JULY 21st
1928
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CENTS

Vol-13
No-18

RADIO WORLD

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The First and Only National Radio Weekly

330th Consecutive Issue—Seventh Year

SCREEN GRID SERIES FILAMENTS HEATED BY TYPE-50 TUBES

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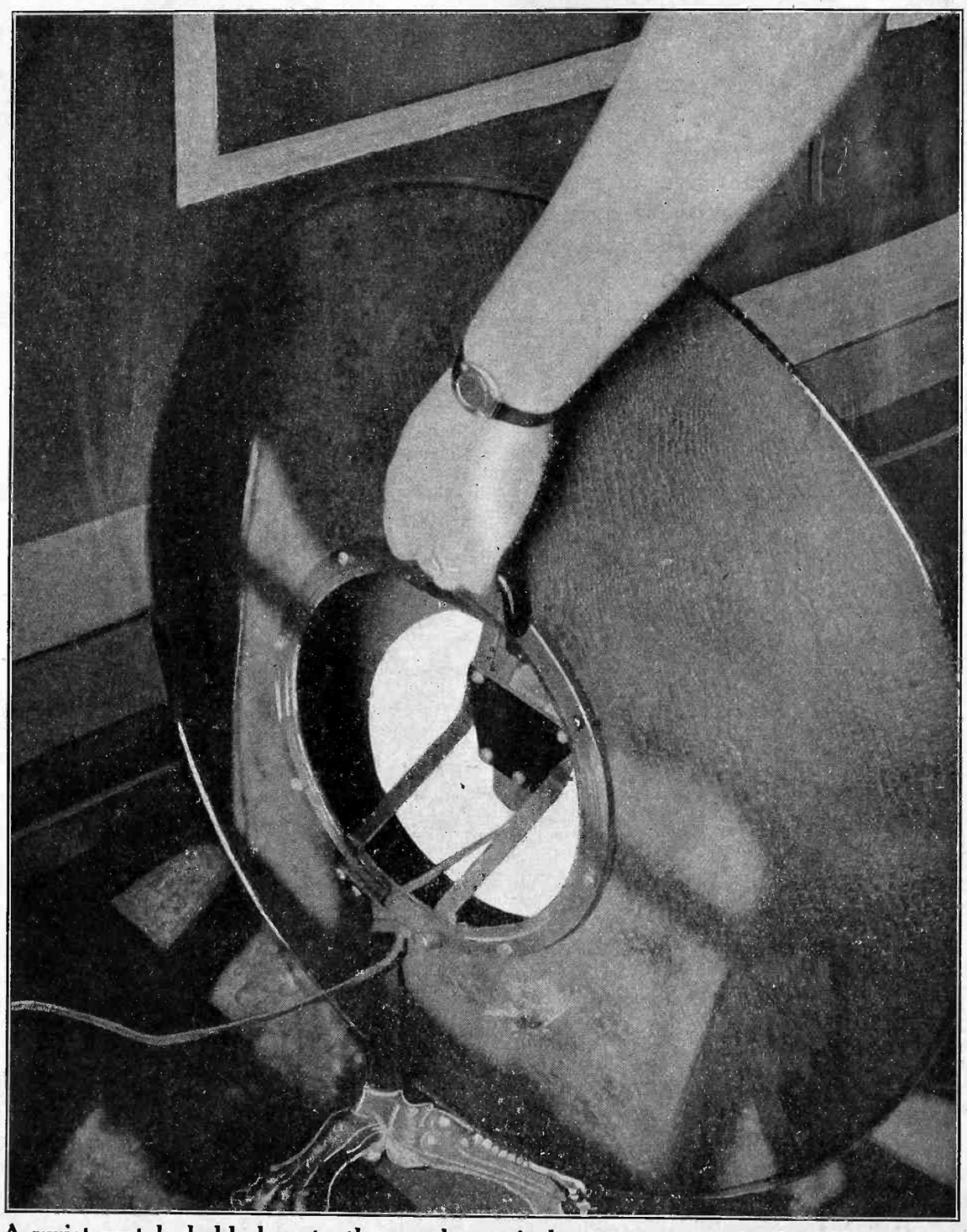

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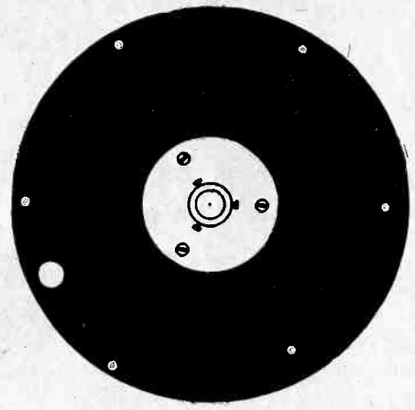

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Titles of Articles on Television and Dates of Sixteen Issues of Radio World containing those articles.

1926

Eyes to Watch Scenes by Radio, by Conrad Nugent, Dec. 25. Illustrated by photograph of Dr. Alexanderson and his first television transmitter.

1927

The Advance Toward Television Told by Alexanderson in Absorbing Brief, by E. F. W. Alexanderson, Jan. 1.

Alexanderson in Address Explains Television Theory, Jan. 22, 1927. A Simple Explanation of Alexanderson Method of Television. Also, Television Set on Way, General Electric Has It, by Herman Bernard. Both in Jan. 22 issue.

Baird Uses Infra-Red in His Television Tests, by Knollys Satterwhite, Jan. 29. A brief discussion on the use of infra-red light in television experiments and possible applications.

First Television Hookups Elucidate Alexanderson and Baird Plans, by Hector Wall, Feb. 26. Hookups illustrating the principles of transmission and reception of television.

New Television Advance Demonstrated, April 23. An account of the television demonstration between New York and Washington by wire and between New York and Whippany, N. J., by radio, conducted by the American Telephone & Telegraph Company.

1928

Television Quits Dream Road for Real Bumps. Also, The New Twist That Made Television Spurt, by Neal Fitzalan, an illustrated article comparing the Alexanderson seven-spot method of illuminating the picture to be sent, with the Gray innovation which overcame the chief difficulty in television transmission, that of adequate illumination without imposing dangerous light intensity on the subject. Also, Television Across the Ocean Claimed by Baird Company, Feb. 4. Also, Colored Television Due; Three Coils Suggested, Feb. 4. All four in Feb. 4 issue.

Movements of Woman in London Watched from New York by Television, by Neal Fitzalan, Feb. 25. An illustrated account of successful television experiments between New York and London by the Baird system.

Television in Five Years, Not Now, Says Trade, April 28.

Jenkins Demonstrates Silhouettes in Action. Also, Nakken to Broadcast Television from WRNY. Both in May 26.

How Television Is Tuned In, by Neal Fitzalan. June 9. A profusely illustrated article on the reception of television signals.

How to Connect Any Set's Output for Television Reception. An article with circuit diagrams showing how to connect the television receiving tube to the output of any radio receiver. Also, Automatic Television Synchronizing Apparatus, By Paul L. Clark. A richly illustrated article of a new system of automatically synchronizing a television receiver with the transmitter, invented by the author. Both in June 16.

The Effect of Wave and Frequency Distortion on Television Reception, by J. E. Anderson. June 23. The writer discusses the effect of wave form and frequency distortion in the transmission and reception apparatus on the received images. Illustrated with diagram showing the blurring effect of high frequency side band suppression.

Requirements for Television Reception, by J. E. Anderson, June 30. The author discusses the necessary conditions for retaining the high and the low frequencies in the side bands to prevent distortion of the received image and gives the design of a receiver which will not only give undistorted television images but which may be used as a high quality broadcast receiver.

Talking Television and How It Is Worked, by J. E. Anderson, July 7. A profusely illustrated article showing how talking television works.

Mechanical Problems in Television, by J. E. Anderson, July 14. Tells how to make disc for WGY reception, also how to avoid distortion due to mechanical conditions. Also schedule of WGY television broadcasts.

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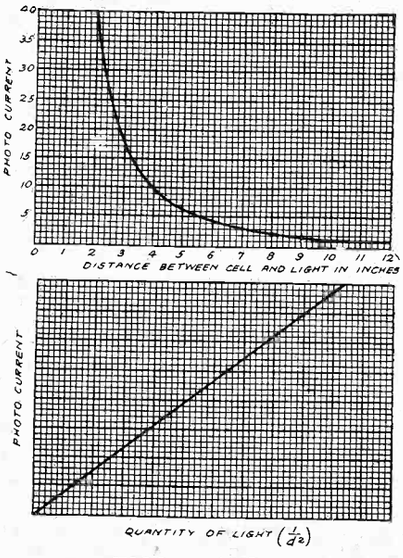
The Fascinating Facts on Photo-Electric Cells

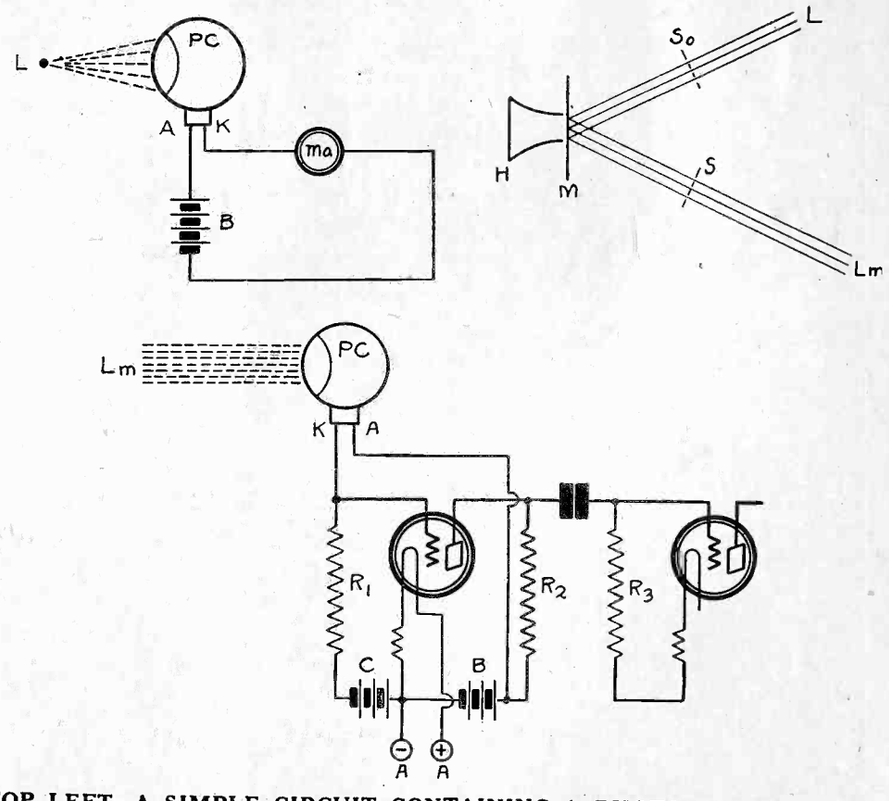
By J. E. Anderson

Technical Editor



FIGS. 1 AND 2

Top—Curve showing the relation between the photo-electric current and the distance between a constant light and the cell. It shows that the current is inversely proportional to the square of the distance and hence that the current is proportional to the intensity of the illumination (Fig. 1). Lower—Curve showing the relation between the intensity of illumination and the photo-electric current. The line is straight showing that the current is directly proportional to the light. (Fig. 2).



TOP LEFT—A SIMPLE CIRCUIT CONTAINING A PHOTO-ELECTRIC CELL, A BATTERY AND A MICROAMMETER BY MEANS OF WHICH THE CHARACTERISTIC CURVES OF A CELL MAY BE TAKEN. (FIG. 3.)

TOP RIGHT—THE PRINCIPLE OF THE PHOTOPHONE TRANSMITTER. A LIGHT BEAM OF CONSTANT INTENSITY IS MODULATED BY MEANS OF A MIRROR SET INTO VIBRATION BY SOUND WAVES. (FIG. 4.)

LOWER—A PHOTOPHONE RECEIVING CIRCUIT IN WHICH A PHOTO-ELECTRIC CELL CONVERTS A MODULATED LIGHT BEAM INTO AN EQUIVALENT ELECTRIC CURRENT, AMPLIFIED BY A RESISTANCE COUPLED AMPLIFIER. THIS IS ALSO AN ESSENTIAL PORTION OF THE TRANSMITTER IN TELEVISION. (FIG. 5.)

THE three-element thermionic tube, that is the ordinary vacuum tube, made radio telephony possible. The two-element photionic tube, that is the photo-electric cell, makes television possible.

The thermionic tube is well understood, even by those who lay no claim to technical training in electronic phenomena. But the photo-electric cell is not so well understood. Yet it is a simpler device than the thermionic tube, and for that reason it will not be long before its characteristics and functions will be as widely known.

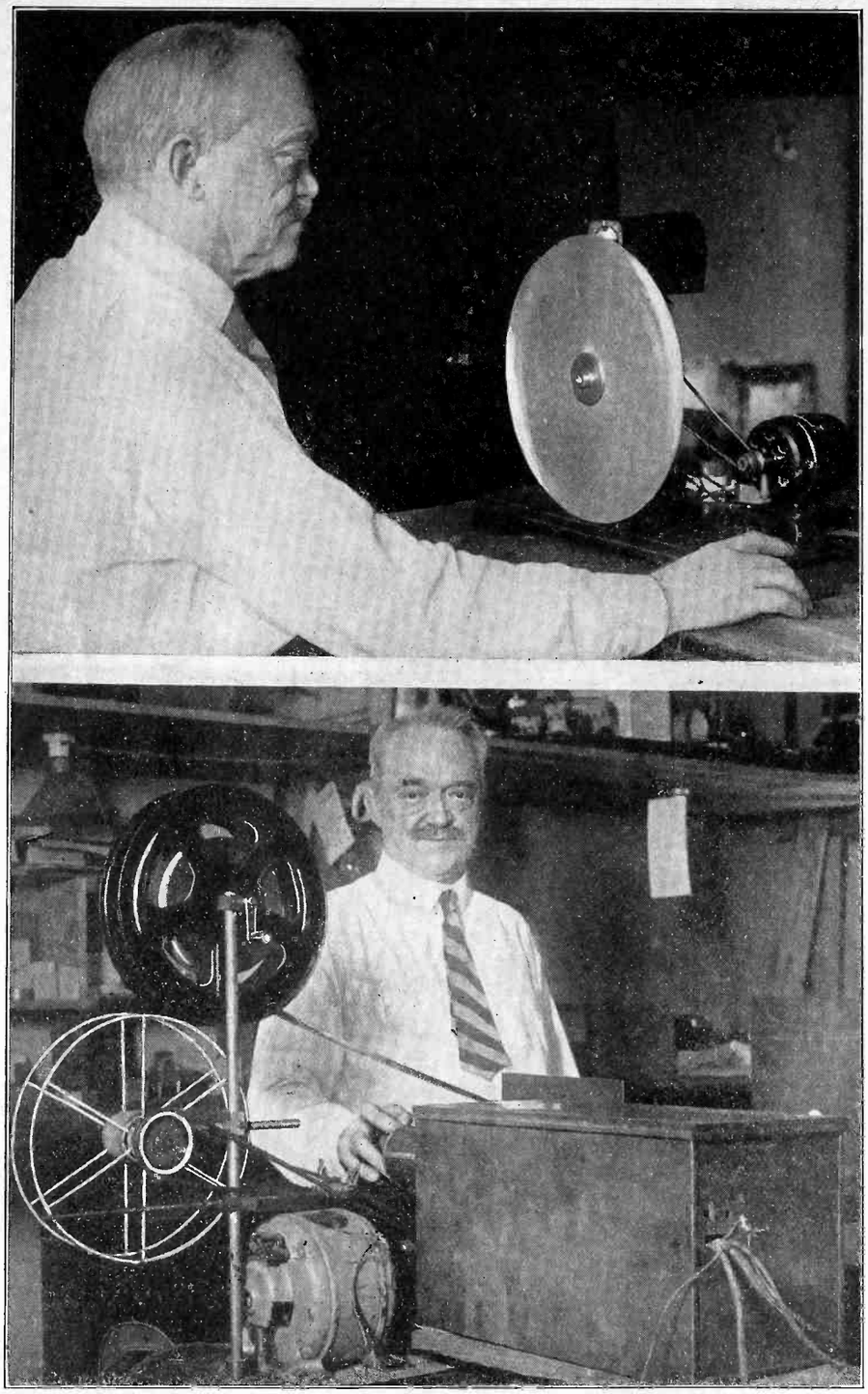
Close Similarity

There is a close similarity between the thermionic tube and the photionic cell. Both depend on free electrons in their operation. In the thermionic tube electrons are released from the cathode by the action of heat. In the photionic cell electrons are released by the action of light. In both instances the electrons are released by energy which is supplied to the cathode, in one case thermal energy, in the other luminous energy.

Since heat is always associated with light and since light is usually associated with heat, there is no definite dividing line between the two phenomena. The line of demarcation becomes still more difficult when the definition of light is changed so as to include radiation of infra-red wavelengths. If infra-red light waves are long enough they are identical with heat waves.

