The RADIO ENGINEERS' DIGEST

MAY 1945 VOL. 1., NO. 10

CONTENTS

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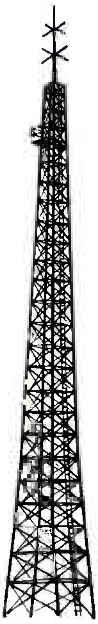

THE RADIO ENGINEERS' DIGEST

JOHN F. C. MOORE, *Editor*

Vol. 1, No. 10 May 1945

Published monthly at New York, N. Y., by The Hudson American Corporation
A subsidiary of Reeves-Ely Laboratories, Inc.

For free distribution to its friends in the radio and electronics industries

Editorial Office, 25 West 43rd Street, New York 18, N. Y.

Printed by Criterion Products Corporation, New York, N. Y., U. S. A.

THE ELECTRONICS ENGINEER

Reprinted from Proceedings of the I.R.E.

By P. R. Mallory

FOR MORE than thirty years my time, to a very large degree, has been spent in dealing with engineers—young and old alike.

For the most part these men have been identified with electronics and metallurgy and many of them have shown outstanding creative abilities.

Among them have been exceptional men and among them, too, have been men for whom I have developed the greatest respect as well as close bonds of friendship.

Therefore, I welcome this opportunity of briefly setting forth some of my views to the members of the I.R.E. at this time.

If there is one thing this war has demonstrated it is the resourcefulness and basic quality of the American engineer. The phenomenal record accomplished by industry is to a major degree the result of the even more phenomenal record of its engineers.

In every field of war equipment the engineer under intense pressure has created new devices—new answers to pressing problems—as they have arisen as a result of war experience. The record of all industries is replete with dramatic evidence of outstanding engineering accomplishment.

Perhaps in no field have these results been so outstanding as in the field of electronics—our youngest industry, manned largely by "young engineers". These men, some of whom are veteran engineers of our radio industry and others only recently released from technical schools, have presented a fresh and dynamic approach to the new challenging problems of each day. Certainly no industry has left such an impress on so many different aspects of this global war—on the ground, in the air and under and on the sea.

You electronic engineers who read these words, know far better than do I the revolutionary results of these accomplishments. Suffice it to say here that they have altered in our favor the entire complexion of this war. They have given our forces a superiority of performance that has a profound effect on tactics and strategy.

Is it too much to anticipate that similarly they will greatly affect our peace time lives; that they will sustain this great new industry that already is an employer of hundreds of thousands of workers? I think not.

In peace, progress comes more slowly. However, modern scientific progress has accelerated the laws of change to a remarkable degree. Even before the stimulation of this war, changes were being affected in a few years which formerly would have required a generation.

In electronics we may look forward to a period of intense development and orderly and substantial accomplishments, affecting all phases of industry, transcending anything we can now visualize. Mr. James H. McGraw, Jr. recently

(Proceedings of the I. R. E., March 1945)

stated. "The future of the electronics industry is limited only by man's imagination." George S. Armstrong and Co., Inc., in a recent booklet on the electronics industry, estimated the war growth of this industry as perhaps thirteen times its prewar volume. Of this at least a $1,000,000,000 annual volume should be retained in the postwar era.

Surely this industry presents a challenging opportunity to engineers.

As a result of the war time accomplishments of our engineers I look for a new and enhanced respect for the engineering profession as a decisive factor in our industrial society. All too frequently in times past the engineer has felt himself at a disadvantage compared to the commercial man in recognition of their respective contributions to industry's growth. Many reasons for this discrimination may be suggested. One unquestionably is that engineers are often trained to deal more with things than with men. This is a weakness that our engineering schools must strive to correct.

Never forget that this new recognition of engineering, won through splendid achievement, also presents its challenge. Engineers to hold their position must be broad-gauged, well-rounded men who not only understand mathematical but human equations as well.

The future opportunity for the well-balanced electronics engineer looks to me to be brilliant indeed. Nevertheless, it is still only an opportunity. Performance will be required to lift the unusual man above his fellow engineers. The field is wide open. The search of management for men who can accept responsibility is just as active as ever.

NOISE METER AIDS WORKERS

An electronic device gauges the noise — or sound — that disturbs factory workers. Thus data can be obtained that will facilitate elimination of unnecessary noise.

IMPROVED ELECTRON GUN FOR C-R TUBES

Reprinted from Eectronics

By L. E. Swedlund
RCA-Victor Division
Radio Corporation of America
Lancaster, Penna.

Gun design involving zero current for first anode simplifies power-supply problem and gives sharper focus. The beam is also less subject to stray fields capable of causing variation in spot brightness. Several constructional advantages are inherent in the design.

CATHODE-RAY oscilloscope tubes that provide improved operating characteristics have recently been designed. The improvement is achieved by the use of a modified electron gun which requires no first-anode current and gives sharper focus.

Figure 1 is a conventional gun. The oxide-coated cathode provides a supply of electrons that pass through the control-electrode aperture. The first anode, which operates at positive potential, accelerates the electrons toward the gun axis and causes them to cross over at the point indicated. It is this cross-over, rather than the cathode surface, which is imaged on the fluorescent screen.

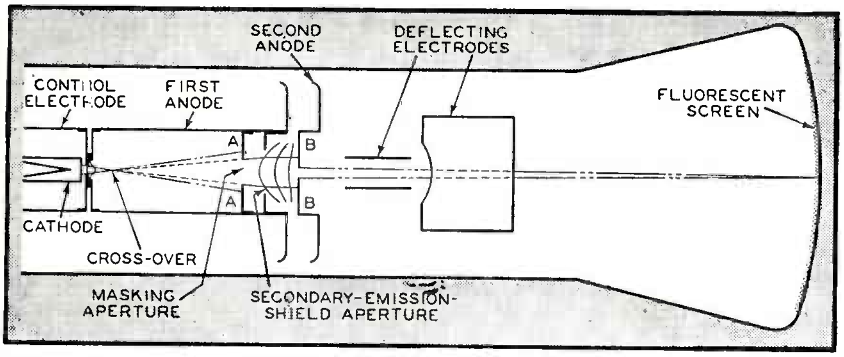

Fig. 1—A conventional cathode-ray tube electron gun, in which the first anode operates at a positive potential and contains a masking aperture which is shown at AA

The cross-over size and intensity depend on the control-electrode bias voltage. The electrons travel through the first-anode cylinder in straight lines and at a uniform velocity until they reach the end of the cylinder. Near the end of the cylinder the electron-beam diameter is limited by a masking aperture shown at AA. The central section of the beam passes into the accelerating and focusing field between the end of the first anode and the second anode. This field constitutes another electron lens, often called the final focusing lens. Its strength, or focal length, is varied by varying the first-anode voltage.

The beam is usually limited in diameter again at the second-anode aperture, as indicated at BB. This procedure insures that the beam is small and well

(Electronics, March 1945)

centered as it passes the deflecting electrodes. The deflecting electrodes are used to apply an electric field at right angles to the beam. This field bends the beam proportionately to the potential applied. The set of deflecting electrodes nearer the gun provides deflection at right angles to that of the other set. The beam converges to a focus, or second cross-over, at the fluorescent screen.

Desirable Characteristics

A gun approaching ideal performance for an electrostatic-deflection type of cathode-ray tube should have the following characteristics:

(1) A small, focused electron spot of high brilliance which exhibits only a small increase in size as it is deflected across the screen.

(2) The ability to operate at low final-anode voltage.

(3) High deflection sensitivity.

(4) Short overall length.

(5) Sensitive control of spot brightness.

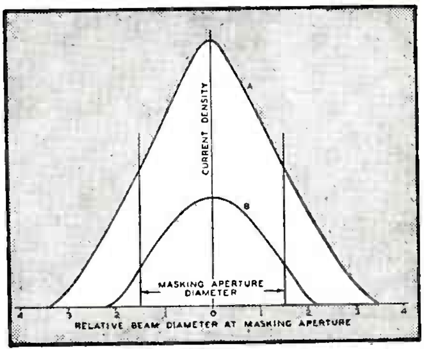

Fig. 2—Current density across beam before it enters masking aperture, for two different operating conditions

A small brilliant spot can be achieved by operating the final anode at as high a voltage as possible, by making the gun long and the gun-to-screen distance short, by using a high-emission cathode, by forming the first cross-over at as high a voltage as possible, and by permitting a wide beam divergence angle.[1] On the other hand, to produce a small change of spot size with deflection, the beam should have a small diameter in the deflecting field; that is, the beam divergence angle should be small, and it should be deflected through only a small angle, thus requiring a long gun-to-screen distance.[2]

Deflection distortion occurs in electrostatic deflection cathode-ray tubes because the electric field which deflects the beam also accelerates one side of it more than the other. The side nearest the positive deflecting electrode is deflected less than the side nearest the negative deflecting electrode. The result is that the focused spot is elongated in the direction of deflection in proportion to the square of the deflection. This spot distortion is inversely proportional to the diameter of the beam in the deflecting region.

Operation at low final-anode voltage is desired because it results in a compact, low-cost, anode power supply and high deflection sensitivity. However, as the anode voltage is increased, the beam current rises as the 3/2 power of the voltage, the spot size decreases due to less space-charge effect, and the fluorescent screen becomes more efficient, giving the overall result that the spot brightness for a given spot size goes up somewhat faster than the square of the anode voltage. Thus, the anode voltage must be high enough to provide sufficient sharpness of focus and brilliance for the maximum required spot-displacement velocity. It generally cannot be less than 500 volts and may be as high as 15,000 volts.

It is to be noted that space charge increases spot size because of the mutual repulsion of the electrons in the beam.

High deflection sensitivity requires long, closely spaced deflecting electrodes and long gun-to-screen distance. These requirements tend to produce a spot of low brilliance.

Short overall length permits a design for small spot size but at the expense of deflection sensitivity and increased distortion with deflection angle.

Sensitive control of spot brightness, sometimes called small grid drive, requires that as large a portion of the current from the cathode as possible go to the screen. In the past, brightness control has usually been a semi-permanent manual adjustment. Sharper focus was secured at the expense of small grid drive. Now the brightness is often modulated at high frequency by an amplifier so that sensitivity is important.

Beam Considerations

The maximum deflection angle, the length of the deflecting electrodes, and the amount of distortion with deflection that can be tolerated determine the maximum permissible diameter of the beam at the end of the gun. Since even with this limitation the current in the beam should be as high as possible, it is an important gun-design consideration to make the current high without at the same time producing a large focused spot.

It is possible to generate a narrow enough beam to pass through the masking aperture without limiting, but usually a large beam is masked down to the desired size. Generation of a narrow beam without masking provides better utilization of the high-voltage current and sensitive control of the beam current but has the disadvantage of providing lower maximum current to the screen. The reason for this is that the beam is more intense at the core than at the edge and this core density rises rapidly with beam size.

The current density across the beam before it enters the masking aperture is shown graphically in curve A of Fig. 2. If the aperture diameter of the control electrode is reduced or the bias voltage of the control electrode is increased, or the accelerating-electrode aperture is moved farther away, the distribution becomes similar to curve B. The beam diameter is reduced but the total current is reduced much more.

By placing a masking aperture in the beam, usually in a region which is field-free, as shown at AA (Fig. 1), only the intense central core of the beam is passed through the gun to the deflecting electrodes. The beam is also usually masked in the second-anode aperture as shown at BB. The latter arrangement prevents the beam from striking the deflecting electrodes in case of misalignment. In addition, the current masked at this electrode reduces the amount which has to be handled in the first-anode circuit.

By enlarging the control-electrode aperture diameter, it is possible to increase the current density at the center of the beam. This enlargement must not be carried very far because it increases the amount of masked current and the size of the cross-over. The latter, since it is imaged at the screen, produces a larger focused-spot size. However, as the control-electrode bias is increased, the control-electrode-aperture diameter is in effect decreased and, therefore, at lower currents a smaller spot size is obtained.

