COMMUNICATIONS

including

TELEVISION ENGINEERING

MARCH

1940

JERRY MINTER

COMMUNICATIONS

MARCH
1940

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer.
Registered U. S. Patent Office
Member of Audit Bureau of Circulations

VOLUME 20
NUMBER 3

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

Television pickup from an airplane. A recent television broadcast over W2XBS featured a pickup from an airplane in flight over New York City. The television transmitter in the plane was of the recently developed portable carrying-case type. The program was conducted jointly by the Radio Corporation of America, the National Broadcasting Co., United Air Lines and RCA Manufacturing Co.

• Editorial Comment •

A RECENT television broadcast over W2XBS featured the New York City skyline picked up from an airplane in flight (see front cover). This broadcast made possible by the development of a portable television transmitter housed in carrying cases, is significant, we believe, in at least two respects. In the first place, it amply demonstrates the entertainment possibilities of television; secondly, it points the way toward the possible future use of television for military applications.

THE Board of Directors of the National Association of Broadcasters have recently set dates for their 1940 convention. This gathering will take place in San Francisco on August 4-5-6-7. Further details will be published in a later issue of COMMUNICATIONS.

THE FCC hearing on aural broadcasting for frequencies above 25,000 kc is just getting under way as we go to press. Postponed from February 28, this gathering is intended mainly to gather data on u-h-f a-m and f-m broadcasting, and as such will be watched with a great deal of interest.

Frequency modulation broadcasting is gaining momentum rapidly. In this connection, it is interesting to note that there are approximately 70 stations with applications pending and about 20 stations that are either licensed and operating or authorized for construction. In addition some 12 organizations have announced their intentions to manufacture f-m receivers.

MUCH interest is being evidenced in the fact that the National Broadcasting Co., has filed applications with the FCC to construct and operate television stations in Philadelphia, Washington and Chicago. This is especially true in view of the fact the relaying of television signals by use of centimeter waves has been successfully demonstrated. It is also understood that an application to cover television relay service between New York and Philadelphia will be filed shortly with the FCC. Coupled with reductions of about 33⅓% in television receiver prices, it would seem that television may come into its own during 1940.

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

BRYAN S. DAVIS
President

JAMES A. WALKER
Secretary

PAUL S. WEIL
Advertising Manager

A. GOEBEL
Circulation Manager

Chicago Office—608 S. Dearborn Street
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.


Coincidental single shaft operated selection switch, and volume or tone control. Station selection in automobile or home radio or wave band selection.
Single push button operated selector switch for Automobile or home radio. Station selection or wave band switching.
Special single contact switch to operate remote solenoid and index dial at same time.
Solenoid operation selector switch, Single push button, automobile, or home radio controlled remotely.
Single-Push operated tone switch. Selections of various tone positions.
Key operated line or tone switch, where unauthorized adjustment is imperative such as coin phonographs. Can be applied to any type of shaft operated switch.
Momentary open and closed circuit switches, Meter insertion, Record rejection, Record selection, Simple On-and-off switch.
Centralab
Special Purpose Switches
Versatility . . . beside the orthodox type, we are equipped to design and create switches and controls for various special applications, including complicated switching mechanisms.
Our Engineers are capable of developing any type of special control or switch apparatus from the "idea stage" to a successfully operating mechanism.
See us about any special application problem.
CENTRALAB: Div. of Globe Union Inc.
MILWAUKEE WISCONSIN

Announcing THE RCA TYPE 64-B

—A New Monitoring Loudspeaker

Famous RCA 64-AX Loudspeaker restyled and redesigned with permanent magnet field which requires no power supply

DESIGNED with the exclusive RCA double voice coil mechanism and folded horn cabinet, the RCA 64-B Monitoring Loudspeaker reproduces what is probably the widest frequency band ever obtained in so small a cabinet. High frequency diffusing vanes in front of cone, spread high fidelity response over a wide angle.

Low Distortion With High Power

Coordinated design of speaker and cabinet reduces harmonic distortion to a new low. And the sturdy, reinforced cabinet is built to eliminate resonance and vibration.

More Acoustic Volume With Less Amplifier Power

The unusually high sensitivity of the RCA 64-B Loudspeaker provides much more acoustic volume with lower amplifier powers than is generally obtained in ordinary speaker design. The highest quality permanent magnet material together with correct pole design permits the use of a permanent magnet without loss of efficiency or power handling capability.

Double Voice Coil Reproduces High Frequencies Naturally

No separate or "tweeter" speakers are required—and the RCA 64-B delivers outstanding performance at a low cost.

The pleasing modern design of the RCA 64-B makes it desirable for use in studios, offices and lobbies. Available in black, umber-grey—or walnut, it blends in with any interior design. A matching base cabinet may be used in installations requiring an amplifier—such as the RCA 82-B—associated with each speaker.

FOR FINER PERFORMANCE... GO RCA ALL THE WAY

RCA *Broadcast Equipment*

Microphones
Speech Input Systems
Associated Equipment
Transmitters

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of the Radio Corporation of America

New York: 1270 Sixth Ave. • Chicago: 589 E. Illinois St. • Atlanta: 530 Citizens & Southern Bank Bldg. • Dallas: Santa Fe Bldg. • San Francisco: 170 Ninth St. • Hollywood: 1016 N. Sycamore Ave.

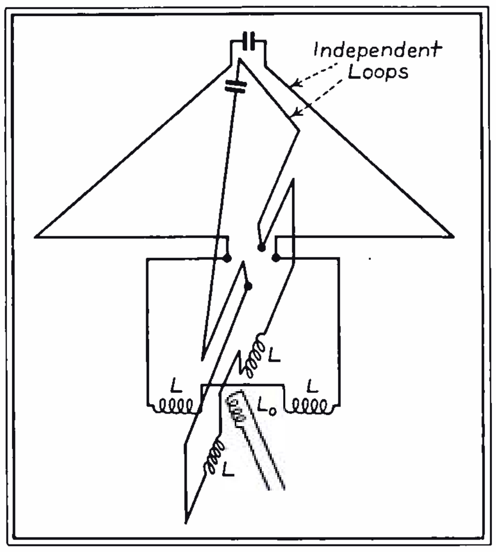
Development of
AIRCRAFT RADIO ANTENNAS

By R. McGUIRE
United Air Lines
and
J. DELMONTE

FOLLOWING a natural course of development, radio antennas for aircraft have appeared in a wide variety of designs, fulfilling certain radio requirements and observing certain limitations imposed by airplane structures. When specific functions of course navigation must be performed by the radio equipment, it is evident that the problem of the radio antenna is more involved than merely placing a wire between two distant points upon the airplane structure. Consideration must be given to whether reception, transmission, or both are desired, whether directional characteristics are required, and the effect of the antenna installation upon efficient airplane operation. Also taxing the ingenuity of radio engineers are space, size, and weight limitations on equipment, as well as problems of vibration, easy maintenance, and accessibility.

In looking over the past fifteen years, one will observe a marked distinction between radio antennas used on obsolete airplanes and modern airplanes. Whereas, in the past, the airplane structure predominated in wood and fabric construction, the installation of radio antennas in the wings and fuselage adequately met all requirements at that time. Woods and organic fabrics offer no hindrance to the electromagnetic waves, and the antenna could be kept out of the slipstream by mounting wires upon insulators in the inside of the wing or fuselage structure. This may be contrasted to the effect of the present all-metal construction, which would screen antennas placed in the interior of the airplane, rendering effective reception impossible.

The growing demand for increased radio facilities was another important factor in determining the nature of the antenna requirements. Radio telephone as applied to airline aircraft was first used practically about 1928. With the development of aircraft and air-transport industry, certain types of antennas appeared to be outstanding in their utility and efficiency. The most widely adopted during the past five years is the circular loop type of antenna, the directional reception properties of which have given it more than one practical application.



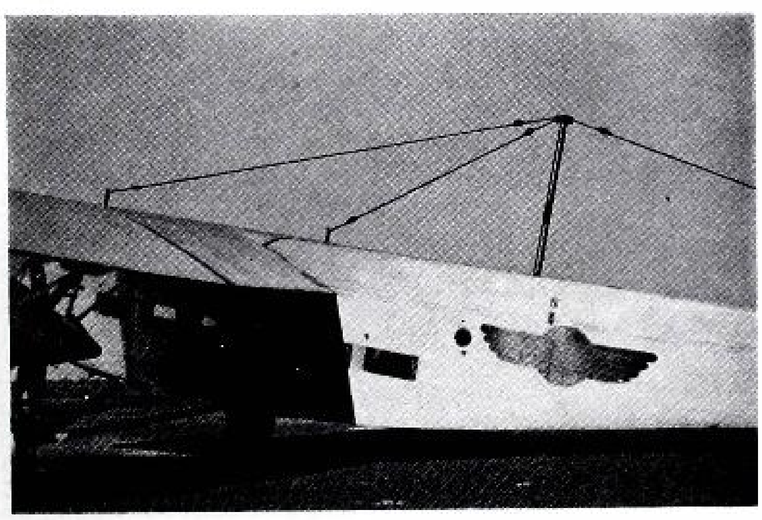
Above: Fig. 1. Tuned loops for Bellini-Tosi system.

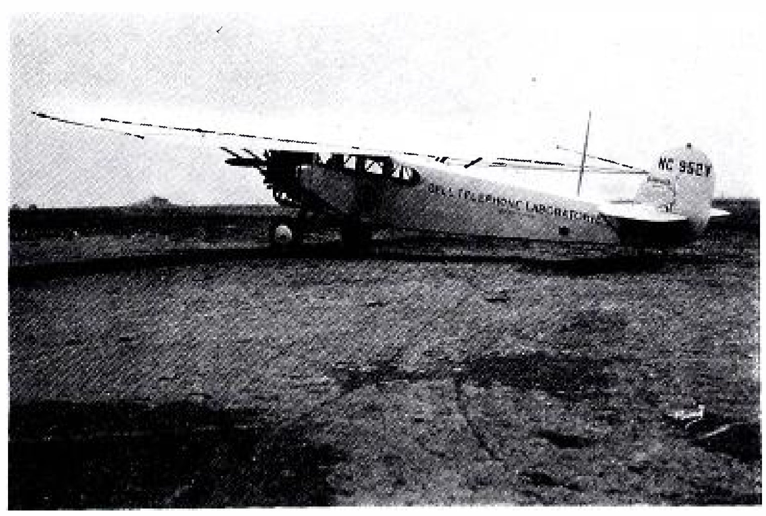
Below: Fig. 5. (Left) Mast antenna used as support.
Fig. 4. (Right) Early installation of mast antenna. Western Electric Photo.

Loop Antennas

The loop antennas have experienced a course of evolution from the cumbersome wing homing loops to the modern, compact circular loop antennas. Fundamentally, their directional properties are based upon the fact that when the plane of the loop is perpendicular to the source of propagation, signals of minimum intensity are received; whereas, signals of maximum intensity are received when the plane of the loop is parallel to the source of waves. It therefore has two maximum and two minimum signals with respect to the source of the waves, and depending upon which direction the airplane is flying.

Wing Homing Loop. One of the first adaptations of the loop antenna to aircraft was the wing homing loop. This was installed on early biplanes since the wings of these craft made it possible to attain coil antenna aerials of 100 to 200 square feet in area. The coil was formed by running a series of parallel wires spanwise through the upper wing, down through an outer strut, across through the lower wing to an outside strut on the opposite side, where it was led upwards again into the upper wing. The bearing of the airplane was checked by swinging the airplane to the port or starboard (as the homing loop was fixed





in position) and flying in the direction of the absolute minimum signal. In the event of a strong wind, allowances were made for drift and the airplane flown in a direction that was slightly from the minimum signal.

There were several objectionable features of the wing homing loop. It was cumbersome and inaccessible, as it was housed within the struts and doped fabric cover of the wings. Repairs meant ripping of the fabric covering the wing to expose the wires. Moreover, in operation, valuable time was often lost by swinging the plane off-course to take a bearing. Further, the 180° ambiguity of the received null signal made it impossible to determine whether the airplane was flying towards or away from the station. These objections eventually gave impetus to new designs, in an effort to overcome undesirable features.

Mr. Keen, in his book on wireless direction finding[1] describes a system of antenna circuit switching used at the time by the Royal Air Force, where it was not necessary to turn the airplane off of the course in order to check its bearings. An auxiliary coil antenna and a main coil antenna are mounted at right angles to each other. The plane of the auxiliary coil, usually divided into two parts on both sides of the airplane, lies perpendicular to the line of flight. A switch, in the form of a radial commutator, is driven at approximately one revolution per second, and the auxiliary loop is switched alternately in series with the main loop and then reversed. In this manner, the process of swinging the airplane off of the course is simulated, as the necessary signal variations for checking the bearings are reproduced. Provisions are also made for flying on the wing coils alone. The ratio of the area of the auxiliary loop antenna to the main loop antenna is usually 6 to 1, as the auxiliary loop receives the minimum signal when the airplane is on course.

Bellini-Tosi System. In the Bellini-Tosi system it was unnecessary to swing the airplane off course to take a bearing. Two large loop antennas, the planes of which were at right angles to each other were installed on the airplane. The two antennas, of approximately the same area, were individually tuned by condensers, and connected with inductors, as geometrically arranged in Fig. 1. An orientable coil, L_o, is placed at the center, the position of which depends upon the direction of the incoming radio wave. For accurate results, the Bellini-Tosi aerial loops must be as nearly symmetrical as possible, covering the same area, and with the same high-frequency resistance to the incoming signal. Otherwise, a careful calibration of the goniometer is essential for the particular loop area used, which is the case for the airplane. Among the basic requirements of the goniometer, which are essential to the correct interpretation of the incoming radio waves, are: tightly coupled, accurately designed coils, and accurate tuning of the two coil aerials to a given frequency, which will insure exactly the same phase relation of the aerial currents. The variable or search coil of the goniometer is controlled by a dial with markings indicating the various points of the compass, such as that illustrated in Fig. 2. The direction of the incoming signal with respect to the position of the search coil may be accurately obtained by referring to the pointer on the dial face. The goniometer is valuable in locating an unknown point of transmission, either on the part of the aircraft in the air, or else on the part of a ground station in locating a signalling aircraft.

Installations of the Bellini-Tosi system on aircraft were necessarily cumbersome due to multiplicity of wires. The lack of absolute permanency of capacitative relations between the loop antennas and the ground (aircraft structure) necessitated frequent calibrations of the goniometer to insure accuracy of direction finding. From the viewpoint of the airplane designer there were other objections, such as the increased drag offered by the large antenna loops of the Bellini-Tosi system and the antenna supports. In addition, accidents in service were reported when the pilot or crew in "bailing out" in some emergency, struck the wires of the loop which extended from the wing tips to the tail surface. In fact, the Radio Technical Committee for aeronautics concluded in one report, that the direction-finding equipment on aircraft should not be contingent upon accurate tuning and adjustments for antenna loops.[2]

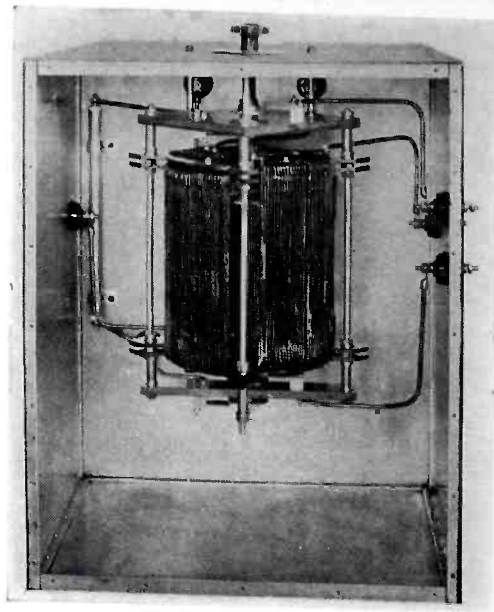


Fig. 2. Radio Goniometer. General Electric Photo.

Circular Loop Antennas. Present day loop antennas in general use are circular in shape and possess diameters ranging from 6 to 18 inches. The installations may be divided into two main classifications: the fixed type and the rotatable type. The fixed design is generally used on small aircraft and the rotatable loop on large aircraft. The former finds its greatest utility as a homing device, while the latter is employed in direction finding and, when shielded, for aural reception under precipitation static conditions.

Fixed loops are installed on small aircraft for reasons of cost, weight limitations, and general utility. Since this design involves no moving parts or remote-control devices, it can be readily installed with a minimum loss in payload. Moreover, they are better suited to small aircraft which can be easily maneuvered to take a bearing. A fixed loop of this description is shown in Fig. 3.

Fig. 3. A fixed circular loop. This type of antenna is designed to give either aural or visual indication. It is used on small and medium size aircraft. Photo from Lear Avia.

The rotatable type is more complex, involves rotating parts, remote-control devices, and in some designs automatic electrical mechanisms which maintain the loop in a constant null position. They are, therefore, heavier installations of greater cost and broader utility. Their broader functions make them more suitable for airliner type of craft, which possess greater flight range and endurance.

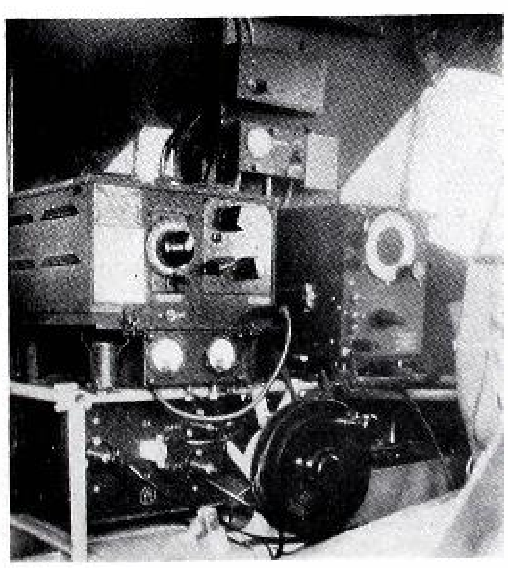
Government regulations[3] require that aircraft operated on schedule airlines carry a radio direction finder and anti-static antenna. It is specified that: "the design of the radio direction finder be such as to permit its regular operation in taking bearings . . . . without altering the course of the aircraft. The radio direction finder shall also be provided with means to eliminate . . . . rain, snow, or dust static. The radio direction finder shall provide means for audible reception of radio range and weather broadcast messages."

For the anti-static antenna, the regulation specifies that: "the design of this antenna system shall be such as to eliminate . . . . interference commonly known as rain, snow, sleet, or dust static. This antenna system shall be designed to operate efficiently when used in conjunction with a receiver installed on the aircraft which has for its primary purpose the reception of radio range signals, weather broadcast and emergency messages."

The installation of shielded, rotatable loops which can be switched into the regular receiver circuit, therefore satisfies both of the above regulations. Moreover, the fact that airline aircraft use the loop frequently for aural reception during precipitation static conditions illustrates that the shielded rotatable loop, has more than one practical adaptation.

Rotatable loops are generally installed on the underside of the fuselage on all metal airliners for structural reasons. This location also makes them easily accessible for maintenance when the airplane is on the ground. Recently developed transport aircraft such as the Douglas DC-4 and Lockheed 14 show the loop installed behind a non-shielding

Fig. 4-A. Antenna reel and equipment. Westinghouse Photo.



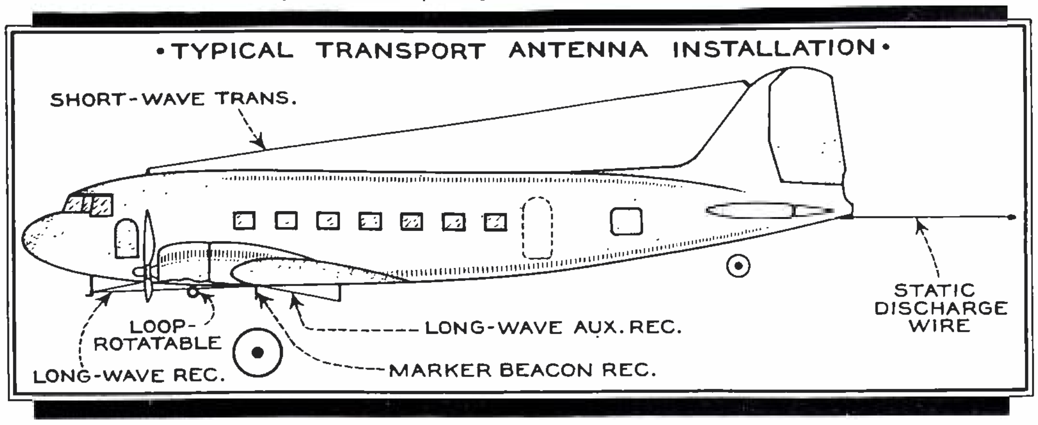


Fig. 6. Antenna installation of United Air Lines Mainliner.

curved door. This installation eliminates the drag existant in externally mounted loops (estimated to be about 2 m-p-h in 237 m-p-h), and also makes the loop invulnerable to ice accumulation. The formation of ice increases drag and sometimes freezes the loop to the fuselage. The magnitude of correction required for observed bearings taken with the nose installations, however, is greater than that for the externally mounted types.

Trailing Wire Antennas

The trailing wire antenna (Fig. 6) is an efficient radiator. Although widely used a few years ago on aircraft of many sizes and designs, it is today mostly confined to private, military, and naval aircraft.

By regulating the length of the trailing wire from the airplane to agree with the desired frequency of transmission, an efficient broadcast may be obtained. The length of the wire has varied anywhere from 100 to 350 feet. The accessories necessary for the effective operation of this type of antenna are: an antenna reel and drum for reeling the antenna in and out of the plane; an antenna weight which is attached to the lower end of the wire; and the antenna fairlead which insulates the antenna wire from the airplane structure. Connection is established from the antenna reel to the radio. Careful regulation of the length of wire is obtainable by means of a counter dial used in conjunction with the reel.

Various types of antenna reels have appeared on aircraft. A typical reel and the accompanying aircraft radio equipment are shown in Fig. 4-a. Some installations have the antenna reel in the cockpit, while others have remotely controlled reels for paying out the wire, the remote control being effected through flexible cables. A still more costly system, effective for larger aircraft where the radio operator may be handicapped by numerous duties, is the electrically driven antenna reel.[5] This antenna reel pays out and draws in the wire through the tail structure of the airplane. Approximately 150 feet of wire is wound upon the reel. Adjustments are usually made to ¼ of the desired wavelength. Operation is simple, as all that is necessary is to set the desired length on the counter dial, and the reel automatically pays out the desired length.

