 5 show two practical circuits embodying the principles set forth above. Both circuits employ pentodes since if high frequencies are to be amplified, the reduction in dynamic input capacity obtained due to the screen-grid shielding is desirable. The circuit of Fig. 4 shows the plate-filtering and cathode-bias system described, but the screen voltage is obtained by means of a conventional series resistance and shunt condenser. While the screen current is usually low compared to the plate current and hence causes less distortion, still if optimum performance is desired, the screen voltage too may be resistance filtered as shown in the circuit of Fig. 5.

•

ANDREW PRESENTS PAPER

Dr. Victor J. Andrew, Consulting Engineer, presented a paper entitled "Directional Broadcast Antennas" before the Detroit section of the Institute of Radio Engineers at a meeting held May 20. Dr. Andrew introduced his subject with an outline of the circumstances which make necessary the use of directional antennas for broadcasting service. The use of arrays of vertical radiators to obtain directional characteristics were described. Various examples of the placement of towers and the required phasing of antenna currents to achieve specified radiation pattern were given.

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INSTRUMENT LANDING SYSTEM

(*Continued from page* 9)

only 1 foot below the glide path. Thus, not only does the accuracy of position indication increase as the aircraft approaches the landing point but also the pilot may choose his glide path by flying a given percentage above or below the glide path when landing.

The aircraft equipment includes a simple calibrating oscillator which, when energized, applies a calibrating voltage in series with the loops or across the input terminals of the amplifiers thus allowing minor adjustments of the gain of each amplifier to be made, if necessary, just prior to landing. Such a calibrating oscillator generating a known and constant signal at an *audio frequency* is entirely reliable. However a similar device generating frequencies in the neighborhood of 100 megacycles, as would be required for any radio instrument landing system, is unreliable and its space and weight requirements would be excessive.

On first consideration it might appear that the ground cables would have to be laid over such great distances as to render the system impracticable but this is not necessarily true. The present-day radio landing systems provide a localizer beam for lateral indications and a glide beam for vertical indications. It is true that the radio localizer beam provides useful lateral indications over distances of 15 to 25 miles but the radio glide beam, because of its parabolic shape, provides useful indications over distances of only 1.5 to 2 miles. Attempts to increase the useful range of the radio glide beam result in a glide path which clears the airport boundaries by only a few feet and which at its starting point is nearly vertical.

Because of the accuracy of indication of the system herein described, it is possible to locate the landing point well across the airport in the landing direction and therefore most of the length of the cables for a 2-mile glide path may be laid within the airport boundaries. If it is necessary to extend the cables beyond the airport, this may be done at small expense by obtaining easements for this purpose from the adjoining property owners.

All commercial aircraft carry beacon receivers for use in cross country navigation. It is therefore a simple and inexpensive matter to provide a low power, loop-type, beacon transmitter to guide aircraft to the entrance of the 2-mile glide path provided by the system herein described. This provision does not require the aircraft to carry additional radio equipment not otherwise carried.

Both this system and the radio systems require the airplane to fly down a constant signal contour. In the radio systems this must be accomplished by depending on the constancy of gain of a temperamental super-frequency radio receiver. In the system described herein, this is done by depending on the constancy of gain of a stable audio-frequency amplifier which is additionally provided with a stable calibrating device which is ready for instant use by pushing a test button and which is provided more to bolster the confidence of the pilot than from actual necessity.

The advantage of this system over the radio systems in dependability and accuracy under all weather conditions is obvious from the foregoing. Its initial cost is not as great as for the radio systems and its maintenance and operating costs are negligible.

The opinions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

BOOK REVIEWS

MALLORY-YAXLEY RADIO SERVICE ENCYCLOPEDIA, second edition, compiled and published by P. R. Mallory & Co., Inc., Indianapolis, Ind., 355 pages, price $3.00.

The second edition of this compedium of radio receiver and servicing data is half again as large as its predecessor, 355 pages as against 216. New, extensive sections have been added to deal with set alignment, afc, automatic tuning and audio amplifier design. Treatment is detailed; the automatic-tuning section for example devotes 26 pages to describing and diagramming a large number of tuning motors, controls and control circuits. The audio-amplifier section is extended to a discussion of loudspeaker requirements and of speaker-matching transformers.

Chapters represented in the previous edition have been greatly enlarged; thus the section devoted to listing control, condenser and vibrator replacements in receivers of standard manufacture has been increased from 99 pages to 144 and now lists 17,000 set models as against 12,000 previously shown.

None of the features which added to the popularity and usefulness of the first edition has been noticeably reduced. The numerous handy charts and useful, condensed formulas, covering every aspect of radio servicing from LC computation to decibel conversion, have been retained, and new ones added.

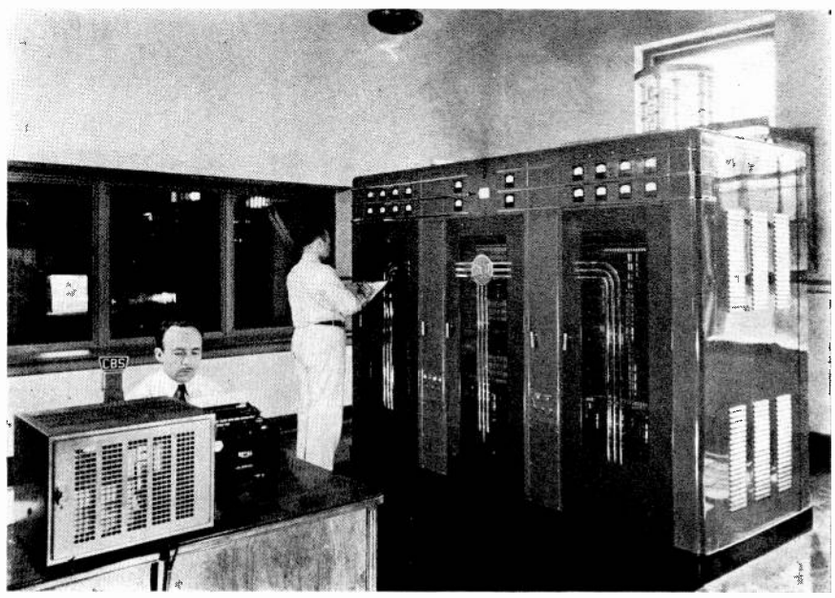
THE LOW VOLTAGE CATHODE RAY TUBE, by G. Parr, Radio Division of the Edison Swann Electric Co., published by Chapman & Hall, Ltd., London, England, distributed in U. S. by Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J., 177 pages, price $4.00.

A very complete treatment of cathode-ray tubes used in communications and

(*Continued on page* 35)

Engineers on duty at W2XE, Wayne, N. J. Note the rotary multi-contact transmission-line switching arrangement above transmitter.

Photo courtesy Columbia Broadcasting System



IRE PROGRAM

(*Continued from page* 14)

SATURDAY, JUNE 18

9:00 A.M.

Exhibition opens.

10:00 A.M.-3:00 P.M.

Trip No. 3. Women's trip to The Cloisters, followed by luncheon at Claremont Inn.

10:30 A.M.-12:30 P.M.—Ballroom

"Radiotelephone System for Harbor and Coastal Service," by C. N. Anderson, and H. M. Pruden, Bell Telephone Laboratories, Inc., New York, N. Y.

