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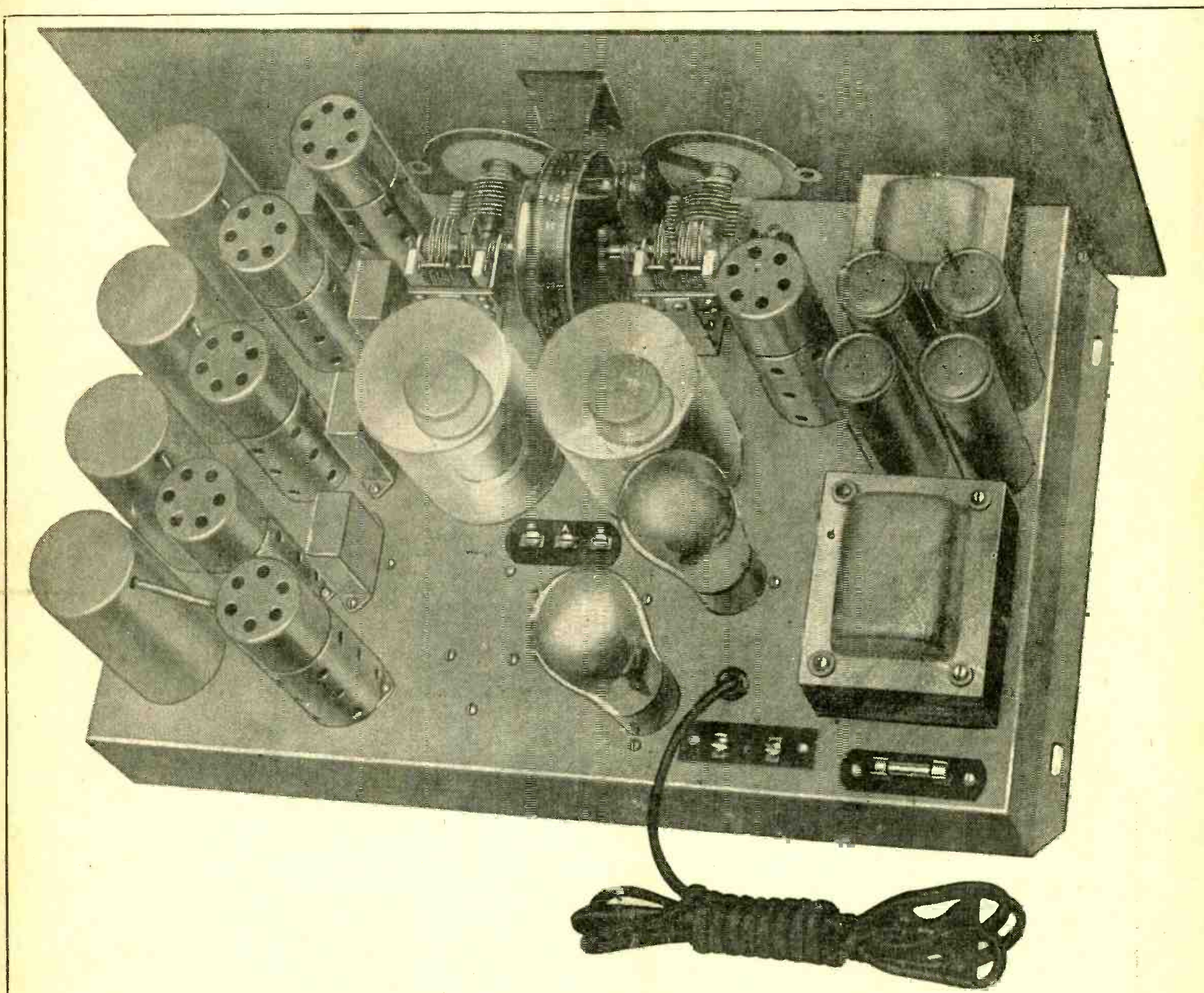

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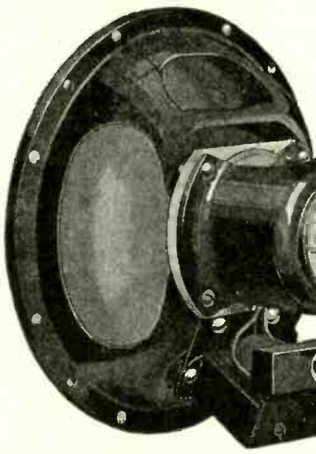

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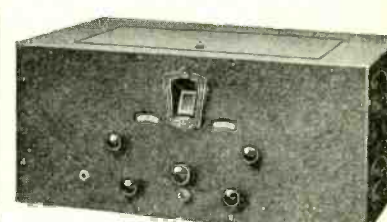

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CLASS "B" ANALYZED
Composite of 'A' and 'B' Advantageous

By Robert Ames Cutler

ALTHOUGH we have previously explained the operation of Class B amplifiers we still have frequent requests for explanations. Some of the questions asked relate to the reason why there is distortion on low signal levels, why the Class B amplifier is more efficient than Class A, why a Class B amplifier will give much higher output power for the same size tubes and the same voltages, why it is necessary to operate at zero bias, why good regulation is required in the B supply, why it is necessary to use special input transformers and a driver stage, and why self-bias on the amplifier tubes is not permissible.

Let us first explain what Class B is. Suppose we hook up a regular push-pull amplifier and then increase the bias on the two tubes so that there is no plate current in either tube when no signal is applied to the grids. Then we have a Class B amplifier. In other words, the Class B differs from the Class A push-pull only in the operating grid bias on the tubes. By increasing the bias of a Class A push-pull amplifier gradually we gradually change the circuit from Class A to Class B.

If Class A requires that the bias be such that half as much current flows in each tube at the operating point as when the bias is zero and if Class B requires that the bias be such that no current flows in either tube at the operating point, it is clear that we can have an intermediate type of amplifier which partakes of the characteristics of both. It is customary to call an amplifier Class B if the tubes are much overbiased compared to the requirements of a Class A amplifier.

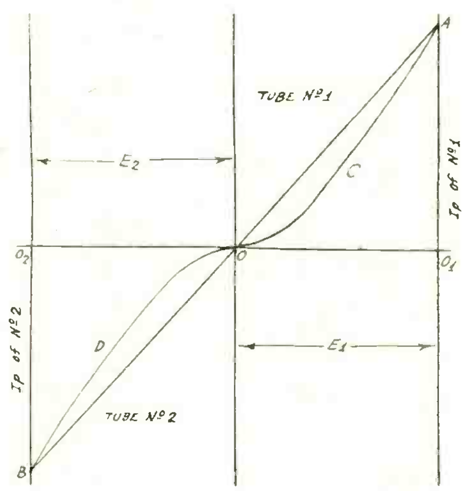


FIG. 1
A representation of the characteristics of two equal tubes in a Class B amplifier when the grids are biased to the cut-off point.

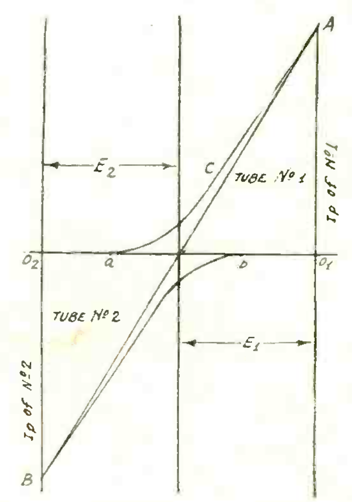


FIG. 2
This graph represents the characteristics of two equal tubes in a Class B amplifier in which a bias less than the cut-off bias is used.

Class B Amplifier

Let us refer to Fig. 1. Here we have the characteristics of two equal tubes, OCA that of tube No. 1 and ODB that of tube No. 2. The curves are drawn in opposite directions because the tubes are connected in push-pull fashion. The point O1 represents the point of zero bias for tube No. 1 and the point O2 the point of zero bias for tube No. 2. Point O represents the operating point of both and is the cut-off point for either tube.

When a signal is impressed between the grids of the two tubes by means of a push-pull input transformer, or by any other means, it must be impressed in one direction or the other, depending on which half of the signal voltage wave is involved. Let us first take the half-cycle that makes the instantaneous grid voltage on tube No. 1 less negative. That is, the voltage changes toward the right. Current flows in tube No. 1 according to the curve OCA. If the signal is limited to such a voltage that the peak is equal to the bias, the maximum current in that tube is represented by the vertical distance to point A.

During this half-cycles the current in tube No. 2 is zero because the instantaneous grid voltage on that tube is greater than the cut-off voltage. Only the first tube causes a current to flow in one half of the primary of the output transformer.

Distortion

During the next half-cycles the grid voltage changes in the other direction, that is, toward the left. The situation is just reversed. Tube No. 1 takes no current and tube No. 2 takes just as much current as the first tube did during the preceding half-cycle. Now the second tube sends a current pulse through the other half of the output transformer primary. In the secondary of the output transformer there is current during both halves of the signal wave. The upper tube will cause a current pulse to flow in one direction and the lower tube an equal pulse in the opposite direction.

The current pulses in the secondary of the output transformer will not be similar to the voltages impressed on the grids because the current pulses will be determined by the curves OCA and ODB. If we assume that the voltage wave was sinusoidal the output current wave in the secondary of the output transformer will not be sinusoidal but it will be much distorted. The peaks will be sharper than the peaks of a sinusoidal wave. Only if the characteristics of the tubes were straight lines like OA and OB would the output current wave be similar to the input voltage wave. The great divergence between the actual characteristics and the ideal straight line indicates that the distortion is considerable. It will be observed that the divergence is greatest near the operating point, which means that the per cent. distortion will be greatest when the signal voltage is low. The peakedness of the output curves indicates that the distortion in the odd harmonics will be great. Incidentally, the curvature of the characteristics has been exaggerated to show the effect the better.

(Continued on next page)

(Continued from preceding page)

As a means of eliminating some of the distortion on the weak signals, the tubes may be operated, not quite at the cut-off point, but at a point of somewhat less bias. This case is illustrated in Fig. 2. The two characteristics are now aCA and bDB and the operating point is O. E1 is the operating bias on the first tube and E2 that on the second tube. Of course, E1 and E2 are identical, not merely equal.

Distortion Reduced

For signal voltages confined to the region (ab) the circuit works as a true push-pull amplifier and therefore much of the distortion on weak signals is eliminated. However, as soon as the peaks of the signal voltage exceed Ob or Oa, only one of the tubes takes current and the circuit is a Class B amplifier. That is, when the signal voltage is in the region bO1 only the upper tube takes plate current and when it is in the region aO2 only the lower tube takes current.