Among other un-weighted trailing wire antennas are the wing tip antennas, now obsolete, which were used at one time on army pursuit planes.[6] When flying in close formation, the airplane must be free to engage in aerobatic maneuvers, and two small wires streaming from the tips have been used. These wires were unweighted and assumed a position parallel to the direction of flight.

Antenna Weights. Weights for trailing wires have appeared in a variety of forms weighing from one to five pounds each. One type is the lead "fish" which provides an attachment for the conductor just aft of the center of gravity. The effect of the weight is to trail the antenna wire at an angle with respect to the ground, which improves transmission. Other types are the tubular, used on some Naval aircraft, the lightweight sphere and the small "windsock" which utilize aerodynamical drag to trail the wire. In some installations, attachment fittings that will break under a tension of 60 to 75 pounds are incorporated in order to eliminate the likelihood of damage when the weight fouls an object on the ground.

For emergency landings, a kite antenna has been devised for naval aircraft.[7] Though this does not strictly fall into the trailing antenna classification, it has been carried to be flown from the ground in some exigency. The kite is 6 to 7½ feet in height, and designed to fly in strong and light winds. Close to 300 feet of wire may be carried aloft.

Static Discharge Wire. Though not strictly an antenna, another type of trailing wire is installed on the "Mainliners" of the United Air Lines. This wire is called a static discharge wire. After a thorough study of the causes and effects of aircraft static, the United Air Lines engineers concluded that the discharge of accumulated potential from the wing tips and tail surfaces of all-metal aircraft was largely responsible for precipitation static experienced in bad weather flying. Tests showed that reception was improved when a fine wire in series with a suppressing resistor was trailed behind the airplane. Two such wires are included as standard equipment on United Air Line "Mainliners." They are housed in special cartridges in the tail cone, and can be individually released when desired by pushbuttons in the cockpit.

Vertical Pole or Mast Antennas

The vertical pole or mast antenna is usually a streamlined metal tube about five feet long, projecting vertically through the fuselage above the receiver unit. This type of antenna was one of the first to be used successfully for plane-ground airline radio communication. A theoretical, yet practical, analysis of the vertical pole antenna on aircraft has been made by Diamond and Davies.[8] An early installation of the mast antenna on the fuselage of an experimental airplane is shown in Fig. 4. A later adaptation of the vertical pole antenna is as a sense antenna. A sense antenna is used to resolve the 180° ambiguity of the loop by connecting it into the loop antenna circuit.

Though widely used on aircraft of many different types and designs in the early nineteen thirties, mast antennas are today confined to airplanes where high speed is not a criterion of performance. The objections to the mast antenna are, namely: its aerodynamical drag, vulnerability to ice accumulation, and its vibration. The magnitude of the drag of mast antennas was borne out a few years ago when the high speed of the Boeing 247 planes operated by United Air Lines, was increased four miles per hour when the mast was removed.

Fixed Antennas on Aircraft

There are several types of fixed antennas which have proven quite satisfactory for aircraft in connection with radio signals and the usual communication with ground stations. The longitudinal L or T antennas are usually mounted on top of the fuselage in the form of a single wire extending from one end of the airplane to the other. The aft end is attached to a point high up on the fin, while the forward end is attached to a short vertical pole installed in the top of the fuselage. In some installations, the vertical pole or mast antenna serves as the support (see Fig. 5), while in others a large ceramic insulator, or streamlined plastic rod about 10 inches long is used.

Symmetrically transverse T antennas are employed on some Navy biplanes, the wing construction lending itself to this installation. Short insulating rods support this antenna from each wing tip. The longitudinal T antenna design which has the lead-in at the middle of the antenna length, is adapted to small aircraft where the receiver unit is installed immediately aft of the cockpit or cabin. The lead-in is brought directly in to the receiver compartment, in as short a length as possible. The longitudinal L design, which has the lead-in attached at one end, is more suitable for large aircraft which have the radio compartments well forward.

Space limitations may sometimes make horizontal V antennas necessary. Antennas on small aircraft can be made of sufficient length by running the conductor from wing tip to tail to wing tip. Likewise, on large aircraft where space may be at a premium because of the many antenna requirements, the V may be installed on the underside of the wing center section and the fuselage. It is common practice to relieve aerodynamical loads upon the wires in the airstream, by helical springs or rubber tension members designed to take up slack.

Fixed antennas are preferably installed on top of the fuselage to avoid damage due to ground obstructions. They have been the subject of much investigation on the part of the Bureau of Standards, with respect to their response to radio beacon signals.[8]

Other Types of Antennas

To correspond with government plans for the modernization of U. S. airways, the Civil Air Regulations issued in 1938 required that all airline aircraft be equipped with marker beacon receivers by January 1, 1939. The antennas favored for use with these receivers are of the half wavelength dipole design. They are formed by stretching a wire between two short masts mounted vertically and spanwise on the underside of the fuselage or center-section wing. The masts are spaced ½ wavelength apart and the wire is divided into ¼ wavelength sections by an insulator at the center of the span.

The widely publicized absolute altimeter recently developed by engineers of the United Air Lines and the Bell Telephone Laboratories incorporates two six-inch dipole antennas. These are installed on the underside of the wing

(*Continued on page 28*)

TABLE I—DIRECTION FINDING RADIO ANTENNAS FOR AIRCRAFT

Type	*Antenna Description*	*Suitable Aircraft*	*Method of Indication*	*Remarks*
Wing homing loop	Large fixed loop of several turns through wing structure	Biplanes of wood construction	Aural	Plane swings from course for bearing
Bellini-Tosi loops	Two fixed loops at right angles to each other, located on wings and fuselage	Large flying boats	Aural	1. Used with the goniometer. 2. See Figs. 1 and 2
R.A.F.-Robinson	Large auxiliary coil in wing, small main coil in fuselage (both fixed)	Biplanes of wood construction	Aural	Requires a rotating switching commutator
Fixed circular loop	Loop	Small and medium sized aircraft	Aural or visual	1. Plane swings from course for bearing 2. See Fig. 3
Rotatable, circular shielded loop	Loop	Large transports	Aural or visual	Shielding reduces precipitation static
Radio compass system	Loop and sense antenna	All types	Aural or visual	Sense antenna used to resolve 180° ambiguity

TABLE II—TRAILING WIRE ANTENNAS

Type	*Installation*	*Remarks*
Weighted trailing wire	From fuselage, or tail cone	Streamlined, tubular, or spherical weigts and windsock are used
Unweighted wing-tip antennas	Wing tips	Obsolete
Kite antennas		Flown from ground
Anti-static wire	From tail cone	Improves reception

TABLE III—FIXED ANTENNAS

Type	*Suitable Aircraft*	*Remarks*
Vertical mast	Where high speed not criterion	Increase drag
Symmetrical transverse T	Biplanes	Easily installed spanwise on upper wing
Symmetrical longitudinal T and L	All types	Good for beacon signals, plane - ground comm.
Horizontal V	All types	Useful where space is limited
Dipole	Large transports	Marker beacon reception

THE VELOCITY OF PROPAGATION

of Electrical Disturbances

By Dr. SIMON RAMO
General Engineering Laboratory
General Electric Co.

Introduction

OF the many important characteristics of electricity, one that is rarely treated adequately in the text books most easily accessible to the radio engineer is the velocity of propagation of electrical effects. With the exception of a mere statement that radio waves travel with the velocity of light, little is apt to be found about this characteristic unless one refers to the highly mathematical treatises. The question of how long it takes for an electric or magnetic field to be felt at a point some distance from the charges and currents giving rise to these fields; of the time it takes for an impulse to make itself felt at the other end of a transmission line or network; of the effect of dissipation in slowing down a transmission line wave; of the exact relation between the velocity of propagation of an electrical effect and that of light in free space; of the meaning and limitation of the terms "phase velocity" and "group velocity"; of the differences in propagation of steady state and transient effects—these have been discussed in certain advanced texts and papers, but so often does the understanding of this material require a broad mathematical background that many engineers fail even to benefit by any kind of physical picture of these phenomena.

The use of the convenient concepts of phase and group velocities to describe propagation characteristics is well established and an understanding of these terms increases the ability of any radio engineer to follow discussions of propagation problems. An appreciation of the reasons for the differences in attack of steady-state and transient propagation problems is especially helpful since there are an increasing number of applications, both in transmission and circuit problems, where transients play an important part. More important than this, however, is the fact that the finite time of propagation of electrical effects is so closely related to the phenomenon of radiation of energy by electro-magnetic waves that to have some knowledge of the fundamentals underlying retardation effects (granted that a detailed mathematical study intended to equip one to make computations along these lines is not contemplated) should be considered a part of every radio engineer's theoretical background.

In the following an attempt will be made to present a number of basic concepts in the propagation of electrical effects in simple terms. The discussion will be non-mathematical and no attempt will be made to prove all statements. It will not be intended that a reader, previously unfamiliar with the phenomena, should afterwards be able to make computations in this difficult field. But it is hoped that his physical picture of propagation effects, particularly those along conductors, will be bettered and that this article may serve as an introduction to further study.

We shall have first to distinguish between the propagation of energy under "steady-state" conditions and the propagation of energy under transient or changing conditions. Strictly speaking, no completely steady-state condition should have the ordinary notion of velocity of propagation associated with it. In a lumped circuit problem, such as that pictured in Fig. 1, when a steady

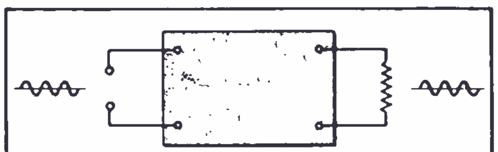


Fig. 1

a-c input results in a steady a-c output, we think of "energy" passing from input to output but not of a "speed" at which a particular point on the sine wave of the voltage input travels to appear eventually at the output. We have no reason to expect that a certain cycle of the input should be identified with a later cycle of the output; we find it meaningful only to recognize that the effect of a steady-state input voltage is to create voltages across all impedances of the circuit with various displacements of phase. There is no fundamental change in this picture as we add more and more circuit elements between input and output. For instance, if a generator feeds a steady sine-wave current into a transmission line with the result that a steady-state voltage appears everywhere on the line and across the load, then the situation is (almost by hypothesis) one that has no velocity of any kind associated with it, because no particular input voltage loop can be singled out and found eventually to arrive at the output. As one author has put it,[1] "velocity of propagation in the usual sense has to do with something that has a beginning and an end and a steady state has by definition, neither beginning nor end."

Still we find it convenient and useful to speak of phase and group velocities on transmission lines. Before defining these concepts and considering their application to the steady-state problem, let us consider an aspect of the transient problem.

Suppose that a disturbance is imparted to a transmission line, by a sudden application of d-c voltage at the input end, for example; here then is a case where the above steady-state argument does not apply and it is certainly natural to think of a velocity with which the impulse propagates down the line. Actually the applied impulse does not travel down the most general line, if we mean by this that the identical wave shape of voltage which was impressed across the input terminals propagates down the line unchanged in any way. To be sure, there is an effect which moves down the transmission line as a result of the applied impulse—but it would be a special selection of the impulse, the arbitrary constants and the initial conditions of the transmission line if the output wave shape were exactly the same as the input wave shape. More will be said about the velocity of propagation of transient effects later.

Phase Velocity

Let us now examine the steady-state situation in more detail to see how the notions of phase and group velocity may be applied conveniently in that case. It is well known that if a transmission line is properly terminated, so that there is no reflected wave, then the application of a voltage, e sin ωt.

[1] "Communication Networks," Vol. II, E. A. Guillemin, John White (1935), page 50.

at the input will result in a voltage everywhere on the transmission line of

$$e \sin(\omega t - kx) = e \sin \omega \left(t - \frac{k}{\omega} x \right)$$

where x is the distance along the line measured from the input.[2] These expressions mean that every point along the line has exactly the same a-c voltmeter reading but that the phase angle differs in an amount proportional to the distance between the points under consideration. Thus at some point x along the line, the voltage will reach peak value at a time $\frac{k}{\omega} dx$ seconds before it reaches peak value at $x + dx$. If we were to move our observation point from x to $x + dx$ along with the peak value (in other words, in a time of $\frac{k}{\omega} dx$ seconds) we would not have noticed that the wave at x has already departed from peak value. We might have chosen any part of the cycle in the same way and moved with a velocity

$$\frac{dx}{k/\omega \, dx} = \frac{\omega}{k}$$

along the line and thus have always seen the voltage at each point of the line at exactly the same point in the cycle.

This velocity has been termed "phase velocity," appropriately so because it is the velocity with which one would have to move to see the same phase at each point of the line. As already stated earlier, nothing can actually be proven to have moved (except our imaginary observer).

Of course, there is indeed a "flow" of energy down the line in the general case, and this energy is entering and leaving the line at a constant rate in the steady case. But there is no "velocity" associated with the energy flow any more than there would be in the case of a d-c network into which energy is being fed by a voltage across two input terminals and dissipated by a load resistor across two output terminals. In this regard the propagation of electrical energy departs from the hydraulic and other analogies which are often drawn for it in that these analogies have asso-

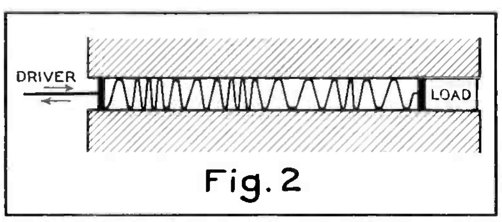


Fig. 2

ciated with them some sort of "particle" motion in the flow. The analogy of a long spring shown in Fig. 2 is more suitable here because there is no particle transfer, but energy is transmitted from the driver down the spring to the load. Due to the fact that different parts of the spring vibrate out of phase, there appears to be a "traveling wave" of spring displacement.

Phase velocity may then be justifiably regarded as a fictitious concept, but it is a convenient one. It applies *only*

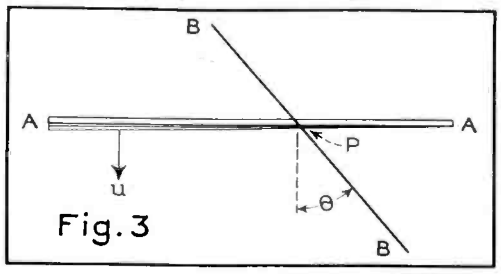


Fig. 3

when a simple sine wave is leaving the transmitter during steady-state condition but it may obviously apply not only to transmission lines but to any type of vibration which varies with distance as given by the expressions above. If a more complicated steady (periodic) wave is applied then it may be resolved into a series of sine waves so that a series of phase velocities, one for each applied sine wave, will be present for such a wave. If the phase velocity happens to be independent of frequency then all periodic inputs will result in waves having a single phase velocity. It is not necessary that the phase velocity should be independent of frequency. In fact, in a general transmission line, the impedances and admittances per unit length vary with frequency and this causes the phase angle constant, k, to vary with frequency.

Since we have established the phase velocity as the velocity of a purely imaginary observer who travels just fast enough to see always the same point on the alternating cycle all along the propagation path, it is not upsetting to find that in certain cases the phase velocity happens to exceed the velocity of light in free space. This is no violation of any fundamental law of physics. It does not disagree with the postulates of relativity nor contradict the electromagnetic theory of light any more than would be the case in the situation pictured in Fig. 3. Here a moving straight-edge A—A intersects a stationary line B—B which makes an angle θ with the direction of motion of A—A. If A—A moves with a velocity u then the point of intersection P moves with a velocity u/cos θ along B—B. As θ approaches 90 degrees, an "imaginary" observer trying to keep up with the point P would have to approach infinite speed.

Group Velocity

Most often in radio engineering work our analyses of propagation must account for the fact that a band of frequencies is being transmitted. Consider the case of two steady-state signals at slightly different frequencies. If the voltage at the transmitting end is

$$\sin(\omega - \Delta\omega)t + \sin(\omega + \Delta\omega)t$$

then the voltage everywhere along the path is

$$\sin[(\omega - \Delta\omega)t - (k - \Delta k)x] + \sin[(\omega + \Delta\omega)t - (k + \Delta k)x]$$

in which k is to be regarded as a function of frequency as is indicated by the use of a Δk change in k for a $\Delta\omega$ change in ω. Now this expression may be changed by a trignometric formula to

$$2\cos(\Delta\omega t - \Delta kx)\ \sin(\omega t - kx)$$

which shows that the resultant voltage on the line at any point may be expressed in terms of the high-frequency wave having an amplitude which varies at the low-frequency rate. The envelope of the wave is

$$\cos(\Delta\omega t - \Delta kx)$$

Now this envelope varies sinusoidally with both time and distance and thus may be regarded as a wave. Repetition of the previous discussion of wave characteristics would lead to a velocity of $\Delta\omega/\Delta k$ for an imaginary observer who travels just fast enough to keep from seeing a change in the instantaneous value of the envelope. Let us name this apparent wave velocity of the envelope the group velocity, V_g, then in the limit

$$V_g = \frac{d\omega}{dk}$$

It will be instructive to relate V_g and V_p, the phase velocity of the high-frequency wave. Since

$$k = \frac{\omega}{V_p}$$

then

$$\frac{1}{V_g} = \frac{dk}{d\omega} = \frac{d}{d\omega}\left(\frac{\omega}{V_p}\right) = \frac{1}{V_p} - \frac{\omega}{V_p^2}\frac{dV_p}{d\omega}$$

Finally

$$V_g = \frac{V_p}{1 - \frac{\omega}{V_p}\frac{dV_p}{d\omega}}$$

Notice that if the phase velocity varies with frequency, then and then only will the group velocity and phase velocity be different. Where the phase velocity is equal to the velocity of light and independent of frequency the group velocity will also be equal to the velocity of light.

Retardation

Quantitative studies of exactly how an electro-magnetic field propagates in

[2] "Communication Engineering," by W. L. Everitt, McGraw-Hill (1937), Chapter IV.

and about conductors are difficult to make. The equations are replete with mathematical difficulties which make the solution almost unattainable if exact results are desired except in a few of the simpler cases. However, if approximate results are satisfactory, then valuable solutions can be obtained in almost every practical case. In particular, some very useful concepts can be understood without a lengthy mathematical study. In the following we shall discuss some of these fundamentals, not with the object of equipping the reader with formulas and tools to solve wave-propagation problems, but to better his physical picture of the phenomena.

Perhaps the simplest but most fundamental concept of all in the physics of propagating electric effects is that of "retardation." It may be best stated in terms of the electric field due to a single point charge, a familiar starting point in electrostatic theory. We know that if a single point charge of strength Q is situated at some point q in space, it will give rise to an electric field proportional to the charge and inversely proportional to the square of the distance from it. Suppose the value of the charge were to be suddenly changed to a new value Q′; the electric field at

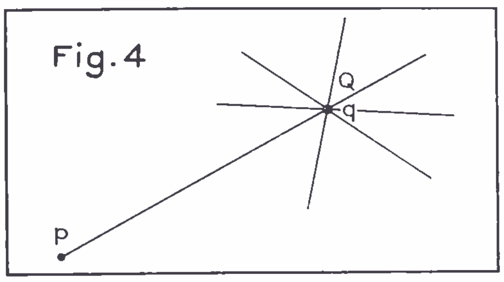


Fig. 4

p (Fig. 4) will not suddenly rise to the corresponding new field. If this rise is not instantaneous, how long does it take?

It can be shown[3] that the electric field due to charges may be found (even if the charges are changing very rapidly) by a process of summing the effect at the point under consideration due to all surrounding charges. These charges may be residing in free space or on the surfaces of neighboring conductors and the summing of effects is done in almost the same way as in electrostatics. The essential difference in the methods is that in considering the contribution to field at p due to a particular charge at point q a distance r from p, we do not use the charge which exists at q at the instant under consideration, but rather the value of charge which has previously existed there at a time interval before the present of r/c units of time. In this expression, c is the velocity of light in the medium.

[3] See for instance, "Electricity and Magnetism." by J. H. Jeans, Cambridge Press (1927), Chapter 17.

Let us consider exactly what this means. The rule states that the net effect of electric charges in producing an electric field is essentially the same whether alternating rapidly or static. However, it takes time for this effect to make itself felt—a time equal to the time it would take light to travel the distance between the point where the charge is situated and that where the field is to be computed. Therefore, if we wish to know the effect at p at time t due charges at q, we must ask: What is the strength of charge that existed at q at time $(t - \frac{r}{c})$ because it is this latter charge which gave rise to the field which is now being felt at p. We cannot expect to feel the field at p due to the present charge at q until time $(t + \frac{r}{c})$. The superposition principle still holds and the resultant field at p due to a distribution of charges is found from a vector sum of retarded contributions from individual charges.

The reader should note that we have spoken solely about the electric field due to charges. In any physical system, if the charges are changing, then currents must be flowing. These currents, in alternating, will in general give rise to alternating magnetic fields which will induce electric fields in addition to those due to the charges. So far we have chosen to consider only that part of the electric field which may be considered as due to the charges alone.

However, a similar principle holds for the magnetic effect due to a current. One way to compute the magnetic field due to a direct-current distribution is to assume that each electric current element gives rise to a magnetic field which is proportional to the strength of the current element and (Fig. 5) inversely proportional

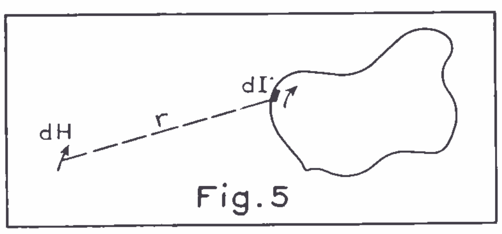


Fig. 5

to the square of the distance from the element. The retardation principle tells us again that the net magnetic field due to any given distribution of electric currents may be obtained by a process of summing vectorially the individual small contributions provided always that the value of current is chosen for each element of integration that existed there at a time r/c seconds earlier than the instant at which the field is being evaluated.

It should be noted that these principles of retardation are simply a broader statement than the usual ones of statics of the effects of charges and currents in producing electric and magnetic fields

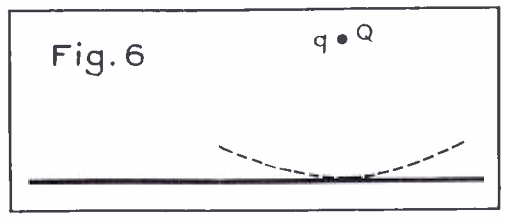


Fig. 6

respectively. In any problem in which the charge distribution and the current distribution are known the corresponding electric and magnetic fields may be computed, by a summing method, for any frequency or any geometry. (Of course in most cases this distribution is not known beforehand so that the mere enunciation of the principles does not imply a solution to all problems.)