"A Vogad for Radiotelephone Circuits," by S. B. Wright, S. Doba, and A. C. Dickieson, Bell Telephone Laboratories, Inc., New York, N. Y.

"Ship Equipment for Harbor and Coastal Radiotelephone Service," by R. S. Bair, Bell Telephone Laboratories, Inc., New York, N. Y.

"Remotely Controlled Receiver for Radiotelephone System," by H. B. Fischer, Bell Telephone Laboratories, Inc., New York, N. Y.

"Coastal and Harbor Ship Radiotelephone Service from Norfolk, Virginia," by W. M. Swingle, The Chesapeake and Potomac Telephone Company, Norfolk, Va., and A. Bailey, American Telephone and Telegraph Company, New York, N. Y.

10:30 A.M.-12:30 P.M.—Parlor I

"Deviations of Short Radio Waves from the London-New York Great-Circle Path," by C. B. Feldman, Bell Telephone Laboratories, Inc., New York, N. Y. (Demonstration.)

"The Application of Maximum-Usable-Frequency Graphs to Communication Problems," by N. Smith, S. S. Kirby, and T. R. Gilliland, National Bureau of Standards, Washington, D. C.

"Factors Affecting the Selection of a Radio-Broadcasting-Transmitter Location," by W. B. Lodge, Columbia Broadcasting System, Inc., New York, N. Y.

"The Effects of Ionosphere Storms on Radio Transmission," by S. S. Kirby, N. Smith, and T. R. Gilliland, National Bureau of Standards, Washington, D. C.

"A Study of Ultra-High-Frequency Wide-Band Propagation Characteristics," by R. W. George, RCA Communications, Inc., Riverhead, L. I., N. Y.

2:00 P.M.-4:00 P.M.—Ballroom

"The DuMont Television System," by T. T. Goldsmith, Jr., Allen B. DuMont Laboratories, Inc., Passaic, N. J.

"Video Modulation Detection," by W. S. Barden, RCA License Laboratory, New York, N. Y.

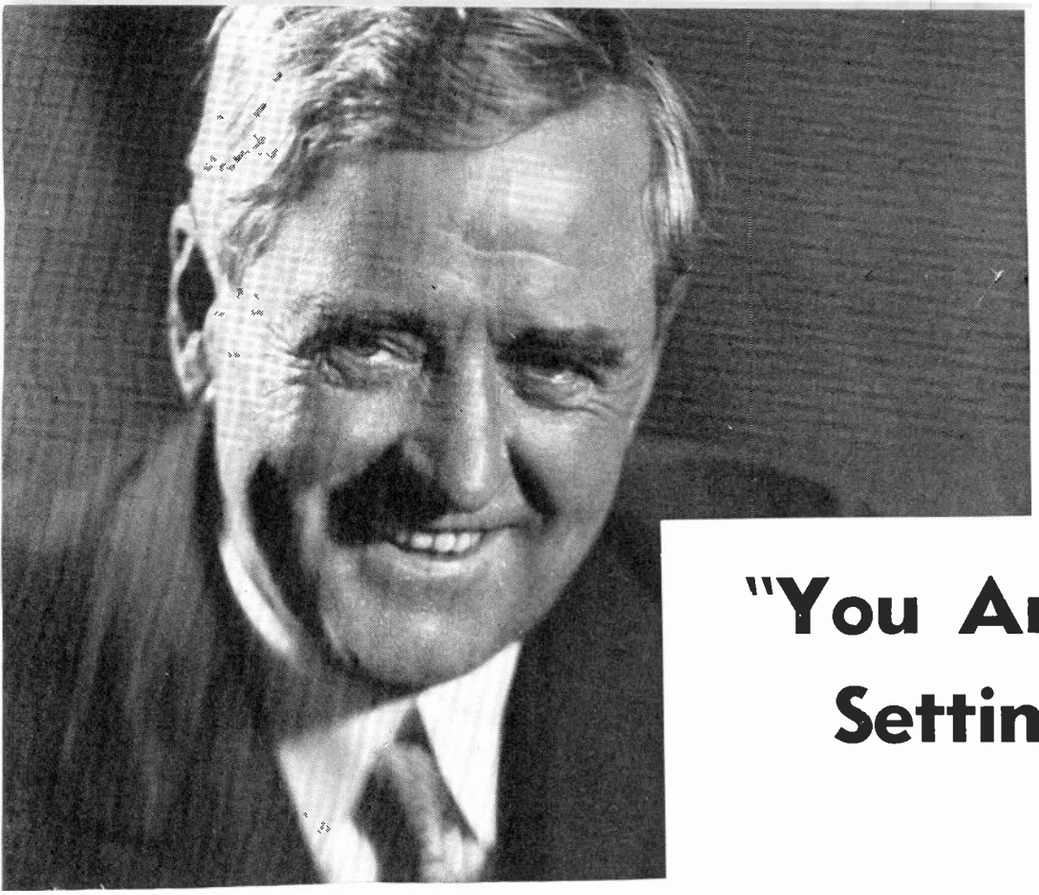
"RCA-NBC Television Mobile Units," by John Evans, C. H. Vose, RCA Manufacturing Company, Inc., Camden, N. J., and H. P. See, National Broadcasting Company, New York, N. Y.

"Wide-Band Amplifiers for Television," by H. A. Wheeler, Hazeltine Service Corporation, New York, N. Y.

"A Theoretical Analysis of Single-Side-Band Operation of Television Transmitters," by L. S. Nergaard, RCA Manufacturing Company, Inc., Harrison, N. J.

6:00 P.M.

Exhibition closes.



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Radio Engineers are conservative, not given to brash statements. But since its inception last September, COMMUNICATIONS must have had plenty on the ball! Our Editors' mail has been chock full of laudatory comments from engineers associated with all phases of the industry. COMMUNICATIONS will continue to have outstanding material, valuable to every executive and engineer. It's your magazine—one which you can't afford to miss for even one month.

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BOOK REVIEWS

(*Continued from page 32*)

allied fields is compressed in this meaty volume.

Two chapters are devoted to description and diagrams of the construction of tubes now commercially available. The mathematics of their operation is presented in concise and simple form. Defects of the different tube types, the means used for overcoming them, and the allowances that must be made for them in interpreting results are covered in considerable detail.

The third chapter explains and diagrams both the figures formed on the screen, including the more common Lissajous' figures, and their interpretation in terms of applied frequencies, phase relations and harmonics. This discussion is carried further in two chapters devoted to the various time bases now in use with commercial types of cathode-ray tubes, the images they can be made to form, and the interpretation of such images. Approximately one-half the book is thus devoted to the tube itself and its associated apparatus. The second half is concerned with its application to problems of radio engineering and communications, and to other electrical analyses. A chapter is devoted to industrial investigations, as, for example, the action inside the cylinder of an internal combustion engine, and another to the use of the tube in television.

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NOTES AND COMMENT

(*Continued from page 24*)

tuned into resonance with an oscillator circuit of average design. With the oscillator set at a definite frequency and with coupling between the external tuned circuit and the oscillator inductance constant, the frequency of the oscillator was measured for different settings of the external circuit variable condenser.

The measurements were repeated for four different values of coupling as shown. When close coupling is employed, the frequency of the oscillator changes about 4 mc when the load circuit is tuned through the resonance point. As the coupling is loosened, the detuning becomes less. When the coupling between the ⅜-inch coils is an inch or more the frequency change is reduced to a fraction of a mc—which is good, comparatively.