By proper design it is thus possible to have a small spot for fine detail as well as a brighter large spot for high-speed traces.

Modified Gun Design

Figure 3 shows a sectional view of a gun design introduced when the RCA-902 was announced in the autumn of 1937. The gun structure of Fig. 1 was modified by placing adjacent to the control electrode an accelerating electrode connected to the second anode. This arrangement overcame the interaction between focus and brightness control. It also permitted the electron cross-over to be formed at a higher voltage with the result, as developed in Langmuir's paper,[1] that a smaller focused spot was obtained at the screen.

Because high voltage was used on the accelerating electrode, its spacing to the control electrode could be made greater. The increased spacing offered two important advantages: first, a narrower beam was generated, and second, mechanical alignment of the apertures was not as critical. The latter resulted because the electrostatic fields acted to pull the beam through the centers of the apertures. Thus, the closer the spacing the farther the beam was bent away from the axis for a given amount of misalignment.

In Fig. 4 a gun construction is shown in which the accelerating electrode has been lengthened to carry a masking aperture and the first anode shortened to a disc which is used only for focusing. This structure is known as a zero-first-anode-current gun. It offers design possibilities of better focus and has the important circuit advantage of requiring no current from the focusing connection on the power-supply bleeder.

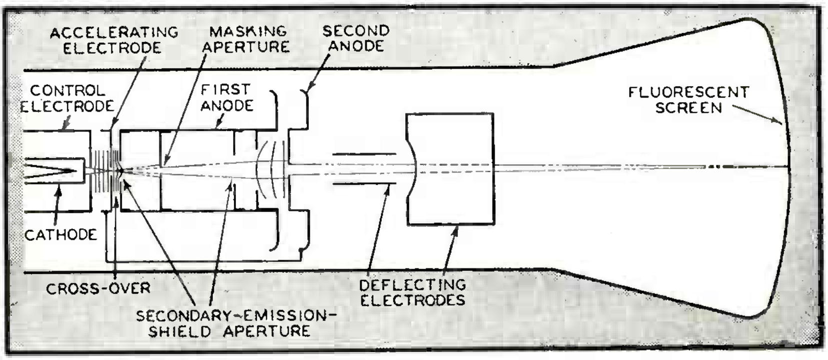

Fig 3—Gun design introduced in 1937, in which the gun shown in Fig 1 was modified by placing adjacent to the control electrode an accelerating electrode connected to the second anode

Since cathode-ray oscilloscope tubes require relatively small currents, it is cheaper and simpler to supply the first-anode circuit from a bleeder across the second anode supply than to provide a separate first-anode supply. However, if the first anode requires a current greater than that required by the second anode, which is now often the case, a large percent of the current from the supply must flow through the bleeder to furnish reasonably good voltage regulation in the first-anode circuit.

It so happens that poorer first-anode voltage regulation than second-anode voltage regulation can be tolerated because the first-anode voltage for optimum focus decreases slightly with increased values of beam current. Generally, however, enough current can not be used in the bleeder to provide the desired regulation. Moreover, the first-anode current varies too much from tube to tube to make such compensation entirely satisfactory. The result is that the focus has to be corrected even for fairly small changes in current.

On the other hand, with the zero-first-anode-current gun, the focus ratio of first-anode voltage to second-anode voltage is determined only by the bleeder tap instead of being influenced by first-anode current, and thus larger changes in beam current can be made without refocusing. In new equipment designs, it may be possible to decrease the bleeder current enough to use less filter capacitance than now required, but even without any decrease in bleeder current, there is still the advantage of less change in focus with beam-current change.

Constructional Advantages

From the viewpoint of tube construction, this gun offers several advantages. The longer accelerating-electrode cylinder is easier to support accurately. The beam is reduced to a small size before reaching the final focusing field. Because of this feature, badly aberrated rays from the edge of the focusing field are prevented from entering the second-anode aperture and thus causing stray current to the deflecting electrodes and the screen. The first anode can be made either as a cylinder or an aperture disc. By changing the length and diameter of the cylinder or the diameter of the aperture, it is possible to vary the focus voltage over a wide range. Therefore, it is easy to match focus-voltage specifications set by previous designs. There is also freedom from reverse currents due to secondary emission from low-voltage electrodes since they are not required to mask the beam. Consequently, aperture discs previously used in the first anode as electrostatic shields against secondary emission can be removed.

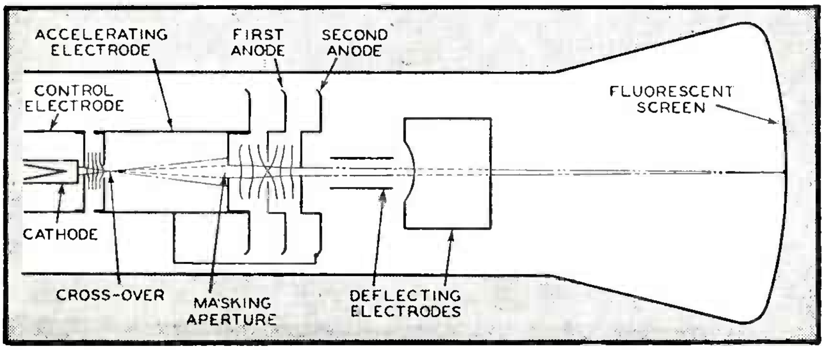

Fig. 4-Gun design based on zero first-anode current, in which the accelerating electrode has been lengthened to carry a masking aperture and the first anode shortened to a disc which is used for focusing

Other designs which are practical have been proposed.[3]

An application of a zero-voltage, zero-current focusing electrode to an electrostatic-focus electron microscope is also of interest.[4] In this case, fine adjustments of focus are made by moving the image surface.

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(2) Deserno, P., *Archiv fur Elektrotechnique*, 29, No. 2, p. 139. 1935.

(3) Iams, Harley, A Fixed-Focus Electron Gun for Cathode-Ray Tubes, *Proc. I.R.E.*, 27, No. 2, p. 103, Feb., 1939.

(4) Bachman, C. H., and Ramo, Simon. Electrostatic Electron Microscopy, *Jour of Applied Physics*, 14, p. 8, 69 and 155, 1943.

HIGHER VOLTAGES SPEED RADIOGRAPHIC WORK

Reprinted from Aero Digest

By Robert Taylor
Consulting Radiologist

RADIOGRAPHIC inspection equipment has contributed greatly to the accelerated production of aircraft. Improved designs, faster operations, higher voltages and more advanced techniques have resulted in consistency and accuracy of inspection, with a minimum of effort on the part of the operator.

Just before our entry into the war, General Electric X-ray Corp. introduced a compact, candid X-ray camera for operation at one million volts. Inspection procedures performed prior to the development of this new machine utilized 400,000 v as maximum. Previously over three hr were required to penetrate a given thickness of steel; with the new million-volt machine this thickness could be satisfactorily inspected in two min.

More recently, Dr. W. D. Coolidge of G-E announced that steel sheet at temperatures elevated to 2000° F and moving at approximately 20 mph could be inspected for thickness, using X-rays. Dr. Coolidge further stated that with one million-v X-rays the inspection of magnesium alloy aircraft castings varying from ¼-in up to and including 12-in cross section could be completed with a single exposure, while the identical casting inspected with 200,000-v X-rays would require 19 exposures.

Million-Volt Unit

One of the added features of the million-v unit is that it may be utilized in the foundry for the purpose of radiographing the molten metal as it feeds into the mold to form a casting and, by so doing, visualize on the spot the sequence of solidification.

When one considers the varying shapes and sizes of aircraft structural materials and castings originating from the foundry industry, as well as the sheeting and tubes produced by rolling mills or extrusion plants and the built-up sections produced by welding, it is obvious that no one particular machine can fulfill the needs of all industries. Therefore, units for X-ray inspection of varying power output have been designed for specific purposes, to fulfill the needs of individual fabricators or manufacturers.

This is worthy of mention principally because this type of inspection has been greatly facilitated with special emphasis on the requirements of the aircraft industry.

The ability of X-rays to penetrate metal depends upon the nature of the radiation produced by the particular machine and upon the absorption coefficient of the metal being investigated.

Because specimens vary considerably as to the nature of the radiation required to complete the inspection, the following types of machines have been constructed with a simplified design for the purpose of meeting the requirements of every group: (1) supervoltage equipment of one million v for heavy industry; (2) medium voltage equipment of 250,000 v for steel and brass up to 3-in thickness; (3) machines of 140,000 v capacity suitable for the inspection of light alloys.

(*Aero Digest, March* 1, 1945)

One of the greatest achievements credited to design engineers is the construction of protective cabinets wherein the work to be inspected is placed. These cabinets, adequately lined with lead, afford complete protection to operating personnel and eliminate the necessity of retiring to an adjoining room to control the machine. The savings in time where valuable man-hours would have been lost in needless trips to and from the controls is a vital factor. Designs of this type* are found in most aircraft plants today.

There are, of course, specific cases where machines designed with the transformer and tube in one single head are preferable for certain types of work. Many aircraft engine manufacturers prefer this type of machine, as the tube head operates from a jib-crane and can easily be placed in position for large specimens.

Either type may be purchased with power output ranging from 140,000 v up to 250,000 v, and choice of equipment involves several models.

Film Processing

Radiography requires also the processing of films which were exposed to the X-rays during inspection. For rapid inspection it would be rather foolhardy to attain considerable speed with the automatic units in the laboratory and neglect the darkroom. Therefore, automatic developing machines have also been designed to keep pace with X-ray inspection, insofar as concerns processing of the films exposed.

A typical machine employs a feeding magazine which correctly locates each developing hanger by means of a lifter arm. Also incorporated is a transfer mechanism which automatically lifts the films from one processing tank to another at the correct time interval. Obviously, this reduces the number of operators required to perform the darkroom work and speeds up this operation appreciably.

By virtue of the fact that many specifications require X-ray inspection of materials which make up our aircraft, radiography has been recognized as an indispensable tool.

* Such a unit was described by the author in the April 1, 1944 issue of AERO DIGEST.

* * *

EXPANDING PENICILLIN SUPPLY

A new electronic device now under test can dry 2,000 bottles of penicillin in an hour — enough for one treatment each to 10,000 persons.

CIRCUIT EQUALIZATION

Reprinted from Radio-Craft

By Robert Smith

IT IS a well-known fact that the higher frequency sounds commonly encountered in voice and music are less intense than the lower frequency sounds, and that most of the sound energy is concentrated in the lows. Referring to Fig. 1, note that at 3000 cycles the curve takes a sharp dip and that the higher frequency sounds have lower levels than those of lower frequency. This is also demonstrated by the curves in Fig. 2. Here, at "loud" level, we find a sharp dip downward at 3000 cycles. For the "soft" level the dip starts at about 350 cycles and for "normal" the break occurs near 600 cycles.

To over-ride noise in the transmitter or recording equipment, pre-emphasis circuit arrangements are desirable and necessary. These are used successfully in FM and movie work, as well as in television sound. The transmitting apparatus may be made to have a special pre-emphasis curve as shown in Fig. 3. The equipment linearity is altered by introduction of a pre-equalizer. In many cases, due to the method of transmission, noise reduction of the order of 10 db may be obtained.