If the characteristics are sensibly straight in the regions bO1 and aO2 there is very little wave form distortion on strong signals. Also, if the two curves are similar in the region (ab) there would be little distortion on weak signals, for the tubes would operate in push-pull.

Optimum Bias

It will be noted that the straight line, which is the ideal characteristic, lies between the two actual characteristics in Fig. 2 whereas in Fig. 1 the straight line cuts the total characteristic ACODB at three points. It would appear that the bias in Fig. 1 is too great and that in Fig. 2 is not great enough for least distortion. If the bias were increased a little in Fig. 2 the straight line would practically coincide with the actual characteristics for the higher values of current. If they would coincide there would be no distortion on the higher values. The circuit would still operate as a push-pull amplifier on low signals. Of course, it would operate push-pull on all signals on low instantaneous values of the voltage.

The optimum bias could be obtained experimentally in any case. Suppose the two tubes with their associated circuits are equal so that the characteristics are equal. Take a grid voltage plate current characteristic. Plot it twice on equal scales and cut the two plots along the line O2O1. Place the two curves with the cut edges opposite each other. Place a straight-edge so that it passes through points A and B. If the straight line does not coincide with the curves for the higher current move one curve with respect to the other one way or the other until the straight line does coincide as well as possible. The required bias is then one half the voltage indicated by the distance between O2 and O1.

If the first placement is that indicated by Fig. 1 the upper plot should be moved toward the left with respect to the lower plot and if the placement is that indicated in Fig. 2 the upper plot should be moved toward the right with respect to the lower plot. Having obtained the optimum bias in the way it can easily be provided by means of a C supply.

Distortion Explained

The above explanation of the functioning of the Class B amplifier also explains why there is much distortion on weak signals. Moreover, it tells what to do to avoid some of the distortion.

Why is a Class B amplifier more efficient than a Class A amplifier using the same size tubes and the same plate voltage? The reason is that no current flows in either tube on no signal, or at least a very small current flows, and when current does flow it is only in proportion to the strength of the signal. In a Class A amplifier the total plate current for the two tubes is about the same all the time and it is the current flowing at the operating bias. Whether or not a signal is present to be amplified, power is expended in the plate circuit of the tube. But in Class B there is no power expended except when it is needed, and only in proportion to the need.

Why is the output power from a Class B amplifier greater than that from a Class A with the same tubes and the same plate voltages? Let us suppose that the characteristics of the two tubes are straight in both classes of amplifiers and also that the maximum current at zero bias is the same in the two cases. In the Class B amplifier the peak of the output current is equal to the maximum current. Each tube contributes the same output. That is, the output current wave has an amplitude equal to this current. Let us call it I for the sake of later comparison. Let the load resistance per tube be R. Sinch only one tube works at a time this resistance is also the effective load on the two tubes in so far as the output power is concerned. Hence the output power is I^2R watts.

Output of Class A

In the Class A the input voltage can only be one half as great as in the Class B. Hence the current amplitude can only be one half as great. If the load resistance on the tube is R as before the output power is $R(I/2)^2$. But there are two tubes in this case, each putting out the same power. Hence the total output is $RI^2/2$, which is only one half as great as the output of the Class B. This does not mean that the output of the Class B amplifier is twice that of the Class A for the same signal input voltage. The required signal input to the Class B is twice that required for the Class A. Hence the power sensitivity of the two is the same, if we use the same type tubes. This analysis is only approximate, but it explains why more power can be obtained from a Class B amplifier than from a Class A, using the same tubes and the same plate voltages.

Why Zero Bias

Why is it necessary to operate a Class B amplifier at zero bias? It is not necessary. It is only necessary to operate the tubes near the plate current cut-off, for that is the definition of Class B. The use of zero bias is only necessary when the power tubes have such a high amplification factor that the cut-off is near zero bias. But why are such tubes used? The only reason is that it avoids the necessity of supplying a grid bias. The zero bias cut-off tubes, like the 46, were designed for Class B operation. It would seem that going to the trouble of designing special tubes, which in turn require a special input transformer and a driver stage, is going to great lengths for trouble and expense. Approximately the same thing can be accomplished by power tubes requiring a negative bias and then supplying an external source of grid voltage. A small C supply could be built for a small fraction of the cost of the driver stage and the special coupling transformer, and no more tubes would have to be used, for the driver could be used for the C supply.

Why is not self bias practical with the Class B amplifier? Because there is no steady plate current at any time and most of the time there is no plate current at all in the Class B stage. If any bias resistance at all were used it would cause an enormous reverse feedback and the amplifier would not be sensitive. It would not be practical to remove the feedback by means of by-pass condensers. Moreover, since most of the time there is no plate currrent in the tubes the bias would be zero most of the time anyway. Either zero cut-off tubes must be used or else tubes biased negatively by a battery or a small rectifier.

Why Driver Stage

Both the driver stage and the special coupling transformer are required because when the tubes used in the Class B amplifier require zero bias the grid potential of the active tube is always positive. Consequently one or the other tube is always drawing considerable grid current. This means a power loss and the loss must be made up by supplying it from the driver stage. The special transformer is needed because it is operated as a power transformer and not as a voltage transformer. Both the driver stage and the special transformer can be eliminated by using a C supply and negatively biased tubes in the Class B amplifier. It would not even be necessary to use a coupling transformer at all between the Class B stage and the preceding stage. So-called resistance coupled push-pull could be used, provided the available signal voltage were properly divided between the two Class B tubes.

Good regulation is essential regardless of whether zero bias or negative bias is used on the Class B amplifier. The reason for that is that when each tube takes current on the strong signals it takes a great deal. If the regulation is not almost perfect the voltage on the plates will drop and there will be distortion. This drop will be prevented by a large by-pass condenser across the B supply line next to the plate return of the Class B tubes. But it must be a large one for the current required on strong, low frequency signals will be so great that the condenser will be discharged. This, too, will cause the voltage to drop.

In the Class A push-pull amplifier there is little variation in the demand for current from the B supply because as one tube calls for more current the other calls for less and the mean is very nearly the same all the time. Hence in a Class A push-pull amplifier it makes relatively little difference if the regulation is not so good. But in a Class B it is essential to have as good regulation as possible.

Radio University

Distortion in Class B

IS THERE a relation between the distortion occurring on low volume in a Class B amplifier and the distortion occurring due to self bias and lack of good regulation?—B. N. R., Camden, N. J.

There is no relation between the distortion occurring on low signals and the distortion occurring due to reverse feedback or due to lack of adequate capacity in the filter. The distortion on low signals occurs because the plate current characteristic is curved near the cut-off point. This would be present even if the plate and grid supplies were perfect. The distortion due to self bias is really not a distortion but a reduction in the amplification. A grid battery or a grid bias rectifier-filter would eliminate the feedback. Distortion due to poor regulation or inadequate tank capacity in the filter can only be removed by making the regulation as good as possible. The use of mercury rectifier tubes, low resistance filter chokes, and large by-pass condensers in the filter would help.

* * *

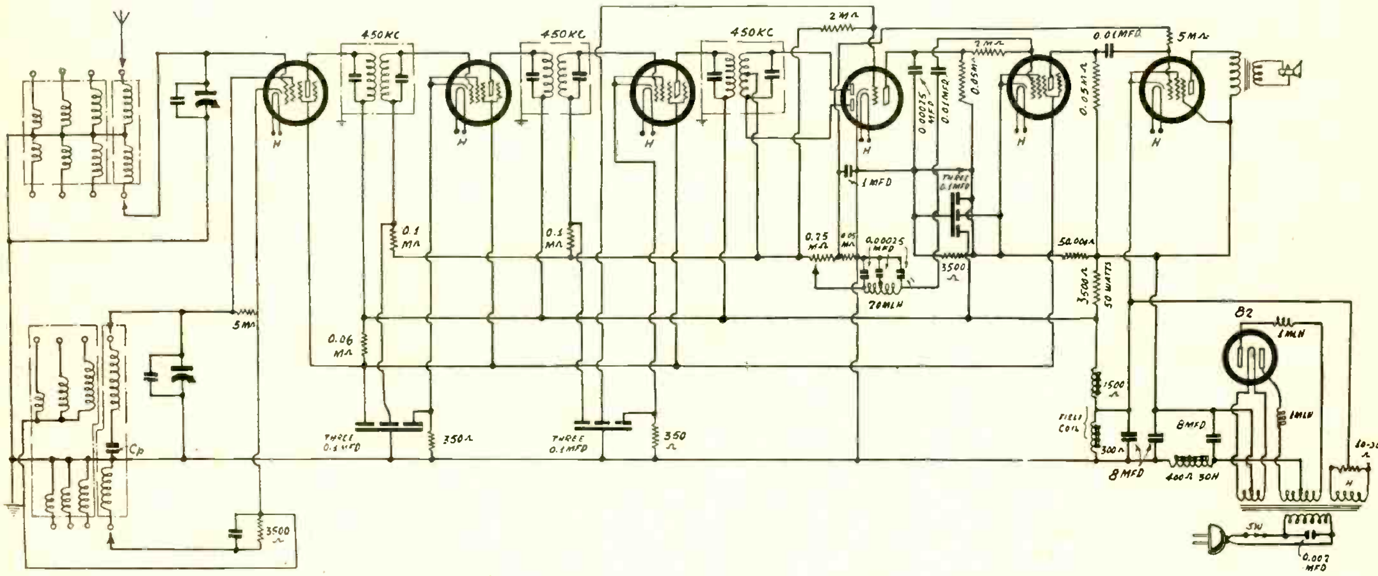
Efficiency of Class B

WHAT IS THE REASON for the greater efficiency of a Class B amplifier than a Class A? Is it because current only flows when required by the signal or is it because current only flows during each half-cycle in each tube?—T. H. Y., Erie, Pa.

It is because current only flows when required by the signal. In a Class A amplifier using two 47s in push-pull the total plate current on no signal is about 70 milliamperes and the voltage around the circuit is about 270 volts. That means a power dissipation of about 19 watts. Practically all of this power is saved in a Class B amplifier because the current on no signal is nearly zero.

WHAT CIRCUIT FOR THE SHORT WAVES?

By Henry C. F. Woodworth



JUST as a superheterodyne can produce a greater all-around result from a given number of tubes, say, above five, in a broadcast set, so it can do likewise in a short-wave receiver.

If one had to select one's own circuit and design it carefully, no doubt some basic arbitrary requirements would govern the final result, but in general there would be a leaning toward automatic volume control. If the primary object of such control is to reduce fading, and in some instances the control will virtually eliminate it, then by all means the corrective should be applied to that type of receiver in which fading is most common. For with short waves, of the frequencies principally to be tuned in, the differences between the time of arrival of the earth-bound waves, and the sky wave that is reflected back from the radio ceiling, are more numerous. So far as known, that is what causes fading.

