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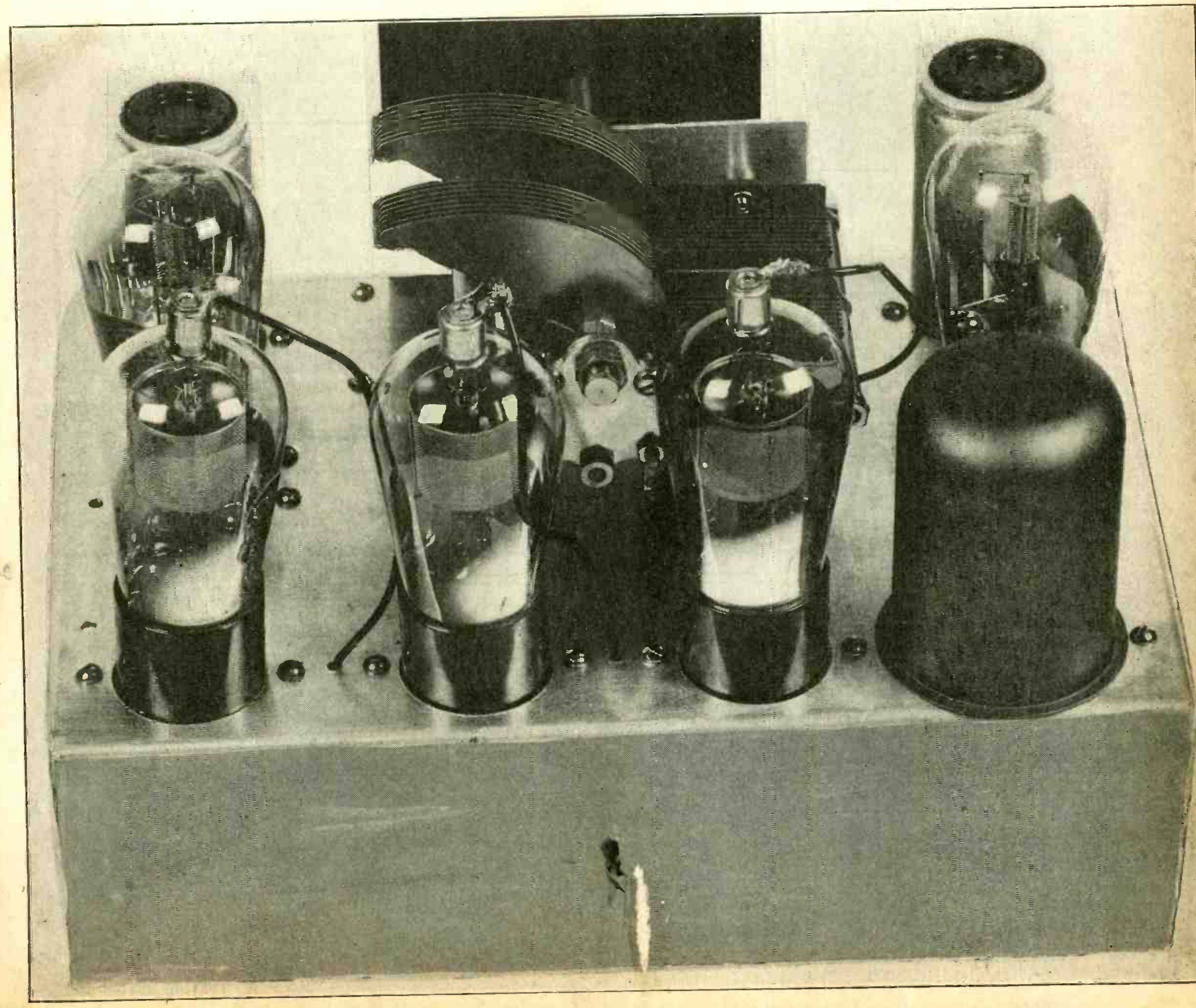
The First and Only National Radio Weekly
474th Consecutive Issue—TENTH YEAR

PENTODE AMPLIFIER

PICTURE DIAGRAM
OF
DX-4 CONVERTER

A SHORT-WAVE TUNER

See pages 3, 4 and 5



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A Short-Wave Tuner

By Herman Bernard

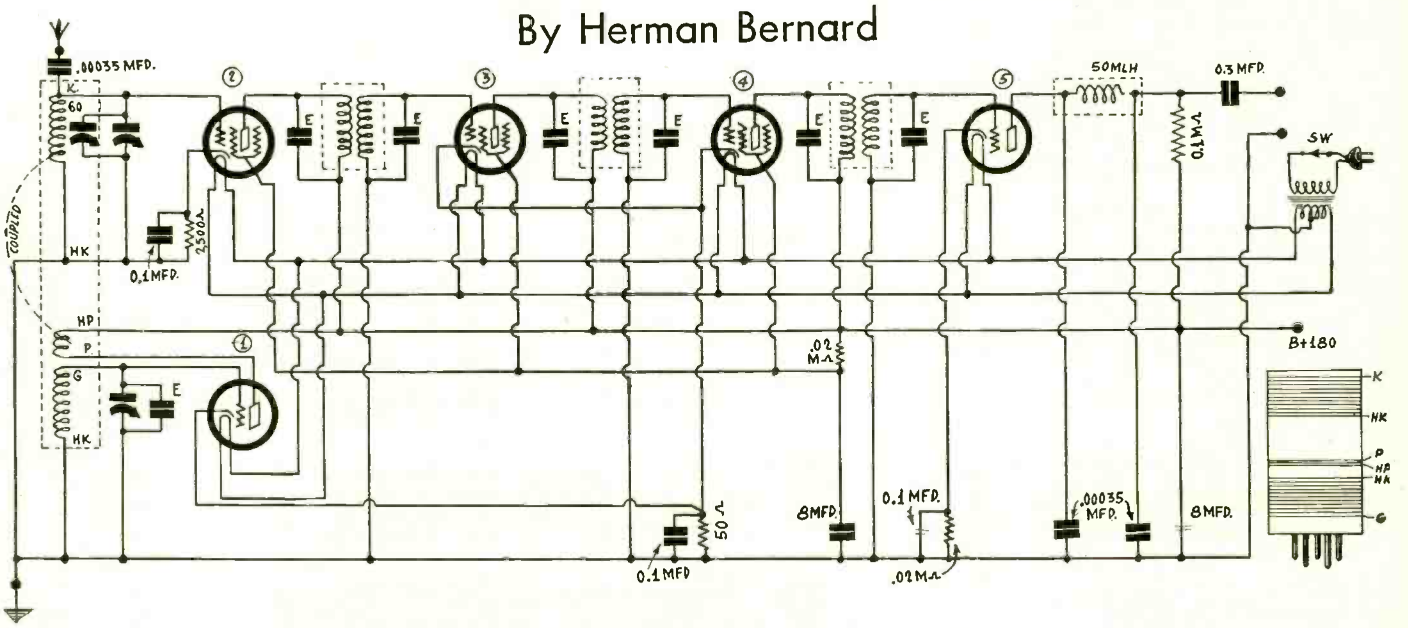


Fig. 1

A highly sensitive and selective short-wave tuner, 20,000 kc to 1,700 kc. The data on plug-in coil connections are shown at right

A TUNER for bringing in short waves, as diagrammed in Fig. 1, permits earphone reception at the output posts, or loudspeaker reception if the lead from the plate of the output tube is connected to the plate prong of the detector socket of a broadcast receiver, from which socket the set's detector tube has been removed, or to a power amplifier. In fact, if your set uses screen grid and 227 tubes, you may remove these tubes and insert them in the tuner, as the device diagrammed in a radio frequency amplifier and detector, and substitutes for the amplifier and detector in a broadcast set, to insure short-wave reception.

A large number of radioists have installations that include a broadcast tuner and a power amplifier, and for them, too, the short-wave tuner is highly serviceable.

Three's a Crowd

The sensitivity developed from a design such as this is so great that extra-special precautions have to be taken against squealing at the intermediate level. It will be seen there are an oscillator (1) and a modulator (2), and that the output of the modulator is delivered to a two-stage intermediate channel.

In theorizing on an intermediate channel, the temptation is to add one stage or two stages more, but when the theory is reduced to practice, the aim being to provide stable amplification at any frequency around 1,600 kc or higher, only two stages will remain. Extra stages prove to be dampers instead of gainful amplifiers, a condition not unfamiliar to set builders.

This is no apology for a mere two-stage channel at this intermediate frequency, but a declaration of the inadvisability or futility of using more than two stages. Of course, two stages require three intermediate transformers, because one transformer is needed to couple to the detector.

(*Continued on next page*)

LIST OF PARTS

Coils

Four shielded plug-in coils
Three shielded 1,600 kc. transformers with tuned primary and secondary
On 50 millihenry shielded RF choke
One 2½-volt center-tapped filament transformer (10 ampere capacity)

Condensers

Two 100 mmfd. Hammarlund equalizing condensers (E) (six are in the transformers)
One 60 mmfd. variable condenser
One two-gang straight frequency line .0003 mfd. condenser, with bracket
Two condenser blocks, three 0.1 mfd. condensers in each block
Three .00035 mfd. fixed condensers
Two 8 mfd. electrolytic condensers with brackets

Resistors

One 2,500 ohm Electrad flexible biasing resistor
One 50 ohm Electrad flexible biasing resistor
Two .02 meg. (20,000 ohm) pigtail resistors
One 0.1 meg. (100,000 ohm) pigtail resistor

Other Parts

One metal chassis with socket holes punched
Five UY sockets
One AC cable with plug
One National velvet vernier dial
One front panel
Three grid clips
Four binding posts, with three sets of insulating washers
One AC shaft type switch
Two knobs

How High Sensitivity Is

Shielding of Intermediate Transform

Fig. 2
Appearance of the shielded intermediate frequency transformer, with socket affixed to the screw cap

(*Continued from preceding page*)

One of the experiments conducted was to use the circuit without shielding. At first transformers were built, consisting of dowel sticks of ⅜-inch diameter, 1½ inches high, and placed parallel, 1 inch apart, transformers 2½ inches apart. No. 38 wire was wound to fill the axial length. The inductance was about 90 microhenries. Trimming condensers were connected across primary and secondary. Then wishes were expressed for enjoyable short-wave reception, although preliminary misgivings were not absent.

How the intermediate channel squealed!

Even the introduction of 2,000 ohm grid suppressors in each of the two control grid circuits, plus increase of negative bias, did not stop or diminish the squealing.

Obviously, shielding was necessary.

Aspects of Chosen Frequency

It is characteristic of an oscillating intermediate channel that noisiness arises. You can touch the high side of any of the trimming condensers with a screwdriver and hear the tap all over the room, when speaker or phones are attached to the output of the fifth tube. Oscillation at the intermediate level is one of the most usual causes of noise in short-wave receivers that use the double detection method of reception.

Experience with tuned radio frequency broadcast receivers proves abundantly that the amplication is exceedingly high at the higher frequencies of response, and here we rise to a frequency slightly higher than the highest in the broadcast band. The main reason for going outside the band is that no interference from broadcasting stations will result. The reason for using a high frequency is so that the frequency range of the short-wave tuner will not be circumscribed, and also that the independence of the tuned circuits of the mixer will be maintained. No matter how the mixer is constituted, it consists of two circuits, one always oscillating, the other usually not, and the two coupled. The degree of coupling affects the independence of the tuning of these two circuits, for when coupling is too close they tune as one circuit, hence selectivity suffers.

When Circuits Pull Together

However, if the intermediate frequency is too low, the frequency separation between the two circuits, in the mixing process, is too small to preserve the independence of tuning otherwise present, hence for frequency reasons (aside from coupling considerations) they pull together. Therefore it is not wholly practical to use a low frequency for the intermediate channel, although the system does work where only the oscillator is tuned. When you have both modulator and oscillator tuned, the intermediate frequency should be high, although one man reported reception of 9 meters with a 250 kc intermediate frequency.

The intermediate frequency should be higher than the highest broadcast frequency by the smallest practical amount, for since circuits tend to pull together when the frequencies are nearly the same, they will certainly pull together only too well when the frequency is actually the same. If a higher intermediate frequency than 1,600 kc were used, the modulator tuner itself could be tuned to the same frequency as the intermediate frequency! Then you would have resonance by the tuned radio frequency method at this frequency, but possibly no reception, as the extra stage of amplication, which the modulator would now comprise, would insure squealing.

Establishing the Intermediate Frequency

While 1,600 kc is mentioned as the desired intermediate frequency, it is not adamant. One point is that a constructor may not be able to establish 1,600 kc for a certainty, particularly as he will be adjusting trimmers to line up the intermediate channel. Exactly 1,600 kc is not imperative. One solution is to tune in 1,500 kc, using a broadcast station's carrier, introduced through antenna to the plate circuit of the modulator, and line up the intermediate channel at this frequency. Then when the entire tuner is functioning, when built as diagrammed, the trimmers may be turned one-eighth turn to the left, whereupon you will be beyond the broadcast band, and realignment can be made. The test now is to tune in a short-wave station and set the trimmers on the intermediate coils for loudest response, which can be done by a movement of less than one-eighth of a turn.

As stated, the tendency for squealing in multiple channel amplifiers using a frequency greater than the highest broadcast frequency is strong. Shielding is imperative for excellent results. The need for short leads carrying "hot" radio frequency current then gains new confirmation. Shielding plus short leads, made possible by a unique method of assembly, brings about the precious requirement of stability.

The shield consists of a round aluminum container, 2¼ inches in diameter, 2½ inches high, with a top that can be screwed off. The only object of the screw cap is to be able to mount the intermediate transformer thereon, and then have an easy method of restoring the container.

If the cap is regarded as the top (no matter in what position the shield actually is used, whether vertically or horizontally), then the bottom is drilled to take a wafer type socket, elevated enough by a bushing and a nut to prevent interference of socket springs with the shield bottom. Fig. 2 illustrates the finished assembly.

Influence of Coupling

By this method the shield is mounted on the socket serving the output tube. Usually we consider a coil in conjunction with the tube into which it works. Now we are considering a coil in conjunction with the tube out of which it works.

The reason is that one of the leads from the shield is the plate lead, and if the coil is placed directly under the socket of this tube, then the plate lead is shorter than a baby's finger. The other "hot" radio frequency lead in conjunction with this coil is for the control grid of the succeeding screen grid tube. This lead has to penetrate the chassis anyway to reach the cap of the tube, and the hole may as well be pierced in the chassis between the two sockets.

The degree of coupling between primary and secondary of the intermediate transformer also affects squealing, as in general the looser the coupling the less the squealing. If honeycomb coils are used, measured from nearest surfaces on the same axis, a ⅞-inch separation is advisable, which permits also of fitting the trimmers inside the shield.

The Double Plop

In adjusting the intermediate trimmers, if a double plop is heard, that denotes oscillation. For instance, suppose the primary of the coil feeding the detector is adjusted. Oscillation might be present over a generous part of the tuning range, but at resonance with the secondary oscillation would disappear, to return again on the other side of resonance when the adjustment is continued in the same capacity direction as before. When two or more transformers are lined up, oscillation might prevail at resonance, also. Therefore shield the coils, use short leads to and from them, and keep out of oscillation mischief.

There is one tube that must oscillate, as distinguished from the four others that must not, and that is of course the oscillator. If a tube base type of plug is used, of the five-prong UY variety, then oscillation will be present when the oscillator grid and plate coil windings are put on in the same direction,

Attained on Short-Waves

ers Essential to Establishing Stability

and the B plus and ground are the adjoining terminals. The symbols, in respect to the base coil prongs, are P for plate, HP for the heater adjoining plate, G for grid, HK for the heater adjoining cathode, and K for the cathode. These references are to prong connections on the base and do not refer to a tube, nor do the equivalent connections of the UY socket used as coil receptacle refer to tube connections, but to coil connections. For instance, K does not go to any cathode, nor does HK or HP go to any heater.

Synchronized Tuning

Fig. 1 (at right) shows the arrangement. The oscillator grid winding is put at bottom, the modulator grid winding at top, while between them is the plate winding. All are wound in the same direction. The grounded side of the modulator grid coil should adjoin the plate side of the oscillator coil.

The system permits the use of only one form for plugging in, instead of the usual two where two tuned circuits are concerned. By putting a fixed condenser in series with the aerial, a more constant condition prevails in duplicated models, so that matching of the tuned windings for synchronized tuning is simplified.

Even though a small variable condenser, 60 mmfd., is placed across the section of the main condenser tuning the modulator, coil and condenser balance must be struck, or the oscillator will greatly outrun the range of the other, except at the extremely high radio frequencies, for then the intermediate frequency is only a small percentage of the incoming signal frequency.

Shielding of the plug-in coils is desirable, particularly at the lower frequencies, to avoid any coupling of the mixer coil with the intermediate frequency coils, under conditions where the difference in frequency between them would not be very much.

Ranges Covered

With four plug-in coils a range of from about 20,000 kc to 1,700 kc can be covered, or 15 to 176.5 meters. The reason for not reaching lower frequencies, using the higher setting of the oscillator, is that 100 kc separation between modulator and intermediate tuning is about as little as the circuit will stand.

The intermediate frequency of 1,600 kc, by the way, is equal to 187.5 meters.

Biases

The modulator tube is worked as a negative bias detector, and the bias here, as in the other instances, depends on the applied B voltage. At the recommended voltage of 180 volts, the bias on the modulator is 2½ volts negative, while that on the oscillator and two intermediate amplifiers is 1 volt negative, and that on the detector second is 12 volts. The voltage drop in the .02 meg. resistor in the common screen circuits is a little less than half of the maximum B voltage.

The frequencies for tuning are so high that it is not necessary to incorporate a series condenser circuit in the oscillator as is done in similar receivers for broadcast frequency reception. The oscillator frequency range always would be greater than that of the modulator, so to compensate for the disparity, and reduce the total number of coils, which otherwise would have to be six instead of four, the trimming condenser E across the oscillator may be set to full or nearly full capacity. This reduces greatly the ratio of the condenser. Instead of 25 to 300 mmfd., a 1-to-12 ratio, which in one instance would tune in twice as great a frequency band as would the modulator, you would have 125 to 400 mmfd., or a ratio of 1-to-3.2. The modulator tuning is the limiting factor so far as frequency range is concerned.

Winding Intermediate Coils

Those who desire to wind their own coils may use the dowel type form for the intermediate frequency transformers, as it is not practical to wind the honeycomb type coil, which requires a special machine. Using ⅛ diameter bakelite, about 1½ inches long, or wooden dowels, if bakelite is not obtainable, put on as many turns of No. 38 wire as will cover the dowel from top to bottom, except for the small space to be allowed for holes for threading and anchoring the terminals. The dowels may be drilled with a No. 30 drill and tapped with a 6/32 tap at the flat ends, being mounted parallel, 1 inch apart. Holes drilled in the removable screw top of the shields, which are separately purchaseable, will permit the insertion of machine screws to hold the dowels in place. The two trimming condensers may be mounted inside, also, or, if it is handier for you, may be mounted outside. They should have a maximum capacity of 100 mmfd.

A wafer type socket should be mounted on the bottom of the shield, elevated by a bushing, so that socket springs will clear.