The pre-emphasis and de-emphasis circuits are shown in Fig. 4. Using certain types of musical instruments, there may be a tendency to overload on the higher modulation frequencies, but this can be controlled by using a limiter amplifier between the speech amplifier and the input to the modulator. The method has been used successfully in recording, with vertical transcriptions, and recently has been used with 33⅓ lateral transcriptions . As the maximum energy density occurs in the vicinity of about 300 cycles for music and around 500-700 cycles for speech, the pre-equalization characteristic should be made to start about 500-

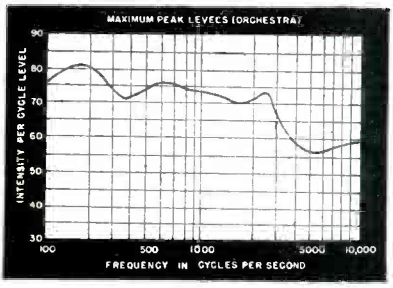


FIG.1

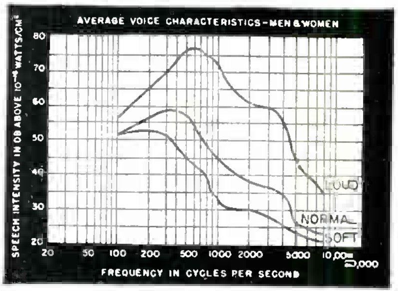


FIG.2

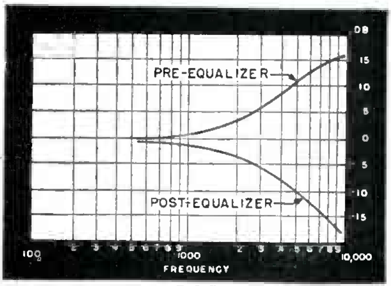


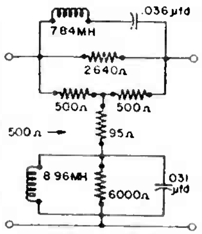
FIG.3

700 cycles if both speech and music are to be transmitted, with a limit of about 15 db equalization at 10,000 cycles.

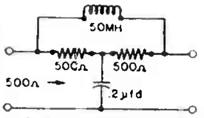
The pre-emphasizer circuit arrangement to the transmitter may be connected between the pre-amplifier and modulator. The receiver de-emphasis circuit may be installed between detector and audio amplifier. The pre-emphasis and de-emphasis curves, as well as the flat over-all response curve for the system will be seen in Fig. 5.

In this form of equalization, where we deliberately introduce a rise in the response at the transmitter, and correct for that accentuation of the "highs" at the receiver, there is still another form of equalization in common practice. We may find, for example, that a telephone line has lowered capacitive reactance as the frequency rises. Accordingly, there is less transfer of power into the line at high frequencies than there is at low frequencies, giving us an uneven freqency response or non-linear characteristic. To correct this we may use some form of equalization.

Such a line may be used to link a studio to a transmitter, an amplifier to a load such as a loud-speaker or it may represent the mike to amplifier link. The input impedance for a short line is essentially capacitive because of the fact that the "loop resistance" is low and the inductance is of small value. We then have the equivalent circuit shown in Fig. 6. As the capacitive reactance decreases with frequency, more and more of the current tends to flow in C than in the higher impedance circuit consisting of R and Z_L in series. R is representative of the loop resistance of the line. (If each conductor of the transmission line has 100 ohms resistance the "loop resistance" of the two conductors in series would be 200 ohms.) This would be the resistance measured at the input terminals with the far end or load shorted, assuming a high leakage resistance between conductors, which usually is the case. The leakage between conductors may be as high as 100 megohms per mile in typical cables used in telephone work.



R.M.A. PRE-EQUALIZER



R.M.A. POST-EQUALIZER

FIG.4

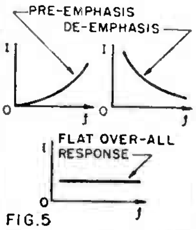
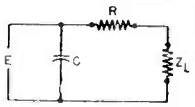
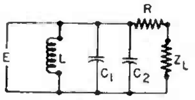


FIG.5



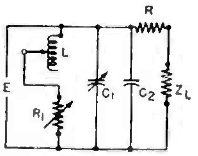
EQUIVALENT CIRCUIT OF AUDIO LINE

FIG 6



AN EQUALIZER CIRCUIT

FIG 7



ADJUSTABLE EQUALIZATION

FIG.8

To compensate the line or "equalize" it, we may use a simple parallel coil, as shown in Fig. 7. The inductance has a low impedance at low audio frequencies, and introduces a loss at the lower frequencies. This compensates for the tendency of the lows to be stronger than the highs—by introducing an inverse characteristic.

In other words, the effect of the coil is balanced against the effect of the condenser. The capacitive input circuit is made up, in this case, not only of the input capacitance of the line, which in Fig. 7 is C2, but also of an additional input capacity due to the equalizer, C1. The resonant circuit L-C1 is made to resonate at about 12,000 cycles if the maximum transmission limit is to be about 10,000 cycles. In a typical installation, where the upper audio limit is 8000 cycles per second, as in movie work, the resonant circuit may have a frequency of 8500 cycles. Values of L and C are usually adjustable so that a transmission characteristic suitable to meet the particular requirements of the circuit may be worked out. A typical set-up is shown in Fig. 8. Elements of the equalizer are variable.

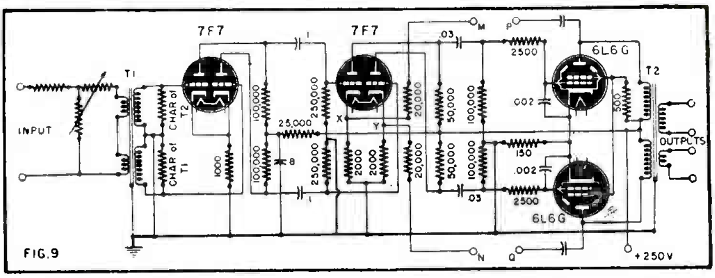
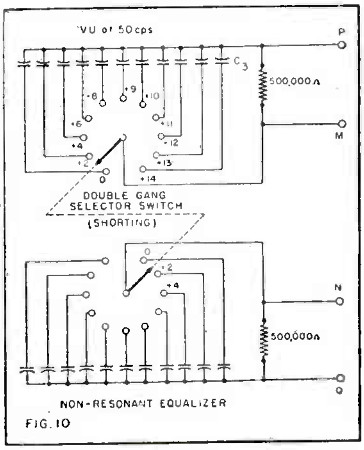


FIG. 9

An equalizing amplifier developed by E. G. Cook, a communications engineer, is shown in Fig. 9. The amplifier is a high-level type and may be used as a sound effects equalizer, recorder cutting head driver, playback equalizer or loud-speaker equalizer amplifier. It can be used to build up or lower the high frequency end of the audio spectrum in calibrated steps at a known frequency, and any specified low frequency may be controlled in the same way. The amplifier uses four tubes. The 7F7 tubes are dual types of the high-mu triode variety having an amplification factor of about 70. The circuit is push-pull or balanced throughout, which keeps down harmonic distortion and hum. It has a gain of 65 VU, a maximum output level of 12 watts and its input may be operated at a level of -40 VU while still keeping a noise level of 65 VU below the output. In radio broadcasting it is possible to purchase or rent the use of an ordinary line between studio and transmitter at a cheaper rate than if an equalized line is rented and the telephone company must guarantee the response. The use of an equalizer which has a rather sharp peak in the frequency characteristic may be necessary. To alter the response of the equalizer amplifier, special feed-back networks may be employed as illustrated in Fig. 10. Several other types of networks, some of them with resistive or inductive components, may be inserted in the feed-back circuit of the amplifier. If desired, two or more networks may be used to secure the necessary operating characteristics, for example, double-peaked responses or other special features which may be needed by particular lines.



NON-RESONANT EQUALIZER
FIG. 10

ELECTRONIC RECORDER FOR FLIGHT TESTING

Reprinted from Electronic Industries

By Thomas A. Dickinson
Consolidated Vultee Aircraft Corp., San Diego

Consolidated Vultee develops ground equipment for making detailed and accurate reports on airplane performance

AN ELECTRONIC flight recorder, vicariously styled an "electric brain," is helping Consolidated Vultee Aircraft Corp. pilots with the job of testing new airplanes. The device consists of a transmission unit, which is installed in an airplane, and a receiving-recording unit, which is installed at a ground radio station. It enables flight research personnel to obtain accurate test-flight performance data without carrying bulky camera equipment or making tedious pencil notations.

The aircraft portion of the equipment includes a number of gage devices, arranged so that various instrument indications will produce signals which can be transmitted to a conveniently-located mechanism through suitable electrical circuits. Each signal has a pre-determined travel or range, and it varies in accordance with the position of the gage device. While passing through a high-speed scanning switch mechanism in a known sequence of 40 to 90 indications per second, the varying signals modulate an alternating current in conformity with the gage indications; then the modulated alternating current is amplified, rectified, filtered, and used to produce an audio frequency signal. A small frequency modulation transmitter broadcasts the signal.

The ground-based receiver unit of the flight recorder is synchronized with the pickup equipment in the airplane, so that it can decode the audio frequency signal by amplifying and converting the signal to an amplitude proportional to that of the original gage reading—then utilizing the proportional amplitudes to record the indications of the gaging devices on individual charts.

Operational Details

This is accomplished by means of a switch which mechanically interrupts the signal at regular intervals. The switch comprises a rotating arm and a series of contacts. When the arm engages one of the contacts, a potential determined by the gage device in the airplane is fed into the electronic portion of the recording unit. There is a separate electronic circuit for each individual gage device, and it includes a condenser and electron tube.

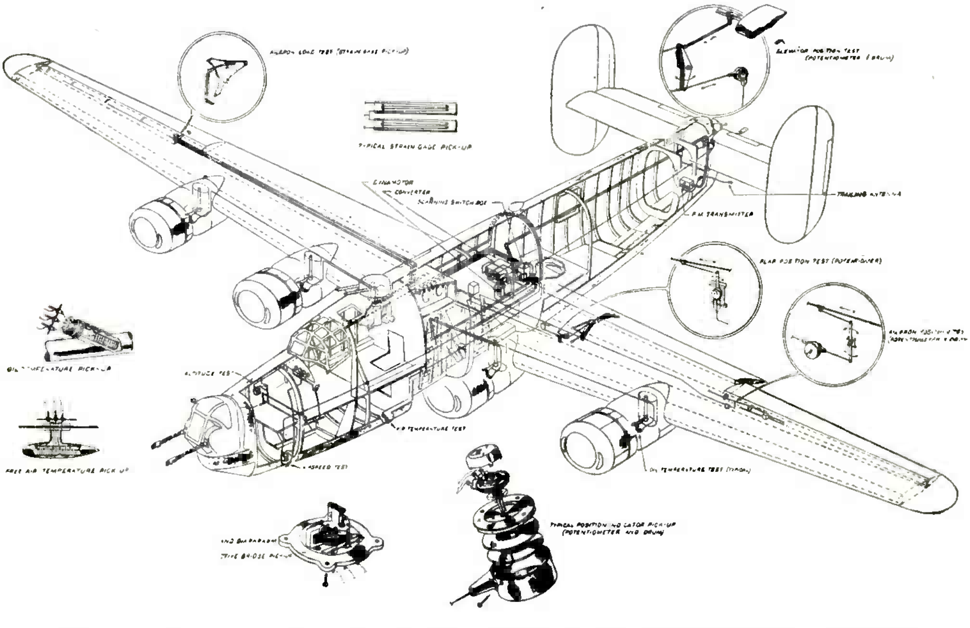
When the potential is fed into the circuit, the condenser is charged to a negative potential. A potentiometer effects the firing of the electron tubes, and it has a slideable contact arm for each of the separate circuits. The movements of the potentiometer arms are synchronized with the movements of the interrupter switch; and, when the arm for a particular electronic circuit moves around the potentiometer a sufficient distance to pass a voltage to the circuit

(Electronic Industries, April 1945)

so as to neutralize the previously-mentioned potential or charge on the condenser, the electron tube fires.

This action energizes an additional portion of the circuit and causes an electric pen or stylus to make a mark on the special recording paper (Western Union Teledeltos Type "L"), which reacts to a passage of current. The positions of the marking pens in the circuits are purely mechanical (i. e., the pens move continuously along a track with a wire trolley for contact with their respective circuits). Each pen circuit is actuated at a specific time during its movement across the recording paper; and, therefore, the potential originally applied to the condenser from the impulse source definitely determines the location of the pen at the time it is energized. The marking pen circuit depends on the firing of the electron tube for its operation, and it acts indepedently of all other circuits—arriving at the zero point if its operation as a contact associated with the circuit commences its travel on the live portion of the potentiometer.