(*Continued on next page*)

Television Transmission



Henry Miller

UPPER—C. FRANCIS JENKINS, WASHINGTON INVENTOR, EXAMINING A NEW RECEIVER FOR THE RECEPTION OF MOTION PICTURES BY RADIO. THIS DEVICE WILL SOON BE PLACED ON THE MARKET. LOWER—MR. JENKINS IS SHOWN DEMONSTRATING HIS PROJECTION APPARATUS BY MEANS OF WHICH HE BROADCASTS NOT ONLY SILHOUETTES BUT HALF-TONE MOTION PICTURES BY RADIO. THE DEVICE SHOWN IN THE UPPER PHOTO IS THE RECEIVER FOR THE TRANSMITTER SHOWN BELOW. MR. JENKINS WILL BROADCAST MOVIES BY HIS SYSTEM EVERY MONDAY, WEDNESDAY AND FRIDAY AT 8 O'CLOCK EASTERN STANDARD TIME ON A WAVELENGTH OF 46.72 METERS.

(*Continued from preceding page*)

In both the photo-electric cell and the thermionic tube an electric current can be established through a vacuum by maintaining a high potential between the electron emitting surface, the cathode, and another conductor, the anode, within the vacuuous space.

The energy supplied to the cathode, whether that energy be thermal or luminous, releases electrons from the cathode, and the positive conductor, or anode, attracts them. Thus the free electrons continually fall into the anode, and this movement constitutes the electric current. There must be an electromotive force in the circuit or the difference of potential betwen the cathode and the anode will not be maintained and the movement of electrons will not continue. The electromotive force may be that of a battery, a generator, thermopile or a B battery eliminator. The electromotive force may even be that of an alternator or of the secondary of a transformer, but in either said instance current will flow in only one direction. That is, either type of electron tube will act as a rectifier.

Sensitivity of Photo-electric Cell

The sensitivity of a photo-electric cell depends on the material constituting the cathode and on the frequency of the light that enters the cell. For any one wavelength of light, that is for any one color, the sensitivity depends only on the kind of material in the cathode, and for any one of the active cathode materials the sensitivity depends only on the wavelength or color of the light.

The light sensitivity of a given material is somewhat similar to the light sensitivity of the human eye, but it does not necessarily cover the same spectrum. The eye is most sensitive in the green-yellow region of the spectrum. At either side of this the sensitivity drops so that at red and violet the sensitivity drops to zero. These limits of sensitivity determine the visible spectrum.

Photo-electric Visibility

Just as the human eye has a definite visible spectrum, so any photo-electric cell has a more or less definite spectrum in which it can "see" and in which it responds. There is one frequency of light at which the cell responds most readily and at either side the response drops. In one cell the maximum sensitivity may fall in the red portion of the spectrum, or slightly below. In another it may fall in the violet end of the spectrum. Since there are several photo-electrically active materials, cells may be constructed which respond most readily at different points in the spectrum.

Photo-electric Active Materials

The principal photo-electrically active materials are the four alkaline metals: sodium, potassium, caesium and rubidium, together with their hydrides.

When light falls on a surface of any one of these materials electrons are released. If the negative terminal of a battery or other source of electromotive force is connected to this surface and the positive terminal is connected to another conductor placed near the photo-electrically active cathode, a current will flow across the space between the two electrodes.

But if the two electrodes are placed in air the current will be extremely small, requiring a sensitive electroscope to determine it. If the two electrodes are placed inside an evacuated glass envelope such as is used in "hard" vacuum tubes, the current will be much greater, and it may be measured with ordinary laboratory microammeters or galvonometers.

Important Property of Tube

All practical cells are enclosed in evacuated envelopes although in some of them the evacuation is not so complete as in radio vacuum tubes. If a small amount of gas is left in the cell the phenomenon of ionization by collision will increase the number of electrons reaching the anode. For some purposes these "soft" photo-electric cells are preferred, but for most applications the "hard" type is used and the amplification necessary is obtained by means of vacuum tube amplifiers.

The most important property of the

Gains Ground with Cell

photo-electric cell is that the current through it is directly proportional to the intensity of illumination, or to the quantity of light that enters it. Nearly all its applications depend on this property.

In order that the current through the cell be directly proportional to the light intensity it is necessary that the voltage across the electrodes be high enough to carry away the electrons from the cathode as fast as they are released. It is also necessary that the voltage between the cathode and the anode be constant.

A simple way of demonstrating that the current through the photo-electric cell is directly proportional to the intensity of light is to measure the current obtained with a light of given intensity placed at different distances from the cell and plotting a curve of current against distance. The intensity of the light varies inversely as the square of the distance. Hence if the distance between the cell and the source of light is doubled the intensity of illumination on the cell is reduced to one fourth of its former value. The current through the cell should then fall off as the square of the distance. This is shown to be the case in Fig. 1.

Linearity Demonstrated

A still better demonstration is to plot the current against the intensity. Suppose I is the intensity of illumination at the cell from a constant source of light at a distance d from the cell. The illumination may then be expressed Ik/d^2, where k is some constant depending on the intensity of the source. If arbitrary units are used this constant may be unity so that the intensity of illumination may be expressed $1/d^2$. Hence if the current obtained is plotted against this value, that is the square of the reciprocal of the distance, a straight line should be obtained. Such a curve is shown in Fig. 2.

If the voltage across the electrodes and the distance between the cell and the light remains constant the current will re-light varies. And if this varies the current will vary directly as the intensity of the source.

Also if some variable light absorber be placed between the cell and a constant source of light the current in the cell will vary inversely as the absorption, or directly as the light transmitted to the cell. It is on this principle that most of the applications of the cell are based.

Applications of Cell

In television an intense beam of light is made to scan the scene to be transmitted. Light from this beam is reflected into the photo-electric cell. Where the scene is white most of the beam is reflected and the corresponding photo-electric current is large. Where the scene is dark very little of the light in the beam is reflected and the photo-electric current is small. Where the scene is gray only a portion of the light beam is transmitted and the photo-electric current is medium. The dark areas in the scene absorb the light, the light areas reflect it.

In the case of photographic film reproduction of sound, the light beam is either transmitted through the clear areas or absorbed by the dark. The light transmitted, and hence the photo-electric current in the cell, is proportional to the transparency of the film.

Measuring Photo-Electric Current

Characteristic curves of a photo-electric cell may be taken with a circuit like that shown in Fig. 3. L is a source of light such as electric lamp. PC is the photo-electric cell. B is a battery of sufficient voltage to insure that all the electrons released by the light are carried from the cathode K to the anode A as soon as released. A microammeter ma having a range of about 0 to 100 microamperes, is inserted in this circuit.

The current may then be taken for different positions of the light L.

Or leaving the light in a fixed position, the current may be taken for different values of the battery B. When the voltage is zero the current is zero. As the voltage is increased the current at first increases very rapidly, then more slowly, and finally it will not increase at all as long as the light is in the same position and of the same intensity.

Photophone

One of the applications of the photo-electric cells is the photophone, a device for telephoning by means of a beam of light. In Fig. 4 is shown a possible transmitter. LM is a parallel light beam either from the sun or from other source of sufficient intensity. M is a tiny mirror placed at the small end of a mouthpiece or small horn H.

In the path of the reflected light beam MLm is a grid S adjusted so that about half of the light reaching it when the mirror is in its normal position is transmitted. When sound waves enter the horn H the mirror is set into vibration, and more or less light will pass through the screen according to which way the mirror moves. Hence the transmitted light beam SLm will be modulated by the sound waves.

Photophone Receiver

The modulated light beam is made to fall on a distant photo-electric cell PC, Fig. 5. This will convert the modulated light beam into a modulated electric current which is amplified in the usual manner.

The varying current flows through the cell in the direction A to K under the combined action of the plate battery B and the grid battery C. A variable voltage is established across the high resistance R1 and this voltage is amplified. The C battery is necessary to make the grid bias negative. Without it, the grid would be positive by the amount of DC drop in R1, and the amplifier would be inoperative.

Television Circuit

In the discussion above it was assumed that the light beam Lm came from a vibrating mirror through a screen S. The beam may also be that reflected from a scene to be transmitted by the television process. In that case the circuit in Fig. 5 is the beginning of an amplifier which ultimately modulates a radio frequency oscillator. For the photophone Fig. 5 is the receiver. For television it is part of the transmitter. For the reproduction of sound recorded photographically on a film it is also the receiver.

Other Applications of Photo-cell

The photo-electric cell has found already numerous applications. For example it is used for grading cigars according to color. A dark cigar will not reflect as much light as one of lighter color. A circuit containing a cell may therefore be arranged which will reject all cigars darker than a specified shade and accept all others lighter than this shade. Another cell may be used to accept or reject according to some other shade. Thus a series of cells may be arranged so that cigars traveling on a belt will be sorted according to shade.

This process is not limited to cigars only but is applicable to any industrial or other use in which the product is graded according to light and shade, color or transparency.

Another application is that of turning on and off electric lights with the setting and rising of the sun. When the sun sets the light that enters the photo-electric cell is cut off and the current in the cell stops. This stoppage can be made to actuate a relay which closes the electric circuit controlling the lights. This is used for advertising signs and marine lights. When the sun rises the photo-electric cell becomes active again and the light switch opens.

[*Other television articles on page 20 et seq.*]

Radio Picture Terms Loose, Says Langley

Cincinnati

Loose use of the "intriguing" terms describing picture transmission is deceiving the public into the belief that true television is at hand, is the opinion of R. H. Langley, director of engineering of the Crosley Radio Corporation. He said a news agency seems to have used several of the words in an article without due reference to their strict meaning.

Langley points out that it cannot be inferred that true television is near at hand even though there are today several reasonably successful methods of picture transmission. The problems of true television are entirely different and enormously more difficult than the problems of still picture transmission, he says.

"Television means 'seeing at a distance'," Langley said in his letter to the news agency. "On this basis any method of recreating on the screen a moving distant scene, simultaneously with the action itself, is television. The simultaneity is, however, essential.

"A motion picture is a record of a moving scene and a motion picture in itself constitutes television except that it lacks the essential element of simultaneity.

"The transmission over wires and reaction on the screen of a distant moving scene is television. The same transmission by radio is also television and may be called radio television, but the contraction 'radio vision' is likely to be decidedly misleading."

"There is already one corporation which uses this word in its corporate title and yet is not offering anything approaching television or radio television.

"The transmission and reproduction of a still scene or a still picture is not television and should be called picture transmission whether by wire or radio," he added.

Push-Pull -50 Tubes H

By Brunste

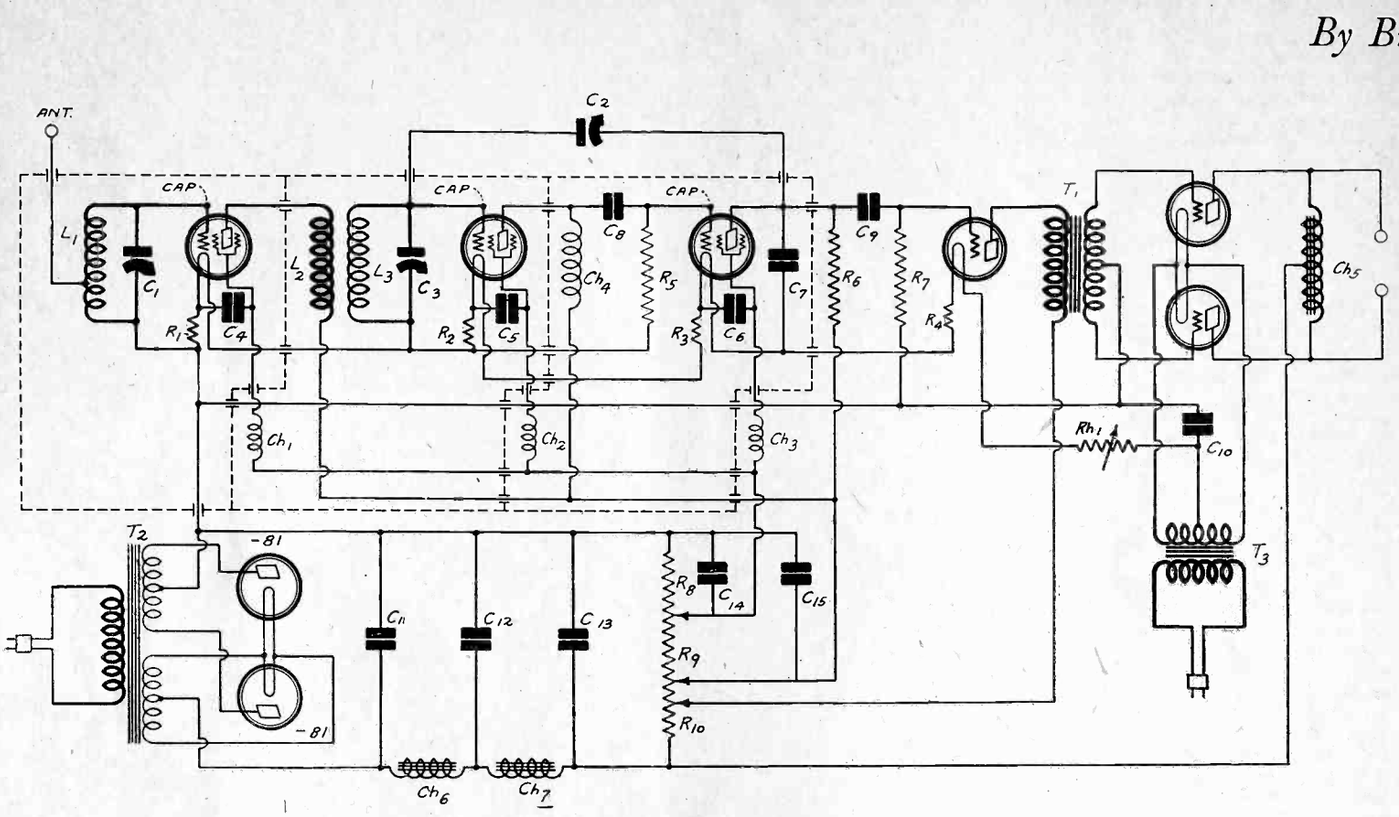


FIG. 1
THE CIRCUIT DIAGRAM OF A COMPLETELY ELECTRIFIED RECEIVER IN WHICH THE FILAMENTS OF THE FIRST FOUR TUBES ARE HEATED FROM THE PLATE CURRENT FROM THE TWO PUSH-PULL -50 TYPE POWER TUBES. GRID BIAS FOR ALL THE TUBES IS OBTAINED FROM VOLTAGE DROPS.

F the many methods for the electrification of receivers that employing series connected filaments heated by rectified and filtered current has always been most attractive. Yet it is the method which is, perhaps, the least applied. The main reason for lack of application of this desirable method is that rectifiers and filters capable of handling sufficient current have not been available.

That impediment to the development of series connected receivers no longer exists. It was removed incidentally when power supply devices for the —50 power tube were developed. It is now practical to build electrified receivers employing series connected filaments and taking the filament power from the plate supply power pack.

All Voltage Obtained

Full electrification requires that all the voltages be taken from the power transformer or transformers. The filaments of the radio frequency tubes and the first audio tube must be heated with rectified current derived from the B battery eliminator supplying the power stage and the grid voltage must be taken from voltage drops in resistors placed in the line. All this is very easily done.

Suppose that the radio frequency tubes and the detector are screen grid tubes. Each of these requires a filament current of 132 milliamperes normally. A small variation up or down does no harm, that is such variation as would be caused by the plate current of one tube flowing through the filament circuit of other tubes.

Since the filament current in the screen grid tubes is 132 milliamperes the first audio tube should draw the same filament current or a lower current. Thus we are limited to the use of a —99 or a 120 type tube. The —99 is ruled out for lack of voltage handling capacity and thus the choice must fall on the 120 tube.

Filament Current Increasing

The 120 tube will work on a filament current from 120 to 132. Therefore let us so adjust the circuit that it gets 120 milliamperes.

The next tube below it in the filament circuit is the detector, a screen grid tube. It gets the 120 millamperes that flowed through the filament of the first audio tube and the plate current of that tube, which is about 6.5 milliamperes. Thus the detector filament carries a total of 126.5 milliamperes. The tube will operate well on this current.

The second RF tube, which is also a screen grid tube, gets the 126.5 milliamperes that flower through the filament of the detector plus the plate and screen grid currents in the detector tube. These may be taken to be 2 milliamperes. Hence the filament current in the second radio frequency tube is 128.5 milliamperes.

First Gets Most

The first RF tube, also a screen grid tube, gets most filament current, for in addition to the filament current of the second tube it gets the plate and screen grid currents of that tube. These may be taken as 2½ milliamperes. Hence the filament current of the first tube is about 131 milliamperes. This is slightly less than the maximum at which the tube should be operated.

The filament current for the two -50 power tubes is obtained from a heating transformer T3, which is capable of delivering 2½ amperes at 7½ volts. If a power transformer is selected which has two such windings then T3 may be omitted, since one of the 7½ volt windings may be used. One of the windings must be used for the filaments of the rectifier tubes.

How Bias Is Obtained

In the negative end of the filament of the first RF tube is a 10 ohm resistance R1. This gives a bias of about 1.3 volts to the control grid of that tube, which is a suitable value. A similar resistor R2 is put in the negative leg of the second RF tube to give the control grid of that tube the same bias.

The grid bias method of detection is used in the third tube. The grid return of that tube is connected to the low end of R2 so that the bias is the sum of the voltage drops in R2, R3 and in the filament of the second tube. If R3 has a value of 10 ohms the total bias is nearly 6 volts, which is a suitable value for detection with a screen grid tube.

The first audio tube, which is a 120 type, requires a bias of 22½ volts or somewhat less. To get this bias the grid return is connected to the lowest potential point in the circuit, that is, the low end of R1, and R4 is adjusted until the proper bias is obtained. The proper value of R4 is 75 ohms.