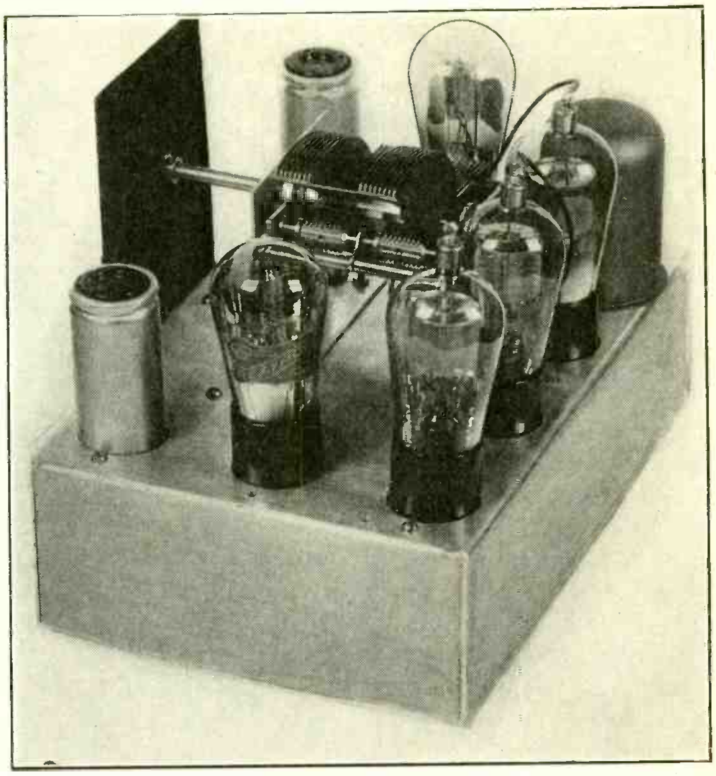


Fig. 3

View of the wired tuner. The double condenser is of straight frequency line type.

The plate lead from the coil inside connects to the plate spring of this socket, while the control grid lead, to go through the chassis, may penetrate the shield circumference. The other leads are for grounded B minus and B plus. They emerge from the bottom of the shield, near the circumference, clear of the socket.

The Plug-in Coils

To wind your own plug-in coils on any form you have, put a resistor of any value, from .02 meg. (20,000 ohms) up, from grid of modulator to ground, and connect a small condenser, 35 mmfd. or thereabouts from modulator grid to oscillator grid. After adjusting the intermediate channel on the basis of 1,500 kc response, and turning out the intermediate trimmers about one-eighth turn, put on the oscillator plate winding, of 15 turns, and then leave ½ inch separation, and put on enough wire for the oscillator grid winding to bring in 1,500 kc or thereabouts. An indication is given: for 1¼-inch diameter, or thereabouts, as applicable to tube base coils, the number of turns will be around 25, while for 1¾-inch diameter it will be around 15.

By tuning with the coil as constituted, correcting the number of turns after you have identified a station at 95 or so on the dial at a frequency around 1,700 kc, you can get another station near the opposite extreme, say 5 to 10 on the dial, and when winding the next coil, bring in this station at 95 or thereabouts, and so on until the four coils give the required range, with adequate overlapping. Fewer tickler turns will be needed on the second coil, while the number may be held constant thereafter.

About the same number of turns will serve as a guide for determining the modulator coil's winding, since a parallel capacity across the oscillator reduces the frequency from what it would be without that condenser, hence tends to level the tuning characteristics of the two circuits.

Separation of Secondaries

The separation between the two secondaries will have to be determined experimentally. If tube base forms are used, trouble will ensue unless the form is at least 2⅛ inches long. Under these conditions, wind the oscillator secondary as close as possible to the bottom and the other secondary as close as possible to the top, for the first or largest coil, with the tickler coil beginning one-eighth inch from the oscillator secondary.

A Portab

By Einar

PORTABLE receivers are in demand these days for the vacation season is rapidly approaching. Here is a superheterodyne that should meet with the approval of those who are contemplating building a small set for that trip into the country or to the seashore. It is designed around the 2-volt tubes, seven of them, so that the auxiliary equipment need not add a great deal to the weight of the receiver, and the audio frequency amplifier is resistance coupled to minimize the weight.

There are two intermediate frequency stages and three inter-

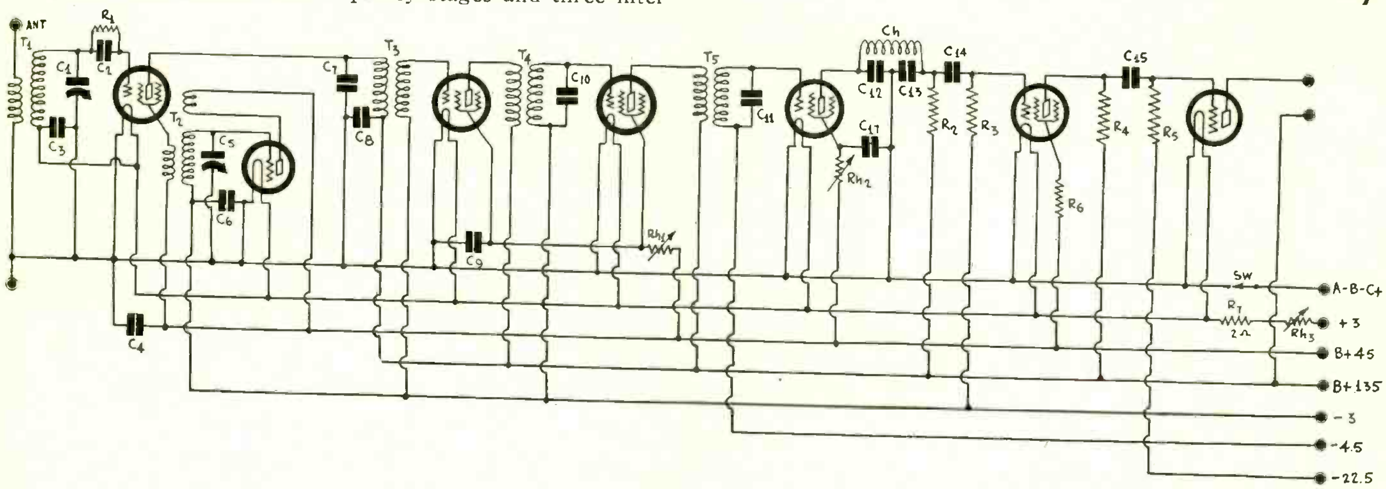


Fig. 1
The circuit diagram of a seven-tube superheterodyne utilizing the new 2-volt tubes and suitable for a portable receiver. The intermediate frequency is 15 kc.

mediate tuners. While the circuit diagram shows that only one winding of each intermediate frequency transformer is tuned, the transformers used in the construction were tuned both in the primary and the secondary. That is, there are six tuned circuits in the intermediate frequency selector and all are adjusted to 175 kc.

Construction of Intermediate Coils

The detailed construction of the intermediate frequency transformers were described in the March 28th issue and tuning curves were given in the March 21st issue. Each transformer is made of two 800 turn duolateral coils loosely coupled inductively and tuned in both the primary and secondary by 100 mmfd. Hammarlund trimmer condensers. Each transformer and the two tuning condensers are put inside an aluminum shield measuring two inches in height and 2.5 inches in diameter.

The intermediate frequency tuners are ordinarily adjusted with the aid of an oscillator, but this is not necessary for any intermediate frequency is about as good as the 175 kc. The simplest method o ftuning is to tune in a strong local station as soon as the receiver has been completed except for the IF tuning and then adjust the trimmer condensers across the intermediate frequency coils until the volume is as great as it can be made. At first set the condensers across the primaries of the three coils near minimum, that is, with the adjusting screw out almost as far as it will go. Then set the trimmers across the secondaries about half way in or a little more. This arrangement is suggested because there is usually more distributed capacity in the primary windings and if the corresponding condensers are set near maximum it may not be possible to tune the secondaries. Of course, another way is to set the trimmers across the secondaries at maximum and then open up those across the primaries until the circuits are in tune. One way is just as good as the other but the resulting intermediate frequency will not be the same in the two cases.

If it is desired to tune the intermediate amplifier to exactly 175 kc it may be done in the following manner. Set up an oscillator circuit using the same kind of transformer and condenser in that circuit. Tune in the finished receiver to 700 kc, which is WLW, Cincinnati, Ohio. Set the oscillator near the receiver and tune it until zero beat is obtained between the carrier of WLW and the oscillator. Then tune the intermediate frequency coils in the receiver for maximum signal. The beat in this case is between the fourth harmonic of the oscillator and the fundamental of WLW, both of which are 700 kc. Hence the fundamental of the oscillator is 175 kc and the intermediate tuner is also adjusted to 175 kc. It should be stated that it is hardly worth while setting up the auxiliary oscillator since any frequency to which the six tuned circuits can be adjusted is just as good as 175 kc.

Detector Output Filter

The output filter in the plate circuit of the detector is composed of one 800 turn duolateral coil Ch just like those used in the tuners and two .0005 mfd. condensers C12 and C13. It is not necessary to shield this choke if the intermediate transformers are shielded, and they shiuld be if the amplifier is to be stable.

The detector tube is a *232* screen grid tube and it operates on the negative bias principle, the bias of 4.5 volts supplied by a small battery. The detector feeds into another *232* screen grid tube through a resistance coupler consisting of a 250,000 ohm plate resistor R2, a .02 mfd. stopping condenser C14, and a 1 megohm grid leak R3. The *232* tube audio amplifier feeds into a 231 power tube through a similar resistance coupler, which consists of R4, C15 and R5. The output tube feeds directly into the louspeaker, which should be either a magnetic or an inductor.

The highest voltage available, namely, 135 volts, is applied on the plates of all the tubes, with the exception of the oscillator. This plate and all the screens are connected to the 45 volt point on the battery. Since the screen audio frequency amplifier will not function well with this high voltage on the screen, a 100,000 ohm resistor R6 is connected in the screen lead. This makes the effective screen voltage correct for distortionless amplification without cutting down the gain appreciably.

Controlling Volume

In the screen lead of the detector is a variable resistance Rh2 of 100,000 ohms which is used to alter the detecting efficiency of the tube. It may be used as a volume control although there is a 500,000 ohm variable resistance Rh1 in the common screen lead to the two intermediate amplifiers for this purpose. This is the main volume control and should be represented by a knob on the panel even if there is no such provision for Rh2.

All the filaments are connected in parallel and are actuated by a 3-volt battery. Since the total filament current is 0.49 ampere and a No. 6 dry cell should not be required to deliver more than 0.25 ampere, at least two No. 6 cells should be connected in parallel. Also, since the voltage of each cell is 1.5 and 3 volts are needed, it is necessary to connect two cells in series. Therefore four No. 6 dry cells connected in series parallel are needed to operate the receiver.

But the voltage is one volt more than is needed. Hence it is necessary to provide a ballast. This takes the form of a 2 ohm fixed resistor R7 connected in the positive lead to the battery. This normally drops 0.98 volt. A third rheostat Rh3 is also connected in the positive lead to take up any excess which may ramain or to cut the current down below normal when it is not desired to operate the tubes at full efficiency. This rheostat need not have a resistance higher than 6 ohms.

By-pass Condensers

Five by-pass condensers are shown in the circuit. Of these, C3 and C6 are used to allow grounding the rotors of the tuning condensers C1 and C5 and at the same time permit returning the grids to the proper bias voltages. Each of these should have a capacity of 0.1 mfd. C4 and C9 should also be of 0.1 mfd. They operate only at high frequencies and therefore need not be larger.

C8 serves to complete the first intermediate frequency tuned circuit, the first trimmer C7 being connected to ground to serve as by-pass for the radio frequency carrier as well as a tuning condenser. C8 also maye be a 0.1 mfd. unit.

C17 operates at audio frequency and therefore should be larger. One microfarad is sufficient in view of the fact that it

le Super

Andrews

96.2 microhenries. Since the selected intermediate frequency may be lower than 175 kc and since the actual capacity of the tuning condenser may be les sthan .0005 mfd. it is safer to make the inductance a little higher. Let us make it 110 microhenries.

If the coil be wound on 1.75 inch bakelite tubing with No. 28 enameled wire, 45 turns will be needed to give this inductance. The tickler should be wound with the same wire and should contain 30 turns. The third winding should contain 10 turns

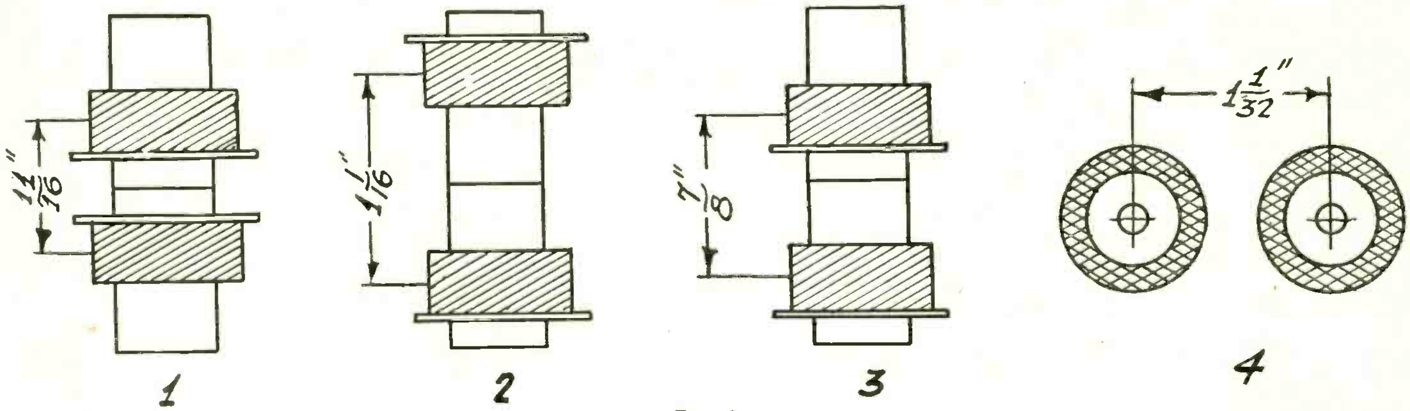


Fig. 2
Four different positions of the two duolater coils in each intermediate frequency transformer. Position (2) is recommended when both the primary and the secondary windings are to betuned, but position (3) or (4) may also be used.

is connected across a high resistance.

C2 is the usual grid condenser in the detector and should have a capacity of 0.00025 mfd. and it should be shunted by a 2 megohm grid leak R1.

Condensers C7, C10, and C11 are 100 mmfd. trimmers, which should be built into the coil assemblies. There should be three more of these although they are not shown.

The Oscillator

The oscillator is of the tuned grid type and the coil has three windings. The tuning condenser C5 should be of .0005 mfd. capacity. If this is to cover the broadcast band when the intermediate frequency is 175 kc and the higher oscillator setting only is used, the inductance of the tuned winding should be

LIST OF PARTS

Coils

T1—One radio frequency transformer as described.
T2—One oscillator coil as described.
described, with shields.
Ch—One 800 turn duolater coil.

Condensers

C1, C5—Two .0005 mfd. tuning condensers.
C2—One .00025 mfd. grid condenser with resistor clips.
C3, C4, C6, C8, C9—Five 0.1 mfd. by-pass condensers.
C7, C7a, C10, C10a C11, C11a—Six 100 mmfd. Hammarlund trimmer condensers.
C12, C13—Two .0005 mfd. fixed condensers.
C14, C15—Two .02 mfd. fixed condensers.
C17—One mfd. fixed condenser.

Resistors

R1—One 2 megohm grid leak.
R2, R4—Two 250,000 ohm plate resistors.
R3, R5—Two 1 megohm grid leaks.
R6—One 100,000 ohm fixed resistor.
R7—One 2 ohm ballast resistor.
Rh1—One 50,000 ohm variable resistor.
Rh2—One 100,000 ohm variable resistor.
Rh3—One 6 ohm rheostat.

Other Parts

Sw—One filament switch.
Eleven binding posts.
Seven UX type sockets.
Five grid clips.
Two dials for C1 and C4.
Four No. 6 dry cells.
Three 45 volt dry cell batteries.
One 22.5 volt grid battery with taps at 3 and 4.5 volts.
Five 232 type screen grid tubes.
One 230 type tube.
One 231 type power tube.
One aluminum chassis, 12x7x2.5 inches.
One 12x7 panel.

of the same size wire, or any other finer wire. Put the pick-up or third winding at the grid end of the form. The grid and the plate terminals of the coil should be at opposite ends of the windings and the plate return and grid return terminals should be close together.

The oscillator tube is a 230 type.

Input Tuner

The radio frequency tuner is also tuned with a .0005 mfd. condenser C1. If this is to cover the broadcast band the needed inductance is 167 microhenries. This will be obtained by winding 59 turns of No. 28 enameled wire on a 1.75 inch bakelite form. Ten turns will suffice for the primary. However, if greater sensitivity is desired the primary turns may be increased to twice or three times that number. It is desirable to use a larger number of turns if the antenna is very short, which it is likely to be on a portable set.

In Fig. 2 is shown the method of mounting the intermediate frequency coils. The proper position for the case when both the primary and the secondary are tuned is that in (2). If, however, a little closer coupling is desired, and hence greater sensitivity but less selectivity, the mounting shown in (3) may be used. The mounting in (1) is not suitable when both windings are tuned but may be used when only one is tuned, whether that be the primary or the secondary. The method of coupling the coils shown in (4) can also be used when both windings are tuned. These statements refer to the distances given between the centers of the coils.

Electric Clocks

DOES the price of an electric clock affect the accuracy of its timekeeping? If so, in what way? Will an electric clock cause radio interference?—C. F.

No, so long as the clock runs, it runs correctly. However, the price would naturally affect it greatly as to dependability, keeping in running condition, durability, appearance, etc. The electric clock is a rather delicate, although not complicated, device.

* * *

His Set Stops

MY set operated well in the past, but now it often stops playing suddenly, and I have to shut it off a moment to get it going again, I noticed that touching various points inside will start it too. I enclose printed circular describing the set.—L. I. Z.

The grid leak may be defective, needing replacement. Or, a tube may have gone bad. Get a new tube of each type you use and try it in one socket at a time and note whether you can locate a defective tube in this way. If this does not remedy the trouble, have your radio service man repair the set. There is then presumably a grid leak, or grid return lead, or transformer winding broken.

* * *

Types of Switches

WHAT is the best material to use for a radio switch—porcelain, hard rubber or bakelite—V. M.

If the switch is to be used for battery or electric power connections, it will make no difference. In fact for any purpose the materials you have named will prove the same. Theoretically the hard rubber is slightly superior in insulative characteristics, but it has mechanical disadvantages for some uses.