In the design of receivers and transmitters, careful selection of the proper value of coupling is quite important. A minimum of coupling should be used wherever possible.

A. BINNEWEG, JR.

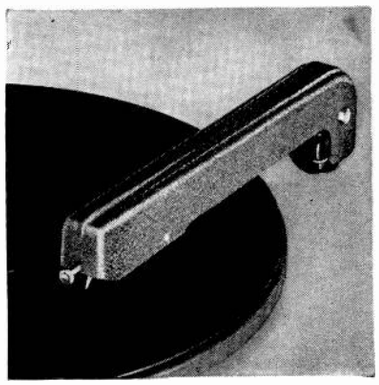
THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATIONS FIELD

CRYSTAL PICKUP

A new "Economy" crystal phonograph pickup for 10- and 12-inch records has just been announced. The new pickup has been designed for small overall dimensions, consistent with good performance, to permit installation on small motorboards, a feature which will appeal to manufacturers of record players, and to those modernizing obsolete phonographs and radio combinations. The rubber-isolated pivot-bearing assembly is designed for single-hole mounting and requires only the tightening of a single nut to mount the unit. The crystal cartridge contains a high-quality moisture-proofed grafoil bimorph crystal. Tracking-error is reduced through the built-in Shure "needle-tilt" principle. Full range frequency response is attained with an output voltage of approximately 2.5 at 1,000 cycles.

The new pickup is known as Model 94A. It is a product of *Shure Brothers*, 225 W. Huron Street, Chicago, Illinois.—COMMUNICATIONS.



Shure pickup.

RAYTHEON TUBES

Raytheon has announced four new receiving type tubes as follows:

OA4G: A gas-filled cold-cathode triode, designed for use in circuits for the remote-control of a-c line-operated devices. General application is anticipated in radio receivers designed for remote-control and push-button tuning.

4A6G: A twin-triode power amplifier designed for Class B use in 90-volt battery receivers. The filament is in two 2-volt sections which may be operated either in series or parallel; the series connection requiring a 4-volt supply. An output of 1 watt is secured with 90 volts on the plate.

6P5G: An octal-based triode which has the same characteristics as the type 76 and which may be used for the same general purposes.

6S7: A low drain r-f pentode in a metal bulb. Has the same characteristics as the 6S7G which was one of the first in the low-drain group, designed for 6-volt battery and auto receivers.

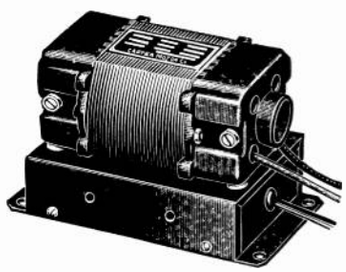
These tubes were announced by *Raytheon Production Corp.*, 55 Chapel St., Newton, Mass.—COMMUNICATIONS.

CO-X COAXIAL CABLE

Co-X is a flexible, low-loss coaxial cable designed for the transmission of a wide band of frequencies and is for use in connection with photoelectric cells, cathode-ray tubes, automobile and home antenna lead-ins, transmitting antenna feeders, television circuits, aircraft radio and high-precision instruments. The cable comprises a central conductor surrounded by insulators on which a cylindrical conductor or shield is woven. This is in turn covered by an insulating braid.

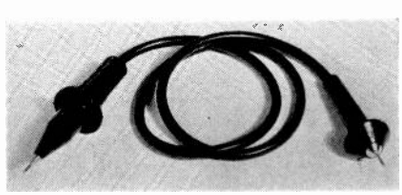
Complete information is available from the *Transducer Corporation*, 30 Rockefeller Plaza, New York City.—COMMUNICATIONS.

Carter genemotor.



Ballantine electronic voltmeter.

Transducer coaxial cable.



GENEMOTOR

A new high power genemotor of small size has been developed for aircraft radios, two-way ultra-high-frequency police radios, hi-gain amplifiers, marine radios, etc. It will deliver up to 500 volts at 200 mils, and the size of the unit less filter is 7" x 4" x 2⅞" high, and the weight, 10 pounds. It can be made for any input.

The use of double enamel and silk insulated wire on all windings is said to eliminate shorted or grounded armatures. Mica insulation extends above the copper bars of the commutator at all points except where the brushes ride.

Complete information may be secured from *Carter Motor Company*, 1608 Milwaukee Ave., Chicago, Illinois.—COMMUNICATIONS.

AUDIODISCS

Audio Devices have announced their Audiodiscs, a recording disc which is said to feature lower surface noise, to be non-abrasive, to be non-deteriorating, and of uniform quality. These discs are available in all regular sizes. Further information may be secured from *Audio Devices, Inc.*, 1600 Broadway, New York City.—COMMUNICATIONS.

STROBOSCOPE

A large-size cardboard Stroboscope in a 13½ inch dimension is now being produced. This precision aid is used by recording studios and research laboratories to calibrate frequencies. The new and large-size Stroboscope was placed on the market by *Universal Microphone Co.*, Inglewood, Cal.—COMMUNICATIONS.

ELECTRONIC VOLTMETER

A new sensitive electronic a-c voltmeter, Model 300, having several novel features, has recently been made available. Said to be one hundred times more sensitive than the conventional type of vacuum-tube voltmeter it is capable of reading down to 1 millivolt and covers the entire range of voltage up to 100 volts in five decade steps. The frequency range of 10 to 100,000 cycles covers the audio, supersonic and carrier-current frequencies. The accuracy is about 2%, which is said to be unaffected by fluctuations in line voltage, variation in tube characteristics, circuit constants and temperature.

One of the most important features is the logarithmic scale, calibrated from 1 to 10, which permits switching in decade steps with but one scale to read. This type of scale also provides uniform percentage accuracy of reading over the entire range. An auxiliary uniform scale in decibels is also provided.

The instrument is compact (4½" x 5¾" x 11") and weighs only 9½ lbs. A descriptive bulletin (Bulletin 2C) giving full technical information is available on request. Write to *Ballantine Laboratories, Inc.*, Boonton, N. J.—COMMUNICATIONS.

(*Continued on page* 42)

BEAMASCOPE

"BEAMASCOPE" is the name given by General Electric to a device designed to replace the conventional radio receiver antenna. This new antenna will be incorporated in the receiving sets now being built by G-E.

The beamascope is said to have the following advantages: it represents a better antenna because it has been correlated with the design of the receiver in which it is installed; it is concealed inside the radio cabinet with no outside connections; and the radio can be moved to new locations without the rearrangement of any antenna and ground leads. It is also said to discriminate against undesirable noise interference, ordinarily carried to a receiver by the electrostatic portion of the radio signal. The beamascope receives only the electromagnetic portion of the signal, and is

P. F. Hadlock demonstrating a jumbo model of the G-E Beamascope. The rejector shield has been torn back to show windings.

fully shielded against the electrostatic portion.

The new device consists of a self-contained acceptor circuit completely enclosed by a rejector winding, or shield. The winding form is made of a special type of wood, impregnated to prevent warping and a loosening of the acceptor winding. The shield or rejector winding, consists of many fine wires surrounding the acceptor circuit and connected to the receiver chassis. Termed the "rejector" circuit, the shield is of the Faraday type, shielding the coil electrostatically but not electromagnetically. When a receiver is first installed in a home, the beamascope is rotated and left in the position of minimum noise pickup. The adjustment is made preferably with the antenna tuned to a weak signal.