Bias on the Power Stage

The power stage is made up of two —50 type tubes in push-pull. Normally the plate current of these two tubes is 110 milliamperes. It is this plate current which is used to heat the filaments of the other tubes. But the filament current required is 120 milliamperes. Hence each of the —50 type tubes will have to deliver 60 milliamperes, or about 10 per cent. higher than normal. This may be done without seriously shortening the life of

eat Screen Grid Filaments

trunn

LIST OF PARTS

C1, C3—Two .0005 mfd. tuning condensers.
C2—One 12 or 15 mfd. midget condenser.
C4, C5, C6, C8, C9—Five .01 mfd. mica dielectric condensers.
C7—One .0005 mfd. mica dielectric condenser.
C10, C15—Two 4 mfd. by-pass condensers, 400 volt rating.
C11—One 2 mfd. by-pass condenser, 1,000 volts rating.
C12—One 4 mfd. by-pass condenser, 1,000 volts rating.
C13—One 8 mfd. by-pass condenser, 1,000 volts rating.
C14—One 1 mfd. by-pass condenser, 400 volts rating.
Ch1, Ch2, Ch3, Ch4—Four 85 millihenry choke coils.
Ch5—Primary winding of a push-pull output transformer.
Ch6, Ch7—Two heavy duty filter chokes, 30 henrys each, to carry 120 milliamperes or more.
L1—One tuning coil as described or any standard coil wound to .0005 mfd. tuning condenser.
L2L3 One RF transformer as described or any standard RF transformer wound to .0005 mfd. tuning condenser and screen grid operation.
R1, R2, R3—Three 10 ohm resistors.
R4—One 75 ohm resistor.
R5, R7—Two 2 megohm grid leaks.
R6—One .5 megohm resistor.
Rh1—One 1,000 ohm variable heavy duty resistor.
R8, R9, R10—A voltage divider of at least 39,200 ohms provided with three to four sliders and capable of carrying 10 milliamperes or more.
T1—One push-pull input transformer.
T2—One heavy duty power transformer.
T3—One filament transformer with 7½ volt secondary and 2½ ampere rating (To be used only if the power transformer T2 does not contain two 7½ volt windings.)
Six standard sockets.

the tubes. Much will be gained in quality and volume.

The increase in the plate current of the power stage may be secured by increasing the plate voltage or by decreasing the grid bias. By adjusting the grid bias, the filament current in the series connected tubes is changed. The grid bias on the power tubes is not critical so that the bias may be varied until the series filament current is correct without affecting the efficiency of the power stage.

Rheostat Controls Volume

A rheostat Rh1 is provided for making the adjustment of filament current and grid bias. The bias on the power tube should be less than 84 volts, with 450 volts on the plates. Since the normal current for the filaments is 120 milliamperes the total grid bias resistor for the power tubes should be 700 ohms, or a little less. The filaments and the grid bias resistors of the four series connected tubes supply 205 ohms of this, so that Rh1 should be adjusted to have 495 ohms. A 1,000 ohm variable resistor with a current carrying capacity of more than .125 ampere may be used for Rh1. This gives wide latitude for adjusting the filament current and the grid bias. It also may be used as a volume control if desired.

The grid return of the power stage is connected to the most negative point, that is, to the low end of R1, and one side of Rh1 is connected to the mid tap of the filament transformer for the two —50 tubes. Fig. 2 is a simplified connection of the filaments and Rh1 showing how the total grid bias resistor is obtained.

Tuning of Set

Two tuned circuits L1C1 and L3C3 are used in the receiver. The first tuned circuit is coupled loosely to the antenna by including part of L1 in the antenna circuit. The antenna tap should not be farther than ¼ of the way up from the low potential side of L1. If it is higher the selectivity will not be satisfactory. If it is lower down the selectivity will be good but the sensitivity will not be so great. Due to the high amplification in the circuit, selectivity is of more importance than close coupling. Hence the tap on L1 may be lower down than ¼ up.

The first tube is coupled to the second tuner by means of L2. This coil should have 2-3 as many turns as L3 and the diameter of these turns should be very nearly equal to the diameter of the turns on L3.

L1 may consist of 72 turns of No. 28 DSC wire on 1½-inch tubing, or any standard coil wound for a .0005 mfd. condenser may be used, provided that a tap is made for the antenna at the desired place. L3 may be wound like L1 except for the tap. L2 may contain 50 turns of No. 28 DSC wire wound on a form that just fits inside the form of L3. The RF transformer L2L3 can be procured ready made, as there are several coil manufacturers who have marketed coils for screen grid tubes.

Aperiodic Coupling

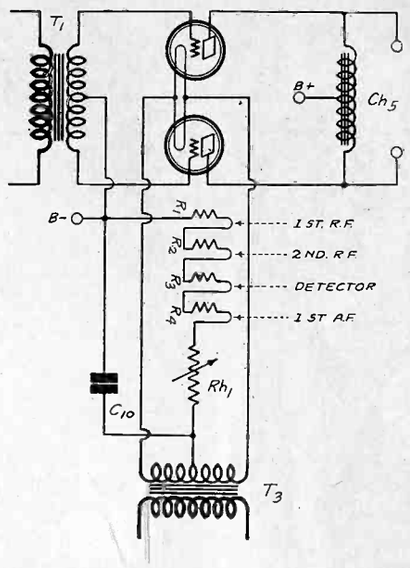
The coupling between the second RF tube and the detector is aperiodic. The coupler consists of an 85 millihenry choke coil Ch4, a .01 mfd. condenser C8 and a 2 megohm grid leak R5. This coupler adds nothing to the selectivity of the circuit but it does transfer the signal voltage from the second RF tube to the detector very effectively.

The selectivity as well as the sensitivity is boosted by a little regeneration through condenser C2. This is a midget of about 15 mmfd., connected from the plate of the detector to the grid of the second RF tube in order that the feed back be in the proper phase.

The coupling between the detector and the first audio tubes is by means of resistance. R6 should have a value of .5 megohm and R7 a value of 2 megohms. The condenser C9 between them should have a value of .01 mfd. This combination puts a load of 400,000 ohms on the detector, except for very low frequencies, and is suitable for taking full advantage of the detecting efficiency of the screen grid tube. The load resistane is shunted by a .0005 mfd. condenser C7 to make the RF impedance low.

Push-Pull Stage

A push-pull input transformer T1 is used to couple the 120 tube to the power stage. Any standard push-pull input transformer such as Silver-Marshall 230 may be used. The output of the push-pull stage is obtained by connecting the loud speaker terminals directly to the plates of the tubes across a mid tapped choke coil Ch5. This choke may be the primary



A simplified diagram showing how the voltage drop in the series connected filaments of the first four tubes in the circuit contributes to the grid bias for the power tubes. The power otherwise merely dropped in the grid bias resistor is used to heat the filaments.

of a push-pull output transformer such as the Silver-Marshall 231. Note that no condensers are used in series with the speaker. None is needed. As a protection against shock from the high plate voltage the operator is advised to keep his fingers away from the loud speaker terminals while the power switch is turned on, and to turn the power off whenever any changes are to be made in the circuit.

In a series connected circuit of this type it is necessary to filter the voltage supply more thoroughly than in parallel connected circuits, and it is also essential to prevent feed back from one stage to preceding stages.

We begin by connecting a .01 mfd. condenser from the screen grid post to the negative filament post on the first socket. This maintains the screen grid at zero potential with respect to the first tube. As a further means of preventing fluctuation of the voltage an 85 millihenry choke Ch1 is put in series with the lead to the screen grid.

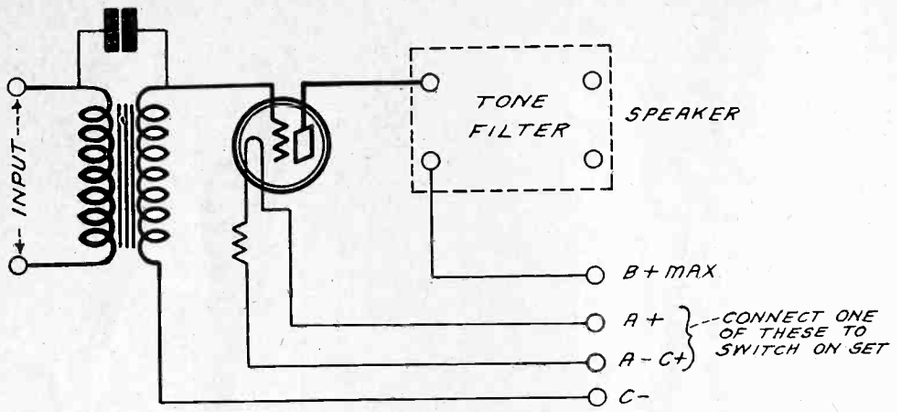
Similar arrangements are used in the second and the third tubes. The by-pass condensers C5 and C6 have the same values as C4 and they are similarly connected. And the coils Ch2 and Ch3 have the same values as Ch1, and they are connected the same way.

Thorough shielding of the RF stages is necessary to prevent feed back and to insure stability. Only one tuner or aperiodic coupler, one tube and one of the screen grid choke coils should be inside any one of the shielded compartments.

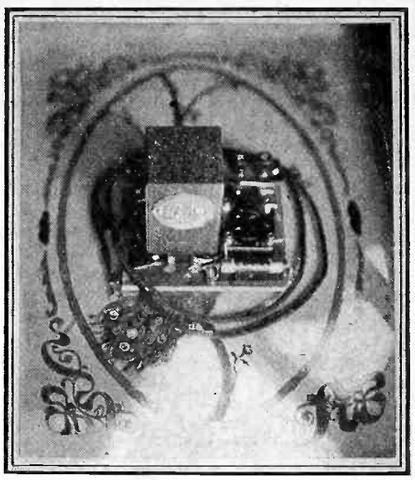
All the leads from the screen grids, after passing through the choke coils, are connected to the same voltage tap on the voltage divider. The common lead should be by-passed by a condenser C14, which is not smaller than 1 mfd. The tap on the voltage divider should be adjusted so that the voltage between this point and the most negative point is 50 volts. This will make the effective screen grid voltage on the first RF tube equal to 50 volts, that on the second about 45 and that on the detector about 40 volts.

One Impedance AF

By Caesar Donizetti



THE CIRCUIT DIAGRAM OF A VOLUME BOOSTER EMPLOYING DOUBLE IMPEDANCE COUPLING



THE EXTRA AUDIO STAGE IS JUST A SMALL PARCEL. THE CORDS CONNECT TO SPEAKER POSTS OF AN EXISTING SET.

THE volume level in radio is constantly increasing. Sets built now contain power tubes, some of the —50 type, some of the —12A type, some of the —10 type, many of the —71A type. Persons who buy receivers now usually get all the volume they desire, for the sets are built to meet the volume demand.

But there are many thousands who have receivers built a year or two ago and who do not care to get new receivers. Yet they want the volume that the new receivers give, and they want the volume with the quality that now goes with modern sets. They want the volume as soon as they have heard one of the modern receivers, for they realize that there is something superior about them.

Volume by Addition

And immediately they want to know how they can get more volume out of their sets. Is there some device which they can get which will raise the volume level without investing in a completely new receiver? Can this device if one exists, be added to their receiver without extensive alteration in the receiver? Will the results obtained with this volume booster be favorably comparable with the results obtained with the receivers now manufactured?

Surely such a device exists, many such devices exist, in fact. And the results obtained in conunction with the old receiver will measure up very well against the results of factory-made receivers. Indeed, if a good volume booster is obtained and connected to a good receiver of old design the quality and volume may not only be equal to that of a new factory-made set but may be much better.

Why It Is So

And why should it not be? What difference does it make whether the volume booster is added in the factory or in the home? The tuner of the old set is as good as the tuner of the set of today. It may be better. The audio amplifier in the set of a year or two ago is as good as the audio amplifier in many of the sets made today. It is true that audio amplification has advanced a great deal during the last few years. But advantage of this advance may be taken when the parts to the volume booster are purchased. If good parts are obtained good results will be obtained.

Much of the distortion noticeable in the old set is caused by overloaded tubes. In an effort to get the volume desired the tubes are overworked. They are driven beyond their capacity. The result is miserable quality and a great deal of noise.

Hence in the choice of a volume booster it is necessary to choose a good coupling device and a tube capable of handling all the volume that is desired. It is also necessary to operate the tube chosen in the proper manner. It must be supplied with high enough voltages and the various voltages must be coordinated properly.

Faithful Coupler

There is one type of coupler which is particularly attractive because of its fidelity to the signal and because of its freedom from operating troubles. That coupler is that which employs a double impedance with a large coupling condenser between the two choke coils.

The large condenser passes all the audio frequencies without appreciable suppression, even down to the lower limit of audibility. The high impedance in the plate impedance insures that a high amplification is obtained, and this is what is wanted in a volume booster. The grid impedance insures that this gain is transmitted to the added tube. The low DC resistance in this grid coil insures freedom from operation troubles, and in that feature lies one of the chief advantages of the system.

Furthermore the inductances of the coils and the capacity of the condensers have been so chosen that there is a resonance effect at. the low end of the audio scale so that the natural suppression of low notes to various causes is offset in just the desired degree.

Tube Suggested

Perhaps the most suitable tube to use in a volume booster for the average set built a couple of years ago is the —71A. This properly operated gives all the volume, without distortion, that one desires in the home. More volume than this tube will give would not be entertainment but tuneful ear punishment.

This tube requires a tone filter, for the plate current is so high that the loudspeaker winding cannot safely carry it. The filter costs less than the speaker so that it is sound economy to buy the filter. The tone filter consists of a high inductance choke coil and a large condenser so connected that the proper filtering is obtained when the device is connected between the last tube and the loudspeaker.

Voltages Required

One of the most important things in the quest for distortionless volume is that the voltages be high. The —71A tube requires a plate voltage of 180 volts for optimum results. It also requires a grid bias of 40.5 volts. Small variations may be permitted without a great change in the output. The filament voltage on this tube should be 5 volts, and this may be obtained either from the storage battery in the old set or else from a transformer having a 5 volt secondary.

The circuit diagram of a volume booster such as described is shown herewith. The tone, or output filter is shown in dotted lines because it was not an integral part of the unit as built up, and it is not necessary unless the —71A tube is used, or a larger tube.

The terminal marked B plus max. should be connected to a battery of 180 volts. A plus should be connected to the positive terminal of the storage battery in set, if this is used and not a transformer. The terminal marked A-C plus should be connected to the minus side of the line inside the set so as to take advantage of the battery switch in the set. This assumes that the filament switch is in the negative lead. If the switch is in the positive lead in the set the procedure should be reversed.

The negative of the 40.5 volts C battery should be connected to the terminal marked C— and the positive of that battery should be connected to the terminal marked A-C plus.

LIST OF PARTS

One FMC double impedance coupler.
One National tone filter.
One No. 1A Amperite.
One standard tube socket.
One —71A tube.
Six binding posts.
One small wooden baseboard (4½ x 5 inches).

No Distortion Here!

By Capt. Peter V. O'Rourke

Contributing Editor

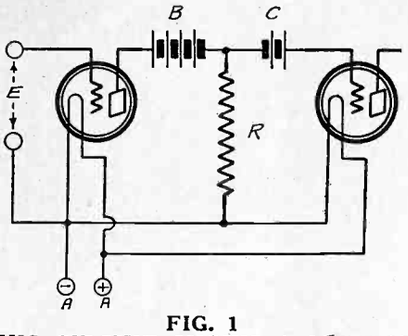


FIG. 1
THIS CIRCUIT SHOWS A METHOD OF RESISTANCE COUPLING IN WHICH THE AMPLIFICATION IS INDEPENDENT OF FREQUENCY AND WHICH CAN BE USED FOR DIRECT CURRENT AMPLIFICATION AS WELL AS AUDIO AMPLIFICATION OF ALL FREQUENCIES

THERE is a system of coupling audio frequency tubes which is practically distortionless. This system is well known to radio and telephone engineers and has been for a decade. Yet there are very few radio fans who have ever heard of it. It is a type of resistance coupling, and was originally proposed by Dr. H. P. Arnold of the Western Electric Co.

This system is used whenever equal amplification for all audio and subaudible frequencies is desired. It differs mainly from the regular resistance coupled amplifier in that no coupling or isolating condenser is used between the plate of one tube and the grid of the succeeding tube. It has one coupling resistor and no grid leak per stage. Fig. 1 illustrates the connection.

Distortionless Amplifier

A signal voltage E is impressed on the grid circuit of the first tube. This causes a varying current in the coupling resistor R and the battery B, which takes the place of the regular plate battery. The varying current in R sets up a voltage across R which is an exact amplified copy of the voltage E. The value of this voltage is the product of the resistance of R and the varying current which flows through it.

If r is the internal plate resistance of the first tube, R the value of the external resistor and u the amplification constant of the tube, the varying current in R is equal to $uE/(r+R)$ and the varying voltage across R is $uRE/(r+R)$. This voltage is impressed on the grid of the second tube. Therefore the voltage amplification of the stage is equal to $uR/(r+R)$.

Since there is no stopping condenser in the grid circuit the amplification does not depend on the frequency and it is a constant over the entire audio range. There may be a slight reduction on the higher audio frequencies due to the output capacity of the first tube and the input capacity of the second tube. But this reduction is negligible. Hence the system is from frequency distortion.