A Pentode Po

Non-Reactive Circuit Adjusted

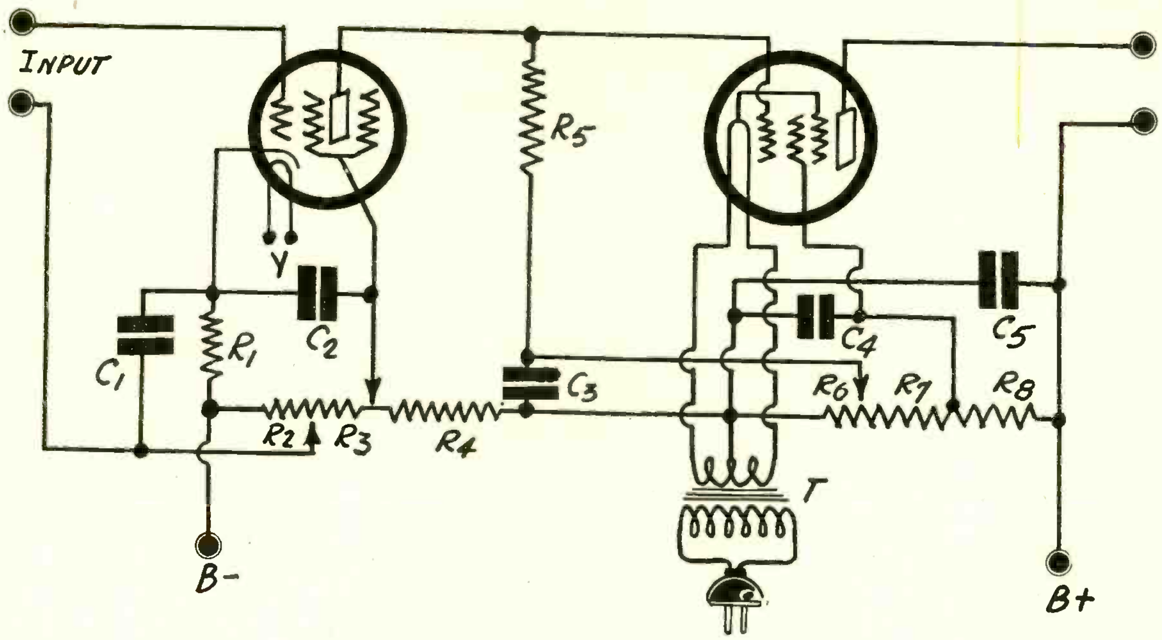


FIG. 1
The circuit of a Loftin-White type amplifier utilizing one 224 screen grid tube and one power pentode tube.

THE new power pentode, the 247, seems to be ideally suited for output tube in a direct coupled amplifier of the Loftin-White type, especially when it is preceded by a 224 screen grid tube or a variable mu tube of the 235 type. Since there is considerable interest in this type of circuit we give a design herewith.

The voltages in a circuit like this are so interdependent that it is not possible to give the correct values for all the resistances except for two particular tubes. Since tubes of the same type vary and it is unlikely that two other tubes like the ones used in working out the design can be found, it is necessary to provide variable values so that the voltages may be made to fit any pair of tubes. However, since the tubes are held within fairly close limits to the average tube, very little adjustment is necessary if the constants are given for tubes that are close to the average.

At least two variables should be provided, but it does not make much difference which two, that is, which two voltages, except the voltages on the screen and the plate of the last tube. We may vary the grid voltage on the first tube, the screen voltage on this tube, or the plate voltage of the tube. By making changes in any one of these the control grid voltage on the power tube is also changed and the object of the changes is to insure the proper grid voltages on both tubes.

Bias on First Tube

It has been found experimentally that if the grid bias on the first tube is one volt, the screen voltage 22.5 volts, and the applied plate voltage 180 volts, the first tube operates as an amplifier with practically no distortion and with a gain of about 66 times. Since the maximum signal amplitude on the pentode is 16.5 volts, the input amplitude on the first tube need only be about 0.25 volts to load up the first tube. The coupling resistance R5 in this case should be 250,000 ohms.

The plate current in the first tube under these conditions is 0.472 milliampere. If we neglect the screen current in the first tube the grid bias resistance R1 should be 2,120 ohms in order to give a bias of one volt on the control grid. However, as it is convenient to be able to vary this both upward and downward, we make R1 3,000 ohms. This is a standard unit and easily obtainable. If now we assume that the screen current is one-third as great as the palte current, the total current through R1 will be 0.629 milliampere and the maximum grid bias will be 1.887 volts. To cut down the voltage when desired to one volt or less, we return the grid of the tube to a slider on resistance R2R3.

The resistances in the voltage divider have been chosen so that 44 milliamperes will flow in R2R3. Hence, if the effective bias on the first tube is to be one volt, resistance R2 should be 0.887/.044, or nearly 20 ohms.

Providing Screen Voltage

The screen voltage on the first tube should be 22.5 volts. But since there is a drop of 1.887 volts in R1, the voltage drop in R2R3 should be nearly 24.4 volts. The current in both R2 and R3 may be taken at 44 milliamperes since the screen current is negligible. Hence R2R3 should be 553 ohms and R3 alone 533 ohms.

We have to leave the determination of R4 until we have found the values of some of the other resistances.

The screen and the plate voltage on the output tube should be equal, or the screen voltage should be slightly less than the plate voltage. Let us assume that the drop in the load on the power tube is due to a current of 32.5 milliamperes in a resistance of 500 ohms. We must connect the screen return to a point on the voltage divider such that the screen voltage becomes equal to the plate voltage. That is, there should be a drop of 0.0325x500 or 16.25 volts in R8. Let us assume that the bleeder current is 5 milliamperes. The screen current in the power tube is 7 milliamperes. Hence the total current in R8 is 12 milliamperes, and therefore R8 should be 1,350 ohms. It is all right to make it 1,500 ohms, which is a standard unit.

We found that the drop in R5 is 118 volts and that the bias on the second tube should be 16.5 volts. Hence we must make R6 such that the drop in it is 101.5 volts. The current in R6 is the bleeder current less the plate current through R5. That is, it is 4.528 milliamperes. Hence R6 should be 22,400 ohms. A 25,000 ohm resistance is recommended since this is a standard unit. This increase will change the bias on the last tube but this can easily be adjusted by changing the bias on the first tube, for which there is a provision.

Voltage on 224

We are now ready to determine R7. We have the currents and resistance in R6 and R8, as well as the current in R7. We also have the total voltage drop in R6, R7 and R8. Hence we

LIST OF PARTS

T—One filament transformer with two 2.5 volt windings
C1—One 2 mfd. condenser, or larger
C2—One 2 mfd. condenser
C3, C4, C5—Three 1 mfd. by-pass condensers
R1—One 3,000 ohm resistance
R2, R3, R4—Two 1,000 ohm potentiometers connected in series (recommended)
R5—One 250,000 ohm coupling resistor
R6, R7—Two 25,000 ohm resistors
R8—One 1,500 ohm resistor
Two UY sockets

wer Amplifier

for the 247, Preceded by 224

have enough data to compute R7. The drop in R6 is 113.2 volts and that in R8 18 volts. The current in R7 is 5 milliamperes and the total drop is 250 volts, the plate voltage necessary on the power pentode. Hence R7 should be 26,240 ohms. Again it is permissible to use 25,000 ohms.

Now we are in a position to compute R4. The drop in R2R3 is 24.4 volts and that in R6 113.2. The sum is 137.6 volts. The drop in R4 should be the difference between this and 180 volts, or 42.4 volts. The current in R4 is 44 milliamperes and therefore R4 should be 965 ohms. The nearest commercial unit is 1,000 ohms. Now we have all the resistance values in the circuit.

If these units are put in, the circuit will be near the proper adjustment, but it is too much to hope that it will be exactly adjusted because there are many uncertainties in commercial resistance values and in the tubes. The final adjustment must be made on the individual circuit and it is sufficient to adjust the grid bias on the first tube and the screen voltage, or the bias and the plate voltage. The grid bias is changed by sliding the grid return on R2 and R3 and the screen voltage by sliding the screen return on R3 and R4. The plate voltage may be varied by varying R6. It is also permissible to change R5 to 500,000 ohms. The most important variable is the grid return of the first tube and it may well be that nothing else need be varied.

Voltage Needed

The voltage needed between B minus and B plus is the sum of the two plate voltages less the voltage drop in R6. The sum of 250 and 180 is 430 and the drop in R6 is 113.2 volts. Hence the voltage required is 316.8 volts. Of course, it does not matter if the total voltage is somewhat less or greater than this. Hence a B supply designed for use with 245 power tubes can be used, for this gives about 300 volts.

The sum of R2, R3 and R4 is 1,553 ohms. This is not a commercial value but there are wire-wound resistors available in 2,000 ohms which have sliders on them, or contact bands which may be moved. Such a unit is suitable since the bands can be set at any value desired. There are also low resistance potentiometers available in 400, 1,000 and 2,000 ohms. Two of these may be used in series. For example, a 400 ohm potentiometer may be connected between B minus and the low end of a 2,000 ohm potentiometer. The other end of this 2,000 ohm unit can then be connected to the end of R6 and the tap on T. The slider of the first should go to the grid return of the first tube and the slider of the second to the screen return of the tube. Or, two 1,000 ohm potentiometers can be used in the same way. Since there are two sliders the proper voltage adjustments can be effected even though the total resistances are not those computed provided the deviation is not too great.

Condensers Required

By-pass condensers are needed to prevent feed-back. The first two, C1 and C2, are connected across low resistances and therefore they should be large, not less than 2 mfd. each. C1 should preferably be 4 mfd. or more. Indeed, it would be desirable to make this a large electrolytic condenser of 8 mfd. The remaining condensers indicated in the circuit are across comparatively large resistances and therefore they will be quite effective even if they are not larger than 1 mfd. each.

The filament transformer supplying the heater current should be provided with two windings, one for each tube. While it is possible to operate both tubes with the same winding, it is better to use two in order to avoid the high voltage between the heater and the cathode on the first tube.

When audio frequency voltages are to be amplified and the amplifier is not to be used for extremely low frequencies, it is not necessary to use direct coupling because the only appreciable difference in the amplification is at the very low audible and the sub-audible frequencies. If the grid leak resistances and the stopping condensers are made high there is even no difference at the lowest audible frequencies. When stopping condensers are used the circuit is much simpler and requires practically no voltage adjustment. At least there are no critical adjustments as in the case of direct coupling without stopping condensers.

Heretofore it has been necessary to use three tubes in the audio frequency amplifier to get enough gain, or to use screen grid or high mu tubes ahead of the power stage. Now that the 247 pentode power tube is available it is possible to get enough amplification for most radio receivers by using one 227 voltage amplifier and one pentode after the detector.

Two Stage Amplifier with Power Supply

In Fig. 2 we have a circuit of this kind together with the necessary power supply, a 280 tube being used as rectifier.

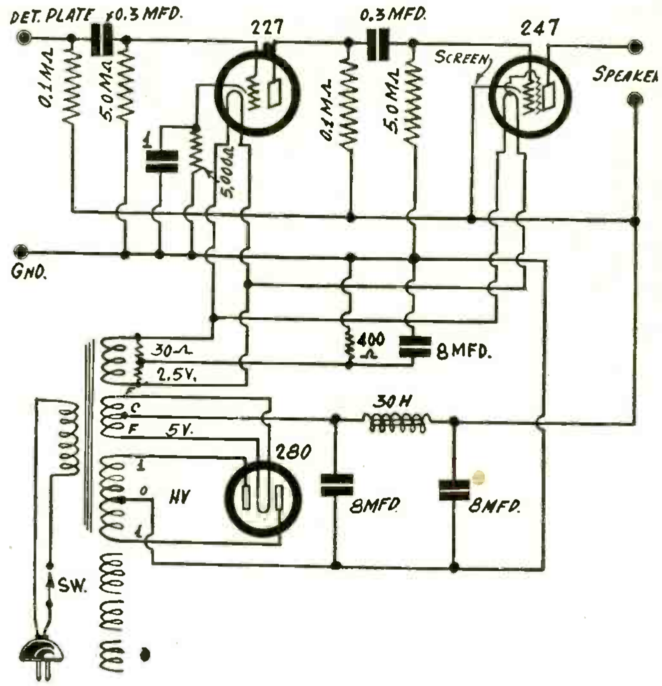


Fig. 2

A two-stage resistance coupled amplifier with power supply in which the first tube is a 227 and the second a 247 pentode

All the necessary constants are given on the drawing so that it is not necessary to enumerate them. We note that the stopping condensers are 0.3 mfd. and that the grid leak resistances are 5 megohms. This means that the time constant of each condenser and leak is 1.5 seconds and that full amplification will be obtained well below 10 cycles per second. Indeed, there will be good amplification down to one cycle per second.

The voltage gain in the first stage is about 7.5 times. Since the maximum signal voltage, peak value, that can be applied to the pentode is 16.5 volts, the voltage necessary across the first grid leak to load up the power tube is 16.5/7.5, or 2.2 volts, which may be obtained without difficulty from a modern detector.

Note that the B supply in this circuit also supplies the detector preceding the amplifier. It is for this reason that the ground connection is provided, which must be connected to the ground side of the detector or radio frequency amplifier. If this connection is not made, the detector will not function. If the B supply is also to supply the radio frequency tubes the plate returns should be connected to the high voltage line at the top of the second 8 mfd. filter condenser.

An amplifier of this kind, which has three plate circuits, counting that of the detector as one, is virtually unstable in the bass region, and this instability may extend upward into the treble. However, the by-pass condensers in the filter are so large that the cause of the instability is practically removed. It is the second 8 mfd. condenser which stabilizes the circuit, the first merely serving to eliminate the ripple.

The 8 mfd. by-pass condenser across the 400 ohm grid bias resistor must be used to prevent reverse feed-back in the last tube and thus to allow the pentode to amplify to the limit of its capacity.

How Beacons Guide Planes

By Brainard Foote

FEW radio listeners realize how extensively radio is being utilized today to assist airplane pilots in maintaining a true course. And yet there are many radio beacons in constant operation which enable the plane equipped with a radio set to keep on the course with an astonishing degree of accuracy. You will find the principles in use of extreme interest and ingenuity.

You're probably familiar with a loop radio aerial. Something like a box in shape, it is really nothing more than a coil of wire made very large—large enough to intercept energy. In fact, many sets, near enough to stations, can pick up enough energy on the coils alone to operate the loudspeaker.

The loop aerial has a peculiar property—directional reception. In directions toward which it points, reception is good. At right angles to its plane, reception is nil.

Continuous Sound Is Guide

When a loop aerial is used for transmitting, a similar effect is noticed. The radio range beacons in service in American airways rely upon this same principle. However, two loop type transmitting aerials are used, at right angles, or at different angles, in accordance with the nature of the course.

A remarkably ingenious system is used to enable the pilot to maintain his direction. One loop aerial is sending out a certain radio code signal, say a dash and a dot, and because of the characteristics of the loop aerial, this particular combination goes out in the general direction of North and South or East and West, as the special position of the course required.

Proximity Narrows Path

The other loop aerial is sending out another combination of dots and dashes which exactly fit in between the signals from the first aerial. In this case, the second aerial sends both dot dash. Therefore when the pilot is located in such a position that he receives the energy from both of the aerials with equal loudness, he is unable to distinguish either the dot dash combination or the dash dot combination, and instead, he hears only a continuous dash or sound.

This condition of equal loudness occurs only along a very restricted path, so narrow in fact, that at 100 miles distance, the path over which the two signals blend perfectly is only 6 miles wide. As the pilot flies toward the beacon he is able to correct his course constantly, for if the plane gets off to one side, his radio set picks up the signals from that side with greater volume than from the other side and he instantly knows which way to turn. As he gets nearer to the beacon, the course narrows greatly, guiding him directly to the airport.

Originally, there was difficulty in setting up the beacons where more than one airway terminated, unless, as rarely occurred, the two airways were exactly in line (180 degrees) or exactly at right angles (90 degrees). Later, however, it was found that it was possible to provide bends or angular directions, by altering the loop aerials used for transmission, by varying the proportionate radio current fed into each aerial, and by also erecting a straight wire aerial, the latter plan used where a greater variation is needed.

For instance, at Bellefonte, Pa., the airway changes its direction 14 degrees, and the radio beacon signals follow this turn by the use of the auxiliary aerial wire.

The transmitting set is a 2-kilowatt model and the dot dash and dash dot impulses are controlled by special cams that are motor-operated, and alternately connect the transmitting power to one aerial and then to the other.

The radio beacons use frequencies in the band from 285 to 350 kilocycles (corresponding to about 857 to 1,052 meters). Originally different groups of dots and dashes were used, but it was found that the pilots got better results with the N and A (dash dot and dot dash) combinations. To identify which station is being received aboard the plane, the number of combinations forming a single group (with a pause between each group) is employed. In addition, every 15 minutes the station switches over to a microphone and an announcer gives the call letters and name of the station, and also weather and wind conditions.

Radio plays an increasingly important part in availability to the airplane pilot and passengers of message communication, weather information and in this newer field of radio beacon signals.

FIRST BROADCAST CREDITED TO HERTZ

The first broadcasting was in a lecture room in Karlsruhe, Germany, in 1887, according to Clarence A. O'Brien, Washington patent attorney. In tracing the experimental work which led up to radio broadcasting, Mr. O'Brien gives first credit to the German scientist, Heinrich Hertz.

This first broadcasting, demonstrating the possibility of radio, is thus described by Hertz, himself: "When I placed the primary conductor in one corner of a large lecture room, fourteen meters long and twelve meters broad, the sparks could be perceived in the farthest parts of the room; the whole room seemed filled with the oscillations of the electro force."

The primary conductor used in this experiment consisted of a straight copper wire 5 mm. in diameter, to the end of which were attached spheres 30 cm. in diameter, made of sheet zinc.

Hertz Applied the Detector

"While James Clerk Maxwell, English physicist, first promulgated the theory in 1865," said Mr. O'Brien, "it was reserved for Hertz to discover and apply with marvelous ingenuity the necessary 'detector,' a resonating circuit with an air gap, the resistance of which was broken down by well-timed impulses."

The results of Hertz's work were published in Wiedermann's Annals, between 1887 and 1890, showing with ample experimental proof and illustration, that electro magnetic action is propagated with finite velocity through space. Hertz found the velocity of electricity to be equal to that of light and, moreover, equal to the velocity of electric waves on metallic wire.

The consequence of this last discovery was that what had hitherto been considered as a circuit of electricity in a wire was found to be really a movement along the surface of the wire.

"Nearly Invented" X-Ray

He also showed that electric waves can be reflected as light waves; that the eye is in itself an electrical organ and that, if electricity were suppressed, light in the universe would disappear. Hertz also came very near to the discovery of the X-ray.

A native of Hamburg, Hertz studied at Munich and Berlin, and later taught physics at Kiel, where he began the study of Maxwell's electro-magnetic theory. The experiments were actually made between 1885 and 1889, when he was professor of physics in the Polytechnic School of Karlsruhe, in Baden. He died in 1894, before Marconi developed the ground wire and antenna.

RECEIVERS FOR AIRPLANES

How Lightness, Simplicity and Sensitivity Are Combined

THE radio receiving set in use aboard the airplane has some very unusual, exacting and technically difficult requirements. The set may be used for short-wave telephone communication or for reception only on short or long waves, but the general requirements are the same.

The dominating requirements are of course light weight and small size. Not only must the set be small and light, but the accessories, such as batteries, must be compact and light, too.

The airplane receiving set must be made so that it can be placed anywhere on the "ship," in some cases with remote controls to operate it. It also must have great sensitivity variation, because it is changed in location so rapidly from nearness to the sending station to a distance from it.