Once one has decided to include automatic volume control he must face two main considerations. One is that the general sensitivity will be less, if such control is included, for the very basis of operation of such control is that of decrease of sensitivity. The decrease is greatest when the carrier is strongest, and hence a levelling effect is produced. The demand for automatic volume control and still greater (instead of less) sensitivity can not be met at the present state of the science. The other consideration is that since only the carrier actuates the automatic volume control, when there is no carrier, or only a very weak one, possibly too weak to deserve classification as reception, the amplification is greatest, hence some regenerative effects will be introduced unwittingly, and therefore there will be most gain and noise in between reception channels.

The Noise Suppressor

To eliminate this noise the ingenious noise suppression circuit has been devised, and as shown in the diagram it is substantially the same circuit as recommended by the leading tube manufacturers. There are other forms of noise suppression control, governing possibly other elements of a 57 tube, but the principle is the same. It is simply that when the amplification is greatest, which is at no carrier, the bias on a 57 tube becomes so high that, due to the sharp cutoff in this tube's characteristic, the tube ceases to function. The noise is there, to be sure, but it is no transfer of audio voltage.

So it is not going too far to assume that a.v.c. and n.s.c. are desired.

There is one thing about n.s.c., however, that isn't so happily attractive, and that is that sometimes one desires extreme sensitivity, consistent with a.v.c., and if the n.s.c. were working there would be a further reduction of sensitivity. Sometimes one wants to put up with static disturbances that can't be avoided anyway, so as to hear a far-distant, particularly foreign station, even through some interference, such type of interference alone the n.s.c does not eliminate, since here we have a carrier of some ratable voltage value, and besides one must remember that the n.s.c is an audio-operated device, and any noise it eliminates also takes the signal through the same exit. So we desire the signal, and therefor why not a switch to cut out the n.s.c. and let the 57 tube perform as an amplifier? That switch in the diagram removes the plate voltage from the triode unit of the 55, so that that tube does not act as a d-c amplifier, or function at all, hence the steady value of bias on the 57, about 3 volts, is unmolested, and the tube remains an amplifier.

Atonement for Sensitivity

Although it has been stated that a.v.c. reduces the sensitivity, and indirectly revealed that the n.s.c. does likewise, we can atone for the a.v.c. condition by building a receiver with an intermediate amplifier of sufficient gain to make up the difference. With given parts, layout and other factors, and considering the noise level as something that should be low in respect to the signal level, we meet a limiting restriction here too, in that the amplification should not exceed the tolerable noise limit at signal reception. That is, we can go only so far in building up the amplification, principally on account of regenerative effects.

Two intermediate stages, requiring three i-f coils, will give us such a superabundance of amplification that we shall have plenty to sacrifice if it may be so called, to the a.v.c. objective. So, after all, we do not lose sensitivity except in a theoretical and narrow sense, for no circuit can be made more sensitive than circumstances permit (because of high noise level) and still be a practical, reproductible circuit.

If we build up the amplification beyond what the circumstances permit without a.v.c., and make the excess just so much as the a.v.c. diminution of sensitivity requires, we are at exactly the same general sensitivity level as we would have been in the first place without a.v.c.

As for n.s.c., that compensation can not be accomplished very well, so the better practice would seem to be the switch to eliminate the n.s.c. entirely.

The B Choke

While we have paid some regard to fading from the viewpoint of the time lag of reception of out-of-phase signals, we must not forget that a high resistance B choke in series with the B supply is an impedance to all levels of frequencies involved in the receiver, and that it constitutes particularly a common coupling device for audio frequencies in the a-f amplifier. Therefore we desire to make the d-c resistance as small as practical, consistent with a high inductance of this choke, and then the current changes caused by carrier and modulation fluctations will not produce a large voltage difference change across this coil, which change affects all the B voltages. This type of instability simply works hand in hand with fading as well as causing motorboating and other common ills.

At first assumption it might seem that

(*Continued on next page*)

MUTUAL INDUCTANCE

Computed from Measured Coupled Coils

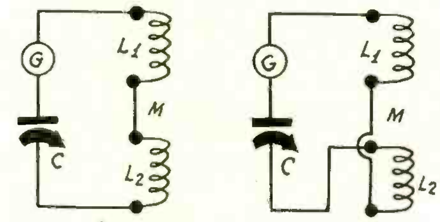
By J. E. Anderson

SOMETIMES it is desirable to know the mutual inductance between two coupled coils; for example, between the primary and the secondary of a radio-frequency transformer. If a calibrated oscillator, a thermo-galvanometer or other resonance indicator, and a condenser of known capacity are available, the mutual inductance can be measured easily.

Let L1 and L2 be the inductances of the two coupled coils and let M be the mutual inductance between them. When these coils are connected in series-aiding, as at left in Fig. 1, the total inductance Lâ is L1 + 2M + L2 and when they are connected in series-opposing, as right in Fig. 2, the total inductance Lô is L1 — 2M + L2. Therefore if we measure the total inductances of the two coils in the two possible series connections, we can compute the mutual, for it is simply M = (Lâ — Lô)/4, that is to say, one-fourth of the difference between the two measured inductances.

Measuring the Inductances

The question now is how to measure the two inductances. There is where the calibrated oscillator and the condenser of known capacity come in. Let us first connect the coils in series-aiding and measure



A B

FIG. 1

The mutual inductance M between two coils L1 and L2 can be measured by first measuring the inductance of the two coils connected in series-aiding and then again in series-opposing.

the natural frequency of the circuit when the known condenser C is across the coils. Let the frequency be F1. Then Lâ = $0.0253/CF1^2$. Next connect the coils in series-opposing and measure the natural frequency again, for the same value of C. Let the new frequency be F2. Then Lô = $0.253/CF2^2$.

From these two values of the total inductance we can compute the mutual as suggested before. Divide the difference between the two inductances by 4 and the result is the mutual inductance.

In case the available condenser is variable and calibrated the inductance of any one of the coils or of any of the two series combinations can be measured with the slope method, which was described in detail last week (Jan. 7th). This would give much more accurate results because it would take into account the distributed capacity in the circuit. Of course, it would take a much longer time to make the measurement.

A modification of the slope method is to measure the natural frequency of a circuit with the given capacity across the inductance to be measured and then measure the frequency again after a certain known capacity has been added to the circuit. Then $L = (F_0^2 — F_1^2)/4\pi^2 C F_0^2 F_1^2$. This formula can be applied twice, once for obtaining L_a and once for obtaining L_o and then M can be obtained by dividing their difference by 4. This method of obtaining the inductance is the same as the intercept method but does not require any plotting. It is applicable only if a condenser of known capacity C and a calibrated oscillator are available.

Unique Power Tube Bias

(*Continued from preceding page*)

a high resistance B supply choke for short-wave work might be desirable, for the higher the voltage level of the carrier, the greater the current drawn from the B supply, and the lower the B voltage, so perhaps the less, the amplification, another levelling effects. Let us confine ourselves only to fading and assume the changes are as stated. Suppose the sky wave is the stronger, as it probably will be. Amplification of that component will be least. Suppose the ground wave or earth-bound wave is much weaker. Then it would be amplified much more. Yet it is the weaker component that constitutes the peculiar form of interference called fading, and we would be amplifying the interference more than the principal component of the signal.

The Power Tube Bias

Another consideration is that a.v.c. is used. Therefore the assumption of large differences in current drawn by the r-f and i-f level tubes is heightened. Since the negative bias is altered considerably, naturally the plate current changes are great. All this current passes through the B supply choke, therefore the voltage instability is high when the choke's d-c resistance is high. Moreover, while radio frequencies are of some importance in this respect, the audio component is emphatically more so, because the modulation intensity differences produce far greater changes, affecting that part of the circuit where the plate current is highest. The output tube is particularly meant.

In the power tube circuit the plate current increases as the signal increases. This is due to two conditions. One is that lack of complete smmmetry in the output inevitably makes one half of the wave have a higher peak than the other half. Which alternation shall predominate may be determined by the point of operation, or actual steady bias voltage, but it is usually that point (due to recommendations in standard tube data) that causes any change in current to be upward. And there is another and more effective consideration: the high value of grid leak in the audio circuit.

It has been pointed out in several articles on the 47 and 59 tubes that a low value of leak is preferable because otherwise when grid current flows in the power tube circuit that tube will lose bias. The recommended maximum is 0.5 meg. Against that recommendation there are two objections. One is that 0.5 meg. is not high enough to support in full the low-note response of which the circuit otherwise is capable. Another is that the lower the leak value in this circuit, the greater the hum. This can be proved very readily by connecting grid directly to ground and noting the high hum component.

Unique Grid Return

There is no doubt about the grid current flow, and for that reason the needle always kicks upward (plate current increases) when the signal becomes stronger. But it is quite possible to return the grid to a d-c potential that itself changes in the right direction with the signal. Of course the radio frequency has been rectified, and the d-c component is used. This is found in the load circuit of the 55 tube (grounded cathode to center-tap of secondary). When the signal is strongest the voltage across this 250,000-ohm resistor is greatest, and since cathode is always positive (otherwise no rectification takes place), the center-tap is negative, equivalent to the series anodes' voltage, hence the stronger signal heightens the bias.

The diagram shows the power tube grid returned to a limiting resistor in this circuit. This resistor is bypassed by a condenser, the larger the capacity the better. Moreover, the values given are not adament. Indeed, the average value of the current through the 250,000 ohms should be determined when only steady bias is on the power tube (grid of power tube returned to ground directly), and the voltage drop then computed (voltage in volts equals resistance in ohms multiplied by current in amperes). Then the power tube should be tested with different battery voltages so that its curve would be known for vacuum tube voltmeter purposes, and the effects of the maximum audio signals noted, as read by the maximum swing position of a plate circuit 0-50 or 0-100 milliammeter, and the interpretation of the peak value of this voltage from the calibration of the power tube. Then the excess over the steady bias voltage (18 volts) should be noted, and the return made to the diode load circuit to a point representing the average value of voltage drop through the limiting resistor. This method also reduces the amount of negative feedback at audio frequencies.

A NEW "C" SUPPLY

Rectifier Type Oscillator Develops 72.5 Volts

By J. E. Anderson

IN A receiver designed for television purposes it was desirable to have an external source of grid voltage which could be used on the power tubes as well as on the high-frequency amplifiers, a voltage that would be entirely independent of the signal voltage. It was realized that a high-frequency oscillator with constant plate voltage would generate a steady oscillation and that this could be rectified and filtered thoroughly with small coils and condensers. The question was how much voltage could be obtained.