Amplification Obtainable

The voltage gain per stage can be obtained readily for the ordinary tubes used in resistance coupled amplification. The type —40 tube has an amplification factor of 30 and an internal plate resistance of 150,000 ohms. Suppose a coupling resistor of 250,000 ohms is used. Then the formula for the amplification given above gives $30x250,000/(150,000+250,000)$, or 18.75 as the voltage amplification. If a coupling resistor of 500,000 ohms be used the amplification becomes 23 times.

A screen grid tube of the —22 type used as a space charge amplifier has an amplification constant of 60 and an internal plate resistance of 150,000 ohms. Hence for the same coupling resistances it gives a voltage amplification of just double that of the —40 type tube. That is, for a coupling resistor of 250,000 ohms the amplification is 37.5 and for a coupling resistance of 500,000 ohms 46 times.

Coupling Condenser Omitted

The coupling condenser can be omitted from the circuit because the plate battery B is placed above the coupling resistor with its negative terminal toward the grid of the second tube. But the plate current flowing through R sets up a steady voltage drop as well as a variable voltage. This steady drop is a bias on the second tube. Since the greater portion of the voltage of battery B is dropped in R when this has a high value compared with the internal resistance of the tube, the bias on the second tube is too high for satisfactory operation of that tube as an amplifier.

Hence it is necessary to insert the battery C in the grid lead of the second tube with the positive terminal toward the grid. The voltage of this battery is adjusted so that the effective bias on the second grid is correct for efficient amplification in the second tube.

Knowing the plate current through R by measurement and the resistance of R it is simple to calculate the voltage required in C. Suppose the plate current is normally 125 microamperes when the coupling resistance has a value of 500,000 ohms. The drop in R is then 62.5 volts. The negative bias required on the second grid may be 1.5 volts. Hence the voltage of battery C must be adjusted to 61 volts.

Disadvantages of System

One of the disadvantages of this system of coupling is that so many batteries are required, and it is for that reason that the system is not used except in special circuits, particularly in circuits used for amplifying extremely low frequency currents or direct currents.

But the circuit can be simplified somewhat by the use of lower voltages. It is not necessary to use as high voltages as are ordinarily used in broadcast receivers, especially where the signal level is low. It is quite pactical to use voltages as low as 7.5 volts for B, such as would be supplied by a 7.5 volt grid battery.

When this voltage is used for B in a circuit having a 500,000 ohm coupling resistor the plate current would be about 10 microamperes. The drop in R would be but 5 volts, and the grid battery C would not have to be more than about 3 volts. This also could be obtained by the use of small dry cells. If the signal level exceeds about 3 volts peak value the voltage on the plate of the next tube would have to be increased, but it would be still practical to use dry cell batteries of small size.

Where the signal level on the first stage is extremely small it would be practical to use such a low value of B that it would not be necessary to use any C battery.

Wave Form Distortion

At first thought it might be supposed that the wave form distortion in a circuit having such low plate voltage would be excessive. But such is not the case because the very high plate resistance used straightens out the dynamic characteristic. Considerable grid swing is permissible before any appreciable second harmonic is introduced into the signal.

As in the case of all amplifiers there will be a certain amount of harmonic introduced. This may be offset by using an even number of stages in the amplifier. One stage will deform the voltage wave in a certain direction. The next stage, being in opposite phase, will deform it in the opposite direction so that the effect of two stages will be less distortion of the wave form. That is the second stage will correct the distortion introduced by the first and the fourth that of the third, and so on.

Advantages of System

The chief advantage if the system is that it amplifies all audible and subaudible frequencies equally. But it has other favorable points. The use of separate batteries for the various plates eliminates the common impedance which has been the cause of more trouble in radio receivers than all other causes of misbehavior. There is no common impedance and hence there is no motorboating, no blasting due to incipient oscillation and no blocking of the grids.

Various attempts at popularizing this system of coupling have been made by radio engineers, but so far no great progress has been made. The fans are reluctant about using it because of the many batteries required. But there is no question that in the near future this system will be used more extensively than it is now. Practical circuits will be developed, circuits which will not only be capable of reproducing broadcasts to a high order of fidelity but circuits which will be suitable for television reception.

Common C Battery Possible

It will be observed that the positive terminal of the C battery is connected to the grid in order to compensate for the voltage drop in the resistor. It is therefore possible to put the C battery below the coupling resistor with the positive terminal toward both the grid and the plate, that is in the usual manner. Then the grid battery portion would not only be effective on the plate of the tube but also it would serve the purpose of properly polarizing the grid.

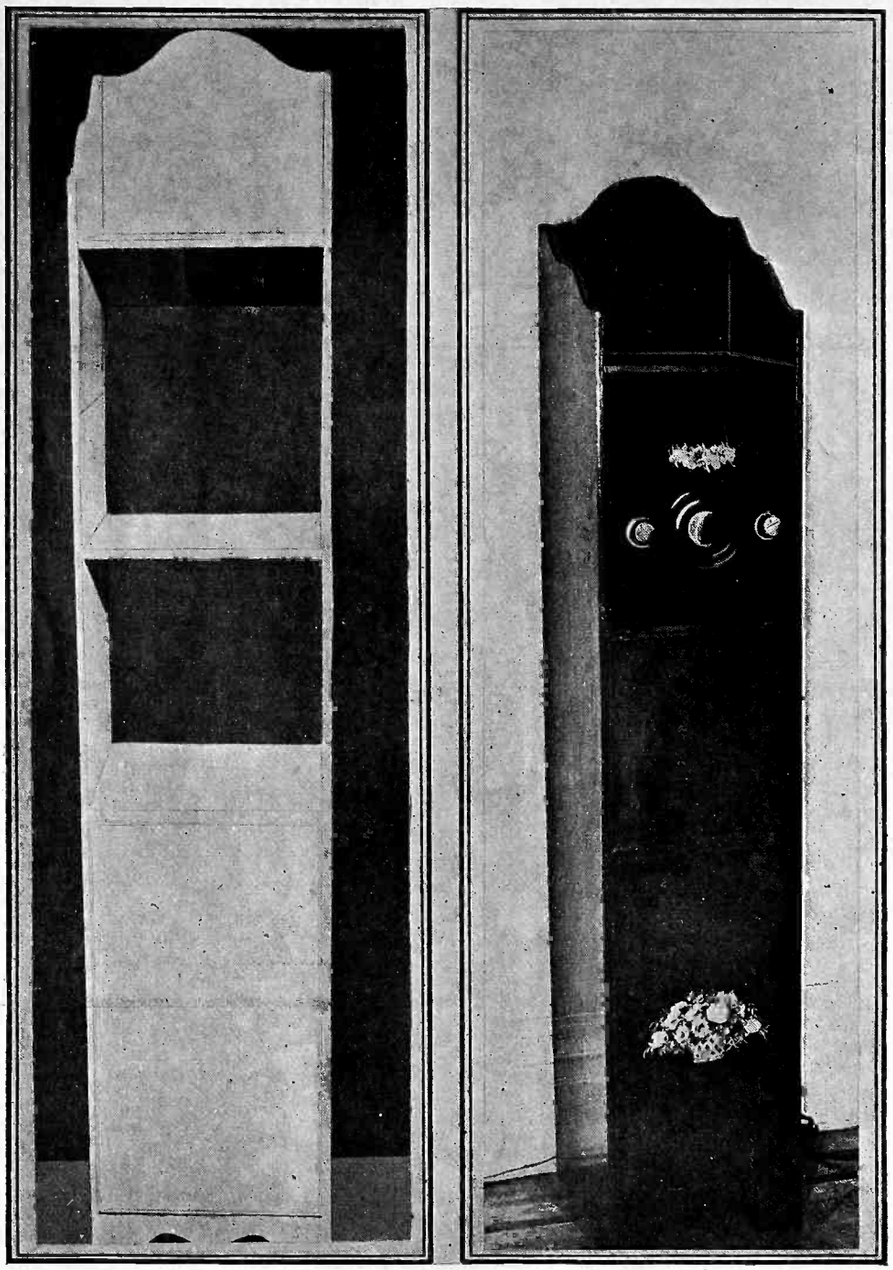
This suggests the possibility of combining the C battery of several stages of a receiver of this type. Thus several of the batteries could be eliminated and the circuit greatly simplified. This idea of combining the C battery in this type of circuit as new as far as this writer knows. Work is now in progress developing the idea. Additional circuits will be published in an early issue, both with separate grid batteries and with a common battery for a number of stages.

Radio fans who like to experiment with new and unsual circuits and who desire quality of the finest type will find these circuits interesting.

A Pier Cabinet that

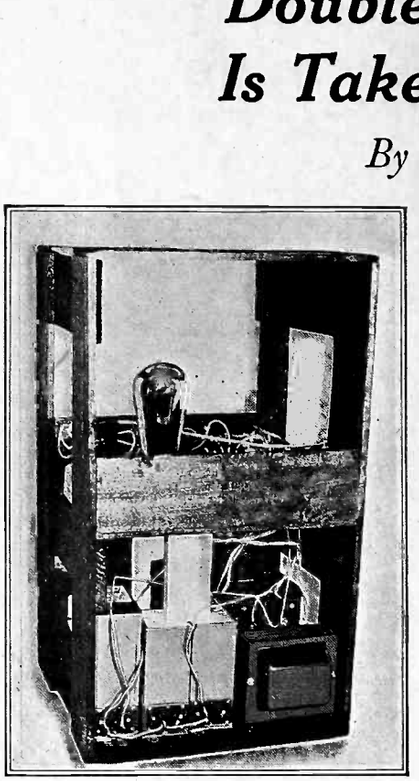
Double Sh
Is Taken a

By Herbe



(Hayden)

THE SKELETON OF THE PIER CABINET IS SHOWN AT LEFT, WITH RECEIVER COMPARTMENT AND SPEAKER HOUSING EMPTY. AT RIGHT IS THE COMPLETED INSTALLATION, NICELY DECORATED.



(Hayden)

THE LOWER COMPARTMENT OF THE PIER CABINET HOUSES THE B SUPPLY, WHICH SHOULD BE BUILT ON A SEPARATE FRAME, AS SHOWN, AND SLID INTO PLACE.

THIS is the age of the skyscraper. There is little room on which to build buildings, but there is an unlimited room upward. There is even little little room on which to stand, but the tall man finds it no more difficult to find space than the short man. Men will have to develop upward just as man develops his buildings upward.

In this skyscraper era it is only natural that radio should be built along vertical lines rather than horizontal. There is ample room for the vertical radio installation in the modern small apartment but there is little room for the set that sprawls over a large area.

Perhaps the idea of the vertical radio receiver was taken from the design of radio transmitting equipment, or telephone exchange equipment, for most of this is built on skyscraper lines in order to save floorspace. Wherever the idea came from the vertical receiver is here in the form of a Pier Cabinet, as can well be seen by looking at the photographs on this page.

This vertical or skyscraper receiver is built into a pier cabinet, the skeleton of which is shown at the left. It comprises three major divisions in as many stories. The top compartment is reserved for the tuner and amplifier. The middle is shelved off for the loud speaker, and the bottom for the power supply.

Fits Any Receiver

There is ample room in the top compartment for almost any type tuner and amplifier. The depth of the pier cabinet is about the same as that of the average

RADIO UNIVERSITY

WILL YOU PLEASE give the milliampere drain of the following tubes: 01A, 112, —71, —10, —16 and —00A.

(2)—What should be the voltage drop across the primary of an audio transformer when 22 volts are applied to its terminals?

(3)—Is there any way of preventing a set from picking up telegraph signals when the telegraph instrument is in the same house as the receiver?

S. E. CARRIGAN, Winthrop, Minn.

(1)—The current drain depends on so many things that this question cannot be answered unless all the operating conditions are given. The following values may be called normal operating currents: —01A, 3 ma., 112, 7 ma., —71, 20 ma.,—10, 16 ma., —16, 7 ma., —00A, 1.5 ma.

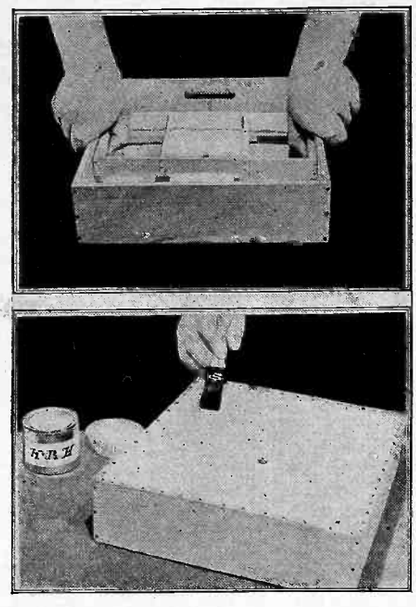
(2)—The voltage drop across the primary of any transformer when 22 volts is applied should be 22 volts, otherwise 22 volts is not applied. If the question means what the voltage drop will be in the primary winding when the transformer is connected in the plate circuit of an operating tube with 22 volts applied to the B battery terminals, the answer is that the drop is the product of the resistance in the primary by the plate current. If the plate current is 1.5 ma. and the resistance is 2,000 ohms the drop is 3 volts.

(3)—Nothing can be done to the set that will cut out the telegraph signals and still retain the sensitivity of the set. But the problem may be attacked at the telegraph instrument. A by-pass condenser across the make-and-break point in the telegraph circuit should help.

Houses Everything

ld Portable
n Example

E. Hayden



(Hayden)

A SPEAKER TO FIT IN THE PIER CABINET IS MADE OF A WOODEN FRAME AND LINEN DIAPHRAGM.

radio set. The length is ample to include a couple of tuning controls and control knobs. The height is such that the compartment may be subdivided if desired for the tuner and the amplifier with ample head room for tubes on both shelves.

The set actually installed in the top compartment was the portable described by H. G. Cisin in the June 30th, July 7th and 14th issues of RADIO WORLD, less the B batteries of the receiver, in view of the complete power supply built into the skyscraper set. A view of this portable, as installed in a suitcase, is shown herewith.

The photograph at the right of the skeleton view shows the skyscraper receiver as it looks when everything necessary has been installed and after it has been attractively decorated. It is a worthy addition to any home and its shape adapts it particularly well to the city apartment.

Construction of Loudspeaker

The middle compartment contains a specially built linen diaphragm speaker. A suitable wooden frame made as large as the dimensions of the middle compartment in the pier cabinet will permit is constructed. This frame shown in the photograph is shown in the upper right corner of page eleven. This photograph depicts the back of the frame and shows the sub-frame upon which the small counter-diaphragm is tacked, that is the diaphragm which used for the purpose of stretching the main sound radiating diaphragm in front.

The photograph below is the front view of the frame after the main diaphragm has been tacked in place. The operator is shown in the act of applying the "dope" which is used to protect the linen fabric against moisture, to stretch the surface and to close up the interstices against air.

When the "dope" has dried and the driving unit is mounted on wooden cross pieces on the back of the frame. The speaker is then ready to insert in the allotted compartment in the pier cabinet. Small wooden screws may be used for holding the speaker in place.

If the builder's esthetic sense is offended by the plain speaker in the middle of the cabinet a suitably colored silk screen may be placed in front of it. This screen will in no way affect the sound emerging from the speaker but it will greatly improve the appearance of the receiver and at the same time prevent dust from entering the driving mechanism of the speaker.

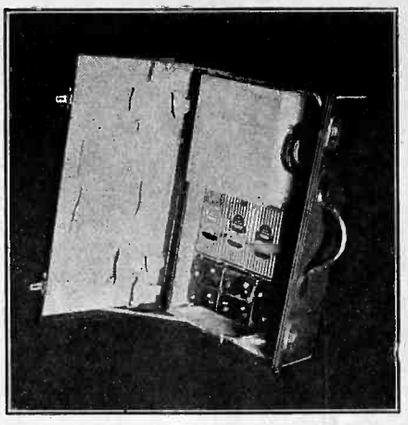
Large Power Supply Space

The power supply in a modern receiver is the bulkiest part of the installation and hence much space must be reserved for it in the base of the cabinet.

The power supply should be built on a separate frame as it requires greater strength and rigidity than the cabinet will afford. The construction of this frame is shown on page ten. It is clear that the parts are mounted on two separate shelves. The condensers and the transformers, which are the heaviest are put in the bottom. This gives stability and anchorage to the cabinet. The rectifier tube and the voltage divider is put on the second shelf, together with other minor parts which may be necessary.

There is ample room on the second shelf so that the tube and the voltage divider may be mounted at some distance away from the wood work. This is an important feature because these two parts liberate considerable heat and if they are placed near the wood work this might be scorched. Circulation of air should be provided in the lower part of the cabinet so that the heat generated may be carried away.

Holes drilled in the bottom and top of the compartment at the back will provide the necessary ventilation. Similarly, ventilation should be provided in the top compartment where the amplifier tubes are located. This ventilation system may run from the bottom of the cabinet to the top, back of the loudspeaker. The chimney effect will create a considerable draft and the holes provided need not be large.



