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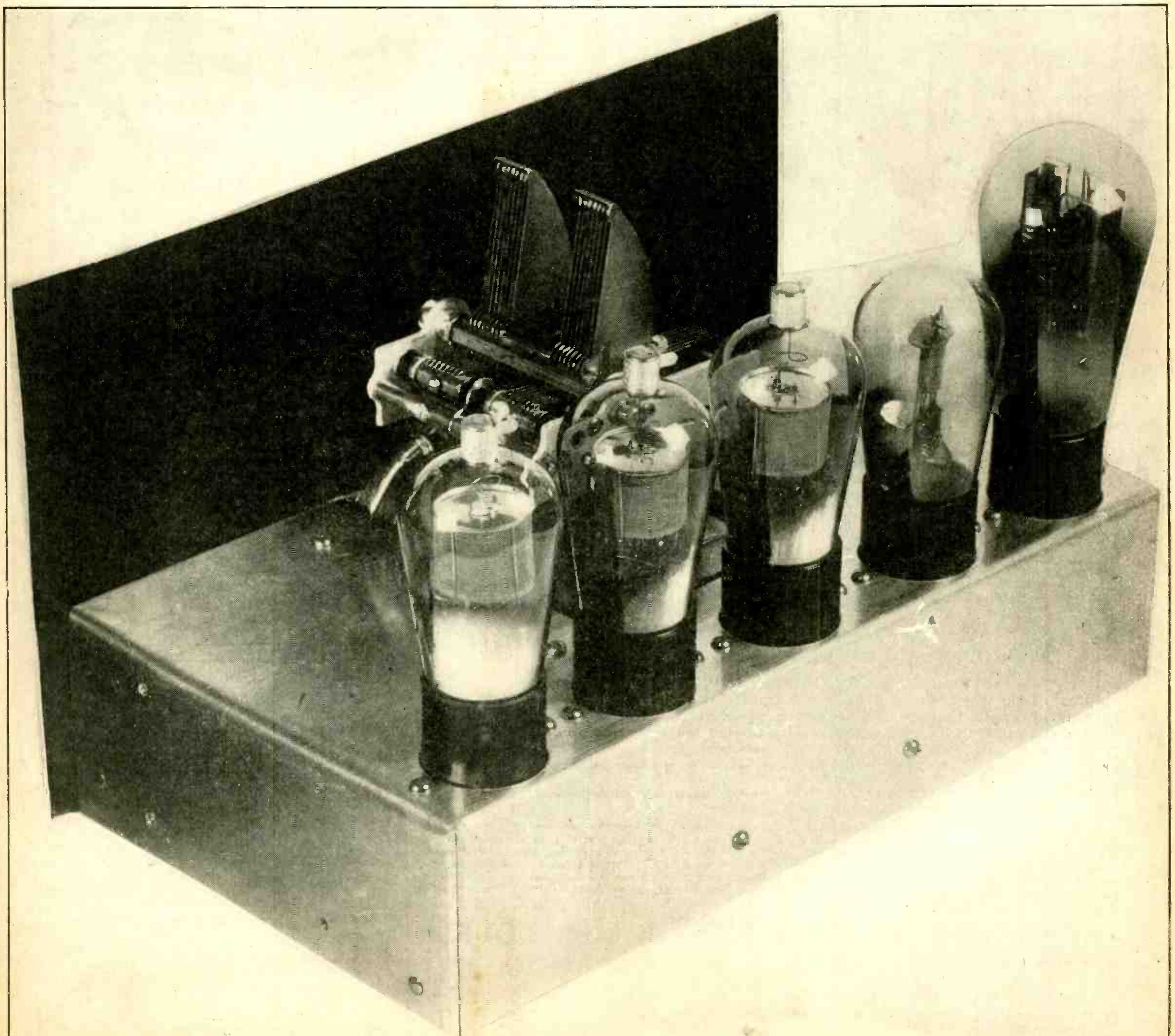

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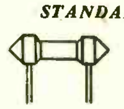

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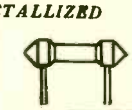

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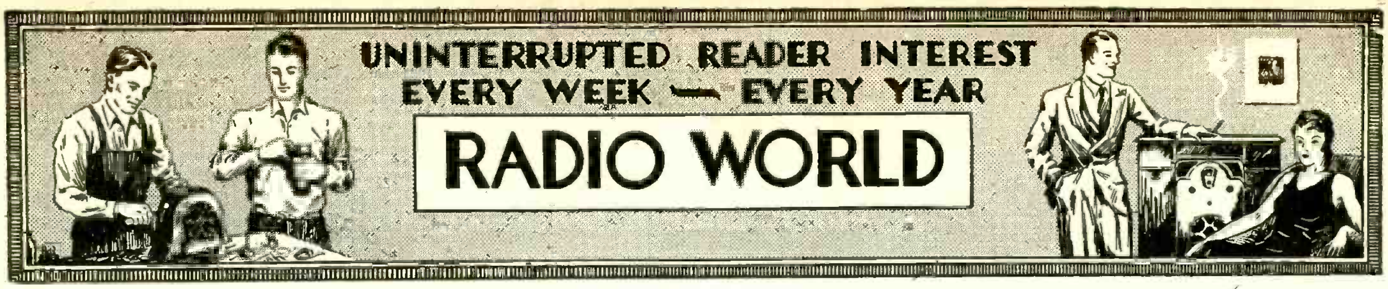

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A Modulated Oscillator

By J. E. Anderson

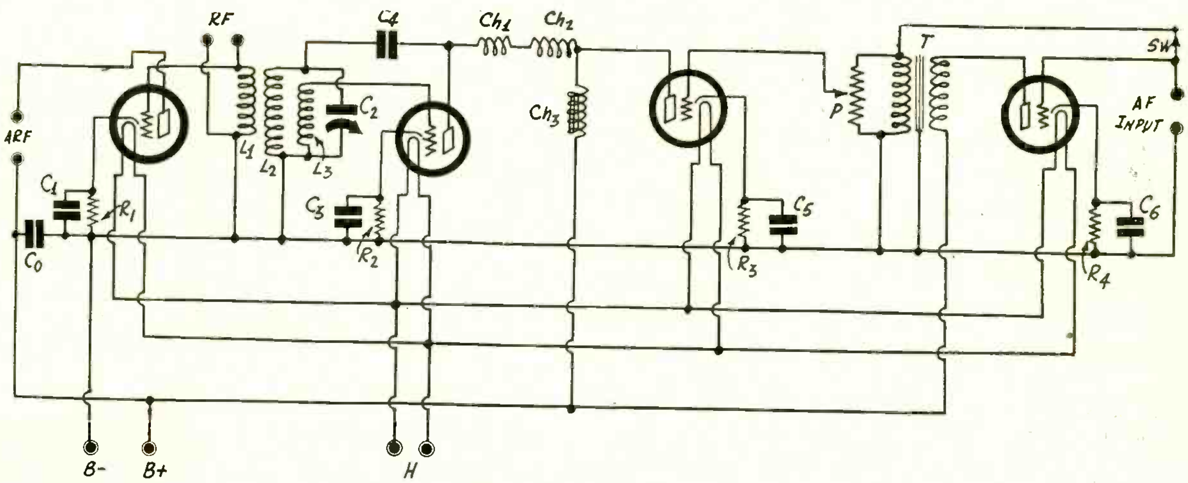

FIG. 1
The circuit diagram of a modulated, and calibrated oscillator containing one RF amplifier, one AF amplifier, and one AF oscillator or amplifier.

[*Data on coils to permit coverage up to* 20,000 *kc and down to* 100 *kc will be published in an early issue.*—EDITOR.]

EVERY radio experimenter often feels the need of a calibrated oscillator, and one that is modulated besides. With such an instrument receivers and many parts of receivers can be tested and calibrated without the necessity of waiting for station announcements. Suppose, for example, that it is required to calibrate the tuning device of a broadcast receiver from one end of the dial to the other. A calibration point should be taken at least every 50 kc. Since the width of the broadcast band is 950 kc there will be 20 calibration points required, there being one more point required than there are 50 kc intervals in the band. Broadcast announcements are supposed to be made every 15 minutes. Therefore to wait for announcements it would take 20x15, or 300 minutes to complete a calibration. Five hours is too long a time for a calibration. With a calibrated and modulated oscillator the work could be done in about 10 minutes and it may be done in five minutes.

Again, suppose we wish to find the natural frequency of a circuit comprising an inductance coil and a condenser. This we can't do at all by waiting for announcements, for there may be no station working on that frequency. With a modulated and calibrated oscillator the frequency could be found in half a minute after the circuit had been set up.

Use as Transmitter

Sometimes it is very convenient to have a transmitter in the laboratory for making tests on receivers. A calibrated and modulated oscillator is such a device. It does not transmit enough power to cause any interference with anybody, but it serves well the purpose of testing. Such a transmitter should be adapted for self-modulation as well as for modification with a microphone, a phonograph pick-up, or any other source of audio frequencies.

To meet the many different requirements in the laboratory the oscillator should cover not only the broadcast band, but practically the entire frequency band used for radio communication. This calls for plug-in coils. While plugging-in may be undesirable for a short-wave receiver or converter, there are no real objections to plug-in coils for a test oscillator.

Another use for a calibrated oscillator is the taking of resonance curves on radio frequency transformers and complete tuners. In such cases we need a fairly strong signal either of a fixed frequency or of a frequency which can be varied by known amounts. A calibrated oscillator may be used either way.

In Fig. 1 we have the circuit of a calibrated, modulated oscillator meeting the above requirements, and in Fig. 2 is a photograph of the assembled unit, looking from the top. It is a very versatile instrument, as will appear as the discussion of it proceeds.

The first tube at the left is a radio frequency amplifier, the output of which is taken of at AFR. This amplified is used when resonance curves are taken on radio frequency transformers when the primary of the device under test is connected to AFR, and it may also be used when a strong signal is to be transmitted.

If it is not desired to amplify the oscillation the output may be connected to RF, but the device that is connected to these terminals may change the frequency by an amount which upsets the calibration too much. However, for many purposes these terminals

(*Continued on next page*)

LIST OF PARTS

Coils
L1L2L3—A special set of oscillator coils
Ch1—One small radio frequency coil as described
Ch2—One 800 turn duolateral choke coil
Ch3—One 30 henry audio frequency choke coil
T—One audio frequency transformer

Condensers
Co, C5, C6—Three one mfd. by-pass condensers, or larger
C1, C3—Two 0.1 mfd. by-pass condensers
C4—One .00025 mfd. fixed condenser, or larger
C2—One Hammarlund .0001 mfd. midget tuning condenser.

Resistors
R1, R2, R3, R4—Four 800 ohm grid bias resistances
P—One 30,000 ohm potentiometer

Other Parts
Ten binding posts
Five UY sockets
One single pole, single throw switch
One sub-panel, 9 x 9.5 x 2.75 inches
One National precision vernier dial
Seven fibre bushings
Seven bakelite washers

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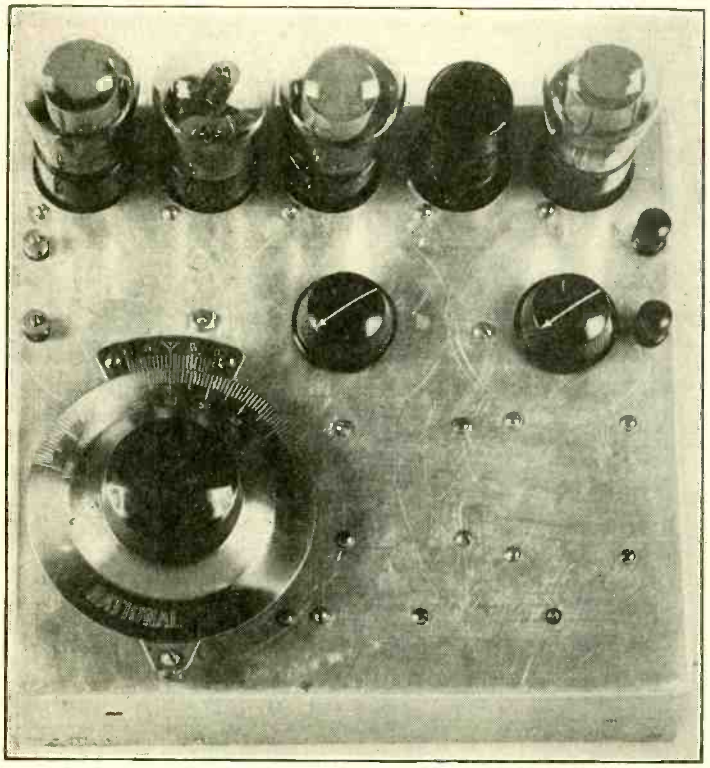


FIG. 2
Top view of the modulated oscillator circuit shown in Fig. 1.

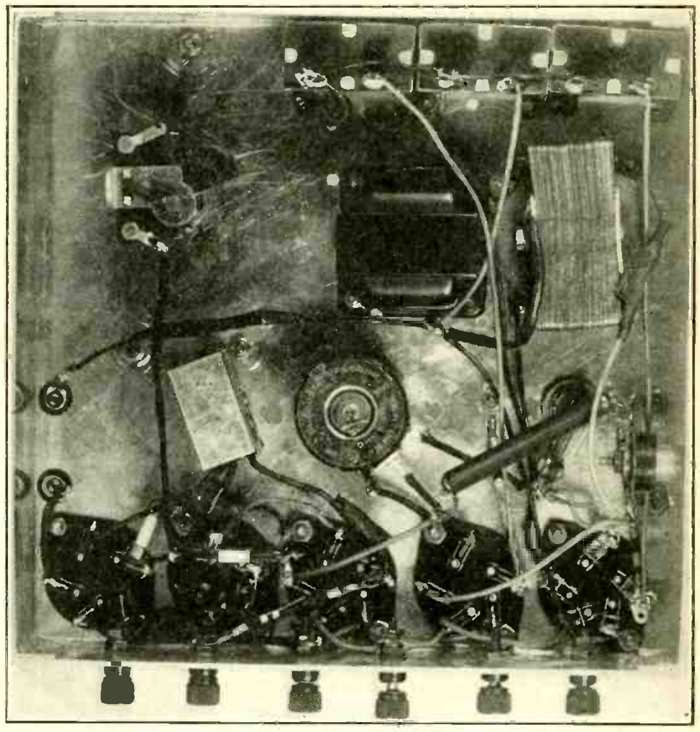


FIG. 3
View of the circuit underneath the sub-panel.

may be used for picking up the oscillation. One obvious use is for pick-up in a superheterodyne. Suppose, for example, that the oscillator in the superheterodyne does not work for some reason. A coil may then be connected in series with RF and this coil may be coupled loosely to the modulator tuned circuit. The oscillator in this circuit will then be substituted for the oscillator in the superterodyne. Many other uses will suggest themselves.

The Oscillator

The second tube from the left in Fig. 1 is the radio frequency oscillator. It is of the tuned plate type, selected because of its relative constancy of frequency. In this respect the circuit is very satisfactory. It was adjuster to several constant frequency broadcast stations so that the beat frequency had a value of about 1,000 cycles. This frequency did not change over several minutes' duration. Likewise the circuit was adjusted to zero beat, and that adjustment was maintained. There was no change when the hand was brought to the tuning dial, but the frequency did change when the hand was brought near the coil. A metal shield might be placed between the coil and the dial knob but this is not necessary for broadcast or lower frequencies.

L2 is the plate or tickler winding, which is shunted by the variable condenser C2. This has a maximum capacity of .0002 mf. and is of the straight line frequency midget type. It is turned with a precision vernier dial which can me read accurately to one part in a thousand. That is, it has 100 divisions and the vernier scale makes it possible to read accurately to one-tenth of the smallest division. We can change this to frequency. One coil covers the band from about 550 to 1,150 kc, or a span of 600 kc. Therefore if a straight frequency line condenser is used each division represents 6 kc and each tenth of a division 600 cycles. Even with a modified or midline condenser, such as used, that is the approximate accuracy of a setting, which is close enough for the purpose for which the oscillator is intended.

Method of Feedback

The tuned circuit is coupled to the plate of the oscillator tube by means of a condenser C4. The value used for this condenser is .00025 mfd., but it may be larger. The plate voltage is applied through three choke coils, Ch1, Ch2, Ch3. Ch1 is a very small coil intended to stop extremely high frequencies from escaping through the ditributed capacity of Ch2 and Ch2 is used to prevent the escape of other radio frequencies through the distributed capacity of Ch3. This in turn is used to couple the output of the audio frequency amplifier to the plate of the oscillator. The method of modulation is that known as the Heising, which is used in most broadcast stations. If Ch2 has a very low distributed capacity Ch1 is not necessary. Also, if the highest frequency to be generated is not higher than about 5,000 kc it is not necessary. Ch1 should have an inductance of from ¼ to one millihenry and Ch2 an inductance of from 10 to 100 millihenries, while Ch3 should be an audio choke of 30 henries or more. The radio frequency chokes are put in the lead between the two plates so that the radio frequency currents from the oscillator cannot escape through the plate to cathode capacity of the third tube. These coils do not have enough inductance to stop the audio frequencies from getting to the plate of the oscillator.

The third tube is an audio frequency amplifier. It serves mainly as a coupler between the audio and radio frequency oscillators. A high resistance potentiometer P is placed in the grid circuit of the amplifier tube for varying the degree of modulation of the radio frequency oscillation. When the slider is moved all the way down the only audio frequency coupling to the oscillator comes through the batteries. When the slider is all the way up the degree of modulation is greater than it should be. The proper or desired degree of modulation can be found by listening to the audio output as it is received by a receiver.

The Audio Oscillator

The fourth tube in the circuit is the audio frequency oscillator, but it may also be used as an audio frequency amplifier. When the switch Sw in the grid circuit is closed the circuit is an audio frequency oscillator, which generates a frequency depending on the inductance of the secondary of transformer T and on the distributed capacity in the circuit. The transformer used gave a frequency about 100 cycles per second. The frequency generated does not matter much, just so it is audible.

When switch Sw is open the fourth tube is an audio frequency amplifier of any signal that is impressed across the AF input terminals. A phonograph pick-up unit, a microphone, the output transformer of a radio receiver, or the output of an audio oscillator of variable frequency may be connected across the terminals.

The connections of the audio transformer which will insure oscillation must be found by experiment. In most cases the proper connections are those marked on the transformer when it is supposed to be used in an amplifier. The one marked P should go to the plate, the one marked B to the battery, the one marked F to ground, and the one marked G to the switch and the top of the potentiometer. If this connection does not produce oscillation, it is only necessary to reverse one pair of leads. A simple test for oscillation is to connect one side of a pair of head phones to almost any point of the circuit, even ground. If there is oscillation,

ment from 20,000 to 100 kc

Self—and Externally—Modulated Operation

the sound will be heard in the phones. Do not connect both terminals of the phones. When the fourth tube is to oscillate at audio frequency nothing should be connected across the AF input terminals.

Tube That May Be Used

The circuit is designed for use with UY tubes, either of the 227 or the 237 types. The heater terminals have been brought out so that either type of tube may be used by merely changing the heater voltage. If 227 are to be used the voltage across the H terminals should be 2.5 volts and if the 237 are to be used it should be 6.3 volts. In case 237 tubes are used the voltage may be supplied by a 6 volt storage battery. In case a transformer is used the center tap of the heater winding should be grounded.

After the radio frequency oscillator has been calibrated with a certain type of tube, heater and plate voltage, and AC or DC on the heater, no changes should be made. That is, the circuit should be used exactly as it was when it was calibrated, except when it does not matter what the frequency obtained is. Sometimes it does not matter whether or not the absolute frequency is correct provided that the relative frequency is all right, and that it will be because the frequency stability of the oscillator is good.