As the engine is ignited by the usual spark system such as used in automobiles, the set must be thoroughly shielded in some fashion, so that minimum ignition noise will be picked up. The assembly must be unusually rugged, so it will withstand the constant vibration of the airplane and its motors. The vacuum tubes used must be non-microphonic and must be mounted in a special manner to avoid shock.

110-V DC SW Converter

By Adam Olcott

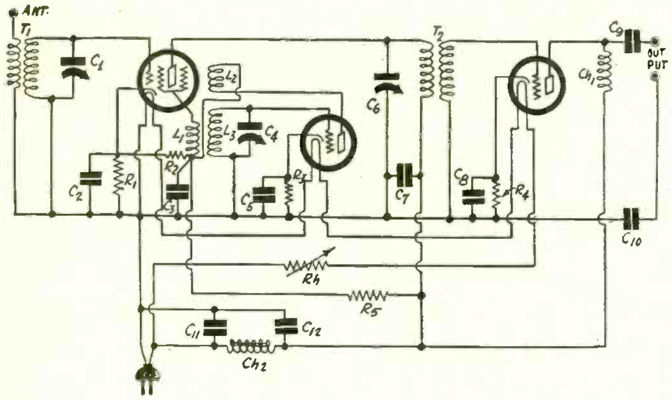


FIG. 1

The circuit of a short-wave converter utilizing the new 6.3 volt heater tubes and deriving all its voltages from a DC line.

THE new 6.3 volt heater tubes are especially suitable for 110-volt DC receivers and converters, and requests for circuits have already been made. Herewith is a circuit for a three-tube converter taking all its voltages from the DC line.

In many respects this converter is similar to the four-tube AC converter described in detail in the November 15th issue of RADIO WORLD. Since that circuit appeared there have been many developments in converters and parts and therefore we shall include the latest improvements.

Let us begin with the heater circuit. There are three tubes with their heaters connected in series, each one requiring a voltage of 6.3 volts and a current of 0.3 ampere. The voltage drop in the heater series will therefore be 18.9 volts. Now if the line voltage is 110 volts we have a difference of 91.1 volts, which must be dropped in a ballast resistance Rh. Since the current through this rheostat will be 0.3 ampere the necessary resistance is 304 ohms.

The line voltage maye be more or less than 110 volts and provision must be made for the variation. It is necessary to arrange Rh so that it will take care of a voltage range of about 100 to 125 volts, since the line voltage may vary between these limits. If the voltage is only 100 the value of Rh should be 270 ohms and if it is as high as 125 volts the resistance should be 353 ohms. Hence we may make up Rh of a fixed resistance of 270 ohms and a variable having a maximum value of 83 ohms, or more.

It is not easy to get a variable resistance of this value that will carry 0.3 ampere and for that reason it is better to measure the line voltage and allow for a variation of 10 per cent, five per cent above and five below the measured value. This will be ample. Suppose, for example, that the voltage measures 118 volts. Allowance should then be made for a minimum of 112 and a maximum of 124 volts. The fixed resistance part of Rh would then be 93.1/.3, or 310 ohms, and the variable portion 12/.3, or 40 ohms.

The fixed portion of the ballast may be obtained by combining lamps or by using resistance wire capable of carrying 0.3 ampere. The hot resistance of a lamp of any wattage can be obtained by the formula V^2/W, in which V is the rated voltage and W the rated wattage of the lamp, both usually etched on the bulb. Suppose the rated voltage is 120 volts and the rated wattage is 60 watts. The hot resistance is then 240 ohms. This is an approximate value of the resistance of the lamp. The current rating of the lamp is also obtained from the rated voltage and wattage by dividing the watts by the volts. Thus the 60 watt lamp has a current rating of 60/120, or 0.5 ampere. Thus a 60 watt lamp will easily pass 0.3 ampere. Two 25-watt lamps connected in parallel have a resistance of 288 ohms and a current capacity of 0.416 ampere.

The adjustable portion of Rh can be made by connecting 10-ohm rheostats in series, or any rheostat or resistances capable of carrying 0.3 ampere and making the required number of ohms.

If the line voltage is 118 volts and remains constant, as is very often the case, 330 ohms will be required. In any case for this circuit, the required resistance is obtained by subtracting 18.9 from the measured line voltage and dividing the difference by 0.3.

Getting the Plate Voltage

The plate, screen and grid voltages are all obtained from the line. The ground of the converter is connected to the negative side of the line and to the negative side of the heater circuit. A filtr choke Ch2 of 30 henries is put in the positive lead and two condensers C11 and C12 are connected across the line, one on each side of the choke. If each of the condensers be made 4 mfd. the filtering will be satisfactory because the supply is already partly filtered .

The plates of the modulator and the output tube are returned to the highest voltage point available, which is just slightly less than the line voltage for the drop in Ch2 is not more than a few volts. The voltage on the plate of the oscillator and on the screen of the modulator is dropped to approximately 36 volts by a 10,000 ohm resistor R5. The drop is caused by the screen and plate currents and by the bleeder current through R2, which is assumed to be 5 milliamperes. R1 should be 500 ohms to make the tube a good detector and R2 about 7,500 ohms. These values are not critical as the tube will detect well over a wide range.

If R1 and R2 be made larger than the values specified the voltage on the screen and the plate of the oscillator because the drop in R5 will be less due to the reduced bleeder current.

Bias resistances R3 and R4 are not critical either. Of R3 it is only required that it give a small bias to the oscillator and 300 ohms is quite sufficient. R4 may be the standard value of a 227 tube, namely, 2,000 ohms.

All the by-pass condensers C2, C3, C5, C7, and C8 operate at very high frequencies or at the intermediate frequency, all of which are high. Hence comparatively small condensers can be used. However, some of them are across rather small resistances so that condensers of 0.1 mfd. are recommended to minimize feed back. Since condensers of this capacity can be had in blocks of three, two of these blocks are needed. This leaves one to be connected elsewhere. Now one side of C10 is connected to ground in the same manner as the others. Hence this may be the sixth unit in the two blocks.

The real object of C10 is to prevent a possible short circuit of the line, which would occur if the grounded side of the converter were connected to the ground post on the set without the intervention of C10. The converter circuit should not be grounded in any other way except by way of C10 to the ground on the set.

C9 is also a stopping condenser, serving to prevent a short through the chokes and the primary of the input to the radio set. Its value should be 0.0015 mfd. The choke Ch1 should be a 50 millihenry coil.

The two tuning condensers C1 and C4 recommended are .0002 mfd. Hammarlund, which are midgets especially made for short wave tuners. Only one of these, C4, need be provided with a regular dial, but this should be of the vernier type for otherwise it will be difficult to tune the converter accurately. C1 may be controlled with a knob such as is used for rheostats for the first tuner may be used more as a volume control than a tuner. However, if it is desired to calibrate the set so that short-wave stations may be logged, C1 should also be provided with a good dial.

(Continued next week)

LIST OF PARTS

Coils

T1—One set of two antenna coils as described
L1L2L3—One set of two oscillator coils as described
T2—One tapped radio frequency transformer as described
Ch1—One 50 millihenry choke coil
Ch2—One 30 henry choke coil

Condensers

C1, C4, C6—Three .0002 mfd. Hammarlund midgets
C2, C3, C5, C7, C8, C9—Two blocks of three-unit condensers of 0.1 mfd. each
C9—One .0015 mfd. Supertone condenser
C11, C12—Two 4 mfd. filter condensers, 400 volt test

Resistors

R1—One 500 ohm resistance
R2—One 7,500 ohm resistance
R3—One 300 ohm resistance
R4—One 2,000 ohm grid bias resistor
R5—One 10,000 ohm resistor
Rh—One rheostat or variable resistance to carry 0.3 ampere and drop the line voltage to 18.9 volts. Resistance about 300 ohms

Other Parts

One UX socket for T1
Four UY sockets for tubes and oscillator coil
One vernier dial for C4
Two knobs for C1 and C6
Three binding posts
One standard outlet plug with cord

First Picture Diagram c

[The DX-4 All-Wave Converter, designed by Herman Bernard, has been discussed from various angles in these columns for several weeks, and now along comes the full-scale pictorial diagram, published because this converter, with rectifier built in, has worked so splendidly that many desire to follow the designer's exact personal layout and specifications. Many users of the DX-4 report the direct reception of far-distant stations. It is one of the best converters available, providing ease of tuning and freedom from body capacity, besides affording high sensitivity.—Editor]

THE fundamental circuit of the DX-4 All-Wave Converter is that of a stage of screen grid radio frequency amplification, with screen grid tubes used also as modulalator and oscillator, while the rectifier is a 227.

There are many possibilities for choice of parts, including resistive antenna and plate loads, different capacities for filtration, even total elimination of the B supply choke, and these possibilities have been dwelt on during the past several weeks. The object of showing the various choices that might be made, as well as detailing and comparing the operation results, was to enable readers to use what parts they have about the house, and still turn out a highly satisfactory converter.

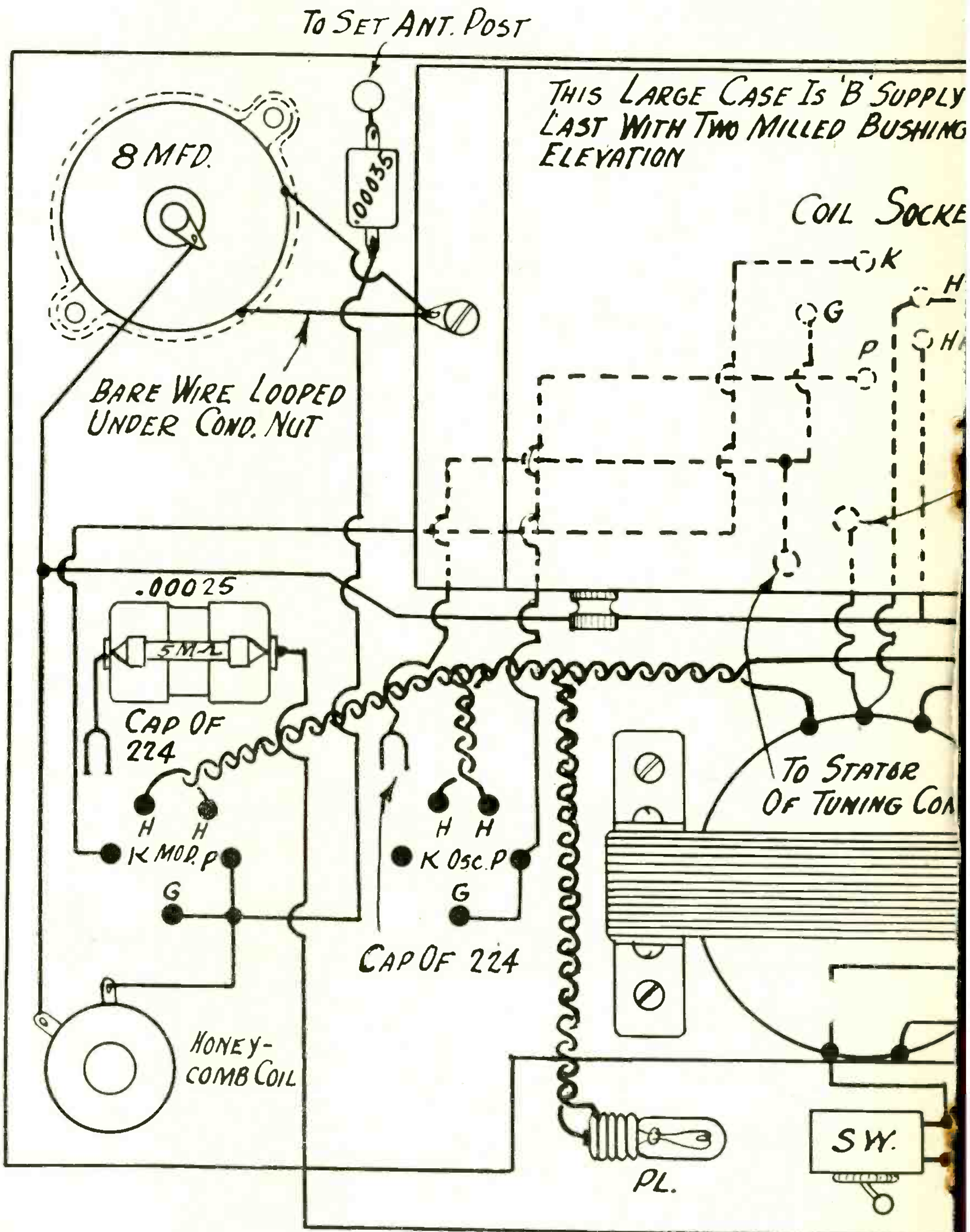
Performance Guide

The pictorial diagram and list of parts published herewith represent a definitive circuit, with no options left, as the purpose is to duplicate exactly the layout and parts as used by the designer. While for economy reasons other choices have been cited in the past weeks, this time the circuit is shown exclusively on a performance basis, for it has been found that the circuit as constituted works better than any of the others, and the constants should be chosen exactly as stated, although any manufacturer's parts, provided they are of high quality, may be used.

All the parts are on the general market and nearly all of them are made by a variety of manufacturers.

16 Mfd. Filter

The layout is such that the socket for the oscillator coil is at the rear center, while below is the B supply choke, which



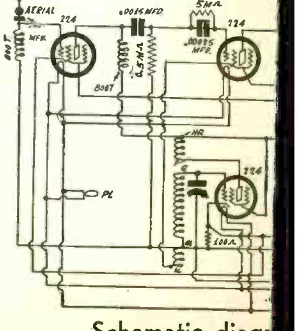
The new DX-4 Converter, using 16 Mfd. of filter capacity and a 30-henry B supply choke, is
control grids and to the tuning condenser are shown only i

is elevated from the socket by two milled bushings 5/8 inch high, aided by a 6/32 nut, to provide for clearance of the socket springs.

The pictorial diagram shows clearly every connection, except the finish of the leads to the three control grids, and the two leads to the stator and rotor of the tuning condenser. Even these are indicated, however, by legends on the diagram, so the five connections to be made to parts on top of the subpanel can not be missed.

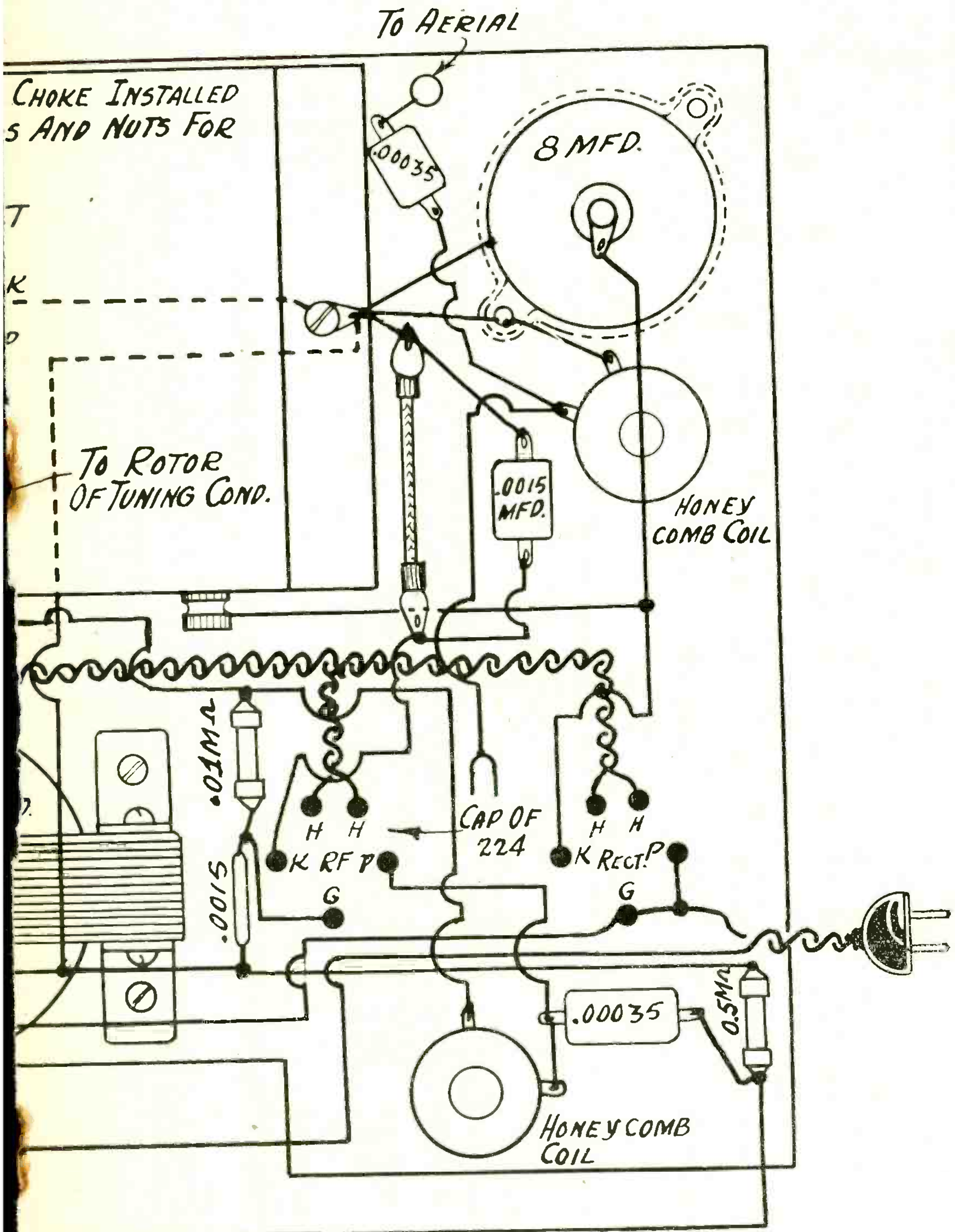
Both Correspond

The schematic diagram corresponds in all particulars with the pictorial diagram, while the list of parts comprises all the parts required, not including, however, the three 224 tubes, the 227 tube

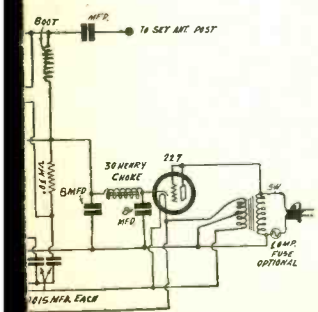


Schematic diagr

of the DX-4 Converter



built compactly, as the full-scale pictorial diagram shows. The leads to part, as they go above the subpanel.



ram of the DX-4

and cabinet. The layout makes it easy to turn out a neat wiring job, although the actual course of some of the leads may be made a little different from what is shown, since the main object of the picture diagram is to show the courses clearly, and not the literal routes.

Stick to Diagram

However, the destinations are inviolate and accurate, and all who desire to build this excellent converter, 10 to 600 meters, should not deviate from the wiring instructions as shown in the diagrams.

Placement of parts should be as shown, because this is doubly important in high frequency work, especially keeping grid leak and condenser clear of coils.

LIST OF PARTS

Coils

Three 800-turn honeycomb radio frequency choke coils.
One 2½-volt center-tapped filament transformer.
One 30 henry choke coil.
One set of precision de luxe plug-in coils (four to a set).