OVER THE TAPE

(*Continued from page 26*)

GENERAL ELECTRIC BULLETINS

General Electric Company, Schenectady, N. Y., have recently issued a number of bulletins of interest. Bulletin GEA-2426A deals with the Type FLO-1 outdoor oil-blast circuit breakers, while GEA-2003B covers the automatic oil circuit recloser. The third bulletin, GEA-2170A, describes the Type GCX three-phase directional distance relays. All are available from the above organization.

INFORMATION BUREAU

Initial plans have been completed for the establishment of a huge technical and commercial information bureau where executives, engineers, designers, production managers, writers and others may procure without cost technical data and literature on materials, products and processes, as well as technical consultation service. The bureau will be located in International Building, New York City, and is being sponsored by Designers for Industry, Inc., through its Chicago, Cleveland and New York offices. An initial ten-thousand drawer filing system is contemplated from which trade literature will be distributed to persons interested.

RADIO TUBE MANUAL

National Union Radio Corp., 57 State St., Newark, N. J., have recently issued a quick-reference radio tube manual in which tubes are grouped by function rather than by a numerical or alphabetical sequence. Within the sections, however, types are listed in numerical-alphabetical order. A further aid to quick use lies in the manner in which the application notes are given; at the beginning of each functional section is presented a generalized discussion to use of tubes in that particular section. The manual has been divided into 9 sections as follows: rectifiers, triode voltage amplifiers, pentode voltage amplifiers, power amplifiers, frequency converters, duplex tubes, tuning indicators, design considerations, and classification tables. The manual is available from the above organization at $1.00 per copy.

K & E GRAPH SHEETS

A new booklet-catalog on graph sheets and co-ordinate papers has recently been announced. This booklet contains a great deal of information and illustrates the use of typical graph forms. Copies may be obtained from Keuffel & Esser Company, Adams and Third Streets, Hoboken, N. J.

WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of COMMUNICATIONS at 19 E. Forty-seventh St., New York City, giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

"TWO-CHANNEL" PICKUP

A NEW TYPE of phonograph pickup has recently come out of the Audak laboratories.

The operating principle of the new unit will be best understood from the accompanying diagram. The shaft A carries a small inductor element I_1, which has secured to it the needle N. A second shaft B carries a larger inductor I_2 and is coupled to the shaft A through a special low-pass filter F. The inductor I_2 is surrounded by the coil C. In operation, the inductor I_1 vibrates continuously with the needle and it alone is said to have a substantially flat response from 40 to above 8000 cycles. However, the filter F, made of a semi-

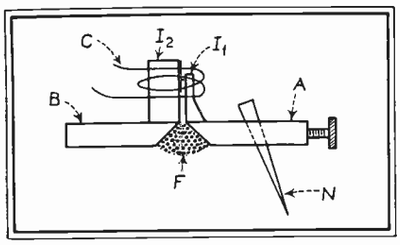
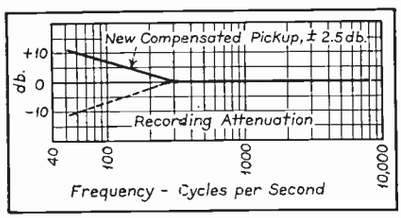


Diagram showing the essential elements in the new type Microdyne pickup.

crystallized substance, has characteristics such that vibrations above 500 cycles are effectively prevented from reaching the shaft B. Below 500 cycles this filter permits the vibrations to agitate the shaft B—such agitation gradually increasing as the frequency becomes lower. The inductors are so proportioned (see diagram) that one delivers a much higher output than the other. The result is a gradually rising curve



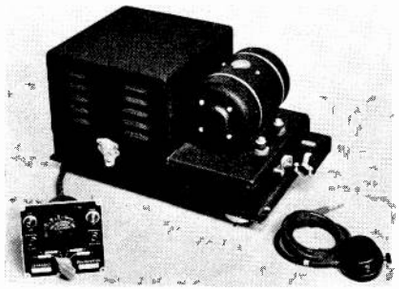
Curves showing the compensation provided in the pickup to offset recording attenuation.

at the lower frequencies (see accompanying curves).

Mechanically, the new pickup has several features in design. An off-set head is used for the reduction of tracking errors. Needle loading is said to have been simplified to the extent that swivel joints and other means of getting the needle chuck in sight have been eliminated. A minimum needle pressure of from 26 to 35 grams is necessary for correct and full tracking.

THE MARKET PLACE

(*Continued from page 36*)



AIRCRAFT TRANSMITTER

Out of the laboratories of Learadio comes this new light-weight, remote-controlled aircraft transmitter. With this unit it is possible to remotely select any one of six frequencies. The total overall size of the unit is 14" long x 8¼" wide x 8½" high, and the weight of the unit completely installed is 27 lbs., including the dynamotor, cables, microphone and remote control unit with output meter indicator.

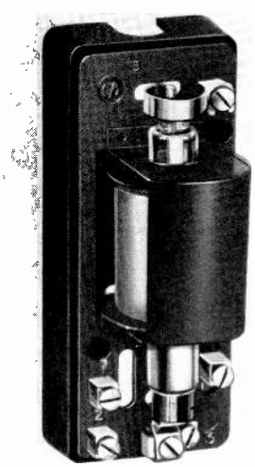
This new UT-6 unit incorporates the Learadio design feature which permits the complete tuning up of the transmitter at the factory. No further adjustments are necessary upon installation. The installation actually consists of mechanically attaching the transmitter and remote-control panel to the airplane and connecting the leads to the storage battery and the hand reel. The only tuning operation necessary is for the pilot to select any one of the six frequencies desired and then reel out the antenna until the meter on the remote-control unit reads maximum current.

The normal power output of this transmitter ranges between 20 and 30 watts, according to battery voltage and plate loading. However, the UT-6B is also available and this model provides a power output of from 25 to 40 watts, according to battery voltage and plate loading. The only difference between the UT-6 and the UT-6B is in the voltage output of the dynamotor. There is only a half pound difference in weight.

Circulars on this unit may be obtained from *Lear Developments, Inc.*, Building No. 31, Roosevelt Field, Mineola, Long Island, N. Y.—COMMUNICATIONS.

VERTEX MERCURY RELAYS

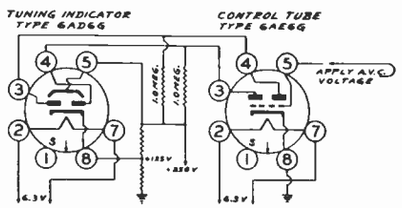
The Vertex relay consists of a vertical tube surrounded by a solenoid. The tube contains a cylindrical plunger which floats on a mercury bath. When the solenoid is energized, this plunger is drawn downward magnetically, thereby displacing the mercury which rises and makes contact with the upper electrode. The mercury tube thus remains entirely stationary and the mechanical motion takes place completely within the hermetically sealed tube. Vertex relays have no loose wires and all moving parts are sealed in glass.