The four tubes in the circuit are all operated under amplifying conditions, and therefore the grid bias resistors may be the same for each tube. The value used for each in the circuit constructed was 800 ohms, which is all right for either 227 or 237 tubes. A suitable operating plate voltage is 90 volts. If a higher voltage is used the bias should be greater than that given by the 800 ohm resistances. The circuit will also work well on 45 volts but 90 volts will probably give more satisfactory results and will insure oscillation at all frequencies.

By-pass Condensers

Condensers C1 and C3 operate at radio frequency, and since the oscillator may be adjusted to a frequency as low as 100,000 cycles, each of these condensers should not be smaller than 0.1 mfd. Condensers C5 and C6 are operating an audio frequency and for that reason these should be large. The values used were one microfarad, but these should be regarded as the minimum capacity. The same applies to Co, which is connected across the B supply. If a B battery eleminator is used the condenser will be built into that device and it is not necessary to wire it into the oscillator circuit.

For many applications of this circuit it is not necessary to have a tube in every socket. For example, when calibrating a broadcast receiver it is only necessary to have a tube in the radio frequency oscillator socket. It is not essential that the signal be modulated in this case, because the beat between the oscillator and the carrier may be used. A station is tuned in with the broadcast receiver, the calibrated oscillator is set near the receiver and its condenser is turned until the zero beat position is found. The oscillator calibration curve then tells what the frequency of the station tuned in is. This can be done for all the stations which can be tuned in with the receiver.

If a tube is put into the RF oscillator, AF amplifier, and AF oscillator sockets, a slightly different method may be used in the calibration. The signal radiated by the RF oscillator coil will then be modulated by an audio frequency. The RF oscillator is set at any desired frequency and then the signal emitted is tuned in with the broadcast receiver. The circuit is tuned for loudest sound from the test oscillator. Thus the location of the selected known frequency on the broadcast receiver dial is found. This may be repeated for a large number of oscillator settings.

Calibrating the Oscillator

The calibration of the oscillator may be done against an oscillator previously calibrated, or it may be done against a broadcast receiver for which there is a log of dial settings for different stations available. If the dial settings are known it is not necessary to wait for the announcements. Just set the oscillator to be calibrated near the broadcast receiver so that oscillator coil is near the antenna. Then tune in a broadcast station near the lower frequency limit. Turn the oscillator condenser C2 until zero beat is obtained. Record the dial setting opposite the frequency of the station. Do the same for as many stations as can be tuned in and identified. If the log is not available the same thing can be done, but as was suggested before, it will take a long time.

After a few well distributed points have been found, a curve should be plotted on a scale which will permit reading at least as accurately as the accuracy of the dial. If the vernier dial discussed above is used this will require a rather large sheet of cross section paper. Since this dial can be read to one-thousandth of the entire scale there should be 1,000 of the smallest division on the dial scale of the cross section paper. Since the smallest division on ordinary cross section paper is one millimeter, the scale should be 1,000 millimeters long, or one meter. That is very nearly a yard.

If less accuracy is permissible we can let the smallest division on the cross section paper represent one-half division on the dial.

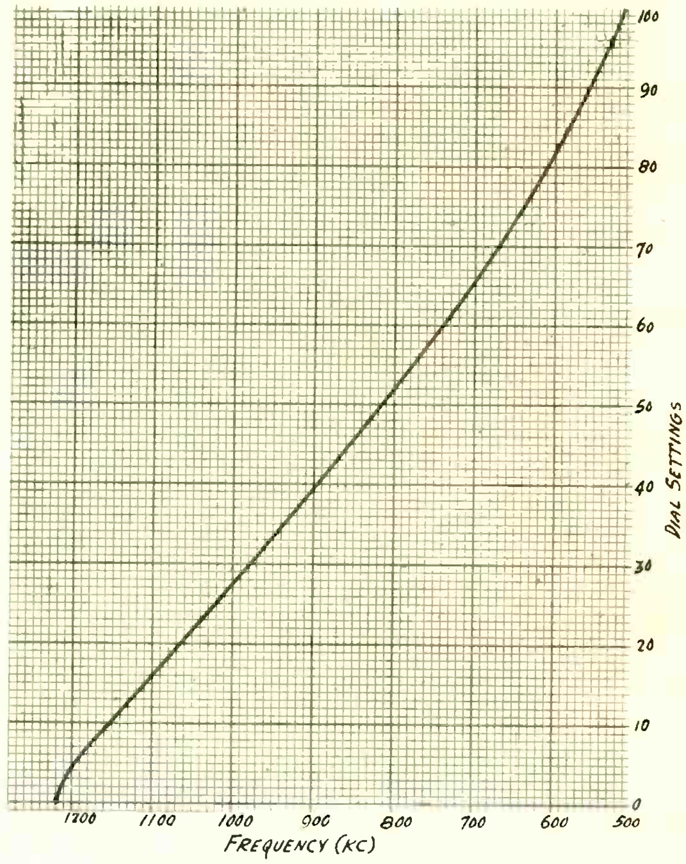


FIG. 4

Calibration curve of the modulated oscillator for the coil that covers the lower part of the broadcast band. The frequency range is from about 510 to 1210 kilocycles. The calibration was extended below 570 kc by the harmonic method.

There will then be 200 divisions on the scale, and if each is a millimeter the length of the paper will be 20 centimeters. This is a common size, being slightly less than 8 inches. It is not difficult to estimate accurately to one-fifth of a division so that this size sheet is almost as useful as the larger one.

The Frequency Scale

The frequency scale should be laid out as large as the other dimension of the cross section paper sheet permits. This will be different for each coil. It is best to have a separate sheet for each coil, because this will avoid confusion. The frequency scale should be started at the lowest frequency to which a given coil will tune and it should be chosen so that the highest frequency comes near the top, using convenient units. For example, suppose one coil covers the band from 550 to 1,150 kc. The 550 line should then coincide with the X-axis. Since the highest frequency is 600 kc higher, there should be 6 main units on the vertical scale. These may be centimeters, but then one millimeter will represent 10 kc. The scale might be estimated to one-fifth of the smallest division, which would represent 2 kc.

It would be better to make each of the main divisions 2 centimeters, in which case the smallest division would represent 5 kc and a fifth would represent 1 kc. If a large sheet of cross section paper is selected for the dial scale, the frequency scale should be correspondingly large. For this particular coil we might make the main division decimeters. One decimeter, or 10 centimeters, would then represent 100 kc, one centimeter, 10 kc, and one millimeter, one kc. Then if we estimate to one-fifth of a division we can estimate to 200 cycles. Such scale dimensions are hardly necessary for ordinary testing purposes. An ordinary cross section sheet 15x20 centimeters should be sufficient.

Reading the Vernier

The reading of a vernier scale is an unfamiliar process to many. If we use the center index on the upper scale, Fig. 2, the reading of the dial is 59.8 divisions, and the center index should be used on this particular dial. The first part of the reading is obtained by noting the position of the index. As will be noted it is close to

(*Continued on next page*)

How to Select Proper Coils

By Einar

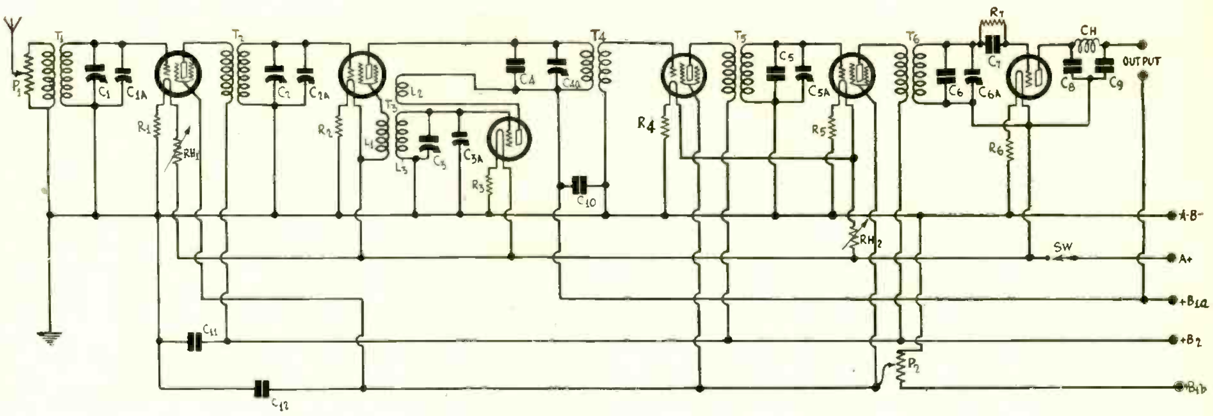


FIG. 1
In this circuit the first two tuners, T1 and T2, may not cover the broadcast band because trimmer condensers C1a and C2a are set at too large values. T2 when accurately tuned may also reflect a capacity back into T1 adding it to C1.

IT is common that amateur set builders complain that they got the wrong coils or tuning condensers when everything is not as it should be with the receiver, or what the builder expected. From one point of view it may be said that every coil is wrong, or that every condenser is wrong, even when the coil designed for that particular condenser is used. Small deviations must be expected. Suppose the highest frequency that can be turned in with the circuit is 1,300 kc when it is supposed to be 1,500 kc. That almost invariably means that there is too much distributed capacity in the circuit, which may be due to the way the coils are placed, or the way they are shielded, or to the use of too much capacity in the trimmer condenser. Possibly if the trimmer condenser is given a turn to the left of the adjuster screw the matter will be remedied.

It may also be that the coil has a turn or two too many. Coils are intentionally made that way in nearly all cases in order to make allowance for possible variations which cannot be foreseen. It is easier to remove turns in case it is necessary than to add turns in case that is necessary. It is nearly always necessary to do one or the other in order to make the stations come in just where they are wanted on the dial. There are two reasons for this. First, the effective inductance of the coil may change when it is put in a given circuit; second, the distributed capacity may be different from the value allowed for in designing the coil. Moreover, the tuning condenser itself may have a different capacity than that listed. For example, it may be called a .0005 mfd. for reference but in fact it may be different. This applies to a .00035 mfd. condenser as well as to all others.

Adjusting Tuners

An amateur set builder who is not willing to adjust the tuners should not undertake to assemble a receiver. A set is not finished until this adjustment has been made.

Suppose a receiver has been finished with the exception of the adjustment of the tuners and it is found that 570 kc comes in at 98 on the dial. Obviously, the 560 and 550 channels cannot be tuned in satisfactorily because beyond 98 on the dial there is practically no change in the capacity of the tuning condensers. What shall be done? Well, either the capacity is not high enough or the inductance is too small. The capacity may be increased by giving the trimmers a turn to the right and the inductance may be increased by adding a turn. It is easier to change the capacity.

But suppose it is found after the capacity has been increased so that 550 kc comes in at 98 that the circuit will not tune higher than 1,300 kc. Now we are in difficulty if we must tune in all the stations between 1,300 and 1,500 kc. We can reach 1,500 by reducing the trimmer capacity or the inductance, but either change will spoil the adjustment at the low frequency end. Possibly the lowest frequency that could now be tuned in is 600 kc.

Too Much Distributed

When the situation is encountered it means that there is too much distributed capacity in the circuit, possibly because the capacity has been increased by the shielding. It may also mean that the effective inductance has been reduced by the shielding. One thing that may be done in a case like this is to remove, partly, the shielding around the coils, or to put on larger shield cans.

It may also be that the situation may be remedied by loosening the coupling between the primary and the secondary of each radio frequency transformer by removing turns from the primary. Doing so may not only make the condenser cover the entire broadcast band but may also increase the selectivity and the sensitivity.

If the tuning condenser is less than about 500 mmfd. it is not always possible to cover the broadcast band because the distributed is too high. This is especially so if the coils are shielded.

If the lowest broadcast frequency, namely 550 kc, cannot be reached with a tuner more turns on the coil or more trimmer capacity will bring this frequency within the tuning range. If the highest frequency, namely 1,500 kc, cannot be reached with the tuner it can be brought within the tuning range by decreasing the trimmer or zero setting capacity or by removing turns from the tuning coil.

If the distributed capacity is so high that the condenser will not cover the entire band it is necessary to increase the variable portion of the tuning capacity or to reduce the zero setting capacity. The distributed capacity may be decreased by increasing the shield around the coil or by partly removing it. This also increases the effective inductance. Loosening the coupling between the primary and the secondary also tends to make the condenser cover the band.

When a given condenser and coil are used together when they have been designed to go together, they did cover the entire broadcast band once and there is no reason why they should not do so again when used in a similar circuit. If the two do not match the reason has been introduced by the builder deviating somewhere and it should be possible to make slight changes to make the two match so as to cover the broadcast band. The needed change may be to remove a few turns from the primary, to move the shield around a coil a little, to run a lead to a grid or the stator of a tuning condenser in a different way. It is rarely necessary to change the turns on the tuned winding.

Construction of a Calibrat

(*Continued from preceding page*)

60. However, it is slightly less than 60. Hence we call it 59. The number of tenths of a division to add we obtain from the upper scale, that is, from the vernier. We look along the vernier scale to a point where a division line on the vernier is exactly opposite a division line on the main scale and then we count the number of divisions on the vernier from the index to the line which is opposite a line on the main scale. We find that it is the eighth. Hence the total reading of the dial is 59.8 divisions. We could have estimated this without the vernier, but the results would only have been an estimate. The vernier reading is exact.

If we use the right index on the vernier scale, the one marked zero, the reading is 50.8 divisions. The difference between these is 9 divisions because 10 divisions on the vernier scale are equal to 9 divisions on the main scale. That is, the difference between the two index positions is 9 scale divisions, although it is 10 vernier divisions.

Affect of Load Resistance

Fig. 2 shows the layout of the parts. There are five sockets at the rear. The first to the left is th RF amplifier, the next is the coil socket, the third is the RF oscillator socket, the fourth the AF amplifier socket, and the fifth the AF oscillator-amplifier socket. The tuning dial is at the left front, the potentiometer in the center and the switch at the right middle. The dial was mounted horizontally to facilitate reading. The coil is not shown in the right socket. The second tube and the coil should be interchanged.

The two binding posts at the left are the AFR and the binding

and Line up Condensers

Andrews

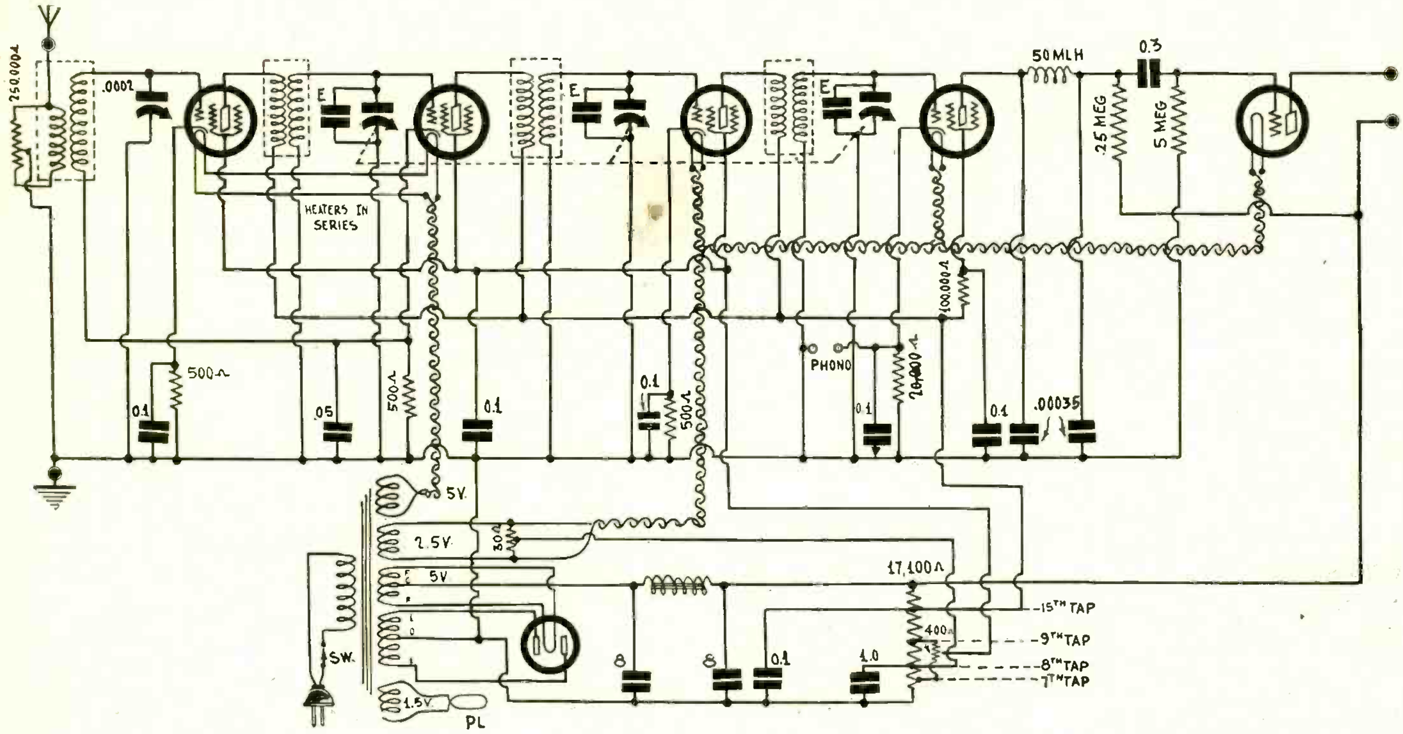


FIG. 2
Separate tuning of the antenna stage simplifies matters.

However, when a coil designed for a condenser of given capacity is used with a condenser said to have that capacity, it may be necessary to change the secondary or tuned winding because the coil may have been wound to a higher inductance so that it will be large enough for a condenser which is somewhat undersize. It is quite often that condensers are undersize. For example, one condenser rated at 500 mmfd. has a capacity of only 460 mmfd. In this case the coil must be about 8 per cent. greater than if the condenser were just 500 mmfd. The number of turns on the coil should be increased by about 5 per cent. Thus if the coil for a 500 mmfd. condenser has 70 turns the coil for the 460 mmfd. condenser should have 73 or 74 turns.

Even the load resistance on a tube has an effect on the tuning characteristic of the tuner ahead of the tube, especially when the tube is a three element one. When the load resistance is high the input capacity of the tube is very high and may be comparable to the capacity of the tuning condenser. This input capacity is put in parallel with the tuning condenser and becomes an addition to the distributed capacity of the coil and the minimum capacity of the tuning condenser.

Close Coupling

When the primary of the coupling transformer is coupled very closely to the tuned secondary the resistance load is high and so the tuning condenser ahead of this tube may have a too high zero setting capacity. Lack of coverage is the result. This is one reason why the coupling should not be close. This effect is present even in screen grid tubes even though the grid to plate capacity is very small. The effective input capacity not only depends on the grid to plate capacity of the tube but also on the amplification in the tube, or on the mu of the tube. Since the mu of a screen grid tube is very high it offsets the small grid to plate capacity.

The effect of the load resistance is such a variable factor that it cannot be taken into account in designing the coils and therefore it must be adjusted for before the receiver can be considered finished. Of course, it is not necessary to adjust for each contributing factor separately, if that were possible. It is sufficient to manipulate the turns, the trimmer capacity, the shielding, or the coupling until a satisfactory coverage is achieved. This need not take long in any case.