Velocity of Propagation Along Perfect Conductors

The next step in the application of this theory towards a better understanding of propagation is to consider the case of a charge suddenly created in front of a conductor (Fig. 6). The field due to the charge will propagate from point q at the instant of the charge's creation with the velocity of light. At any instant of time before the wave front meets a discontinuity, it is spherical. What happens as soon as the field reaches the conductor? Suppose the conductor to be perfect. We know that a perfect conductor must always have the electric field perpendicular to its surface (for the slightest electric field along the surface would create an infinite current flow). Moreover the charge density distribution on a perfect conductor must be such that the electric field flux normal to the surface will terminate in the proper amount of charge. Thus we can foretell that as soon as the propagating field reaches the surface of the conductor, charge will appear there. Now there will be a new field emanating from this surface charge such that the resultant total field at the conductor surface due to the combined effects of charge Q and the surface charge is normal and of the proper amount.

We should not be concerned because the creation of charge on the surface is instantaneous upon arrival of the wave front at the conductor. This instantaneous action simply follows from our initial condition—that of creating the charge at q instantaneously. Had we allowed the charge at q to build up gradually the charge on the conductor would have built up in a similar fashion, but at a later time.

Let us apply these concepts of retardation to obtain a picture of how a disturbance may be propagated along conductors. Consider the transmission line of Fig. 7 and suppose that a d-c voltage is suddenly applied between inner and outer conductors. The result-

Fig. 7

ing charge on each conductor at the point of application of the voltage will immediately send out field toward point A further along the transmission line. After the passing of sufficient time for the effect to propagate that far, this must result in the appearance of charge of the proper amount at A to keep the electric field normal there. But the charge at A will give rise to field further along the line in the same way. It is thus seen that the field propagates between the conductors accompanied by the charging up of the conductors. We could follow a similar line of attack for the magnetic fields arising from the currents on the surface of the conductors.

Propagation in Dissipative Media

Suppose now that the conductors are not perfect. This simply means that the currents cannot be considered to reside entirely on the surface of the conductors but must be considered to flow inside of the conductors. Mathematically the problem becomes very difficult because we must account for phenomena going on in two regions, both on the inside and the outside of the conductors' surfaces and our very simple picture requires some correction.

To gain some appreciation of how the necessity for considering the two parallel regions, one having dissipation, alters our propagation picture the following diagram and discussion may prove helpful.

Fig. 8 is intended to illustrate the propagation of a wave along a perfect conductor. Here two regions are shown, a perfect dielectric bounded by a perfect conductor. Each region is supposed to be semi-infinite and the problem may be assumed to represent a radio wave traveling along a perfectly conducting earth. The vertical vectors represent the electric field at the surface of the conductor. The electric field is properly shown as perpendicular to the surface of the conductor, the direction either in or out of the conductor depending upon the phase, and the lengths of the vectors indicating the amplitude of the field strength. No field exists in the conductor because with the assumption that it is perfect we have eliminated the possibility that a field can penetrate into it. This field propagates with the velocity of light because of the principles we have already discussed and all the current in the wave is on the surface as shown by the horizontal vectors.

Suppose now that we revise the picture of Fig. 8 to remove the assumption of perfect conductivity. In Fig. 9 we have now allowed the current to penetrate into the conductor. If there is to be current in the conductor there must

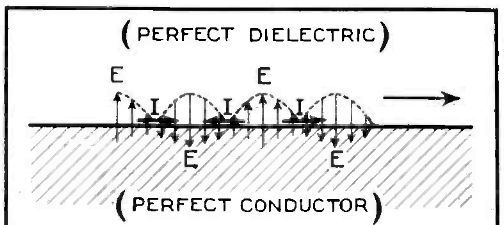


Fig. 8

be an electric field in that direction to overcome the finite resistivity of the conductor. Thus the electric field at the surface is no longer entirely perpendicular to the surface but will have also a component parallel to the surface. Thus the propagating electric field at the surface is shown "tipped" in Fig. 9.

A study of the laws relating the fields and currents in a conductor will lead to an equation for the propagation of electrical effects in a dissipative medium that is identical with that for a perfect dielectric if only an "effective" dielectric constant is used in place of the actual dielectric constant of the conductor. The effective dielectric constant is a complex quantity, the real part being the true dielectric constant and the imaginary part consisting of a term which includes the effect of the conductivity. In other words, an electric effect propagates in a conductor just as it propagates in a perfect dielectric, but the velocity of propagation is different (for the velocity is dependent upon the effective dielectric constant).

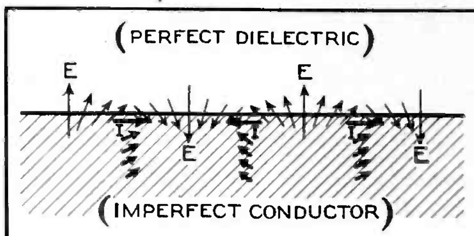


Fig. 9

Now for an electromagnetic wave in a dielectric, expressed in complex notation by

$$E\,\varepsilon^{j\,(\omega t - kx)}$$

the propagation constant, k, is known to be proportional to the square root of the dielectric constant. (The reader will probably remember this from his studies of the electro-magnetic theory of light.) In a conductor

$$\varepsilon' = \varepsilon - j\frac{\sigma}{\omega}$$

in which ε' is the effective and ε the true dielectric constant and σ is the conductivity. Thus if c is the velocity of propagation of light in vacuum then

$$k = \frac{\omega}{c}\sqrt{\varepsilon - j\frac{\sigma}{\omega}}$$
$$= \beta - j\,\alpha$$

in which β is defined as the phase constant and α the attenuation constant. Thus in metal the steady state voltage wave could better be written

$$E\,\varepsilon^{-\alpha x}\,\varepsilon^{j\,(\omega t - \beta x)}$$

which says that the phase velocity is less than that of vacuum (since $\beta > \frac{\omega}{c}$) and that the wave also attenuates. The second effect alone is due to the imperfect conductivity.

BOOK REVIEW

FORTSCHRITTE DER FUNKTECHNIK UND IHRER GRENZGEBIETE (Progress in Radio Engineering), Volume 3, by H. Günther, published by Franck'sche Verlagshandlung, Stuttgart, Germany, 1938, 214 *pages, price RM* 11.50.

This book, like the two preceding volumes, consists of a compilation of the past year's developments in the radio art. The reviewer knows of nothing in English that is comparable to this volume, the nearest approach being the annual summaries which appear in the *Proceedings of the Institute of Radio Engineers.*

This book discusses in some detail the new developments that have occurred throughout the world in the entire field of radio. Among the subjects covered are the following: vacuum-tube construction, radio-receiver developments, loudspeakers, short and ultra-short-wave apparatus, television, electron optics, and high-frequency measurements.

The final one-third of the book is devoted to a representation of the schematic diagrams of recent German radio receivers. This portion of the book may be likened to an abbreviated version of *Rider's Manuals.*

A yearly summary of developments in the radio field of this sort becomes increasingly valuable as a reference as the years pass, and this book is accordingly recommended to communication engineers. It is much to be hoped that a book such as this is made available in English for the benefit of non-German reading engineers.

R. L.

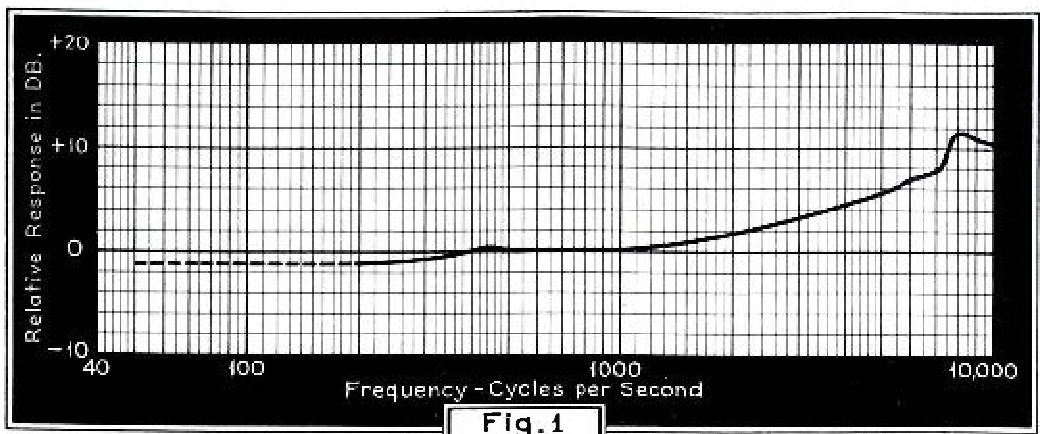


Fig. 1

ENERGY DISTRIBUTION OF SURFACE NOISE FROM A CELLULOSE ACETATE RECORD

Improvements in Disc Records Through

CONSTANT AMPLITUDE RECORDING

By A. W. DUFFIELD
Brush Development Co.

IN 1939 over fifty million dics records were sold in the United States alone. This was approximately double the number sold in 1936. The reason for this tremendous increase in interest is evidently due to the fact that the moviegoing and radio-listening public has been introduced to good music and has enjoyed it. Furthermore, disc records provide a means of retaining good programs which can be reproduced at will.

Because of this renewed demand, considerable improvements have been made in recent years in recording and reproducing equipment and associated techniques and processes. One of the most serious limitations today to good quality reproduction from disc records is "surface noise," also referred to as "needle scratch." This not only produces an irritating effect, but has restricted the range of frequencies which could be reproduced if quieter conditions existed.

Measurements have shown that the noise components in disc records are definitely more pronounced in the higher frequency spectrum and are caused mainly by tiny irregularities in or on the record surface in the form of abrasives, grain, dust, dirt, etc. These irregularities, which are of random distribution, transmit "scratch" vibrations to the stylus of the phonograph pickup.

Since the majority of phonograph pickups in use today still employ ordinary steel needles, practically all commercial phonograph records (usually shellac pressings) contain abrasives to grind these needles to fit the grooves of the records. This is necessary, since the tips of these needles do not have sufficiently accurate contours to produce good quality results. It is quite evident in these records that the abrasive materials, plus any particles deposited in the grooves during this grinding process, will contribute to the surface noise of the record.

Surface noise has been effectively reduced in some cases through the use of "scratch" filters in reproducing circuits. But this method of noise reduction has been accomplished only with a decrease in high-frequency response, usually above 3,000 cycles per second. This results in a so-called "mellowness" which some people prefer, but it cannot be considered good quality.

Some of the recent records made, particularly for radio transcription and sound studio use, are pressed from cellulose acetate or vinylite. Others are made by cutting directly on cellulose nitrate. The surface noise of these records is considerably reduced because of the smoothness of these materials, and the fact that no abrasives have been added. Also, these records are made under very accurately controlled manufacturing processes. Fig. 1 shows the energy distribution of surface noise from a cellulose acetate pressing.[1] Such records have provided from 15 to 20 db improvement in signal-to-noise ratio over commercial shellac pressings. For best quality results, it is necessary that these records be reproduced with high-fidelity phonograph pickups employing permanent jewel styli of optimum shape. In most cases, a sapphire is used because of its smoothness and hardness.

While these quieter materials and improved methods of record manufacture contribute considerably to the reduction of surface noise, it seems logical, since the noise components are more pronounced in the higher frequency spectrum, that additional noise reduction can be had by providing a higher signal-to-noise ratio in this range during recording. This consists of increasing the amplitude of the higher frequency undulations in the record in such a manner that they are considerably higher than those created by the tiny irregularities in or on the record surface. This, of course, takes into consideration that during final reproduction the same relationship which existed in the original sound, beween the high and lower frequency amplitudes, will be maintained.

This method of noise reduction can be accomplished effectively through "constant amplitude" recording by using crystal cutters in recording and crystal pickups in reproduction. Due to the inherent characteristics of these devices, this type of noise reduction requires no equalization in either the recording or reproducing circuits.

Practically all commercial records today are cut by a modified "constant velocity" method using magnetic cutters. In these records the amplitudes at the higher frequencies are considerably smaller than for "constant amplitude," and for this reason noise reduction cannot be realized in this range except through equalization.

Before discussing the advantages of "constant amplitude" recording, it may be well to clarify how this method differs from "constant velocity" recording.

In "constant amplitude" recording, constant sound pressure for all frequencies at the microphone (assuming an over-all uniform frequency characteristic up to the cutter) is represented by the same amplitude in the undulations cut in the record.

[1]H. A. Frederick, "Vertical Sound Records," *Journal of the Society of Motion Picture Engineers*, Volume XVIII, February, 1932.

Under these same conditions, "constant velocity" recording is represented by the same vibrational velocity; that is, the amplitude of the undulations cut in the record is inversely proportional to the frequency, viz.:

$$\text{Amplitude} = \frac{\text{Velocity}}{\text{Frequency}}$$

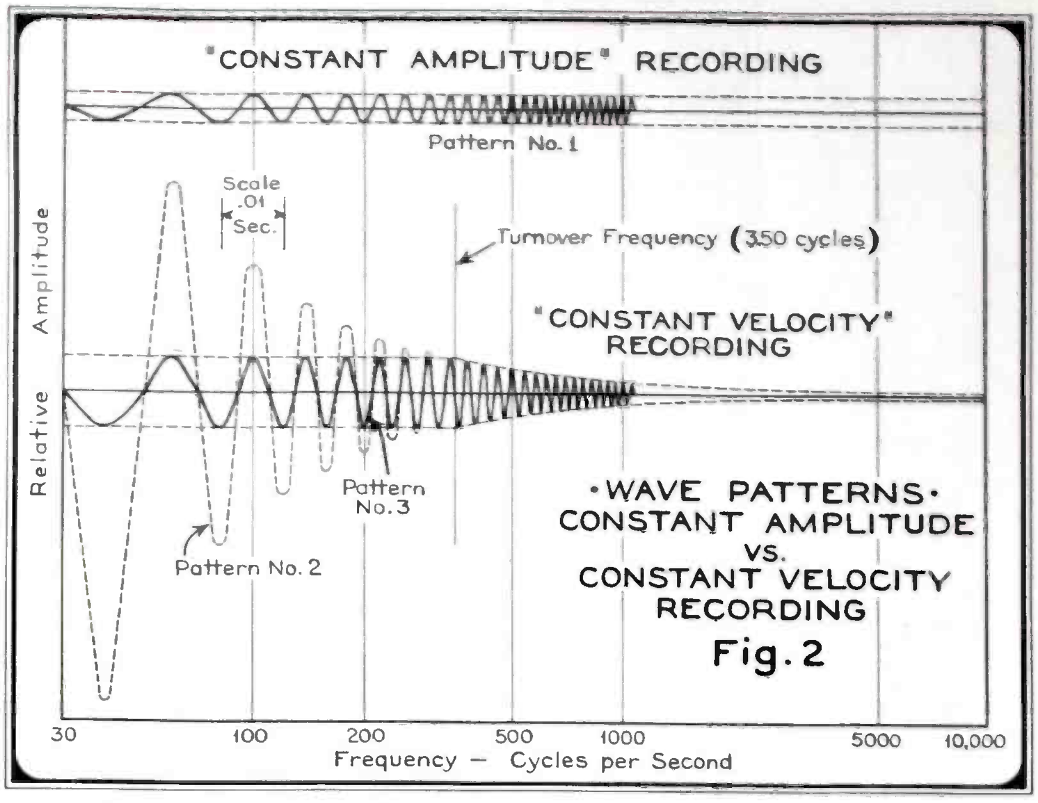
but since the velocity is constant, this may be written as

$$\text{Amplitude} = \frac{\text{K (Constant)}}{\text{Frequency}}$$

In Fig. 2, wave patterns are shown which represent groove undulations for both types of recording. These wave patterns for purposes of illustration are shown with progressive increase in frequency. In pattern No. 1, which represents "constant amplitude" recording, it will be noted that the amplitude of the groove undulations is constant regardless of the frequency. In pattern No. 2, which represents "constant velocity" recording, it will be noted that the amplitude of the groove undulations decreases as the frequency increases in such a manner that a frequency of 10,000 cps has only one hundredth the amplitude of 100 cps.

Since this latter method would necessitate excessive amplitudes at the lower frequencies to obtain sufficient amplitudes at the higher frequencies for satisfactory reproduction, commercial "constant velocity" records are usually cut "constant amplitude" from the lowest frequencies up to approximately 350 cps, as indicated in pattern No. 3, Fig. 2. (This frequency is usually referred to as the "turnover" frequency.) This is also done to permit more grooves to be recorded without danger of "cross-over" or "echo" effect.[2]

Assuming that for average recording the amplitude for a frequency of 1,000



•WAVE PATTERNS•
CONSTANT AMPLITUDE
VS.
CONSTANT VELOCITY
RECORDING
Fig. 2

cycles will be the same for "constant velocity" and "constant amplitude" recording as shown in Fig. 1, then the amplitude for a frequency of 5,000 cycles for "constant velocity" recording will be only one-fifth the amplitude for "constant amplitude" recording. (This, of course, takes into consideration that the cutters used in both methods of recording have a uniform characteristic at least up to 5,000 cycles per second.)

It is apparent from the above that "constant amplitude" recording has an advantage over "constant velocity" recording, since the cutter automatically provides the higher amplitudes at the higher frequencies required for noise reduction during reproduction.

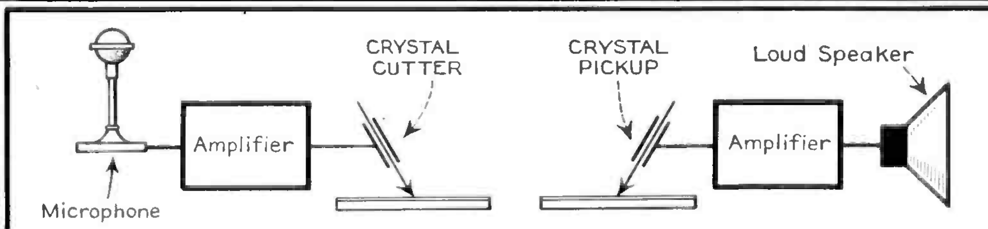
The crystal cutter is suited for "constant amplitude" recording, since its stylus displacement (amplitude) is proportional to the input voltages over its useful frequency range. Furthermore, due to the inherent stiffness of the crystal element, the amplitude and frequency response are practically unaffected by depth of cut and variations in hardness of recording materials.

In reproducing "constant amplitude" records with high-fidelity crystal pickups, the relationship of the higher and lower frequencies at the input of the cutter is maintained since the output of the pickup is proportional to the stylus displacement (amplitude) over its frequency range.

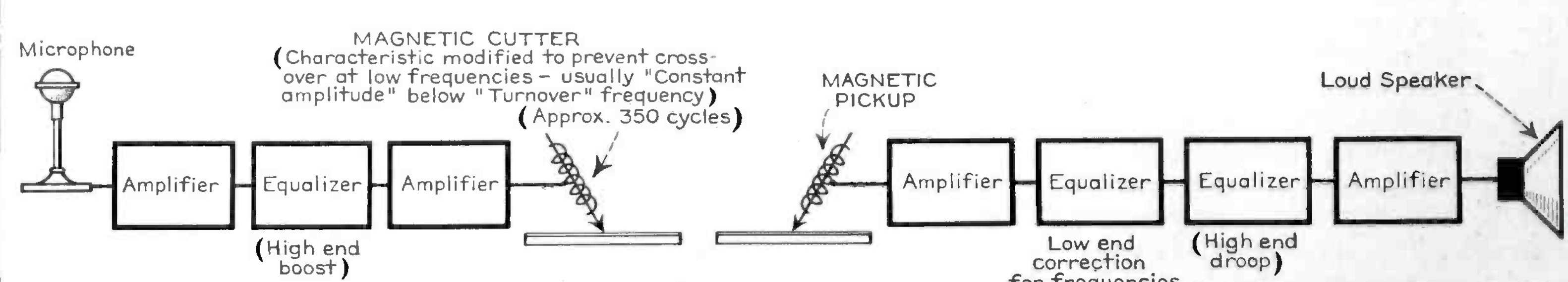
Considerable noise reduction takes place in reproduction, since the output voltages, as generated by the higher frequency sound undulations in the record,

(*Continued on page* 28)

[2] "Cross-over" effect is that condition in which one groove cuts completely over into an adjacent groove. "Echo" effect is that condition in which one groove deforms the wall of an adjacent groove.



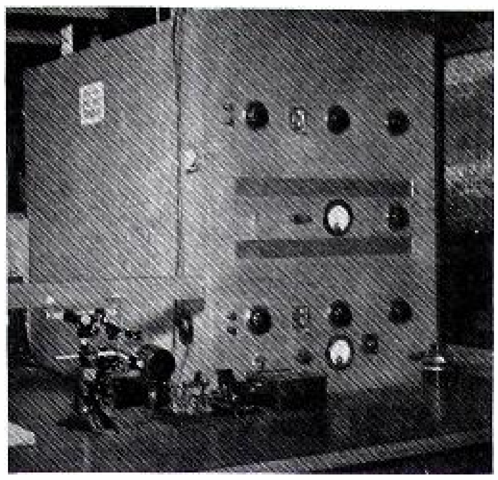
"CONSTANT AMPLITUDE"
RECORDING
WITH CRYSTAL CUTTER AND PICKUP
No equalization required
Fig. 3



"CONSTANT VELOCITY" RECORDING
WITH MAGNETIC CUTTER AND PICKUP
Showing equalization necessary to approximate "Constant Amplitude" Recording
Fig. 4

Production of THE MODERN LOUDSPEAKER

By H. GOLDEN
Plant Manager
United Teletone Corp.
(Cinaudagraph)



A specially designed "permeameter" employed to measure the characteristics of magnetic specimens.

It was scarcely a decade ago that the dynamic loudspeaker in its modern form was introduced to the radio field, yet during this period its improvement has been considerable. But as marked as its improvement in operating characteristics has been the constant downtrend in prices. The result is that today speakers considerably superior to those early ones retail at a small fraction of the earlier prices.

The universal adoption of the dynamic speaker in the radio and p-a fields created a large demand justifying large-scale production and the economies attendant thereon. But this alone could not entirely account for the improvements in both cost and quality. To determine just what other factors are involved let us consider the nearby United Teletone Cinaudagraph speaker plant.