Condensers

Two .0015 mfd. mica fixed condensers.
Two .00035 mfd. fixed
One .00025 mfd. fixed condenser with clips.
One Hammarlund Junior midline .0002 mfd. tuning condenser.
Two 8 mfd. electrolytic condensers with brackets.

Resistors

One 0.5 meg. (500,000 ohm) pigtail resistor.
One .01 meg. (10,000 ohm) pigtail resistor.
One 5.0 meg. grid leak.
One 100 ohm flexible biasing resistor.

Other Parts

One front panel 7x10½ inches.
One subpanel, with five UY sockets.
One National dial.
One AC toggle switch.
One 1 ampere fuse with holder (optional).
One AC cable lead with male plug.
Two binding posts (for antenna input and for output).
Three grid clips.
One dozen 6/32 machine screws and one dozen 6/32 nuts.
Three flat-head 6/32 machine screws.
Three 6/32 machine screws 2 inches long.
Two brass angles for affixing front and subpanels.
Two milled bushings for elevating 30-henry choke.
Four lugs.

At left and right rear are two electrolytic condensers. These are of the inverted type and must be used that way. The lug attached to the anode must be below. The condenser is secured to the subpanel by a special bracket which is placed on the under side of the subpanel.

When one duplicates the parts and wiring the result will be an all-wave converter of excellent performance, particularly on the short waves. The advantage of broadcast frequency reception is only incidental.

There should be no difficulty in tuning in European stations, although one must bear in mind ether conditions vary nightly on short waves.

The Micro

Transmission on 18 Centimeters Wav

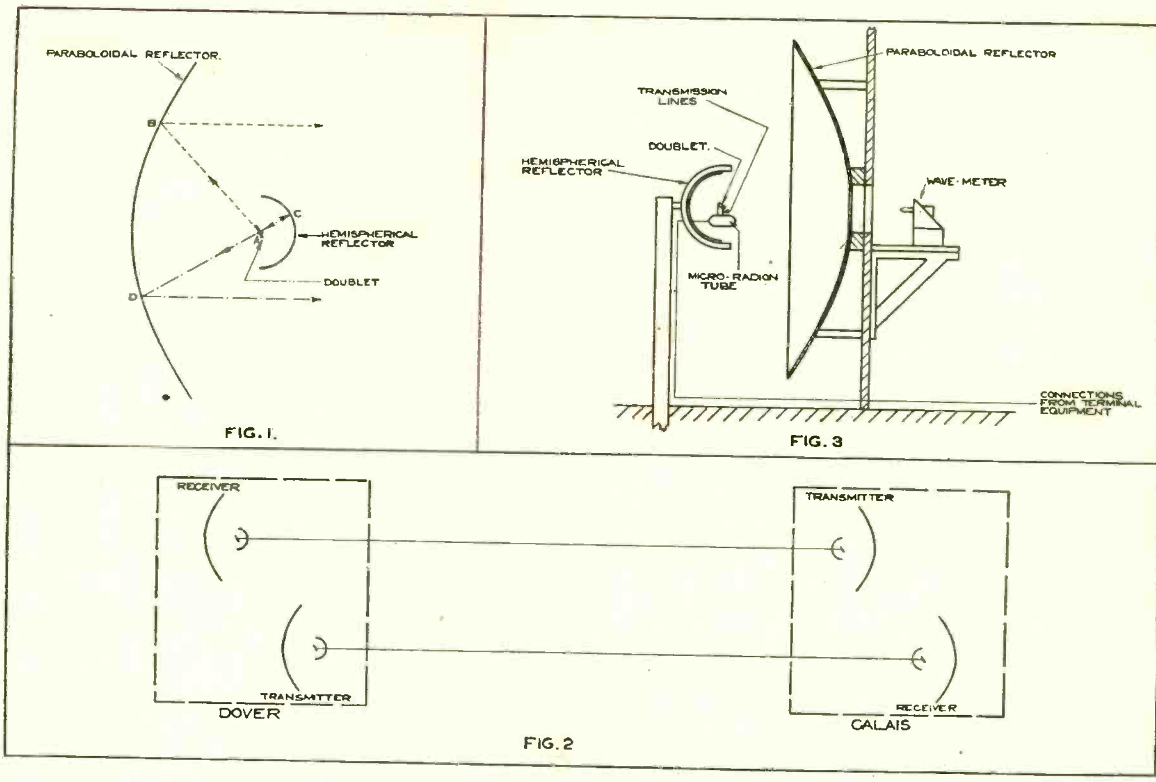


FIG. 1
A cross section of the paraboloidal and hemispherical reflectors employed in the micro-ray system of communication, showing the location of the radiating antenna A at the focus of the paraboloid and at the center of the hemisphere.

FIG. 2
Schematic of the dual transmitter and receiver showing identical reflectors at the two receivers and the two transmitters.

FIG. 3
Detailed cross section of the transmitting reflectors with the transmitting tube and antenna at the focus of the paraboloid and at the center of the hemisphere. The wave meter and radiation meter are at the back of the paraboloid, receiving via a hole.

[Last week we published a report on the demonstration of two-way telephone and telegraph communication on a wavelength of 18 centimeters between England and France. Herewith we publish additional details of the method and apparatus employed in the demonstration.—Editor.]

On the cliffs at St. Margaret's Bay, Dover, England, the International Telephone and Telegraph Laboratories, Hendon, England, in cooperation with the Laboratories of Le Materiel Telephonique, Paris, France, recently gave a successful international demonstration of a new ultra short-wave radio telephone and telegraph equipment and circuit between Dover, England, and Calais, France. This equipment was largely developed by French engineers in the Paris Laboratories. The demonstration at Dover was conducted by engineers of the International Telephone and Telegraph Laboratories and at Calais by engineers of Le Materiel Telephonique.

In this demonstration, oscillations of wavelengths as low as 10 centimeters designated as Micro-rays, were used for the first time to provide a high quality two-way radio telephone circuit. From distances covered and results obtained it was quite clear that the equipment employed can readily be adapted to commercial use.

Though a certain number of experimenters have already succeeded in generating and utilizing oscillations of such wave lengths nothing beyond what may be described as laboratory investigations has up to now resulted. The enormous advance in technique shown by the present demonstration definitely indicates that the range of wave lengths as low as 10 centimeters are now available for commercial radio transmission.

Quality in Speech, No Fading, On 18 cm.

In the demonstration a link had been established between a station on the cliffs at St. Margaret's Bay, near Dover, and a similar station across the Channel at Blanc Nez, near Calais. The two-way radio telephone circuit using a wavelength of 18 centimeters was noteworthy for the quality of speech received. Not only was it well up to the standard of a high quality telephone circuit, but it showed no signs of being affected by fading, a disability from which waves in this frequency are apparently immune.

When compared with radiations of the more usual wave lengths, micro-rays present many striking features. For example, their extremely short wave length permits the use of electro-optical devices more usually associated with light, such as reflectors or refractors in addition to diminutive antennae systems. A further similarity between these radiations and light is that fog, rain, and such like climatic effects, as well as day and night, do not materially interfere with the propagation of the waves.

The two stations at Dover and Calais were in all essentials identical. Each comprised a transmitter and receiver with terminal equipment of normal design for connecting them together so as to give facilities for two-way communication.

Fig. 3 shows the essential features of the transmitter, and Fig. 5 is a reproduction of the photograph of the transmitter and receiver at Dover. The outgoing signals are applied to a micro-radion tube in which the high frequency oscillations are generated.

Concentrated Projection

A short transmission line connects the micro-radion tube to the radiating system or doublet which is about two centimeters long, in contrast to the enormous system usually employed. The amplitude of this high frequency current along the doublet at any instant is substantially the same. The doublet is situated at the focus of a paraboloidal reflector some three meters in diameter.

After concentration of the rays by the paraboloidal reflector into a fine pencil of rays somewhat similar to light rays sent out by a searchlight, they are projected into space.

In the reflector the relation between the focal length and the diameter is so proportioned as to insure maximum efficiency for the diameter used. In order further to increase the efficiency of the system by the prevention of radiation other than in the required direction, a hemi-spherical reflector is located at the opposite side of the doublet to the paraboloidal reflector and having the doublet at its centre. This serves to collect all the radiation propagated in a forward direction and to reflect it back again towards the source.

The radius of the hemi-spherical reflector is so chosen that when the reflected radiations reach the focus again they are in phase with those being radiated at that instant. The appropriate length of the radius depends upon the wavelengths, the relation being that it should be substantially a multiple of half wavelengths, namely, N multiplied by Lambda divided by two. The factor N is so chosen that the radius shall be large enough to insure that the reflector has satisfactory electro-optical properties, but not so large as to intercept unduly the radiations reflected forward from the paraboloidal reflector.

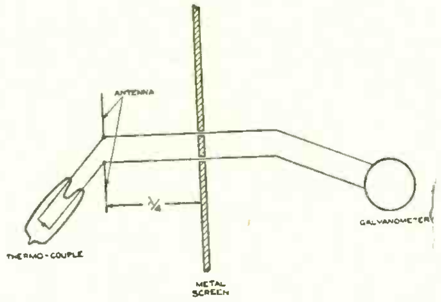
Method of Radiation

The function of this hemi-spherical reflector is illustrated in Fig. 1, the effect of diffraction being neglected in this description, although in practice it must be taken into account. It will be seen that the direct radiations such as AB pass straight to the para-

Ray System

elength Between Dover and Calais

FIG. 4
Detail of the radiation meter showing the position of the antenna serving the meter, the thermocouple and the galvanometer.



boloidal reflector and so are directed towards the distant receiver, whereas waves such as AC are reflected by the hemi-spherical reflector back through A onto the paraboloidal mirror at D, and so out in the required direction.

It is estimated that the gain due to the paraboloidal reflectors on one channel is of the order of 46 decibels to which the hemi-spherical reflectors add another 6 decibels.

A further interesting point is the arrangement made for measuring the high frequency output at the transmitter. For this purpose an aperture is provided in the centre of the paraboloidal reflector through which part of the radiation passes.

No Loss In Radiated Power

By making the diameter of the aperture slightly smaller than that of the hemi-spherical reflector no loss of radiated power results. The radiations passing through the aperture fall upon the special measuring instrument employed, as indicated diagrammatically in Fig. 4. This takes the form of a wave meter calibrated for and normally set to the transmitted frequency. It comprises a small receiving antenna in which the induced emf is used to act upon a thermo couple junction. The readings of the associated galvanometer are an indication of the radiated power, while the distance between the antenna and metal screen, being adjustable, also enables wave length measurements to be made. In the demonstration the wave length use was 18 centimeters while the radiated power was about half a watt.

The receiver is a counterpart of the transmitter except that no high frequency measuring device is provided. That is to say, it comprises a doublet connected by a transmission line of the microradion tube where detection takes place. Paraboloidal and spherical mirrors exactly similar to those of the transmitter are also provided for concentrating the received waves upon this doublet.

To avoid coupling, the receiver is situated about 80 yards from the transmitter at each terminal and is arranged to be in its electro-optical shadow, adequate allowance being made for diffraction. The arrangement will be apparent from Fig. 2. The same wavelength is used both for sending and receiving.

What the Demonstration Proves

The success of this demonstration has definitely shown that a wavelength range as low as 10 centimeters is opened up. The importance of this from the point of view of ether congestion need hardly be stressed. Calculation will show that the range of frequencies available in the "micro-metric" wave band (between 10 and 100 centimeters) is some nine times as great as in the whole of the ordinary radio field. Added to this is the fact that the radiations can easily and cheaply be concentrated into a small solid angle.

Commercial applications in a world-wide communication network like the International System are obvious.

The frequency band available will permit the working of a very large number of permanent and continuous channels between the same places without mutual interference.

Suitable for Television

A further very important use will be for television transmission. The present difficulty with regard to television is the very large frequency range required for satisfactory definition of the object transmitted. It should now be possible to allocate as wide a band as is necessary for television without causing any ether congestion.

For navigation purposes and especially for radio beacons the simplicity of the transmitters has obvious advantages.

Valuable applications seem possible in ship to ship communication, as the small size of the equipment would enable easy use to be made of its directional properties. In addition, the micro-ray system affords a satisfactory method for virtually secret intercommunication between war vessels.

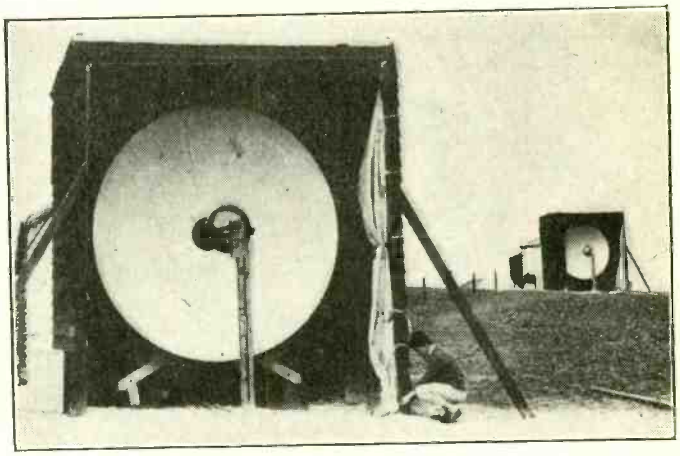


FIG. 5

Photographic view of a transmitting reflector. In the background, is the receiver reflector, located in the electro-optical shadow of the transmitter.

Demonstration was also given of the high-speed facsimile transmission system developed by the International Telephone and Telegraph Laboratories.

While this successful demonstration proves the practicability of the micro-ray, further refinements are being carried on to prepare it for everyday commercial application.

It is interesting to recall that just forty years ago another pioneering departure, the first submarine telephone cable between England and France, was laid over practically the same ground as the recent epoch-making achievement.

[The wavelength used in the Dover-Calais demonstration, 18 centimeters, is 7.08 inches, or a little less than the total width of the rule under the date line at top of this page.—EDITOR.]

Screen Grid Tube Requirements

THE screen grid tube holds marvelous possibilities for the improvement of radio reception. It is not an easy tube for the radio experimenter to use, however, and it calls for special consideration in its circuit connections and mechanical arrangement of the set.

The listener must not imagine that he can replace his 201A or 226 tubes with screen grid tubes and revolutionize his reception! The changes are so complex that it is hardly worth while for the owner of an older model set to attempt to make the changes that are required.

The screen grid tube usually demands:

(1)—Shielding
(2)—Special circuits
(3)—Specially designed coils

Shielding is the outstanding requirements and it is very difficult to install proper shields except in a new set. The screen grid tube is designed to prevent the re-transfer of energy from the plate circuit to the grid circuit that causes the tube to "oscillate" or set up a howl.

However, the feedback must not take place by any other route, such as from coil to coil by induction, from condenser to condenser, from wire to wire, etc. In order to prevent this, it is necessary to completely enclose the grid circuit in a metal case or box and as a rule the plate circuit is similarly enclosed. The metal cans have removable covers so that repairs and renewals may be made.

Screen grid tubes are manufactured for AC or DC sets. The storage battery screen-grid tube, which is not in wide use except by radio experimenters and those limited to storage battery supply, is the 222. The AC screen-grid tube, in very gide service today, is the 224.

Radio University

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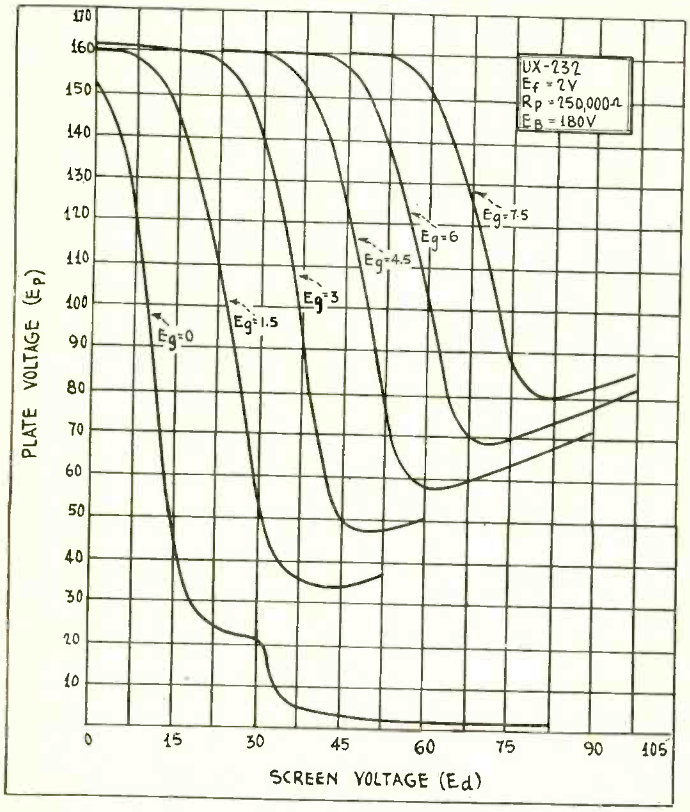

FIG. 912

A family of screen voltage plate output voltage curves for a 232 screen grid tube with 180 volts in the plate circuit and various control grid voltages.

Computing Bias Resistors

HOW is the grid bias resistor for a tube computed? What must be taken into account? Please give a formula in words that is applicable to any tube.—W. G. J.

The first thing that must be known is the bias that is desired on the tube. Then the current that will flow through the bias resistor must be determined. From these two the value of the resistance can be determined by simply dividing the bias voltage by the current through the resistance. If the bias is given in volts and the current in milliamperes, multiply the quotient by 1,000. For example: suppose we want to determine the bias resistor for a 245 tube. The needed bias is 50 volts and the current through the bias resistor will be 32 milliamperes. Therefore, the resistance is 50/32 times 1,000 ohms, or 1,562.5 ohms.

In case of a three element tube, the current through the bias resistance is only the plate current at the given bias. Both these values are given with the tube. In case of a screen grid tube the screen current as well as the plate current flows through the bias resistor and the two must be added. The exact value of the screen current may not be furnished with the tube but it is usually stated that it is less than one-third as much as the plate current. Hence, it is customary to assume that the screen current is one-third as much as the plate current, or a little less. For example, the 224 screen grid tube requires a grid bias of 1.5 volts and it takes a plate current of 4 milliamperes. It is customary to take the screen current as 1 milliampere, so that the total current through the grid bias resistor is 5 milliamperes. Hence, we have 1.5/5 times 1,000 as the value of the bias resistor; that is, 300 ohms. This is near enough.

* * *

Variation of Output With Screen Voltage

IN what manner does the output voltage of a screen grid tube vary with changes in the screen voltage when the grid and plate voltages are held constant?—E. S. D.

In Fig. 912 is a family of curves between the screen voltage and the voltage between the plate and the filament of a 232 screen grid tube for a fixed voltage in the plate circuit of 180 volts, a plate load resistance of 250,000 ohms, and various control grid voltages. The voltage drop in the plate coupling resistance is the difference between 180 volts and the voltage indicated by the curves. For example, on the 1.5 curve at a screen voltage of 22.5 volts, the curve indicates a voltage drop in the tube of 110 volts. Therefore, the voltage drop in the resistance is 180—110, or 70 volts. Since the resistance is 250,000 ohms, the current through the resistance under these conditions is 70/250, or 0.28 milliamperes. The voltage drop in the coupling resistance and the current through it for any other combination of voltages encompassed in the family of curves can be obtained in the same way.