A circuit like that in Fig. 1 was hooked up using a 55 tube. Condensers C2 and C3 were equal and each had a value of 250 mmfd. C1 had a value of 1,000 mmfd. and was used only to lower the frequency generated to keep it well below other frequencies in the receiver. C4, C5, and C6 were equal and each had a value of 0.1 mfd. R1 was a grid leak of 50,000 ohms and R2 had a value of 100,000 ohms. L1 was a small duolateral wound coil and L2 was a similar coil slightly larger. The two were coupled as closely as possible, the distance between them being about 1/8 inch. L3 was a 10-millihenry choke coil also of the duolateral type. This inductance was slightly larger than L2. M was a 0-1 milliammeter connected in series with the load resistance R2 to measure the output.

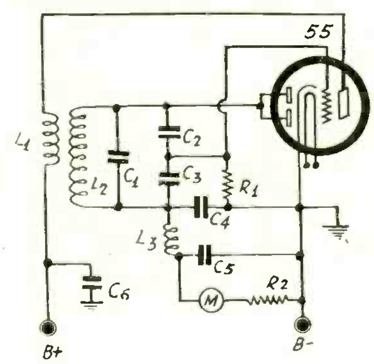


FIG. 1

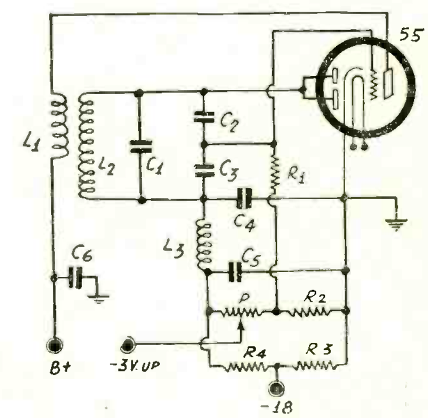


FIG. 2

Output Obtained

When a plate voltage of 135 volts was applied to meter indicated a current of 0.725 milliampere, which means that the voltage drop across R2 was 72.5 volts. This voltage was considerably greater than the grid bias required and therefore the circuit would do very well. The bias required for the power tubes was about 18 volts and that required for the high-frequency amplifiers varied between about 3 and 50 volts.

Reducing the applied plate voltage to 90 volts reduced the current to approximately 0.6 milliampere or the voltage across R2 to 60 volts. Leaving R2 open, so that the grid leak resistance was theoretically infinite, made the current 0.2 milliampere, and making the resistance 5 megohms did not change the current from this value. The use of the filter L3 and C5 increased the output a little. Without C4 the circuit would not oscillate at all.

The effect of variation of the bias on the oscillator was noted. Returning R1 to 1.5 volts made little difference but as the bias was increased in steps of 1.5 volts up to 7.5 volts the output was progressively decreased to about 0.4 milliamperes. Varying the bias, therefore, provides a method of varying the total voltage across R2. A similar variation can be effected by varying the grid leak resistance R1, since this also varies the effective grid voltage on the oscillator.

Arrangement of Bias Supply

In the circuit where the eliminator is to be used one fixed bias of 18 volts is required and one variable bias between 3 and 50 volts. To provide these two voltages the circuit was arranged as in Fig. 2. In this circuit the load resistance is made up of two resistors in parallel. One branch consists of a 250,000-ohm potentiometer P and a 12,500-ohm fixed resistor R2. This combination makes the limiting bias, the drop in R2, equal to 3 volts if the total drop is 63 volts.

If R3 is made 50,000 ohms, the current through this must be 0.36 milliampere if the voltage drop is to be 18 volts. If the total voltage is 63 volts the drop in R4 must be 45 volts. Therefore R4 should be 125,000 ohms. If P is 250,000 ohms, R2, 12,500 ohms, R3, 50,000 ohms, and R4, 125,000 ohms, the total load resistance on the rectifier is 105,000 ohms which is about the same as that used when the output was 72.5 volts. The 3-volt bias on the rectifier reduced the output to approximately 63 volts.

Of course this output depended on the applied plate voltage of 135 volts and on the particular combination of the oscillator coils and condensers. With some other choice of values in the oscillator circuit another output will be obtained. However, it is always possible to adjust the plate voltage for any given output voltage in the rectifier. The change in the applied plate voltage may be obtained by returning the oscillator plate to a suitable point on the voltage divider of the receiver B supply or by putting a resistor in series with the plate lead of the oscillator.

Controlling Volume

The potentiometer P, of course, is used for controlling the volume by varying the bias on the high-frequency amplifiers in the set. There is a marked advantage in using this independent source of grid bias. The screen and the plate voltages on these tubes are not affected when the bias is varied. When the bias is varied by changing the cathode resistors in the controlled tubes both the effective plate and screen voltages are varied.

As far as the bias on the power tubes is concerned there is also an advantage. There can be no reverse feedback to reduce the amplification on any audio frequency, however low. Large by-pass condensers across bias resistors are eliminated, as are the bias resistors themselves. All the cathodes of all the tubes in the receiver are grounded, at least all the cathodes of tubes biased by the C supply. The only thing that would cause any variation in the bias would be a change in the plate and filament voltages supplied to the oscillator. These voltages may change because the line voltage fluctuates, but these variations will be relatively small. Moreover, they would affect all voltage in the receiver in the same degree. Another cause of possible variation is that due to poor regulation. On strong signals the demand for plate current will be strong and that might cause a fall in the plate voltages supplied all the tubes, including the oscillator. If there is plenty of tank capacity in the B supply filter this variation will be small.

NEW INCORPORATIONS

Lew's Auto Radio Supply Co., Yonkers, N. Y.—Atty., D. D. Factor, 258 Broadway, New York City.

Wego Condensers, New York City, radio tubes—Atty., F. Finkelhor, 225 Broadway, New York City.

Perfection Broadcasting Corp., New York City—Atty., M. & S. Meyere, Times Building, New York City.

Commercial Radio-Sound Corp., New York City—Atty., H. G. Marks, 232 Madison Ave., New York City.

Franklin Electric Co., Atlantic City, N. J., electrical appliances—Atty., Elwood F. Kirkman, Atlantic City, N. J.

Neu-Dimond Wire Corp., New York City, metal wire—Atty., C. A. Levy, 110 William St., New York City.

Capitol Washing Machine Patents Corp., Wilmington, Del., patents—Attys., Corporation Trust Service Co., Dover, Del.

Elliott-Lewis Electrical Co., Inc., Wilmington, Del., electrical supplies—Attys., Corporation Trust Co., Dover, Del.

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SIMPLE TEST CIRCUITS

Continuity and Resistance Measured

By Jack Tully

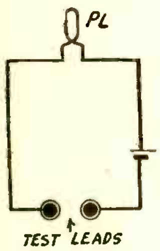


FIG. 1

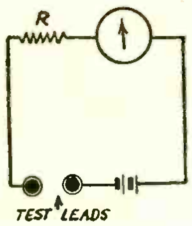


FIG. 2

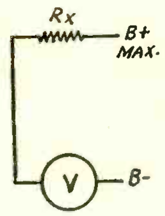


FIG. 3

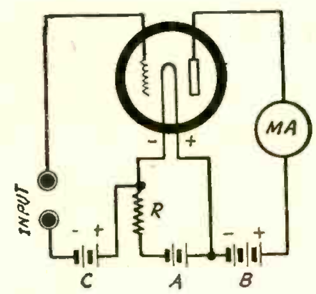


FIG. 4

MUCH work about a radio receiver can be done with improvised testers, or with simple devices connected up for permanent use. Perhaps the simplest is the continuity tester. It may consist of a pilot light and a battery suitable to that light. The two are connected in series and then to the test leads. When the two test leads are brought together the lamp lights up. While probing around with the test leads in the set, every time the lamp lights up it is known that the circuit is continuous. If the lamp lights up to full brilliancy, there is a dead short circuit and if it lights up feebly there is some resistance between the test prods. By suitable interpretation of the brilliancy of the lamp it can be determined whether the circuit is what it should be.

In case a lamp is not available a buzzer may be substituted for it, or even an ordinary door bell. However, a buzzer or a bell will only indicate continuity when there is comparatively little resistance in the circuit. Neither provides the gradations that the lamp affords. Of course, a meter could be substituted for the lamp and that would give an even better indication of the conditions in the circuit. It is only necessary to select a voltmeter that fits the battery used, or to select a voltage suitable to the meter.

Measuring Resistance

A voltmeter, a battery, and a resistance of known value constitute the essential elements of a resistance meter. Hence if a meter is used the tester can just as well be made into a resistance meter. This will indicate open circuits, short circuits, and continuous circuits between these extremes. In Fig. 2 a voltmeter, a known resistance R, and a battery are connected in series with the test leads. If the voltmeter range and the voltage of the battery are suitably related it may not be necessary to use the resistance at all. Suppose, for example, that the full-scale reading is 4.5 volts and that the voltage of the battery is 4.5 volts. Then the meter will read full scale when the test leads are shorted and when R is zero. Suppose the meter range and the voltage of the battery are so related. Then if any resistance be placed between the test prods the meter will read less than full scale depending on the amount of the resistance and the current drawn by the meter. If Ro is the resistance of the meter, R the resistance of the resistor between the test prods, E the voltage of the battery, and V the voltage reading when the resistance R is between the test prods, then $R=(E-V)Ro/V$. Thus to measure an unknown resistance it is necessary that the internal resistance of the meter be known. The internal resistance of the meter is equal to the voltage range of the meter multiplied by the ohms-per-volt of the meter. Suppose, for example, that the meter used has a sensitivity of 1,000 ohms per volt and that the range is 4.5 volts. Then Ro is 4,500 ohms.

Use of External Resistance

If the voltage of the battery and the scale of the meter don't quite match, they may be made to do so by means of the external resistance as in Fig. 2. The voltage of the battery should be greater than the voltage range of the meter and the external resistance should be adjusted so that the reading is full scale when the test prods are brought together and when there is no unknown resistance in the circuit. The total resistance then should be used. Perhaps we do not know exactly what the added resistance is, but if we know the ohms-per-volt of the meter we can get the total resistance, that already in the meter and that added, by multiplying the voltage of the battery by the ohms-per-volt. For example, if the voltage of the battery is 6 volts and the meter has a sensitivity of 1,000 ohms per volt, we know that the total resistance is 6,000 ohms.

If it is necessary to use the external resistance to match the battery voltage and the range of the meter, we can no longer use the voltage of the battery and the voltage reading of the meter. However, we may use meter deflections although they no longer represent the voltages involved. E would now be the full-scale deflection and V would be the deflection when the unknown resistance is between the test prods. Even when the battery voltage is equal to the range of the meter the deflection may be used and it is not necessary in any case to think of the voltages.