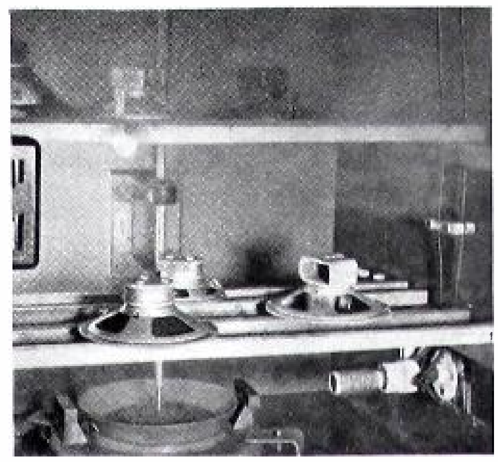
The accompanying photos and the information contained in this article are all based on this plant and its product. In some respects features found here are not typical of the loudspeaker industry as a whole, but in any event this plant serves to demonstrate the extent to which manufacturing refinements have been carried in the production of the modern loudspeaker.

In addition to the main speaker lab there are separate magnet, metallurgy, chemical and test labs each concerned with its particular phase of the work.

The reason for all this is that every operating part of all Cinaudagraph speakers is designed—and for the most part made in its entirety—right in this one plant, only the most basic of raw materials coming from outside. Not only that, but all tools, dies and jigs are designed, and actually made in a special department for that purpose. This department has built most of the mechanical equipment used throughout the plant.

These speakers are being tested for their rust- and dust-proof qualities.

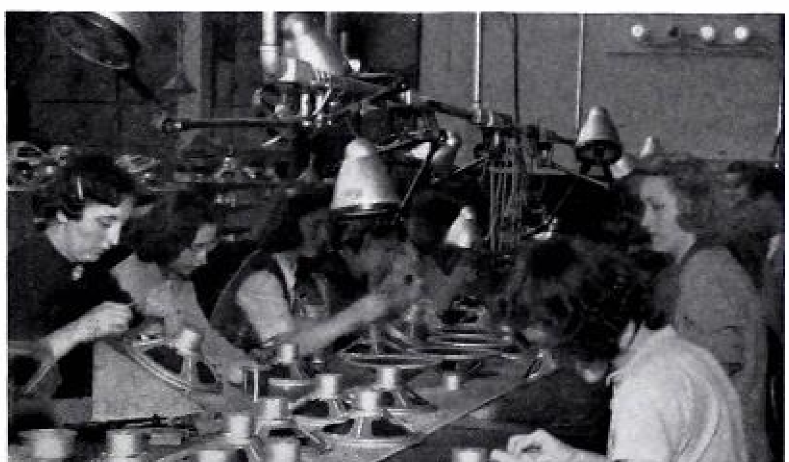
Lower left: Approaching the end of the assembly line. Lower right: Another part of the speaker assembly line.

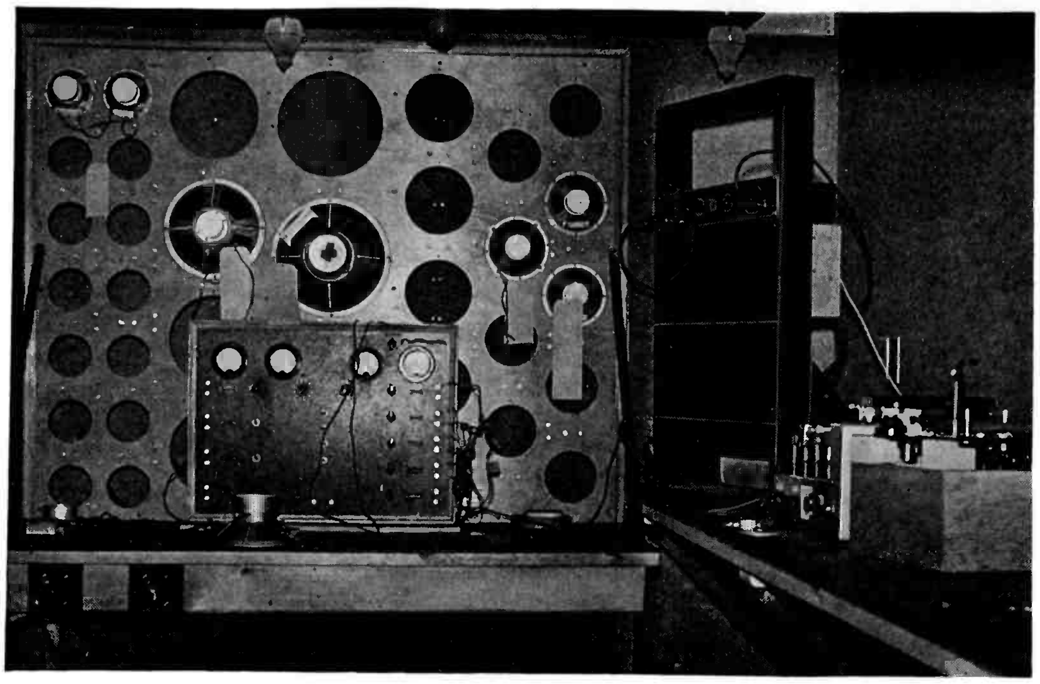


A fog-filled humidity chamber in which various types of atmospheric conditions can be simulated.

All magnets are rough cast in an affiliated plant from exclusive formulae of the metallurgy lab. These castings are then heat-treated and otherwise processed, finished and magnetized in the plant magnet department. The magnet output is so geared that large stocks of the valuable finished magnets need not be maintained. Instead they are normally produced in the types and quantities called for by current speaker production schedules and orders on hand.

Every step in making cones, from compounding the pulp to the finished cone, is the work of one department. These cones are of special patented construction, made by the flotation process, and of such design that compliance rings or corrugations are not required except at the very edges. Instead graduated compliance within the polyfibrous, cellular structure of the material itself provides for proper handling of all fre-





Above: Speakers being tested under full load conditions.

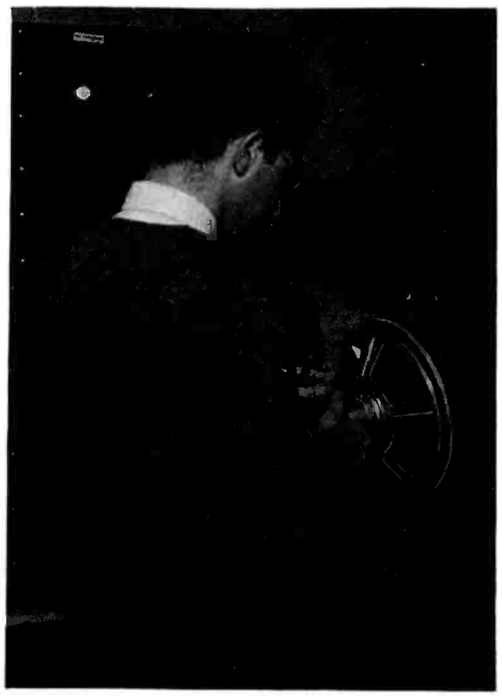
quencies and varying degrees of air coupling.

The voice coil is unique in that the entire assembly including coil and form is of metal. Although the wire for the coils is brought in from outside, even this is reprocessed in the plant to convert it from standard (and always readily available) round wire to the ribbon form employed in the various speaker types. The form is of "Acim," an exclusive metal developed in the metallurgy lab. This metal is basically light in weight and is sufficiently strong and rigid that when rolled to paper thinness it still provides adequate stiffness to drive even the largest cone. It offers the further advantages of imperviousness to moisture, good heat radiation, and the reduced overall thickness of the voice coil permits use of a smaller gap with increased magnet efficiency.

Thus the main operating elements—magnet, cone and voice-coil, are produced as needed with no worry about delayed deliveries and with minimum inventories (except such as may be accumulated during slack periods in preparation for peak speaker production periods).

In the actual assembly of the speakers there are the usual conveyor-belt production lines, but with the advantage that every production line is capable of handling the assembly of any one of the speaker types manufactured, including not only the regular line but also those made to the special requirements of individual radio set manufacturers. Thus if a large number of one speaker type is to be produced more than one line may be swung in on it.

This arrangement is simplified by the fact that every speaker, regardless of size and type, involves exactly the same assembly operations. Magnet and cone compositions may differ, but the assembly details are identical. An operator need therefore be trained in only a single operation and can perform it with equal facility on any speaker type, or can be shifted from one line to another as needed, providing complete labor flexibility with more steady employment and minimum labor turnover.



Above: Speaker being tested for performance.

Below: One of the steps in heat treating magnet iron.

A special development of the engineers is a form of assembly which automatically insures accurate alignment of the voice coil in the gap and at the same time eliminates the factor of human error. This is accomplished through the use of two sub-assemblies, one consisting of the cone and voice coil, the other the magnet itself. The cone assembly is precisely centered in the frame by means of a centering device which also serves as the suspension web. A special moisture-proof centering net developed in the laboratory assures centering with ample axial freedom. This design eliminates spiders, screws and lock-washers—the adjustment of which tends to slow down production, and it also avoids subsequent misalignment of the voice coil in service.

On the production line the voice coil is mounted on the cone. The chassis suspension web, magnets, transformers, etc., are fed into the line at appropriate points, to come out at the end as finished speakers. Actually these speakers continue on the conveyor belt right into a sound-proof cubicle at the end of the line where every individual speaker is tested in actual operation on a variable audio tone generator which periodically sweeps through the audio-frequency range. The tester can instantly detect any subnormalities in either frequency response or power handling ability, or any other electrical or mechanical defects in the individual speakers.

Still more comprehensive operating

(*Continued on page 37*)

At The BROADCAST ENGINEERING CONFERENCE

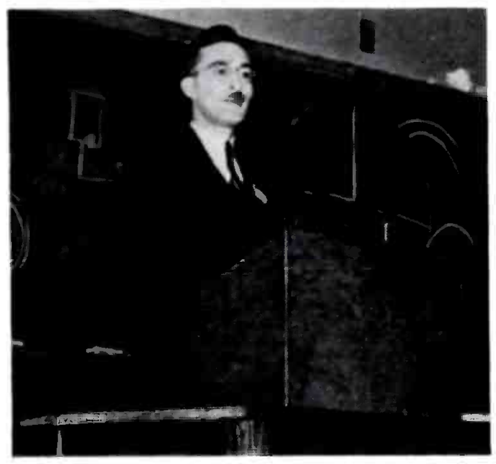
R. N. Marshall, of the Bell Telephone Laboratories, demonstrating a uni-directional microphone.

THE 1940 Broadcast Engineering Conference, which was held at Ohio State University from February 12 through 23, was a distinct success. As a matter of fact, these gatherings have been growing in popularity since they were first started in February, 1938. This year's meeting had additional significance since it also served as an engineering convention for the National Association of Broadcasters.

As in previous years, speakers and discussion leaders were selected from those organizations actively engaged in the solution of the problems considered. Much interest was evidenced in the discussions on frequency modulation which were conducted by Major E. H. Armstrong, Columbia University, Paul deMars, Yankee Network, and H. P. Thomas, I. R. Weir and R. F. Shea, all of the General Electric Co.

The subject of television also received its share of attention, with Raymond F. Guy and Robert Morris, of the National Broadcasting Co., describing the television service of W2XBS. Also, T. L. Gottier, RCA Manufacturing Co., compared television measurements with broadcast station measurements.

I. R. Weir, General Electric Co., who described G.E.'s experience with frequency modulation.



H. J. Schrader, RCA Manufacturing Co., discussing broadcast station measurements.

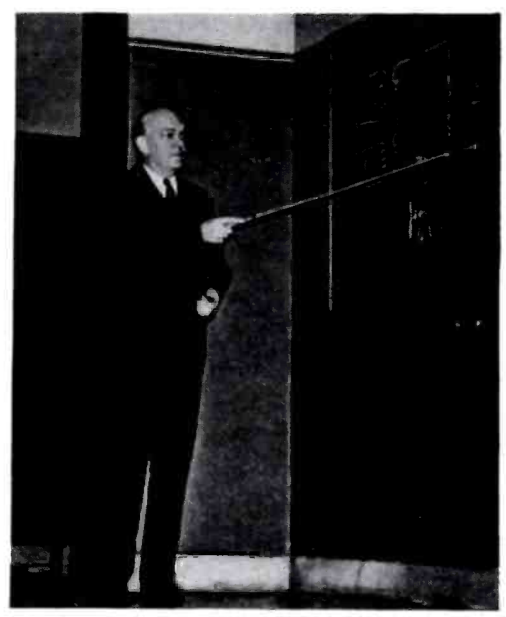
Other subjects discussed were: "Broadcast Station Measurements," by H. J. Schrader, RCA Manufacturing Co.; "Ultra-High-Frequency Propagation," by H. O. Peterson, RCA Communications; "Studies of Noise," by J. H. DeWitt, WSM; "Microphones," by R. N. Marshall, Bell Telephone Laboratories; "Transcription Recording and Reproduction," by R. A. Lynn, National Broadcasting Co.; "Audio-Frequency Testing by Means of Square Waves," by L. B. Arguimbau, General Radio Co.; "CBS Broadcasts from Europe," by A. B. Chamberlain, Columbia Broadcasting System; "Foreign Relations in Broadcasting," by Gerald C. Gross, Federal Communications Commission; "Some Engineering Aspects of International Broadcasting," Raymond F. Guy, National Broadcasting Co.; and "The Lawyer and the Engineer," A. W. Scharfeld.

W. L. Everitt, Director of the Conference, demonstrating f-m with a mechanical model.

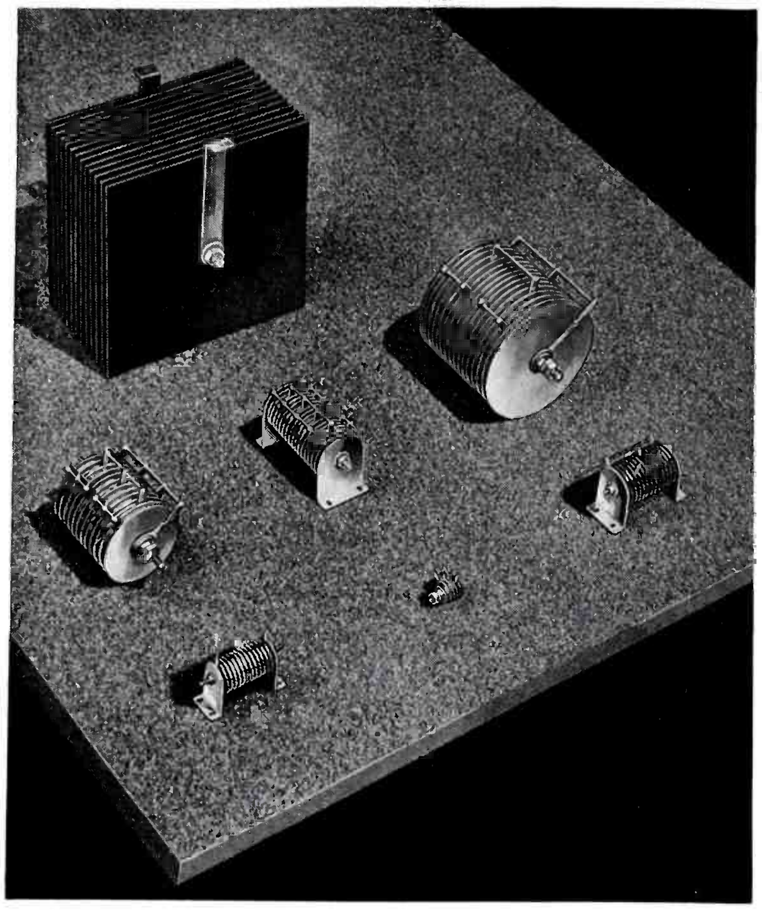
In addition to the foregoing, another interesting feature of the conference was a round table discussion on receivers conducted by D. D. Israel, Emerson Radio, Wm. F. Cotter, Stromberg Carlson, and R. M. Wilmotte. There was also a general discussion and question box handled by A. D. Ring, Federal Communications Commission, and by R. M. Wilmotte.

All in all, the 1940 Broadcast Engineering Conference was well worthwhile. In addition to the timely subjects selected for the gathering, the informal nature of the meetings and the round table discussions contribute much to the success of the conference. Much credit should be given to W. L. Everitt, Director of the Conference.

Major E. H. Armstrong, Columbia University, discussing various aspects of frequency modulation.



Some Notes on SELENIUM RECTIFIERS



A group of selenium rectifiers.

ALTHOUGH selenium rectifiers have been used abroad for several years, it is only recently that they have been introduced in this country by the International Telephone Development Corp. The combination of metals which makes this rectifier effective was discovered during research on light-sensitive cells.

Basically the selenium rectifier makes use of the rectifying properties of selenium which has been subjected to certain carefully controlled processes. Simplicity is attained by combining all rectifying essentials in one metal plate, groups of which are assembled in various sizes and arrangements to meet requirements.

The combination of selenium and iron has the useful property that current will flow easily in the direction iron to selenium but hardly at all in the other direction. In other words, selenium rectifiers present a very low resistance to current flowing from the iron to the selenium and a very high resistance to current flow in the reverse direction. Fig. 1 shows the relation between the potential difference across a selenium rectifier plate and the resulting currents in the forward and reverse directions.

No special means of cooling are required with the selenium rectifier due to its high efficiency and high permissible plate temperature. The relationship of plate spacing to plate diameter has been chosen for optimum cooling. Since the current which may be carried by one of these units is limited only by the maximum allowable plate temperature (75° C.), the current output can be increased by the provision of forced ventilation or radiating fins. However, internal losses are increased for a rectifier used in this manner beyond normal rating.

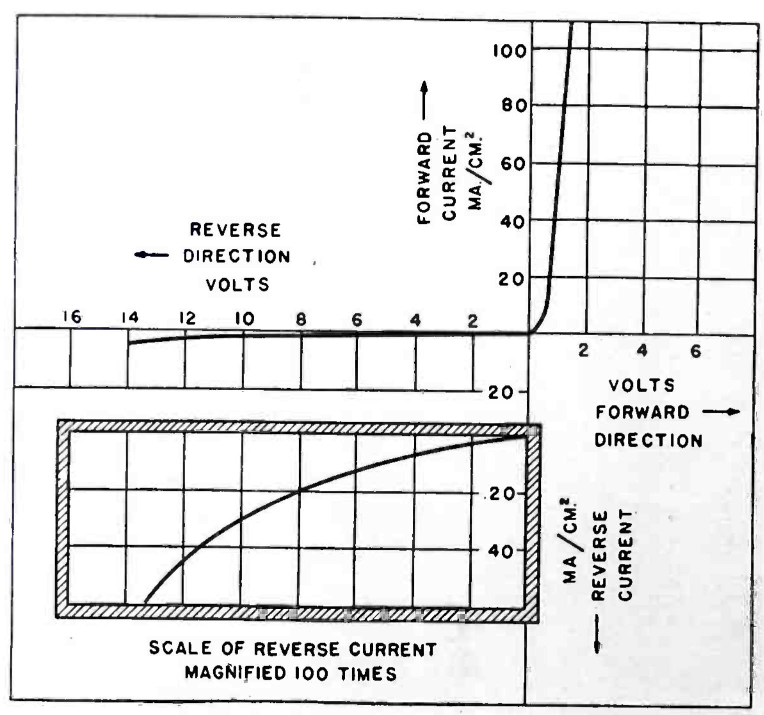
The efficiency of these units is between 65 and 85 percent, depending upon circuit arrangement. This efficiency is maintained from approximately 20 to 150 percent of full load. This type of rectifier has substantially unity power factor.

The voltage regulation of these instruments is good, due to the low forward resistance. For a single-phase bridge rectifier with a resistance load, the mean d-c output voltages at full load and at no load are respectively about 77 and 90 percent of the r-m-s input voltage. Hence, the regulation from no load to full load is of the order of 15 percent.

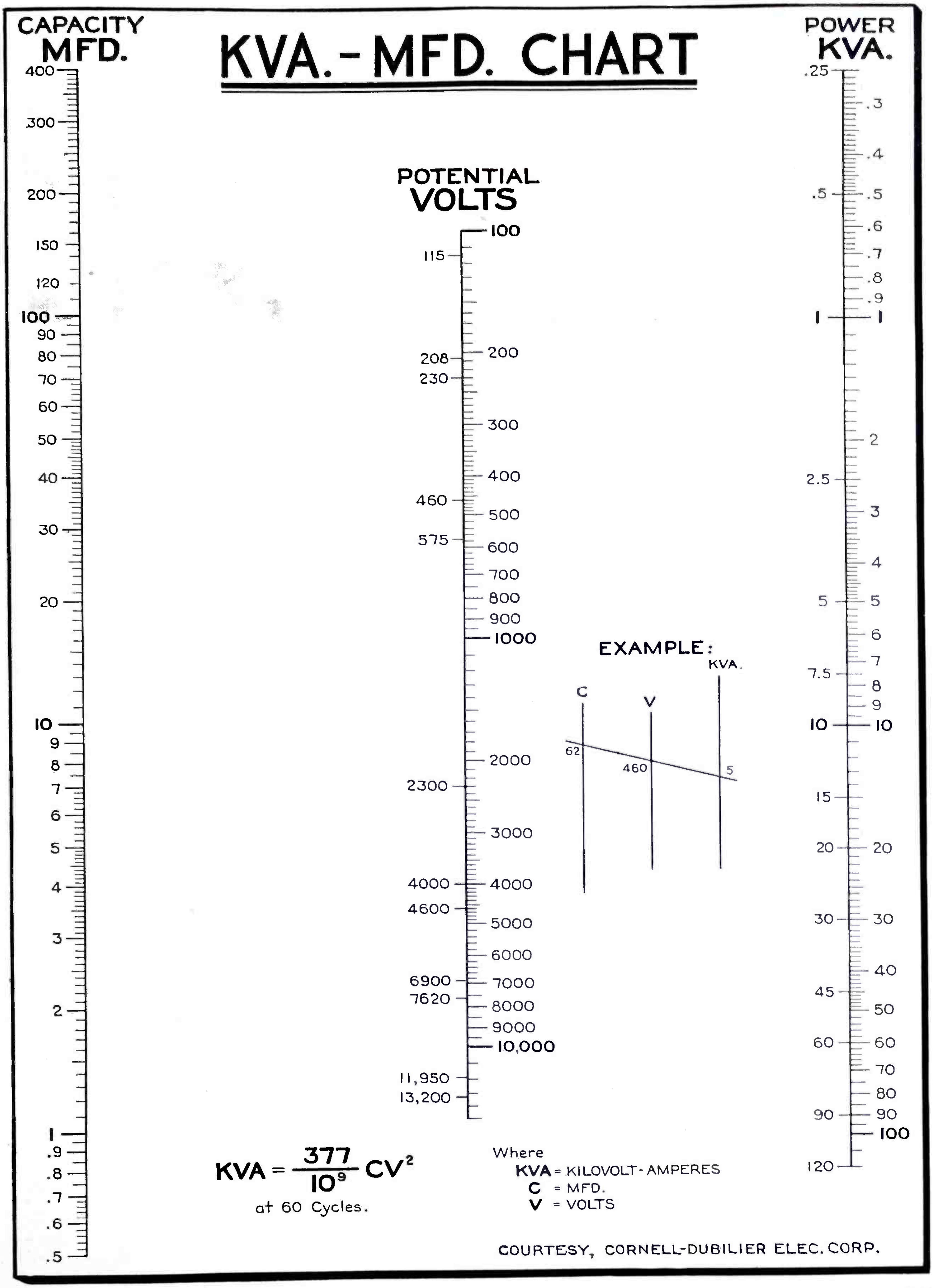
Experience shows that in common with other metal rectifiers, the selenium rectifier ages slightly, i.e., the forward resistance increases slightly during the first 10,000 hours of use, remaining constant thereafter. However, the change in output voltage is slight and is compensated by a 5 percent tapping on the transformer.