Procedure of Adjustment

The first thing to do is to ascertain whether or not the coils are too large or too small. First tune in the lowest frequency station and note where it comes in. If it is well below 100 chances are the coil is too large. But to be certain tune to 1,500 kc. If this comes in above zero the coil is sure to be too large and all that may be necessary is the removal of a turn or two. Do not cut the wire, simply straighten it out. It may be necessary to put on the turns again. After one turn has been removed try again and note whether there is coverage.

If the tuner will neither reach to 550 nor to 1,500 the coupling should be loosened between the primary and secondary by removing turns from the primary. If the 550 kc signal comes in well below 100 the only thing that may be necessary is the reduction of the capacity in the trimmer condenser in order to reach 1,500 kc and still retain 550 on the dial below 100.

ed Modulated Oscillator

posts at the right are for the audio frequency input in case an external source of modulation is used. At the rear are six binding posts, to in the middle for the heater circuits, two at the left for RF output, and two at the right for the B supply. The posts for ground and B minus are connected to the sub-panel. The right front post is also connected to the sub-panel.

Fig. 3 is a view of the circuit as it appears under the sub-panel. The long narrow coil that looks like a sausage is the small radio frequency choke, Ch1, which is made of a 5/15 inch bakelite tube 2.5 inches long and filled with No. 32 double silk covered wire. Ch2 is mounted next to it on the left side of the sub-panel. It is an 800 turn duolateral coil wound on a half-inch dowel. The coil with the exposed iron core is Ch3 and the audio transformer is next to it at the right.

What to Expect

The oscillator coil for the lower part of the broadcast band was wound on a tube base type of form 1.25 inches in diameter with 140 turns of No. 32 enameled wire for the tuned winding L3, and 50 turns for L2. The pick-up winding L1 was placed inside on a form that just fit the internal diameter of the main form. This also had 50 turns of the same wire. Only the tuned winding is critical as to the number of turns.

A second coil is needed to cover the broadcast band, and this should have 70 turns for L2. The other windings may be the same as before except that in this case all three windings may be put on the same form.

(*More coil data next week*)

An All-Wave Mixer with

By Herman

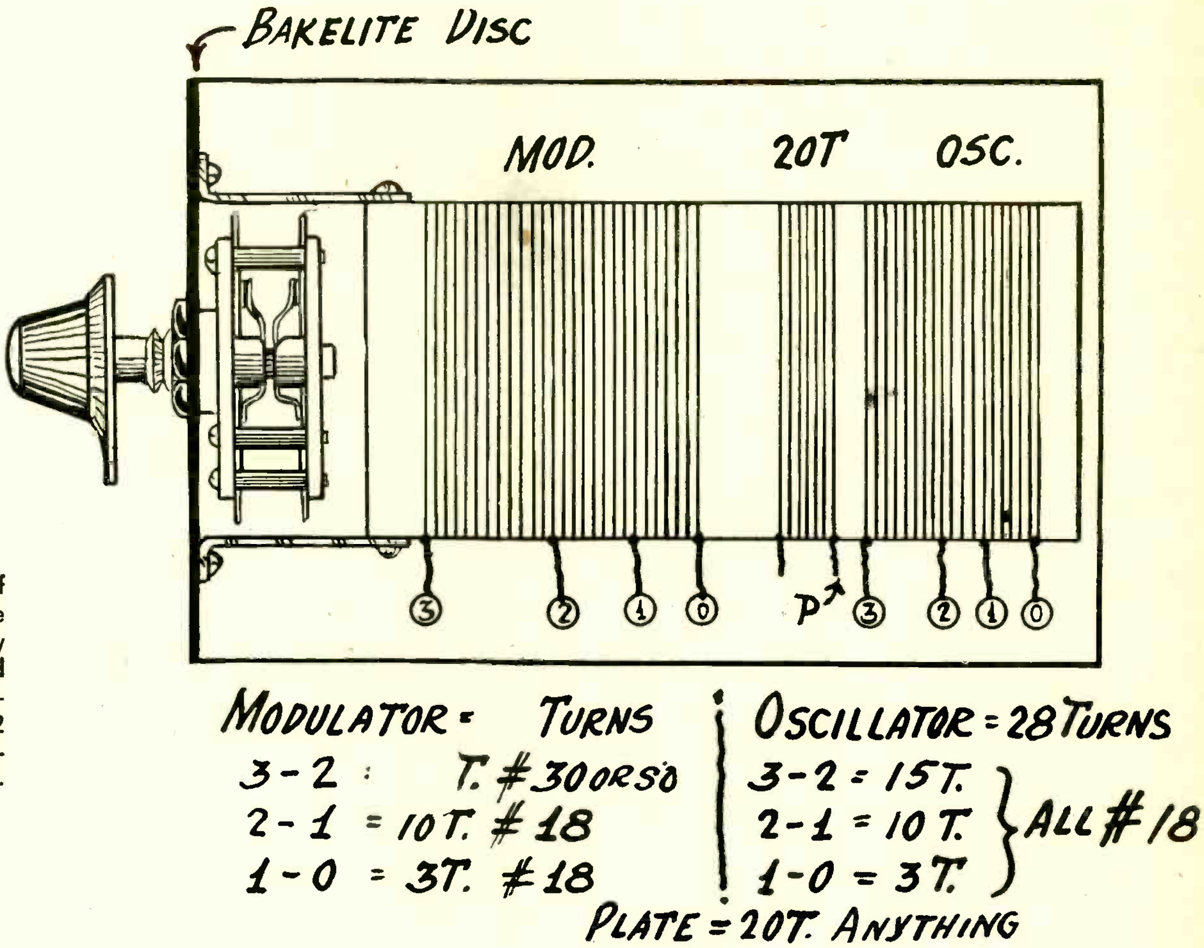


FIG. 1
Full-scale drawing of the assembly of the coil, dual rotary switch, disc and equalizer in a copper shield. The 3-2 winding of the modulator has 79 turns.

HERE is something new for converters and sets—a mixing circuit for all-wave reception, 550 to 15 meters, without plug-in coils. There are two tuned circuits, using a two-gang condenser, while the coupling between circuits is due to mutual induction, the tuned windings being on one form.

The coil is placed inside a copper cylinder shield, at one end of which shield is a multiple switch that enables one motion to control the wave-band changing of both circuits. Two insulated leads emerge from the side of the shield for connection to the respective stators of the gang condenser, and two for the plate coil of the oscillator. Since the grid returns are grounded, they are connected to the shield as part of the construction, while the switching function requires no outlets, the two wires to stators completely taking care of the connections to the inductance.

Freedom From Body Capacity

The gang condenser is mounted on a 7½-inch high front panel. In line with and below the shaft of the condenser is a bushing, and the ends of this bushing line up with holes in the shield brackets.

The constructional plan of the shield and its three principal adjuncts—coil, switch and equalizer—is illustrated in Fig. 1. The switch is mounted at center so that its knob will not interfere with any disc type dial of ordinary proportions. If the knob of the dial drive is centered 3¼ inches from the condenser shaft hole, assuming a 1¼ inch knob, there would be left 2⅝ inches for half the dial, allowing room for a 5¼ inch dial, which is a liberal allowance. See the front panel drilling dimensions in Fig. 3.

How the switch works may be gleaned from Fig. 1. There are two simultaneous contacts to different points, electrically independent. The switch shaft itself is insulated from the rest of the mechanism, and is actually grounded through a lug connection, as a final preventive of body capacity.

Broadcast Problem

Only one tuning problem is present, and that concerns the broadcast band. If the unit assembly were intended only for short wave work this problem would not be present.

It is not known what intermediate frequency will be used, but it will be some frequency to which your broadcast receiver can be tuned. Let us assume the worst condition in respect to the broadcast tuning problem, which is an intermediate frequency as high as can be tuned in by your receiver, say, 1,600 kc.

The broadcast band corresponds approximately to a span from 1,500 to 550 kc. The oscillator frequency will be higher than the desired incoming carrier frequency by the amount of the intermediate frequency. Therefore the oscillator will have to tune from 3,100 kc to 2,150 kc. The incoming carrier frequency of 1,500 kc is therefore about 50 per cent. of the oscillator frequency, a wide difference. Yet consider the lowest broadcast frequency, of 550 kc, where the incoming carrier frequency is only about one-fourth of the oscillator frequency (550 kc as compared to 2,150 kc). So we have to take care of a changing ratio, from 2-to-1 at one extreme and 4-to-1 at the other extreme.

How Problem Was Solved

This might be solved by using the same inductance in each of the tuned circuits, but having smaller capacity in the oscillator circuit, as by introducing a series fixed condenser from stator of the oscillator tuning section to switch arm. But do we want equal inductance, since for broadcast tuning of the modulator, 98 turns

LIST OF PARTS
For Tuning Element

One two-gang .00035 mfd. straight frequency line allocating condenser.
Three 6/32 flat-head screws for mounting the condenser.
One copper shield, 3-1/16-inch outside diameter, 4½ inches long.
One bracket for shield, with two nuts and two bolts for bracket.
One coil form, 1¾-inch diameter, one 1½ diam.; wire for both.
One disc, 3-inch diameter.
One compound switch, two sections, single pole, triple throw for each section, with a break contact; shaft insulated; connections non-shorting.
One 7½ x 12-inch drilled bakelite front panel.
One AC shaft switch.
One 60 mmfd. manual trimmer.
One 100 mmfd. equalizer.
Three knobs.
One veneer dial.

Band Selector Switch

Bernard

are needed? Where would we put another 98 turns, plus a plate winding—216 turns?

The solution selected was to tie down the low frequency end of the oscillator tuning to coincide with the setting required of the modulator for the incoming carrier frequency, using less oscillator inductance but more capacity. An equalizing condenser, actuated by a switch so as to be out of circuit for two switch stops out of three, is adjusted until the teaming of the two circuits is established at the lowest receivable broadcast frequency. Discrepancies arising at the higher frequency end of the broadcast band can be taken up by a manual trimming condenser that is on the panel at left as part of the assembly. The other panel-mounted part is a line switch, useful for AC or battery service.

A break contact, built into the switch, automatically closed by positioning the inductance range knob to position 3 on the oscillator, takes care of inclusion and exclusion of the fixed condenser E in parallel with the oscillator tuning condenser. The capacity of E at maximum setting is 100 mmfd. while the minimum capacity is 20 mmfd. The tuning condensers have .00035 mfd. capacity, with straight frequency line plates, the minimum being 30 mmfd., so that with the equalizer across the oscillator section in one instance, the tuning condenser's capacity range is 50 mmfd. to 370 mmfd., and in the other extreme case, 130 mmfd. and 450 mmfd. It can be seen that the ratio of maximum to minimum capacity may be changed by the equalizer adjustment, as well as increase of both minimum and maximum capacities, so that the means are provided for equalizing the broadcast band tuning.

Easy on Short Waves

On the short waves there is no frequency difficulty like the one described, because the intermediate frequency is a small percentage of the desired incoming carrier frequency. Take as an example of a medium case that of 100-meter reception. The incoming frequency is 3,000 kc, the oscillator frequency for a 1,600 kc intermediate would be 4,600 kc. Even with equal inductance and equal capacity tuning condensers, a 60 mmfd. trimmer across the modulator condenser, the difference easily can be taken up by the trimmer, because the modulator frequency always is lower than the oscillator frequency (more capacity required in modulator) and the operating frequency is high.

Take 5,000 kc. or 60 meters. The oscillator frequency would have to be 6,600 kc. It can be seen that the higher the incoming carrier frequency, the smaller percentage of difference in frequency between the two circuits.

The assembly, consisting of the two coils on one form, the multiple switch, the shield and the brackets, the tandem tuning condenser, equalizer, manual trimmer, line switch, front panel and dial, may be used in any converter circuit where the modulator and oscillator circuits are tuned.

If radio frequency amplification ahead of the modulator is desired, with retention of single tuning control, it would have to be of the untuned type, with a choke and condenser in the plate circuit of the preceding RF tube because of the grounded returns of the modulator coil in the assembly.

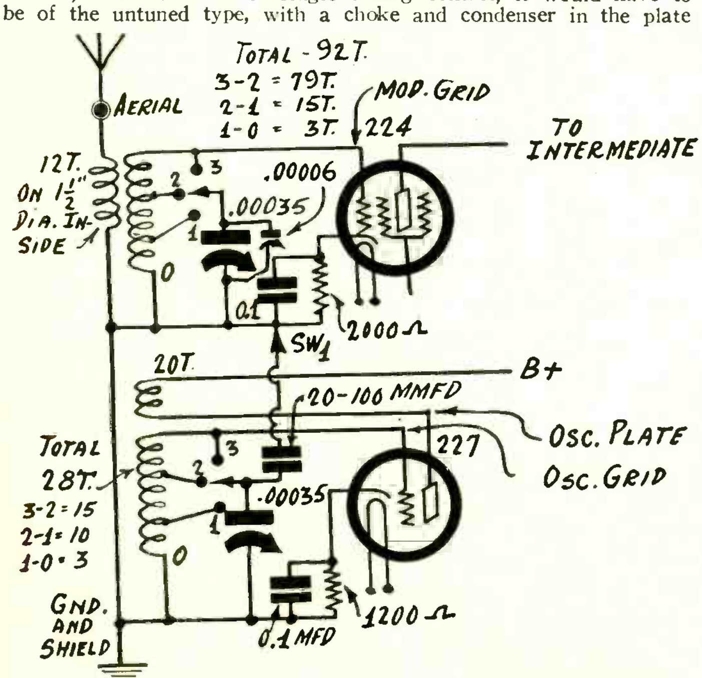


FIG. 2
Diagram of the mixer, with coil data and other constants, with some of the connections identified by legends.

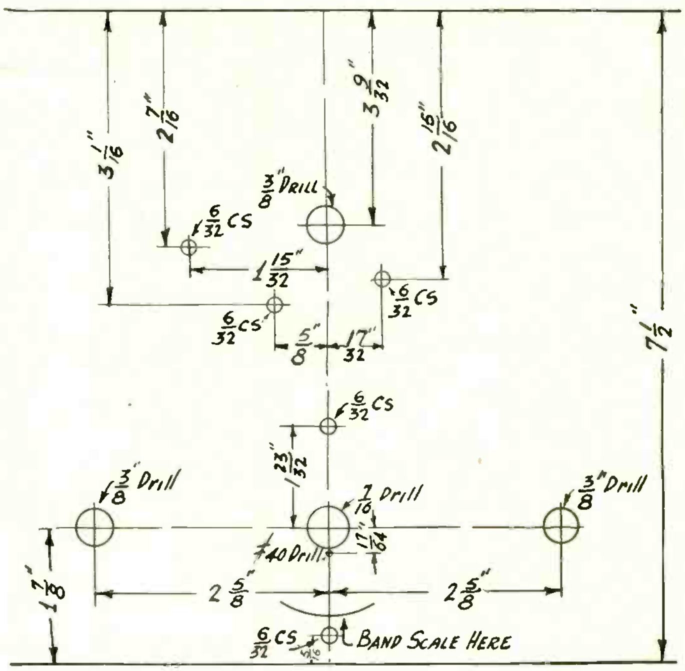


FIG. 3
Front panel data. The width is 12 inches.

Use of Lowest Intermediate

The intermediate frequency previously discussed, 1,600 kc, was taken as the extreme example, and it or some closely related frequency, is often used in practice. The reason is that most receivers, particularly those of models prior to 1930, are much more sensitive at the high frequency end of the broadcast band.

If the broadcast set tunes selectively at higher than 1,500 kc an added advantage is the absence of interference due to the direct reception of broadcasts.

However, the same absence of direct interference from broadcasts would result from use of the lowest frequency to which your set can tune. The sensitivity may be less, but you may build a converter that has some intermediate frequency amplification in it, whereupon you will find yourself in possession of a combination all-wave converter and all-wave adapter!

A converter is a device for changing the frequency to one that may be amplified at a radio frequency level by your broadcast set, detected and audio-amplified. An adaptar is set without audio amplification, which uses the audio amplification of the receiver to which it is connected.

Adjust Intermediates to Your Set

With some intermediate frequency amplification in the converter we do not care particularly whether the broadcast set itself is sensitive at the lowest frequency setting, as we provide abundant sensitivity, and whatever the broadcast set contributes is just so much extra.

We would select the lowest intermediate frequency because the difference between the oscillator frequency and the incoming carrier frequency would be smaller—instead of 1,600 kc this difference would be, say, 520 kc. If we used tunable intermediate frequency transformers—accessible set-screw adjustment for trimmers—all we would have to do would be to tune the broadcast set to the lowest frequency to which it responds, and set the intermediate transformer trimmers in the converter to duplicate this frequency.

It is assumed the broadcast set will tune lower than the lowest broadcast frequency, which is nearly always true. If it is not true in a given instance, provided there is no very strong local at the low end of the frequency spectrum, the same benefits may be derived.

Fig. 4 shows the schematic diagram for wiring such a converter. A transformer connects the antenna-ground circuit to the modulator, a 224 tube, while the inductive mutual coupling of the windings of modulator and oscillator (227 tube) bring about the mixture.

There are two intermediate frequency stages, using the new variable mu tubes, 235. Because of the inclusion of these tubes the volume control is of the changing grid bias type. To be effective the range must be great enough to vary the bias by about

(Continued on next page)

AC and Battery Model Convert

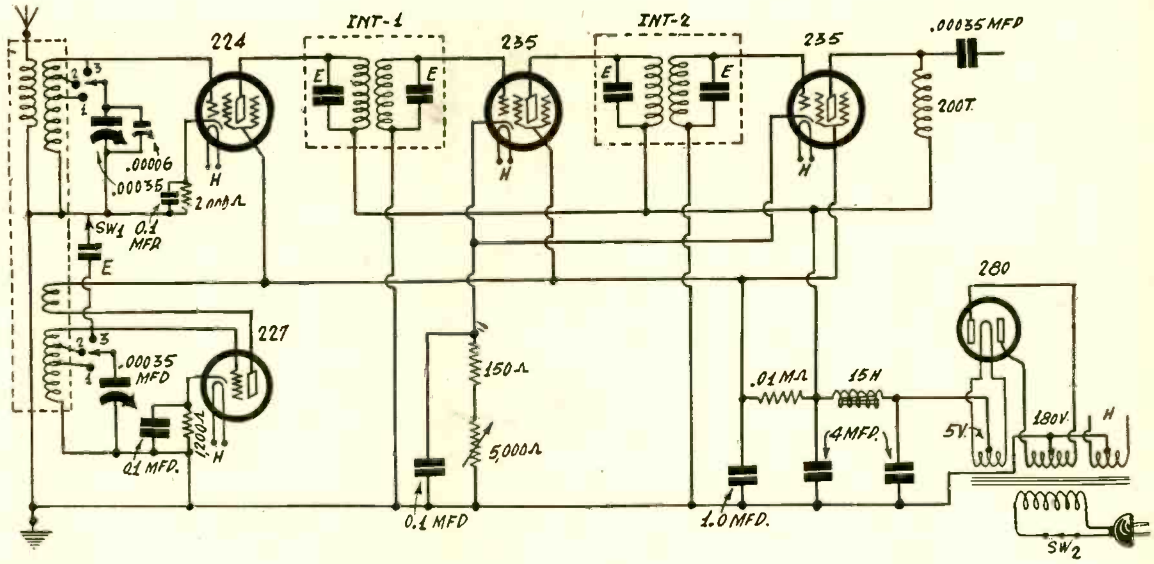


FIG. 4
An all-wave converter, with two built-in intermediate stages.

(Continued from preceding page)

40 volts. This a 5,000 ohm potentiometer (used as a rheostat) will do.