High-range Voltmeter

If a high-range voltmeter is available the voltage in the receiver can often be used in place of the battery. This is indicated in Fig. 3. As a matter of fact, that is done every time the voltmeter negative terminal is connected to B minus of the set and the other side of the meter is used for probing. When the prod is connected to the highest voltage the maximum voltage, of course, is indicated. If the prod is connected to any point that gives a lower voltage there is a resistance in series with the meter somewhere. An estimation of the value of this resistance can often be obtained by making use of the deflections and the resistance in the meter. Suppose that the meter is a 1,000-ohms-per-volt instrument with a full-scale deflection of 300 volts. The resistance if the meter is then 300,000 ohms. The maximum voltage reading might be 250 volts and some other reading with an additional resistance in the circuit may be 100 volts. The effective voltage in the circuit has not changed and therefore the change in reading is due to a decrease in the current through the meter, due in turn to the added resistance. If Rx is the added resistance and R the resistance of the meter, the total resistance in the circuit when the voltage reading is 100 is Rx+R. By proportion we have $(Rx+R)/R=250/100$, when Rx is 1.5R. That is, the unknown resistance is 450,000 ohms. This proportion is justified if the effective voltage in the circuit does not change, and this assumption is all right when the current drawn by the meter is so small, or rather when the change in the total current is so small in comparison with the total current that flows.

Vacuum Tube Voltmeter

What can be done with a voltmeter can usually also be done with a milliammeter, for a voltmeter is nothing but a milliammeter with a suitable resistance in series with it. If the milliammeter has a range of 0-1 milliampere, a 1,000-ohms-per-volt voltmeter can be made out of it by connecting a resistance of 1,000 ohms for every volt on the scale in series with it.

A milliammeter can also be used as indicator in a vacuum tube voltmeter. The circuit of a vacuum tube voltmeter is shown in Fig. 4. It has a plate battery, a filament battery, and a grid battery. The filament voltage A must be suited to the tube or the ballast resistor must be adjusted so that the current is right. The grid bias voltage C should be adjusted so that the plate current is practically zero when the input terminals are shorted. The circuit can be calibrated to read a-c voltages by getting the relation between the effective values of a-c voltage impressed across the input terminals and the current in the plate circuit. Or it may be calibrated to read d-c voltages.

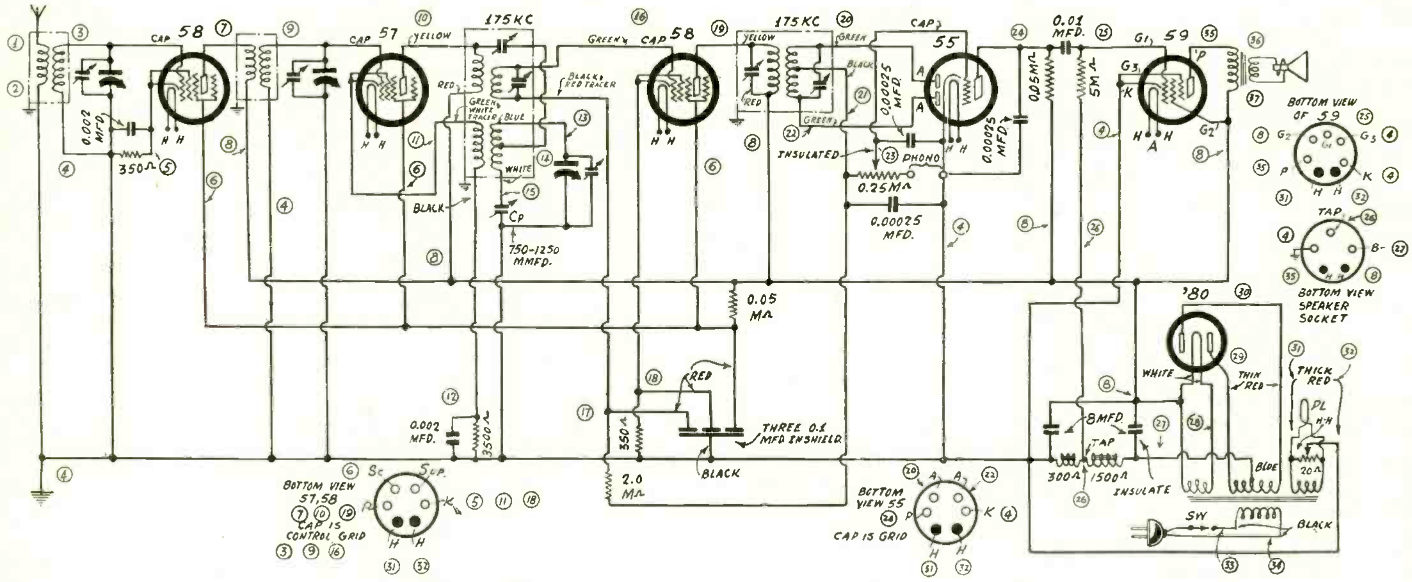
A vacuum tube voltmeter can be used for making tests where d-c methods fail. For example, suppose it is required to determine whether there is a signal voltage across a tuning condenser or across the secondary of a transformer. By connecting the input terminals across the condenser or across the transformer winding an indication will be obtained, for the vacuum tube voltmeter would act as a transrectifier. It would not be necessary to calibrate the instrument if only relative values are desired. Care must be exercised against applying high d-c potentials on the voltmeter.

Peak values of a-c voltages can be measured with the circuit in Fig. 4 by the so-called slide-back method. First the input terminals are shorted and the value of C is adjusted until the plate current as indicated by the milliammeter is just cut off. Then the a-c voltage is impressed across the input terminals and the value of C is increased until the plate current is again just brought to zero. The peak value of the voltage applied is then equal to the difference between the two values of the grid bias. For this purpose the tube used should have a sharp cut-off. A variable mu tube is not suitable.

Short-Wave Set Being Made Ready; Preferences Desired

Work is going forward in RADIO WORLD'S laboratories on an efficient but inexpensive short-wave receiver. Whether to include the broadcast band is a question, so readers are asked to state their preference. Write to Short-Wave Editor, RADIO WORLD, 145 West Forty-Fifth Street, New York, N. Y.

Testing Data on SUPER DIAMOND



The circuit diagram of the Super Diamond, corresponding to the picture diagram on pages 12 and 13

THE Super Diamond was designed so that by use of precision parts a great deal more could be gotten out of a six-tube receiver than by the usual processes. The chief development concerns the radio frequency tuning system, including the mixer and its associated coil system and tuning condenser. Taking commercial coils and condensers "as is" the results were not nearly so good as when special coils were wound experimentally, the necessary padding capacity accurately measured, and curves run on the r-f tuning and the oscillator tracking, and corrections then introduced for a still higher degree of accuracy. Then it was possible to calibrate a dial specially in frequencies, and have the receiver actually tune to the registered frequencies, using coils manufactured on the basis of the inductance previously obtained experimentally.

So that any one desiring to build this receiver will be able to do so, even if his knowledge of radio is slight, the circuit diagram is shown with numerical coding, and on pages 12 and 13 is printed the full-scale picture diagram of the wiring, with the same numerical coding. Thus any one in doubt as to where a particular part is physically located, need only consult the picture diagram, besides being guided by that diagram as to wiring placement.

Shielded Antenna Post Wire

The two diagrams are identical, but in case of any confusion, follow the circuit diagram rather than the picture diagram to resolve the doubt.

The circuit is easy to build, and is erected on a chassis that provides for eight sockets. This receiver uses only six tubes, therefore two of the socket holes are not used for working tubes, but you may desire to put sockets in them to accommodate spare tubes, or, extra filter capacity may be added, an electrolytic condenser being mounted at each or both of these two positions by using a bracket.

So sensitive is the circuit that in many localities there would be considerable pickup by a wire from the antenna post to "P" of the antenna coupler, which is one side of the primary. The antenna coil is the one with the larger primary, even though this is contrary to general practice. The smaller-primary coil is between the r-f tube and the autodyne (combination oscillator and first detector).

To avoid such pickup it has been decided to recommend the use of a shielded wire run between these two points—antenna lug and "P" of antenna coupler—but this wire should be about ½-inch outside diameter. Really, the wire is about No. 14, and there is extra thick insulation, and then the braided shield. This shielded covering should be grounded at two places, first near the antenna lug of the antenna binding post assembly, and second near the connection to "P" of the first transformer. Of course the antenna wire connection itself, represented by the concealed No. 14 wire, is not grounded, but only the braided shield covering of that is over the thick cotton insulation.

Capacity to Ground Made Small

The reason for insisting on this thick insulation is that it increases the distance between the actual antenna feed wire and the grounded shield covering, and thus the capacity between the two is reduced to a trivial value. If this were not done the loss in input, due to part short-circuiting of this input to ground through the relatively high capacity between the feed wire and the shield braid, would be considerable. Under the present plan this loss does not exist, and yet the antenna feed is effectively grounded against stray pickup, and moreover the oscillation peril is greatly reduced in the r-f stage.

In fact, an unshielded wire would introduce an accidental source of considerable coupling, not only to the r-f tube but to the autodyne and intermediate tubes and their associated coil systems. This would decrease selectivity, because some antenna voltage would go direct to the autodyne control grid without benefit of the tuning in the r-f amplifier stage, and besides the lead would be a source of squeals due to signals that are harmonics of the intermediate frequency. In other words there would be a coupling device where the requirements call for filtration. Shorting stray pickup to ground is the best filter, provided that the intentional pickup is not diminished thereby. And in the second detector the three 0.00025 mfd. condensers provide sufficient filtration. One of them is from plate to ground (55 triode), since some intermediate frequency voltage often exists in this plate circuit.

Padding Condenser Grounded

The circuit, in both representations, is shown with grounded padding condenser, as that makes the adjustment of this condenser much easier. Otherwise it is almost a necessity to judge the setting when the screwdriver and hand are removed, which means small changes in capacity made, one after the other, and with never

(*Continued on next page*)

Table No. 1—Tube Socket Data

Tube Type	Circuit	*Filament Volts H to H*	*Plate Volts P to Gnd.*	*Screen Grid Volts SG to Gnd.*	*Cathode Volts (K to Gnd.)*
58	R-F	2.5	270	110	3.5
57	1st Det.-Osc.	2.5	270	110	5.0
58	I-F	2.5	270	110	3.5
55	Det.-1st A. F.	2.5	270	..	0
59	Output	2.5	270	110 (G²)	(*)

(*) 59 cathode voltage measured between cathode and tap of field coil. 18 volts.
Note: Control grid to cathode measurement can not be made directly with ordinary meters as to the 58 intermediate tube, tbe 55 triode and the 59 tube. For the 58 R-F and 57 Det.-1st A.F., control grid to ground measures 0 volts.

'80	Rectifier	5.0 (F to F)	350 v. a-c between either plate and B minus

LIST OF PARTS

Coils

Two shielded radio frequency transformers for 0.00037 mfd. condensers.