High working temperatures and high permissible back voltage on the rectifier plates also offer another advantage. It permits the use of fewer plates and results in lighter and smaller units.

Fig. 1. Static characteristic of selenium rectifier plate (effective surface, 1 cm²).



KVA.-MFD. CHART



$$KVA = \frac{377}{10^9} CV^2$$

at 60 Cycles.

Where
KVA = KILOVOLT-AMPERES
C = MFD.
V = VOLTS

COURTESY, CORNELL-DUBILIER ELEC. CORP.

TELEVISION ENGINEERING

FUNDAMENTALS OF TELEVISION ENGINEERING

Part VII: Television Receivers*

By F. ALTON EVEREST
Dept. of Electrical Engineering
OREGON STATE COLLEGE

As far as the basic principles of operation are concerned, the television receiver does not differ from the usual broadcast sound receiver. The television receiver does differ greatly in several details, however. The carrier frequencies are much higher for the television receiver (44 to 108 megacycles for seven channels) which alone demands many refinements for satisfactory operation. The television receiver must receive and care for two carriers simultaneously, one for sight and one for sound. The sound channel must be very wide (about 2 to 4 megacycles) to pass the high-frequency components of the normal video signal. The existence of this wide pass band introduces problems concerning noise. Although this ultra-high-frequency region is practically immune from natural static, it is particularly vulnerable from man-made interference such as that generated by automobile ignition systems, street cars, diathermy machines, various domestic appliances, etc. The interference generated by many of these devices is of a random character having its energy distributed more or less evenly throughout the spectrum. The gain of the video channel is thereby somewhat limited due to the wide pass band and the resulting greater noise level. This means that the sensitivity of the television receiver is less than the ordinary broadcast receiver. The necessity for wide video pass bands results in the realizing of only a relatively low gain per stage, more or less offsetting the lower sensitivity advantage economically.

TABLE I
Probable frequency relationships when receiver tuned to television channel I (44-50 mc)

Picture carrier frequency	45.25 mc*
Sound carrier frequency	49.75 mc*
Oscillator frequency	58.00 mc
Picture IF frequency	12.75 mc*
Sound IF frequency	8.25 mc*

*Plus sidebands.

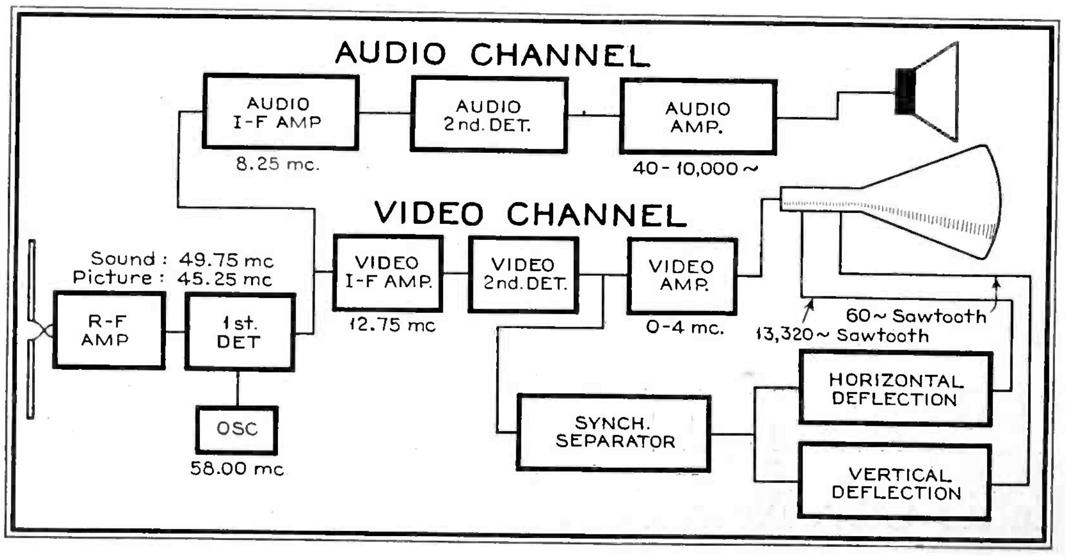
Above: Fig. 7. Smallest RCA receiver (5" c-r tube).
Bottom left: Fig. 1. Block diagram of typical receiver.
Bottom right: Fig. 6. Rear view of large RCA receiver.

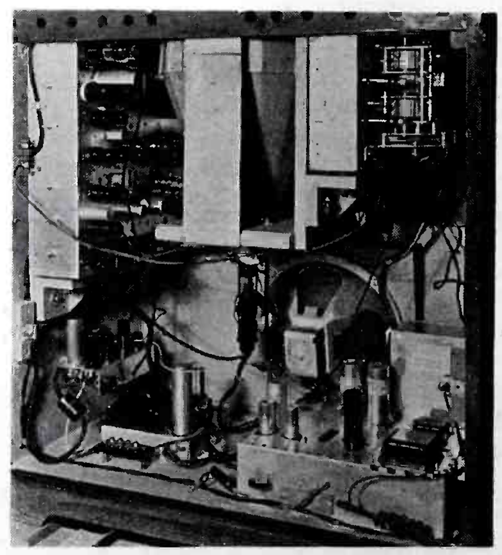
The superheterodyne receiver has been almost universally adopted for television receivers. The tuned-radio-frequency receiver can be used, but economic considerations rule largely against it. Serious variations of sensitivity and pass-band width throughout the tuning range are also detrimental.

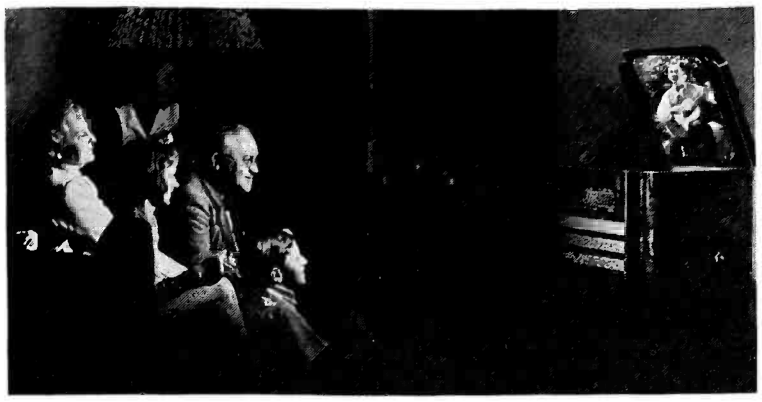
Fig. 1 shows a highly simplified block diagram of a typical television receiver for both sight and sound. The degree of simplification of Fig. 1 can be realized by counting the number of tubes in the television receivers now on the market in this country. The number varies from 16 tubes for a 5-inch receiver designed to use the audio power amplifier of a usual broadcast receiver to 32 tubes in a receiver having a 12-inch cathode-ray tube which is complete plus an all-wave receiver. The usual sight and sound receiver complete utilizes about 25 vacuum tubes. Future development and research will undoubtedly lead to simplification.

The radio-frequency amplifier, if one is included, amplifies both the video

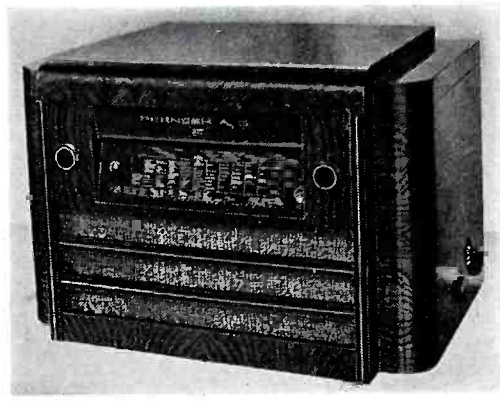
*Parts I-VI appeared in April-Sept. 1939 COMMUNICATONS.—Ed.







Left: Fig. 12. The Fernseh HPE-5-R receiver in use. Note directional screen affixed to lid in viewing position. Picture size 17 x 20".



Right: Fig. 11. The Fernseh HPE-5-R receiver.

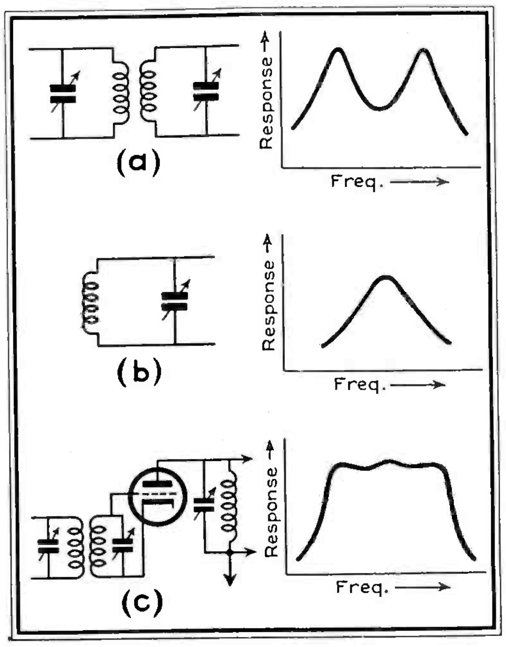
Below: Fig. 2. Various response characteristics.

carrier and its side-bands and the audio carrier and its side-bands at the same time. This is accomplished by designing the tuned circuits to give essentially uniform response over a wide band and yet provide ample discrimination against unwanted signals. This usually entails the use of a coupled circuit rather than a heavily loaded single-tuned circuit, because the selectivity for a given band width is better for the former. The new high transconductance type 1853 tube is almost universally used in this position, because it will give a satisfactory stage gain with relatively low plate load impedance.

As shown in Figs. 3 and 4 of Part II*, there is a constant spacing of 4.5 megacycles between audio and video carriers in each of the television channels when arranged for single-side-band transmissions. This paves the way for simplification of tuning controls, as both the sound and sight signals may be tuned by the same operation. This spacing of 4.5 megacycles has superseded the 3.25-mc spacing which is discussed in the first twelve references in the bibliography. The process of re-adjusting a receiver to accommodate the new sound-sight carrier spacing of 4.5 mc is a minor one, however.

The output of the radio-frequency amplifier is fed to the first detector or converter stage. Here the local oscillator signal is heterodyned with the incoming signal resulting in sum and difference frequencies as in the conventional superheterodyne receiver. The oscillator may be adjusted to operate at a frequency above that of the incoming signal. The sound carrier is always at a higher frequency than the video carrier by 4.5 mc. This would cause the video intermediate-frequency (i-f) channel to lie at a higher frequency than the sound i-f channel, which is helpful in designing the video i-f channel circuits to pass the necessary band width. The various frequency relationships when the receiver is tuned to accept the lowest frequency television channel (44—50 mc) are shown in Table I.

*Communications, May, 1939, p. 26.

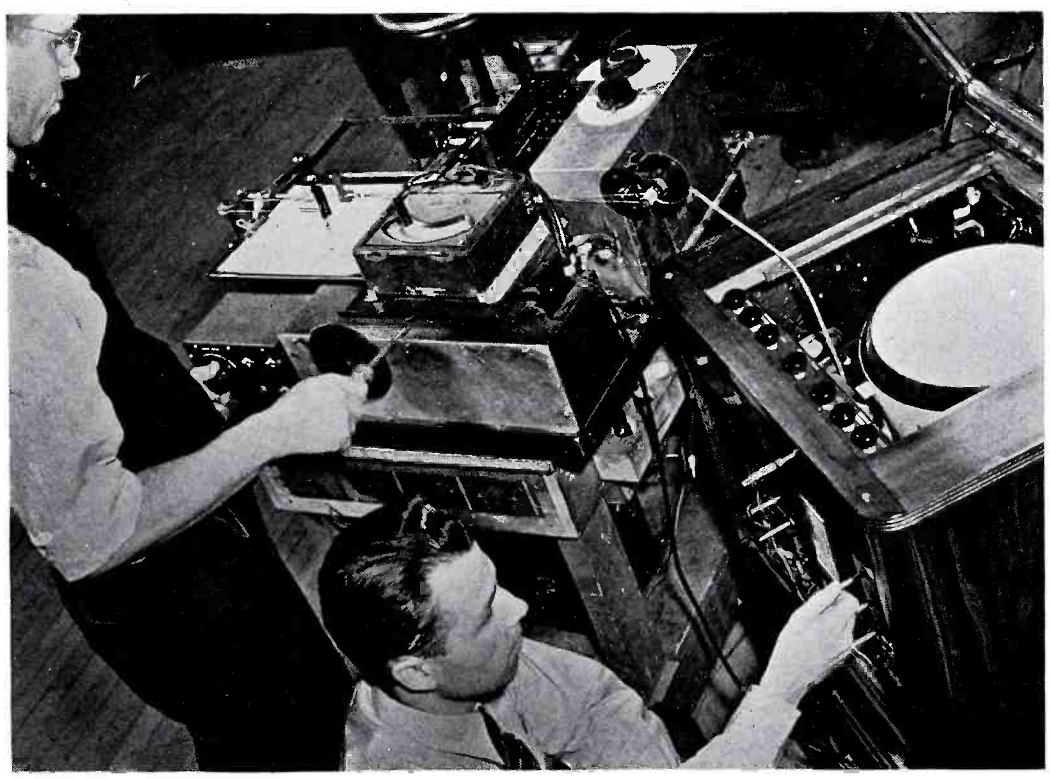


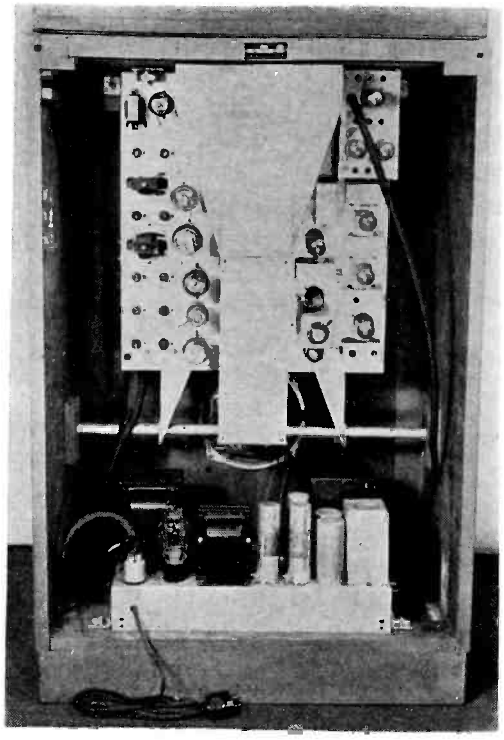
It will be noted that the intermediate frequencies are selected in the order of 10 mc. This choice is determined by the necessity of avoiding strong signals from local transmitters at the intermediate frequencies. As amateur transmitters are probably the most likely sources of interference, the 7 and 14-mc amateur bands must be avoided. A lower picture i-f is not practical since with even 12.75 mc, a video-frequency band of 4 mc represents about 30% of the intermediate frequency. This complicates circuit design to achieve the necessary pass band.

The television receiver is actually two separate receivers beyond the converter stage. The sound only is accepted in the sound i-f channel for it is tuned sharply to that frequency. The

Below: Fig. 8. Checking frequency response in RCA plant.

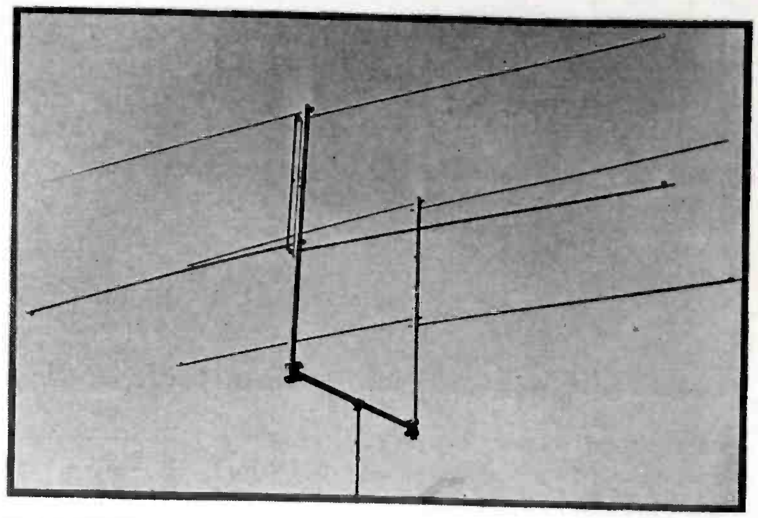
Left: Fig. 5. Front view of RCA receiver with 12" tube.



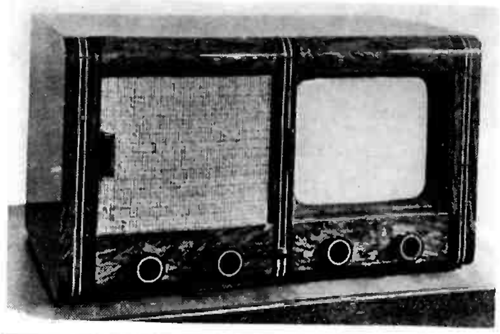


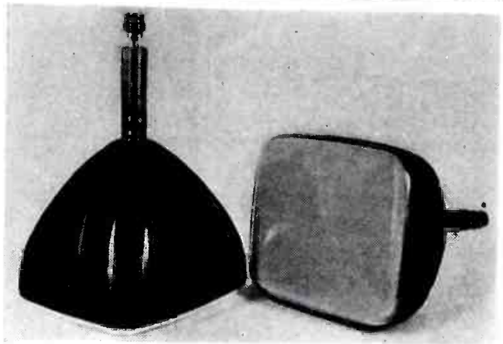
Left: Fig. 4. Rear view of Philco receiver.

Right: Fig. 13. An RCA antenna kit.



Below: Fig. 9. A table model receiver put out by Fernseh A. G. and Telefunken in Germany. Picture size approx. 7.7 x 8.9". Fig. 10. Picture tubes used in receiver of Fig. 9. Note shape of tube. Photo courtesy Fernseh, A. G.





picture signals are passed through the picture i-f channel, as the sound channel is not sensitive to frequencies lying within this range. It is interesting to point out that a short-wave broadcast type receiver tuned to 8.25 mc for channel I could replace the entire sound channel of the television receiver including i-f amplifier, second detector, audio amplifier, and loudspeaker. The broadcast receivers now appearing with claims that they are "wired for television" usually mean that the input terminals of the audio power amplifier are brought out, such as for a phonograph pickup.

The sound carrier and its sidebands are greatly amplified in the i-f amplifier and are then demodulated at the second detector. The audio voltage derived drives the audio amplifier which in turn drives the speaker in the usual manner.

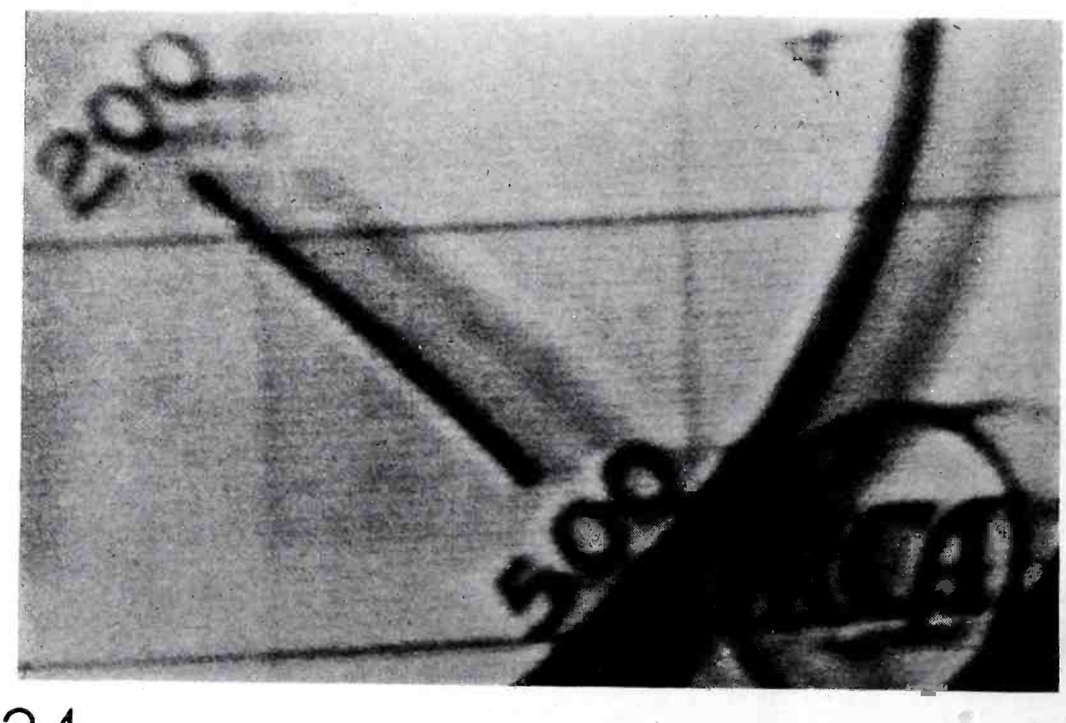
The picture signal is greatly amplified in the video i-f channel, passed to the video second detector, and this demodulated video signal is conducted to the grid of the cathode-ray tube through a video amplifier. A signal of 10 to 50 volts peak-to-peak is necessary to drive the cathode-ray spot from full brilliancy to cutoff.