The marking paper is fed between rollers in the recording unit so that marks will be made by the pens at definite intervals, according to the time that elapses between impulses at the transmitter. This makes it possible to place time lines on the paper, and allows the plotting of two-dimensional graphs with time and position or other ordinates; and thus ground engineers can obtain true reproductions of the movements of gaging devices in the airplane. The graphs can be readily calibrated in terms of airspeed, altitude, positions of control surfaces, etc.



Phantom view showing how the aircraft portion of the electronic recorder would be installed in a Liberator bomber.

Prior to the development of the flight recorder, it was customary to have members of the aircraft crew manually record pertinent data from dials, gages, and other instruments in the course of a test flight. In large aircraft, such as the Liberator and Dominator, it was possible to carry engineering observers who could do this job; but, in small fighters and pursuit planes, the test pilot himself often had to keep books. Therefore, it was frequently necessary to make dozens of test flights in order to obtain even the most simple performance data; and sometimes this was unreliable, because it is virtually impossible for human eyes and hands to keep track of all the gyrations of even a single aircraft instrument in flight.

Motion picture and "magic eye" cameras were developed for the purpose of recording instrument indications, but photography did not solve the problem for a number of reasons. The equipment required was bulky, and it was exceedingly difficult to attain the lighting conditions necessary to make clear pictures inside of an airplane. Moreover, it was found that, at the higher altitudes, the oil on camera shutters would congeal — causing the mechanism as a whole to fail.

In these circumstances, if an experimental airplane crashed, there was less than a 50-50 chance that ground personnel would be able to determine what caused the accident; because it was likely that all clues as to the source of the trouble would be destroyed, even when the flight crew managed to survive.

Detailed Reports

With the Consolidated Vultee flight recorder, it is possible to obtain a detailed and accurate report on the performance of an aircraft; and, if an accident occurs, it is virtually certain that ground engineers can determine why. Besides this—with all its gages, switches, converter, and transmitter—the aircraft portion of the flight recorder weighs only 56 lbs. and occupies only four cubic feet of space. Even the smallest engineering observer would weigh more and take up more space.

The flight recorder was invented and perfected by Harvey D. Giffen, Thomas B. Thomson, Jr. and Willard C. North—all flight research engineers for Consolidated Vultee at San Diego, California. The development work required approximately three years' time.

FOILING ENEMY CAMERAMEN

Textile mills use the electric spectrophotometer to match camouflage colors so they can't be detected by German and Japanese infra-red cameras.

POSTWAR RECEIVER COMPONENTS AND ACCESSORIES

Reprinted from Service

By Donald Phillips

A VARIETY of new and remarkably effective developments will contribute to the postwar receiver.

We will find, for instance that most components will have been improved in some manner; performance, durability, size or weight. In factories improved methods of production and tests, adopted during the war, will play their role toward providing these improved components.

Loops

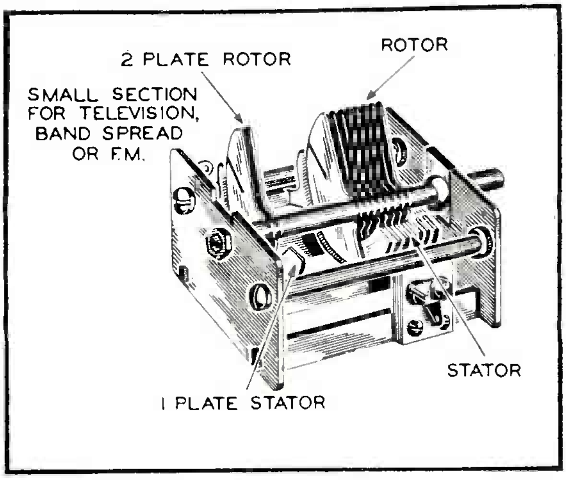
One improved component that will find itself used in many receivers is the loop. As a matter of fact many new types of windings have been developed. These improve the *Q* of the loop. Developments have shown that copper foil placed between loop and chassis reduces the loss in *Q* due to chassis absorption. We'll find that loops will be larger and wound with heavier wire, allowing greater pickup with a consequent improvement in signal-to-noise ratio. In higher priced receivers, loops with iron cores may be used. Iron-core loops have been popular in German aircraft direction finders. We'll also find an increased use of solinoid types of loops.

I-F Coils

In spite of reduced size, i-f transformers will provide increased efficiency. We may even be using pre-tuned i-f transformers, so matched that no adjustments are required. The more expensive units may have fixed temperature compensated capacitors for increased stability. This will be particularly useful in f-m television or other v-h-f receivers. I-f frequencies are expected to remain at 175,262 and 455 kc for standard a-m receivers. F-m, television and v-h-f receivers will probably employ 8 to 20 mc for the i-f-t frequency.

Capacitors

We may have an extension of the broadcast-band frequency range. This would appear at the lower end, and may extend to 520 kc. Ordinarily, such a



A multi-function capacitor for f-m, broadcast, television or band-spread

(Service, February 1945)

move would necessitate larger variable condensers with greater maximum capacitance and not more minimum. But tuning condensers are a lot more precise than in the old days and their size can be kept down by using thinner plates with smaller spacing. New methods of manufacture will provide for improved calibration methods and increased tuning efficiency. The Service Man will also be aided by novel methods of condenser mounting which will lessen microphonics. It appears as if the 100% tuned r-f stage is going to return. This will require 3-gang variables instead of the too-familiar 2-gangs to provide improved selectivity.

New type trimmers are now being designed which will probably be constructed along the lines of miniature variables. The better grades of tubular paper capacitors, as well as electrolytics, will be mounted in drawn aluminum cans which have proved to be far superior to cardboard and other types. New sizes providing an extremely high density per square centimeter will also be made.

Resistors

New types of carbon resistors with smaller temperature and voltage coefficients, greater stability and higher power ratings, recently developed will find many postwar receiver applications.

Wirewound elements are far superior to prewar varieties, failures due to opens being greatly reduced. Insulation has also been improved to increase resistor life and usefulness.

Volume and Tone Controls

High standards set by Army-Navy procurement agencies have introduced many improvements in tone and volume controls. Metals recently developed not only prevent wear of element, but avoid humidity effect, thus eliminating noise problems. Improved pigtails have also minimized contact noise.

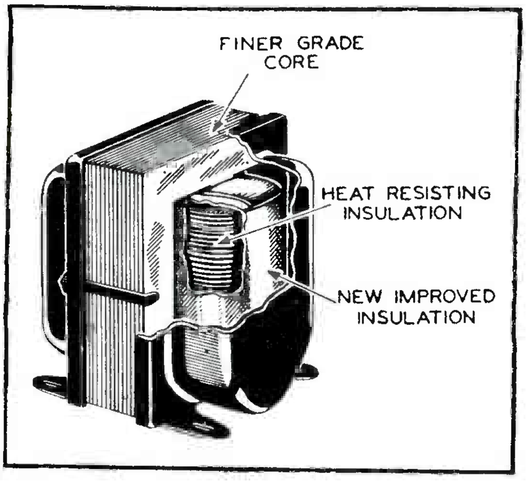
Tuners

Accelerated compact receiver design has provided improved permeability (iron core) tuners. And we will find them in many of the smaller type receivers instead of variable condensers. Such receivers will also see new methods of coupling loop antennas to these tuners. Frequency ranges will be greater due to improvements in powdering techniques. A change in the shunt capacity as well as a change in the position of the iron slug increases frequency range quite effectively.

Power and Output Transformers

Instead of the old type wax paper separators between layers, new type plastic sheets will be used. There'll also be new types of insulation for wire allowing higher operating temperatures, and permitting greater output for a given

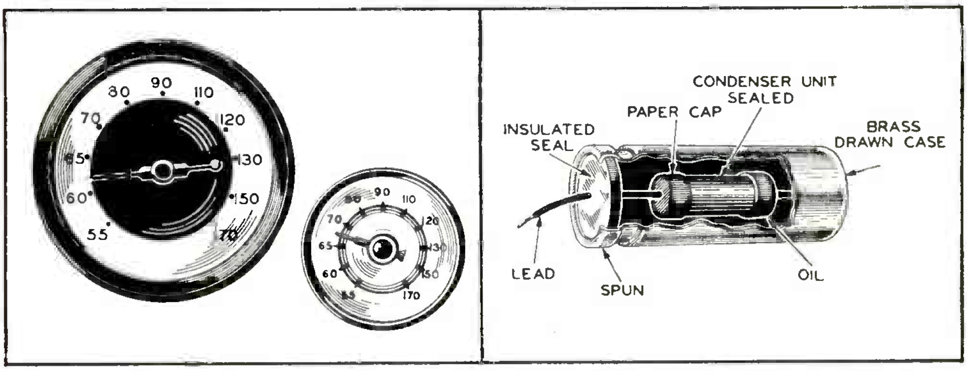
Postwar power transformers that will probably use plastic sheet separators, and other improved forms of insulation. This, with better grades of steel and generally improved design, will provide transformers of unusually high efficiency



size transformer. Laminations will be of a better grade of steel providing a further reduction in size, an improvement in power factor and frequency response.

Sockets

Many receivers, particularly the f-m and television types, will feature many low-loss sockets. This will be important because of the high-impedance circuits. Sockets will be of polystyrene low loss ceramic, and other similar materials. Various forms of beryllium copper and other spring alloys will provide for better and more permanent gripping.



Left, comparison of prewar and postwar dials. New dials will be larger, with large size frequency designations. Right, cross-sectional view of postwar tubular paper condenser design with hermetically sealed case.

Tubes

Improvements in miniature type tube technique will probably result in their being standard in all types of receivers for r-f, i-f, converter and low power audio uses. Only the rectifiers and audio power tubes may be standard size and many of these may be GT or metal.

Dials

The trend in postwar design indicates that we'll have larger dials, better viewing and clearer figures. There are new forms of illumination with three dimensional effects, and a variety of new materials to enhance appearance.

Cabinets

Cabinet designs will be most unusual. With new materials on hand for both compression and injection molding, striking new designs are in the offing. Combinations of bakelite with wood and other materials have great possibilities. There are plastics available which are practically unbreakable.

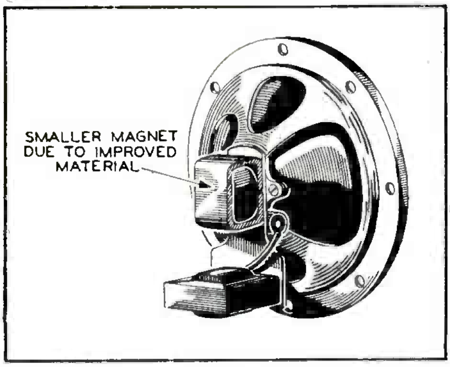
Speakers

The strongest of the present alnico alloys, No. 5, will prompt an increased application of p-m speakers. With this alloy unusually high flux densities can be obtained with very small magnets. In fact, the speakers may be so tiny that receiver purchasers may doubt their usefulness. However, as tiny as some may be, their performance will be substantial. The low-frequency response and power output of these speakers will far surpass any similar type speaker made before the war. The new types will feature increased frequency response, lighter voice coils, closer gaps, and better dust-proofing.