One combination oscillator and 175 kc first intermediate transformer, in a single high shield. Total outleads, eight.

One 175 kc intermediate transformer, with center-tapped secondary.

[*The intermediate frequency coils have both primary and secondary tuned.*]

One power transformer, primary, 105-120 volts, 50-60 cycles; secondaries, 5 volts, 2 amperes; 700 volts center-tapped, 60 ma; 2.5 volts, 7 amperes.

One dynamic speaker, with 1,800 ohm field tapped at 300 ohms, and with output transformer for 59 tube used as pentode built in; equipped with 18-inch cable and UY plug.

Condensers

One three-gang 0.00037 mfd. tuning condenser with trimmers built in; ⅜-inch shaft 1⅛ inches long, mounting spades built in.

Two 0.002 mfd. fixed mica condensers.

One 750-1250 mmfd. padding condenser.

One shielded block containing three 0.1 mfd. condensers.

Three 0.00025 mfd. fixed mica condensers.

One 0.01 mfd. fixed mica condenser.

Two 8 mfd. wet electrolytic condensers, inverted mounting type; two insulating washers and extra lug for one of them; extra lug only for one of them; nuts for both of them; peak voltage rating 435 volts d-c.

Resistors

Two 350-ohm pigtail resistors.

One 3,500-ohm pigtail resistor.

Two 0.05 meg. (50000-ohm) pigtail resistors.

One 2 meg. (2000000-ohm) pigtail resistor.

One 5 meg. (5000000-ohm) pigtail resistor.

One 20-ohm potentiometer.

One 250000-ohm potentiometer, insulated shaft type, with switch.

Other Requirements

Seven socket insulating wafers and seven sockets as follows: four six-spring; one seven-spring; one four-spring; one five-spring (UY). The UY socket is for speaker plug.

One vernier dial, travelling light type, equipped with pilot bracket, lamp and escutcheon.

One drilled chassis.

Four tube shields.

Two knobs.

One foot of thick shielded wire.

Three tapped insulator tubings.

[*Questions about parts should be addressed to Trade Editor.*]

(*Continued from preceding page*)
the assurance of absolute correctness. The grounded method beats the other one all hollow.

Grounding is one of the favorite devices used in the Super Diamond, being present in the padding condenser, the manual tuning condensers, the field coil and the cathode of the 55. The tone is greatly improved when the 55 cathode is grounded, because then no resistor need be interposed between cathode and ground to reduce the amplification of the low audio frequencies and incidentally introduce an agency for development of a hum voltage. While it is true any biasing resistor here would have a bypass condenser across it, this condenser hardly ever would be large enough in practice (some 20 mmfd. would come close to sufficiency), yet here we get the benefit of infinite capacity across a theoretical resistance simply by omitting the resistance.

The triode unit of the 55 is coupled directly from the full-wave duo-diode detector's load resistor. This load is the fixed total of a potentiometer, while the amount of voltage taken off, for delivery to the first audio amplifier, or triode unit, determines the volume level. Thus the potentiometer is the manual volume control. The negative bias on the triode is equal to the voltage between the arm and ground. This can never be zero practically, because the signal disappears before the volume control reaches zero, and besides the control does not have a zero resistance point, the minimum being about 150 ohms. This potentiometer has arm self-insulated, so no insulating washers are required.

Tabulated Information

The resistance values between points, as well as the essential voltage difference between points, are given in tables, following commercial practice; and with a view to imparting fullest possible information to the constructor, both as to building the set and as to trouble-shooting.

The circuit has been discussed constructionally in these columns, and the facts laid down in earlier issues will not be repeated, but a summary given both as to constructional details and trouble-shooting.

Constructional Summary

(1)—Mount the padding condenser before you mount the tuning condenser. The padder is accessible from chassis top.

(2)—Solder leads to the stator lugs on the under side of the tuning condenser, and when mounting this condenser pass the leads through holes already drilled on the chassis. In some instances there will not be a good fit of the front spade of the tuning condenser in respect to the chassis, so either drill out this spade and turn it around (putting it in back of the condenser shield wall) or leave it off and rely on the dial bracket holding the front of the condenser, which it does very well.

(3)—In mounting the sockets be sure to put the heaters toward the front panel, in the four instances where this advice applies, and put the tube shield base on chassis top, socket insulator next to chassis bottom, and socket itself below the insulator. Note the insulator for the 59 socket is larger than the others.

(4)—The two 8 mfd. electrolytic condensers have their cases at different potentials, about 100 volts apart. One condenser is insulated from the chassis, and insulating washers and a special lug are used. This is for the condenser 100 volts below ground, for its case is B minus, and the difference is the total voltage drop in the field winding. On the other 8 mfd. only the conductive washer is used, no insulator, and this can is at chassis potential. Hence chassis and ground are identical (4). On this grounded lug the center-tapped low resistance is mounted. This may be 10 to 30 ohms, either fixed center tap or variable, as the setting is not critical.

(5)—The power transformer's bulge fits into a chassis cutout, upper right in picture diagram, and the transformer should be so inserted that the primary leads emerge toward the chassis front.

Adjustment Summary

(1)—After the circuit is built the lining-up procedure should be in the following order: intermediate amplifier fixed at 175 kc, oscillator padded at 600 kc and r-f lined up at 1450 kc, by using a modulated test oscillator. Preferably connect 175 kc at chassis bottom to plate of the autodyne tube when that tube is in circuit, otherwise to the plate spring of socket of the 57 when that tube is out of the socket. The signal of 600 kc is fed to the antenna post of receiver, with antenna disconnected, and the padding condenser screwed down nearly all the way. Determine the padding condenser setting by maximum response. The signal of 1450 kc is fed to antenna post with the antenna removed, and trimmers adjusted on r-f, autodyne control grid and oscillator, all of these being critical, the oscillator particularly. Recheck at 600 kc and readjust the padding capacity, required if any change was made in parallel trimmer across oscillator.

(2)—If a frequency-calibrated dial is used, the dial should be set so that with the condenser plates fully meshed the lowest frequency is read, which is one end of the scale. For the 600 kc test the dial should be turned to read 60. For the 1450 kc test the dial should be turned to read 145.

Trouble-Shooting

(1)—If the receiver does not give any response, check up the voltages to see that they are at least approximately those given in the table. If the r-f or i-f- biasing voltage, between cathode and ground, is less than indicated, this is not serious. Failure to perform at least in some manner is due to an open or short-circuit, which may be in the set or in a tube, or to absence of

Table No. 2—Resistor Data

Circuit Diagram Number	Resistance in Ohms	Color Code Body	Color Code End	Color Code Dot
4 to 5	250	Orange	Green	Brown
12 to 4	3,500	Orange	Green	Red
17 to 21	2,000,000	Red	Black	Green
18 to 4	350	Orange	Green	Brown
21 to 4	250,000-ohm	potentiometer not coded.		
8 to 24	50,000	Green	Black	Orange
6 to 8	50,000	Green	Black	Orange
25 to 26	5,000,000	Green	Black	Green

Note: The ground lead (metal chassis) is 4.

TABLE 3

Resistance Values of Coils

Circuit Diagram Number	Resistance in Ohms
1 to 2	8
3 to 4	20
7 to 8	6
4 to 9	20
8 to 10	40
11 to 12	8
13 to 15	10
16 to 17	40
18 to 19	40
20 to 21	20
21 to 22	20
20 to 22	40

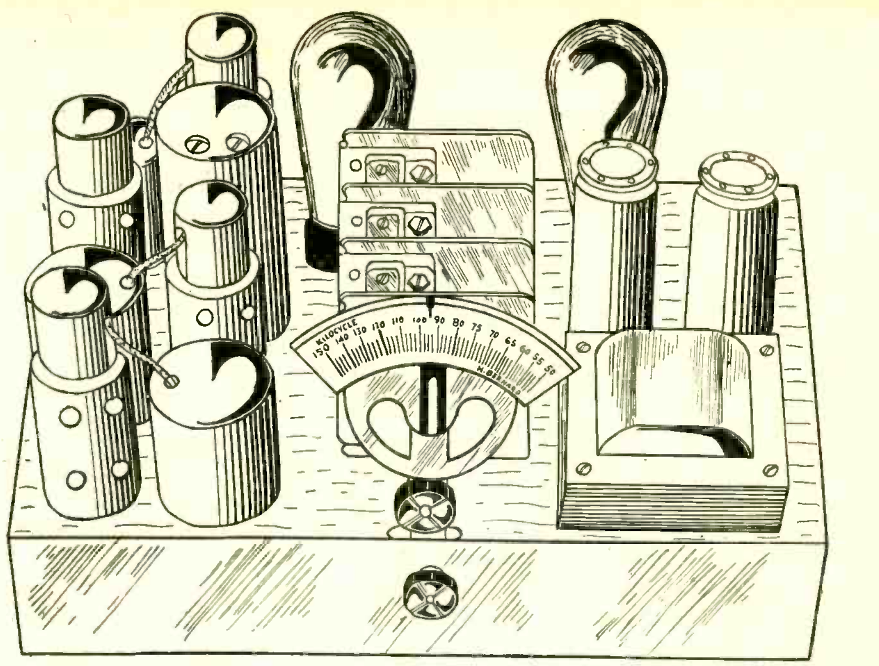
Circuit Diagram Number	Resistance in Ohms
8 to 35	700
36 to 37	2
4 to 26	300
26 to 27	1500
4 to 27	1800
8 to 28	4
27 to 29	200
27 to 30	200
29 to 30	400
31 to 32	2
33 to 34	12

oscillation in the oscillator. If the intermediate amplifier does not pass through the 175 kc, then the trouble is there. If the intermediate channel performs all right, then it and the audio and output circuits are satisfactory, but the trouble may be in the oscillator, so test the 57 cathode winding and oscillator tuned winding, to be sure both of continuity and correct identity. The wrong colored outleads may have been put on at a factory, a checkup is readily made, as to polarity but not continuity, by reversing the connections to the cathode pickup coil on the 57, putting green with white tracer to ground and black to cathode.

(2)—If stations come in with much less volume than should prevail, and there are squeals with the reception of virtually every carrier, and even when no station is heard, then the tracking is off or the intermediate amplifier is oscillating. Pinching the control grid lead to the first intermediate amplifier will detune it enough, and introduce enough absorption, to stop oscillation if in the intermediate amplifier, and if the squeals disappear then you know the trouble source. The remedy is to increase the 350-ohm biasing resistor of the i-f tube to such a value as stops the oscillation. If poor tracking is the fault, the set may have been incorrectly lined up at the 1450 kc level by using too much oscillator trimmer capacity, resulting in the low frequency setting (1450—175, or 1275 kc), instead of the higher frequency oscillator setting (1450 + 175, or 1625 kc), so readjust at this end. If there are squeals only at the higher frequency settings, then the r-f amplifier tube is oscillating, which is quite likely also if a short antenna is used, especially if without a ground. The oscillation would stop at about 1200 kc. Again, increase the resistance of the biasing unit in this stage until oscillation stops. If squeals are heard at only a few places, and three of them are at 700, 1050 and 1400 kc, with possibly two others at 870 or 880 and 1220 or 1230 kc, then increase the capacity of the bypass condenser between arm of volume control potentiometer and ground until these squeals disappear.