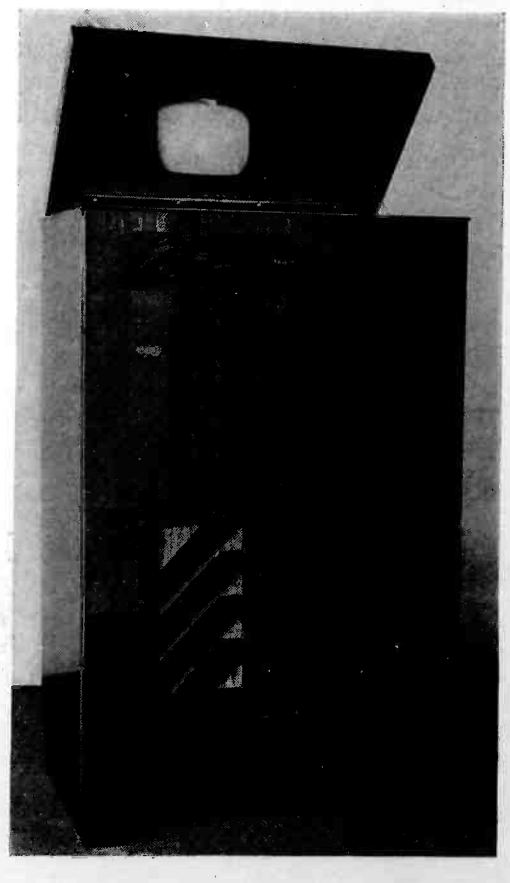
The video i-f amplifier circuits are quite interesting, especially in the manner in which the wide response range and steep sided characteristic is obtained. Fig. 2 shows one method[16, 17] of obtaining excellent characteristics. Fig. 2a shows the response characteristics obtained from an over-coupled, double-tuned radio-frequency transformer. The tighter the coupling, the farther apart the peaks occur. Fig. 2b shows the familiar response characteristics of a single, parallel-resonant tuned circuit. By placing one in the grid and the other in the plate circuit of a vacuum tube, the curve at (b) fills up the gap of (a) if the design is correct and the adjustment properly made. Several such stages will be necessary to build the sides of the composite characteristic up to a steepness sufficient to guard against any of the sound signal being passed and applied to the picture tube grid. There are other coupling networks by which the desired wide pic-

(*Continued on page 29*)

Right: Fig. 3. Front view of Philco receiver.

Below: Fig. 14. Effect of multiple reflections on received image.





TELEVISION LIGHTING

Part II*

By W. C. EDDY
National Broadcasting Co.

Photo (Charlotte Manson) taken from kinescope, illustrating use of light and shadow. Lighting from portrait equipment.

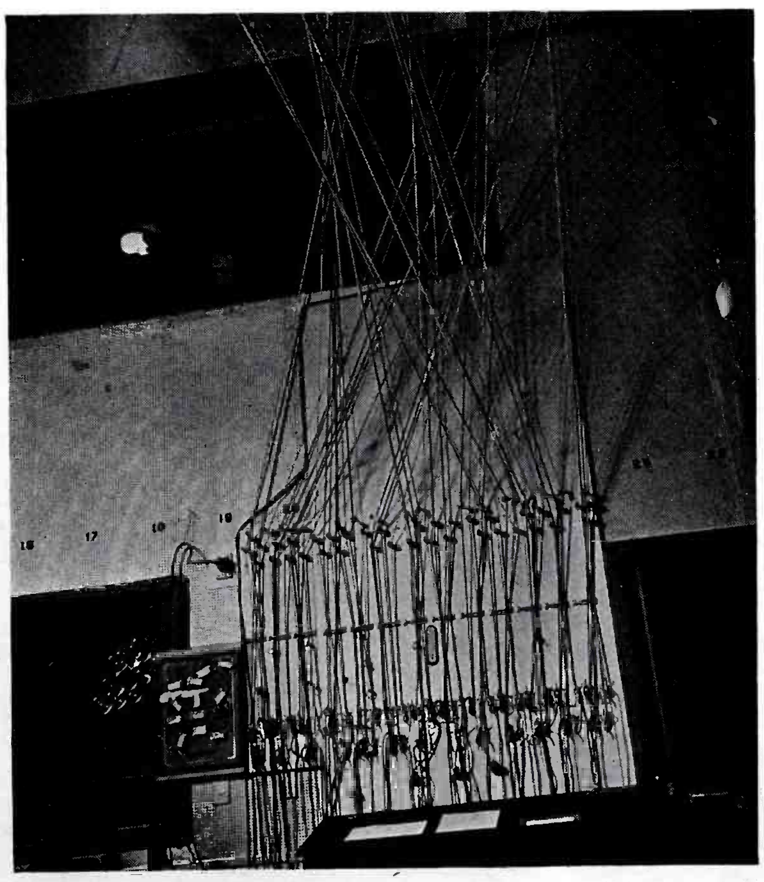
*Part I appeared in May, 1939, COMMUNICATIONS, page 17.—Editor.

As a result of two years' experimentation, the National Broadcasting Company had developed a set of specifications descriptive of a satisfactory lighting system for television. It remained to design the equipment incorporating the usable characteristics of the various types of light under test.

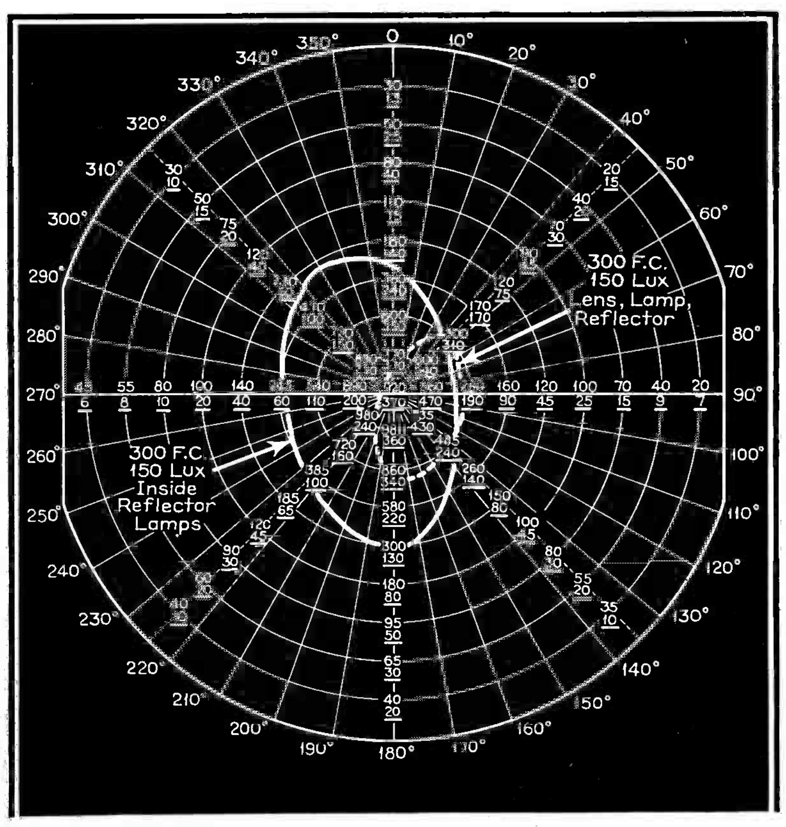
An incandescent source of light had been agreed upon as a satisfactory type of illumination. From the economic viewpoint, a standardized lamp of approximately 1,000 hours life appeared to be the most logical choice, providing that such a lamp in the wattage required would be available on the market. Our experimentation had further specified that the unit be of relatively high efficiency, a factor that concerned both the lamp and the reflector. Other qualifications related to the weight of the assembly, its freedom of movement, its angular throw and the general characteristics of its radiated beam.

In order to establish the relative efficiencies of the several types of lamps that were available to us, we conducted a series of photometric tests in the studio. Rather than compile data that had already been established in the testing laboratories, we arranged a typical three kilowatt bank as our test unit. By suspending this unit over an area marked out with polar coordinates on the studio floor we were able to analyze the nature and quality of light from each of the competitive assemblies under test. In this manner we were able to estimate the pattern size and shape as well as compute the approximate efficiency of one type of light over another. Typical of the findings of these tests are the curves in Fig. 1. The comparative pattern size and light distribution over a given area can best be judged from the 300 foot candle isolux curve illustrated. In this test the dotted line represents the inside silvered lamp and the solid line the lens, lamp and reflector unit. By totalizing the various readings on this graph we were able to establish an index figure indicative of the light furnished the area under observation. To further insure that our assumptions were reasonably correct, measurements of the current consumed by the test lamps were conducted and further tests were made to determine the amount of waste light in each installation. As a result of these experiments, we anticipated better than twice the amount of light per watt consumed by adopting the inside silvered lamp.

Our first fixture was relatively simple, although it still finds application in the studio as a strip light for back-



Left: Lighting control panel for flexible lights. Photos by Wm. Haussler, NBC. Below: Fig. 1. Approx. efficiency of various types of light.



ground illumination. The framework is constructed of short sections of seamless steel tubing with the six sockets arranged so that the beams of the separate lamps interlock approximately eight feet from the fixture. This provides a naturally diffused light on throws in excess of ten feet.

The unit, which we call the "single six" mounted 500-watt lamps and was suspended from the overhead gridiron by a swivel clamp which approximated universal action about the point of suspension. It was possible and practical to direct the radiation of this bank in any direction by merely adjusting the arm and securing a single swivel clamp. Although this flexibility in operation answered many of the immediate problems in the studio, it still required considerable time and application to set the lights for a new set. To simplify the arrangement on the gridiron, the long "single sixes" were compressed to the "double threes," a change in structure which remodeled the radiated beam from a diffused sheet of light into a more easily operated diffused beam.

Above: Remotely controlled foundation mounted on ceiling. Below: As seen from control room.

This type of arrangement for six lamps is now used for all general purpose lights in the studio.

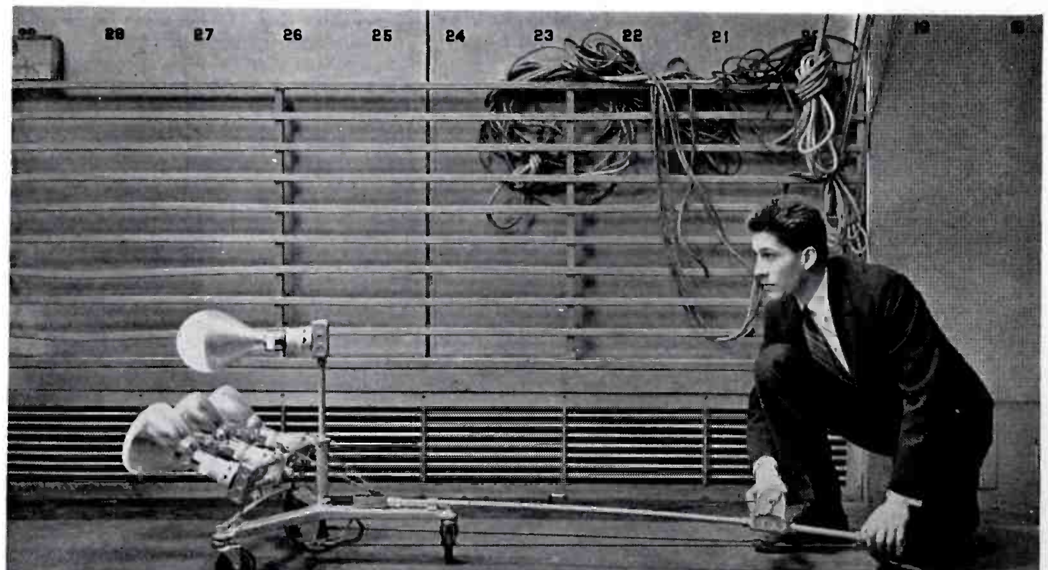
Finding that it was generally necessary to reinforce the lighting near the wings of a set, a "single three" was constructed for this work. These units prove to be most valuable for special lighting effects and can generally be put into use where the larger assemblies can not be worked. Two of the "double threes" were rebuilt for floor work, mounted on portable stands, and used from stage right and left to create the rough modeling effects on the set.

Observation of the studio temperature and lighting load during this period confirmed our previous assumptions as to the efficiency of the lamps in use. With light available for larger and more complicated sets neither the electrical load nor the studio ambient temperature registered a marked increase over the average operational mean of the previous year.

In estimating the performance of this system in view of the specifications that had been determined from other types of illumination equipment, we found indications of satisfactory progress. We were able to produce more light with less kilowatts, we could direct our light more easily, and on more sets than had been possible previously. The ambient heat problem had been reduced to a more reasonable ratio to the light used in the studio and the general quality of lighting in the programs was beginning to show improvement. On the other hand we were still forced to shift the lighting manually from one set to the next during the film interludes in the studio program. An alternative was to install sufficient equipment over-

(Continued on page 37)

Below: Remotely controlled foot lights.



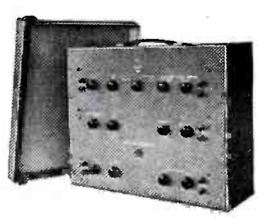
RCA offers complete TELEVISION service to the broadcaster

TELEVISION CAMERAS

RCA television cameras have been designed for studio or field use and for film transmission. They make use of the Iconoscope, the all electronic pick-up tube or the newly developed Orthicon—a low velocity Iconoscope. RCA cameras are equipped with first class optical systems and various focusing and framing devices to add to the ease of operation.

NEW FIELD PICK-UP EQUIPMENT

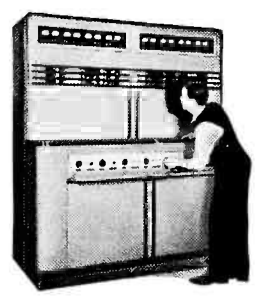
Television has been given 7-league boots and a multitude of new program sources have been opened up by new field pick-up apparatus developed in RCA Laboratories. Costing about one-sixth as much . . . weighing about one-tenth as much . . . consuming about one-fifth the power required by former mobile television units, the equipment is built into cabinets about the size of a suitcase and may be carried easily in passenger cars or light trucks.



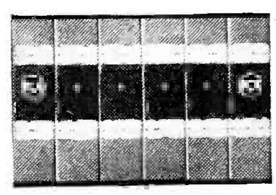
TELEVISION TEST EQUIPMENT

RCA has developed a number of high-quality instruments to meet the exacting requirements of television. These include a 9″ Special Cathode-Ray Oscillograph, a Square-Wave Generator, a Video Sweep Oscillator, R-F and I-F Sweep Oscillator, Sweep Rectifier, and other units essential to the television broadcaster.

RCA 1 KW PICTURE TRANSMITTER, TYPE T-1



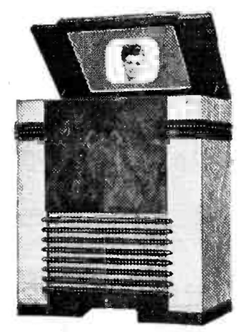
Product of RCA's extensive research and field tests is the RCA Picture Transmitter, Type T-1. Built to commercial standards, it offers a number of important circuit developments. It is crystal controlled and AC operated. The tubes have been designed expressly for this application. The transmitter is easy to install and easy to operate.



VIDEO EQUIPMENT

In the studio, video equipment engineered by RCA is housed in racks. The synchronizing generator, the power supply units . . . and equipment required for amplification and for supplying suitable deflection voltages for the camera . . . all are arranged for accessibility as well as for carrying off heat from components and tubes. RCA video apparatus may be obtained in rack and panel design for any number of camera channels or in simplified cabinet form for use with one camera only.

RCA VICTOR TELEVISION RECEIVERS



Completing the television chain, are the RCA Victor Television Receivers. The performance of these instruments has justified over and over again the vast sums spent in research and field tests. Thanks to this performance, the consumer has received a favorable first impression of television.

RCA

TELEVISION EQUIPMENT

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of the Radio Corporation of America

AIRCRAFT ANTENNAS

(*Continued from page* 8)

about six feet to each side of the center line of the airplane, and are welded assemblies of metal tubing. Though this altimeter is still in its experimental stage, the fact that it measures the height of the airplane above the ground rather than the height above sea level, gives it wide possibilities. The extent of its success will undoubtedly be evident within the next few years.

Tables I, II and III have been prepared to summarize the various types of antennas used upon aircraft. Fig. 6 illustrates many of the present types as installed on a United Air Lines Mainliner. In this installation six distinct antenna types are carried. Other types that will undoubtedly be carried within the next few years are those used in connection with the absolute altimeter and the instrument landing system.

Although antennas and their associated radio and electrical equipment reduce the payload of airplanes, they are of unquestionable value where safety is concerned. The stress placed upon safety has contributed greatly to the progress made by the aviation industry in the past decade.

References

(1) "Wireless Direction Finding and Directional Reception," R. Keen, 2d Edition, Illife & Sons, Ltd., London, p. 383, 1927.

(2) "Report of Radio Technical Committee for Aeronautics," *Air Commerce Bulletin*, vol. 7, no. 7, p. 162, Jan. 15, 1936.

(3) Civil Air Regulations No. 40.2530 and No. 40.2531.

(4) "Radio Antennas," *Aviation*, vol. 33, p. 178, June, 1934.

(5) "Motor Driven Antenna Reel," *Aero Digest*, vol. 27, no. 3, p. 41, 1935.

(6) "Simplified Aerodynamics," Monteith and Carter, p. 335, Ronald Press Co., New York, 1929.

(7) "Aircraft Radio Installation," M. P. Hanson, *Proc. IRE*, vol. 16, p. 921, 1928.

(8) "Characteristics of Airplane Antennas," H. Diamond, G. Davies, *Bu. Std. Jl. of Res.*, vol. 6, no. 5, p. 901, May, 1931.

AMPLITUDE RECORDING

(*Continued from page* 14)

are considerably greater than the output voltages generated by the tiny irregularities in or on the record material (surface noise). While it might appear that these higher amplitudes may interfere with the reproducing stylus tracking the grooves at these higher frequencies, this defect can be practically disregarded, considering the fact that both speech and musical sounds contain much less energy for the higher frequencies than they do for the lower frequencies.[3] Furthermore, "high fidelity" crystal pickups are available with low inertia vibratory systems and styli of small radius of curvature which are capable of tracking high-frequency undulations of rather high amplitude.[4]

It is impractical to give definite values of noise reduction resulting from "constant amplitude" recording, since the surface noise in disc records, due to the random distribution of the surface irregularities, varies in degree and frequency spectrum. In general, "constant amplitude" recording has provided noise reduction of from 6 to 10 db as compared to commercial "constant velocity" recording using the same type of recording materials. In subjective tests, because of the irritating nature of the surface noise, this noise reduction appears even greater.

Noise reduction, as obtained in "constant amplitude" recording with crystal cutters, can also be approximately realized with magnetic cutters, providing equalization is used in both recording and reproducing circuits. Fig. 3 shows a simplified circuit for "constant amplitude" recording and reproducing, using crystal cutter and pickup. Fig. 4 shows a simplified circuit for "constant velocity" recording and reproducing using magnetic cutter and pickup. Since the higher frequencies in "constant velocity" recording are of very small amplitude, an equalizer which introduces a high-end boost is required in the recording circuit. This provides the higher amplitudes at the higher frequencies, as obtained in "constant amplitude" recording. In view of this high-end boost in recording, a high-end droop is required in reproducing to restore the higher frequencies to their normal level and at the same time attenuate the surface noise in the record. Assuming that both magnetic cutters and pickups have uniform frequency characteristics over a rather wide range, the reproducing equalization in this case will usually be the conjugate of the recording equalization.

"Constant amplitude" recording and reproducing, using high quality crystal cutter and pickup, eliminates not only the equalization required in the circuits referred to above, but also equalization required during reproduction to correct for the low frequency characteristic of commercial "constant velocity" records below the turnover frequency. Also, since no equalizers are required in either recording or reproducing, no additional amplification is required to offset the electrical losses due to this equalization.

[3] Fletcher, H., Some Physical Characteristics of Speech & Music," *Bell System Technical Journal*, July, 1931.
[4] See *Brush Strokes*, April-June, 1939.

TELEVISION FUNDAMENTALS

(*Continued from page* 24)

ture i-f response band can be obtained[2, 11]. The type 1853 tube is used extensively as the video i-f amplifier tube.

The picture signal passes from the i-f amplifier to the second detector. A diode is used for this function and the demodulated signal has video components up to 4 mc. This demodulated signal is amplified in the wide-band video amplifier[18] and applied directly to the grid of the picture tube.

The output of the picture second detector contains all of the horizontal and vertical synchronizing pulses in addition to the video signal itself. The synchronizing signals are "clipped" from the composite video signal by a synch separator circuit as shown in Fig. 2 of Part VI*. Other circuits separate the horizontal from the vertical pulses in a manner also described in Part VI. The horizontal synch pulses are then inserted into the horizontal deflection-signal generator to control its speed. The vertical pulses are likewise used to control the rate of operation of the frame deflection generator.

Figs. 3 to 7, inclusive, illustrate typical television receivers available in the United States at this time or in the near future. Figs. 3 and 4 show the front and rear views, respectively, of a recent Philco experimental television receiver. The method of mounting the main chassis is quite interesting. Figs. 5 and 6 show front and rear views of one of the most elaborate receivers available at this time put out by the RCA. The best engineering features are incorporated in this type, the price being secondary. In Fig. 6 note the cardboard protector around the picture tube serving both to protect those handling the tube from flying glass in case the tube is broken and to afford protection to the tube against accidental breakage. Fig. 7 illustrates the vision-only type of receiver, the sound channel stops at the second detector, the audio amplifier and speaker of a normal broadcast receiver being utilized for this function. As the resolution of the tube is limited by spot-size, the video channel width is purposely limited to 2.5 mc, another factor contributing to low cost. Fig. 8 shows a view of the Camden plant of the RCA company.