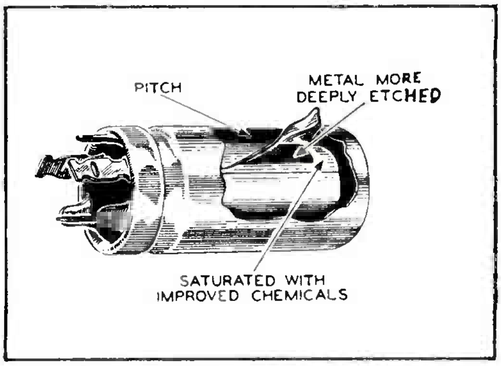
Most speakers will be supplied less output transformers which will be a big help to the Service Man. Standardization on 3½-ohm voice coils by industry established a short time ago will help the Service Man too. Instead of a wide variety, only a few size speakers and transformers need be carried in stock.

Chassis

The postwar receiver chassis will be constructed from aluminum, magnesium and steel, depending upon the application. Plated rust-resisting steel chassis having new types of coloring effects will be used in large console sets. Portables and light weight models will probably use aluminum as standard material and magnesium where the utmost saving in weight is required.



Typical postwar speaker that will be smaller and have stronger alnico magnets.



Post war type of electrolytic. Drawn aluminum cans will probably be featured in most types.

Wire

New types of plastic insulation which stand up in all climates will be featured in the better sets. We'll also see new types of insulated wire for use in r-f and i-f coils. Adverse climates will not affect such wire. And Q-loss will be minimized by the use of this new type of insulation.

Portables

There'll be several types of portables, using new *A* and *B* storage batteries. Most of these will be of the self-charging type and unusually compact.

Postwar Television

Since television will probably be a major postwar factor, it is prudent to survey some of its features and problems. An effective analysis of the new video receivers was prepared recently by Frank Freiman, executive vice president of Magnavox. He said:

"The location for best television viewing is seldom the location for best auditory reception. The radio-phonograph may be in the living room and the television receiver in the den or library. The television antenna installation, which is of major importance for successful operation, will frequently determine the location of the television receiver. It may be one least desirable for the radio-phonograph.

"Furniture size adversely influences the combination of television and the radio-phonograph. The spontaneous revival of interest in phonograph records developed a prewar trend toward console instruments, embodying both the radio and the phonograph. This trend was no doubt aided by the public's realization that they had missed most of the musical entertainment through the inadequacy of small table model sets. There has been ample proof of resistance toward the purchase of large cabinets because the modern home will not accommodate bulky furniture. Combining a good musical instrument with television completely ignores these basic factors.

"Industry must take a more realistic view of television in relation to the immediate postwar period and the effect it will have on the radio market as a whole, as well as for the long pull growth of television itself. Factual information should be substituted for ballyhoo in television promotion now. The public should be told what it may expect of television, what the television receiver will be like, what effect, if any, it will have on the radio and the phonograph and the specific areas that will be served by television transmitters. All this in relation to the immediate postwar era, not what might be expected two, three or five years after television is launched. Let's present television as the wonderful separate service that it is and not as either an adjunct to or successor of the radio and phonograph."

PHASING OF LOUD SPEAKERS

Reprinted from Radio News

By Nicholas B. Cook

Failure to observe proper phasing of speakers will result in an inefficient audio installation with apparent deadspots and lower volume.

A FACT well known to sound men is that in order to obtain best reproduction of sound with more than one speaker, it is necessary that the speaker cones move "in phase." They must all move in or out, "in step," so that the total cone area may be regarded, in effect, as a single diaphragm. In this manner, each speaker contributes aid and reinforcement to the sound wave. If the speakers are not in phase, there will be interference and cancellation.

Not so well known, however, are the means for checking the phase relations, particularly where line-matching transformers are involved. One method permits testing by ear while the speakers are connected; other methods make use of polarity relations, both mechanical and electrical, by which proper phasing is assured at all times.

Ear Test

In order to make the ear test, the following procedure should be followed: Place two speakers in a horizontal line, typical of their placement in a theater. Next, turn up the gain to produce hum and walk across the stage in front of the two baffles, from the outer edge of one to the outer edge of the other.

If the hum level is approximately uniform, the speakers are in phase. However, if the hum is appreciably lower in the vertical plane between the two baffles than at the outer edges, the speakers are out of phase.

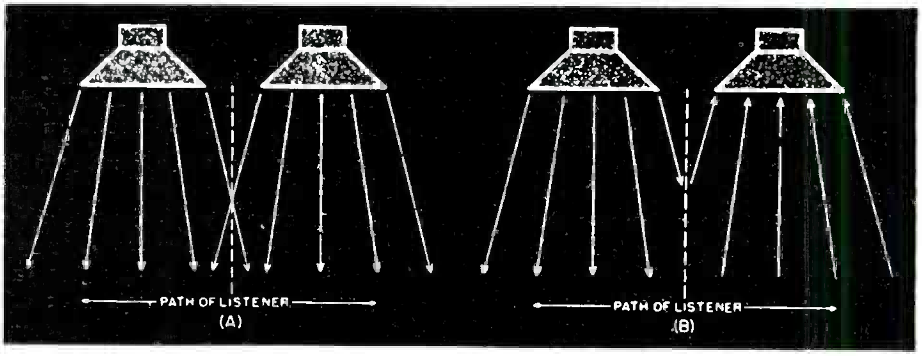


Fig. 1. Proper phasing can be determined by applying ear test. When out of phase the hum level will be lower, in a plane between the two speakers, than at the outer edges (B). When correctly phased, a more uniform distribution of volume will be obtained (A).

A second test is to place two speakers in a vertical line. The procedure is similar to the above, except that the listener must move in a vertical plane. In this case, if the speakers are out of phase, the hum level will be appreciably lower in a horizontal plane between the two speakers.

In the final analysis, instead of remembering these rules, it is helpful to draw a simple diagram representing two speakers in phase and out of phase (Fig. 1). Fig 1A shows that the instantaneous wave is outward from both cones. Clearly,

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(Radio News, April 1945)

there is reinforcement where the outputs overlap. In this plane the level is not likely to be *lower,* but rather somewhat *higher* than at the ends of the path transversed by the listener. In Fig. 1B it is shown that the instantaneous wave is *outward* from one cone and *inward* toward the other. Cancellation occurs where these two effects overlap. In this plane the hum level will be appreciably lower.

Phasing Voice Coils

When phasing voice coils, the first step is to excite the speaker field, and then short out the hum-bucking coil, if one is used. Next, apply 1.5 volts from a flashlight cell to the voice-coil terminals. By the trial and error method, polarize the voltage so that the cone jumps *outward* on voltage contact, and put an identifying mark on the voice-coil lead to which the positive voltage was applied when the cone jumped outward. Speakers having permanent magnet fields require no further check.

When the field is electrically excited, the positive terminal of the field coil (as then connected) must be determined and marked. In both cases, the polarity now has been definitely established.

As an aid to remembering that the cone jumps outward, we may recall the rule that *like* poles *repel.* (*Positive* voltage goes to *positive* terminal; cone is *repelled.*) It is generally understood that voice coil currents are assumed to *enter* at the positive terminal. For the use of parallel operation, like terminals are connected together, while for series connection, the unmarked terminal of the first speaker must be joined to the marked terminal of the second, and so on.

Transformer Connections

In a case where a line-matching transformer is used, the phasing between the line and voice coil may be done in a similar manner. By reason of the step-down ratio of the transformer, a higher voltage is required. A 22½-volt "C" battery may be applied to the line. When the cone jumps *outward,* the positive terminal of the transformer (high side) should be marked.

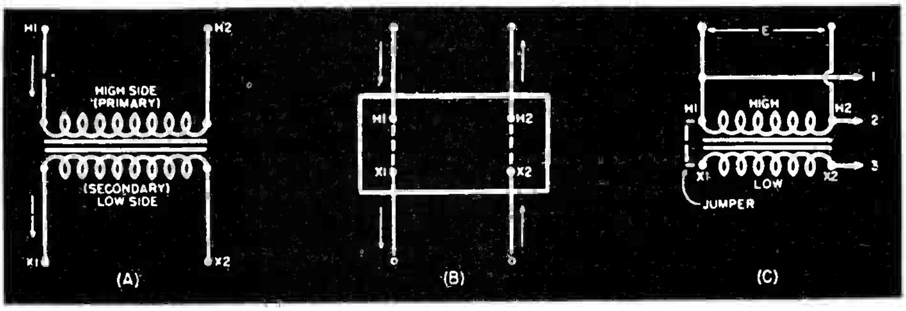


Fig. 2, (A and B) Assumed instantaneous direction of current flow in an output transformer. (C) Determining proper polarity, applying voltmeter method.

The polarity of the voice coil is still unknown. For this reason it is best to proceed as follows:

1. Determine the positive terminal of the voice coil in the manner previously described.

2. Connect the transformer to the voice coil. Determine the positive terminal of the primary (the line side). Also, mark the secondary lead that goes to the marked terminal of the voice coil.

Now both the speaker and the transformer are polarized *permanently.* When such marked units are interchanged with others, properly connected, and similarly marked, the speakers will always be in phase.

Transformer Polarity

Transformer polarity is a matter of great importance to the power engineer. The radioman becomes acquainted with it when he replaces an r.f. primary or some other transformer winding in a tuned circuit. He has learned also that feedback may be good or bad, depending upon the polarity of certain coils.

In the electric power industry the practice of marking transformer terminals in such a manner as to indicate the *sense* of the winding has been standardized by the American Institute of Electrical Engineers. The sound man will derive considerable profit from these conventions.

Fig. 2A shows that the assumed instantaneous direction of current flow is into terminal H_1 and out of terminal X_1 as indicated by the arrows. So far as phase relations are concerned, connecting to terminal X_1 is equivalent to connecting to terminal H_1 (Fig. 2B). The magnitude of the secondary voltage (with given primary voltage) depends upon the turns ratio. Phase change is zero in the ideal transformer.

A standard method of checking polarity is by means of voltage measurements, as shown in Fig. 2C. The correct procedure is to connect a jumper between H_1 and X_1. Apply voltage to the primary (high) side, and measure the voltage between points 1-2 and points 2-3. If E_{2-3} is *less* than E_{1-2}, the polarity markings are correct.

The sound man may adopt the following method to determine the polarity of audio transformers

1. Select one terminal of either the high or low side and mark it +.
2. Tie this terminal to one lead of the other winding.
3. Apply voltage to the high side and measure voltage (1) across high side and (2) between terminals not tied together.
4. If measurement (2) is lower than measurement (1), then the terminals tied together are of the same polarity.
5. If measurement (2) is higher than measurement (1), then the terminals tied together are of opposite polarity.

Fig. 3A is a diagram of connections and an actual test of a "line to voice coil" transformer. In order to determine the polarity, one terminal of the primary has been arbitrarily selected as positive. The voltage measurements are E_{1-2} measures 6.6 volts and E_{2-3} measures approximately 6.0 volts. Therefore, it is determined that terminal *a* is the positive terminal of the secondary.

Tapped or extended windings can be checked similarly. The polarity of each section is the same as the polarity of the entire winding, as shown in Fig. 3B. Terminal 1 is positive to all other secondary taps, terminal 2 is positive to 3 and 4, and so on.

Checking with D. C.

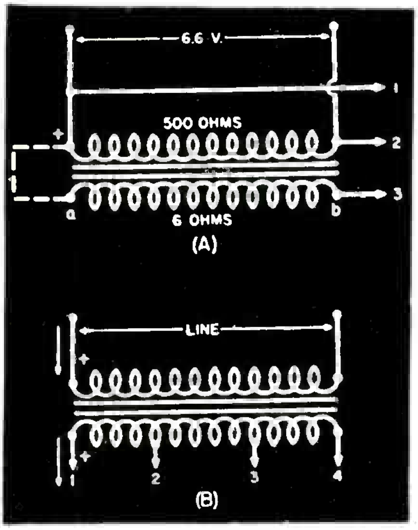
To check transformers by using direct current, connect a d.c. voltmeter across the low side of the transformer. The range may be 50 v. for the first trial. Next, designate and mark one primary lead as positive and connect the other primary lead to the negative side of a flashlight cell. Now touch the marked primary lead to the positive pole of the cell. The voltmeter pointer should deflect momentarily up or down scale. If it does not, then reduce the range. When the pointer jumps *up* scale on contact, then the secondary lead connected to the positive terminal of the voltmeter is the positive end of the secondary. With this connection, the pointer should jump *down* scale when the contact is broken. Keep the voltmeter range high enough so that deflection will be small and make sure that a deflection up scale is not just a rebound from a jump down scale.