(3)—If motorboating is experienced it will be of a low-frequency type of unequal accentuation, with something of the rhythm of a person saying "a trap trap" over and over again. If hum is objectionable the phase may be wrong in the output transformer connection. In either of these cases the same remedy applies. Reverse the connection to the primary of the output transformer, putting to plate the lead that formerly went to B plus, and putting to B plus the lead that formerly went to plate. That is, the correct connection is the one that helps remedy both conditions. If you are using some speaker that has an output transformer intended for another type power tube, or a speaker with the correct output transformer but with a higher resistance field coil, get the proper speaker, correct in both particulars, especially as a higher resistance field coil tends to produce motorboating. An auxiliary remedy for motorboating, and one that will increase the B voltage and the volume a little, is to put an extra filter condenser next to the rectifier. This is the insulated one, so if two 8 mfd. electrolytics are used, one in a vacant socket hole, use a round bracket and drill the mounting holes large enough to accommodate ¼-inch insulating washers of the extruded type. In case motorboating is experienced, a resistor in parallel with the 250,000-ohm potentiometer sometimes acts as a complete corrective, values of 0.1 and 0.25 meg. being suggested. The trouble would not be due to the time constant of the filter circuit of the automatic volume controlled intermediate tube. Anybody not able to correct motorboating on the bases outlined should communicate with the author, care Radio World, 145 West 45th Street, New York, N. Y., and state full particulars, whereupon the remedy for the particular case will be supplied.

(4)—The use of a pre-calibrated dial is very handy, especially as then you will have a receiver with the frequencies right on the



dial, and no arbitrary numerical recordings. However, it is not practical to achieve precision results, because there will be small differences in receivers, although the accuracy will be better than usually found in commercial receivers. The adjustment is to be made on the basis first of the radio frequency tuning, and then of padding the oscillator to coincide in dial settings with the r-f level. Perhaps the best way to get the r-f response is to untie the plate connection of the autodyne, and connect its plate instead to plate of the 55. Untie the cathode of the 57 and connect to cathode of the r-f tube. This method is surer than connecting grid clip intended for the autodyne to grid cap of the 55. Then if a frequency of 1400 kc is receivable, adjust the r-f circuit at 1400 kc and then adjust it at 700 kc, or use any other 2-to-1 ratio, where one of the frequencies is at the high end, e.g., 1500 and 750 kc, and the coincidence will be very close indeed. When comparisons are made with some lower frequencies it may be found that the calibration is off a trifle, not more than 2 per cent., however, but this can not be compensated for very well, and a correction factor may be made on a sheet of paper for reference if any very close accuracy is required, as for testing purposes in conjunction with radio work. At 570 kc the calibration may be off 10 kc, which is less than 2 per cent., and of course does not in any way prevent finding the stations even at this end. The accuracy averages better than 1 per cent. The low frequency divergence represents an extreme case, on the basis of several sets built, and of course some of the sets came out just on the dot. It is therefore extremely important to get the r-f end lined up according to the pre-calibrated dial, otherwise not only with the r-f be off, but if the oscillator is padded to the r-f, then the whole reading will be off, whereas if the oscillator is padded to the dial and not to the divergent r-f, it really won't be padded. On the basis of the new procedure outlined, the r-f trimmers will have to be almost all the way out, while the oscillator trimmer is adjusted as required by the high frequency end, and the padding condenser at a low frequency. The oscillator padding tie-down points suggested are, again, 1450 and 600 kc, with checkup at 990 kc, or 1,000 kc may be used for checkup, if preferable or handier (signal frequencies given). If one has a modulated oscillator of the low-frequency fundamental type, useful for some intermediate frequencies on its fundamental, the other intermediate frequencies at low order of harmonics, and for the broadcast band at high order of harmonics (tenth harmonics, for instance), then the lining up is made easier, particularly since the 70 kc setting may be used for lining up at 700 kc, and the oscillator not molested when the receiver is turned to 1400 kc, to use the 20th harmonic. Or an oscillator that covers the broadcast band may be used the same way, set at 700 kc for taking care of that frequency in the r-f tuner, and of 1400 kc in the tuner due to use of the second harmonic of 700 kc. If a numerical dial is used (0-100) or 100-0), it is not important just what numbers represent extreme r-f frequencies, so long as the band is covered and the oscillator padded accordingly.

In conclusion it should be stated that the Super Diamond outperforms all t-r-f Diamonds, being both more sensitive and more selective, and having most excellent tone quality.

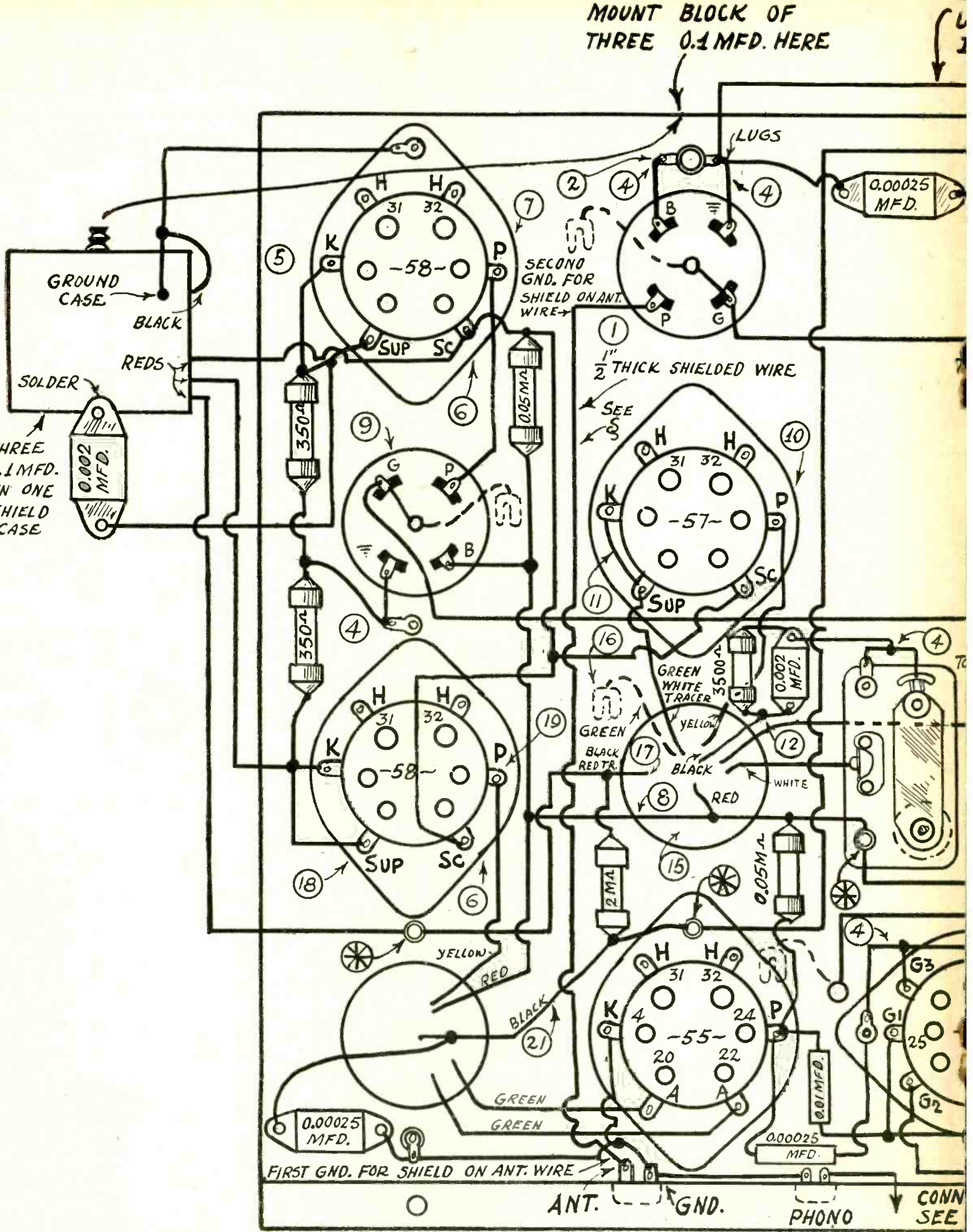
Microphone Dancer Is Latest Radio Toy

One of the cleverest toys has come from the National Company, Malden, Mass., in the form of a minstrel that dances to a microphone input. The actuating power is contained in a small dry cell battery under the platform on which the jack dances. When a switch is turned on the figure dances continuously until the power is turned off again, or until the battery is run down.

When a pair of leads from a toy microphone is inserted into a pair of pin jacks, the figure will no longer dance continuously but only when sound impinges on the microphone or when the microphone is jarred. Whistle into the microphone and the jack will dance. Talk to the microphone and the jack will dance some more. Tap the frame of the microphone with the finger and the jack will execute a tap dance. Use the radio when the toy is in the room and the figure will dance in time with the music. The device is a toy that interests both children and adults.