DOUBLE SHIELD PORTABLE MOUNTED IN SUITCASE

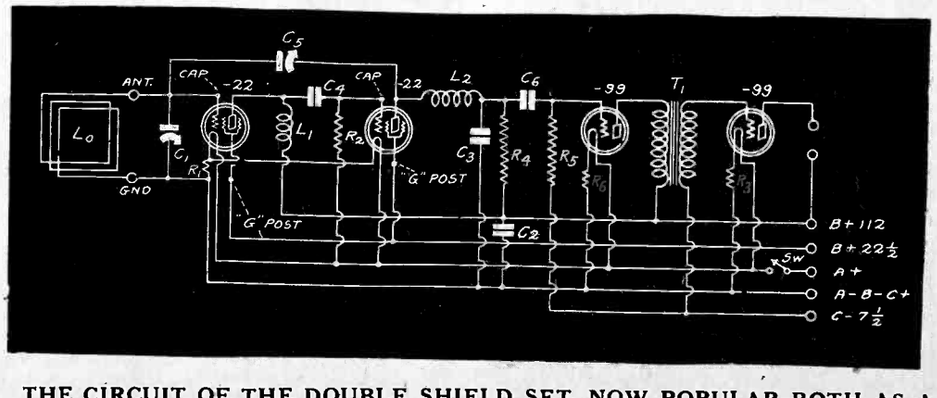
As soon as the power supply has been assembled and wired the frame containing it should be put into the lower compartment of the pier cabinet. The door provided in that cabinet will cover the frame and the equipment attractively.

It should not be necessary to fasten the power supply frame to the cabinet for it is heavy and will not only hold itself in place but it will also hold the cabinet down. The tuner and amplifier, however, should be firmly secured.

The skyscraper receiver is not only an attractive addition to the home, but as a radio receiver it is unusually convenient. All the parts are in one compact container and the tuning dials and control knobs are at the proper altitude for the average person while standing in front of it. And the dials are easy to read.

American Mechanical Now Clarostat, Inc.

John Mucher, president announced the change of name of American Mechanical Laboratories, Inc., to Clarostat Mfg. Co., Inc. The factory is at 285 North Sixth Street, Brooklyn, N. Y. The company manufactures principally clarostats, adjustable resistors of any range and current carrying capacity, but also values other radio and allied products.



THE CIRCUIT OF THE DOUBLE SHIELD SET, NOW POPULAR BOTH AS A PORTABLE AND AS A HOME RECEIVER.

Apartment Houses H
in Antenna and G

THE STEAM RADIATOR IS MORE OFTEN USED FOR GROUND IN AN APARTMENT HOUSE THAN IS A COLD WATER PIPE

By Walter J. McCord

BUILDINGS more than two stories high present new problems in grounding and in antenna connections. Therefore in cities particularly, where radio sets are abundant in apartment houses and hotels, and present even in some office buildings, the radio installation engineer meets problems that never presented themselves to him before. If he knows the solution he makes a success of the installation. If he does not know it, he should know how to ascertain it. Anything and everything must be done to make the installation a success.

Also the home-constructor is often puzzled by antenna and ground conditions. Having completed a receiver that should be a real performer, he may find he is barely able to get the set to work. He casts around for a solution. He checks up the wiring once again—for the fourth consecutive and painstaking time—and in fact examines everything except the relative potentials of his antenna and ground.

Got Signals by Accident

"I wonder what can be the matter?" asked one exasperated home-constructor, who had built six successful sets, without missing a trick in any one of them, but who could not get a good signal out of any one of them in his new home on the sixth and top floor of a New York City apartment house.

Then he did a little tinkering with the aerial as follows: he connected a lamp socket antenna from the wall socket to the antenna binding post of his set and to the ground post of the receiver he connected the steam radiator. Next he tried an outdoor aerial, joining the lead-in to the antenna post of the set. This helped, but not enough. Finally he removed the ground connections but retained the outdoor aerial—and signals came in fine!

Then he connected the steam radiator to the antenna binding post and that constituted the input entirely. He obtained still more volume. But the set was not selective enough. WOR, the strongest station in most parts of New York City, was hard to tune out. In fact, it constituted a background even when he tuned in WMCA and WNYC, which would not do.

He had half stumbled on the solution, but still he did not know the reason, nor was he able to proceed in any new direction that promoted the exactly desired solution of his odd difficulty.

Must Understand Situation

In the rustic part of the United States there is little or no chance of encountering these mysteries, but in the cities with their multi-storied residential buildings and office buildings there is plenty of room for signal strength improvement, selectivity gain and general uplifting of performance. And as there is alternating current supply in nearly all such places, the problem arises frequently with AC receivers, and it is baffling and often expensive.

How to get the desired results is the problem. And the goal is reached only by an understanding of the peculiar conditions that prevail, but which, in the course of time, will become very well known, to the combined joy of all concerned.

Let us take the particular instance of the ground post of the receiver not being connected anywhere, but the steam radiator valve being connected to the antenna post of the set. We will assume that the receiver is AC operated, although that may not change conditions much in any event, if a B eliminator furnishes the plate current.

Up in the Air

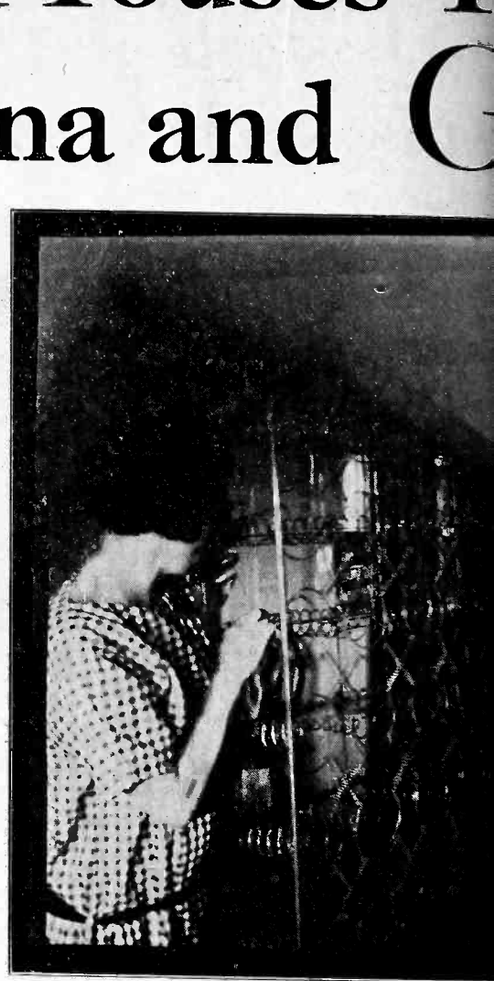
The building was six stories high. The steam heat was supplied to all the sixty families in the house from the same boiler in the cellar. Whether heat was being supplied or not, the physical and electrical connections remained the same.

All the steam piping and all the radiator surface in the house constituted a pickup of radio energy, and the pipes ran as high as 55 feet from the ground. Also, there is no certainty that the radiator system actually was connected to ground, for although the boiler was embedded in Mother Earth, pipe connections thereto had packing in them that prevented continuity of metallic contact.

All this piping, the boiler, and the radiators in the sixty apartments as well as the hallways, basement and a garage, constituted a long antenna. Yes, it was an antenna, at least for the families on the upper floors, because the higher the piping from ground, the higher the radio frequency potential from ground and finally a really high potential existed, and that is what made the radiator at those points an antenna rather than a ground. For tenants on the lower floors the radiator might be a good ground, although probably the cold water pipe would be better.

Bad as Counterpoise, Too

The long antenna on the sixth floor, coming unsuspectedly from the radiator,



THE BEDSPRING (LEFT) HAS CEA FOR SEVERAL REASONS, WHICH THE FIRE ESCAPE BE USED, BECAUSE SO

had a fundamental wavelength that was not only in the broadcast band, but indeed was somewhat near the wavelength of the station that anyway produced the greatest microvoltage per meter in the pickup. It was only a little difficult to tune out WOR under best conditions, but when the radiator was used as antenna, and the signal strength of WOR boosted above and beyond anything that had been experienced in this particular location before, the combination defeated all attempts at selectivity.

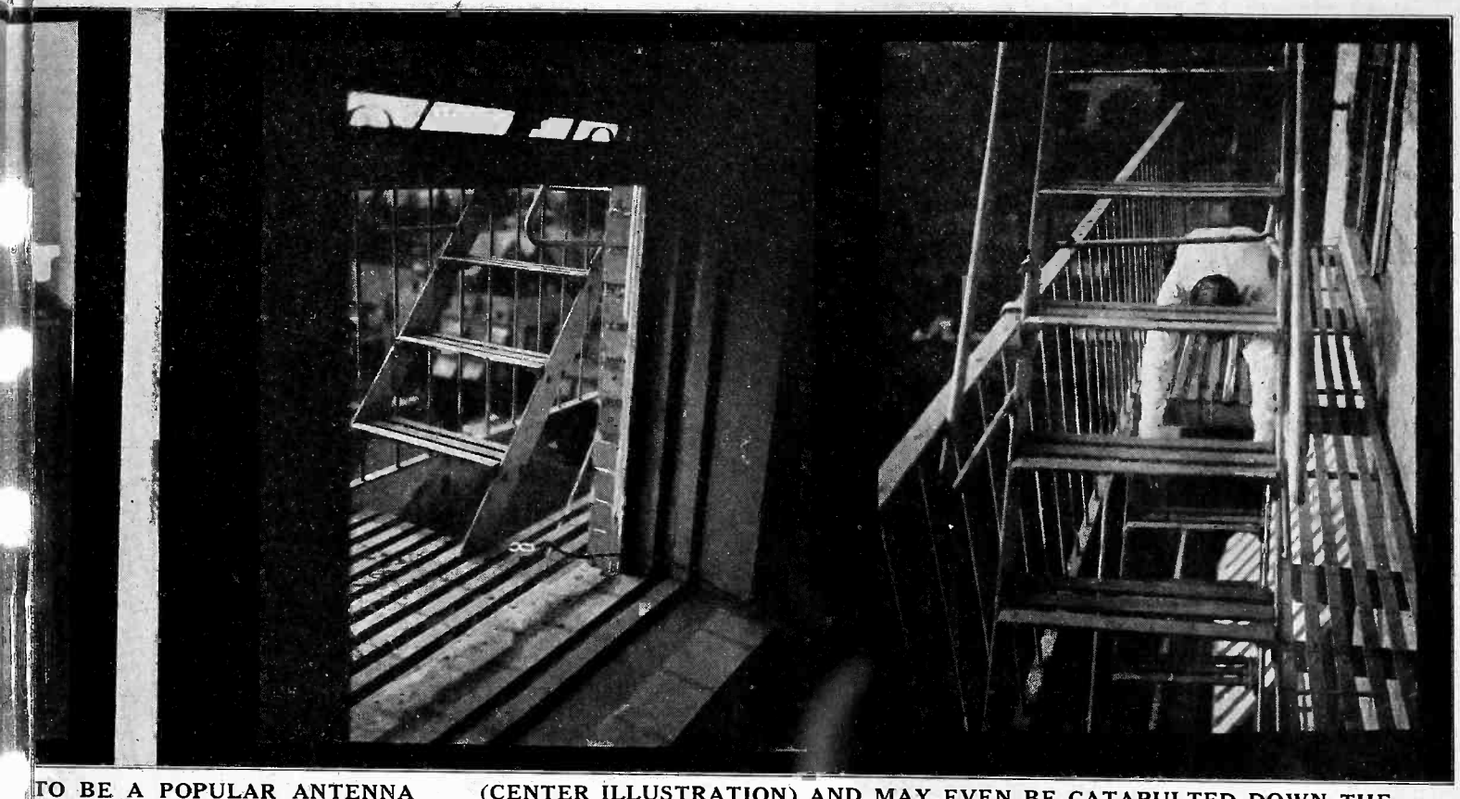
Hence the radiator was out of the question either for ground or antenna, for although it was an antenna it could be used as ground with a sort of counterpoise effect, yet due to that same high natural wavelength it would produce the same trouble.

The exact solution in this given instance, therefore, was to connect the outside antenna, which is usual had a natural period below the broadcast band, or about 175 meters, to the antenna post of the receiver, and to leave the ground post blank, because enough capacity to ground existed between the secondary of the power transformer in the B eliminator to give an effectual ground.

The grounded circuit therefore was completed in the AC receiver through B minus to the center-tap of the filament resistors across the AC tubes.

A small increase in hum might result, due to the absence of direct ground, or

resent New Problems round Connections



TO BE A POPULAR ANTENNA HOR CITES. NOR SHOULD THE NE MAY TRIP OVER THE WIRE (CENTER ILLUSTRATION) AND MAY EVEN BE CATAPULTED DOWN THE OPENING, AS THE MAN AT RIGHT IS DOING. THE FIRE ESCAPE IS NEITHER A GROUND NOR AN ANTENNA

to unexpectedly large capacity to ground in the power transformer, the voltage drop in the condenser slightly accentuating hum.

Adjustable Antenna Capacity

But the circuit was much more selective, behaved well indeed and gave all the volume that the erstwhile troubled fan wanted—more, if need be.

Under circumstances such as these, where the input is too strong, other remedies may be used as auxiliaries, for instance an adjustable condenser, like X-L .0001 to .0005 mfd., may be connected in series with the outdoor antenna, and adjusted until selectivity is sufficient while volume is likewise, it being understood, of course, that with the same amount of receiver amplification, the gain in selectivity always is at the expense of volume. However, even a reduction of volume to 70 per cent. of the original may not be noticed by most ears.

Test for Grounded Side

Another auxiliary remedy is that if the cold water pipe or steam radiator gives selectivity trouble, a lamp socket antenna may be plugged into the convenience outlet, electrolier socket, standing lamp socket or two-way plug, and may be used as a ground. To do this effectively requires a test as to which slot the single prong of most lamp socket devices is to go into, since even in AC lines one side usually is grounded.

The test may be made by expert hands by connecting a 25-Watt lamp so that one side of the lamp filament goes to the wall socket, the other side to the radiator or possibly conductive path to ground. The side of the outlet that makes the lamp light is the conductively grounded side.

Of course, where adequate grounding is available without selectivity absence, a lamp socket antenna plug may be used as aerial, and the same facts previously stated in regard to the radiator may apply to the lighting main, i.e., the conductively grounded side, at a high location, may be at a high radio frequency potential.

Another point is that under certain conditions the AC or DC house line may be grounded for all RF potential, because of connections made when this wiring was installed, either in the house, or, more likely, farther away.

The pickup between this RF shorted point and the point of insertion of the plug may be too small to be useful. In most instances, however, the lamp socket antenna works well.

The fire escape used to be almost popular as an antenna, because there it was, and all you had to do was to hook up to it. Likewise the bedspring had some ardent followers for radio purposes.

Both of these antennas have fallen into disfavor.

Avoid Fire Escape

The fire escape is a large structure, because it is not required in small buildings. Its natural wavelength often at an awkward frequency, causing a strong resonance peak which badly hurts selectivity. Also, the connection to the fire escape was usually made in an unlawful, manner, by clamping a spring clip to a scraped-off part of the iron slats, in such a way as to constitute an encumbrance, violating both the Building Law and the Fire Law in many cities .

It would be quite possible, amid the excitement of a fire, for some one rushing down the fire escape to trip, and possibly fall through the ladder opening. By all means forego any connection to the fire escape for that reason, if for no other.

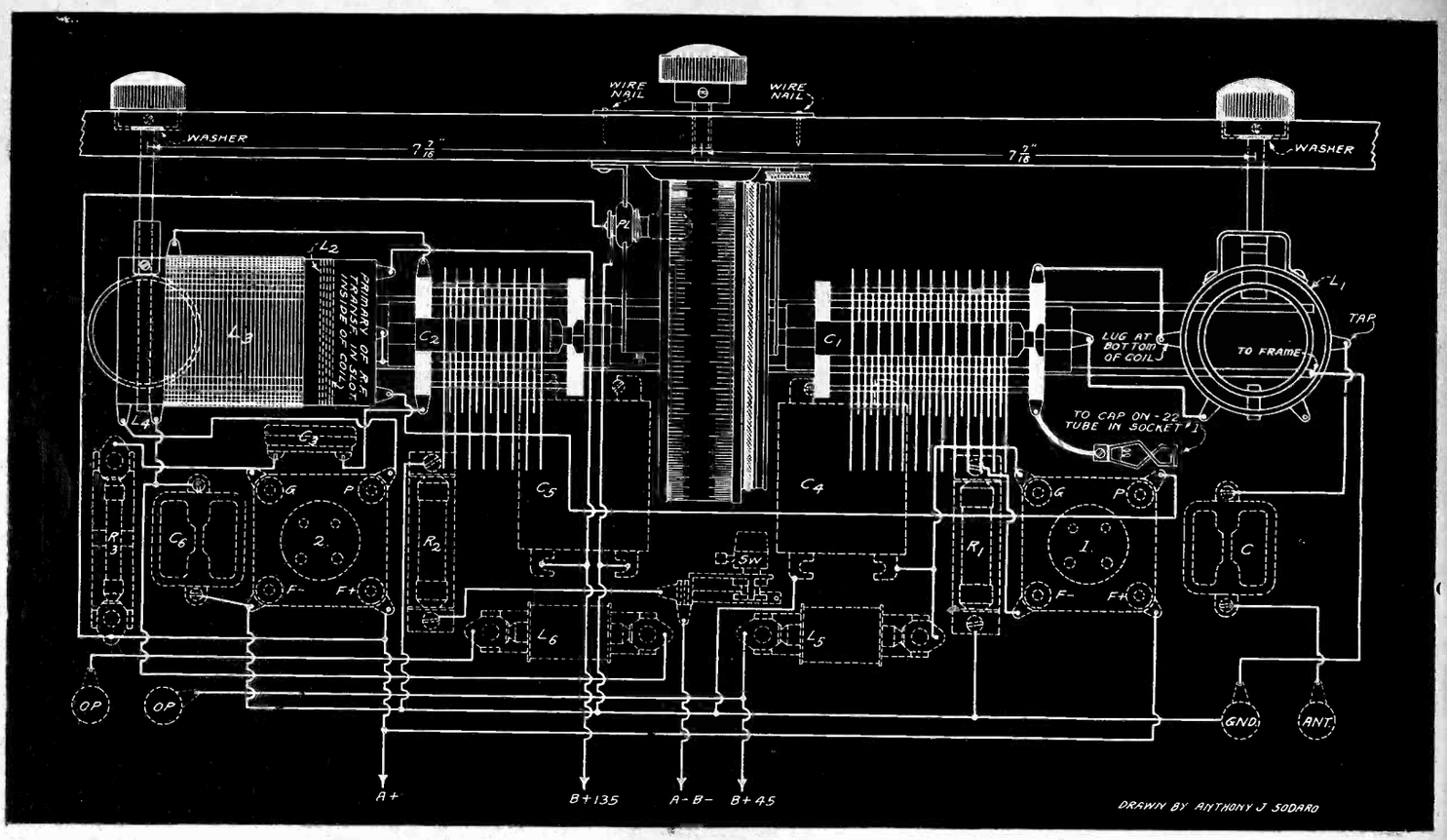
The bedspring did not pick up enough energy, and besides required wire be run into some other room.