This d.c. test is not recommended for transformers of the better grade, since it may put a magnetic bias on the core. However, a series condenser may be used to block the steady direct current while allowing a polarizing pulse to flow. The various connections are shown in Fig. 3C, although the values given are for a particular case.

In the case illustrated in Fig. 3C a milliammeter can be used. Here, one terminal of the primary has been arbitrarily selected as positive. When testing it is seen that in contact (1) the pointer kicks *up* scale, and when breaking contact (2) the pointer kicks *down* scale. From the previous discussion it is concluded that terminal *a* is positive.

Testing with Oscilloscope

This is a rapid and safe method, wherein very low exciting voltages may be used. The connections are shown in Fig. 4. The preliminary step is to use connection (1) to determine the "in phase" pattern. Since the same voltage is applied to both sets of plates, the trace will be a straight line. With equal horizontal and vertical amplitudes, the line will be inclined either 45° or 135°. The 45° position is considered standard, but in either case an "in phase" reference position is established.



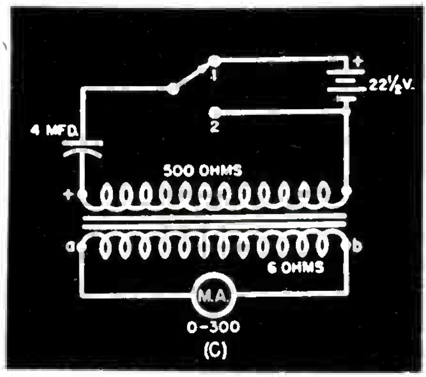


Fig. 3 Diagram of connections and polarity test of an output transformer,

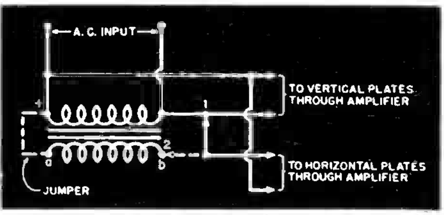


Fig. 4 Method of employing an oscilloscpoe when determining proper phase polarity.

The next step is to change horizontal input connection from point (1) to point (2). (Readjust for equal horizontal and vertical amplitudes.) If the straight line trace is inclined at the same angle as for the "in phase" connection, then terminal *a* is positive. (The designations "vertical" and "horizontal" may be transposed to utilize the higher gain of the vertical amplifier.)

Summary

Proper reproduction of sound from multiple speakers requires that all diaphragms move simutaneously "in phase." Arbitrarily, we may choose outward motion as positive. Then the positive terminal of the voice coil is the terminal to which positive voltage is applied to produce positive (outward) motion.

Transformers are to be polarized and marked so that the current shall flow, in effect, in at the primary marked terminal and out of the secondary marked terminal. When speakers and transformers have been so marked, they may be interchanged without risk of upsetting phase relations. As has been seen, various simple methods of checking transformer polarity are available.

Manufacturers and users of sound equipment are urged to polarize transformers where proper application involves correct phase relations.

TELEVISION AND ITS POST-WAR OUTLOOK

Reprinted from Domestic Commerce

By Mort N. Lansing

Specialties Unit, Bureau of Foreign and Domestic Commerce

DREAMS of the past have often become miracles of the present. This is true in the case of television, which now gives every promise of becoming one of the commonplaces in the near future.

Certain technical problems have been solved by radio engineers and now the industry believes that it will be possible even to have color within a year or two after V-E Day. These radio engineers have been experimenting and conducting research ever since the birth of radio. From the infant radio industry which began with headphones and crystal detectors there grew up a giant industry with two promising lines of development—frequency modulation and television.

If television is to follow in the footsteps of the phenomenal expansion of the radio industry, some conception of what may occur can perhaps be obtained from an analysis of that industry. The establishments covered by the figures in the table were engaged primarily in the manufacture of radio receiving and transmitting sets and tubes, television sets, phonographs, accessories and associated equipment. The value of products for the year 1939 was produced by 224 establishments which employed an average of 43,508 wage earners in that year. Approximately 8 percent of the total production was exported in 1939.

ANNUAL PRE-WAR PRODUCTION OF THE RADIO INDUSTRY

Year	Value of Products
1931	$193,142,845
1933	121,801,611
1935	200,972,523
1937	122,901,524
1939	275,870,165

Source: Bureau of the Census. U. S. Department of Commerce

Since 1939, the industry has expanded rapidly in order to meet the large and complex military requirements.

For a number of years television programs have been broadcast experimentally. In 1941 the Federal Communications Commission issued rules and standards providing for monochrome television broadcasting on a commercial basis. Eighteen channels, each 6 megacycles wide, were assigned for television use in that part of the spectrum between 50 and 294 megacycles. Not all of these were adjacent channels. By September 1944, six commercial television broadcast stations had been licensed and each was telecasting a program, although three of these stations had not been fully completed because of wartime limitations. Estimates as to the number of television receivers in the hands of the public range all the way from 7,000 to 40,000. These receivers are generally designed for reception of stations on frequencies below 90 mc.

New Channel Allocations

By provisions of the January 15, 1945, allocations, the spectrum from 84 to 88 mc. will be divided into 20 channels each 200 kc. wide for FM Programs

(Domestic Commerce, April 1945)

radiocast from noncommercial educational stations. The region from 88 to 102 mc. will be divided into 70 channels, each 200 kc. wide, for regular commercial use.

TELEVISION CHANNEL ASSIGNMENTS PROPOSED JANUARY 15, 1945

Channel number	Megacycles
1	44 to 50
2	54 to 60
3	60 to 66
4	66 to 72
5	[1] 72 to 78
6	78 to 84
7	180 to 186
8	186 to 192
9	192 to 198
10	198 to 204
11	204 to 210
12	210 to 216

[1] Available upon removal of 75 mc. aviation markers.

Source: F. C. C. "Report of Proposed Allocation from 25,000 Kilocycles to 30,000,000 Kilocycles," Jan. 15, 1945.

Courtesy of General Electric

Shooting a scene in a television studio. This picture shows the placement of the television cameras and microphone booms.

In considering the proposed television allocations, a fact of tremendous importance becomes evident. If necessary, it will be possible to authorize 7 television stations in one city by assigning 4 stations in the 6 channels below 100 mc. and the other 3 in the 6 channels available between 180 and 216 mc.

In order that developments might take place in a television broadcast system for the transmission of high definition monochrome pictures and superior color pictures through wide channel usage, the space from 480 to 920 mc. (less 508 to 524 mc. temporarily), has been made available for experimentation. It is important that wide channel high definition television be developed, for this type of service will enable the viewer to enjoy finer detail than that now received. The illusion of "presence" or "realism" will be enhanced. This will increase the value of television as an entertainment, educational, and merchandising service. Sales appeal of merchandise may be greatly enhanced when exhibited by television with every detail of color and texture of the merchandise clearly shown.

Television Reception

A word about the picture itself. Commercial monochrome 525-line television has a clearness somewhat better than 8 millimeter home movies. An outstanding difference between aural radio and television is the fact that, unlike aural radio programs, most television programs must be watched with complete and undivided attention. Obviously, for one to go about his regular affairs while viewing a television program may be difficult, if not impossible. This limits the time of television programs to periods of relaxation, and thereby restricts television audiences.

On the other hand, from the educational and advertising viewpoint, television is 100-percent attention-compelling and completely absorbing. Hearing combined with seeing has much greater realism and audience appeal than either separately. Television has the unique characteristic of enabling the television looker, from his comfortable vantage point at home, to see and hear events of interest miles away exactly at the moment they occur!

Costs of television programming at present are much higher than of comparable sound broadcasts, and this factor combined with the inability of the television looker to sit still and look for more than a few hours at a time seems reason enough to expect that post-war television programs will be furnished only at those times when a comparatively large audience may be reasonably expected. Evening programs of 4 or 5 hours and limited morning or afternoon programs are likely. Daytime programs broadcast for educational purposes in schools and colleges will have an important place in the television picture.

Program Financing

It has been estimated that as many as a thousand firms have used television programs experimentally as an advertising medium. The present television audience is not large enough to support regular schedules of original television programs, a service which is considerably more costly than aural radio broadcasting.

Some television broadcasters have been willing to start the ball rolling by underwriting their own programs, thus arousing the interest of television audiences to such a degree that these audiences will buy television receivers in quantity when they are available. In this way an ever-increasing television audience will probably be built up. Before long, by this means, television broadcasting may be expected to become a self-supporting, profitable, advertising medium.

Types of Programs

Television programs will receive far fewer "attention hours" than will aural radio programs. However, this factor may be offset to a large extent by television's reportedly greater commercial value and selling power.

The advertiser, through television, can present to the buying public interesting video and sound programs such as current events in the making, tennis matches, football games, the opera, night club floor shows, parades, political meetings, and product-use educational features. He can show his products by television shopping tour through his store or showroom, familarize his potential buyer by telecasting trips through his factory, have his best salesman demonstrate selling points and present the most effective selling ideas in many homes simultaneously.

The program may be varied by the presentation of visiting celebrities. Tours of a city can be broadcast by chambers of commerce to attract new industries and the traveling public. Industrial plants and large estates for which buyers are sought may be shown by television. The mail-order house can exhibit articles more effectively than by means of a catalog; clothing manufacturers and clothing stores can televise fashion shows. Appliance manufacturers can broadcast demonstrations of their products and department stores can show specials for the week.

By the use of color television, fashion parades, showings of patterns, designs and colors in fabrics, carpets, wallpapers, dishes and art goods should be especially valuable in promoting sales.

Courtesy of RCA

New large screen home-television receiver utilizing unique lens syhtem which provides a picture approximately 16″ x 21″ in size.

Post-War Prices

As military requirements diminish, much of the very large manufacturing capacity of the electronics industry and many of its highly skilled personnel will become available for the production of civilian radio equipment.

In 1940 the manufacture of FM receivers was a fully developed branch of the radio industry swinging into full commercial production. Television receivers were also in commercial production but on a much smaller scale. However, as soon as wartime restrictions are lifted, volume production is expected in both of these fields.

Few FM Receivers

Before the war very few radio receivers were designed to receive only FM programs. The FM feature was built into sets in addition to the AM feature, enabling the listener to receive either service. AM-FM receivers usually cost approximately 25 percent more than AM recivers of equivalent quality; this differential may still hold after the war. Television receivers will probably cost approximately 50 percent more than AM receivers of comparable quality.

For convenience in discussion let us denote by the symbol "194V-E" the 12 months beginning on the day on which victory in Europe is achieved, and by "194V-E plus 1" the first year thereafter, and so on.

Demand and Prices

It is generally believed that some civilian production will be resumed very soon after V-E Day arrives. However, because of increases in labor and material costs, it is estimated that in 194V-E plus 1, radio receivers will bear an increase in price of approximately 30 percent over the amounts paid in 1941 *for equivalent models*.

The demand accumulated since 1941 will result in a seller's market, but after the accumulated demand has been satisfied, there will be much competition among the various radio manufacturers to keep busy their tremendously expanded facilities.

In 194V-E plus 1 it is estimated that the average purchase price of AM-FM post-war receivers will be between $45 and $75 for table models, and between $100 and $350 for consoles. Several prospective manufacturers of television sets are planning some models priced between $150 and $200, but the price range may extend up to $500 or more. Television-phonograph combinations will probably appear on the market priced at $300 and up.