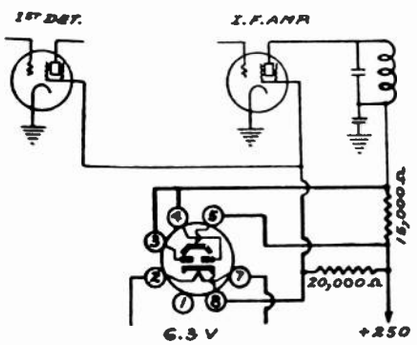
Literature on these units may be obtained by writing to *Dr. F. Lowenberg*, 10 East 40th St., New York City.—COMMUNICATIONS.

NATIONAL UNION 6AD6G, 6AE6G

National Union has developed a novel cathode-ray tuning indicator tube which is being introduced to the trade as type number 6AD6G. This tube embodies several new features. It is comprised of a circular



Two applications for the 6AE6G and 6AD6G

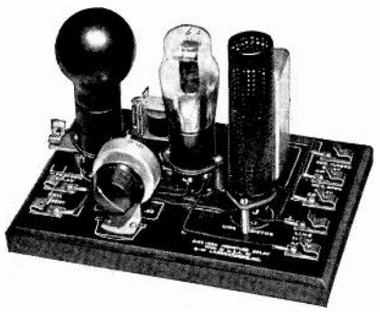


target, two ray-control electrodes, and a cathode, indirectly heated by a 6.3-volt, 150-milliampere filament. Structurally, the tube is much smaller—approximately one-half the length of previous tubes—and has a metal shell type of base, thus facilitating its use in a clamp behind the dial of a radio-receiving set. Two identical ray-control electrodes are employed with connections to each brought out to separate pins on the base. These control electrodes each produce a shadow pattern on the circular target, and consequently, several varieties of shadow movement are available.

In operation, a special control tube, actuated from the avc voltage of the receiver, and this special control tube in turn controlling the 6AD6G, provides for dual-range indication with shift from one range to the other automatically accomplished.

The special control tube referred to above is identified as type number 6AE6G. The 6AE6G is a tube having a single cathode indirectly heated by a 6.3-volt, 150-milliampere filament.

These tubes were announced by *National Union Radio Corporation*, 57 State Street, Newark, N. J.—COMMUNICATIONS.



PHOTOTUBE RELAY

Suitable for experimental or research work, for educational problems or lecture demonstrations, this new model photo-tube (photoelectric) relay unit, shown in accompanying illustration, is inexpensive yet contains all the parts necessary to a complete relay installation.

This phototube relay, known as Type 1224A, comprises a phototube, thermionic amplifier, resistor, potentiometer, condenser, and a small electromagnetic relay. The wiring diagram is printed on the base.

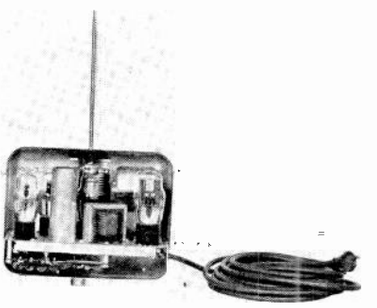
Literature is available from *G-M Laboratories*, 1731 Belmont Ave., Chicago, Illinois.—COMMUNICATIONS.

HIGH-VOLTAGE OIL CONDENSERS

Distinguishing between heavy-duty and normal-service applications, Hyvol transmitting condensers in both oil-filled and wax-filled types have been made available. These compact, rectangular, high-voltage paper condensers are provided with adjustable mounting bracket, for upright or inverted mounting, protruding any height above or below chassis platform. The selected paper sections are impregnated with "super-dielectric" Hyvol oil and placed in welded-steel cans provided with high-tension pillar terminals. In the oil-filled type, the section is surrounded by an oil bath. In the wax-filled type, the section is sealed in a protective coating of high-melting-point wax.

Otherwise the two types are identical. The oil-filled 609 series units are available in 1, 2 and 4 mfd, 600 to 3,000 volts d-c working. The wax-filled units, 1011 series, come in 1, 2 and 4 mfd, 1,000 to 3,000 volts.

These condensers are products of the *Aerovox Corporation*, 70 Washington St., Brooklyn, N. Y.—COMMUNICATIONS.



POLICE FREQUENCY MONITOR

To enable police radio operators to check station frequency periodically or continuously General Electric has developed a new frequency monitor. This monitor operates from 110-volt, 60-cycle, single-phase power, and is installed merely by plugging into a convenient outlet. The equipment is entirely self-contained and requires no tuning or adjusting. Use of headphones prevents audio feedback from entering the station microphone.

The monitor comprises a crystal oscillator stage, detector or mixer stage, which also serves as the first audio-frequency amplifier, a second audio stage, and a plate rectifier. The crystal is mounted in a plug-in type crystal cell. The crystal-cell unit determines the frequency of the monitor. Ordinarily the monitor is supplied with one crystal cell adjusted for a given frequency. Additional crystal units can be obtained for the several ultra-high-frequency and medium-high-frequency police-frequency assignments.

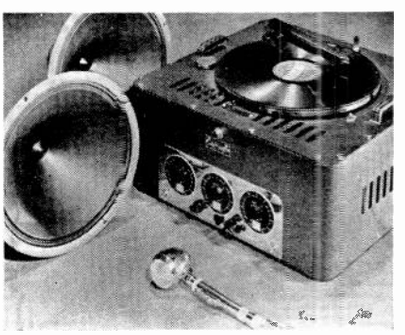
The monitor has a frequency range of 1500 to 3000 kilocycles and 30 to 42 megacycles, a frequency stability of plus or minus .02 percent, and an audio output of 600 milliwatts available.

Additional information is available from the *General Electric Company,* Schenectady, N. Y.—COMMUNICATIONS.

MOBILE P-A SYSTEM

The new Bell combination mobile p-a system, Model M-24, is shown in the accompanying illustration. It can be used in a car on 6 volts d-c, or on 110 volts a-c. Conversion is accomplished when the proper connecting cables, supplied with the system, are used. Permanent-magnet dynamic speakers are used. Separate power switches are provided to control the turntable motor, amplifier B supply and amplifier filaments. This unit also has 3 input channels, allowing for electronically mixing two microphones and a phono unit.

Further information is available from *Bell Sound Systems, Inc.,* 61 E. Goodale Street, Columbus, Ohio.—COMMUNICATIONS.



A & B ELIMINATOR

The unit shown in the accompanying illustration is an A and B battery eliminator designed for radio receiver or laboratory use. It operates from 60-cycle, 100 to 125-volt power source. The A supply has two-stage filter and potentiometer control with a voltmeter. The range is from 0 to 5 volts maximum rating 2 volts, 1 ampere. The B supply is said to be amply filtered and has 5 voltage taps; namely, 45, 67, 90, 135, and 180 at 50 ma.

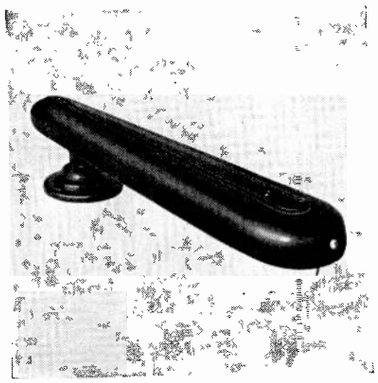
Further information is available from the manufacturer, *Electro Products Laboratories,* 166 East Erie St., Chicago, Illinois.—COMMUNICATIONS.

Electro Products eliminator.