No fear need be felt that detection will arise in the intermediate amplifier because of detecting bias, since this tube is so designed as to be a poor detector, and it will be predominantly an amplifier even at 40 volts negative bias.

The composite assembly is introduced into this circuit in the manner previously described. A point to remember is that the moving arm of the switch in each of two instances goes to the stator of the tuning condenser and nowhere else, while the connection to the grid is made through the coil, except for position (3), where coil and stator connections are common. The switch may be wired as preferred, either for increase in frequency by clockwise or counter clockwise rotation.

Tuning of both primary and secondary makes for high gain, at relatively loose coupling. What this coupling should be is determined by the coil form. Each of the Int. coils is a honeycomb, with several hundred turns, and E are equalizers, of 20 to 100 mmfd. capacity, accessible to a screwdriver. The long extensions of the coil forms are placed end to end, giving a separation of about ⅞ inch.

The intermediate frequency coils are shielded.

The fifth tube is a 280 rectifier, thus affording full voltage to the plates and screens. Filtration is afforded by two 4-mfd. electrolytic condensers and a 15 henry B supply choke coil. Higher capacity and inductance may be used if desired, but are not requisite. The maximum B voltage, about 180 volts, is dropped to the screen voltage by 10,000 ohm resistor (0.1 meg.), but if you have two 20,000 ohms resistors of the pigtail or cartridge type you may connect them in parallel to constitute the 10,000 ohms.

LIST OF PARTS
For Fig. 4

One All-Wave Foundation Unit, consisting of two-gang .00035 mfd. straight frequency line condenser; one 60 mmfd. trimmer condenser, one 100 mmfd. equalizer, one mixer coil assembly, one dual rotary switch with break contact, each section single pole triple throw; one 7½ x 12 inch front panel; one copper shield and bracket; five flat head 6/32 machine screws; one 5,000 ohm potentiometer with switch attached; one vernier dial and three knobs.

Coils

Two 450 kc intermediate transformers in shields, with equalizers E across primary and secondary (INT-1 and INT-2)

One 200-turn honeycomb RF choke coil

One 180-volt power transformer; primary 110v, 50-60 cycles; secondaries, 180v DC @ 50ma; 5v AC @ 2 amps and 2.5 volts AC @ 10 amps.

One 15 henry B supply choke, 400 ohms DC resistance, 50ma rating

Condensers

One .00035 mfd. fixed condenser

Two 4 mfd. electrolytic condensers with two brackets

One 1 mfd. bypass condenser

One block of three 0.1 mfd. condensers (black is common ground)

Resistors

One 2,000 ohm Electrad flexible biasing resistor

One 1,200 ohm wire-wound resistor

One 150 ohm Electrad flexible biasing resistor

One 5,000 ohm rheostat or potentiometer

One .01 meg. (10,000 ohm) pigtail resistor, or two .02 meg. for parallel connection

Other Parts

One subpanel with socket holes drilled, and cutout for shield.

Two binding posts (Ant., Gnd.)

One 7½ x 12 inch front panel

Four UY sockets and one UX socket

One dozen 6/32 round head screws and one dozen nuts

One roll of hookup wire

One service man's adapter

One AC cable and plug

Data on Connections

The connections to make are:

1. Remove aerial from the broadcast receiver and connect it instead to the antenna post of the converter.

2. Connect a wire from ground post of the converter to ground post of the set, but leave the ground connected to the set post.

3. Do *not* connect the output of the converter to the vacated antenna post of the broadcast set. If you have a tuned radio frequency set, use a service men's adapter. Remove the tube from the first radio frequency socket ahead of the detector, insert the service men's adapter in the empty socket and put the tube in the adapter. Connect the output of the converter to one of the two G posts of the adapter. To do this, remove the brad or pin from the G post of the adapter, and attach the output of the converter to one opening at G in the adapter. If it brings through a rushing sound all is well. If not, as there are two openings for each element, all you need do is connect to the other opening at G.

If you have a superheterodyne, without TRF, insert the adapter in the socket of the set's modulator (first detector). If the set has TRF insert the adapter as in the case of a TRF set.

An exception exists if the TRF, either in Super or TRF set, is screen grid stage, as then no adapter is necessary. The output of converter is simply connected to cap of the screen grid tube.

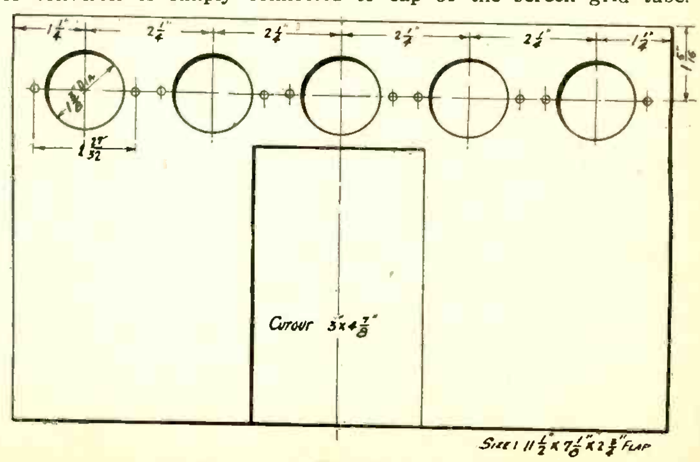


FIG. 5
Plan of the chassis, including the drill holes for wafer type sockets and the cutout to pass the copper shield.

er—Adapter, Using a Switch

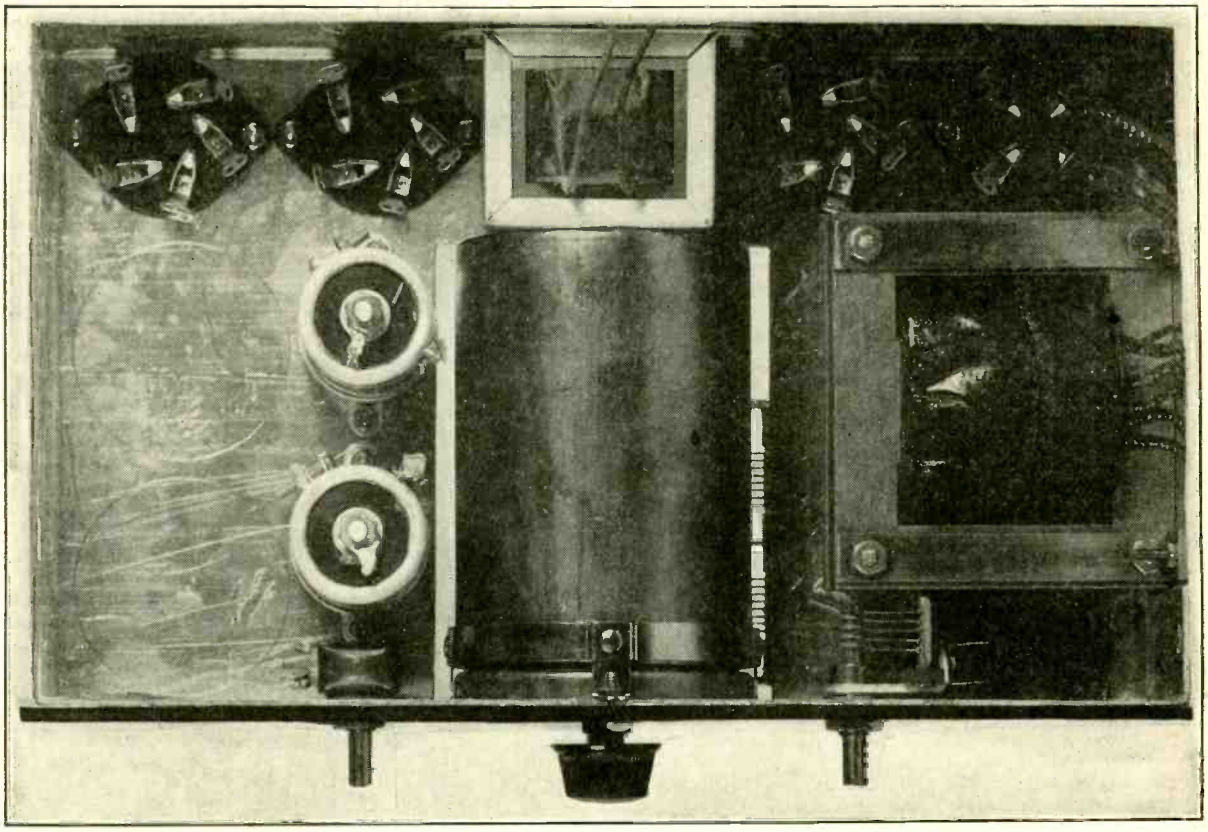


FIG. 6
How the parts are placed underneath. The two faint circles at left show where the intermediate frequency transformers are located. The by-pass condensers are mounted on the rear flap.

The cap in the set stays at its regular use. Only one extra conection is made to the cap.

The foregoing directions apply to working the device as a converter. But it may be worked as an adapter in any set merely by tube ahead of the detector, and connecting the tuner's output to the P post of the service men's device, instead of to G. The brad should be removed from P instead of from G.

TWO forms are used in coil winding. One is 1¾ inches in diameter, 3¾ inches axial length, the other is 1½ inch diameter, 1½ inch length.

The plate winding for the oscillator has 20 turns, but the total windings of the two grid coils are entirely different from each other, for instance, the modulator has a total of 92 turns, while the oscillator has a total of 28 turns.

The reason for this great difference is the great difference in frequencies that the two respective circuits must tune to for reception in the broadcast band. Going above the broadcast band of frequencies the percentage of frequency difference, incoming carrier frequency as compared with oscillator frequency, becomes smaller and smaller, and it is practical to use identical number of turns then, the manual trimming condenser taking up any difference. In the broadcast band, however, the difference is too great to make the manual trimmer sufficiently effective for use of equal inductances.

Take the oscillator winding first. (Fig. 1). Use No. 18 enamel wire for the entire winding. Begin at the secondary terminal, 0, and wind 3 turns. Tap, wind 10 turns; tap and wind 15 more turns. The total is 28 turns, not enough inductance for a low intermediate frequency, say around 520 kc, but when the total winding is used for broadcast work an equalizing condenser E is parallel with the .00035 mfd. and it is adjusted after the converter is built, so that a broadcast station on some low frequency, say 570 kc, comes in loudest. Wind the plate coil in the same direction, of 20 turns of any size wire, say No. 24 or No. 30.

Now wind the modulator secondary. Two different sizes of wire are used. Start at the opposite end of the one formerly used for beginning the winding. Put on 79 turns of No. 30 wire, tap; put on 10 turns more, tap; then put on three turns and terminate. It is well to solder together the beginning of the No. 30 wire winding with the end of the 13-turn tapped winding previously put on. Make this soldered connection inside the form, by scraping off the enamel insulation, twisting the two wire ends together with the end of a fabric insulated or rubber covered leadout wire for the tap, and then using the iron.

The Plate Winding

The plate winding starts ⅛ inch from the end of the adjoining terminal of the oscillator winding. If practical, a slot may be cut for this plate winding, and the wire wound in the slot, thus increasing the separation that will exist between the plate winding of the oscillator and the grid winding of the modulator.

The fine wire used for the 79-turn portion of the modulator secondary constitutes a fairly high resistance to radio frequencies in the broadcast band, but this is met to an extent by the use of negative bias modulation, whereby no grid current flows, the input impedance is high and the selectivity better than if No. 18 wire were used with grid leak-condenser modulation.

When the switch is turned for any short-wave reception, the fact that there is high resistance in the 79-turn section becomes a substantial advantage, since the voltage is greater the higher the secondary impedance. Large diameter wire is used in the tuned circuit (that part of the modulator secondary affected now by the tuning condenser and the resistance of the step-up portion of the auto-transformer thus constituted really should be as high as practical.

The other form, 1½ inches in diameter, about 1½ inches axial length, has 12 turns of No. 18 enamel wire.

How to Insure Oscillation

The direction of winding or polarity of connection is of no consequence in regard to any winding except that for the plate circuit of the oscillator. If the plate winding is put on in the wrong direction, or no matter in what connection it is put on, is connected wrongly, the intended oscillator will not oscillate.

Consult Fig. 1. Assume all windings in the same direction. Take care to observe the precaution that in wiring the respective secondaries from opposite ends, if one is wound in a left-to-right direction, the other, because begun at the opposite end, should be wound in the right-to-left direction. That is, the windings are put on seemingly opposite, but in reality, as second thought will confirm, and actual observation prove beyond doubt, the windings then will be in the same direction electrically and mechanically. Since taps 3 go to grids, the polarities are taken care of, the other extremes of secondaries going to ground.

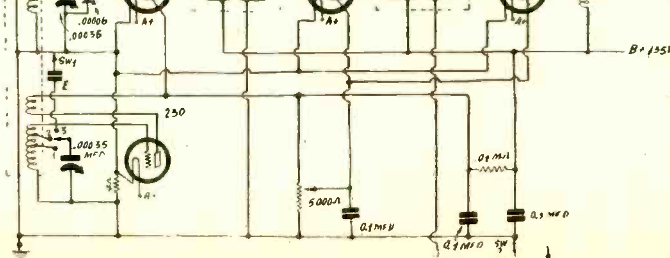


FIG. 7
The system adapted to 2 volt battery tubes.

Grid Current

By Franci

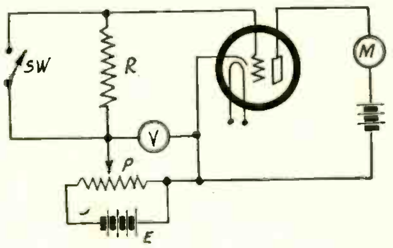


FIG. 1
A simple circuit by means of which the grid current in a vacuum tube may be measured when it is so small that it cannot be measured with ordinary current meters available.

THAT grid current flows in vacuum tube circuits is often forgotten due to the fact that it is usually ignored in designing receivers, especially amplifier circuits. But the grid current sometimes is an important factor in determining the operation of a receiver. Take, for example, a resistance coupled amplifier in which the grid leak is effectively several megohms. The grid current flows through this resistance and sets up a voltage drop which acts as a bias on the tube. In some instances this is the only bias needed, particularly when the signal voltage impressed on the tube is less than a volt, which is often the case.

A method of measuring the grid current in such circuits is often needed. The current is so small that it cannot be measured with any degree of accuracy with a milliammeter even if that is as sensitive as 0-1 milliampere. Even a microammeter sometimes does not measure the current. It requires a calibrated galvanometer of high sensitivity. But microammeters and galvanometers are expensive and are not often found in radio experimenters' laboratories. A method by which ordinary instruments may be used is needed.

Measuring Grid Current

There is such a method of extreme simplicity and the circuit of it is given in Fig. 1. It is applicable to any tube whatsoever, but the circuit is shown for a heater type tube. R is a high value grid leak, P is a potentiometer by means of which the grid bias on the tube may be measured with voltmeter V. E is a grid battery across the potentiometer, and this instrument serves as a means of applying any portion of the battery voltage in the grid circuit. A milliammeter is connected in the plate circuit to indicate the current.

The process of measurement is as follows: First the resistance R is shorted by closing switch Sw. Then the bias is adjusted by means of the battery E and the potentiometer until the bias has the value at which it is desired to measure the grid current. The reading of the meter M is carefully noted. Then the switch is opened. The grid current will now flow through resistance R and the grid bias will change by the amount of drop in it. This will be indicated by a change in the reading of meter M. If the reading is decreased, the grid current flows toward the grid and the bias is increased. If the reading on M is increased the grid current flows away from the grid and the bias is decreased.

When the plate current changes the potentiometer is readjusted until the current has the same value as it had when the switch was shorted. The difference between the two readings on the voltmeter V is then equal to the drop in resistance R. Let this difference be dV. Then the grid current Ig=dV/R.

Sensitivity of Method

The sensitivity of this method is very great if suitable values are chosen. For example, suppose that the value of resistance R is 100 megohms. A voltage change of 0.2 volt can easily be read on ordinary voltmeters of low range. Then it would be possible to measure a grid current at low as 0.002 microamperes. This is of the same order of sensitivity as laboratory galvanometers. Of course the accuracy depends on the accuracy with which the current in the plate circuit can be adjusted to the same value in the two cases. If a change in the plate current due to a change of 0.2 volt can be read easily the adjustment can be made.

When the plate current is large a relatively insensitive milliammeter must be used in the plate circuit and this limits the sensitivity of the grid current measurement. There is a simple way of avoiding this difficulty. A low voltage battery in series with a high value variable resistance is connected across the milliammeter so that the normal plate current is balanced out of the milliammeter. This permits the use of a much more sensitive milliammeter.

Uncertainty of Resistance Value

The accuracy of the measurement of the grid current depends on an accurate knowledge of the resistance R. Resistances of such high values are not very dependable because they might vary with the current flowing through them, and insulation resistances of the tube, supports, and of the switch mounting are in parallel with it. All these reduce the effective resistance so that the grid current may be larger than the value obtained with the method.

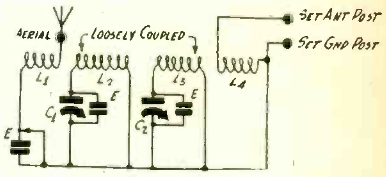
These difficulties may be corrected for to some extent by measuring the effective resistance across the switch when it is open and when the tube is dead. But how can the effective resistance be measured? One possible way is illustrated in Fig. 2. Let the tube in this circuit be a calibrated vacuum tube voltmeter by which grid bias can be measured, and let R1 be a resistance of known value, say 250,000 ohms. Close the switch Sw. This short circuits the effective resistance Rx which is to be measured.

A certain bias will be impressed on the tube, which is equal to the voltage of the battery E. This should be adjusted to such a value that the plate current in the meter M has a suitable value. Let us call this voltage E. Then open the switch. This connects the unknown resistance in series with R1 and the voltage drop in R1 will decrease because most of the battery voltage is now dropped in Rx. From the reading on the meter M and the cali-

A Simple Ba

By Rolar

FIG. 1
Diagram of a band pass filter that uses mutual inductive coupling to obtain the double-hump effect in the tuning characteristic.



THIS little circuit is a band pass filter with mutual inductance coupling between the two. The coupling between the antenna winding L1 and the first tuned winding L3 must be loose, so that the antenna capacity does not affect the tuning characteristic of the circuit. Likewise the coupling between the two tuned coils L2 and L3 must be loose if the band passed is to be narrow and if the characteristic of the combined circuit is to be practically single peaked. The coupling between L3 and 4 need not be loose if the fourth winding is to be connected in the grid circuit of a vacuum tube. However, if it is to be connected across still another winding it must be rather loose in order that the tuning characteristic be independent of the constants in the load circuit.

The output terminals are marked "Set Ant. Post" and "Set Gnd. Post." If this connection be followed it may mean that the connection will be to a very small winding, to a choke coil, or to a high resistance, for there are many different inputs to receivers. If the input is a resistance of 100,000 ohms or more, or a choke coil having an inductance of 30 millihenries or more, the same winding may be used as if the coil were connected directly in the grid circuit.

Windings

Let us suppose that each of the tuning condensers C1 and C2 has a capacity of .00035 mfd. and that the distributed capacity in each circuit, including the capacity of the trimmers, is 75 mmfd. The total capacity in the circuit is then 425 mmfd. Hence to tune down to 550 kc we need an inductance of 197 microhenries.

If we use 1.75 inch tubing and No. 28 enameled wire for windings L2 and L3, we will need 65 turns to give this inductance. These two windings may be put on the same form if this is long enough. The length of each winding will be .879 inch and there should be about the same distance separation between them so that the form should be 2.64 inches long for these alone. If L2

Measurement

s O'Fallon

bration curve for the vacuum tube voltmeter obtain the new voltage drop in R1. Let this voltage be E1. Then Rx = (E/E1 — 1) R1. Now if R1 is known we know the value of Rx.