Figs. 9 to 12 illustrate some interesting developments abroad which have not yet been put in commercial form in this country. Fig. 9 is a table model television receiver giving an extremely large picture (7.7 x 8.9 inches) for

(*Continued on page* 33)

*Communications, September, 1939, p. 19.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. — GEORGE H. CLARK, Secretary

Cruise

THE Fifteenth Anniversary Dinner-Cruise of our Association was held at the Hotel Astor, New York City, on Wednesday evening, February 21, 1940. Seated at the speaker's table were, left to right in photo: T. D. Haubner, who first used SOS as a signal of distress in 1909; George H. Clark, Secretary and Director of our Association and first Expert Radio Aide in the Uinted States Navy; Captain Charles H. Maddox, USN, now stationed at the Naval War College at Newport, R. I., and the first man to communicate from an airplane by radio back in 1912—from a Navy plane; O. B. Hanson, Vice-President and Chief Engineer of the National Broadcasting Company, who received a Marconi Memorial Medal of Achievement; Neville Miller, President of the National Association of Broadcasters, who came up from Washington to receive our Marconi Memorial Service Award—a beautiful bronze plaque—and also to be inducted as an Honorary member of our Association; William J. McGonigle, VWOA President and Toastmaster of the evening, who presented the awards; Lenox R. Lohr, President of the National Broadcasting Company, who was made an Honorary member of our Association; E. K. Cohan, Director of Engineering of the Columbia Broadcasting System, who returned from the Inter-American Radio Conference at Santiago, Chile, just in time to attend the dinner and receive his Marconi Memorial Medal of Achievement; J. R. Poppele, Director of our Association and Chief Engineer of WOR-Mutual, who received a Marconi Memorial Medal of Achievement; Inspector Gerald Morris, Superintendent of Communications of the New York City Police Department; Robert Barkey, winner of our First Marconi Memorial Scholarship and now a student at RCA Institutes under the Scholarship; R. H. Frey, Chairman of our Reception Committee and Radio Supervisor of the Bull Steamship Lines.

In the smaller inset pictures—the lower left photo shows George H. Clark with Captain Maddox; next on right—William J. McGonigle, VWOA president, opening the broadcast. Directly in front of Speaker's table—Mr. and Mrs. Ray Rettenmeyer; photo above—Messrs. Miller, Hanson, McGonigle, Lohr, Poppele and Cohan (Mr. Miller holding plaque); next right a photo of the Marconi Memorial Service Award. All photos, except main Dinner picture, by T. D. Haubner, VWOA Staff photographer.

A complete report of the Fifteenth Anniversary Dinner-Cruise at the Astor will appear in the next issue.

Messages

Among the messages received at the Cruise at the Astor were the following: "VWOA Astor—Greetings to the VWOA on their Fifteenth Annual Cruise from way down South in old Louisiana. May tonight surpass the many past cruises in pleasure and camaraderie. We are with you in 'spirits' and extend to 'you all' our seventy-three. Steve Wallis and Mackay Radio Staff at New Orleans"; "VWOA Astor—The San Francisco gang, including Arthur Isbell, Captain Dodd, Ray Myers, Rex Willets and forty others, send seventy-three to the New York assembly and assure you the sun has gone over the year arm—Fenton"; "VWOA Astor—Regret exceedingly my absence. Would enjoy helping celebrate presentation of Marconi Memorial Medal to my good friends Hanson, Cohan and Jack Poppele, I appreciate beyond words and accept gratefully the Honorary Membership accorded me. Best wishes. Alfred J. McCosker (Chairman of the Board Mutual Broadcasting System)"; "Bill McGonigle, VWOA, Astor—New RCA short-wave greetings to all from Belgian Congo. Pleasant successful cruise. Dick Cuthbert, Sr."; "VWOA Astor—We, the undersigned, original Charter members of the newly formed Los Angeles-Hollywood Chapter, send greetings and congratulations to the Veteran Wireless Operators' Association in honor of their Fifteenth Anniversary being celebrated tonight. The best of 73 to all the gang. Dr. Lee de Forest, Hal Styles, Richard Stoddart, Leroy Bremmer, James Chapple."

San Francisco Chapter Cruise

At 7 P. M. on the evening of Feb. 21, 1940, more than 50 old-time wireless operators gathered at the El Jardine Restaurant, 22 California St., San Francisco, under auspices of the San Francisco Chapter of the Veteran Wireless Operators Association.

We had a private room, excellent service and a fine dinner. Festivities started promptly at 7:15 with an address of welcome from the chair and an announcement that there *would be no speeches.* This rule was followed to the letter. The Army, Navy, every leading radio company and numerous ancient enterprises were represented among those present. The dinner lasted until 10:30 P. M., after which festivities continued until almost four o'clock in the morning! Everybody had a great time and the cruise was declared the most successful in the history of the Pacific Coast Division.

Among those present were Arthur A. Isbell, retired official of the RCA, to whom many of those present owed their first jobs. Capt. E. H. Dodd, U. S. N., Retired, was another extremely popular mem-

(*Continued on page 32*)

Fifteenth Anniversary Dinner-Cruise at the Astor, New York City.

You and your associates can obtain a year's subscription to COMMUNICATIONS (12 issues) for only $1.00 each by using the Group Subscription Plan.

A regular yearly subscription to COMMUNICATIONS costs $2.00 — but when four or more men sign up at one time, each one is entitled to the half-price rate. (Foreign subscribers on the "G-S-P" only pay $2.00 each).

COMMUNICATIONS
19 E. 47th St., N. Y. C.

Please enter annual subscriptions (12 issues) for each of the undersigned for which payment is enclosed at the rate of $1.00 each. (This rate applies only on 4 or more subscriptions when occupations are given.) Foreign Subscriptions are $2.00 each.

Name ....
Street ....
City-State ....
Occupation or title ....
Employed by ....
Nature of business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

Name ....
Street ....
City-State ....
Occupation or title ....
Employed by ....
Nature of business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

Name ....
Street ....
City-State ....
Occupation or title ....
Employed by ....
Nature of business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

Name ....
Street ....
City-State ....
Occupation or title ....
Employed by ....
Nature of business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

VWOA NEWS

(*Continued from page* 30)

ber who was at the speaker's table. An often heard remark of the evening, "Why, I haven't seen you in more than 20 years." Slogan of the evening, "Everything but the truth!" Stanley W. Fenton, Supt. with Mackay Radio, was Chairman of arrangements for the evening and the success of the affair was almost entirely due to his efforts in getting the men together. The Cruise was 100% stag! Ray Myers, who has the VWOA Gold Medal, was present with 10 men from the Mare Island Navy Yard.

Others who attended included: Walter W. Fanning, C. H. Cannon, J. F. Hoover, Arthur Rice, Marian G. Hanson, F. Wilhelm, C. H. Isaacs, I. H. McCarthy, C. A. Lindh, Louis Spiegel, George E. Taylor, L. Myrick, Alvin J. Bookmyer, Edward D. Stevens, Corwin R. Henry, C. L. McCarthy, Charles H. Cross, James Blanchet, Henry McDonald, Van Carroll, H. W. Dickow, Gilbert W. Cattell, James B. Doflemeyer, Edgar Case, Forbed Van Why, A. B. Wanshape, Frank J. McQuade, T. L. Haire, "Dick" Johnston, J. A. Miche, Ray Farrell, Fred M. Hoehn, E. W. Neff, D. Mann Taylor, Elmer D. Freeman, Irwin L. Kaufmann, W. A. Vetter, Ray Myers, F. E. Dunken, A. A. Socaret, Lee Gassett and Gilson Willets.

Many members wish to have a smoker during the year. This was agreed upon. A quorem of VWOA members held a business meeting and Gilson Willets was unanimously appointed Chairman and Corresponding Secretary for another year. Several applied for membership, but as no applications were available they were promised word from us later on when applications could be obtained from New York.

Los Angeles-Hollywood

Hal Styles, newly elected Chairman of the Los Angeles-Hollywood Chapter of our Association, writes:

"I called a meeting on the evening of February 14, 1940, and among those present were Dr. Lee de Forest, Richard Stoddart, James Chapple and Le Roy Bremmer. The following officers were elected: Hal Styles, Chairman ('Help Thy Neighbor' program); Richard Stoddard, Vice-Chairman (Chief Engineer Hughes Aircraft Corp.); LeRoy Bremmer, Secretary-Treasurer (Technical Staff, National Schools, Los Angeles); Dr. Lee de Forest, Chairman of Advisory Committee (Father of Radio Broadcasting), and James Chapple (FCC Inspector), Historian.

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.

"Mr. LeRoy Bremmer will send you a copy of the minutes of the meeting and I hope you can send us a Charter at your earliest convenience as we plan on conducting a campaign among more than a hundred good prospects in the very near future. These prospects include old operators who are identified with the motion picture and radio studios and other organizations.

"As soon as we get the Charter we'll get going in a big way. In the meantime, please remember me kindly and with best 73 to all the old-timers, and especially good old Fitzpatrick, Honeij, Lazarus, Maresca, Pete Podell—(will I ever forget the Alamo?—Sam Schneider and all the others whose names escape me at the moment. With every good wish for the Cruise. Hal Styles."

• • •

TELEVISION FUNDAMENTALS

(*Continued from page* 29)

the size of the cabinet. The cabinet size is: height 14.5 inches, breadth 25.5 inches, and depth 15 inches. A modest priced receiver having a picture about this size would give far more satisfaction than the picture possible on a 5-inch diameter tube. The picture size of this model El German receiver is due to the development of the cathode-ray tube of Fig. 10. This tube uses magnetic deflection in both the horizontal and vertical directions as well as magnetic focusing.

Another development in television receivers of which we will hear more in this country is exemplified by the Fernseh receiver model HPE-5-R home projection receiver shown in Fig. 11. This receiver is shown in use in Fig. 12. A directional screen is used to give a brighter image in the forward direction. A tiny, but intense, image is formed on the fluorescent screen by a high-velocity electron beam, and this small image is then projected onto the screen by a system of lenses.

The Television Receiving Antenna

The sound broadcast receiver differs from the television receiver in that practically anything can be used for an antenna with quite satisfactory results.

The television receiver will demand a great deal more of the antenna both as to its efficiency and to its noise pickup. Due to the fact that much ignition interference originates on the streets and roads, the antenna should be located as far to the rear of the lot as practicable. As the direct line-of-sight ray is the more dependable at frequencies of the order of 50 mc, the television antenna should be as high as possible. There seems to be a difference of opinion as to which polarization has the better characteristics with regard to noise pickup, but the horizontally polarized wave is being used most in this country. Thus, a horizontal dipole placed as high and as far from the street as possible will probably give good results. Experimental determination of the best position is the suggested method.

The specific inductive capacities of many construction materials as stone, brick, paving material and even soil, are enough greater than air to give high reflection factors under certain angular conditions, provided the surface is comparable to a wavelength in size. For this reason, we should expect, and we actually do get, severe reflection phenomena. For RMA standards and a picture tube 12 inches in diameter, the scanning spot travels about 0.06 inch while a radio wave is traveling 400 feet[19]. This may result in an "echo" image slightly displaced from the primary image which results in a general loss in detail. Fig. 14 taken from Seeley's paper[19], showing an enlarged portion of a received test image, illustrates an aggravated reflection condition. These reflections may occur from surrounding objects, or they may be due to transmission line impedance mismatching giving rise to discontinuity reflections. The transmission line effect will not be objectionable unless the line exceeds 100 feet in length. Even then it can be minimized by proper matching of the elements.

(*Continued on page* 39)

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATIONS FIELD

LENZ AEROLAC

Aerolac is a recently introduced high-voltage wire offered to radio and electrical manufacturers. In addition to high dielectric strength the wire is said to possess high heat resistant qualities. The voltage breakdown is said to be over 9000 volts a-c per foot immersed in mercury. Cellulose insulation and flame resistant lacquer impregnation are employed. Indicated uses for the wire are power transformer leads, high-voltage television circuits, aircraft instrument wiring, high-voltage plate leads, etc. Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.

ATLAS SPEAKERS

Atlas Sound Corp., 1449 39th St., Brooklyn, N. Y., have announced a new line of storm-proof dynamic reflex trumpets and driver units. The model illustrated has a 6-foot air column, bell opening of 29" and total depth of 31". The new line includes trumpets and units of various sizes.

HIGH-FREQUENCY RELAYS

Allied Control has recently announced a new line of high-frequency relays suitable for antenna change-over, switching of band, crystal or tank circuits, etc. The coils on these units are layer wound, impregnated and designed for continuous duty. Double-pole double-throw contacts are used, providing ample wipe and high contact pressure. Further information may be secured from Allied Control Co., Inc., 227 Fulton St., New York City.

"MULTIVOLT" RESISTORS

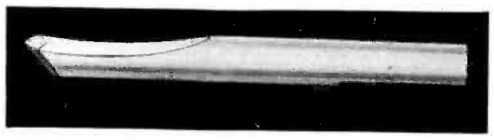
"Multivolt" multi-tap vitreous-enameled resistors especially suited for cathode modulation radio telephone circuits are offered by Ohmite. These 50-watt units (No. 1206 of 10,000 ohms resistance and No. 1209 of 25,000 ohms resistance) make it possible to secure the proper impedance match of the modulator to the filament or cathode circuit of the final radio-frequency amplifier. In addition to their convenience in cathode modulation circuits, the multivolts are also handy as voltage dividers, etc. They are available in many resistances in 50, 75 and 150 watt sizes. Ohmite Mfg. Co., 4835 Flournoy St., Chicago.

UNIDYNE CARDIOID MIKE

A new cardioid dynamic microphone specially engineered for broadcasting and recording is now offered by Shure Brothers. This new Model 555 Unidyne utilizes the "Uniphase" principle developed by Shure Engineers. It provides true cardioid unidirectional pick-up and may be used to reduce the pick-up of troublesome reflections, reverberation effects, or random background noise. Microphone tilts forward as well as rearward through an angle of 150 degrees. Easily mounted or demounted from stand. It is available in 35-50 ohm and 200-250 ohm models (or in high-impedance model). For complete information, write to Shure Brothers, 225 West Huron Street, Chicago, Ill.

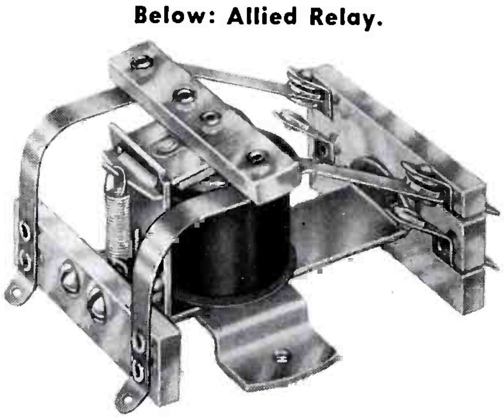
Above: General Electric Cable.

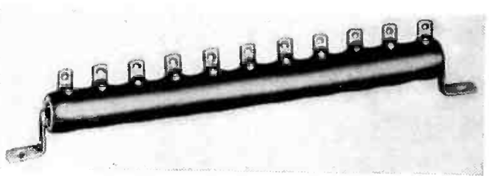
Below: Atlas speaker.



Above: Permo needle.

Below: Allied Relay.





Above: Ohmite resistor.

Below: Shure microphone.

DELTABESTON RESISTOR CABLE

A new Deltabeston Resistor Cable has been announced by the General Electric appliance and merchandise department, Bridgeport, Conn., designed especially for connecting banks of resistors where moisture and heat are prevalent. The insulation of the new Deltabeston Resistor Cable is composed of a layer of Flamenol tape next to the tinned copper conductor, then a layer of felted impregnated asbestos, and finally an overall asbestos braid with a heat-and-moisture-resisting finish.

HOME RECORDING NEEDLE

The new Permo point home recording needle is made by electrically welding a special alloy to specially drawn shank material, resulting in a rugged and sturdy product which is said to withstand considerable abuse, yet provide long life, with low surface or background noise. This cutting needle will fit all standard recorders, and will be found useful on home type recording machines. Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.

COIL REWINDING

A new department featuring a coil rewinding service and duplication of any i-f, r-f, osc. coils sent to them is a new service offered by Barber & Howard, manufacturers of coils and coil winders, of East Avenue, Westerly, R. I. This firm will design any coils needed for experimental work, custom built radios, and also other radio equipment such as radio direction finders, ship-to-shore sets, or other uses.

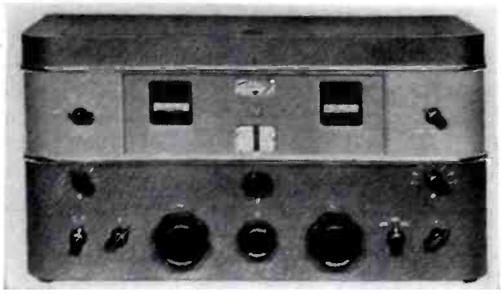
TUBES FOR SOUND AMPLIFIERS

National Union Radio Corp., 57 State St., Newark, N. J., have announced that they are prepared to supply a special line of tubes for use in sound amplifiers.

In making the announcement, H. A. Hutchins, N. U's General Sales Manager, states: Our chief requirements for these tubes is that they must be demonstrably better to the ear. We are now prepared to supply thirteen types (5U4G, 5V4G, 5Y3G 6C5G, 6F6G, 6J7G, 6K6G, 6L6G, 6L7G, 6N7G, 6V6G, 6X5G, 83) after several months of field experience in addition to engineering and laboratory work.

COMMUNICATION RECEIVER

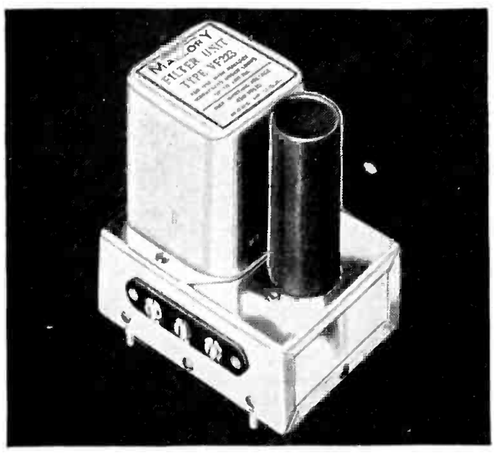
A new medium-priced communication receiver has been announced by the RCA Manufacturing Company, Camden, N. J. Designated as "General Purpose Communication Receiver Model AR-77," the new instrument comes complete with built-in power supply, variable selectivity crystal filter and tubes. An eight-inch permanent-magnet dynamic loudspeaker, giving a high degree of sensitivity and faithfulness of reproduction, and housed in a metal cabinet to harmonize with the receiver, is recommended for use with the AR-77. The



AR-77 has three new features: polystyrene insulation, which contributes to improved reception by keeping circuit losses at a minimum; "stay put" tuning, which insures against bothersome frequency drift; due to temperature; and negative feedback (applied at will by a special switch) which provides better audio fidelity by smoothing out and extending the audio response. Another important feature is a new calibration of the two illuminated tuning dials, so the operator can tell at a glance to what part of the radio spectrum the receiver is tuned. Only the calibration of the range in use is visible.

MALLORY FILTER

A new audio or hum filter unit, the Mallory VF-223, is now available for use with all single unit Mallory Vibrapacks. The filter condenser is a three-section Mallory FPT-390 of 15-15-10 mfd capacity, 450 working volts. The two 15-mfd sections



are used with the choke to form a conventional pi-section filter, while the 10-mfd section connects to a separate terminal so that, if desired, a filtered intermediate output voltage may be obtained. The filter choke is rated at 100 ma and has a d-c resistance of 90 ohms. P. R. Mallory & Co., Inc., Indianapolis, Ind.

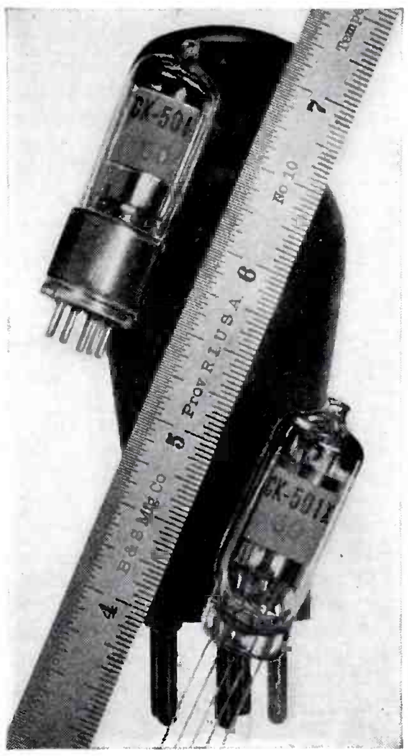
MARINE RADIOPHONE

A new and compact 25-watt marine radiophone for use on small commercial and pleasure boats is the Model HT-8 an-

nounced by Hallicrafters, Inc., 2611 Indiana Ave., Chicago, Ill. It provides for 2-way communication with other boats, land telephone and Coast Guard stations. Any one of five crystal-controlled transmitting frequencies is instantly selected by a rotary switch on the panel and another switch gives an instant choice of five corresponding receiving frequencies plus an extra weather report channel. All transmitter and receiver circuits are internally pre-tuned during installation of the equipment, thus reducing subsequent operation to the utmost simplicity. The transmitter and 7-tube superheterodyne receiver are inclosed in a single compact cabinet designed either for table or bulkhead mounting. The power supply is a separate unit and connects to the main unit by plug and cable. Power is drawn from the boat's battery, but by interchanging one plug provision is made for operation from any 110-volt a-c line.

HEARING AID PENTODES

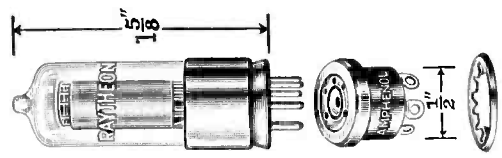
Four tiny filament type pentodes are available for use in wearable hearing aids. The filament drain, 33 ma 1.25 volts, is



low enough to make standard flashlight cells economical sources of filament power. All types are available either with miniature bases or with tinned copper leads for direct soldering. The tinned lead tubes are only 1½" long and ½" in diameter. The based construction is 1¾" long and 9/16" in diameter. The amplifier tube is of a special low microphonic design. Although bias improves operation, the tubes will all operate at low distortion with zero bias. Raytheon Production Corp., 55 Chapel St., Newton, Mass.

HEARING AID TUBE SOCKETS

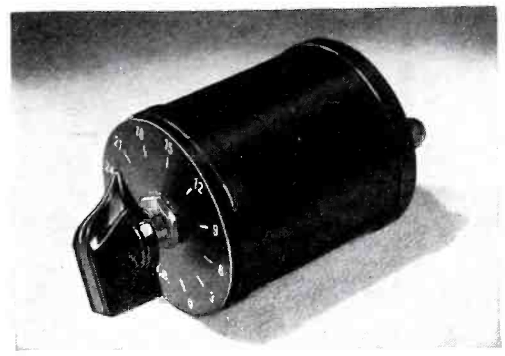
A tiny socket that matches Raytheon's new hearing aid tubes for compactness. It is molded of high-dielectric black bakelite, with a body diameter of only ½" and adds only 3/32" to the length of the



tube (including prongs). A spring steel retainer holds the socket in place. Socket manufactured by American Phenolic Corporation, 1250 Van Buren Street, Chicago, Ill.