One good wife whose husband used the bedspring as an antenna so far forgot the fact that when she was removing the spring for insecticide application, she pulled her husband's ten-tube set off the table in the next room and broke every tube in it!

National
Screen Grid Five
Part-2

The Novelty of Quickly Solved

By H. B.



PICTURE DIAGRAM OF THE WIRING OF THE NATIONAL SCREEN GRID TUNER (TWO TUBES) AS ADAPTED TO TABLE TOP INSTALLATION.

[*The first installment of this article on the construction of the National Screen Grid Tuner for table top installation was published last week issue of July 14th. A radio table top is drilled as if it were a front panel, so that you do not need front panel, cabinet or even a subpanel. The set goes underneath. The two-tube design lends itself to supplement by suitable audio.*]

THERE are four holes to be made on the table top, by generous count, and these are: one each for the two coil knobs, one for the large opening so that you may "sink" the dial escutcheon low in the wood, and the fourth for the dial shaft itself. This is the tuning shaft that protrudes, not a condenser shaft, because a drum dial is used, and the condensers are mounted at right angles thereto as a part of the factory assembly. This is shown in the graphical diagram of the wiring published above. By the way, the dimensions are written on that diagram so that you may locate the knob holes, although the template furnished with the National unit assembly better serves the purpose.

How to trace the escutcheon outline was described last week, and the directions were carried to the point of assembly, with sketchy data on the assembly as well, but these are supplemented this week with the detailed data, constituting full exposition of the only unfamiliar consideration.

At top of the next page is printed a skeleton diagram, showing what the tickler coil looked like when being prepared for installation by the new table top method. Note the shaft. A dotted line shows the end of the shaft partly through the wood. Of course the opening has been drilled so that it would be easy to push the shaft all the way through, and fasten thereto the knob (not shown), but the dial frame is flush against the under side of the table top, and this prevents you from moving the coil farther up. This whole frame will pivot circularly on the condenser shafts, also, but once you engage the coil shafts in the holes drilled in the table top, the rocking ends, for all time, and the shafts are at right angles to the table top. See the picture diagram again, atop this page.

Now look once more at the coil placement diagram on page 15. This represents just about the condition that will confront you. The shaft will go as high as shown, if the wood has the usual thickness of 5/8 inch. Now, if you will imagine a knob with a collar on it, and a set screw in this collar, you can visualize the impossibility of tightening the set-screw unless the coil shaft is removed sufficiently to afford access. The wood surrounds the knob collar, in fact, most of the knob depth, and there is no other way to get at it, save to elevate the shaft.

Exactly follow the directions about to be given, which make the work very simple and equally safe, whereas disobedience may cause you to spill the bushings and collars all over the floor. Even if you spill them anyway, look at the drawing and note how to replace them.

With a small driver unscrew slightly the set-screw on the lower bushing. This is the end-stop device. Then turn the shaft from below, with your fingers, until the other set-screw is within convenient reach, meanwhile holding firmly to the lower collar, which has not been loosened enough to fall off. Now, with progress made easy, place a matchstick or short dowel piece against the lower end of the shaft and push up, following through with the match to prevent dissembly of the bushings and washers. Thus you may remove the shaft completely.

If you tie a piece of string at the end of the match, and hold the other end of the string, you may pull the string through and remove the match, leaving only the string to be tied against the screw machine parts to keep them in place.

Now you may remove the shaft entirely, pushing it up until you can conveniently complete the removal with a slight upward pull from a position above the table top. The only object is to attach the knob, and this is done by bearing rather heavily against the set-screw, because under no circumstances must you permit yourself to do a lazy job of this screw

Table-Top Mounting Without a Spill

Herman

tightening, otherwise you may have to go through this process all over again some early day, to engage a loosened set-screw.

Better put a 3/16 diameter oiled washer between the knob and the table top, when replacing, so that the shaft collar will have a slippery seat in which to turn.

Now you may slide your dowel or match stick again through the unfilled opening in the coil construction, remove the string and drop the shaft into place, letting it ride on the top of the match, as it were. The untightening process will have familiarized you with the reconstruction work—which takes two minutes or so—and when this is completed, turn the knob and see to it for sure that, when the end-stop strikes, the tickler coil is parallel with the secondary, not sticking out at an angle.

If by chance you get the tickler on in reverse inductive fashion, something hard to determine at this stage, you will ascertain that fact later, because looser coupling will give more regeneration, tighter coupling less. By this time you will have wired up the coil-to-socket connections and the like, and the reversal of wired connections would be awkward because of inaccessibility, but you can always loosen the end-stop screw just a trifle, and push the tickler coil half way around, to reverse the field. Then retighten the end-stop set-screw.

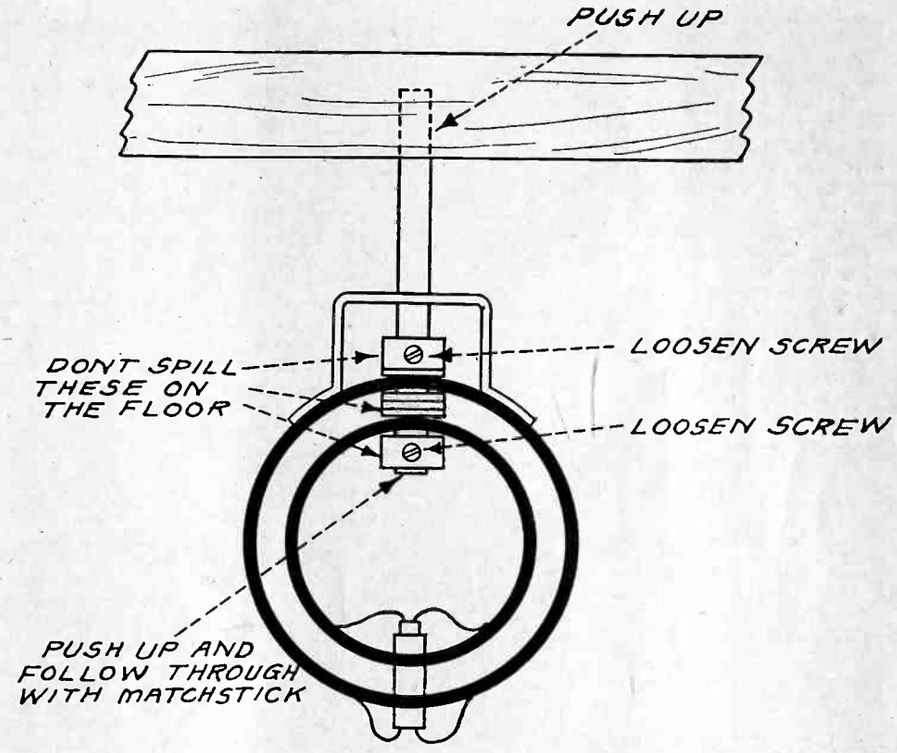
You will have noticed that the unit assembly had to be pressed up tight so that the knob could seat itself properly, and still grip the coil. This is as it should be. You have done the job right even though the tickler will not alter its position unless just a trifle more pressure is exerted than usual. The same will be true of the knob of the inductive trimmer or built-in variometer, which is mounted in the same fashion and by the same operation. The same precaution about having this variometer winding parallel with its secondary mate, when the end-stop is struck, holds true.

The reversal of the field likely will be of no importance here, since the trimming effect is gained amid generous margin of "play." If your later results with the trimmer lead you to believe you have to monkey with it more than should be expected, to get loudest signals, you may reverse its field in exactly the same manner as previously related in reference to the tickler of the three-circuit coil.

There is just enough room in front of the assembly—that is, between the assembly frame and the front of the usual kind of table—to permit you to mount the sockets on the underneath level of the table top.

Of course you could go in for brackets and have a subpanel attached thereto, so that tubes could be mounted upright, but there's no need for that. The tubes do not develop much heat, except only the power tube, and that is plentifully rugged to stand it.

The sockets therefore are screwed to the under side of the table top, upside down, and the tubes will be inserted upside down, there being no good objection against this for element protection, but

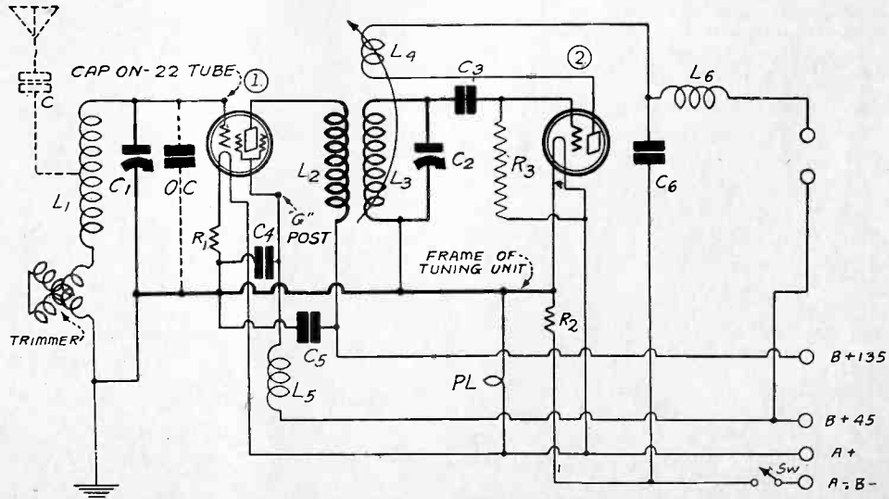


TO UTILIZE THE TABLE TOP WITH ITS FIVE-EIGHTH-INCH THICKNESS IT IS NECESSARY TO DRILL DEEPLY ENOUGH TO SEAT THE COLLAR OF THE COIL KNOB (NOT SHOWN), WHICH REQUIRES PUSHING UP THE SHAFT TO GET AT THE KNOB'S SET SCREW. THE DRAWING ELUCIDATES THE OPERATION, FULLY DETAILED IN THE TEXT

only the theoretical one of too much heat rising into the base, instead of toward the tube top. To prevent tubes from falling out, use Benjamin sockets.

Many hours of testing prove that the heat is only 9 per cent greater around the base area when the tube is mounted upside down than when it is mounted upright, and as the temperature as measured averaged about 142 in this region, the temperature differences was little more than 12 degrees, and the upside-down method of mounting is therefore heartily recommended for this type of installation. Also it completes the economical trilogy—elimination of front panel, cabinet and subpanel.

The wiring of the set and the audio channel will be subects for future articles.



THE FIXED CONDENSER OC, WHICH WAS STATED IN PREVIOUS ARTICLES AS BEING OPTIONAL, NEED NOT BE USED, FANS REPORT, AFTER BUILDING THE CIRCUIT. THE VALUE GIVEN WAS .0001 MFD., BUT THE INDUCTIVE TRIMMER TOOK CARE OF ALL COMPENSATION.

Hearings Are Begun for Barred Stations

Washington

Representatives of 107 of the 164 smaller radio stations named in the general order of the Federal Radio Commission issued May 25, for removal from the air on August 1, for alleged failure to serve public interest, appeared before the Commission to contest the Commission's action. The action was taken by the Commission pursuant to the new radio law.

The Commission's order (General Order No. 32), named only 162 stations, but two stations which subsequently applied for renewal of broadcasting licenses were included.

Fifty-seven stations failed to answer when the roll was called. It was assumed these 57 are ready to quit or at least join in consolidations. Of these, ten were in the first or Eastern zone, in which 36 stations were refused renewal of licenses; seven in the second zone, including Pennsylvania, Ohio, Kentucky, Michigan and bordering States, in which zone 31 stations were named; 36 out of the 91 in the Fourth or Middle-western zone, in which the most stations were named by the order; and four out of the five in the Pacific Coast zone. The third zone, embodying the southern States, is not affected by the order, being below its quota of stations.

Procedure is Explained

Opening the hearings, the Chairman of the Commission, Ira E. Robinson, announced that everyone would be given "a full and fair hearing." He stated that testimony would not be heard until after it had been ascertained how many stations would contest the Commission's order.

The General Counsel of the Commission, Louis G. Caldwell, outlined the procedure to be followed in hearing the arguments of protesting stations. He said that all cases must be closed by August 1.

Announcing that it was the intention to exclude from evidence all letters, petitions and other documentary evidence not sworn to, and that only affidavits, and oral testimony would be accepted, Mr. Caldwell evoked responses from several of the representatives of stations, who objected on the ground that it would entail additional expenditures and lost time in getting affidavits, and bringing witnesses before the Commission. Norman Thomas, the Socialist candidate for President, representing WEVD, of Woodhaven, N. Y., which is the Debs Memorial Fund Station, and Frederick C. Dow, of WLBH, led the opposition, but were overruled by Chairman Robinson.

Emergency Cases First

Emergency cases will be given preference in the hearings, General Counsel Caldwell stated. He read the following announcement to the meeting:

"As each station is called, it should be stated whether it desires a hearing, and 1, amount of time presentation of station's case will take and probable number of witnesses; 2, preference of station for date; and 3, mention of consolidation or merger proposals.

"1. Intention to exclude all evidence such as letters, petitions, etc., not sworn to, but to permit station to make an offer of these in evidence, describing them in such a way that they will not become part of the record.

"2. Intention to permit affidavits subject to right of Commission's counsel to cross-examine. Cases may be submitted on affidavits entirely.

"3. Intention, so far as possible, to present Commission's evidence against a particular station as each case is heard.

"4. Intention to hear evidence on engineering facts applicable to all cases, to be offered in behalf of the Commission, promptly.

"5 At conclusion of call of docket, calendar will be made up showing dates of hearings. It may be possible to hear one or two today and emergency cases will be given right of way.

"6. As to stations not appearing on requesting a hearing, an order in nature of a default will be entered, precluding them from presenting any evidence in their behalf."

Mergers Announced

A roll call of the stations involved in the Commission's general order was had, to ascertain those present; the time that would be required to present arguments; the date preferred; and consolidations with other stations contemplated, if any. Chairman Robinson stated that a docket of hearings will be drawn up with the Commission adhering to the requests of stations as to date and time allotments as far as is possible.

Several of the stations announced their intention of effecting consolidations, while others announced that they would vigorously oppose the order of the Commission to exclude them from air.

Mr. Thomas filed with the Commission a brief in behalf of the Debs Memorial Radio Fund, which he made public. The brief, which he filed jointly with August Gerber, secretary of the fund, raised the issue of free speech as follows:

"If WEVD is taken off the air and in fact is not treated on a parity with others who are richer and more influential with the government, the people of this nation can truly recognize the radio, which might be such a splendid force for the honest clash of ideas, is nothing but a tool to be used by the powerful against any form of disagreement or any species of protest."

Raises Americanism Issue

He stated that WEVD asked for no special privilege.

"Give us the power and the time and the advantageous wavelengths that have been bestowed on these great and mighty money-making interests," the brief read. "To destroy us is unthinkable and un-American."

General Counsel Caldwell opened the afternoon session with the announcement of the docket of the hearings. He named 16 stations that would be heard first, because they requested only short periods of time ranging from 5 to 30 minutes.

Mr. Caldwell also explained that general engineering evidence would be heard, such as the number of channels available for broadcasting, and the number of stations that may safely operate simultaneously in one geographical district. Other technical phases of broadcasting also will be considered. It is not the intention of the Commission to go into these technical discussions at great length, Mr. Caldwell said.

Channel Opportunities Unknown

Ernest R. Richmann, counsel for the Independent Broadcasters' Association of Chicago, asked of the Commission whether there was any possibility of informing representatives of the named stations at any early date the number of wavelengths that will be available for the existing stations. He said that he understood this information would not be available until after the hearing of the 107 stations had been concluded.

Chairman Robinson replied that it was not practicable to make this information public at this time. He said that the Commission's action was not against the small stations, and that "whatever is done will be done fairly, squarely, and open and above-board."

The first station to offer argument against the exclusion order was WGDM of Stockton, Calif. E. F. Peffer, on behalf of the station, said that it served 85,000 people, and that no other stations were available in that area.

Offering documentary evidence in the form of petitions signed by listeners, Mr. Peffer was not privileged to insert it in the record because it was not sworn to. This objection was made by General Counsel Caldwell in line with the prescribed procedure outlined at the outset of the hearing.

Mr. Gerber, on behalf of WEVD, then began presentation of the case for retention on the air of his station. He said that the Commission had failed, when it licensed this station, to give it adequate power, and favorable wavelength assignment to serve the number of people the Commission deemed requisite to warrant its retention on the air.