UNI-DIRECTIONAL MICROPHONE

A new American uni-directional dynamic microphone has recently been made available. The energy response pattern is a cardioid, which gives a wide pickup angle from the front with an apparent dead rear field. The frequency response is said to be adequate for any sound application. It is built with customary output impedances: 50, 200 and 500 ohms, and high-impedance 10,000 ohms.

Further information may be secured from *American Microphone Co., Inc.,* 1915 South Western Ave., Los Angeles, Calif.—COMMUNICATIONS.



Unit Reproducers pickup.

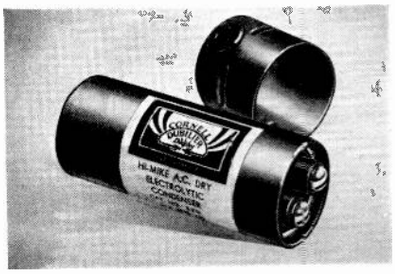
PLATE AND FILAMENT TRANSFORMERS

A complete new line of plate and filament transformers for the electronic field has been made available. These transformers embody high efficiency, low regulation, and heavy duty designs incorporating low temperature rise, it is stated.

Stock transformers are available up to 200 va and the line is comprised of three separate groups: a series of plate-filament transformers for use in conjunction with all the latest tubes; a group of filament transformers; and a group of filter reactors. This last group is unique in that each reactor is double-wound so that it may be connected in series or parallel thus obtaining either of two different values of inductance and current in the same unit.

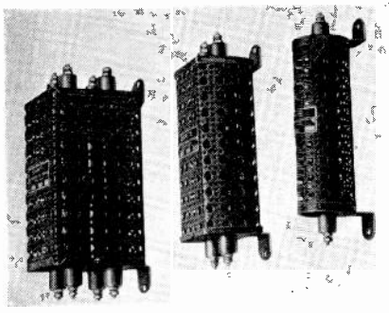
Further information may be secured from *Ferranti Electric, Inc.,* 30 Rockefeller Plaza, New York City.—COMMUNICATIONS.

Cornell-Dubilier capacitor.



Ferranti transformer.

Ohmite resistors.



CONVEYOR BELT

A belt of special cover design and character for conveying various types of packaged material on a greater degree of incline than is normally encountered in regular conveyor work has been designed and placed on the market. This belt, developed after study to determine the type of surface providing the greatest degree of efficiency for all incline service requirements, has a crepe surface of good holding qualities, it is reported. The tan compound is said to be tough and resilient, as well as attractive in appearance. While it provides the necessary roughness, its design is such that it is easily cleaned. U. S. crepe finish package conveyor belt it furnished on 28 oz and 32 oz duck with the special crepe finish cover on the carrying side. Minimum top cover thickness is 1/16 inch. This may be increased as required. Additional back cover thickness will be also furnished as ordered.

This new conveyor belt is a product of *U. S. Rubber Products, Inc.,* 1790 Broadway, New York City.—COMMUNICATIONS.

PEE WEE TRANSMITTER

A low-power transmitter, supplied in kit form has been announced. It is called Pee Wee. The kit contains all of the parts required for building the unit—tubes, crystal, coil form—even the hook-up wire and solder. Both the power and the r-f portion are mounted on a single battleship gray chassis.

For further information write to *General Transformer Corporation,* 1292 W. Van Buren St., Chicago, Illinois.—COMMUNICATIONS.

MAGNETIC PICKUP

The new Unit magnetic type flat arm pickup, shown in the accompanying illustration, features a tilted needle for less wear and proper tracking of the unit. Characteristics of the pickup are as follows: impedance—10,000 ohms at 1,000 cycles, or 200 and 500 ohms; voltage output—1.5 volts at 1,000 cycles with 10,000-ohm coil; frequency response—60 to 5,500 cycles. The weight is approximately 3½ ounces.

Further information may be obtained from the manufacturer, *Unit Reproducers Mfg. Co.,* 999 E. Main St., Rochester, N. Y.—COMMUNICATIONS.

ELECTROLYTIC CAPACITORS

Designed for motor-starting and other a-c applications, the Cornell-Dubilier type ETN dry electrolytic capacitors are hermetically sealed in small aluminum cans and are externally insulated with an impregnated fibre sleeve or container. The low power-factor characteristics of these capacitors and their construction is said to assure freedom from internal corrosion.

These capacitors have been designed for operation involving a maximum of 20 starts per hour, each start of 3 seconds duration. They are specially suited for use with fractional horsepower motors.

Information on these and similar capacitors may be obtained by addressing inquiries to the *Cornell-Dubilier Electric Corporation,* South Plainfield, New Jersey.—COMMUNICATIONS.

VENTILATED RESISTORS

A new standardized series of ventilated cage type resistors are shown in accompanying illustration. There are three sizes, for one, two, or four resistors.

These cage resistors are suited for use where it is desired to prevent accidental contact with the resistor. They can be mounted on switchboards and test panels, etc., in control, protective, or line-voltage dropping circuits, where wattages up to several hundred watts are to be dissipated.

The cages consist of sturdy sheet metal ends with perforated metal sides finished with black wrinkle japan. Mounting is by means of two holes in the supporting brackets. The terminals of the resistors are brought out at the ends by "feed-through" type porcelain insulators. This makes interconnection simple to wire the resistors in series or parallel when desired.

The illustration shows cages for one, two or four resistors 1 inch in diameter by 6⅝" long. Overall dimensions are 2⅞", 2-29/32", and 4¼" respectively, by 9-9/16" long; mounting centers are 8⅜".

Cage resistors of different sizes and types are also available from the maker, the *Ohmite Manufacturing Company,* 4835 W. Flournoy Street, Chicago, Illinois.—COMMUNICATIONS.

RADIOTONE RECORDERS

Radiotone recorders are now being made in six standard models, covering nearly every demand in home and professional acetate recording.

Two home models are sold only through retail music dealers, on a strict protected policy. These are the Radiotone HR-12 portable and Radiotone HR-50 console models, both of which are 78 rpm, 12" models, complete with specially-designed built-in amplifiers, high-grade crystal playback arms, and loudspeakers.

Two portable professional recorders are available, using separate amplifiers. The Radiotone PR-12 is a 78 rpm, 12" portable of very rigid construction and light weight. The PR-16 is a dual-speed, 16" turntable portable with several interesting features. Any number of lines-per-inch from 90 to 125 can be cut by moving a lever. Inside-out or outside-in recording is secured by throwing a cam, while turntable speed changes are secured instantaneously by the movement of a lever. A line-spreader for start-and-stop marks, or for difficult passages in recording, is standard equipment, as is a microscope of new design.

A studio model, the Radiotone PR-20 (shown), has all of the PR-16 features, and in addition is mounted in a very heavy, cast-iron base, with four adjustable leveling screws, and is equipped with a metal dust-cover, panel light, and other refinements. Either of these models can be furnished with a VI meter and attenuator mounted on the panel, for use in radio stations where power is taken from a remote amplifier, thus permitting the operator to regulate the degree of power closely, while the program is being monitored as usual.

The PR-50 is a console model similar to the PR-16 and PR-20 in most details, and completed with a built-in amplifier especially designed for best results with Radiotone cutting heads. Matched walnut is standard for the console, but woods of other characteristics can be furnished, and a black-and-chromium console is also optional.