OUTPUT ATTENUATOR

A means of controlling the volume of individual loudspeakers in a sound system is provided by the new Series CIB output



attenuator just released by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y. Capable of dissipating 10 watts at any setting, this unit is a junior version of the 25-watt Series CIA attenuator. Insertion loss is below zero. Db range is in 3 db steps up to 24, and then a 6 db step, with final step to infinity. Stock ohmages are 8, 15, 50, 200, 250 and 500 ohms. These units do not come equipped with power switches.

TRIUMPH UTILITESTER

The Triumph Model 334 Utilitester is a compact all-purpose test instrument. It features 22 ranges and has a 3-inch meter. It measures volts 0 to 3,000 a-c and d-c, milliamps 0 to 300, and decibels minus 6

to plus 64. The sensitivity is 1,000 ohms per volt. All ranges are selected by a single rotary switch. Complete information may be secured from Triumph Mfg. Co., 4017-19 W. Lake St., Chicago, Ill.

AVIATION TRANSMITTER-RECEIVER

Among the new products of interest is the Harvey IMP telephone transmitter-receiver, designed particularly for private plane installation. This new development contains a sensitive 5-tube receiver, including one multi-purpose tube, which, according to the manufacturer, gives it the effectiveness of a 7-tube receiver. This receiver may be used on aviation beacon bands. The transmitter operates on 3105 kilocycles. Harvey Radio Laboratories, Inc., 25 Thorndike St., Cambridge, Massachusetts.

OVER THE TAPE

GOODWIN RECEIVES AWARD

In recognition of his outstanding contributions to industrial progress through invention and research, W. N. Goodwin, Jr., Vice-President in Charge of Engineering and Research, Weston Electrical Instrument Corporation, was chosen as the recipient of one of the Modern Pioneer Awards, sponsored by the National Association of Manufacturers. This award, part of the celebration in connection with the 150th anniversary of the patent system of the U. S., was presented to Mr. Goodwin at a dinner at the Waldorf Astoria Hotel, New York, on February 27th.

L & N CATALOG

A 66-page, condensed catalog, just issued, lists the entire Leeds & Northup line of instruments for research and for routine testing in laboratory, plant and field . . . standards, galvanometers and dynamometers, bridges, potentiometers, photometric apparatus, miscellaneous apparatus, primary elements, accessories, supplies, instrument parts. Every standard L. & N. item is briefly described, and most of the principal ones are illustrated. A copy will be sent promptly to anyone who asks Leeds & Northup Company, 4934 Stenton Avenue, Philadelphia, for Catalog E—"Electrical Measuring Instruments for Research, Teaching and Testing."

W. E. BULLETIN

"Telephone Cables" is the title of a comprehensive brochure issued recently by the Western Electric Company, 195 Broadway, New York City, to familiarize the communications industry not only with the Company's cable products but with pertinent tabular and factual data vital to the communications engineer. Its 30 pages are generously illustrated with photographs of historical, manufacturing, and installation operations, and with diagrams showing interesting constructional features. The recently developed 2121 pair unit, which adds 606 conductors to the largest previous cable, is treated fully.

SPERRY FLYING LABORATORY

The purchase of a new Lockheed twin-engine airplane is announced by the Sperry Gyroscope Company. Designed as a flying laboratory, the new plane will be used for flight research by the Sperry Engineering Department in connection with the company's program of research and development.

WESTINGHOUSE ENGINEERING DIVISION

A new engineering department devoted to the general commercial design and production of radio apparatus of all types, and associated products has been created by the Radio Division, Westinghouse Electric & Manufacturing Company, at Baltimore, Md. This new department will be known as the Special Apparatus Engineering Section and will be under the direction of Ralph N. Harmon. The nucleus of the group is composed of engineers formerly associated with the company's broadcast activities in the operation and maintenance of Westinghouse Stations KYW, WBZ, WBZA, WOWO, WGL, WPIT, and WBOS. Several in the group were actively engaged in the design and installation of the new KDKA transmitting plant at Allison Park, Pennsylvania, and all members of the section have had wide experience in the technical phases of radio.

FM RECEIVERS

Fast growing public interest in frequency modulation has opened up a new field for manufacturers of radio receiving sets. Frequency-modulation receivers capable of reproducing the programs sent out over the new type stations are now on the market. Stromberg-Carlson, General Electric and R. E. L. (Radio Engineering Laboratories) offer f-m receivers to the public in various console and table models. The experimenter, who wishes to build his own, may secure a kit of all necessary parts with complete, simple direction for assembling from Browning or Meissner. Other companies which have secured permission from Major Edwin H. Armstrong to manufacture sets under his patents are Zenith, Stewart-Warner, Pilot, Scott, National, Hammarlund and Hallicrafters.

SHALLCROSS LITERATURE

Bulletin No. 146-1 describes Shallcross resistance standards, decade boxes, and special parts for electrical measurement.

Bulletin No. 146-2—A number of unique bridges are listed in this new bulletin. They are convenient for measuring d-c resistance, high and low resistance, conductivity, and many other special problems.

Bulletin No. 146-3—Announces a large number of test sets and special apparatus used in all sorts of electrical measuring, particularly in different phases of industrial work, electrical laboratories, etc.

Shallcross Mfg. Company, 10 Jackson Avenue, Collingdale, Pa.

RCA ACQUIRES PLANT

The RCA Manufacturing Company, world's largest manufacturer of radio products, has acquired a plant at Bloomington, Indiana, preparatory to the establishment of another modern factory for the production of "Nipper" table model radios. The RCA Manufacturing Company now has domestic manufacturing plants for its varied radio and allied products in Camden, New Jersey (where it makes its headquarters), in Harrison, New Jersey, in Indianapolis, and in Hollywood, and employs more than 15,000 men and women.

WORNER PRODUCTS PLANT

The announcement is made by Worner Products that they are now located at a new address, a greatly enlarged and modernly equipped factory, 1019 West Lake Street, Chicago. This move was necessitated, according to officials of the concern, by a rapidly growing demand for its line of electronic devices.

VAN CLEVE JOINS LEAR AVIA

Lear Avia announces the appointment of Robert S. Van Cleve as its Director of Sales in the commercial and military aeronautical fields. Mr. Van Cleve has been actively engaged in furthering the development of aircraft radio almost constantly since 1917, when he served as an instructor in tactical radio operation to U. S. Navy flying boat pilots, and has been a pilot himself since 1929.

OXFORD-TARTAK APPOINTMENT

Paul H. Tartak, President of the Oxford-Tartak Radio Corporation, has announced the appointment of Robert "Bob" Adams, Sales Engineer, effective immediately. "Bob" is well known in the radio industry, having been connected with it in various capacities for the past seventeen years.

JANETTE BULLETIN

The Janette Manufacturing Co., 556-558 W. Monroe St., Chicago, have recently issued a technical data sheet on rotary converters. These units are intended for use with radio receivers, amplifiers, phonographs, etc. Write to the above organization for data sheet 13-25.

HARVEY RADIO APPOINTMENTS

The Board of Directors of Harvey Radio Laboratories, Inc., Cambridge, Mass., has announced the election of Frank Lyman, Jr., as President, succeeding J. B. Parker. Other changes include the election of J. S. Lyman as Vice-President, succeeding C. A. Harvey, who recently resigned. At the same time, it was announced that Ralph A. Vacca has been named Chief Engineer, N. R. Hinckley has been appointed Marine Sales Manager.

CROWE BULLETIN

Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, have made available an interesting bulletin covering their line of remote controls for automobile radios. Considerable information is contained in this 16-page booklet. Write to the above organization for Bulletin No. 232.

• • •

MODERN LOUDSPEAKER

(*Continued from page* 16)

checks are made on sample speakers selected at random from each production batch. These include further tests of response and power handling and a certain percentage of these random samples are subjected to the rigors of the humidity chamber where they must withstand abnormal conditions of temperature and moisture for some hours. Others are put on accelerated life tests to insure their ability to stand up in normal service.

• • •

TELEVISION LIGHTING

(*Continued from page* 26)

head to permit of each set having its own lighting. The installation of this additional equipment was impractical, for even though the ceiling of this particular studio had been reinforced to carry a reasonable hanging load, it would be impossible to effect a large increase in the lighting equipment without decreasing the desired factor of safety. The electrical installation was sufficient for the present equipment but it too would have to be redesigned and amplified to accommodate the additional fixtures. The problem appeared to be answerable only by increasing the flexibility of the present equipment so that it could be rearranged and redirected without seriously interfering with the conduct of programs in the studio. An experimental "double three" unit was constructed controllable in rotation, tilt and elevation by a series of ropes from the back of the studio. This unit was successfully tested in a studio program early in the summer of 1938 and on the strength of its apparent application to studio work, was redesigned for production duty.

This unit, the remotely controlled "double three" comprised a lighting fixture mounted on an arm which was capable of being rotated, tilted or moved transversely in any direction by means of the four control ropes. With a series of these remotely controlled units mounted on the gridiron, their hemispheres of operation tangent to each other, it is possible to select the particular units available to light a single set. The remaining units can then be reset remotely for the next sequence while the first group, when cleared on the first set can be brought into play on set three. This one-man control of the overhead or foundation lighting appears to be a logical answer to television's requirement for extreme flexibility. By properly choosing the available fixtures, the operator can readily establish a modeling angle, can control back lighting as the characters move about the stage and can also preset the scene to be televised next. In addition it is possible to vary the lighting while the set is in work to satisfy either engineering or program requirements.

Another piece of equipment that has found immediate acceptance in the NBC television studios is known as the portable footlight. This unit is primarily a "single three" mounted horizontally on a lightweight dolly. A second lamp, generally of the non-focused type, is positioned in a rotatable column in line with the control arm. The entire unit is moved and operated by means of the extension arm, the "single three" being tilted up and down to suit the action on the stage and the central light being rotated to cover split action to the right or left. The operator of this equipment remains behind the camera with the unit itself working several feet ahead of the "on stage" camera. In this position the operator can accurately control his modeling light without interfering with the freedom of camera operation.

In certain cases the program production technique requires an intimate close-up of the subject being televised. Rather than attempt to handle the large banks of light designed to illuminate an entire set we employ a unit referred to as "the portrait table." This device consists of a table, mounting on its camera side, four low wattage lamps on flexible goose necks. By adjustment of these arms and variation of the wattage it is possible to properly model the face, controlling the high lights and shadows within the compressed limits allowed by the television camera. Typical of this use of light and shadow is the photo taken from the kinescope of Miss Charlotte Manson being televised at the portrait table.

In reviewing the lighting equipment now in use in the National Broadcasting Company television studios, we find a system designed solely for the television camera. The remotely controlled foundation lighting possesses the required characteristics of extreme flexibility and high efficiency. The floor units are light, portable, and where required, can be controlled remotely. The detailed photographic problems are handled satisfactorily at the portrait table or with a portable hand light. The angle of overhead illumination can be adjusted and maintained for all conditions of set depth and length of throw. Backlight can be controlled remotely and can be made to follow the action on the stage. The problem of lighting successive stages can be handled either by splitting the available light or by following the action directly with one or more banks of the remotely controlled lamps. Economically the system now in use is satisfactory. With standard long life lamps the replacement cost is of such order as to be negligible. The personnel problem has been satisfactorily answered. At the present time, three operators can easily handle all of the lighting equipment even though an hour's program may cover as many as ten different stages. The set up time, formerly required to readjust the studio lighting for a change in set location has been reduced to a matter of minutes. Equipment has been simplified, reduced in size or removed from the floor altogether, providing additional space for camera operation. With one standardized type of light it is possible to quickly estimate the quantity of light and its distribution on the set rather than having to interpolate the resultant light from several different sources.

At this writing, it appears that this system is a reasonably satisfactory answer to the problem. It does not mean that we have stopped our experimentation or that we feel that we have in any sense produced the ultimate in television lighting. Each production brings with it new problems that will either prove or disprove our present theories and equipment. We therefore describe our present installation as merely another phase in the attempt to solve the problems of television lighting.

• • •

TELEVISION FUNDAMENTALS

(*Continued from page* 33)

Bibliography

The Engstrom and Holmes series appearing in *Electronics* as follows:

1. "Television Receivers," April, 1938, page 28.
2. "Television I-F Amplifiers," June, 1938, page 21.
3. "Television V-F Circuits," August, 1938, page 18.
4. "Television Synchronization," November, 1938, page 18.
5. "Television Deflection Circuits," January, 1939, page 19.
6. "Power for Television Receivers," April, 1939, page 22.

The Fink series appearing in *Electronics* as follows:

7. "A Laboratory Television Receiver"—I, July, 1938, page 16.
8. "A Laboratory Television Receiver"—II, August, 1938, page 26.
9. "A Laboratory Television Receiver"—III, September, 1938, page 22.
10. "A Laboratory Television Receiver"—IV, October, 1938, page 16.
11. "A Laboratory Television Receiver"—V, November, 1938, page 26.
12. "A Laboratory Television Receiver"—VI, December, 1938, page 17.

The above twelve articles are available in reprinted form in a booklet entitled "Television Receiver Practice."

The Goldsmith series appearing in COMMUNICATIONS as follows:

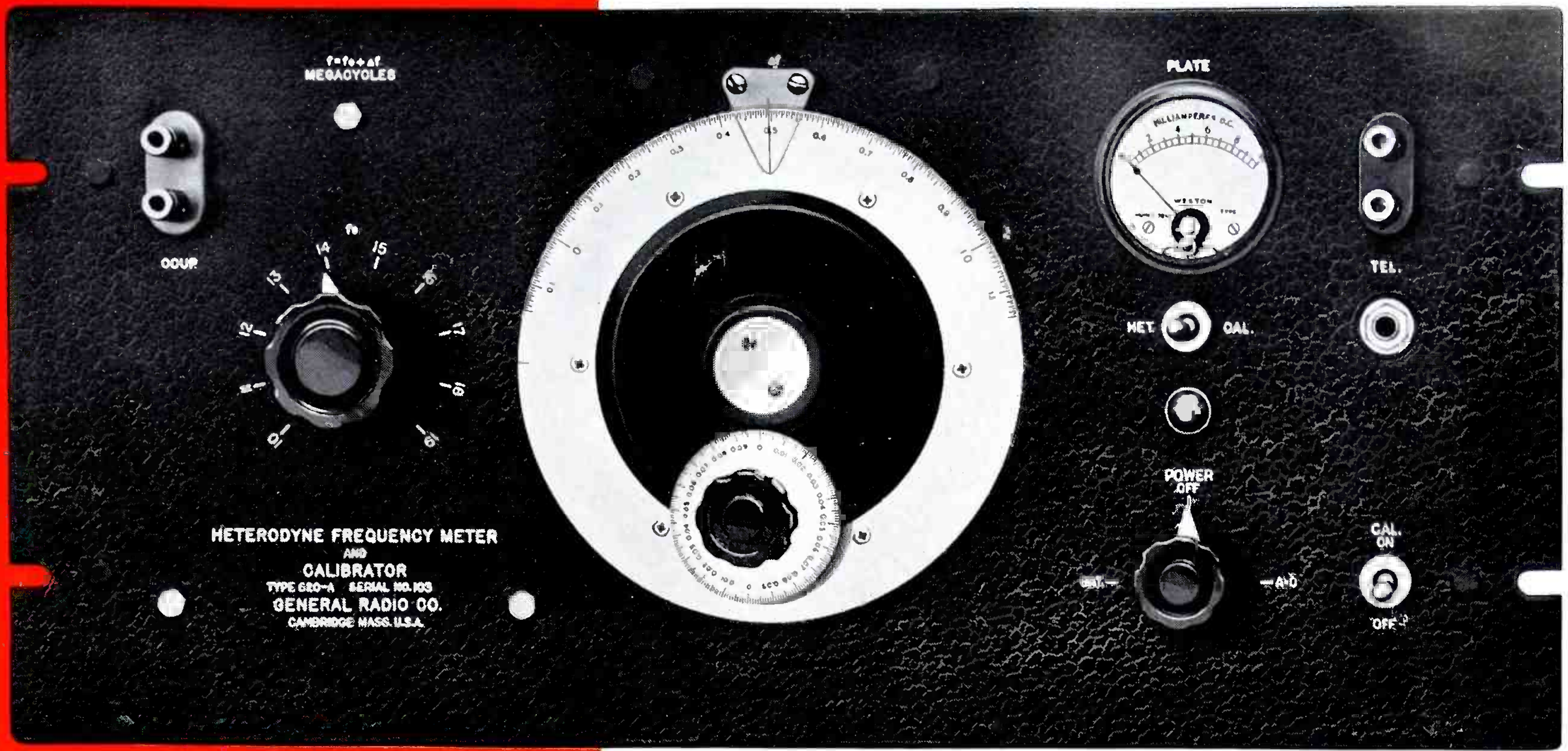
13. "Television Economics"—V, June, 1939, page 21.
14. "Television Economics"—VI, July, 1939, page 20.
15. "Television Economics"—VII August, 1939, page 18.

16. Aiken, "Two-mesh Tuned Coupled Circuit Filters," *Proc. IRE,* Vol. 25, No. 2, p. 230, February, 1937.
17. Loh, "On Single and Coupled Tuned Circuits Having Constant Response-Band Characteristics," *Proc. IRE,* Vol. 26, No. 4, p. 469, April, 1938.
18. Everest, "Wide Band Television Amplifiers," I & II, *Electronics,* January, 1938, and May, 1938.
19. Seeley, "Effect of the Receiving Antenna on Television Reception Fidelity" *RCA Review,* Vol. II, No. 4, April, 1938, p. 433.
20. Pock and Epstein, "Partial Suppression of One Side-Band on Television Reception," *RCA Review,* Vol. I, No. 3, January, 1937, p. 19.
21. Perkins, "Television Receiver Design Factors," COMMUNICATIONS, February, 1939, p. 32.
22. Waller, Kinescopes for Television Receivers," COMMUNICATIONS, April, 1939, p. 21.

(*To be continued*)

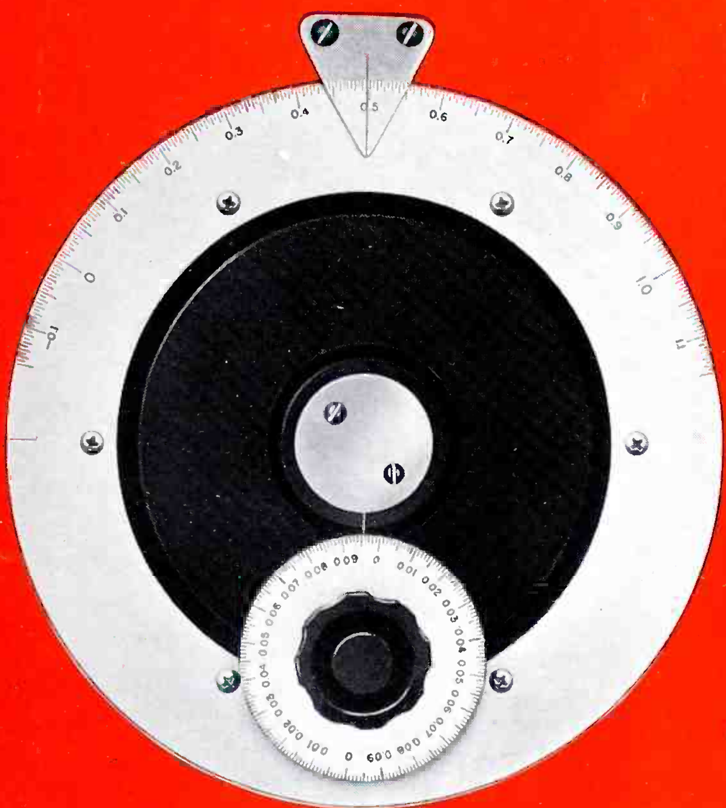
Index to Advertisers

IMPROVED HETERODYNE FREQUENCY METER



With Greatly Increased Precision

THE POPULAR G-R Type 620-A Heterodyne Frequency Meter and Calibrator is now provided with a geared slow-motion drive and auxiliary dial, greatly increasing the precision of setting and ease of operation. Routine frequency measurements to 0.005% are now possible for communication companies, laboratories, transmitter and receiver manufacturers and inspection services.



With a new gear driven slow-motion mechanism the reduction ratio is 15-to-1. Internal drive gear is spring-pressed to remove backlash. Fundamental frequency is 10 to 20 Mc. Auxiliary dial subdivides each main scale division into 10 parts; at the 10 Mc. end of the main scale the smallest auxiliary scale division is 0.01%; at the 20 Mc end it is 0.005%.

FEATURES

- HIGH UPPER-FREQUENCY LIMIT—300 Mc or higher
- VERY WIDE RANGE—300 kc to 300 Mc
- DIRECT READING—no charts or curves
- SELF-CALIBRATING — calibration can be checked instantly from built-in piezo-electric oscillator
- NO COILS TO CHANGE—built-in coil system with 10-point panel selector switch
- GOOD ACCURACY—over-all accuracy 0.01% or better—can be used as *transmitter frequency monitor* for all services having allowable tolerance of 0.02% or greater
- FLEXIBLE POWER SUPPLY—built-in a-c operated supply or external d-c source, either selected by panel switch

TYPE 620-AR (Relay Rack Model) $490.00
TYPE 620-AM (Portable Model) 555.00

WRITE FOR BULLETIN 563 FOR INFORMATION

GENERAL RADIO COMPANY

CAMBRIDGE, MASSACHUSETTS

Branches in New York and Los Angeles

Here is another new Lenz development. AEROLAC offers the radio and electrical manufacturer a happy combination of high dielectric strength and outstanding heat and flame resistant qualities.

With a voltage breakdown of over 9000 volts AC per foot immersed in mercury, AEROLAC is indicated for a wide variety of applications. It is particularly well suited for use where excessive heat is encountered as its cellulose insulation and flame-resistant lacquer impregnation are effective under temperatures where ordinary rubber insulation would deteriorate.

AEROLAC is made in a variety of sizes and colors. Samples will be submitted on request.

Indicated for use for—

- POWER TRANSFORMER LEADS
- HIGH VOLTAGE TELEVISION CIRCUITS
- AIRCRAFT INSTRUMENT WIRING
- HIGH VOLTAGE PLATE LEADS
- WHEREVER A HIGH-TEMPERATURE-RESISTING AND HIGH-DIELECTRIC WIRE IS REQUIRED.

LENZ

LENZ ELECTRIC MANUFACTURING CO.

1761 No. Western Ave.

CHICAGO U. S. A.

ENJOYING OUR 35th YEAR OF SUCCESSFUL BUSINESS