Measuring Any High Resistance

If R1 is a commercial resistance of 250,000 ohms we can measure its value with the aid of a 180 volt battery and a 0-1 milliammeter for the current will be of the order of 0.72 milliampere. If the voltmeter tube is such that we can make E 45 volts to start with we may find that the value of E1 is 0.5 volt. Then we have Rx = 89x250,000 ohms. This is 22.25 megohms, which is of the order that may be expected. A calibration curve for the vacuum tube voltmeter is simply a grid voltage, plate current curve for given values of plate voltage, grid bias resistance R2, and plate load resistance R3.

The method outlined in Fig. 2 may be used for measuring any high resistance in terms of a lower and known resistance by connecting the high resistance across the switch and proceeding in the manner just outlined. Thus if R1 in Fig. 2 is not known it may first be measured in terms of a resistance of lower and known value of resistance.

When the effective value of the resistance across the switch in Fig. 1 when the switch is open and when the tube is dead but in the socket it may be used in Fig. 1 for measuring the grid current.

It may be that the grid current will flow either toward or away from the grid, depending on the tube and the grid bias at which the measurement is done. The direction of the current should be determined by the change in the plate current when the switch is opened as was explained above. The effect on the operation of the tube of the grid current depends on the direction in which the current flows. If the current flows toward the grid the bias is increased and if the current flows away from it the bias is decreased.

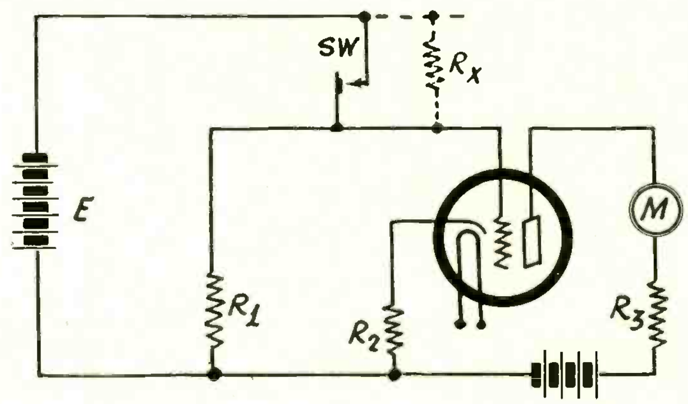


FIG. 2

By means of this circuit a high resistance may be measured in terms of a lower resistance of known value. It is useful for measuring the high effective resistance across the switch

nd Pass Filter

ıd Tookle

and L3 are put on the same form the other two windings should also be put on the same form. L1 might contain 20 turns of the same wire and separated from L2 by half inch. This adds .77 inch to the length of the form. L4 should have as many turns as L3 if the circuit is to be connected directly in a grid circuit, without any separation between L3 and L4. This adds still another .879 inch, so that the total length of the four winding form would be 4.28 inches. In order to make room for mounting screws we should allow ⅜ inch at each end, making a total of practically 5 inches for the tubing.

If the circuit is to be adaptable for different receivers L4 should be provided with taps at about every 10 turns so that different numbers of turns and different degrees of coupling may be selected. In some cases best results may be obtained with only the 10 turns farthest from L3 while in other cases best results may be obtained with the entire L4 winding in use.

Trimmers

There is a small condenser in the antenna circuit which is provided with a switch for short circuiting. If this condenser is small, say .00025 mfd. or less, it will change the antenna characteristics so that they will have little effect on the tuned circuits. The selectivity will be greater when the condenser is in series than when it is shorted.

The trimmer condensers should be set at minimum so that the distributed capacity is as low as practical. If the coils have been made exactly alike, that is, L2 and L3, and if the two tuning condensers are the same, the trimmers should also be set alike when the circuits are lined up. Adjust the trimmers near the middle of the broadcast band, that is, around 900 kc., if the selectivity of the broadcast receiver is to be improved throughout the band. Otherwise adjust them near the end of the broadcast band where the selectivity must be increased. Since it is usually at the high frequency end where the selectivity is poor, the adjustment should be made around 1,400 kc.

In case it is not desired to wind the two tuned windings on the same form they may be wound on two similar forms. L1 and L2 would go on one and L3 and L4 on the other. When they are so wound it is possible to vary the coupling between the two tuned circuits in order to vary the band width. They may also be placed side by side as well as end to end. Either way of placing the coils the coupling may be varied by varying the distance between them. When they are placed side by side they may be as far as 5 inches apart.

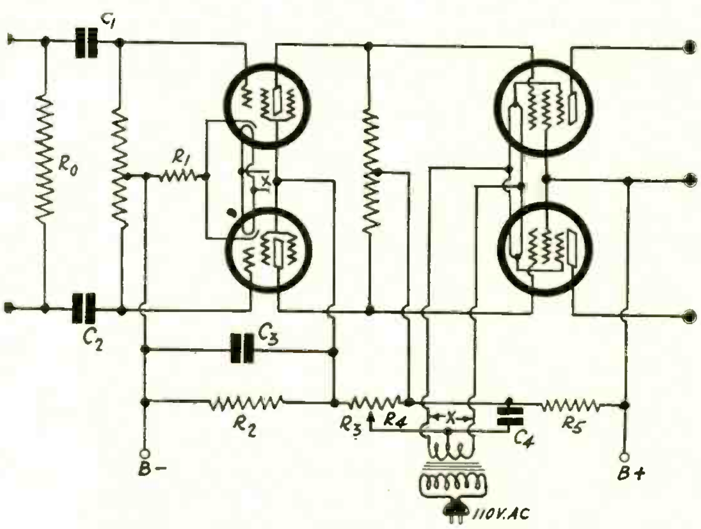


FIG. 3

Diagram of a push-pull resistance coupled audio amplifier with pentode output, to be used with a special filter detector. Flow of grid current must not take place in the amplifier.

List Prices of Tubes

The following table gives the prevailing list price of the various tubes:

Tube	*Price*	*Tube*	*Price*	*Tube*	*Price*
227 @	$1.25	551* @	$2.20	200A @	$4.00
201A @	$1.10	171A @	$1.40	222 @	$4.50
245 @	$1.40	112A @	$1.50	BH @	$4.50
280 @	$1.40	232 @	$2.30	281 @	$5.00
230 @	$1.60	199 @	$2.50	250 @	$6.00
231 @	$1.60	199 @	$2.75	210 @	$7.00
226 @	$1.25	233 @	$2.75	BA @	$7.50
237 @	$1.75	236 @	$2.75	Kino	
247 @	$1.90	238 @	$2.75	Lamp @	$7.50
223 @	$2.00	120 @	$3.00		
235 @	$2.20	240 @	$3.00		

* *This is comparable to the 235.*

The Vari-Mu and Pentode

By Allen B. Dumont

Chief Engineer, De Forest Radio Company

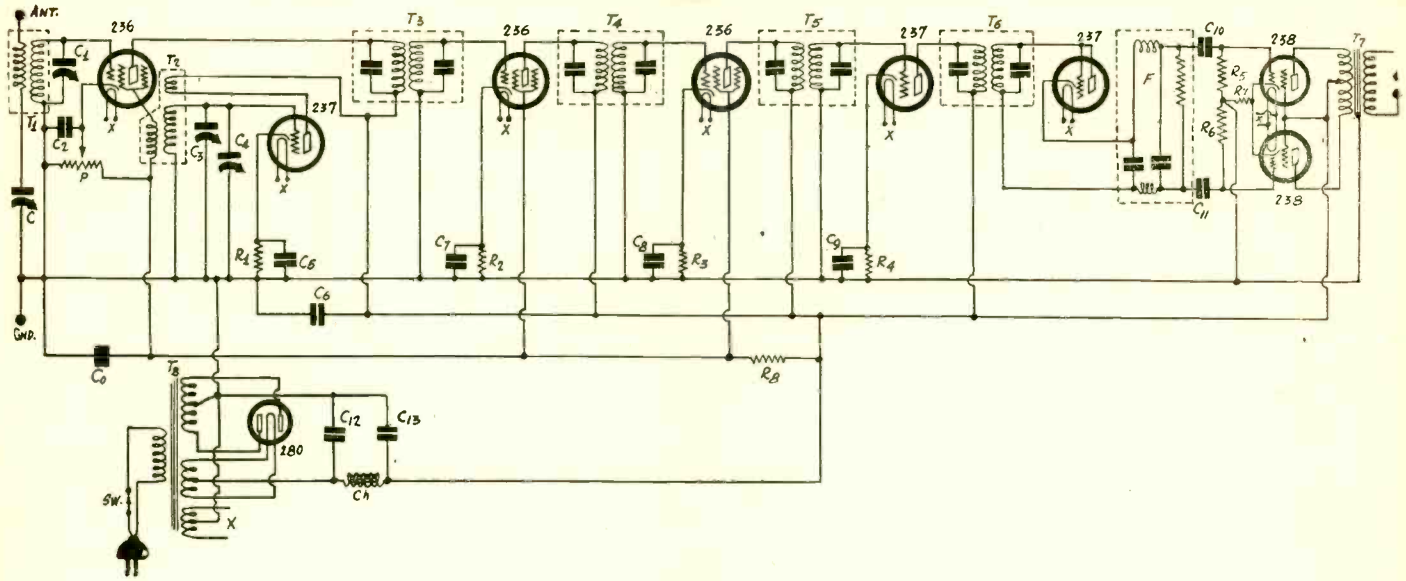


FIG. 1

A circuit using automotive series tubes, with pentode output in push-pull.

THE variable mu screen-grid tube permits stronger signals to be fed into the radio frequency amplifier without causing cross talk. Hence the ratio of the desired signal to the noise level is raised, eliminating hissing which is common on sets using several stages of pre-selection.

Most important of all, the variable mu screen grid tube eliminates the need for various controlling devices heretofore employed to compensate for the difference between distant and local signals. In th set employing the new tubes there is no need for the antenna-ground potentiometer shunt, the local-distance switch, the double pre-selector and other compensating means.

Prevents Overload

The radio frequency amplifier using the new tubes automatically takes care of building up the signals to the desired high level yet prevents building beyond that level.

In general appearance, the variable mu screen grid tube is not very different in appearance from the usual screen grid. Only a slight internal variation marks the difference in performance.

The power pentode is here. Not only has it emerged from the laboratories of several tube manufacturers, but it is now being produced in large numbers to meet the urgent demand of pentode set manufacturers. While the radio frequency type pentode developed a year or more ago did not meet with commercial success, the present power pentode is certain to find a very definite place in the radio set field.

More Amplification

The power pentode, with many times the usual amplification of a power tube, will serve to reduce preceding amplification to a minimum or, what is more likely, to produce receiving circuits of extreme sensitivity. A pentode delivers half again as much output as the usual -45 power tube with only a third as much input voltage. To be exact, it delivers an output of 2.5 watts with only 11.7 volts input, as contrasted with a maximum output of 1.6 watts with an input of 35.4 volts for the usual -45 power tube. The amplification factor is 95 as contrasted with 3.8 for the usual -45 tube.

Simplifies Circuit

Thus the power pentode may be operated at maximum output directly from the usual detector tube, doing away with the first audio stage. Not only does this make for a simpler circuit with corresponding economy, but it should also make for purer tone quality by eliminating a transformer.

The only question is one of sufficient clearance between filament and control grid in the pentode. The tendency is to allow too little spacing between filament and adjacent grid, thereby making the tube liable to short circuits in transit.

Answers to Questions About Pentode Tubes

Conections of Filament Type Pentodes

YOU have described two new pentodes, the 247 and the 233. Each of these is supposed to be a filament type tube, yet has the base of the UY type, indiating that there are five connections. What is the extra terminal for?—A. M. D.

The two H terminals are for the filament, the K for the screen, the G for the grid, and the P for the plate. The cathode of these tubes is the filament. Hence the K is left for the extra element.

* * *

Bias Resistor for Pentode

IN the pentode tube there is an extra element connected to the filament or the cathode. This must draw some current. Should this not be allowed for in computing the grid bias resistor, just as allowance is made for the screen and the plate currents? How should the total current be measured to test whether this current is large enough to affect the value of the bias resistor?—T. H. J.

The milliammeter should be connected in the B minus lead of the tube, when no other current drawing device is connected to the supply. In case there is another current the milliammeter might be put in the lead to the center tap of the filament transformer, or in the cathode lead. That is, the milliammeter should be put where the bias resistor is to go. When the current is measured the proper voltages should be on the elements, including the proper grid voltages, which is best applied by means of a battery for the test. When the total current has been obtained, the proper value of grid bias resistor is obtained by dividing the desired grid bias by the current, using volts and amperes. The result will be the resistance in ohms.

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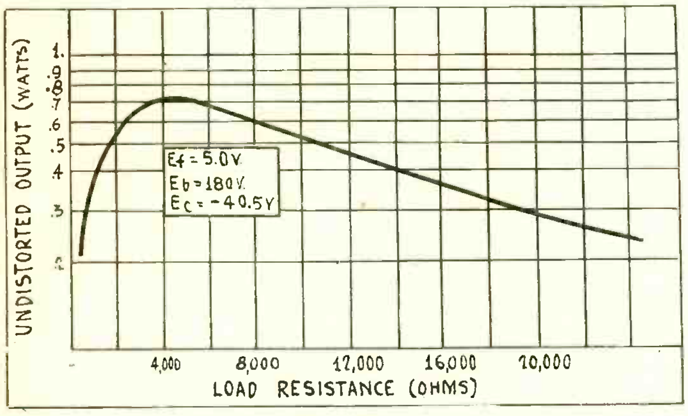

FIG. 920
A curve showing the variation in the undistorted output power of a 171A tube as the load resistance varies. The maximum occurs at 4,000 ohms.

Output Power From Tubes

WILL you kindly publish a curve showing how the output power of a tube varies with the resistance of the load? I am interested in knowing whether or not the load resistance is critical or whether it may be varied over wide limits without a noticeable change in the volume.—S. W. R.

In Fig. 920 you will find a curve of this type for a 171A tube. This curve is typical and although it does not hold quantitatively for other power tubes it holds qualitatively. You will note that for resistance loads above that which gives maximum the tube is not critical, but below that the output power drops rapidly. Hence it is important that the load resistance be not made too small. For this tube it should not be made less than 2,000 ohms, which is equal to the internal resistance of the tube. This, incidentally, is the resistance which gives greatest output, while 4,000 is that which gives greatest undistorted output.

* * *

Meter Indicates Performance

I HAVE an electric model set, 110 volts A. C. I would like to add a meter somewhere to make sure the set is working properly. What type would you advise?—C. V.

A 110 volt alternating current voltmeter is suggested. Your set will give satisfactory service in all probability provided you use the correct voltage. In your suburban location, line voltages may change. The meter may be placed on the panel, or in back, where it will be less conspicuous. If your meter is mounted, attach the cords to a plug and use a double plug or receptacle so you can connect the meter to the lighting circuit. The set has a switch inside, near the rear, which is marked, in event the voltage is higher or lower than the rated 110 volts.

* * *

Selectivity Help

WHAT do you recommend for the very congested section I live in—to receive distant stations? I have tried wavetraps and I am using a good set with three stages of screen-grid amplification. Would a super-heterodyne give more selective results? I had one tried here, without much improvement over what I am using now. A wavetrap helps, but is hard to operate. What about costs?—F. W. C.

A band selector unit, with two or three separate stages but with a single control, would probably be the best device to get. This is connected in advance of your present set, and will greatly sharpen the tuning. The cost is from $18 to $30. A band selector uses no tubes, and is simply a succession of coupled circuits.

* * *

Television Scanning

I HAVE noticed that in television transmission there are many different speeds, such as 15, 20, and 24 frames per second. Is it possible to receive with a given scanning disc transmissions on the different speeds provided that the disc is run at the proper speed and the number of lines per frame match the transmitter disc? For example, if there are 60 lines per frame and the scanning disc at the receiver contains 60 holes is it possible to receive regardless of the speed?—S. F.

If the scanning discs at the receiver and transmitter correspond it is possible to receive provided the two discs are synchronized regardless of the actual speed of the two discs, provided that the speed is not less than about 15 frames per second. If the two discs are not the same in design it is not possible to receive even if the speeds are exactly the same. In one disc there are three spirals each covering a particular region of the field. If this disc contains 20 holes, and thus a total of 60, it cannot be used for receiving from a disc having 60 holes in a single spiral.

* * *

Oscillation in Audio Amplifier

I HAVE a good radio receiver in which the last stage contains two 245 tubes in push-pull. When I take out one of the 245 tubes the set continues to play with a slight decrease in the output, but when I take out the other there is a terrific roar through which it is impossible to hear any intelligible sounds. The bias for these tubes is obtained from a drop in the voltage divider and it is not changed appreciably when either tube is taken out. What is the reason the set plays all right on one tube and not on the other? By the way, I have interchanged the tubes and either tube causes the noise in the same socket, so that the trouble is not in the tubes.—W. G. S.

When you take out one of the tubes the last stage becomes unbalanced. In one case it remains stable while in the other it becomes unstable by feedback. You simply have a case of motor-boating. It is possible that the feedback takes place through the grid bias resistor. You could probably stabilize the circuit if you use the individual grid bias resistors for all the tubes in the audio amplifier, or rather one for each stage.

* * *

Adjusting Superheterodyne Tuner

IF the radio frequency tuner and the oscillator condensers are to be ganged would it not be possible to get correct alignment throughout the scale if straight line frequency condensers were used in both by merely lowering the inductance of the oscillator coil so that the two circuits were properly lined up at one setting? Why is this method not used if it is feasible?—W. E. C.

If both condensers were strictly straight line frequency this would be possible. The trouble with this scheme is that no condensers are straight line frequency even if they are so called. The condensers have to be made straight line frequency over a given frequency band when there is a certain minimum capacity in the circuit. A condenser that is designed mathematically to be straight line frequency on the assumption that there is no zero setting capacity will not be straight line frequency in the circuit at all, because the zero setting capacity which will inevitably be introduced will upset the rate of change of capacity. Since the oscillator and radio frequency condensers cover different wavebands it would be necessary to have differently shaped plates in the two. Since this is necessary for so-called straight line frequency condenser it is just as well to use condensers with different rates of change of capacity. The use of a fixed condenser in series with the variable in the oscillator circuit and another condenser in shunt is a makeshift and only ties the two circuits together at two selected frequencies. If these frequencies are chosen properly the deviation at any point need not be very large so that for practical purposes it may be said that the two circuits are lined up throughout the scale.

* * *

Phonograph Pick-up on Modern Sets

IN many modern sets there is only one stage of audio frequency amplification and the amplification in this stage is usually not enough to permit the playing of phonograph records with sufficient volume. How can this difficulty be overcome? Is it possible to convert the detector tube to an amplifier so that the phonograph pick-up unit could be put in the grid circuit?—T.G.H.

If the detector is of the grid bias type it is very easy to convert it to an amplifier. It is only necessary to change the bias. If this is obtained with a high resistance in the cathode lead, which is usual, a lower resistance may be connected across it, one that is suitable for the tube when it is used as an amplifier. Perhaps the simplest way is to connect the phonograph pick-up terminals across the high bias resistance and at the same time removing the condenser which is normally across it. In this case the resistance of the pick-up unit would become the grid bias resistance for the tube.

* * *

Diode Rectifier Detector

IN the May 16th issue you show a superheterodyne circuit in which there is a diode type rectifier working into a push-pull amplifier. What is the function of the filter F following the rectifier tube? Would the circuit not detect as well without this as with it?—K. T.