* * *

Conversion Table Accuracy

IN the April 11th issue of RADIO WORLD, you published a conversion table between kilocycles and meters, in which you based the conversion on 300,000. Is it not a fact that the conversion factor should be a little smaller than this? How much is the error, if any, and is it large enough to affect the calibration of an ordinary wavemeter?—B. N. F.

The error is less than one per cent, for the correct factor is about 299,860. An ordinary wavemeter may be accurate to one per cent so that the error in the table is not large enough to make any difference.

* * *

The LC Factor

WHAT is the meaning of the LC factor as applied to wavelengths?—E. W. H.

The LC factor determines the resonance of a circuit to a particular wave. Any circuit having the same value of the product LC is resonant to the same wave regardless of the relative values of L and C. If L is reduced in value to one-half, the value of C must be doubled to maintain the circuit in resonance with the same frequency. This formula is sometimes very useful. Sometimes the numerical values of LC for different waves are also useful and tables giving these values are available. The square root of the product LC is more useful than LC itself.

* * *

Self-Modulated Oscillator

IS it possible to build an AC operated oscillator which is self-modulated with either 60 or 120 cycles? If so, how can it be done?—H. E. H.

It is very easy. If you use a filament type tube and put raw AC on the filament, returning the grid to one side of the filament, you modulate the generated current by a combination of 60 and 120 cycles. With raw AC on the plate, you get a type of oscillation which is modulated with 60 cycles. If you put rectified but unfiltered voltage on the plate you get an output that is modulated with 120 cycles. If you put an extra winding of low voltage on the filament transformer and connect this winding either in the plate or the grid circuit, you get a 60-cycle modulation.

* * *

Significance of Power Sensitivity

CAN you state in a few words the significance of power sensitivity and the advantage of having a tube in which this figure of merit is high?—R. E. J.

The power sensitivity is a measure of the power amplification of the last tube or of the tube so rated. The advantage is that a given power output is obtained from the tube with a small input voltage. Hence, a tube having a high power sensitivity will make a set more sensitive and in some cases permits the omission of a stage of audio frequency amplification. A tube having a high power sensitivity is suitable after a power detector.

* * *

Limiting Screen Current

SCREEN grid tubes are supposed to be operated so that the screen current is not more than one-third of the plate current. Does this apply to resistance coupled amplifiers as well as to transformer coupled circuits? What happens if the screen current is allowed to become equal to or greater than the plate current?—J. B. Y.

HOW TO GET QUESTIONS ANSWERED

QUESTIONS of general interest are answered by publication in this department, and the answers invariably are to questions submitted by members of RADIO WORLD'S *University Club. Copies of the answers, in such instances, are mailed promptly to the inquiries, so they will not have to wait to see the answers published in this department. We can not undertake to answer questions except those submitted by members of the University Club. For details of acquiring membership in this Club please see notice printed in the heading of this department.—Editor.*

It holds for all types of coupling. In resistance coupled circuits it is especially important to limit the screen current to a comparatively low value. If the screen current is allowed to become equal to or greater than the plate current, distortion results. In resistance coupled circuits the screen current may be kept down either by applying a low screen voltage or by putting in a resistance in the screen lead. If a sensitive current meter, such as a 0-1 milliameter, is available the adjustment of the circuit may be made with its aid.

* * *

Why Large Capacity Is Used

IN your short-wave converters with built-in B supply, the first condenser next to the rectifier is usually 8 mfd. Why is it necessary to use such a large value? Would it not be better to use four microfarads on each side of the choke coil?—A. A. L.

It is necessary to use a high capacity because the rectifier is of the half-wave type and the condenser is needed to fill in the inactive half periods and to smooth out the current. The filtering would be just about as good if 4 mfd. were placed across the line at each end of the choke coil.

* * *

Converter Picks Up Broadcasts

WHY is it that most short-wave converters pick up broadcast stations directly without the aid of the oscillator in the converter? I have one that is very sensitive to short-waves but broadcast stations come in no matter where I set the oscillator condenser. It should not be that way, should it?—S. F.

They come in because the wiring in the converter acts as an antenna. The interference can be reduced by shielding the converter, especially the voltage supply leads and those leads which pertain to the output of the detector or the intermediate frequency stage, if any. It can also be reduced by tuning the input to the short-wave converter detector to the short-wave signal.

* * *

Band-Spanning Condensers

IF the minimum capacity of a condenser in a tuned circuit is 20 mmfd. and the maximum is 125 mmfd., the distributed capacity in each case being included, what is the wave band that condenser will cover? Will it cover the same band no matter what the absolute frequency may be; that is, no matter what the inductance in the tuned circuit may be? How is the width of the band covered determined?—W. E. F.

When the ratio of the highest to the lowest capacity in the tuned circuit is 125/20, the ratio of the highest to the lowest frequency is equal to the square root of this ratio. That is, the ratio of the frequencies is 2.5. It does not depend on the inductance or on the absolute frequency. The ratio of the highest to the lowest frequency in the broadcast band is 1,500/550. The square of this ratio is equal to the ratio of the highest to the lowest capacity in the tuned circuit if it is to cover the broadcast band. That is, the capacity ratio must be 7.44. If the tuning condenser has a range of 500 mmfd. and the distributed capacity in the circuit is 25 mmfd., the highest capacity is 525 and the lowest is 25 mmfd. The ratio is 21. Since this is higher than 7.44 the tuner will cover the broadcast band and still more. In fact, it will cover a frequency ratio of 4.58.

Suppose the capacity range of the tuning condenser is 350 mmfd. and that the distributed capacity is 50 mmfd. The maximum capacity is, therefore, 400 and the minimum 50 mmfd. The capacity ratio is 8. This also is larger than 7.44 and the broadcast band will be covered. However, if the distributed capacity is much more, the tuner will not cover the band. In fact, the distributed capacity cannot be more than 54.4 mmfd. It is usually more when the tuning condenser is a 350 mmfd. and for that reason this condenser does not cover the band. This is particularly true when the coil is shielded and when there is a trimming condenser across the variable.

* * *

One Tube Receiver

IN the April Special issue, on page 5 you published a one-tube set utilizing a 230 tube. Would there be any advantage in using a 231 power tube in this circuit instead of a 230? Could this circuit be used as a portable for earphone reception?—A. E. M.

No improvement would result by using a power tube for the 230. If that tube had been better, it would have been specified. Sure, the circuit can be used as a portable for earphone reception. But it will not be very sensitive unless you provide a good antenna and a ground wherever you set up the circuit.

* * *

Bending of Characteristics of Tubes

WHAT makes the grid voltage, plate current curve of a tube bend over as the grid bias approaches zero? That is, why does it not continue to rise more and more rapidly? There is an indication that the mutual conductance drops as the bias approaches zero.—J. P. L.

There are several reasons for this. One is that when AC is on the filament and the grid return is made to the midpoint of the filament transformer, part of the filament is positive part of the time when the grid bias indicated is still negative. This does not apply to heater type tubes nor to tubes on which the filament is heated with direct current. Another reason is that the cathode emission may approach the saturation point when the grid bias goes toward zero. This applies to all types of tubes but only when the filament temperature is so low that the saturation is reached for low values of plate current, or when the plate voltage is very high. Still another reason is that the effective plate voltage is reduced as the plate current increases. This, also, applies to all tubes but only when there is an appreciable resistance in the plate circuit. In the case of a screen grid tube, or pentode, the drop in the rate of increase of the plate current may also be due to too high screen voltage, the screen robbing the plate of current.

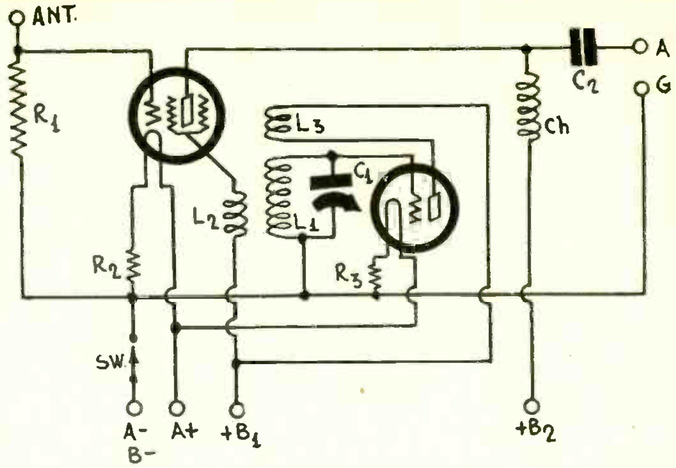

FIG. 913
A two tube converter circuit utilizing 2 volt tubes and a single tuner.

* * *

Two Tube Converter

I WISH to build a short-wave converter with two tubes and one tuner utilizing 2-volt tubes and screen grid modulation in the detector. If you have a suitable diagram please publish it.—A. B.

A circuit of this type is given in Fig. 913. The first tube is a 232 and the oscillator is a 230. If the filament battery voltage is three volts, R2 and R3 each should be 16.7 ohms. Twenty ohm rheostats are suitable provided that they are set so that the voltage across the filaments does not exceed 2 volts. The oscillator in this circuit was described in the Nov. 15th, 1930, issue of RADIO WORLD. R1 can be 100,000 ohms, C2 .0015 mfd. and Ch 50 millihenries. B1 should be 45 volts and B2 135 volts.

* * *

A Question of Bias

IN the DX-4 converter discussed in the April 11th issue, you have a 100 ohm bias resistor for the amplifier and the oscillator. Does this give enough bias for the tubes when each should have a resistance of 300 ohms?—W. C. B.

It is sufficient. A tube does not have to be operated with the same bias under all conditions, nor with the same bias resistor. In this case, the 100 ohm resistance serves two tubes and it is the equivalent of using two 200 ohm resistances, one for each tube. The circuit would work well without any bias resistor.

A THOUGHT FOR THE WEEK

ROXY is to head the entertainment section of the Rockefeller Radio City, which is to raise its head on what is the most costly parcel of land ever devoted to any amusement enterprise. Rumors of the engagement of Samuel L. Rothafel have been heard for months, and recently the official announcement was made. Roxy occupies an unique position in radio. He is beloved by millions of listeners-in. He is admired and respected by the many artists who have been associated with him. He has vision and keen understanding in building up programs. His experience is wide and his successes are many. Radio City has an entrepreneur of whom even so rich and powerful an organization may well feel proud.

RADIO WORLD

The First and Only National Radio Weekly
Tenth Year

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Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

New Plant Expense Cuts Pilot's Income

The Pilot Radio and Tube Corporation reported for the year ending December 31st, 1930, net income, after all charges, of $62,361, equal to 28 cents a share on the capital stock, compared with $404,162, or $1.84 a share, in 1929. Isador Goldberg, president, said the net income did not reflect the true earning capacity of the company in 1930, as $255,000 of non-recurring expense in concentrating activities in a new factory had been incurred and that if this operation had not taken place the earnings a share would have been higher than in 1929.

CALCATERRA QUITS AEROVOX

Joseph Calcaterra has left the employ of the Aerovox Wireless Corporation, 70 Washington street, Brooklyn, N. Y., where he served in an advertising and sales promotion capacity. He will conduct his own publicity business.

Forum

Wants Service Data Only

I HAVE perused carefully the sample copy of RADIO WORLD which you sent me recently, and do not consider it would be of benefit to me to subscribe for it. The contents are of great value to experimenters and amateurs who like to build their own sets, but are of very little use to the service man who has to deal with manufactured receiving sets, mostly. For that reason, it would be only money thrown away were I to subscribe for it. A real good weekly, for service men only, giving diagrams and service notes, would, no doubt, have a ready sale to the trade and I would recommend this to your attention.

C. D. ARMOUR,
237 River Street East,
Moose Jaw, Sask., Canada.

Rose Marie's Tonsils Removed in Hospital

Baby Rose Marie, six-year-old crooner, is in a hospital, where her tonsils and adenoids were removed. She cancelled radio and vaudeville contracts.

Although Baby Rose Marie has not suffered from any acute attack of tonsilitis or other serious trouble, indications that such might develop in future years induced her parents to order the operation. Physicians report that the operation will not affect the child's singing voice.

Rose Marie is a radio star and her name flashes in theater bright lights. She has been making public apeparances since she was two years old, when she won an amateur stage contest. For more than a year she has held a contract with the NBC Artists Service.

ARCTURUS LOST $1,368,898

The Arcturus Radio Tube Company reported for the year ending December 31st, 1930, a net loss, after expense, depreciation, amortization, plant value and inventory adjustments, of $1,368,898, against a 1929 net income of $538,429, equal to 89 cents a share.

The company's business is increasing greatly, due in part to inclusion of its tubes in the new Atwater Kent pentode set.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y.

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J. W. Myers, Vandalia, Mo.
Alvin Current, Tontogany, Ohio.
C. W. Woodworth, P. O. Box 364, Lockney, Texas.
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Archie Hamil, 1810 No. 6th St., Minneapolis, Minn.
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J. Verbeke, 919 Sixth Ave., Saskatoon, Sask., Canada.
H. A. Lathe, 4667 Edgewood Ave., Oakland, Calif.
E. M. Garl, 418 Hubbard Ave., Elkhart, Ind.
Simon Gordon, 562 Ashford St., Brooklyn, N. Y.
Charles E. Reed, 815 Missouri Ave., Kansas City, Mo.
E. L. Krueger, 210 Sumner St., Peoria, Ill.
Harold Reiling, 1121 Huffman Ave., Dayton, Ohio.
Mahd-LO Wave Converter Co., 20 Chatham Rd., Columbus, Ohio.
John L. Cronk, 15 Elmore St., Grove Hall, Boston, Mass.
Radio Repair Co., 253 Center St., Bangor, Maine.
F. P. Jones, 303 Pound Bldg., Chattanooga, Tenn.
D. Anastasio, 83006 Panola St., New Orleans, La.
J. F. Chromcak, Box 258, Louise, Texas.
F. W. Fox, 1332 Burrard St., Vancouver, B. C., Canada.
E. H. Freeman, Box 283, New Albany, Miss.
C. R. Milligan, Moultrie, Ga.
Frank Viscount, 462-11th Ave., San Francisco, Calif.
Oliver Anderson, 605 N. 59th Ave., W. Duluth, Minn.
D. H. Nirst, Scotts Bluff, Nebr.
R. C. Dodge, 1507 Olive St., Texarkana, Tex.
Roy N. Brougher, Box 1650, Dallas, Tex.
Chris. Nelson, Plano, Ill.
Jacob Hauck, J. Hauck & Sons, Oregon City, Ore.
O. Trumbauer, 356 10th St., Brooklyn, N. Y.
Wm. S. Burke, Box 654, Trinity, Texas.
John A. Nagy, 1319 Merrill Ave., Lincoln Park, Mich.
C. Hellums, Exeter, Calif.
D. E. Stevens, 6524 Lebanon Ave., Philadelphia, Pa.
S. O. Weltman, 10520 Columbia, Cleveland, Ohio.
Fred M. Kiser, Radios, 303 N. 1st St., Phoenix, Ariz.
John T. Roper, 746 Lincoln St., McKeesport, Pa.
Liston Comer, Box 435, Cape Girardeau, Mo.
Paul E. Mills, Lake Mary, Fla.
James Muir, 15039 Stansbury, Detroit, Mich.
V. D. Wyllie, 36 Maple Ave., Gloversville, N. Y.
Louis Jacobson. 420 Carolina St., Vallejo, Calif.
Wm. W. Ritter, Box 3312, Dodge City, Kans.
George F. Cornet, Radio Engineering, Altoona, Pa.
I. L. Denham, 521 W. 17th Ave., Houston, Tex.
Erle Hathaway, R. F. D. No. 6, Walla Walla, Wash.
Bakers Radio Service, 1512 Meadowbrook Ave., Youngstown, Ohio.
M. H. Steele, 3030 Potomac Ave., Los Angeles, Calif.
Frank Luck, 300 E. Second St., North Portland, Ore.
Theodore Eckfeldt, Banner Radio Service, 7334 S. Green St., Chicago, Ill.

Aerial Attack on N. Y. To Set Radio Record

The largest fleet of airplanes ever assembled will occasion the most complicated and pretentious special event broadcast in the history of radio Saturday afternoon, May 23, the National Broadcasting Company announced. There will be 672 planes in the fleet.

The broadcast will be a complete account from land and sky of the aerial attack on New York City incident to the Army air maneuvres. It will be the last of a series of programs which NBC will distribute to its combined, nation-wide networks in connection with the week of sham battles, scouting expeditions and other tactical maneuvres annually staged to keep the United States air fleet in trim.

NEW $300,000 TRANSMITTER USED BY WEAF

The new WEAF transmitter at Bellmore, N. Y., begun last Summer and recently completed at a cost of more than $300,000, was put on a permanent operating basis.

The WEAF transmitter gives 100 per cent. modulation.

The station continues to operate with a maximum power of 50,000 watts. With modulation increased from less than 50 to 100 per cent., listeners receive the station's signals several times louder. This also means practically perfect transmission of every audible sound picked up by the microphone. These improvements eliminate many, but not all, spots or areas in which the station could not be heard.

The new transmitting apparatus has been heard even in New Zealand.

Art in the Hotel Manner

The transmitter is installed in a new wing of the WEAF operating building at Bellmore, which is on Long Island. This room rivals a hotel lobby in artistic arrangement and style.

Additional features of the new equipment are that it gives uniform frequency response and passes all frequencies in the audible range. High and low notes, sybilants and certain other sounds heretofore either lost to the listener or received indistinctly, are transmitted perfectly. Operation can be changed from the new transmitter to the old or vice-versa with such facility that the listener will be conscious of no actual mechanical change except a noticeable variation in the volume of reception.

The equipment includes latest refinement in crystal control apparatus to hold the station on its assigned frequency (660 kc.), giving increased frequency stability. Careful observations show that the fluctuation is only ten cycles in 660,000. The transmitter employs two 100 kilowatt tubes which stand five feet high and require thirty gallons of water per minute to cool them.

Observation Facilities

An improved water cooling pond having a capacity of 75,000 gallons has been constructed in front of the transmitter building and with its two ten-foot cooling sprays greatly enhances the scenic attractiveness of the grounds.