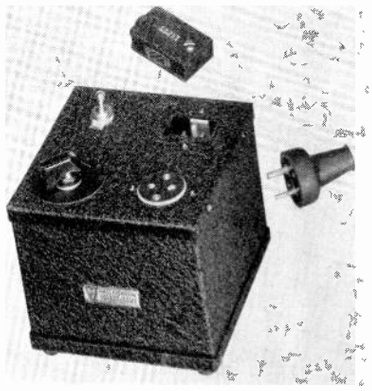
All Radiotone recorders are standard with the Radiotone VA-2 high-impedance cutting head, operating at 500 ohms impedance. Its frequency characteristics are good from 40 to 6,000 cycles, with the periods of greatest efficiency from 2,300 to 3,500 cycles. For more critical work a new cutting head has been developed—the VA-3. This 500-ohm impedance cutting head gives good results at frequencies ranging from 30 to 8,000 cycles, with little variation in efficiency at any point, and no perceptible peaks, it is said.

Further data is available from *Radiotone, Inc.*, 6105 Melrose Ave., Hollywood, Calif. —COMMUNICATIONS.

ALLIED RELAYS

A new line of relays for use in aircraft and mobile transmitters and receivers has recently been placed on the market. The size of these relays is said to give a large current-carrying capacity with a basic rating of 1,000 watts a-c. The contactor section (see accompanying diagram) is a specially designed high-speed solenoid plunger of high efficiency. The coupling is of such design as to give a linear action. The advantages claimed for this system are: freedom from the effects of external vibration, and high-speed operation.

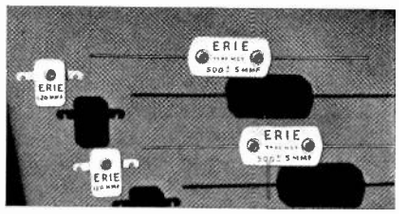
Literature on these relays is available from *Allied Control Co., Inc.*, 95 Liberty Street, New York City.—COMMUNICATIONS.

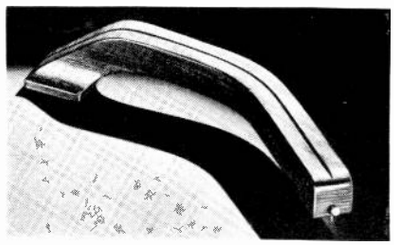


Halldorson transformer.

Radiotone PR-20 recorder.

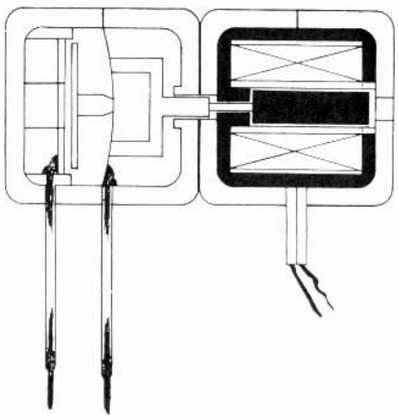
Erie condensers.





Webster pickup.

Diagram of Allied relay.



TRANSFORMER

Halldorson engineers have announced a device for use in changing the impedance from a 250 or 500-ohm line to match impedance of any number of 500-ohm speaker transformer primaries up to six. Two multi-speaker transformers will take care of 12 speakers.

Full information available from *The Halldorson Company,* 4500 Ravenswood Avenue, Chicago.—COMMUNICATIONS.

ERIE CONDENSERS

Two new Erie condensers of the silver-mica type, with stable characteristics, have been announced. The Type F, which measured approximately 1⅜" x ⅝" x 7/32" thick has a positive temperature coefficient of capacity of approximately .000025 mmfd/mmfd/°C. They are said to have practically no change in capacity with time and have a power factor of about .04%. Type F condensers can now be supplied in production quantities in ranges from 15 mmfd to 2,500 mmfd. They are impregnated and sealed with high-grade waxes in a low-loss ceramic case that provides protection against humidity.

The Type A silver-mica condenser is similar in construction to the Type F, but much smaller in size. It has a positive temperature coefficient of approximately .00005 mmfd/mmfd/°C. As it measures ¾" x ½" x 11/64" thick, the Type A is suitable for mounting in close spaces such as the inside of i-f shield cans. This midget condenser is now available in production quantities in ranges from 40 mmfd to 120 mmfd.

Samples of both Type F and Type A condensers can be obtained by writing *Erie Resistor Corporation,* Erie, Pa.—COMMUNICATIONS.

DRAKE HEAT CONTROL

Said to increase the life of the soldering iron, keep the tip properly tinned, and to keep the iron warm at a low cost, the Drake No. 300 heat control is announced by *Drake Electric Works, Inc.*, 3654-56 Lincoln Avenue, Chicago.—COMMUNICATIONS.

CRYSTAL PICKUPS

The new X-76 series pickups are said to incorporate advancement in principle and construction of the crystal cartridge in particular.

The crystal element, of rectangular shape, torque type, is moisture-proofed. In addition, it is housed and completely sealed in a molded flexible rubber housing. A metal outer shell serves as an electromagnetic or electrostatic shield, as well.

This construction offers protection against the damaging effects of moisture or humidity, and at the same time offers increased protection against accidental breakage of the element.

Further advantages claimed—the crystal element is of high capacity and low reactance; has low needle point impedance and improved tone; leads are brought directly out of the cartridge, eliminating necessity of soldering; good damping quality of the rubber housing eliminates internal resonance.

This new crystal cartridge is offered in a solid walnut hand-rubbed tone arm. This tone arm is designed to reduce tracking errors down to 3 to 4%. Full lift facilitates needle insertion.

Licensed under patents of Brush Development Laboratories, Cleveland, Ohio, these pickups are products of the *Webster Electric Co.*, Racine, Wisc.—COMMUNICATIONS.

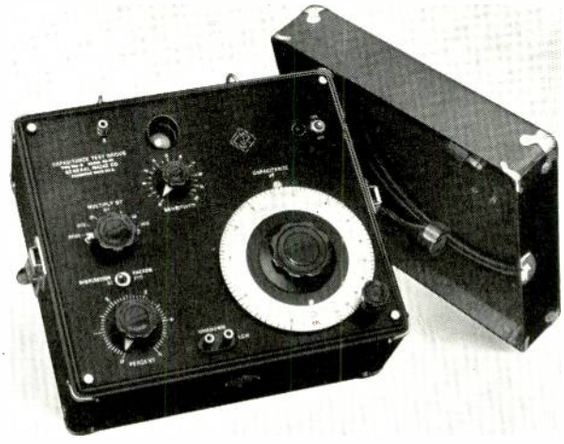
CORRECTION

THE G-R D-C AMPLIFIER ADVERTISED ON THE THIRD COVER SHOULD READ MODEL 715-A INSTEAD OF 751-A. Unfortunately, the covers were printed incorrectly before the rest of the magazine went to press—the publisher is attempting to rectify the error herein.

Advertising Index

DROP AROUND TO THE G-R BOOTH AT THE I.R.E. EXHIBITION

MANY NEW INSTRUMENTS ON DISPLAY



Type 740-B Capacitance Test Bridge

TYPE 700-A BEAT-FREQUENCY OSCILLATOR

A general-purpose, wide-range beat-frequency oscillator with moderate power output covering an extremely wide frequency range. Frequency range: 20 cycles to 50 kc and 10 kc to 5 Mc; output voltage 10 to 15 volts; harmonic content less than 2% throughout larger part of range; hum level less than 2%; differential temperature effects in oscillator compartment eliminated; a.v.c. circuit maintains constant output voltage over line voltage fluctuations between 105 and 125 volts.