The circuit would detect without the filter but not as well. In principle there is no difference between this rectifier and the rectifier used in a B supply. As is well known the B supply rectifier works without a filter following it, but if the first condenser is omitted the output voltage is very low. The same holds true in the case of the detector. The two chokes in the detector filter serve the same purpose as the chokes in a B supply. But they have different values because the frequencies involved are different. The second condenser in the filter F serves to make the choke coils more effective. The object of the rectifier and the filter is to produce a steady voltage across the resistance when a radio signal of constant amplitude is impressed on the tube, and as high a voltage as possible for a given signal amplitude. When the signal is modulated the amplitude varies and therefore the voltage across the resistance varies, and this variation constitutes the audio frequency signal. The condensers and the inductances in the filter must not be too high in value for if they are the higher audio frequencies in the signal are filtered out just like the radio frequencies, although not to the same extent.

* * *

Two Stage Push-Pull Amplifier

I AM planning to build a two stage amplifier for phonograph reproduction. I wish to use one 112A tube and two 171A tubes. Will you kindly publish such a circuit? Please give values of ballast resistors and voltages.—H. B. W.

In Fig. 921 is the circuit you ask for. T1 is an ordinary audio frequency transformer, T2 a push-pull input transformer, and T3 a push-pull output transformer. On the quality of these three transformers depends the quality of the amplifier. The plate and grid voltages are indicated on the drawing. The filament battery voltage should be 6 volts and the resistance R1 and R2 should be 4 and 2 ohms, respectively. This circuit will give ample volume from a phonograph pick-up unit.

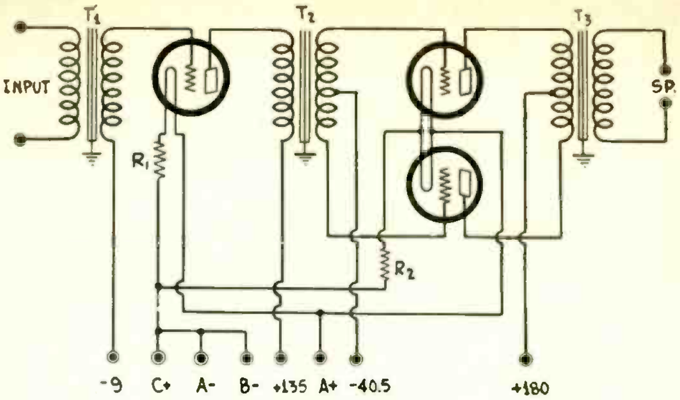

FIG. 921

A two stage push-pull audio frequency amplifier for battery operation suitable for phonograph pick-up reproduction.

* * *

Harmonics in Superheterodyne

I HAVE a superheterodyne which is extremely sensitive but it brings out a lot of harmonics of strong local stations. What is the cause of harmonics and how can they be avoided?—T.R.M.

By harmonics we presume that you mean that local stations can be received on many different positions on the oscillator dial in addition to the two regular points. If that be the case, you have harmonics and there are many causes for their appearance. Ordinarily they are heard only on very strong local stations. First, the trouble may be that you do not have enough selectivity in the radio frequency tuner. This may be the case even if you have many radio frequency circuits ahead of the modulator because the interfering signal may be picked up directly by the modulator circuit or by the oscillator. Lack of shielding would account for it. It is also possible that the signal is picked up by the ground, screen, plate, and other leads of the modulator or oscillator. Lack of shielding again, or lack of by-passing, would account for it. One of the main reasons for strong harmonics is too close coupling between the oscillator and the modulator tubes.

* * *

Selectivity of RF in Super

IS it really necessary to have an extremely sharp tuner in a super-heterodyne with a high intermediate frequency, say 175 kc? It seems to me that it is only neessary to suppress the carrier frequencies, which differ by twice the intermediate frequency from the desired carrier. If this is so, it should not take a very selective receiver to suppress the interference.—T. R. Y.

If you have a band pass filter in the RF tuner it does not have to be very selective. It may have a transmission band almost as wide as twice the intermediate frequency provided that at the two interfereng frequencies the suppression is complete. It is not easy to get such a filter, for if it is broad it is likely to have considerable transmission at the potential interference frequencies. There is an advantage in having a broad tuner of the band pass type when the RF tuner and the oscillator condensers are ganged, for if the condensers are not lined up it would not make much difference. Suppose, for example, that the transmission band is 50 cycles wide. The oscillator and the RF tuners could then be out of alignment by about the same amount without any appreciable reduction in the output. Yet there would be no interference, for the intermediate selector would eliminate the signals lying close to the carrier. The difficulty is to get a band pass filter that suppresses well beyond the 50 kc limit. The suppression must be very thorough or the signals will come through.

* * *

Color Television

WHAT is the principle of colored television? Is the process similar to three color printing of half tones?—W. C. B.

The process is similar and is based on the use of three primary colors, red, blue and yellow, or any other three colors that may be considered primary when taken as a group. The object to be transmitted is scanned by white light containing all the colors. The reflected light falls on photo-electric cells made sensitive to certain colors and screened by color filters so that only the desired color reaches a given cell. Then three different signals are transmitted on three different channels. Each is received and is made to actuate a kino lamp giving out the appropriate color. The three signals are then combined on the viewing screen in the proper sequence.

* * *

Variation of Bias with Resistance

IN what manner does the grid bias vary as the grid bias resistor is increased? Is the bias proportional to the resistance in accordance with Ohm's law or does it vary in some other manner?—E. W. H.

The variation is very complex and does not follow Ohm's law. The variation is complex because, first, the plate current varies due to the change in the grid bias; second, the plate voltage varies due to the fact that some of it is transferred to the grid circuit, and third, the internal resistance of the tube varies. The variation is so complex that no useful equation can be found for it. Qualitatively, however, we can examine what happens. At the beginning, when the resistance has a certain value the plate current has a corresponding value and so has the bias. As the bias resistance is increased, the plate current is decreased because the bias is increased, because more resistance is put in the plate circuit, and hence because the plate load is increased. But the decrease in the plate current causes a reduction in the grid bias. This means that the grid bias does not increase as rapidly as the grid bias resistance. This is about all that can be said. The proper way to show the exact variation is to take a curve between the grid and the bias resistance for otherwise constant conditions.

* * *

Combination of Resistances

WHEN two resistors are connected in parallel the effective resistance of the two is obtained by dividing their product by their sum? Is this rule applicable when there are more than two resistors in parallel? If not, is there a similar expression that can be used? Could the rule for combining two resistances be applied to more by repeating the process for two?—F. D. M.

The rule is not applicable to more than two resistances. However, there is a similar rule for more than two but it is so complex that it is not easy to remember. The better way is to repeat the formula for two resistances. After the resistance of any two has been found, that of these two and one more can be obtained by the same formula. This process can be extended to any number. When there are more than two resistances the best way to find the resistance of the combination is to add the reciprocals of all the resistances and then take the reciprocal of the sum of the individual reciprocals. To illustrate: Suppose we have the four resistance 2, 20, 5 and 10 ohms in parallel and we want to find the effective resistance of the combination. The reciprocals of these are in order, 0.5, 0.05, 0.2, and 0.1. The sum of these reciprocals is 0.85. Hence the total resistance is 1.176 ohms. Using the formula for two resistance we get first that of 2 and 20, obtaining 2x20/22, or 1.82 ohms. Then we get that of 5 and 10, obtaining 5x10/15, or 3.333 ohms. Then we use the formula again on 1.82 and 3.333, obtaining 1.82x3.33/5.15, or 1.176 ohms. Inductances in parallel and condensers in series are combined in the same manner as resistances in parallel.

* * *

Measuring Unknown Resistance

I HAVE a 1,000 ohms per volt voltmeter having a scale of 100 volts. When I connect this across a 45 volt battery the meter reads 45 volts. When I connect a certain resistance in series with the voltmeter the voltage reading on the same battery is only 31 volts. Is it possible to determine the resistance of the resistor from these data? If so, please show how?—J. H.

It is possible and very easy. Since the meter is a 1,000 ohms per volt instrument and has a maximum reading of 100 volts, the total resistance of the meter is 100,000 ohms. Also, since the instrument is a 1,000 ohms per volt instrument it is a 0-1 milliammeter and the current can be read just as easily as the voltage. When the meter alone is across the battery the current is 0.45 milliampere and when the added resistance is in series the current is 0.31 milliampere. The voltage in the circuit is always the same, namely 45 volts. Hence we have $45=(100{,}000+r)0.00031$ from which to calculate r. We get $r=45{,}160$ ohms. We can also get it from the proportion $R/(R+r)=31/45$, knowing that the value of R is 100,000 ohms. It is clear that the same formula can be used to measure the resistance of the meter provided that an external resistance of known value is connected in the circuit.

W5NE OUSTED FOR AIDING IN RUM RUNNING

Washington.

The Federal Radio Commission issued the following announcement in connection with the revocation of an amateur's license:

On April 11, 1931, agents of the Department of Justice, accompanied by U. S. Radio Inspector Dutrauil, went to the home of Chas. Andres, Jr., 2748 Gladiola St., New Orleans, La., and arrested Chas. Andres, Jr., and seized the radio transmitter he was using. This was part of the raid made by Department of Justice agents in connection with smuggling liquor into the United States at that time.

Chas. Andres, Jr., holds an amateur radio station license and has been assigned the call letters W5NE. This amateur station license does not expire until March 20, 1932.

Four Points in Affidavit

An affidavit made by Chas. Andres, Jr., on April 27, 1931, shows: (1) He used an unauthorized call, (2) handled messages without knowing what they meant, (3) used frequencies not in the amateur band, and (4) kept no log of this transmission.

The United States Supervisor of Radio at New Orleans, in a letter to the Director of Radio, dated April 28, 1931, states that Andres has become a voluntary Federal witness in the cases charging conspiracy to violate the prohibition law and also states that he does not believe that any action will be taken against him unless he should be given suspended sentence. The Supervisor of Radio says that Andres has shown a very co-operative spirit throughout the whole matter and undoubtedly regrets his actions. The Supervisor of Radio suggests that the station license and operator's license held by Chas. Andres, Jr., be suspended for a definite period inasmuch as he is anxious to get back on the air as an amateur.

Frowns on Continuance

It has been found from experience that radio stations have become very important factors in connection with rum running and other smuggling activities. Without these stations their operations would be much harder for them and their apprehension much easier for Federal agents. It is not believed that by becoming a Government witness and escaping all criminal punishment is sufficient reason to allow this man to continue operating.

It is, therefore, recommended that an order of revocation be made by the Commission to revoke the license of Station W5NE, as provided for in section 14 of the Radio Act of 1927, and in accordance with the Commission's practice and procedure adopted by General Order No. 95.

Dealers Handling Sound Equipment

Radio dealers are constituting an outlet for synchronous and non-synchronous sound equipment said Louis Gerard Pacent, president of the Pacent Reproducer Corporation, 91 Seventh Ave., New York City. For the first time in the history of talking motion pictures, he said, radio dealers are now permitted to act as representatives in the sale of Pacent sound movie outfits.

Stations Give Bootleggers Aid

Washington

Scores of unlicensed radio stations, operating principally in the high frequency bands, are aiding rum runners, particularly along the Atlantic seaboard and the Gulf coast, said William E. Downey, Acting Director of Radio, United States Department of Commerce.

Inspectors of the Department of Commerce are checking up on these outlaw stations, as well as on some licensed stations believed to be used as message centers for rum runners. Licensed operators seldom participate in these illicit enterprises, said Mr. Downey, although he cited the instance of Charles Andres, Jr., whose radio plant was seized in New Orleans.

Great reliance is being placed on the constant frequency monitoring station, which has been in modified operation since last Fall, but which will be on full schedule, with a frequency range over the entire spectrum of licensed frequencies, in July or August, when there will be facilities for a "double check" on outlaw stations. Now fifty inspectors check frequencies and use of transmitters, but when activities are enlarged it is expected this force will be increased.

NOTABLES TALK IN NEW SERIES

The National Advisory Council on Radio in Education, 6 East Forty-second street, New York City, has begun the first of a series of radio lectures entitled, the "Men of America" series, to be broadcast over country-wide networks. President Hoover, speaking from the White House, introduced the first speaker of the series, Robert A. Millikan, who talked from Los Angeles. Dr. Millikan then gave the inaugural address of the series, which will be carried over coast-to-coast hook-ups to the First Annual Assembly of the Council in session in New York at the New School for Social Research. The cooperation of both the National Broadcasting Company and the Columbia Broadcasting Systems has been assured by the officials of those organizations.

Other speakers who have been invited to participate in the series for the first year are Nicholas Murray Butler, who will speak on some phase of international relations, Charles Evans Hughes on the law, Walter Lippman on journalism and John Dewey on education.

According to Levering Tyson, director, the Council plans to continue the series indefinitely, and will invite only four or five individuals annually to deliver the addresses. Although lecturers for only the first year have been approached, it is probable that such men as Dwight Morrow, Julius Rosenwald, Silas Strawn, Gerard Swope and Newton D. Baker will be asked to carry on the series.

The function of the National Advisory Council on Radio in Education is to further the art of radio broadcasting in American education. The "Men of America" series is the first attempt the Council has made to demonstrate the type of educational broadcasting that it believes will excite the interest of the American people.

Outstanding men from every field of human endeavor are expected to speak in the series.

GOOD IMAGES CALLED VITAL TO TELEVISION

In a statement to stockholders at their annual meeting, David Sarnoff, president of the Radio Corporation of America, said that television is promising but not yet ready for a public that has been educated by the movies to expect finest quality reproduction. He said:

"Important forward strides are being made with television. In our development work now proceeding at Camden we are seeking to perfect television to a point where it is capable of rendering real service before offering it to the market. While the public was willing, and even eager, to experiment with radio in the early stages of broadcast development, it seems to us that it will desire a comparatively more advanced television receiver than the early crystal radios.

Expects High Quality

"There was no precedent for the taking of sound and music out of space, but the public has been educated by the motion picture industry to expect picture transmission of a high quality, and it is doubtful whether interest can be long sustained by inferior television images.

"The progress we have made so far has given us the belief that ultimately a great service of television can and will be made available.

"Because of our present and past efforts in this field of research and development I feel that the position of the Radio Corporation both as to patent rights and technical facilities is promising.

"I do not believe that television will supersede sound broadcasting by radio. It will be a correlated industry.

Promises Development

"Television promises another great industrial development, but to assure this, we cannot disappoint the public and defeat the possibilities of a future great service by hasty and premature action at the present time."

He said that midget sets are helping to keep up sales, which are behind previous year, yet there is the encouragement of improved sales in recent months.

Sound Track Station Gets 500 Watt Permit

The Federal Radio Commission has granted a license for the newly-built experimental station W1XAU to operate with 500 watts on the experimental frequency of 1604 kilocycles.

This is to be used as the sound path for the television transmission of W1XAV, which operates on the television band between 2850 and 2950 kilocycles with 500 watts power. A renewal license was granted to the latter station. Both stations are owned and operated by the Short Wave and Television Corporation of Boston, Mass. Synchronized programs are broadcast daily from noon to 1 p.m., 3.30 to 4 p.m. and 7.30 to 10 p.m., Eastern Daylight time,

NAYLOR TRANSFERRED

L. P. Naylor, former sales manager of Arcturus Radio Tube Company, Newark, N. J., has assumed the management of Arcturus activities on the Pacific Coast, at a branch in Los Angeles.

A THOUGHT FOR THE WEEK

AND now the American Newspaper Publishers Association, the members of which have been discussing the pros and cons of radio as a competitive force working against the interests of the publishing business, asks the Federal Radio Commission to ban the broadcasting of air programs in instances where the prizes offered depend upon chance. Our advice, unsought, but, we believe, worth listening to, is that broadcasting stations take the matter in hand and refuse to broadcast programs that in any way are contrary to state or Federal laws governing lotteries. This probably would present other drastic and uncalled-for regulations being proposed and passed. Let the housecleaning come from within—and come immediately.

RADIO WORLD

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

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

RCA'S Aftermath

WHEN the directors of the Radio Corporation of America sat in a room in the Woolworth Building in New York City, four years ago, and decided that it would be a smart business stroke to compel the 23 receiving set licensees initially to equip all sets with only RCA tubes, they little thought that a storm would rock the entire structure of the corporation and its subsidiaries as a result of such business acumen.

That the provision of "clause 9," written into those licenses, requiring that only RCA tubes be used initially to equip the sets, really was a stroke more paralytic than vitalizing to the administering agency soon became evident, and clause 9 was deleted from the contracts in July, 1928. That the clause was bad policy was admitted, but not that there was anything illegal in it.

Meanwhile independent tube manufacturers felt that their business had been injured, irreparably damaged, to hear them tell it, because for several months they had tough sledding trying to sell tubes to set manufacturers. These independents were left to squabble over what business remained, and they did not find the skim milk of their replacement market and the supply of tubes for initial equipment of unlicensed sets very nourishing. So, led by the DeForest Radio Company, they started suit, asking for an injunction, with damages. The injunction was granted. The Court of Appeals of the District of Columbia decided that clause 9 was in violation of section 3 of the Sherman anti-trust law, and the case went to the Supreme Court of the United States, on the defeated defendant's motion for a writ of certiorari, that is, a writ to search the record, in back of which was the hope of at least a new trial. The Supreme Court, by failing to grant the writ, in fact refused to issue it, and the finding of the lower court stood. There was no further appeal. The highest court had spoken the last word.

Meanwhile the damage suits, to which the injunction was preliminary, are still to be tried. The plaintiffs gained nothing directly from the injunction, as the provision in clause 9 was rescinded before the court determination. The original independents, for the most part, have lost interest in any subsequent outcome of the case, save the damage recovery, as since the suit was started they have become tube manufacturing licensees themselves, all save the prime mover, the DeForest Company, which has no such license and asserts in suits brought by RCA that it needs no license.

The DeForest Company, which always can be relied on for strong opposition to RCA, is perhaps alone among the original plaintiffs to desire that further punishment be meted out to RCA and its subsidiaries, apart from the direct issue of the case, which now remains one involving only money.

So some other interests have come forward with a demand that full punishment be visited upon the RCA and its subsidiaries, because, first, violation of the Sherman anti-trust law is a matter of final court record, and, second, the Radio Act provides that the "licensing authority is hereby directed to refuse a station license" to any person, firm, company or corporation, or any subsidiary thereof, "which has been finally adjudged guilty by a Federal Court" of monopolizing or attempting to monopolize radio communication, directly or indirectly. That is the crux of section 13 of the Radio Law, while section 15 provides that "all lawful restraint and monopolies, and to combinations, contracts or agreements in restraint of trade" are to be held applicable to the radio business.

Under section 15 the court is empowered (not directed) to cancel the licenses of the offender as part of the decree.

It is thus clear enough, despite some phases of confusion in these provisions, that while the licensing authority, or Federal Radio Commission, is directed to refuse a station a license, for adjudicated violation of the anti-trust laws, the court is given discretionary power to cancel the license for the same reason. Such cancellation, effective as the of the date of the decree, is to be distinguished from mere refusal to grant a renewal, which seems to be the only power vested in the Fededal Radio Commission, which perforce would have to wait for renewal applications to accrue. The court did not exercise the discretionary power. Will the Commission exercise the directory power?

RCA and its associates are believed to contend that the provisions of the Radio Law relate to an adjudication in a criminal proceeding, that is, one such as would be waged by the United States government under the anti-trust laws, as distinguished from a private civil suit, as the one that is the basis of the present trouble. Senator Dill, of Washington, who wrote the sections of the Radio law, says there certainly was no such intention on his part, but that the law should be interpreted by the Commission to hold that an adjudication in any suit, civil or criminal, of violation of the anti-trust or laws, is applicable. He cites the good work done by RCA and its subsidiaries, and suggests there be no token of revenge in the proceedings.