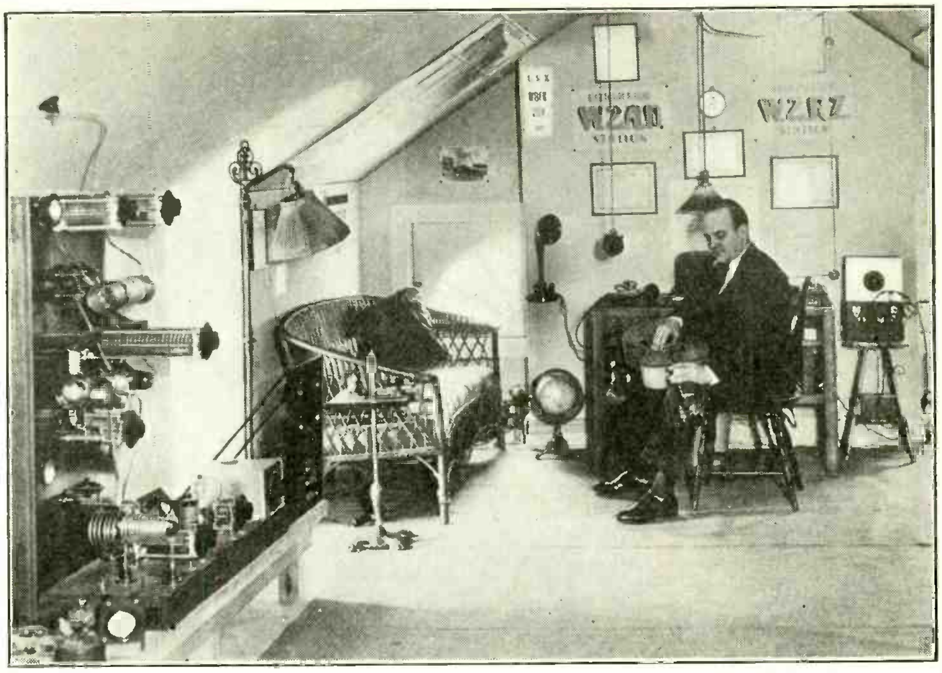
The engineers also installed independent power transmission lines, thus greatly reducing the possibility of delays from power failure. A special power vault was constructed for metering and switching these lines.

The control room is provided with double glass observation windows so visitors may observe apparatus functioning without endangering themselves and so that the control operator may have the transmitter under observation.

NEWSPAPER RADIO EDITOR FINDS RADIO WORLD USEFUL

"I find your paper extremely useful from the point of view of referring my correspondents to it for more complete information on their problems than it is practical to give in a single letter."—*From Radio Editor of a noted American daily paper and a subscriber for Radio World.*

NEVER OFF HIS KEY, SANELLA'S BOAST



(Acme)

Andy Sanella, player of a variety of musical instruments and featured on several sponsored chain programs originating from New York, is an amateur radio operator. He has an expensive transmitter and receiver.

All-Wave Receiver Uses Switch System

A new combination-wave radio receiver has been brought out by the Pilot Radio & Tube Corporation. It covers 15 to 650 meters without the use of the plug-in coils. The shifting from one wave range to another, in seven steps, is done from the front panel by the turning of a knob. It is available in both factory-built and kit models, for either AC or battery operation.

While intended primarily for use on the short waves, for the direct reception of foreign stations, the new instrument is also a broadcast receiver, and takes in the calling waves used for ship-to-shore radio telegraphic traffic.

A pair of molded bakelite cam switches is used. Each switch carries fifteen thin cams which make contact, in predetermined sequence, with fifteen little plungers sticking out of the housing like the spark plugs in an automobile. As the switches are turned they change the electrical connections between four pairs of fixed tuning coils and two double-section variable condensers. There are seven combinations, producing the following wavelength ranges: 15 to 23 meters, 22 to 41, 40 to 75, 70 to 147, 146 to 270, 240 to 500, and 470 to 650.

Gibbons Signs Up For Movie "Shorts"

The biggest contract ever offered for a series of movie shorts has been signed by Floyd Gibbons, broadcaster and former war correspondent.

He will appear in a series of thirteen shorts, entitled, "Floyd Gibbons' Supreme Thrills," to be produced by A. P. Waxman and Michael Mindlin in association with the RKO-Van Beuren Corporation. Aside from Gibbons, many military celebrities will face the movie cameras in the series, and the shorts will portray episodes of their experiences. Most of the military men will be of World War fame.

58,446 Florida Families Have Sets

WASHINGTON.

Of the total number of families in Florida, 15.5 per cent have radio sets, the Bureau of Census, Department of Commerce, announced. The statement follows:

The Director of the Census announces the results of a preliminary count of the number of families in the State of Florida according to the 1930 census, together with the number of families reporting radio sets. The whole number of families in the State on April 1st, 1930, was 377,823, as compared with 234,133 in 1920. The number of persons per family in 1930 was 3.9, as compared with 4.1 in 1920. The number of families reporting radio sets in 1930 was 58,446, or 15.5 per cent of the total.

The term "family," as used in making the count referred to above, signifies a group of persons, whether related by blood or not, who live together as one household, usually sharing the same table.

One person living alone is counted as a family, and, at the other extreme, all the inmates of an institution, or all the persons living in a boarding house, are ordinarily counted as one family. The detailed tabulation of the 1930 family statistics will show separately several different types of families, and will give much information as to the number of families of various sizes, the number of families having children, etc., which has not been tabulated in connection with previous censuses.

Cunningham Heads RCA Radiotron Co.

Appointment of Elmer T. Cunningham as president of the RCA Radiotron Company, Inc., tube manufacturing subsidiary of the Radio Corporation of America, was announced.

T. W. Frech, former president of RCA Radiotron Company, Inc., returns to his former duties with General Electric Company as vice president in charge of its Incandescent Lamp Department.

Stations in United States and Canada, Corrected to Press Time

CANADA

Station	kc
CFAC	690
CFBO	890
CFCA	840
CFCF	1030
CFCH	600
CFCL	580
CFCN	690
CFCO	1210
CFCT	630
CFCY	960
CFJC	1120
CFLC	1010
CFNB	1210
CFQC	910
CFRB	960
CFRC	930
CHCA	690
CHCK	960
CHCS	1120
CHCT	840
CHGS	1120
CHLS	730
CHMA	580
CHML	880
CHNS	910
CHRC	645
CHWC	960
CHWK	665
CHYC	730
CJBC	690
CJBR	960
CJCA	930
CJCB	880
CJCJ	690
CJGC	910
CJGX	630
CJOC	1120
CJOR	1210
CJRM	600
CJRW	600
CJSC	690
CKAC	730
CKCD	730
CKCI	880
CKCK	960
CKCL	580
CKCO	890
CKCR	1010
CKCV	880
CKFC	730
CKGW	690
CKIC	1010
CKLC	840
CKMC	1210
CKMO	730
CKNC	580
CKOC	1120
CKOW	840
CKPC	1210
CKPR	890
CKUA	580
CKWX	730
CKX	540
CKY	780
CNRA	630
CNRC	690
CNRD	840
CNRE	930
CNRH	910
CNRL	910
CNRM	730
CNRO	600
CNRQ	880
CNRR	960
CNRS	910
CNRT	840
CNRV	1030
CNRW	780
CNRX	960
CPRY	690

UNITED STATES

Station	kc
WAAF	920
WAAM	1250
WAAT	940
WAAW	660
WABC	860
WABI	1200
WABZ	1200
WACO	1240
WADC	1320
WAIU	640
WALR	1210
WAPI	1140
WASH	1270
WAWZ	1350
WBAA	1400
WBAK	1430
WBAL	1060
WBAP	800
WBAX	1210

Station	kc
WBBC	1400
WBBL	1210
WBBM	770
WBBR	1300
WBBZ	1200
WBCM	1410
WBEN	900
WBEO	1010
WBGF	1370
WBIG	1440
WBIS	1230
WBMS	1450
WBNX	1350
WBOQ	860
WBOW	1310
WBRC	930
WBRE	1310
WBSO	920
WBT	1080
WBTM	1370
WBZ	990
WBZA	990
WCAC	600
WCAD	1220
WCAE	1220
WCAH	1430
WCAJ	590
WCAL	1250
WCAM	1280
WCAO	600
WCAP	1280
WCAT	1200
WCAU	1170
WCAX	1200
WCAZ	1070
WCBA	1440
WCBD	1080
WCBM	1370
WCBS	1210
WCCO	810
WCDA	1350
WCFL	970
WCGU	1400
WCHI	1490
WCKY	1490
WCLB	1500
WCLO	1200
WCLS	1310
WCMA	1400
WCOA	1340
WCOC	880
WCOD	1200
WCOH	1210
WCRW	1210
WCSC	*1360
WCSH	940
WDAE	1220
WDAF	610
WDAG	1410
WDAH	1310
WDAY	940
WDBJ	930
WDBO	1120
WDEL	1120
WDGY	1180
WDIX	1500
WDOD	1280
WDRC	1330
WDSU	1250
WDWF	1210
WDZ	1070
WEAF	660
WEAI	1270
WEAN	780
WEAO	570
WEBC	1290
WEBQ	1210
WEBR	1310
WEDC	1210
WEDH	1420
WEEI	590
WEHC	*1200
WEHS	1420
WELK	1370
WELL	1420
WENR	870
WEPS	1200
WETS	1200
WEVD	1300
WEW	760
WEXL	1310
WFAA	800
WFAN	610
WFBC	1200
WFBE	1200
WFBG	1310
WFBL	1360
WFBM	1230
WFBR	1270
WFDF	1310
WFDV	1370

Station	kc
WFDW	1420
WFI	560
WFIW	940
WFLA	620
WFOX	1400
WGAL	1310
WGAR	1450
WGBB	1210
WGBC	1430
WGBF	630
WGBI	880
WGBS	1180
WGCM	1210
WGCP	1250
WGES	1360
WGH	1310
WGL	1370
WGN	720
WGR	550
WGST	890
WGY	790
WHA	940
WHAD	1120
WHAM	1150
WHAP	1300
WHAS	820
WHAT	1310
WHAZ	1300
WHB	860
WHBC	1200
WHBD	1370
WHBF	1210
WHBL	1410
WHBQ	1370
WHBU	1210
WHBY	1200
WHDF	1370
WHDH	830
WHDI	1180
WHDL	1420
WHEC	1440
WHFC	1420
WHIS	1410
WHK	1390
WHN	1010
WHO	1000
WHOM	1450
WHP	1430
WIAS	1420
WIBA	1280
WIBG	930
WIBM	1370
WIBO	560
WIBR	1420
WIBU	1210
WIBW	580
WIBX	1200
WICC	600
WIL	1200
WILL	890
WILM	1420
WIOD	1300
WIP	610
WIS	1010
WISJ	780
WISN	1120
WJAC	1310
WJAG	1060
WJAK	1310
WJAR	890
WJAS	1290
WJAX	900
WJAY	610
WJAZ	1490
WJBC	1200
WJBI	1210
WJBK	1370
WJBL	1200
WJBO	1420
WJBT	770
WJBU	1210
WJBW	1200
WJBY	1210
WJDX	1270
WJJD	1130
WJKS	1360
WJR	750
WJSV	1460
WJW	1210
WJZ	760
WKAQ	890
WKAR	1040
WKAV	1310
WKBB	1310
WKBC	1310
WKBF	1400
WKBH	1380
WKBI	1420
WKBN	570
WKBO	1450
WKBS	1310

Station	kc
WKBV	1500
WKBW	1480
WKBZ	1500
WKJC	1200
WKRC	550
WKY	900
WKZO	590
WLAC	1470
WLAP	1200
WLB	1250
WLBC	1310
WLBF	1420
WLBG	1200
WLBL	900
WLBW	1260
WLBX	1500
WLBZ	620
WLCI	1210
WLEX	1410
WLEY	1370
WLIB	720
WLOE	1500
WLS	870
WLSI	1210
WLTH	1400
WLVA	1370
WLW	700
WLWL	1100
WMAC	570
WMAK	1240
WMAL	630
WMAQ	670
WMAZ	890
WMBA	1500
WMBC	1420
WMBD	1440
WMBG	1210
WMBH	1420
WMBI	1080
WMBO	1310
WMBQ	1500
WMBR	1370
WMC	780
WMCA	570
WMMN	890
WMPC	1500
WMRJ	1210
WMSG	1350
WMT	600
WNAC	1230
WNAD	1010
WNAX	570
WNBF	1500
WNBH	1310
WNBO	1200
WNBR	1430
WNBW	1200
WNBX	1200
WNBZ	1290
WNJ	1450
WNOX	560
WNYC	570
WOAI	1190
WOAX	1280
WOBT	1310
WOBU	580
WOC	1000
WOCL	1210
WODA	1250
WODX	1410
WOI	640
WOKO	1440
WOL	1310
WOMT	1210
WOOD	1270
WOPI	1500
WOQ	1300
WOR	710
WORC	1200
WOS	630
WOV	1130
WOW	590
WOWO	1160
WPAD	1420
WPAW	1210
WPCC	560
WPCH	810
WPEN	1500
WPG	1100
WPOE	1370
WPOR	780
WPSC	1230
WPTF	680
WQAM	560
WQAN	880
WQAO	1010
WQAP	1010
WQBC	1360
WQDM	1370
WQDX	1210
WRAF	1200
WRAK	1370

Station	kc
WRAW	1310
WRAX	1020
WRBI	1310
WRBJ	1370
WRBL	1200
WRBQ	1210
WRBT	1370
WRBX	1410
WRC	950
WRDO	1370
WRDL	1310
WRDW	1500
WREC	600
WREN	1220
WRHM	1250
WRJN	1370
WRNY	1010
WRR	1280
WRUF	830
WRVA	1110
WSAI	1330
WSAJ	1310
WSAN	1440
WSAR	1450
WSAZ	580
WSB	740
WSBC	1210
WSBT	1230
WSEN	1210
WSFA	1410
WSIX	1210
WSJC	1310
WSJS	1310
WSM	650
WSMB	1320
WSMK	1380
WSOC	1210
WSPA	1420
WSPD	1340
WSSH	1410
WSUI	880
WSUN	620
WSVS	1370
WSW	1500
WSYB	1500
WSYR	570
WTAD	1440
WTAG	580
WTAM	1070
WTAQ	1330
WTAR	780
WTAW	1120
WTAX	1210
WTBO	1420
WTEL	1310
WTFI	1450
WTIC	1060
WTMJ	620
WTNT	1470
WTOC	1260
WWAE	1200
WWJ	920
WWL	850
WWNC	570
WWRL	1500
WWVA	1160
WXYZ	1240
KBGX	1310
KBTM	1200
KCRC	1370
KCRJ	1310
KDB	1500
KDFN	1210
KDKA	980
KDLR	1210
KDYL	1290
KECA	1430
KELW	780
KEX	1180
KFAB	770
KFBB	1280
KFBK	1310
KFBL	1370
KFDM	560
KFDY	550
KFEL	920
KFEQ	680
KFGQ	1310
KFH	1300
KFHA	1200
KFI	640
KFIO	*1120
KFIU	1310
KFJZ	*1420
KFJB	1200
KFJF	1480
KFJI	1370
KFJM	1370
KFJR	1300
KFJY	1310
KFKA	880

Station	kc
KFKX	1020
KFKB	1050
KFKU	1220
KFLV	1410
KFLX	1370
KFMX	1250
KFNF	890
KFOR	1210
KFOX	1250
KFPL	1310
KFPM	1310
KFPY	1340
KFQD	1230
KFQU	1420
KFQW	1420
KFRC	610
KFRU	630
KFDS	600
KFSG	1120
KFUL	1290
KFUM	1270
KFUO	550
KFUP	1310
KFVD	1000
KFVS	1210
KFWB	950
KFWF	1200
KFWI	930
KFXD	1420
KFXF	920
KFXJ	1310
KFXM	1210
KFXR	1310
KFXY	1420
KFYO	1420
KFYR	550
KGA	1470
KGAR	1370
KGB	1330
KGBU	900
KGBZ	930
KGCA	1270
KGCI	1370
KGCR	1210
KGCU	1200
KGCX	1310
KGDA	1370
KGDE	1200
KGDM	1100
KGDY	1200
KGEF	1300
KGEK	1200
KGER	1360
KGEW	1200
KGEZ	1310
KGFE	1420
KGFG	1370
KGFI	1500
KGFJ	1200
KGFK	1200
KGFL	1370
KGFW	1310
KGFX	580
KGGC	1420
KGGF	1010
KGGM	1230
KGHF	1320
KGHI	1200
KGHL	950
KGIQ	1320
KGIR	1360
KGIW	1420
KGIX	1420
KGIZ	1500
KGJF	890
KGKB	1500
KGKL	1370
KGKO	570
KGKX	1420
KGKY	1500
KGMB	1320
KGMD	1500
KGMP	1210
KGNF	1430
KGNO	1210
KGO	790
KGRS	1410
KGU	940
KGW	620
KGY	1200
KHJ	900
KHQ	590
KICK	1420
KID	1320
KIDO	1250
KIT	1310
KJBS	1070
KJR	970
KLCN	1290
KLMB	1200
KLO	*1400
KLPM	1420

Station	kc
KLRA	1390
KLS	1440
KLX	880
KLZ	560
KMA	930
KMBC	950
KMCS	*1120
KMED	1310
KMJ	1210
KMMJ	740
KMO	860
KMOX	1090
KMPC	710
KMTR	570
KNX	1050
KOA	830
KOAC	550
KOB	1180
KOCW	1400
KOH	1370
KOIL	1260
KOIN	940
KOL	1270
KOMO	920
KONC	1370
KOOS	1370
KORE	1420
KOY	1390
KPCB	650
KPJM	1500
KPO	680
KPOF	880
KPPC	1210
KPQ	1500
KPRC	920
*KPPS	1420
KPSN	1360
KPWF	1490
KQV	1380
KQW	1010
KRE	1370
KREG	1500
KRGV	1260
KRLD	1040
KRMD	1310
KROW	930
KRSC	1120
KSAC	580
KSAT	1240
KSCJ	1330
KSD	550
KSEI	900
KSL	1130
KSMR	1200
KSO	1380
KSOO	1110
KSTP	1460
KTAB	560
KTAP	1420
KTAR	620
KTAT	1240
KTBI	1300
KTBR	1300
KTBS	1450
KTHS	1040
KTLC	*1310
KTM	780
KTNT	1170
KTRH	1120
KTSA	1290
KTSL	1310
KTSM	1310
KTW	1270
KUJ	1500
KUOA	1390
KUSD	890
KUT	1500
KVEP	1500
KVI	760
KVL	1370
KVOA	1260
KVOO	1140
KVOS	1200
KWCR	1310
KWEA	1210
KWG	1200
KWJJ	1060
KWK	1350
KWKC	1370
KWKH	850
KWLC	1270
KWSC	1220
KWWG	1260
*KXYZ	....
KXA	570
KXL	1420
KXO	1200
KXRO	1310
KYA	1230
KYW	1020
*KZM	1370

[The list of United States broadcasting stations by frequencies, with full details of call, owner, location, power and time-sharers, was published in the April 11th issue, and comprised nine full pages. Details of any of the U. S. stations listed above may be ascertained by reference to the frequency in the April 11th list. No more complete details ever were published than were in that most comprehensive register. The list of short wave stations of the world, by frequency, with waves given, was printed in the March 28th issue, giving the hours on the air for all time zones in the Western Hemisphere. Additions to the short-wave list appeared in the April 4th issue. Send 45c for the March 28th, April 4th and April 11th issues to Radio World, 145 West 45th Street, New York, N. Y., and the copies will be mailed to you promptly.]