Fights Back

He emphasized several points in asking that the stations should not be deleted as follows:

"The burden of proving the necessity of the cancellation of the permit rests upon the Commission; and the proof should be clean and overwhelming before the Commission should act.

"To reproach WEVD for not having a more extensive audience is equivalent to reproaching the Radio Commission for failing to provide its own licensee with adequate power, time and wavelength,

"WEVD should be given a preferential position among radio licensees because it is not operating for the purpose of profit."

Cites 20,000 Telegrams

Mr. Gerber stated that many thousands of persons have endorsed WEVD, and that 20,000 telegrams had been received, endorsing the station.

Mr. Gerber, in closing, asked for sufficient power, time and wavelength, to "cope with our problem." He said that this should follow the formal petition presented to permit the station to continue to operate.

Norman Thomas also took the stand and gave testimony to confirm the statement of Mr. Gerber, that WEVD was not being used to further Mr. Thomas' political aspirations.

Outlaw Broadcasts of Scandal Probed

Washington

Upon receipt of reports that an "outlaw" radio broadcaster, who has adopted the call letters of "Station PDQ" was interrupting programs in the vicinity of Crooksville, Ohio, and disseminating "town scandal," W. D. Terrell, Chief, Radio Division, Department of Commerce, announced that S. W. Edwards, Radio Supervisor at Detroit, had been ordered to trace the law violator.

Operation of a broadcasting station without a license is a specific violation of the law, Mr. Terrell said. The penalty under Section 33 of the Radio Act, he said, is a minimum of $5,000 fine for each count, and a prison sentence may be imposed.

Fan and Trade Problems In the British Field

Washington

The sale of American radio merchandise in Great Britain, particularly of tube receiving sets is hampered by the fact that the Marconi Wireless Telegraph Company owns and controls practically every type of valve (tube) set manufactured, according to a statement by Hugh D. Butler, just made public by the Department of Commerce. Mr. Butler is Assistant Commercial Attache in London.

First-class American five-tube receivers can be laid down complete in the British market for £9 (about $45), Mr. Butler points out. The patent royalties of 12s and 6d for each tube in such set would add another £3 to this cost.

Thus it can be seen, he says, what a large factor the patent royalties constitute in the sale of sets, of British or American make, in this market. British manufacturers are required to obtain a license from the Marconi company.

Full Text of Summary

Certain makes, such as Neutrodyne sets, are sold in increasing quantities, the statement points out, but the chief interest from the American point of view, is in components and accessories.

The full text of the Department's summary of Mr. Butler's statement follows:

On January 1, 1927, formed by royal charter, the British Broadcasting Corporation came into being. Its policy is controlled by the Government, and its board of seven governors are appointed by the Crown. Under a 10 years' license, the new corporation is granted a monopoly to carry on all broadcasting in Great Britain.

There are 20 stations in Great Britain, 10 broadcasting and 10 relaying; the single station in London (2LO) operates on a 366 meter wavelength. Sets tuned for 200 to 600 meter wavelength will receive most of the European stations.

Some Get Daventry

They will not, however, be able to pick up the high-power English station at Daventry, 1,609-meter wavelength which provides alternate programs to the local stations throughout the British Isles, but will be within the range of the Daventry junior station with its 480-meter wavelength.

Certain American receiving sets which have come into the market have been specially adjusted to receive the programs from Daventry station as well as those from the other stations, and this has been a popular feature of their construction.

On August 31, 1927, there were in Great Britain and Northern Ireland, 2,316,433 licenses issued to listeners-in, at an annual charge of 10 shillings each. Most of this revenue, which is collected by the post office, is placed in the hands of the broadcasting corporation to meet the expenses of broadcasting, etc.

Tube Popularity Grows

Of these licensed listeners-in, it is estimated that in 1925, 70 per cent were crystal-set users, but by 1927 the popular sale of tube sets had rapidly increased, until at the present time nearly half of the receivers are thought to be of valve construction.

Similarly, two years ago there was a large proportion of experimenters among the licensed listeners-in—a number sometimes estimated as high as 100,000—a development stimulated by the heavy royalty charges on the manufacture of valve sets. But the experimenters' enthusiasm has declined, so that probably there are not more than 50,000 in the country today.

The interest in broadcasting has grown quite rapidly in Great Britain, but the expansion of the market for sets and accessories has been retarded by several factors.

Four Factors

First, there has been a steady decline in the buying power of the population in certain individual areas, particularly during the last 18 months;

Second, the broadcasting policy pursued has favored crystal-set users and has not promoted the sale of valve sets as rapidly as in the United States, where each large city has a number of broadcasting stations;

Third, the recent short-lived compact organization of the trade—manufacturers, wholesalers and retailers— into one organization; and

Fourth, the patent controversy.

Each of these influences has retarded sales of radio apparatus in general and hampered the sale of American radio merchandise in the British market; and in addition, the attitude of the radio press and the import tariffs on certain parts have, in a lesser degree, had an effect, so that the import of American sets has been comparatively small. Components and accessories have continued to be of chief interest from the American point of view.

Foreign Exclusion No Success

The trade organization referred to (National Association of Radio Manufacturers and Traders) attempted to regulate prices, wholesale and retail, and to exclude foreign-made manufactured products form established trade channels. The organization encountered insurmountable difficulties and has been supplanted by the Radio Manufacturers' Association, a body functioning on similar lines to the usual manufacturers' association in this country and not making an ambitious attempt to establish price schedules or exclude foreign products.

All British manufacturers of valve sets are required to obtain a license from the Marconi Wireless Telegraph Co., as practically every type of valve set manufactured is said to involve the patents owned and controlled by that company.

License Terms

The Wireless Trader in its yearbook has but the terms of this license as follows:

Only broadcast apparatus is covered.

Every effort must be made to insure that the apparatus is used for private use only, and especially not for public entertainment or profit.

Export is not allowed.

Royalty is 12s. 6d. per valve holder.

A £50 deposit may be required.

The validity of the patents must be accepted without question.

The license is not transferable.

Valve making is not permitted.

The license is subjected to 12 months' notice.

The manufacture or sale of supersonic receivers requires a license from the Standard Telephone & Cables (Ltd.), as they hold a master patent on the supersonic principle. This same company also holds patents covering many features of the cone type loudspeaker.

Royalties Large Factor

American companies importing tube receiving sets in the British market have had varying experiences with regard to the patents. In most cases this obstacle has been the important one in preventing the sale of American sets here, but certain makes, such as Neutrodyne sets, are being sold in increasing quantities.

The small market which has been developed for American radio receiving sets in Great Britain may be judged by the export figures, which amounted to $55,375 in 1926. Radio tubes exported to this country in the same year amounted to $34,089.

First-class American five-tube receivers can be laid down in the British market for £9 complete. The patent royalties of 12s. 6d. for each tube in such set would add another £3 to this cost.

Thus it will be seen what a large factor the patent royalties constitue in the sale of sets, British or American made, in this market. Nevertheless, importers of American apparatus are of the opinion that they could sell large quantities of American-made sets, even under these circumstances, if it were not for the exclusion of American apparatus from the market because of patents.

Parts Stimulated, But Shrinking

As has already been pointed out, the market for components (parts) has been considerably enhanced by the widespread experimenting among consumers as a result of the expenses incurred by manufacturers because of Marconi royalties. This side of the Market, however, is shrinking, and it is to the large number of manufacturers, who are mainly assemblers, that components will have to make their chief appeal in the future.

In this field the cheaper articles are mainly of German manufacture, the medium priced of British make, and the more expensive articles of American make.

With the import value of American components amounting to $238,055 in 1926, this classification accounted for about half of the total exports of American radio apparatus to Great Britain.

Short Waves Popular

Condensers, resistances, coils, B battery eliminator parts, and short wave apparatus constitute the principle articles of American make sold. It is essential that new American component entering this market be carefully protected by patents, in order to prevent copy.

The radio exhibition is reserved exclusively for British-made products and is, therefore, of no value to importers of American goods in expanding their sales in this market. It is held annually in September or October. Some idea of the size of the trade is indicated by the fact that there are 5,000 wholesalers, retailers, etc., on the mailing list of one of the leading importers.

SPEED REGULATOR OF WLEX

WLEX, Lexington, Mass., is pioneering in television transmission and reception. The staff of this station is utilizing the power clarostat for controllng the scanning disk, in this manner obtaining the necessary micrometric speed control. This device, with its 40-watt rating, is satisfactory for the 1/8 horse-power motor employed

RADIO WORLD

The First and Only National Radio Weekly

Radio World's Slogan: "A radio set for every home."

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ADVERTISING RATES

General Advertising

1	Page, 7¼"x11"	462 lines	$300.00
½	Page, 7¼"x5½"	231 lines	150.00
½	Page, 3¼" D. C.	231 lines	150.00
¼	Page, 4⅛" D. C.	115 lines	75.00
⅛	Page, 4⅛" S. C.	57 lines	37.50
1	Column, 2¼"x11"	145 lines	100.00
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CLASSIFIED ADVERTISEMENTS

Ten cents per word. Minimum 10 words. Cash with order. Business Opportunities, 10 cents per word. $1.00 minimum.

Entered as second-class matter March 23, 1922, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

Sure In Hard Luck

Washington

Poor reception is declared the cause of poor radio sales in Malay Peninsula in spite of greater interest in radio by the inhabitants and campaign work by radio dealers, according to Vice Consul John H. Bruins, Singapore, in a report made public by the Department of Commerce. The full text of the report follows:

"Malaya, it is said, seems to be in a definitely 'dead' spot with high static. Practically no amateur reception is known, and the one amateur broadcasting station has been discontinued because of continuously bad atmospheric conditions.

"Malaya has two spark wireless telegraph stations, both owned by the Government. One is at Singapore, call letters VPW, five kilowatts, with a wave length of 600 to 1,900 meters; and the other at Penang with call letters VPX, five kilowatts and a wave length of 600 to 1,030 meters. Both stations communicate continuously with ships except for certain half-hour periods."

What the Other Fellow Is Doing

"Radio News" for August

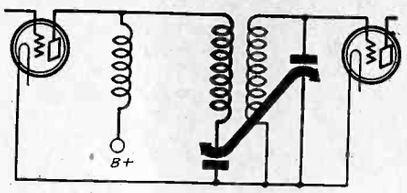


FIG. 1

FUNDAMENTAL ZERO REACTANCE CIRCUIT, WITH A TWO-SECTION CONDENSER, THE SHAFT BEING COMMON TO BOTH PLATE AND GRID RETURNS

"The Zero-Reactance Plate Circuit" is the title of a very interesting and instructive article by Sylvan Harris in the August number of "Radio News." Mr. Harris calls attention to the three possible types of load on a vacuum tube, namely, inductive, non-reactive and capacitive and discusses the behavior of a circuit with each type of load. He says:

"The first case is that of an *inductive* load—exactly the kind of load we always have in radio-frequency amplifiers. The primary of the radio-frequency transformer, aided by the effect of the secondary *via* the coupling, furnishes an inductance in the plate circuit. As a result the tube is caused to regenerate by virtue of this inductive plate load.

"The second case is that in which there is no reactance at all in the plate circuits of the tubes. In this case there is no regeneration—the tube circuits *neither furnish nor absorb power* — and consequently the plate-circuit load produces no effect on the amplification, except so far as the voltage step-up in the RF transformer is concerned. This case is the subject of this article, so we will leave further details until later on.

Condenser Does Trick

"The third case—that in which the load is the plate circuit is *capacitive*—is of no particular interest this time, as the effect of such a load is not merely that it does not add to the amplification, but that it actually causes the circuits to *absorb power*."

Mr. Harris reduces the inductive reactance of the primary of the RF coupling transformer by connecting a condenser in series with it. He then makes the primary inductance equal to the secondary inductance and couples the two coils very closely so that the mutual inductance is as high as possible.

He shows that the effective or apparent inductances of the primary and the secondary are L1—M and L2—M, respectively, where M is the mutual inductance between them. These apparent inductances are made equal so that they can be tuned simultaneously by two equal condensers mounted on the same shaft. Thus the two tuned circuits are always tuned to the same frequency and the load is always non- reactive. As long as this condition exists there can be no regeneration, unlike when the load is inductive, and no reverse feedback, unlike when the load is capacitive.

Amplification Not Stated

The article is illustrated with several diagrams showing the method of obtaining zero-reactance in the plate circuits and how to gang the condensers for single control. The diagram of a complete receiver comprising six tubes and seven tuning condensers all controlled by the same knob.

While Mr. Harris shows how to obtain zero-reactance coupling between stages and stability in the circuit, he does not show what amplification may be obtained per stage with this system. It would seem that voltage gain per stage is not so high as it is with some other types of coupling.

Fig. 1 shows the method of coupling and the connections of the tuning condensers.

Other Articles

"A Visit to 'Radio Central'," an illustrated article by Robert Hertzberg, describes in detail the operation of the Radio Corporation of America's station at Rocky Point, Long Island, and gives an insight into the operation of the beam systems of communication with foreign countries.

Orrin E. Dunlap, Jr., answers the question "Radio Advertising, Does It Pay?" in the affirmative.

"Radio Movies and Television for the Home" gives a detailed account of C. Francis Jenkins' system of broadcasting movies by radio. It is illustrated with photographs and line drawings of both the transmitter and the receiver which show the principles involved in the system and how they are supplied in practice.

"Why the Weather Affects Radio Reception" is an article by B. Francis Dashiell, member of the American Meteorological Society, in which the causes of various kinds of static and fading are discussed.

"A Screen-Grid Short-Wave Receiver," by Fred H. Canfield, is a constructional article. The Circuit is a three-tube receiver of sound design in which sensitivity is obtained by the use of a screen grid amplifier and a regenerative detector.

Kennedy Radio Chief in Yacht Race

J. E. Kenndey, formerly chief-engineer of WEBJ, which voluntarily went off the air, sailed Saturday on the yacht Guinevre in the international cup race to Santander, Spain. He was chief-engineer of the radio installation. The yacht is owned by Edgar Palmer, zinc manufacturer, and the race was for a gold cup donated by King Alphonso of Spain.

Mr. Kennedy, is one of the old guard in radio, having filled responsible positions in many branches, also directing installations in many broadcasting stations. Just before sailing he was encountered in the store of Blan, the radio man, 89 Cortlandt Street, New York City, brushing up his French, Spanish and German with that master linguist, and incidentally, ordering a long list of radio parts and supplies for the cruise.—J. H. C.

The Radio Trade

Baldwin at the Helm as Receivership Ends

The Bankers Trust Company, receiver for National Baldwin, Inc., has returned the huge radio plant at Salt Lake City to the management and control of the original organizer, Nathaniel Baldwin. Although wealthy today, Mr. Baldwin started out as a poor boy, working nights to pay for his education.

At twenty-two he was an instructor in the Brigham Young University at Provo City, Utah. After several years of teaching, he had a serious disagreement with the governing board of the university and soon thereafter found himself without a job.

Since teaching positions were scarce at the time, young Baldwin got a job in a power house and between intervals of starting and stopping the engines he thought of ways and means to make his fortune. He started experimenting with telephone receivers and finally evolved the Baldwin mica-diaphragm phone unit, which eventually made him famous.

Starting to manufacture his phones in a small shack, he expanded by leaps and bounds, until it occupied an enormous plant. Reverses were experienced about two and one-half years ago, however, and the company was forced into the hands of receivers. Increased demand for the units and phones enabled all debts to be cleared up.

J. W. & W. L. Woolf, 227 Fulton Street, New York City, have been reappointed as Eastern representatives and export agents for the Baldwin company, having acted in this capacity for the past five years. The Baldwin company will shortly announce a new and more powerful loudspeaker unit based on an interesting principle.

Fiske Proves Valuable Sales Agent to CeCo

Edward R. Fiske has been assistant general sales manager of the CeCo Manufacturing Company, Inc., for the past two years, directly under H. H. Steinle, general sales manager.

Prior to connecting with CeCo Mr. Fiske was eastern sales manager for the Waage Electric Company of Chicago, manufacturers of heating appliances and B eliminators. Mr. Fiske had offices in New York City out of which he travelled six men covering the entire Eastern half of the country.

From shortly after the war up until going with the Waage Electric Company he was identified with the John Wanamaker Department Store, New York, as buyer for the radio department.

During the war Mr. Fiske was on active duty in the Radio Communication Division of the U. S. Navy and served overseas on the transport Pocahontas and battleship Mississippi. He was graduated from the Radio Institute at Harvard when it was under supervision of the U. S. N.

In all, his varied experience in radio covers a period of more than eleven and a half years.

REALLY NEW PRODUCTS

Versatile Features In Eby's Tip Jack

The H. H. Eby Manufacturing Co., 4710 Stenton Ave., Philadelphia, Pa., has announced the manufacture of a new tip jack suitable for use on metal as well as on insulated baseboards and panels. The new tip jack is made with countersunk head to afford special support to the shank of the cord tip and to provide greater rigidity when the tip is plugged into the jack.

This countersunk feature also makes it easier to insert the tip. Double spring contact is provided to counteract small differences in the diameter of cord tips and to provide firmer and more positive contact.

Each tip jack is equipped with two special insulating washers permitting use of the tip jacks on metal baseboards and panels. One of the top washers is red and the other is black to make identification in the circuit easy.

The tip jack is mechanically strong. It lends itself to a variety of applications, including plug-in coils for short waves.