It is well indeed that the Commission proceed with utmost deliberation, and take no hasty action on so vital a subject. Despite their enormous proportions, and their controlling skein woven in the broadcasting and commercial radio network, the RCA and subsidiaries, natural targets for corporation-hating and success-baiting, are entitled to the same even justice as the smallest corporation or poorest person. In fact, it can be said that many, even those not over-friendly with RCA and its affiliates, or the objects they represent, and including heated competitors, more than half wish that nothing very serious emanates from the present side issue that is overmastering the injunction and damage suits out of which it grew.

Meanwhile the question is before the proper authorities and it is hoped will be treated with even an extra measure of fairness.

"Capacitance" Selected

THE Institute of Radio Engineers has given its official approval of the term capacitance for the better known term capacity. Notwithstanding this official recognition of the term it remains artificial, even monstrous, and shocks those who have become assustomed to use the term capacity. The only justification for changing the name of this electrical term is that it ends in "ance" in common with inductance, resistance, impedance, conductance, and many others. Perhaps the advocates of capacitance thought that capacity felt out of step with the other terms because of its unique ending.

If all the electrical terms must end in "ance" in order to fit into the scheme, why do we retain such words as current, potential, power? If we are to be terminologically consistent we have to change the names of these quantities to currance, potance, and powerance. It would be just as logical as to use capacitance.

The IRE is not consistent in the use of the term capacitance in its 1930 year book, for quite frequently it reverts to capacity. Thus the static capacity of an antenna is defined in one place and a method given for measuring the effective capacity. Also, methods are given for measuring various capacitances, but under the pertinent circuit diagrams it states they are circuits for measuring capacity.

The Radio Census

Connecticut

Washington.

The Director of the Census announced the results of a preliminary count of the number of families in the State of Connecticut 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 389,596, as compared with 311,610 in 1920. The number of persons per family in 1930 was 4.1, as compared with 4.4 in 1920. The number of families reporting radio sets in 1930 was 213,821, or 54.9 per cent of the total.

* * *

Nevada

The Director of the Census announced the results for the State of Nevada. The whole number of families in the State on April 1st, 1930, was 25,730, as compared with 21,862 in 1920. The number of persons per family in 1930 was 3.5, the same as in 1920. The number of families reporting radio sets in 1930 was 7,869, or 30.6 per cent of the total.

* * *

Kansas

The whole number of families in the State on April 1st, 1930, was 488,055, as compared with 435,600 in 1920. The number of persons per family in 1930 was 3.9, as compared with 4.1 per cent in 1920. The number of families reporting radio sets in 1930 was 189,527, or 38.8 per cent of the total.

COLLEGE SERVICE COURSE

The Second Annual Short Course for Radio Service Men, sponsored by the University of Florida, will be held on the campus during the week June 1-6.

BITTAN COMPANY MOVES

D. R. Bittan Sales Co., Inc., has moved to 27 Park Place, New York City, from 14 Warren Street.

TWO LICENSES HELD UP OVER RCA'S "GUILT"

Washington

Pending a hearing by the Federal Radio Commission on whether the Radio Corporation of America and subsidiaries must be denied applications for renewal of 1,409 licenses for radio service, including licenses of broadcasting stations, the Commission took no action on petitions for renewal of two expiring licenses.

Expiration of the licenses of W10XL, of the Radiomarine Corporation of America, to operate on airplane frequencies, and W3XAD, an experimental television transmitter of the RCA-Victor Company, at Camden, N. J., with failure of the Commission to take action on renewals, left these two stations without a license. Three other licenses expired, but due to special conditions temporary permits were issued. One of these was for apparatus on the steamship Penquin, sanctioned because safety of life and property at sea was at stake. None of the five licenses affected broadcasting.

Subsidiaries

The question of whether RCA and its subsidiaries, the National Broadcasting Company, the Radiomarine Corporation of America, the RCA-Victor Company and RCA Communications, Inc., should be denied license renewals came up because of the adjudication in a court proceeding that the RCA had violated section 3 of the Clayton Anti-Trust Law regarding an unlawful monopoly in restraint of trade. RCA had demanded that its set manufacturing licensees initially equip receivers only with RCA tubes, and the Federal Court held this was in contravention of the Clayton Act. The Supreme Court of the United States refused to disturb this decision.

Under Sections 13 and 15 of the Radio Law it is provided that license renewals be refused to holders adjudged by a court to be guilty of violation of anti-trust laws of the United States.

The restrictive provision of the licensing agreement with set manufacturers has not been in effect since July, 1928, when it was abandoned as a bad business policy.

RCA's Contention

RCA maintains that the court decision in the tube case, which involved "clause 9" of the license agreement with set manufacturers, compelling initial tube equipment, does not apply at all to the provisions of the Radio Act, because lacking any criminal aspects. It is believed RCA will contend that as the criminal aspect of the anti-trust laws was not in issue, and as the suit was a private one involving an injunction pending money damage suits by independent tube manufacturers, the defendants were not "guilty" under the anti-trust laws, and station licenses should be renewed.

Preliminary to the hearing, representatives of the companies affected, and the Commission, regarding details of procedure at the hearing. Four license renewal applications are set for a hearing, although substitution of license renewals is possible, thus changing the identity of the stations involved.

WAVE SWITCH POPULAR

Recently experimenters in short-wave and all-wave work have turned to switches for wave band changes, instead of plug-in coils.

7 Big Stations Are Affected

The suggestion that license renewals be refused to the Radio Corporation of America and its subsidiaries because of the adjudication that RCA was guilty of violation of the anti-trust law has aroused great interest in broadcasting circles, because the National Broadcasting Company, one of the subsidiaries, holds seven broadcasting station licenses, which stations serve as nuclei for broadcasting networks.

Besides, the National Broadcasting Company holds two television transmitting licenses, nine general experimental licenses and three special experimental licenses.

The largest number of licenses is held by Radiomarine Corporation of America, totaling 1,241, of which 1,175 are ship station licenses.

The list of broadcasting stations issued by the Federal Radio Commission gives the following as licensed to the National Broadcasting Company: WJZ, New York; KGO, San Francisco; KOA, Denver; WTAM, Cleveland; WEAF, New York. Since the list was published the company acquired WENR, Chicago.

DILL ASKS SUIT, BARS REVENGE

Washington

The contention that RCA and its subsidiaries are expected to make in fighting to retain their radio licenses for broadcasting and commercial and experimental traffic, that the sections of the Radio Law do not apply because there was no adjudication of guilt in a criminal case, is contested by Senator Dill (Dem.) of the State of Washington, who wrote the two sections, 13 and 15, of the Radio Law that call for refusal of license renewal or optional forfeiture for anti-monopoly adjudication.

The Senator recommended that one license renewal be refused, in a test case, while the other licenses be renewed temporarily, pending the outcome, since, said he, the Supreme Court ought to pass on the question, and action should be taken against RCA and its affiliates without malice or any spirit of revenge. He said:

"The RCA has done and is doing a great service in broadcasting and communication, and drastic action should not be taken without proper legal steps. This ought not to be a matter of revenge.

"I feel, however, that section 13 does apply. The natural interpretation by the Commission of section 13 should be such that the Commission will refuse to renew RCA licenses. I think it would be a mistake, however, for the Commission to take arbitrary action. I see no reason why the action should be drastic."

Lower Prices Effected on 201-A, 112-A,

Following the reduction of prices on 12 popular types of tubes, the manufacturers reduced prices on four others as follows:

Type	*Old Price*	*New Price*	*Reduction*
201-A	$1.25	$1.10	$.15
112-A	2.25	1.50	.75
171-A	2.25	1.40	.85
226	1.75	1.25	.50

VISION WAVES TESTED TO FIND STEEL EFFECT

The new 50-story RCA Building, at Lexington Avenue and Fifty-first Street, New York City, has become a center of intensive experiments in the development of television broadcasting, according to C. W. Horn, general engineer of the National Broadcasting Company.

By using the tower as a central transmitting station engineers are testing what effects the great steel buildings of Manhattan have upon the propagation of radio waves suitable for television broadcasting.

"It has been known for some time," explained Horn, "that the tremendous steel masses of New York distort all types of radio waves. Television is, of necessity, being operated on short waves, but the true values of the different wavelengths have never been determined—merely guessed at—under the conditions confronted in New York. We are now attempting to determine these values accurately."

Antennas Concealed Behind Stone

A special transmitter, with antennas concealed behind the stone balustrade and filigrees, has been installed in the golden tinted RCA tower crown. By permission of the Federal Radio Commission a station using the call letters W2XBT is broadcasting on various wavelengths.

A motor truck equipped, with special measuring and experimental apparatus, cruises around the metropolitan area while its crew tests and records the effects of fading, absorption and reflection caused by the steel edifices in various sections. Engineers have discovered great absorption around Wall Street due to the cluster of large buildings there and the large number of other structures between the RCA Building and the financial district.

Building Dissipates Wave

"It has been found," said Horn, "that often when a certain type of wave was received satisfactorily at the top of a building the same wave was received only feebly in the street below. Engineers are finding many difficulties which must be overcome before television waves can be utilized satisfactorily in New York.

"An entirely different situation exists in outlying districts. In Manhattan buildings even influence sound broadcast waves. For example, the same wave is received with different strength on opposite sides of the city. Before the wave encounters the steel building it has full power, but after passing through the structures the same signal is weak.

Television to be Tried Below 8.5 Meters

The Short Wave and Television Corp., of Boston, has a construction permit for a 30 watt portable transmitting station to experiment with television transmission on 35,300 to 36,200 and 39,650 to 40,650 kilocycles.

Authority was also granted to operate on the frequency around 43,000 to 48,500 and 50,300 kilocycles. The Boston experimenters have just joined the ranks of the very small group of research men testing the efficiency of extremely short waves between 6 and 8.5 meters.

These are not now covered by International treaty because hitherto they have been regarded as useless.

BOARD GRANTS 21 PETITIONS OF STATIONS

Washington.

Decisions were announced by the Federal Radio Commission on applications regarding station frequency, power and operation. The following were granted:

KTSL, G. A. Houseman, Shreveport, La., granted license covering new equipment, 1,310 kc., 100 w., shares with KRMD.

WILM, Delaware Broadcasting Co., Inc., Wilmington, Del., granted license covering new equipment, 1,420 kc., 100 w., unlimited time.

WNBR, The Memphis Broadcasting Co., Memphis, Tenn., granted permission to continue use of WBBC's transmitter until construction now authorized is completed and transmitter of WNBR is in proper operating condition.

WCAC, Connecticut Agricultural College, Storrs, Conn., granted permission to discontinue operation from June 9 to Oct. 5. (WICC has agreed to use the additional time.)

KGB, Pickwick Broadcasting Corp., San Diego, Calif., granted consent to voluntary assignment of license to Don Lee, Inc.

WGAR, The WGAR Broadcasting Co., Cleveland, Ohio, granted construction permit to move transmitter to Cuyahoga Heights, Ohio.

KEX, Western Broadcasting Co., Portland, Ore.; KOB, New Mexico College of Agriculture and Mechanical Arts, State College, New Mex., granted authority to operate daylight hours.

WPDR, City of Rochester, N. Y., granted license for police service, 1,712 kc., 200 w.

WPDX, Police Department, Milwaukee, Wis., granted authority to operate police transmitter now installed, with maximum power of 500 w.

W9XF, Great Lakes Broadcasting Co., near Downers Grove, Ill., granted consent to voluntary assignment of license to National Broadcasting Co., Inc.

WLEX, Bay State Broadcasting Co., Lexington, Mass., granted construction permit to move transmitter from Lexington, Mass., to Quincy, Mass.

WJSV, The Independent Pub. Co., Alexandria, Va., granted license covering installation of new equipment, 1,460 kc., 10 kw., unlimited time.

WFOX, Paramount Broadcasting Corp., Brooklyn, N. Y., granted license covering changes in equipment, 1.400 kc., 500 w., shares with WCGU, WLTH, WBBC.

WHBF, Beardsley Specialty Co., Rock Island, Ill., granted license covering installation of new equipment, 1,210 kc., 100 w., unlimited time.

WRAF, Charles Middleton, LaPorte, Ind., granted license covering installation of new equipment, 1,200 kc., 100 w., shares with WWAE.

WAWZ, Pillar of Fire, Zarephath, N. J., granted license covering relocation of transmitter and changes in equipment, 1,350 kc., 250 w., shares with WCDA, WBNX, WMSG.

KGPJ, City of Beaumont, Tex., granted license for police service, 1,712 kc., 50 w.

KGPI, City of Omaha, Nebr., granted license for police service, 2,470 kc., 400 w.

WNAL, near Brookville, Pa., granted license, 3,160 kc., 400 w.

W8XAL, Crosley Radio Corp., Mason, Ohio, granted license, 6,060 kc., 10 kw.

KGPL, Polcie Department, Los Angeles, Calif., granted modification of construction permit to change modulator tube type. Also granted license, 1,712 kc., 400 w.

Lee Adds Eleventh Station to Chain

Following the purchase of KDB, Santa Barbara, the Don Lee Broadcasting System has bought KGB, San Diego, from the Pickwick Broadcasting Corporation.

The acquisition of this station completes a chain of eleven broadcasting units extending from Seattle to San Diego, known collectively as the Columbia-Don Lee Coast Unit, and comprising KOL, Seattle; KVI, Tacoma; KOIN, Portland; KFPY, Spokane; KFRC, San Francisco; KMJ, Fresno; KWG, Stockton; KFBK, Sacramento; KHJ, Los Angeles; KDB, Santa Barbara, and KGB, San Diego.

Robert Binyon, present manager of KGB, will continue in that capacity. The equipment of KGB consists of a 1,000 watt transmitter.

New Corporations

American Television and Theatres Corp., Jersey City, radio equipment, etc.—Corporation Trust Co., Jersey City, N. J.

Short Wave Broadcasting Corp., New York, N. Y., electric generating, power stations—Corporation Trust Co.

Gold-Hall Industries, radios—Attys. Halperin & Muney, 501 5th Ave., New York, N. Y.

Capitol Broadcasting System—Atty. M. D. Kopple, 36 West 40th St., New York, N. Y.

Stroz Tubeless Radio Corp., Wilmington, Del., radios—Corporation Trust Co.

American Television Laboratories, Inc., Dover, Del., research, experiments in respect of television, wireless—U. S. Corp. Co.

Electro Sound Products Co., radio, television receiving sets—Atty., H. G. Kosch, 383 Madison Ave., New York, N. Y.

Radiocast, Inc., Wilmington, Del., disc records, music rolls—Corp. Trust Co.

Annenberg Cherwin Co., radio specialists—Attys. Dewitt & Van Aken, 420 Lexington Ave., New York, N. Y.

Radiovision Corp., electrical transmitting and receiving sets—Atty., S. V. Ryan, Albany, N. Y.

WORTH THINKING OVER

A CAREFULLY kept record indicates that President Hoover has used the radio several times more frequently than Calvin Coolidge made use of it when he was in the White House. Do not jump at conclusions. The figures given out officially do not prove that Mr. Coolidge is taciturn or that Mr. Hoover is loquacious. However, it does accentuate the obvious fact that during the past few years the radio has come into wider use, that the public looks to it for intimate information on important subjects and that those in high places are not only willing but eager to give out messages directly to their millions of listeners. The world's ear has become radio-minded, if it can be said that ears have minds.

STATIONS GET WARNING OVER LOTTERY CRAZE

Complaint by the American Association of Newspaper Publishers against lotteries advertised in broadcasts, which are illegal in printed form using the mats, has resulted in a warning by the Federal Radio Commission that stations specifically complained of would be set down for a hearing when license renewals come up. Not only lotteries, but fortune telling, gift enterprises and schemes depending on lot or chance for prize awards, are included in the warning.

Lots of It Lately

Lately the air has become suffused with fortune telling, astrological analyses and forecasts and numerological divinations, besides the many lottery schemes, and even the largest stations carry paid programs involving the objectionable features. Interest focuses on what the large networks will do about the subject, now that license renewal is endangered.

The Publishers' Association had adopted a resolution asking that radio stations be prohibited from broadcasting such programs. It charged that certain stations have been devoting more time to programs in which lottery and gift enterprises predominate, while all other advertising media are forbidden from accepting such advertising under both Federal and State laws.

The Announcement

The Commission's announcement follows in full text:

"Upon frequent occasions there has been brought to the attention of the Commission complaints against radio stations broadcasting fortune telling, lotteries, games of chance, gift enterprises, or similar schemes offering prizes dependent in whole or in part upon lot or chance. On that subject the Commission has to say:

"There exists a doubt that such broadcasts are in the public interest. Complaints from a substantial number of listeners against any broadcasting station presenting such programs will result in the station's application for renewal of license being set for a hearing.

"Copies of this statement were this day ordered by the Commission to be mailed to each broadcasting station licensed by the Commission."

FREE AID TO A NEW JOB!

SITUATIONS WANTED AND HELP WANTED ADVERTISEMENTS WITHOUT COST!

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SITUATIONS WANTED

EXPERIENCED RADIO MAN wishes connection with reliable concern, in servicing or sound work, the latter preferred. Graduate of School of Engineering of Milwaukee, in radio television and talking pictures. Excellent references on request. Age, 20 years; free to travel. Clarence Laatsch, 3268 N. 16th Street, Milwaukee, Wis.

BOY, 16 YEARS OF AGE, desires position in radio laboratory, store or corporation. Three years of set building, both long and short-wave receivers. Willing to start at low pay. James McSorley, 146 Maple Street, Kearny, N. J.

GRADUATE of National Radio Institute, age 19, two years in repair and set building, would like work anywhere in repair shop or research work. Willing to start at small pay with opportunity for advancement. References: National Radio Institute, Washington, D. C.; Layton's Radio Shop, Corsicana, Texas. Address: Miles Washburn, R. F. D. No. 3, Corsicana, Texas.

YOUNG MAN, 19, desires position in radio, with chance for advancement. Has some experience in building radio receiving sets. Speaks and writes Norwegian perfectly. Also very much interested in Short-Wave transmission and reception. T. Olsen, 427 Elizabeth Ave., Elizabeth, N. J.

EXPERIENCED SUPERVISOR, soldering, wiring, assembling; some test experience; wishes position with city manufacturer or other line. Production pusher. Ex-operator. Henry Flack, 78-16 Ford Ave., Queens, N. Y.

EXPERIENCED—Age 30 years, married. Hold Dutch Commercial 2nd Class license. Five years' experience on ships and seven years' general experience in America. Talk German and Dutch, and have fair knowledge of French. Willing to take any kind of position or job. P. M. Verbruggen, Gen. Delivery, Detroit, Mich.

REPLACEMENT VEXES MAKERS OF RADIO TUBES

C. E. Stahl, general manager of Arcturus Radio Tube Company, discussing 100 per cent. replacement policy, points out that the effect is to permit a customer to return a tube no matter if it has given service for the usual period or was damaged by the customer. He added: "Today, the practice, on the part of the set manufacturer, of furnishing his set complete with tubes, is becoming more general. Should this practice become universal and a 100 per cent. replacement policy be standardized, just what tubes will the jobber and dealer sell? Outside of experimenters no one would need a tube except to replace one in a set which came equipped with tubes. These tubes would be replaced for nothing if a universal 100 per cent. replacement policy prevailed. Under these conditions, the jobber and dealer must either surrender all interest in tubes, or else establish themselves as service stations for the manufacturer, bear all handling charges, all the overhead expense of doing business, yet realize not one cent of return."