TYPE 740-B CAPACITANCE TEST BRIDGE

A 60-cycle bridge for capacitance and power factor measurements on paper, electrolytic and mica condensers, and for specific inductive capacitance, direct and mutual capacitance and capacitance between conductors in cable and wire manufacturing. Also for measurement of winding capacitances and capacitances between windings and case in transformer testing. Direct reading in capacitance from 5 micromicrofarads to 1100 microfarads with an accuracy of ±1% over most of the range. Dissipation factor ranges are 0 to 5% (±0.075%) and 0 to 50% (±0.75%).

TYPE 736-A WAVE ANALYZER

This new wave analyzer offers a number of improvements over its popular predecessor. Frequency range: 20 to 16,000 cycles; selectivity is constant over this range and is approximately 5 cycles flat top band width. Response is down 15 db at 4 cycles, 30 db at 10 cycles, 60 db at 30 cycles from the peak. Voltage range: 300 microvolts to 300 volts full scale with an accuracy of within 5% on all ranges. Input impedance 1 megohm for direct voltage measurements and 100,000 ohms when input potentiometer is used.

A PREVIEW OF SEVERAL G-R INSTRUMENTS WHICH WILL BE AVAILABLE THIS FALL

TYPE 760-A SOUND ANALYZER

An accurate and portable analyzer for measuring the relative amplitudes of the component frequencies in a sound wave. Consists of a degenerative selective amplifier with constant percentage band width, and a vacuum-tube voltmeter having approximately logarithmic characteristics. Very valuable as a bridge balancing indicator since it may be tuned to the bridge frequency, eliminating harmonic errors. Frequency range: direct reading in cycles from 20 to 6,000. Input voltage range from 1 millivolt to 10 volts. Band width: selectivity is such that the relative attenuation is 3 db at 4% off the peak to which the analyzer is tuned.

TYPE 751-A DIRECT-CURRENT AMPLIFIER

This a-c operated d-c amplifier is designed for use with a 5-milliampere recorder such as the Esterline-Angus type. This combination finds wide application in process-control instrument manufacture and in radio receiver and transmitter manufacture and operation where an instrument capable of accurately recording small d-c voltages and currents is needed. The instrument will give 5 milliamperes output in a 1,000 ohm recorder circuit for input voltages of 0.1 to 1.0 volts. As a calibrated voltmeter the accuracy of calibration is 1%. The circuit is exceptionally stable. Any one of a number of input resistances may be selected, so that the instrument serves as a calibrated millivoltmeter or microammeter.

HIGH-FREQUENCY COMPONENTS

TYPE 722-N PRECISION CONDENSER: Direct reading from 100 to 1100 micromicrofarads; semi-circular plates; figure of merit: 0.05. Inductance: 0.02 to 0.025 microhenry; series resistance at 10 Mc; 0.025 ohm. **TYPE 663 RESISTORS:** values of 1, 2, 5, 10, 20, 50 and 100 ohms. Inductance from 0.005 to 0.030 microhenrys. Direct capacitance 1.9 micromicrofarads. Temperature coefficient less than ±0.002% per deg. C. at normal room temperatures. Accuracy of adjustment is 1%.

THESE ARE ONLY A FEW OF THE NEW G-R INSTRUMENTS. SEE THEM ALL! VISIT OUR BOOTH AT THE I. R. E. EXHIBITION.

GENERAL RADIO COMPANY, Cambridge, Massachusetts

AMPERITE offers "ADJUSTABLE RESPONSE"

(HIGHER OR LOWER PITCH WITH THE SAME MICROPHONE)

. . . made possible by THE ACOUSTIC COMPENSATOR

(pat. pend.)

Here is an improvement of great value at no extra cost! Exclusive with Amperite, the Acoustic Compensator gives you these advantages:

(1) With the flip of a finger, you can now *lower or raise the response of the microphone*—without introducing any peaks or other undesirable effects. (*Not a volume control.* Gradually changes operation of the microphone from constant velocity to constant pressure.)

(2) Permits adjustment of the microphone for most desirable response for close talking or distant pickup.

(3) Makes the system immediately adjustable to any "taste," room condition, or equipment.

MODELS RBHK, RBMk, with Acoustic Compensator. Frequency range 40 to 11000 CPS. Output, -65 db. Complete with switch, cable connector and 25' of cable. . . . **$42.00 LIST.** Chrome, $43.00 List.
MODELS RBHn, RBMn, without acoustic compensator, **$42.00 LIST**

IMPROVES ANY "LOW-COST" INSTALLATION ON 4 COUNTS!

P. A. Men, you can improve those "price" jobs by using the popular Amperite Model RAH (or RAL). You will get better results because (1) it is excellent for both speech and music; (2) has flat response without undesirable peaks; (3) reduces feedback; (4) stands up under rough handling, changes in temperature, pressure or humidity. . . . Frequency range 60 to 7500 cps. Output, -68 db.
MODEL RAH (Hi-imp.) with 12' of cable; **MODEL RAL** (200 ohms) with 8' of cable. . . . . **ONLY $22.00 LIST**

NEW LOW-PRICED CONTACT MICROPHONE . . $12.00 LIST

The success of our Model KTH ($22.00 List) has created a demand for a popular-priced Amperite Contact Microphone. The new model listed below can be used on most radio sets made since 1935 and on all P.A. systems. It "makes an ordinary violin sound like a Strad" . . . gives a small piano the tone of a Grand. And yet, there is *no distortion. No unnatural effects. No "fingering noises."* Installation is simple . . . no changes in strings or instruments . . . attached without tools.

Operates with either high or low gain amplifiers. Has frequency response of 40 to 9000 cps. Output, -40 db. 20' of cable.

MODEL SKH (Hi-imp); **SKL** (200 ohms) **$12.00 LIST**
SKH or **SKL** with foot-operated volume control . . . . . **$20.00 LIST**
Professional Model KTH (or KTL) . . . . . **$22.00 LIST**

"TOPS IN MIKES"

Station KVOL, of Lafayette, La., writes us, unsolicited: ". . . the Amperite mikes have been in service here for almost three years, and have proven themselves to be "tops" in mikes. They have broadcasted in the rain and in the hot sun. They have even been dropped, but they always came through in fine shape . . ." The *Amperite Studio Velocity Model SR80n now has -56 db output.* Frequency range 40 to 15000 cps. Triple shielded, fitted with switch, (optional), cable connector, and 25' of cable.
MODEL SR80n (200 ohms); **$80.00 LIST**
MODEL SR80Hn (Hi-imp.).. **$80.00 LIST**

Sales Aids for the P. A. Man Amperite offers the following co-operation to P.A. Men.

(1.) FREE Window Decal advertising your Sound Service. Size 5¼ x 9¼, finished in 4 striking colors. (2.) FREE Window Display, 11 x 17. (3.) Special Sound Equipment Letterheads. Samples and prices on request. (4.) FREE use of cut for printing business cards, etc.

Write for these valuable sales helps, and new Illustrated Bulletins, today!

"Better Systems Specify Amperite"

AMPERITE CO. 561 BROADWAY, N.Y. U.S.A. CABLE ADDRESS ALKEM, NEW YORK

VELOCITY **AMPERITE** MICROPHONES