Saftler Appointed as Mack is Promoted

Perry Saftler is now sole representative for Acme Apparatus Company, of Cambridge, Mass., known the world over under the slogan of "Acme for Amplification" and known also for the manufacture of quality products since the inception of radio. Mr. Saftler will carry on also the business of Pearcy W. Mack, Inc. Headquarters will be maintained at 122 Greenwich Street, New York City. He will cover the Metropolitan and adjacent territory.

Mr. Saftler is well-known and liked by the entire trade and is on the job with the Acme Voltage Regulator and the new Acme B and C eliminator and promises some new and wonderful Acme apparatus for the Fall. He also handles the new Shamrock AC set. Mr. Mack has been made general sales manager of Acme, working out of Cambridge, his territory being the whole United States. If a radio man were ever selected as a Presidential candidate, Mr. Mack would be the man! Full information on the Shamrock set may be had by writing to Perry Saftler at the address above. Mention RADIO WORLD. —J. H. C.

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufacturers, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank below may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.

I desire to receive radio literature.

Name .....

Address .....

City or town .....

State .....

G. M. C. Electric Co., 113 N. Main St., Eureka, Kansas.
J. A. DeFonso, 624 Reynolds St., New Castle, Pa.
A. G. Diro, 4204 Florida Ave., Cincinnati, Ohio.
W. D. Williams, 0167 65th St., Milwaukee, Wisconsin.
Paul Rosenberg, 725 E. 3rd St., Lima, Ohio.
E. Ruth, 23 Munro St., Toronto, Ontario, Canada.
Fred M. Spencer, 160 N. E. 19th Terrace, Miami, Florida.
W. F. Watley, 438 Randolph St., Portsmouth, Virginia.
William Brien, 81 Oneida, Cohoes, New York.
P. R. McCully, 1148 Portland St., Pittsburgh, Pennsylvania.
G. J. Harrison, 285 Broadway, Chicopee Falls, Massachusetts.
Exide Battery Station, Schuyler, Nebraska.
Chas. W. Golden, care Ideal Radio, 4709 Calvert St., Okaley, Cincinnati, Ohio.
R. Barker, 214 Parkside Ave., Brooklyn, N. Y.
Walter A. Bachman, 45½ Sherman St., Albany, N. Y.
Wm. E. Conrad, 621 S. River Ave., Sunbury, Pa.
L. E. Suck, 508 West 34th St., Austin, Texas.
Elza E. Beck, Box No. 148, Mt. Ayr, Iowa.
Alfred Roberts, 123 S. Richland, York Pa.
Arthur Helander, 7054 Winchester Ave., Chicago, Ill.
Fred Roach, 3034 3rd Ave., New York City.
R. Robitaille, 193 Des Fossees, Quebec, P.Q., Canada.
Leonard Caughron, c/o J. M. King & Co., Franklin, Tennessee.
T. B. Muskett, Carpinteria, Calif.
E. T. Richey, Le Blanc, Louisiana.
C. E. Brause, Box 632 Lake Worth, Florida.
Lawrence Gerry, 696 Flushing Ave., Brooklyn,
Ernest B. Way, 314 Main St., Telford, Pennsylvania.
D. S. Nash, Box 193, Geneva, Alabama.
Dr. J. D. Butler, 55 Main St., Danville, Va.
Ira A. Ludwick, Nokomis, Illinois.
S. F. Lively, 106 Walnut St., Covington, Va.
N. Y.
B. G. Starkweather, 334 S. Main Street, Ottawa, Kansas.
Wm. T. Jelliffe, 1765 G. N. Bronson Ave., Hollywood, California.
ham, Ala.

Edison and Splitdorf Join to Make Sets

Thomas A. Edison, Inc., and the Splitdorf Co. have formed an association for the manufacture and merchandising of electric radio receivers and electric phonographs. The company will operate under the combined patents of Splitdorf and Edison and under licenses of Radio Corporation of America and its allied companies.

Charles A. Edison, son of Thomas, will become a member of the board of directors of the Splitdorf-Bethlehem Electrical Co., and Walter Rautenstrauch, president of the Splitdorf Company, will become associated with the Edison Company as consulting engineer.

NEW CORPORATIONS

Telvision Publishing Co., Attys., Boynage & Barker, 115 Broadway, New York City.

Greater Hudson Radio and Electric Corp., Rensselaer, New York—Atty., E. A. Tennant, Albany, N. YY.

Pan Mac, Radio Apparatus—Attys., Talley & Lamb, 165 Broadway, New York.

NEXT WEEK—One stage of audio works speaker. Total of three tubes in an efficient receiver.

Hungarian's Pinholes Give Speedy Scanning

Berlin,

Denes von Mihaly, a Hungarian engineer engaged in television research work in Berlin, believes that the major problem of transmitting vision by electricity has now been solved.

Von Mihaly employs a system of transmitting vision which is based on the use of a Wolfram point light at the receiver. The light emitted by this lamp responds to the current received from the television transmitter.

A scanning disc rotating at 12 revolutions per second is used for exploring the picture to be sent. This disc has a large number of pin holes arranged in a spiral so that for every revolution of the disc the screen is covered by 150,000 points of light. Identical discs are used for scanning the picture to be sent and for distributing the light values received on the viewing screen.

Experiments have shown that the received pictures are exceptionally clear and distinct. Photo-electric cells are used for converting the light values of the transmitted picture into equivalent electrical currents.

WGY Television Schedule

WGY of the General Electric Company is maintaining a regular schedule of television broadcasting. The transmission is from 1:30 to 2 p. m. on Tuesday, Thursday and Friday, and from 10:15 to 10:30 Sunday. At present 24 scanning lines are used at a speed of 20 repetitions per second.

The transmission is on the regular wave of WGY of 379.5 meters, or 790 kc. The signals are also transmitted on the 31.4 meter wave of 2XAF.

Forty Ask Short Wave Television Licenses

Washington

Forty applications for low wave assignments for television have been received by the Federal Radio Commission. Only eighteen channels were provided for this work by the International Radio Convention held in Washington. The applications have been called on to show what "public interest, convenience and necessity" they will serve if granted assignments.

The Commission has already conferred with engineers about the bands specified by the International Radio Convention for high frequency broadcasting, relay and television.

The frequency bands from which assignments may be made, together with approximate distances for each, are:

Frequency K.C.	*Wavelength Meters*	*Range Miles Day*	*Night*
6,000-6,150	50-48.8	500	4,000
9,500-9,600	31.6-31.57	1,200	5,000
11,700-11,900	25.6-25.1	2,500	5,000
15,100-15,300	19.9-19.5	2,500	5,000
17,750-17,800	16.9-16.85	3,000	6,000
21,450-21,550	14.0-13.94	4,000	7,000

Engineers have suggested that stations for television experimental development be licensed between 4,500 and 5,000 kc, on five channels each 100 kc wide, to be assigned to each zone for night work and all five channels to each zone for day work. They also suggested that due to the shortage of available channels only the more important applications be considered and that the basis for consideration be as follows:

(1.)—Overseas and international relay broadcasting.

(2.)—Long distance broadcasting beyond reliable distance range of national networks in the broadcast band.

(3.)—Television and experimental work.

(4.)—National relay broadcasting (within the United States).

PHASE SHIFT FOR REGULATION

An ingenious method of automatic compensation for line voltage variations, based on obtaining a phase shift between the primary voltages of two transformers connected in series, one of the transformers to perform as a capacitive reactance and the other as a straight inductive reactance, has resulted from extensive research work on power unit design conducted in the Raytheon Laboratories.

The practical results of these research efforts are now published in Raytheon Technical Bulletin Vol. 1. No. 2, under the title of "Constant Potential Regulator", by D. E. Replogle. Copies of this bulletin may be obtained free by addressing Raytheon Co., Cambridge, Mass. Mention RADIO WORLD.

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

10 cents a word — 10 words minimum — Cash with Order

EVERY FRIDAY at 5:40 P. M. (Eastern Daylight Time) **Herman Bernard, managing editor of Radio World,** broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics, mostly television.

BLUEPRINTS of National Screen Grid Five, 4-tube Screen Grid Diamond and Karas 3-tube Short Wave Set—three blueprints—one dollar. Guaranty Radio Goods Co., 145 W. 45th St., N. Y. C.

KARAS SHORT WAVE SET, three tubes, 13 to 750 meters, described in the March 31, April 7, 14, 21 and 28 issues. Send 60 cents for these five issues and get blueprint free. RADIO WORLD, 145 W. 45th St., N. Y. City.

What Television Offers Now and Promises Later

By Hugo Gernsback

Editor, "Radio News"

"What will we be able to see?" is the question that is most frequently asked. Frankly, not a great deal. We shall be satisfied if it is possible to see clearly silhouettes, letters, designs, diagrams, large print and so forth; that is, with television broadcast over the usual broadcast channels. Here, for the present, we must be satisfied with rather coarse and indistinct details at the receiving side; although a number of broadcasters will probably broadcast television on short waves, where the details will have greater clearness, due to the wider frequency channels available.

Like all arts, television must first pass through a preliminary stage, and from the experience we gain during the first few months, better and better transmission may be expected.

The Early Days

We all remember the time when "wireless" first arrived, and when, prior to 1920, all we could get in our head receivers was dots and dashes—and these not always clear—rather than actual voices and music now known as broadcasting. It will be so with television; so don't expect too much, and you won't be disappointed. In my opinion, it will be quite marvelous if, on your television receiver, you will be able to see good silhouettes, and can read large letters, broadcast from the studio.

And don't expect simultaneous transmission of voice and television. That, at the present stage of the art, is not possible. The procedure will run somewhat like this:

The studio announcer will say, "Now we shall televise such and such an object." It will take one or two minutes to show

(*Continued on next page*)

Do not expect much of television for some time to come. At the present time, there is feverish activity by many firms, large and small, to put television receivers on the market.

WGY of Schenectady may be called the pioneer television broadcaster, as it started to broadcast television some time in May of this year. WRNY began broadcasting television in June.

Let Radio World Follow You on Your Vacation

If you are a subscriber and are going away this summer, send us your name and change of address and we will see that the paper reaches you every week.

If you are not already a subscriber, send us one dollar and your name will be placed on our subscription list from now until Labor Day and your address will be changed as often as you desire. Such change should reach subscription office two weeks in advance of date of publication.

Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City

(*Continued from preceding page*)

the object and then the voice or sounds from the studio will again be heard in your receiver In between announcements you will be able to pick up television on your television receiver; but you can't get both together until an entirely new invention is made, which, to my knowledge, is not as yet in sight. It may, however, come along any time.

Revolving Disc Used

At the receiving end, we have a revolving disc, which is usually made of aluminum, about 14 to 24 inches in diameter, and through it a number of holes. Directly behind the holes is a neon lamp, which is attached to your ordinary radio receiver. If necessary, the impulses coming through your radio broadcast receiver may be amplified in order to make the light of the neon lamp bright enough for receiving purposes.

The aluminum disc is rotated by means of a motor, and your television receiver will have a rheostat in series with the field of the machine By adjusting this rheostat, you will be able to keep the rotation of your disc in step with that of the transmitter at the distant station. Through the holes, a "virtual" picture is built up, and thus you see what is shown at the broadcast studio.

This, at best, is a more or less crude way of doing things, and will not prevail in the future. It may be stated that the use of the present revolving disc at both the transmitter and receiver corresponds to the coherer-and -spark-gap stage of the old days of "wireless."

A Prophecy

The ideal television receiver of the future will have no moving parts at all. There will be no motor, or if there is one, there certainly won't be a large disc such as we have now. What we probably will have is some sort of a cathode tube, in which a weightless electron beam will rotate in an induced magnetic field. It will be much easier to keep such a device as this in synchronism, and there is no doubt that the built-up picture thus produced at the receiving end will be far superior to what we have today.

The question that is asked frequently about present-day devices is, "How big is the received picture that you see?" As a rule, it is not large. This depends upon the diameter of the disc and the size of the plates of the neon tube.

Usually, the picture is about two to three inches high, and from one and one-half to two inches wide. It is possible to enlarge this picture by means of a lens, and thus get a larger image; but so far experiments along these lines have not been very fruitful, because the picture becomes coarse and loses its luminosity as well.

Must Wait

As for televising the artists in the studio (that is, showing the radio audience what the artists look like), it seems quite a few months in the future; or, if they are shown at the present time, it will be most difficult to distinguish a man from a woman.

These remarks are meant to apply only when the impulses are broadcast over the present broadcast band of wavelengths, that is, between 200 and 550 meters, and kept within the 5,000-cycle limit under which broadcasters operate. On the short-wave channels, as I said before, details are usually much clearer.

From the above, it should be understood that such a thing as televising in detail a moving object in the studio (for instance, a pianist playing) will not be possible for quite awhile to come. Anything in motion will be extremely difficult to receive and see well, with any kind of detail.

Start Has Been Made

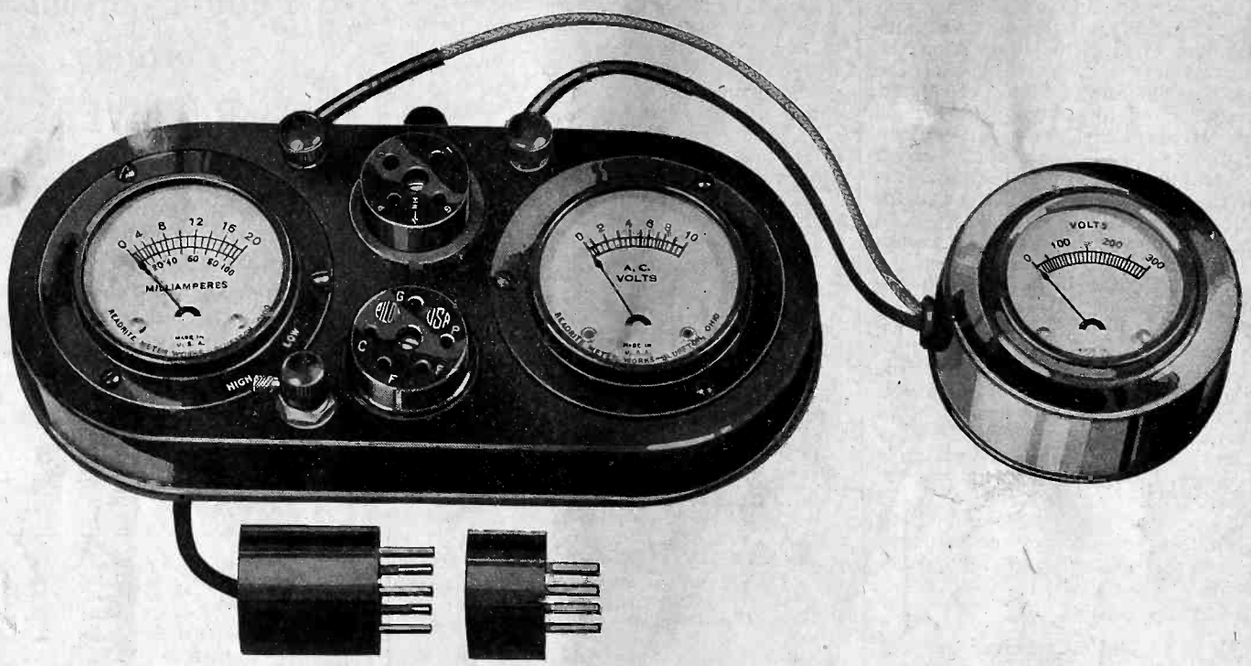
But the important point is that a start has been made, and that the public is interested. That is what counts. If enough people work on the new art, progress will no doubt be made quickly. I predict that, within one year, such tremendous strides will have been made in television that it will be possible actually to see what is going on in a distant studio.

But the broadcasting of such events as a ball game or a boxing match would seem at the present time, to be distant anywhere from two to five years; at least, until such time as an entirely new television device will have been invented. That is, as I said before not as yet in sight.

Next week—Three-tube set that works. Speaker with only one audio stage; The Tube Regiment Reviewed by Jas. H. Carroll.

12 VITAL TESTS

In Only 4½ Minutes!



The Handsome Outfit, Shown One-Half Scale

With this Scientific Trouble Shooting Combination AC and DC Tester (at left) and the high resistance voltmeter (at right) twelve vital tests were made of tubes and receivers, in 4½ minutes, because the combination can be used quickly for the following purposes:

(1) to measure the filament voltage, up to 10 volts, of AC and DC tubes.

(2) to measure the plate current of any one tube, including any power tube, from less than 1 milliampere up to 100 milliamperes;

(3) to measure the total plate current of a receiver or amplifier, up to 100 milliamperes. (Hardly any set draws more). Open common A and B of set and connect to P of tester socket and to P prong under adapter plug;

(4) to measure the B voltage applied to the plate of tube; the voltage across B batteries or B eliminators, up to 300 volts.

(5) To determine the condition of a tube, by use of the grid bias switch.

(6) To measure any tube's electronic emission (tester cuts in at no load, hence plate current equals filament emission).

(7) To regulate AC line, with the aid of a power rheostat, using a 27 tube as guide, turning rheostat until filament voltage is 2.5 or 2.25 volts.

(8) To test continuity of resistors, windings of chokes, transformers and circuits generally.

(9) To find shorts in bypass and other condensers, as well as in inductances, resistors and circuits generally.

(10) To read grid bias voltages, including those obtained through drops in resistors (bias read by noting plate current and voltage and consulting chart).

(11) to determine the presence of distortion and overloading, by noting if milliammeter needle fluctuates.

(12) to determine starting and stopping of oscillation, as milliammeter needle reads higher current for oscillation and lower for no oscillation.

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