The year 1942 was abnormal on account of the war. Because large quantities of radio equipment which had been sold on priorities in 1942 were not included in the value given for 1942 sales, this figure was not considered in estimating the rate of growth of the radio industry. The years 1940 and 1941 were also somewhat abnormal because of the advance purchases by distributors, dealers and consumers in anticipation of wartime shortages. After making adjustments for these factors, the growth rate in the sale of radio receivers during the period 1930 through 1941 was approximately 800,000 per year.

Increase in Broadcasting

Tendency to approach saturation has been offset by replacements of old receivers and purchases of additional receivers for the home or car. It is believed that any tendency to approach saturation in the future will be counterbalanced by the same factors and, in addition, by the effects of increases in broadcast coverage by the development of the newly established Citizen's Radio Communication Service, and by the introduction of FM and television broadcasting on a large scale. These last two factors will result in the buying of new receivers by owners of AM receivers and by individuals in areas previously not covered by broadcasting, who will wish to enjoy the new service.

TOTAL CIVILIAN RADIO RECEIVERS MANUFACTURED FROM 1933 TO 1942

Year	Number sold	Retail value[1]	Average retail price per receiver
1933	3,806,000	$180,500,000	$47.40
1934	4,084,000	214,500,000	52.50
1935	6,027,000	330,000,000	54.70
1936	8,248,000	450,000,000	54.50
1937	8,065,000	450,000,000	55.80
1938	6,000,000	210,000,000	35.00
1939	10,500,000	354,000,000	33.70
1940	11,800,000	450,000,000	38.10
1941	13,000,000	460,000,000	35.40
1942	4,400,000	154,000,000	35.00

[1] Figures for receivers include value of tubes in receivers.
Source: Radio and Television Retailing.

It is the post-war plan of most manufacturers to continue selling AM receivers, inasmuch as Standard Broadcasting has been established for a quarter of a century and is now a 285 million-dollar industry. In addition to their AM receiver line most manufacturers will also offer AM-FM receivers and television receivers. During the next few years, as in the past, very few manufacturers will make receivers to accommodate FM channels only.

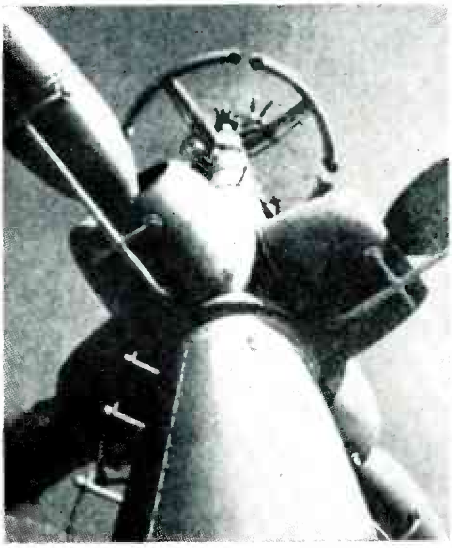
It might be well at this point to analyze factors affecting the type of radio receivers that will be sold in the future.

As of February 1, 1945, licenses had been issued to 46 commercial and 2 experimental FM stations. In addition, construction permits had been issued for 7 commercial FM stations. As present FM broadcast coverage is supplemented by the granting of licenses for the 356 applications now pending for commercial FM station, an increasingly larger proportion of the receivers sold will be of the AM-FM type. As previously stated, this type sells for approximately 25 percent more than comparable AM models.

Six Experimental Stations

By February 1, 1945, licenses had been issued to 6 commercial and 25 experimental television stations. Moreover, construction permits for 3 commercial television and 20 experimental television stations had been issued. As present telecast coverage is greatly increased through the granting of licenses for the 103 applications now pending for commercial television stations, television will claim its share of the receivers sold. The receivers which comprise this portion of the total sales probably will sell at prices averaging approximately 50 percent higher than the average prices of AM receivers of equivalent quality.

Another interesting war development may increase radio sales. During the current war, lightweight, portable short-range radio communications equipment of the "walkie-talkie" type proved to be highly useful.



Courtesy of RCA

Television antennas atop the Empire State Building. The sound signals are radiated from the quadrants at the top. Image signals are transmitted from the curved surfaces below.

It is proposed to establish in the 460-470 mc. band a low-power short range Citizens Radio Communication Service, widely available to citizens of the United States. It is believed that this service will have many every-day and emergency uses, especially in rural areas and between points which do not now have convenient communication facilities.

A typical example of such a use would be for a central physician's service which could communicate with doctors traveling to and from patients. Department stores, dairies, and other organizations operating delivery trucks, by means of this service, could intercommunicate with their delivery vehicles en route. Large industrial plants and construction projects may also use this new device.

It is quite likely that the sales of this type of equipment may reach a considerable volume.

Potential Sales

Following is a table giving estimates of post-war annual volume of radio receiver sales:

ESTIMATES OF POST-WAR ANNUAL VOLUME OF RECEIVER SALES

(Millions of dollars)

Year	Retail Value
1941	$ 460
194VE plus 1	1,410
194VE plus 2	1,650
194VE plus 3	1,870
194VE plus 4	1,430

Many factors were considered in making these estimates. Among them are the various considerations enumerated under the previous section titled Post-War Prices. These estimates also take into account proposed broadcast stations with their increased coverage. Allowance has been made for delayed purchases by persons who will wait varying periods for "futuristic" models.

Weight is given to the fact that AM-FM receivers and television receivers will represent an increasingly larger proportion of total sales each year. This in turn will result in increased average receiver prices each year.

However, it is believed that, at least on a short time basis, FM will be much more important than television on account of its more general utility and the fact that sound broadcasting techniques have already been developed. As television broadcast techniques are perfected, television sales will become increasingly larger.

In this appraisal, accumulated demand has been distributed in accordance with the industry's estimated ability to handle it.

It is assumed that the demand accumulated from 1941 to the end of the European war, plus natural increases in current demand, will maintain production and employment at high levels for the first few years after the war, and that there will be a continuation of the past trend toward increased output per worker resulting from technological developments.

It is realized that in practice the radio market may be subject to many influences not mentioned here — for example, the export markets may increase at an unexpected rate. There is no positive assurance that peacetime sales will approach the values given, but post-war planning in the radio industry—as in all others—is based on the asumption that post-war opportunities for United States business will be great. The radio business is expected to be large and at the same time play a big part in contributing to the development of other industries.

WHAT'S BEING READ THIS MONTH

For our reader's information, we take pleasure in presenting the following list of articles which have appeared in the most recent issues of the leading trade and professional magazines:

COMMUNICATIONS (April 1945)

WARTIME BROADCAST STATION MODIFICATIONS
Studio Facility Expansion (Using spare parts and converted equipment)........*Lawrence A. Reilly*

CIRCUIT ANALYSIS
Frequency Conversion Circuit Development........*Harry Stockhman*

TELEVISION ENGINEERING
A Television Studio Installation (Part II)........*Albert Preisman*

TRANSMITTING TUBE DESIGN AND APPLICATION
External Anode Triodes (Part IV—Analysis of Applications in Class C, Class B, R-F and A-F Amplifiers and High Power Oscillators)........*A. James Ebel*

OSCILLOGRAPHY
Measuring Q with the C-R Oscilloscope........*Robert C. Paine*

FILTERS
Filter Analysis and Design (Part II)........*C. E. Skroder*

V-H-F TRANSMISSION TESTS
45.5 and 91-mc Field Intensity Tests........*Ralph G. Peters*

STUDIO DESIGN
First Prize Designs WGN Air Theatre Contest........*Arthur Frederick Adams and William F. Clark*

CQ (May 1945)

AC4YN, LHASA, TIBET
Who's who and what's what at a famous ham station........*McMurdo Silver*

GRIFFIN TRIPLE DETECTION SUPERHET
Dana Griffin's new communications receiver has many revolutionary ideas. You'll hear more about it post-war.

150-*WATT TRANSMITTER FOR* 5-*BAND OPERATION*
Some ideas which may help you when and if you remodel your rig........*Lt. Comdr. W. B. Bernard, W4ELZ*

ANTENNAS—AND WHAT HOLDS THEM UP
Second article in a series on u-h-f antenna design and construction........*Arthur H. Lynch, W2DKJ*

A SIMPLE ROTARY ANTENNA SUPPORT
Easy to build, and worth building........*Lawrence LeKashman, W2IOP*

ELECTRONICS (May 1945)

ELECTRONIC APPLICATIONS IN INDUSTRY
Present and potential uses in 796 plants in 11 major industries are surveyed

ROCK ISLAND RAILROAD RADIO TESTS
Signal-to-noise ratios are charted for 40, 118, 150 and 2000 to 3000-Mc systems......*Ernest A. Dahl*

ORBITAL-BEAM U-H-F TUBES
Frequency of oscillation can be controlled with external keying signals, at values up to 500 Mc......*Rogers M. Smith*

SHIELDING OF DIELECTRIC HEATING INSTALLATIONS
Field intensity measurements show effects of various shields, grounding systems and filters on radiation......*G. W. Klingaman and G. H. Williams*

F-M FIELD SURVEY TECHNIQUES
Procedure for equipping, calibrating and using a field car to secure data for actual coverage contours......*Phil B. Laeser*

AGC-NOISE CONSIDERATIONS IN RECEIVER DESIGN
Automatic gain control and its effect on signal-to-noise ratio...*John B. Moore*

FUNGUS AND MOISTURE PROTECTION
Methods of combating two adversities which combine to attack electronic gear......*R. Proskauer and H. E. Smith*

COAXIAL CABLE DESIGN
Shortcuts to coaxial-cable design by means of graphs and approximate formulas......*N. O. Kenney*

V-H-F DUMMY ANTENNA
Construction and calibration of resistive load for production testing of transmitters......*Stanley Cutler*

GASEOUS RECTIFIER CIRCUITS, PART II
Voltage and current wave forms of commonly used bi-phase circuits, with pertinent equations......*P. T. Chin*

FREQUENCY MONITOR STROBOSCOPE
Allows checking transmitter frequency at any time without pushing button every fifteen minutes......*W L. Wiggins and S. G. Guenther*

PI-NETWORK CALCULATOR
Graphical method by which effects of varying circuit elements can be studied directly......*Warren B. Bruene*

ELECTRONIC INDUSTRIES (May 1945)

OPERATIONAL ELEMENTS OF A RADAR SYSTEM..............*Wm. E. Moulic*

RALROAD RADIO

SIMPLE FM CONVERTERS

MEETING SPECS IN UHF..............*H. Gregory Shea*

CASE-STUDIES OF TYPICAL ELECTRONIC HEATING JOBS

TUBE CHARACTERISTICS

GUN SOUND RANGING

COLD CATHODE OSCILLOGRAPH

THERMAL STABILITY IN RECEIVER OSCILLATORS..............*R. R. Batcher*

100-300 *MC EQUIPMENT*..............*Wm. F. Frankfurt and John A. Rhoads*

REVIEWING SOME BASIC MODULATION PROCESSES

INTERFERENCE EFFECTS IN FM WITHOUT LIMITING........*G. F. Leydorf*

PRODUCTION SHORT CUTS

MAGNETRON FREQUENCIES..............*E. Djakov and A. Raev*

3-*BAND "MORALE" SET*

DESIGN OF ELECTRONIC HEATING GENERATORS........*Wesley M. Roberds*

FM AND TELEVISION (April 1945)

OPPOSING VIEWS ON LOWER TELEVISION CHANNELS
Texts of DuMont and CBS briefs

HOW FM LINKS ARMY WIRE SYSTEMS..............*Lieut. Robert W. Ehrlich*

FM BROADCAST & COMMUNICATIONS HANDBOOK..............*René Hemmes*

DETAILS OF TELEVISION STATION WRGB..............*James D. McLean*

PROCEEDINGS OF THE I.R.E. (May 1945)