Exports up $759,832 for 2 Months This Year

Washington.

During January and February, 1931, the value of all exports of radio receiving sets totaled $2,010,190, as compared with $1,260,358 in tthe corresponding period of 1930, representing an increase of $758,832, according to the Department of Commerce.

Canada was the leading market, taking $254,321 worth of sets, and was followed by Italy, taking a total of $123,704. Argentina was in third place with $97,840.

Mexico and Spain each took between $45,000 and $50,000, and sets valued at $38,137 were exported to Spain. France and Uruguay each took approximately $31,000 worth.

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.*

Rupert Folse, P. O. Box 1467, Sarasota, Fla.
Joe Sherman, 527 Dixon St., Homestead, Pa.
Arthur G. Niemeier, 6835 Palmetto Ave., Cincinnati, Ohio.
E. G. Crafton Radio Service, 2411 B. Washington Blvd., Ocean Park, Calif.
C. A. Buchert, 442 Soraparu St., New Orleans, La.
Ralph Hoschna, 14816 Woodmont Rd., Detroit, Mich.
C. A. Turner, 1002 N. Washington, Enid, Okla.
Florian Snella, 109 No. Vine St., Shamokin, Pa.
Earle S. Grooms, Grooms Radio Service, 302 E. Main St., Deshler, Ohio.
Bernard H. Swaney, 528 West 18th St., Erie, Pa.
Joseph G. MacNeil, 2, Reserve Mines, C. B., N. S., Canada.
W. H. Wienmiller, 810 Cedar Ave., Pittsburgh, Pa.
E. J. Kuhn Radio Service, 17th and Elm Sts., Murphysboro, Ill.
Walter Toscanini & C., Milano (4), Via Cerva, 19, Italy.
M. T. Rosacker, Central Brass Works, 26 So. 10th St., Reading, Pa.
Adolph L. Hoppe, 31 Wolfert Terrance, Rochester, N. Y.
H. L. Case, 5432 Center Ave., Pittsburgh, Pa.
Dr. R. R. Voght, 16515 Euclid Ave., Cleveland, Ohio.
H. B. Cockrell, 1113 Allison St., N. W., Washington, D. C.
Peter Sunde, 20 Butler Place, Brooklyn, N. Y.
Paul Budnick, 734 Weed St., Chicago, Ill.
F. S. Tromblee, 32 Hamilton St., Plattsburgh, Pa.
Frank Karesck, 2314-41 St., Long Island City, N. Y.
C. F. Wrightsman, Holmesville, Nebr.
Lawrence Krantz, R. F. D. No. 4, Dover, Ohio.
Harry F. Feigley, r., Potomac Radio Shop, 120 So. Potomac St., Hagerstown, Md.
Richard H. Spessard, 18 West Main, Schoolfield, Va.
Leslie P. Whitten, 421 Madison Ave., Plainfield, N. .
E. H. Lyons, 2114 Huron St., Chicago, Ill.
Nick Motil, Box 26, Huntsburg, Ohio.
Frederick Wilcoxen, Blacksmithing, Letart Falls, Ohio.
Gilbert H. Doty, 139 Galloway St., Dayton, Ohio.
Emil J. Novak, 2215 So. 13th St., Omaha, Nebr.
Alex E. Rat loff, 1415 Corbett St., Lansing, Mich.
H. Spicer Davis, 76 Grove St., New Haven, Conn.
Arthur K. Woodman, 251 Royal Palm Way, Palm Beach, Fla.
Stanley R. Ritt, 204 May Ave., Niagara Falls, Ont., Can.
O. A. Fincher, 824 Bayland Ave., Houston, Tex.
J. F. Williamson, Beaulaville, N. C.
Goodwin Williams, Jr., 829 Avery Ave., Dyersburg, Tenn.
Robert M. Knowsley, 497 Chase Ave., Lyndhurst, N. J.
Clyde Hobbs, Box 264, Wetumka, Okla.
Alexander Crichton, 244 Orange Ave., Coronado, Calif.
Elmer Rowder, 2863 Edgewood Ave., Chicago, Ill.
Reuben Balfour, 4216 N. Francisco Ave., Chicago, Ill.

LEAGUE TO GO ON AIR, USING OWN STATION

Washington

All the necessary agrements and contracts for the League of Nations radio station have been signed, the grounds and buildings for the station are about ready, and the technical experts of the League are consulting with the various contracting firms in regard to the materials, according to a report from Consul Prentiss B. Gilbert, Geneva, Switzerland, made public by the Department of Commerce.

Work on the station itself is to begin shortly and it is expected that the actual construction will be completed about December 1st, and the station placed in limited operation immediately afterward. If present expectations are fulfilled, the necessary technical arrangements will be completed in time to put the station in full operation before the convening of the General Disarmament Conference in February, 1932.

Aviation Frequencies Changed by Board

Washington.

At a session of the Federal Radio Commission it was ordered that General Order No. 99 be amended in the following particulars, respecting aviation frequencies:

"The frequencies hereinafter mentioned are hereby added to those already assigned the Southern Transcontinental Chain and Feeders (Brown):

"(a) Mobile Service: 3,004 kilocycles—unlimited hours—to be used west and north of Chicago, Ill.

"(b) Fixed Service: 2,680 kilocycles—unlimited hous—to be used west and north of Chicago, Ill."

Kahle Starts Business

The Kahle Engineering Company opened offices and a warehouse at 548 Thirty-ninth St., Union City, N. J., to do business in machinery, equipment, and raw materials used in the manufacture of radio tubes, incandescent lamps, neon lamps and other vacuum products. L. C. Kahle, the head of the concern, has occupied engineering positions with the Westinghouse Lamp Company, Independent Lamp and Wire Company, the Crystolite Mfg. Company, David Grimes, Inc., Pilot Radio Company and others.

GIGANTIC SALE ON FINEST QUALITY
RADIO TUBES
GUARANTEED 60 DAYS

SAVE MONEY BUY NOW

AT THESE LOW PRICES

TYPE	YOUR COST	TYPE	YOUR COST
226	$.40	120	$.55
280	.50	200A	.55
201A	.40	WD11	.55
227	.50	WD12	.55
171A	.50	210	.95
112A	.50	250	.90
245	.50	281	.90
195X	.50	222	.90
199V	.50	230	.70
224	.50	231	.70
BH125	1.35	232	.70

Pilot Lights 2½ and 6 Volt 8c Each

20% With Order, Balance C.O.D.

FREE A GENUINE "KEEN KUTTER" SAFETY RAZOR AND BLADE TO EVERY PURCHASER WHOSE ORDER AMOUNTS TO $5.00 OR OVER.

A Complete Line of Radio Parts and Accessories In Stock At Equally Low Prices

Send for Bargain List.

Universal Radio Service Co.

923 Rogers Place Bronx, N. Y. C.

ELECTROLYTIC CONDENSERS
[WET]

Polymet 8 mfd. inverted single unit, in an aluminum case. The anode terminal at bottom meets the requirement for concealed wiring. Single hole mounting, if to a metal chassis, provides automatic contact to the aluminum case.

If the mounting surface is insulated, as in a bakelite subpanel, a special lug makes the contact.

Connections: Case to negative, anode (at bottom) to positive.

Rating: Peak voltage, 420 volts; recommended maximum working voltage, 375 volts.

Performance: Self-healing in case of puncture of electrolytic film due to application of great overload of voltage. Very low leakage. The high capacity lasts.

Order Cat. C-701, consisting of electrolytic condenser 5 9/16 inches long, over all; 1⅜-inch diameter; with mounting nut, negative connecting lug for insulated subpanels, mounting bracket. List price, $2.50; net price, $1.47.

Large triple Polymet electrolytic condenser, three capacities of 8 mfd. in one copper case; upright mounting.

Connections: Case to negative, each anode (at top) to positive. Anodes may be used separately for 8 mfd. each, or two interconnected for 16 mfd. or three for 24 mfd.

Rating: Leak voltage, 420 volts; recommended maximum working voltage, 375 volts.

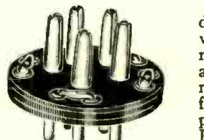
Performance: Self-healing, low leakage, high capacity lasts.

Order Cat. C-729, consisting of electrolytic condenser and mounting bracket. List price, $5.00; net price, $2.94.

RELIABLE RADIO CO.

143 West 45th Street, New York, N. Y.

SERVICE MEN'S NEW ADAPTER



Here is a new adapter that does the very trick you've wanted done—enables interruption of the connections to a tube, so current can be read, at the same time affording direct access to the prongs for voltage tests. Remove tube from socket, insert adapter in socket, put tube in adapter, and you're all set. Removable links, supplied with adapter, permit access to current.

For 5-prong tubes, Cat. B-1 @ $1.05.

For 4-prong tubes, Cat. B-2 @ $1.05.

Connecting cables, 2 ft. long, jack pins at both ends, Cat. 2067 (two leads), @ 36c.

Connecting cables, 2 ft. long, jack pin one end, forked lug at other, Cat. 2066 (two leads), @ 48c.

DIRECT RADIO CO.

143 West 45th Street, New York, N. Y.

NEW VARIABLE MU TUBE

To remedy cross-modulation and cross-talk, without circuit changes, a new screen grid tube has been developed. 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. Order VM-51. Price $2.66.

RELIABLE RADIO CO.

143 WEST 45th ST. N. Y. CITY

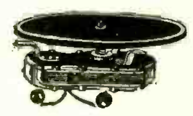
Large Temple Dynamic

Dynamic speaker, AC 110 Volts, 50 to 60 cycles, housed in table cabinet made of walnut, with carved grille. Output transformer and dry rectifier built in, also a hum eliminating adjuster and a variable impedance matcher. Plugged AC cable and tipped speaker cords are attached to dynamic. Outside cabinet dimensions: Height 14", width 11, depth 7½". Speaker diameter 9". Price, $11.50 net.

Guaranty Radio Goods Company

Dept. A, 143 W. 45th St., N. Y. C.

SYNCHRONOUS MOTOR, $4.25



For use on 60-cycle AC line. 12-inch turntable included. 80 revolutions per minute. The speed is self-regulated. This compact synchronous motor may be used with a phonograph pickup to play records. Cat. SYN-M @ $4.25.

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

ATWATER-KENT HORN UNIT, $1.95. For use in home or portable, 108-inch tipped cord; 1½ lbs. weight; size 3-inch height; 1-inch diameter. Guaranty Radio Goods Co., 143 West 45th St., N. Y. C.

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

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

7 cents a word—$1.00 minimum—Cash with Order

SMASHING BARGAIN—Surplus Laboratory Tester. $5.50 buys it! A perfect Readrite Tube Checker for either DC or AC testing from set socket, plus a separate 0-300 Voltmeter accurate to 95%, and a free wooden case. Postage paid to domestic destination. First order with remittance received officially gets this individual combination testing material. Direct Radio Co., 143 W. 45th St., N. Y. C.

"RADIO FREQUENCY MEASUREMENTS," by E. B. Moullin, M.A., A.M.I.E., M.I.Rad.Eng. A New and Revised Edition, 289 Illustrations, 487 and 12 Pages—Index. $12.50. Radio World, 145 W. 45th St., N. Y. City.

"FORD MODEL 'A' CAR AND 'AA' TRUCK," by Victor W. Page, M.E. Revised and Enlarged Edition. $2.50. Radio World, 145 W. 45th St., N. Y. City.

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

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.

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 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.

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

"HANDBOOK OF REFRIGERATING ENGINEERING," by Woolrich—Of great use to everybody dealing in refrigerators. $4. Book Dept., 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.

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.

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.

"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.

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.

TRANSFORMERS—1½, 2½, 5 volt; 2½ volt, 7¼ amp.; or 7½ volt, 3 amp.; 99c each; shielded $1.45. Shielded 2½ volt, 11 amp.; $1.60. All center-tapped. Shielded .00035 or .0005 coils, .50; 3 coils, $1.45. Four gang .00035 mfd. condenser with drum dial, $1.25. Special transformers, tube testers, etc. Custom work. Phone: Walnut 0615-J. L. Waterman, 2140 Kirby West, Detroit, Michigan.

Single Switch Control of *All* Waves!

Band Scale Indicator Removes Guesswork from Tuning a Converter or Set, 15 to 600 Meters.

THE outstanding advantage of a new and complete convenience in tuning a converter or set is afforded by the Supertone All-Wave Foundation Unit. This advantage is complete command of the band selection from the front panel. A single switch does the trick! Whether you want to tune in 550 kc or 20,000 kc—545 meters or 15 meters—the switch responds instantly! There are three bands. The tuning condensers cover the frequencies in each.

The All-Wave Foundation Unit, used with two tubes, affords the complete frequency changing circuit for an all-wave mixer for any converter or set. The converter may be of a type with or without built-in rectifier, or may be for battery operation—the Foundation Unit is applicable nevertheless.

There are two tuned circuits with synchronized tuning.

If you have a converter or set that uses plug-in coils (and perhaps tunes in only short waves) here is your chance to rebuild it around the Foundation Unit, for all waves, with band control from the front panel.

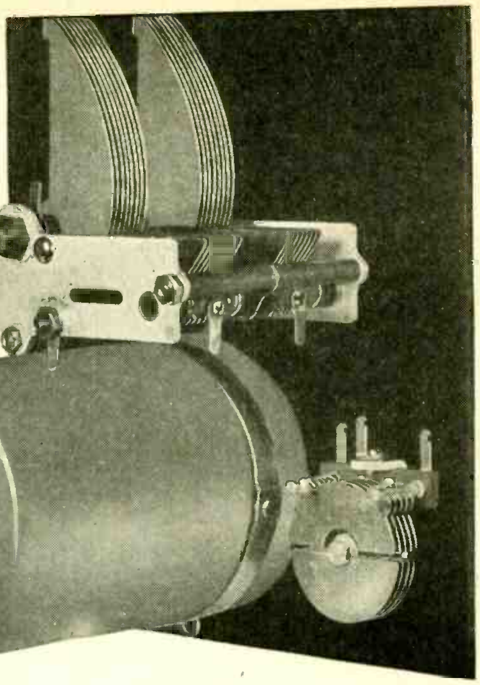
The Foundation Unit of course is suitable for an all-wave mixer in any converter or set that uses an intermediate frequency.

The Unit consists of an assembly comprising:
- One two-gang .00035 mfd. straight frequency line condenser.
- One .00006 mfd. manual trimming condenser.
- One 20-100 mmfd. equalizing condenser.
- One wound mixer coil with copper shield and bracket.
- One dual rotary switch, with insulated shaft, non-shorting contacts, and break circuit; double pole triple throw.
- One front panel 7½x12 inches, with band scale engraved in kilocycles. One line switch.
- One vernier dial. Three knobs. One disc.

The assembly is wired, ready for the construction of converter or set, and has identified outleads.

Order Cat. AWFU, net price **$13.50**

If a volume control potentiometer is desired with line switch attached, order AWFU-VC at **$14.75**



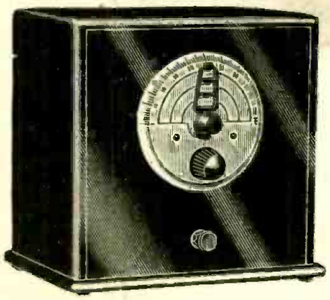
***THE SUPERTONE ALL-WAVE FOUNDATION UNIT**, for the construction of All-Wave Converters or Sets (15 to 600 meters), comprising the assembled parts for the mixing circuit, with a line switch and manual trimmer. On the front panel is a band scale in kilocycles.*

Two-gang .00035	$3.00	1¾" coil form	.25	7½ x 12" dr. panel	1.50
Five 6/32 flathead	.05	1½" coil form	.20	Copper shield	1.00
One 60 mmfd. trimmer	.90	Shield disc	.40	Shield bracket	.15
One 100 mmfd. equal	.35	Two coil brackets	.10	AC shaft switch	.40
		Wire for coils	.25	Vernier dial	1.00
		Dual switch	2.00	Three knobs	.45

TOTAL, ALL PARTS **$12.00**
Parts Assembled and Wired (Cat. AWFU) **$13.50**

OTHER SUPERTONE PRECISION PRODUCTS

SELECTIFIER



AN extremely important precision product of the Supertone Products Corporation is the Selectifier, which makes any set selective. This device is a doubly tuned band pass filter with 10 kc. band width and primarily enables cutting out an interfering station. It is thus particularly important to those who live near a broadcasting station. It kills off the interferer mercilessly! Besides this rejection feature, it also has an acceptance characteristic, a few dial degrees to the right, permitting you to build up the volume of weak stations, and bring in far greater distance, than you ever thought possible with your set.

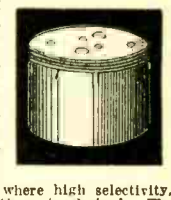
Many persons own sets excellent in every respect, except for insufficient selectivity. Why not capitalize on the heavy investment already made, by installing a Selectifier, and rid yourself forever of interference from other stations, due either to crosstalk or crossmodulation?

There are only three connections to make (1) Remove the aerial from the antenna post of your receiver and connect it instead to the (left) antenna wire of the Selectifier; (2) Connect a wire from the ground of your set to the ground wire (center) of the Selectifier; (3) Connect the output wire of the Selectifier (right) with a wire to the vacated antenna post of your set.

The Selectifier, a band pass filter pretuner, has two ganged tuned circuits. No tubes are used in it.

Supertone Selectifier, wired model, on 7 x 7 inch front panel, in an attractive 10-inch walnut finish cabinet, order Cat. SEL, net price $10.00

450 KC TRANSFORMER



A DOUBLY tuned fixed-frequency transformer, 1 to 1 ratio, tuned to 450 kilocycles, but adjustable from 400 to 550 kc., is another of Supertone's new precision products. Two loosely coupled duolateral-wound high-inductive choke coils constitute primary and secondary. Suitable for all uses where high selectivity, without sideband cutting, is desired. The transformer may be mounted on the side of a chassis, in horizontal position, or upright either above or below the chassis top.

Tuning condensers are across primary and secondary, both accessible; in aluminum shield 2¼ inches diameter, 2½ inches high, with removable bottom. both horizontal and upright mounting facilities. For screen grid tubes. Order Cat. FF-450, net price $3.00

175 KC TRANSFORMER

Same as above, except that frequency is 175 kc., adjustable from 100 to 190 kc. For screen grid tubes. Order Cat. FF-175, net price $3.00

FULL-BAND COILS

SPACE-WOUND tuning coils for shielded circuits, designed with special care to insure identity of inductance and minimum distributed capacity, with assurance of covering the whole broadcast wave band, and more, with .0005 mfd.

With each coil is supplied a drawn aluminum finished shield, 3-inch diameter, 3½ inches high. Copper shield extra.

ANTENNA COIL for all circuits, also interstage coil where the primary is in the plate circuit of a general purpose tube. Order Cat. 15-85, net price..........$2.50

INTERSTAGE COIL, where primary is in the plate circuit of a screen grid tube. Order Cat. 25-85, net price..........$2.50

OSCILLATOR COIL, consisting of secondary, fixed tickler and small pickup coil winding, each winding wholly independent of the others. Order Cat. 8-30-85, net price $2.75

COPPER SHIELD, bracket, Cat. CS-B @ $1.15

(Substituted for aluminum shield above, extra 65c.)

Telephone: WIlliamsburg 5-3872

SUPERTONE PRODUCTS CORPORATION

216 WALLABOUT STREET, BROOKLYN, N. Y.

We Make What We Advertise & Guarantee What We Make