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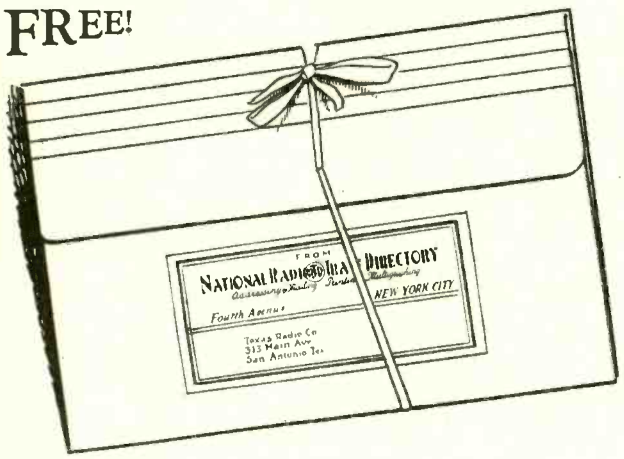

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Enclosed please find $1.00 for one year's subscription to your "Big Mail" and "Radio" Information Service. It is understood that you are to put my name on your stencil list to receive mailings, including catalogs, bulletins, price lists, samples, etc. I am also to receive free a 10 by 12-inch accordion portfolio.

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175 KC Transformer

A doubly tuned fixed-frequency transformer, 1 to 1 ratio, tuned to 175 kilocycles, is one of Supertone's new precision products. Two loosely coupled duo-lateral-wound high-inductance choke coils constitute primary and secondary. Suitable for all uses where 175 kilocycle frequency is desired, and affording high selectivity, without side-band cutting. The transformer may be mounted on the side of a chassis, in horizontal position, or upright either above or below the chassis top.

Supertone 175 kc. transformer, for screen grid tubes, with tuning condensers across primary and secondary, both accessible; in aluminum shield 2¼ inches diameter, 2½ inches high, with removable bottom, both horizontal and upright mounting facilities. Order Cat. FF-175, net price........$3.00

For other than screen grid tubes (secondary alone is tuned to 175 kc.; ratio is 1 to 4). Order Cat. FF-175-G, net price........................$2.65

1600 KC Transformer

Doubly tuned, primary and secondary, in same type shield as the 175 kc. transformer, for use with screen grid amplifier tubes, and any type detector tube. Order Cat. FF-1600, net price $2.50

For other than screen grid tubes (secondary alone is tuned), order Cat. FF-1600-G, net price $2.15

[Either transformer, assembled on tube socket, 50c extra. Add "S" to catalogue number]

Aluminum Shields

3" diameter, 3½" high, bottom open; for broadcast coils. Order Cat. SHN, net price......... .25

2¼" diameter, 2½" high, removable top; total enclosure. Order Cat. SHS, net price......... .25

Selectifier

Band pass filter pre-selector, 10 kc admittance band, two tuned circuits, single control, vernier dial, makes any set selective, tunes out interference, including neighboring station. In beautiful walnut finish cabinet, 7¾" high x 7¾" wide x 5½" front to back. Order Cat. SEL, net price $10.00

Supertone Products Corporation
216 Wallabout Street, Brooklyn, N. Y.
Telephone: WIlliamsburg 5-3872
[10-DAY MONEY-BACK GUARANTEE!]

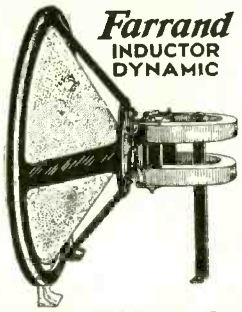
"RADIO TROUBLE SHOOTING," E. R. Haan. 328 pages, 300 illustrations, $3. Guaranty Radio Goods Co., 143 W. 45th St., New York.

NEW VARIABLE MU TUBE

To remedy cross-modulation and cross-talk, without circuit changes, a new AC screen grid tube has been developed, the G-51. In AC circuits where the volume control varies the grid bias or the screen voltage, or in which there is an automatic volume control, the new tube works wonders. This is the sensational tube developed by Stuart Ballantine. Price, $3.80.

RELIABLE RADIO CO.
143 WEST 45th St., N. Y. City

Farrand INDUCTOR DYNAMIC



The inductor dynamic offers high sensitivity and true tonal response. It requires no exciting field current, unlike other dynamics. Order model B for 112 or 112A, and Model G for all other output tubes.

Cat. 9-G (9" extreme outside diameter) $8.49

Cat. 9-B $8.49

Cat. 12-G (12" extreme outside diameter) $10.03

Cat. 12-B $10.03

GUARANTY RADIO GOODS CO.
143 W. 45th St., New York, N. Y.

ALL U. S. BROADCAST STATIONS BY FREQUENCIES

Nine full pages in Radio World dated April 11. Send 15c in stamps or coin for copy. Or start your subscription with that number. Radio World, 145 W. 45th Street, N. Y. C.

RESISTORS
and Mountings

Plate Circuit

0.25 meg. (250,000 ohms) Brach resistor, for all screen grid tubes. Order Cat. BRA-25, at....12c

0.1 meg. (100,000 ohms) Brach resistor for all except screen grid tubes. Order Cat. BRA-10, at 12c

Grid Circuit

1.0 meg. Brach resistor for grid leak. Order Cat. BRA-100 at.....................................12c

2.0 meg. Brach resistor for grid leak. Order Cat. BRA-100, at.....................................12c

Carborundum grid leak for highest detector sensitivity. The leaks are marked "5 to 7 meg," because values in this range are present. Order Cat. CAR-57, at.................................12c

Biasing Resistors

.005 meg. (5,000 ohms) Brach resistor. Order Cat. BRA-005, at.................................13c

.015 meg. (15,000 ohms) Amsco resistor. Order Cat. AMS-15, at.................................14c

.025 meg. (25,000 ohms) Amsco resistor. Order Cat. AMS-25, at.................................14c

[The above resistors are of the tubular type and require a mounting. Lynch moulded bakelite mountings, Cat. LYM, at.......................15c]

Filament Circuits

1-ohm Brach resistor, to afford 5 volts for four ¼ amp. tube when source is 6 volts. Supplied with mounting capacity 2 amps. Order Cat. BRA-1, at 22c

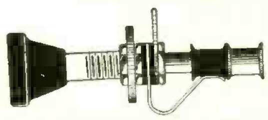
2-ohm Brach resistor, to afford 5 volts when two ¼ amp. tubes are supplied from a 6-volt source. Furnished with mounting; capacity 1 amp. Order Cat. BRA-2, at.................................20c

4-ohm Brach resistor, to drop 6 volts to 5 for one ¼ amp. tube. Mounting supplied at this price. Order Cat. BRA-4, at..................18c

30-ohm Brach resistor. To drop 3 volts to 2 volts on 232 and 230 tubes; use two of these resistors in parallel. Order Cat. BRA-30 (mounting supplied); price is for TWO sets at........22c

DIRECT RADIO CO.
143 West 45th Street,
New York, N. Y.

"A" BATTERY SWITCH



A push-pull switch for battery-operated sets. Made by Benjamin. Firm, sure contact, extremely long life. Price, 25c.

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SCHEMATIC DIAGRAMS for rewiring your battery set into all electric, or building a new set for 110-120 v. DC current line. Using from 5 to 10 tubes—201As and 171As throughout circuit flexible, using standard parts. Quality the best. Cost $1.00 any part of the United States. Foreign $2.00, postage paid. Gert Da Costa, 309 W. 114th St., N. Y. City.

TRANSFORMERS—700 V. C. T. secondary; 2-2.5 V.; 1-5 V. windings $6.00. Special made. Radio Power, 1028 Forest Road, Schenectady, N. Y.

PILOT AC SUPERWASP SW RECEIVER, brand new, completely wired, includes five tubes, KIII power pack and Baldwin headphones. $35. J. Adamson, 60 Chestnut, Albany, N. Y.

"A B C OF TELEVISION" by Yates—A comprehensive book on the subject that is attracting attention of radioists and scientists all over the world. $3.00, postpaid. Radio World, 145 West 45th St., N. Y. City.

BALKITE A-5 RECEIVER, eight-tube, three stages of Neutrodyne RF and two stages audio with push-pull output. Good distance-getter and very sensitive. Has post for external B voltage for short-wave converters. Brand new in factory case. Berkey-Gay walnut table model cabinet. Price $35 (less tubes). Direct Radio Co., 143 West 45th St., New York.

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TRANSFORMERS—ABC 224, 227, 245, 280 tubes, $2.35. 1½, 2½, 5 volt; 2½ volt, 5½ amp.; 7½ volt, 3 amp. 99c each. Shielded 2½ volt, 11 amp. $1.65. All center-tapped. Shielded .00035 coils, screen grid or three element, 65c; 4 coils, $2.25. Shielded INF transformers. L. Waterman, 2140 Kirby West, Detroit, Michigan.

WANTED — SILVER-MARSHALL 677-B audio amplifying unit. Address P. L. R., Rm. 1601, 130 N. Wells St., Chicago.

PRINTING: 1000 BUSINESS CARDS $2.75 POSTPAID. Other printing reasonable. Samples free. Miller, (RW), Printer, Narberth, Pa.

FILAMENT TRANSFORMERS, 1½, 2½, 5, 7½ volt, center tapped. State voltage wanted. $1.15 each. V. C. Cook, 3406 Frederick, Detroit, Mich.

"MATHEMATICS OF RADIO."—A great help to everybody interested in radio. $2 postpaid Radio World, 145 W 45th St., N. Y City

U. S. BROADCASTING STATIONS BY FREQUENCY.—The April 11th issue contained a complete and carefully corrected list of all the broadcasting stations in the United States. This list was complete as to all details, including frequency, call, owner, location, power and time sharers. No such list was ever published more completely. It occupied nine full pages. Two extra pages in the April 11th issue were devoted to a conversion table, frequency to meters, or meters to frequency, 10 to 30,000, entirely reversible. 15c a copy. RADIO WORLD, 145 West 45th Street, New York, N. Y.

PILOT A. C. SUPER WASP, TUBES, VOLUME CONTROL, 245 POWER STAGE. Perfect condition, $20. R. E. L. Ultra-Vernier dials, 65c. 2½ volt, 16 amp. transformers, $2. Include postage, money order or cash with order. Sidney Magid, 275 Corbin Place, Brooklyn, N. Y.

HI-Q 31 COMPLETE $100. F. L. Hanson, Ilion, N. Y.

"A DISCUSSION OF RADIO TUBES FOR THE LAYMAN," a copyrighted article by L. G. Mason will help you sell radio tubes in competition with mail order and chain store houses. $1.00 per hundred, $7.50 per thousand. Mason-Radio, 6212 Florida Ave., Tampa, Florida.

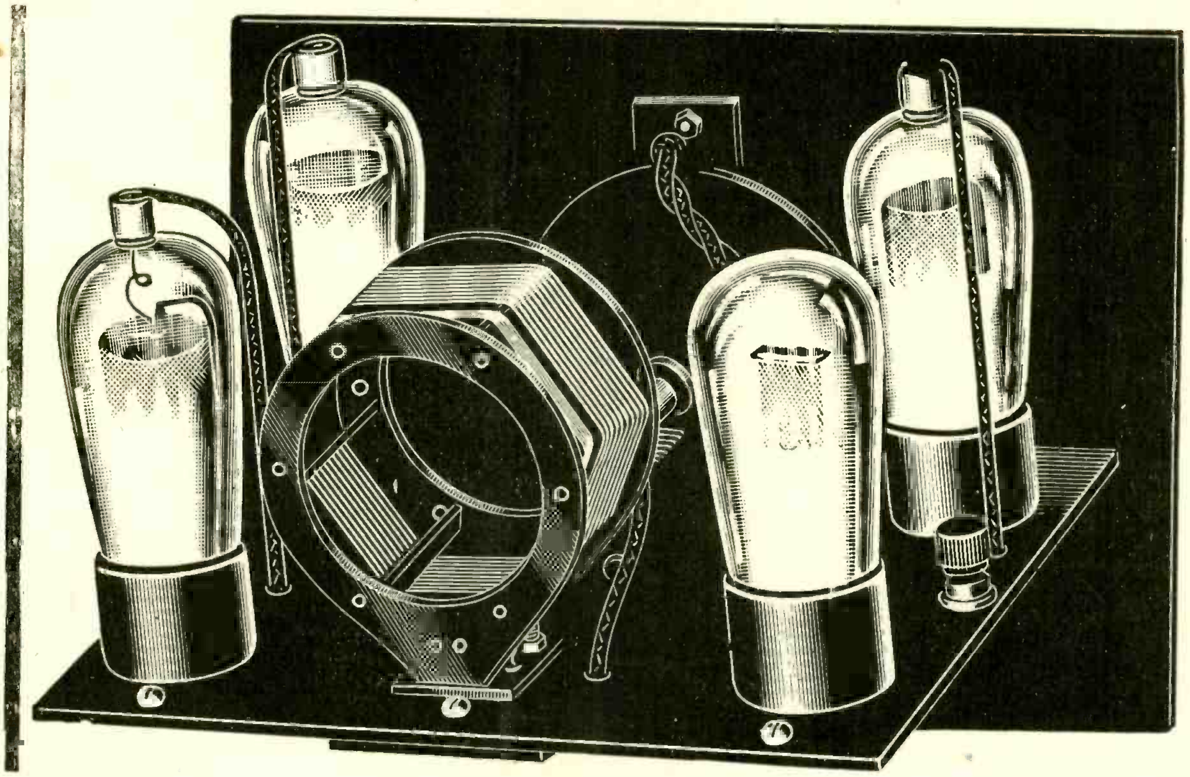
SHORT-WAVE NUMBERS OF RADIO WORLD. Copies of Radio World from Nov. 8, 1930 to Jan. 3, 1931, covering the various short-wave angles, sent on receipt of $1.00. Radio World, 145 W. 45th St., N. Y. City.

BARGAINS in first-class, highest grade merchandise. Phono-link pick-up with vol. control and adapter, $3.32; four-gang .00035 mfd. with trimmers built in, $1.95; .00025 mfd. Dubilier grid condenser with clips, 18c. P. Cohen, Room 1214, at 143 West 45th Street, N. Y. City.

RADIO WORLD AND RADIO NEWS. Both for one year, $7.00. Radio World, 145 W. 45th St., N. Y. City

SOUND PICTURES TROUBLE SHOOTER'S MANUAL, by Cameron and Rider, an authority on this new science and art. Price $7.50. Book Dept., Radio World, 145 W. 45th St., N. Y. City.

POLO DX-4 ALL-WAVE CONVERTER



WIRED MODEL

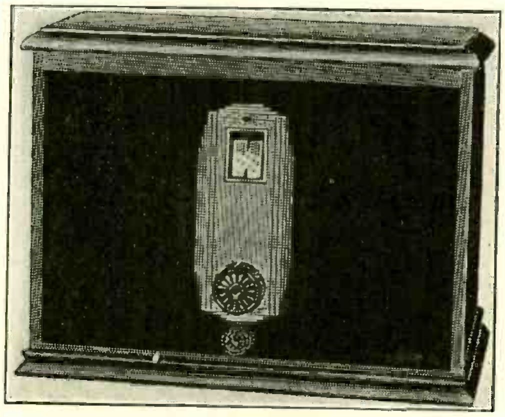
Following exactly the specifications of Herman Bernard, the designer of the DX-4.

Incomparable in performance; the Polo DX-4 All-Wave Converter uses three screen grid tubes in an AC design, with 227 rectifier. It affords high sensitivity and selectivity when worked with any broadcast receiver. Users report consistent reception of European and other foreign stations. Frequency range, 10 to 600 meters.

Wired model, Cat. DX-4W (including coils, less tubes, less cabinet)... $31.00

Walnut finish wood cabinet, Cat. CBT at $5.00

10-DAY MONEY-BACK GUARANTEE ON WIRED MODELS OF DX-4



FRONT AND REAR VIEWS OF THE DX-4 ALL-WAVE CONVERTER

COMPLETE PARTS

As Per Sandard Factory Model

DX-4 Converter with Built-In Power Supply

COILS

Three 800-turn honeycomb RF chokes @ 50c.....$1.50
One Polo S. W. Filament transformer.......... 2.40
One 30 henry B choke coil.................... 1.75
One set of precision De Luxe plug-in coils (4 to set).............................. 4.50

CONDENSERS

Four .005 mfd. fixed condensers @ .10......... .40
One .00025 mfd. fixed condenser with clips...... .14
One Hammurland Jr. Midline .0002 mfd. tuning condenser 1.25
Two 8 mfd. electrolytic condensers with brackets @ 1.15 .... 2.30

RESISTORS

One 0.5 meg (500,000 ohm) pigtail resistor...... .25
One .01 meg (10,000 ohm) pigtail resistor...... .40
One 100 ohm flexible biasing resistor........... .20

OTHER PARTS

One front panel 7 x 10 Inches...................2.00
One subpanel with five UY sockets............. 3.00
One National dial 2.50
One AC cable lead with male plug.............. .30
One AC toggle switch.......................... .35
Two binding posts for antenna input and for output @ .05.................................. .10
One roll of slide-back hookup wire............. .30
Three screen grid clips @ .05.................. .15
Two feet of wire for connection to grid clips..... .10
One dozen 6/32 machine screws and one dozen 6/32 nuts .... .10
One flat-head 6/32 machine screw.............. .01
Three 6/32 machine screws 2 inches long @ .02.. .06
Two brass angles @ .05........................ .10
Two milled bushings @ .10..................... .20
Four legs @ .0025............................. .01
One 30 Hy Filter Choke........................ 2.00
Two Right angle brackets...................... .10

Parts for Short-Wave Tuner

This tuner works into earphones or the audio channel of a broadcast set, or into a power amplifier.

Four shielded plug-in coils @ $1.50........................$8.00
Three 1,600 kc. shielded transformers with sockets affixed @ $3.00 .... 9.00
One 50 mlh. shielded RF coil @.............................. .57
One 2½ v. ct. filament transfomer........................... 2.50
Seven 100 mfd. Hammarlund equalizers @ .35.................. 2.45
One 60 mfd. Hammarlund variable @........................... 1.00
One 2-gang .0003 SFL bracket @.............................. 3.00
Two blocks, three 0.1 mfd. in each @ .57.................... 1.14
Three .00035 mfd. @ .10..................................... .30
Two 8 mfd. with brackets.................................... 1.50
One 2,500 biasing resistor.................................. .20
One 50 ohm biasing resistor................................. .20
One .02 meg. (20,000 ohm) pigtail........................... .25
One 0.1 meg. (100,000 ohm) pigtail.......................... .25
One metal chassis. socket holes............................. 4.00
Two UY sockets @ .20.. .40
One AC cable and plug @..................................... .25
One National velvet vernier dial............................ 2.25
One front panel 1.00
Three grid clips @ .03...................................... .09
Four binding posts, three washer sets....................... .45
On AC shaft type switch..................................... .50
Two knobs @ .15... .30

All parts (Cat. BSWT).........$39.60

We Are Short-Wave Headquarters

PARTS FOR MIDGET RECEIVER

Listen to short waves on earphones, if you like, or plug into the detector socket of your set for loudspeaker reproduction, using the Short-Wave Midget Set. Shielded plug-in coils are used. Wave coverage, 15 to 200 meters. Single tuning control, Hammarlund condensers. The rectifier is built in.

All parts for AC model (less two 224 and two 227 tubes, less front panel) order Cat. SWMS at $24.86

All parts for battery model (less two 232 and one 230 tubes and less front panel) order Cat. BMSWM at $19.92

OTHER STANDARD MERCHANDISE AND PARTS

Polo 245 Power Transformer $8.00
Polo 245 B Supply Choke 3.25
Polo Short-Wave Filament Transformers............................. 2.40
R. E. L. Vernier Dials .... .70

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