THE ENGINEER GOES TO WAR AND PREPARES FOR PEACE..............*Paul W. Keston*

STUART L. BAILEY—BOARD OF DIRECTORS, 1945

THE ENGINEER'S PLACE IN THE MODERN WORLD........*Ivan S. Coggeshall*

THE ENGINEER AND HIS FUTURE..............*C. A. Powel*

THE ENGINEER'S PLACE IN THE SCHEME OF THINGS— ROUND TABLE DISCUSSION..........*R. H. Herrick, J. E. Hobson, J. E. Brown, and A. B. Bronwell*

THE NAVY ELECTRONICS PROGRAM AND SOME OF ITS PAST, PRESENT, AND FUTURE PROBLEMS..............*J. B. Dow*

MOULD AND HUMIDITY IN RADIO AND SIGNALS EQUIPMENT..............*C. P. Healy and J. C. Niven*

THE COMPENSATED-LOOP DIRECTION FINDER..............*Frederick Emmons Terman and Joseph M. Pettit*

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF TUNED-CIRCUIT DISTORTION IN FREQUENCY-MODULATION SYSTEMS..............*David Lawrence Jaffe*

STANDARD-FREQUENCY BROADCAST SERVICE OF NATIONAL BUREAU OF STANDARDS

QST (May 1945)

"RADIO SET SCR-506"—A BIOGRAPHY
The history of the U.S. Army's highly perfected medium-range
mobile radio set........ *A. David Middelton, W2OEN*

A SEARCH FOR V. F. O. STABILITY
Some pointers on reducing frequency drift in
transmitter oscillators........ *Claude L. Robinson, W6KJV*

A CRYSTAL-CONTROLLED TRANSMITTER FOR THE V.H.F.s
Three tubes in a simple 175-watt job........ *George W. Brooks, W1JNO*

NEW APPARATUS
Plywood antenna masts

PRACTICAL DESIGN OF VIDEO AMPLIFIERS — PART II
High-frequency compensation........ *Elliott A. Henry, W9FEN*

A LOW-FREQUENCY AIRCRAFT TRANSMITTER FOR CAP
A two-band light-weight unit for
small aircraft........ *George A. Peterson, Jr., W3IOV*

RADAR TECHNIQUES
II — Simple analogies........ *Clinton B. DeSoto, W1CBD*

RADIO (April 1945)

PARALLEL WIRE TRANSMISSION LINES
Clarifying an important subject which has
received scant attention in textbooks........ *Arthur C. Gardner*

NON-LINEAR RESISTORS
Characteristics and applications of these
relatively unfamiliar units........ *A. P. Howard*

FM RECEIVER DESIGN, PART II
In this series of articles the author discusses the
various factors entering into the design and
and testing of f-m receivers........ *A. C. Matthews*

COMMUNICATIONS AND CONTROL RELAYS, PART II
New types of relays and their applications........ *Geoffrey Herbert*

RADIO DESIGN WORKSHEET: NO. 35—TRANSMISSION THEOREM; COMPUTATION OF OPTICAL PATH OVER BALANCED EARTH; BALANCED MODULATOR CIRCUITS; COMPENSATED POTENTIOMETERS

CHART—TRANSMISSION PATH FOR QUASI-OPTICAL WAVES OVER SPHERICAL EARTH

RADIO BIBLIOGRAPHY: 17—AIRCRAFT RADIO, PART 8.... *F. X. Rettenmeyer*

RADIO CRAFT (May 1945)

KLYSTRON CIRCUITS	*Capt. Eugene E. Skinner*
RADAR PRINCIPLES, PART II	*R. L. Smith-Rose*
FUTURE ASPECTS OF TELEVISION, PART II	*Dr. Lee DeForest*
POLICE RADIO ON V.H.F.	
ELECTROSTATIC MODULATOR	*R. S. Havenhill*
H. F. HEATING AT A GLANCE	*William Lyon*
ELECTRONS TRAIN AVIATORS	*T. R. Kennedy, Jr.*
ARMY RADIO COMMUNICATIONS	
AMATEURS AND POSTWAR RADIO	*Raymond Lewis*
SPEECH AMPLIFIERS, PART VIII	*Robert F. Scott*
BROADCAST EQUIPMENT, PART VIII	*Don C. Hoefler*
TEST COMPARATOR	*Wm. F. Frankart*
PRACTICAL V.T.V.M.	*Wm. B. Miller*
BETTER SIGNAL GENERATOR	*L. Lane*
VOLTAGE REGULATORS	*Jack King*
RAPID CONVERSION	*W. G. Eslick*
CAPACITOR AND RESISTOR CODES	*Stuart Distelhorst*
HOW TO REPAIR ELECTRIC CLOCKS	*Homer L. Davidson*
LOW-VOLTAGE RECEIVER	*Paul Abramson*
SOUND UNITS AND SOUND RATINGS	*T. H. Phelan*

RADIO NEWS (May 1945)

INTER-AMERICA RADIO	*John W. G. Ogilvie*
BRITISH ELECTRONIC TARGET LOCATORS	*Kenneth R. Porter*
RADIO FOR MORALE	*C. T. Read*
ELECTRONIC AIDS TO PHOTOGRAPHY	*Rufus P. Turner*
ELECTRONIC MOISTURE INDICATOR	*Earl Seidlinger*
THE RURAL RADIOMAN	*S. R. Winters*
450-mc. MICROWAVE TRANSMITTER	*Raymond B. Frank, W9JU*
ANTENNAS FOR TELEVISION RECEIVERS	*Edward M. Noll*
AN INEXPENSIVE REMOTE ANTENNA METER	*Charles Sumner*
DESIGNING A COMMERCIAL TYPE FRONT PANEL	*A. A. Goldberg, W2HKU*
QUARTZ CRYSTAL FREQUENCY MEASUREMENT	*Kenneth M. Laing*
DUAL SPEED RECORDING UNIT	
PRACTICAL RADIO COURSE	*Alfred A. Ghirardi*
LINEAR SWEEP GENERATORS	*Abraham Tatz*
CLASSROOM CHORES 10,000 FEET UP	*Sgt. Edwin Kent*
THE SAGA OF THE VACUUM TUBE	*Gerald F. J. Tyne*
NEWS FROM OVERSEAS	*Kenneth R. Porter*
ELECTRONIC CIRCUITS PERFORM MATHEMATICAL PROCESSES	*M. N. Beitman*
LOUIS WEBB CHARTS PRESENT-DAY SERVICE PROCEDURE	*Eugene A. Conklin*

RADIO NEWS Radio Electronic Engineering Edition (May 1945)

CATHODE FOLLOWERS..........*John M. Haerle and John DeWitte*

HIGHER FIDELITY BROADCASTING..........*Harold E. Ennes*

ELECTRONIC TIMING OF MANUFACTURING OPERATONS......*D. Fidelman*

HEARING-AID MICROPHONE DESIGN..........*V. E. Eitzen*

ELECTRO-MEDICAL DIAGNOSIS AND THERAPY..........*John D. Goodell*

SERVICE (April 1945)

ELECTRONIC SPOTWELDING TIMERS
Design and service problems..........*S. J. Murcek*

FIXED RESISTORS
Troubles and service hints..........*Alfred A. Ghirardi*

HUM
Its causes and cures..........*Edward Arthur*

I-F AMPLIFIERS
Design and service problems..........*S. J. Murcek*

OLD TIMER'S CORNER

TELEVISION (May 1945)

WASHINGTON TO PHILADELPHIA

SMALL STATION OPERATION: THE LOCAL ADVERTISER

VIDEO LIGHTING PROBLEMS..........*Worthington Miner*

TELEVISION STATION DESIGN

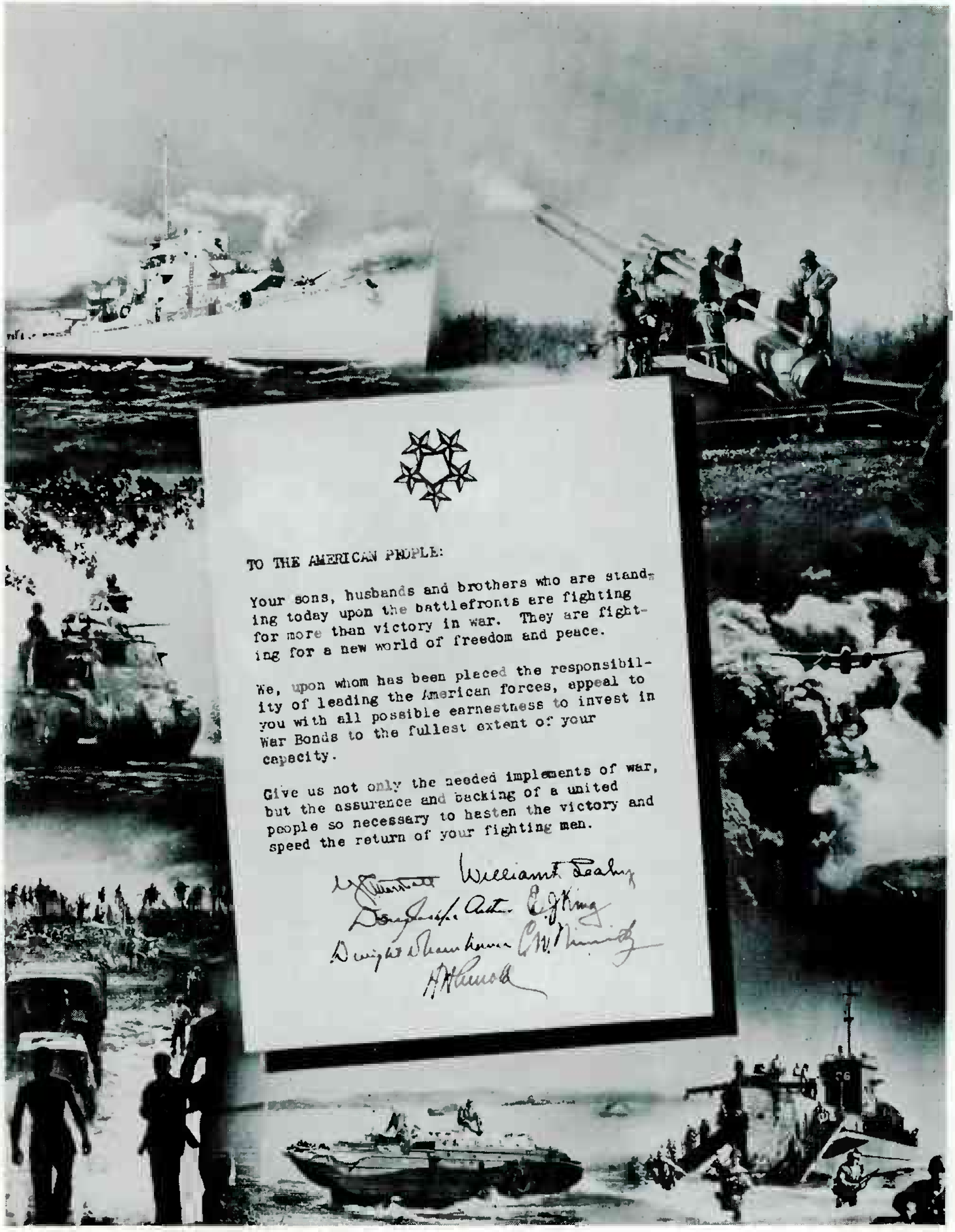
EDUCATIONAL FILMS AND TELEVISION..........*Henry Clay Gipson*

LOS ANGELES TELEVISION OUTLOOK

DuMONT LARGE SCREEN

PATENT AND LICENSING PICTURE

NOTES ON THE BALLET "SCHEHERAZADE"..........*Raymond Nelson*



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Your sons, husbands and brothers who are standing today upon the battlefronts are fighting for more than victory in war. They are fighting for a new world of freedom and peace.

We, upon whom has been placed the responsibility of leading the American forces, appeal to you with all possible earnestness to invest in War Bonds to the fullest extent of your capacity.

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H H Arnold

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OF SEAGOING COMMUNICATIONS

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