A THOUGHT FOR THE WEEK

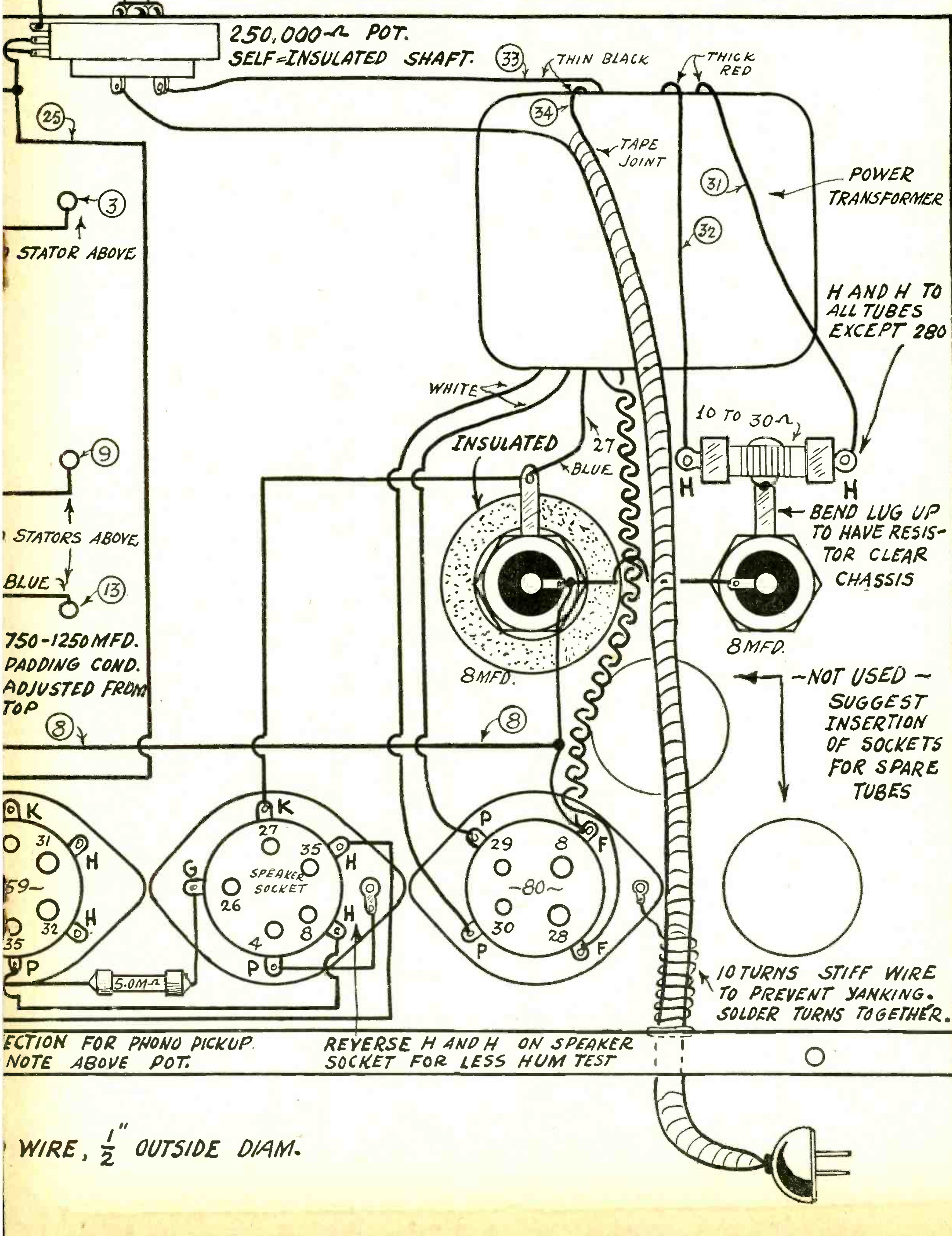
WHY ARE PUBLIC LIBRARIES all over the United States, Canada and foreign countries sending us in large numbers their yearly subscription orders for Radio World? *In these days the budgets of libraries, like those in all branches of activities, are being deeply slashed—and yet* Radio World's *subscribers in the library and educational fields are increasing rapidly. We do not ask for an answer to our opening query. We like the effect, be the causes what they may!*



✱ INSULATED TAPPED BUSHING. DO NOT GROUND!

§ LEAD FROM ANT. POST TO "P" ON COIL IS SHIELDED

SUPER DIAMOND



THE COMET "PRO"
A Short-Wave A-C Receiver

By Lewis Winner
(Hammarlund Manufacturing Co.)

THE Comet "Pro" is a high frequency superheterodyne receiver designed to meet the exacting demands of professional operators and advanced amateurs interested in the reception of both code and voice radio signals in the frequency range from 20,000 kc. to 1200 kc. In addition, it is suitable for various kinds of experimental and research work involving frequencies in that range where high sensitivity, low noise level, and great selectivity are important. The rather unusual tuning system as well as several other interesting features are described in detail in the following paragraphs.

Before taking up the actual description of the receiver it may be interesting to go over some of the more important considerations involved in shortwave receiver design. First of all comes the question of power supply; shall it be batteries or alternating current? Of course this controversy is automatically answered in situations where no alternating current is available, but these relatively few cases were disregarded and complete a-c operation decided upon. There is really no comparison from the viewpoint of convenience; in fact, the only argument in favor of battery operation seemed to be from the viewpoint of quietness of operation which is unquestionably of paramount importance in the reception of extremely weak signals. After some experimental work even this argument was disproved, as it was found perfectly possible to build an all a-c receiver just as quiet in operation as the finest battery-operated receivers.

High Sensitivity

Next come selectivity and sensitivity, which while separate and distinct qualities in themselves, are nevertheless dependent on each other in most practical receiver designs. The superheterodyne, or double detection type of receiver, undoubtedly offers outstanding advantages in selectivity and sensitivity, especially where such a wide range of signal frequencies must be covered. Then once again the question of noise was raised—all superheterodynes were considered too noisy for satisfactory weak-signal reception. But experimental work also disproved this theory and so work was started on an a-c operated superheterodyne.

An intermediate frequency of 465 kc was chosen as a compromise. It is below the broadcast band, and at the same time is high enough to provide a large spread between a desired signal and its "image" interference. By using Litz-wound intermediate coils the selectivity and sensitivity are kept high. This and many other design features are described in more detail in the following paragraphs.

Tests on the final model were exceptionally gratifying. The selectivity is such that the over-all response curve averages only 30 kc wide at 10,000 times input. The sensitivity is so high and the receiver noise level so low that, under test in a prominent laboratory, it was found possible to read a c-w code signal at twenty words per minute (single transmission) when the input to the receiver was only 1/10 micro-volt. The signal was fed from a signal generator through a 200-ohm resistor to the "Ant" and "Gnd" terminals of the receiver. Dividing this figure by four gives a value of 1/40 micro-volt per meter (assuming an effective antenna height of four meters, which is the generally accepted measure of signal field-strength).

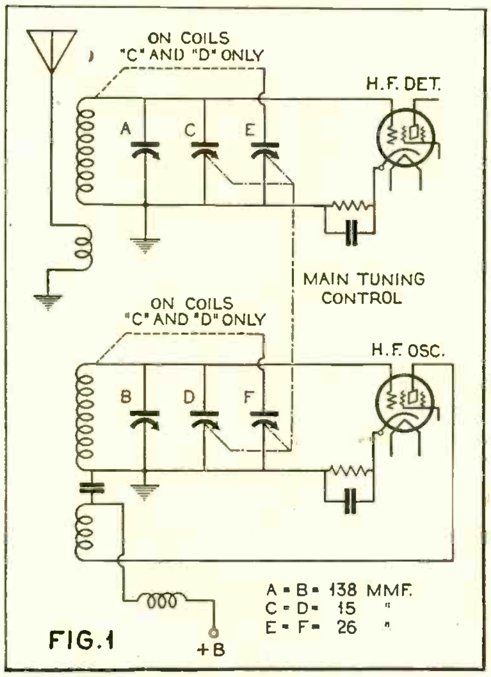


FIG.1

Plug-in Coils Used

Interchangeable plug-in coils are used to shift from one frequency range to another. Two coils, one "OSC" and one "W.L.," constitute a set, and the tuning condensers are of such size that each set of coils covers a frequency range of approximately two to one. To provide ample overlap four sets of coils are used to cover the range from 15 to 250 meters. The coils are wound on extruded Isolantite forms 1½" in diameter. This results in high electrical efficiency and also great mechanical stability, which aids materially in maintaining dial calibrations. The coils plug into special extruded Isolanite sockets with double grip clips which make contact to opposite sides of each coil prong, insuring reliable electrical connection with consequent freedom from noise due to variations in contact resistance. Any variation in resistance at these coil terminals would modulate the incoming signal carrier. Since these coil terminals are really the input to the receiver, any modulation at this point would be amplified by all succeeding stages, resulting in serious noise in the output circuit. For this reason all switches or other sources of variable contact resistance have been avoided in the design of this receiver. Both the "OSC" and "W.L." coils are completely shielded in are readily removable to facilitate changing from one frequency range to another. The use of these coil shields eliminates all electro-magnetic coupling between "OSC" and "W.L." coils as well as direct pickup from stray fields of any kind.

Band-Spread Feature

The arrangement of the tuning condensers is unique. The fundamental circuit is shown in Fig. 1, and although designed primarily to give a band-spreading action on the four amateur bands of 20, 40, 80, and 160 meters, the same effect is obtainable throughout the entire range from 15—250 meters (20,000 to 1200 kc). Condensers A and B, of 138 mmfd. each, constitute tank condensers and are individually controlled by separate vernier dials, one at left center and one at right center of the panel. By means of these two condensers, together with the appropriate set of coils, the receiver may be tuned to any frequency within its range. After this has been done, the main tuning dial, which controls condensers C, D, E, and F, will provide substantially true single control over a relatively narrow band of frequencies. If the main dial is set at 50 when the adjustment of the two tank condensers is made, approximately half of the spread-out band will be above and the other half below the mean frequency determined by the choice of coils and the setting of the two tank condensers. If the main dial is at zero when the tank condensers are adjusted the entire spread-out band will be above that frequency. Conversely, setting the band with the main dial at 100 will throw the spread band on the lower frequency side. The dials on the two tank condensers are finely and accurately calibrated to facilitate precise logging. While calibration curves are furnished with each receiver, the operator should make an accurate calibration of his own receiver by means of standard frequency signals, certain stations known to be well controlled, etc. Very precise duplication of band settings can be made by logging a few "key" stations in or near a desired frequency band. The stations chosen as "key" stations should be of known frequency stability, and moreover should operate on fairly continuous schedules.

Suppose, for example, station XYZ meets the above requirements and is selected as a "key" station for the 14 mega-cycle amateur band extending from 14 to 14.4 mega-cycles. After setting the tank condensers (with main dial at 50) as near as possible to 14.2 mega-cycles, let us assume that station XYZ is found at 7 on the main dial. The settings of both tank condensers and main dial for station XYZ should now be recorded. To reset the receiver at any subsequent time to *exactly* that same band, the tank condensers should be set as logged and the main dial set at 7. If station XYZ is heard (which is not very probable) all well and good. If not, a slight readjustment of the *tank* condensers will bring it in if it is on the air, after which the band setting of the receiver will be exactly the same as on the previous occasion when the original logging of station XYZ was made.

Image Suppression

This type of band spreading circuit necessarily results in a non-uniform band width at various frequencies, and this fact should be taken into consideration by the operator. At 20 megacycles the band is approximately 1500 kc wide and narrows to 300 kc wide at 10 megacycles (using the "AA" coils). With the "BB" coils the band width is 1000 kc at 10 mc and 150 kc wide at 5 mc. The band spreading on these two ranges is accomplished by the 15 mmfd. condensers C and D, Fig. 1, on the main tuning dial. These condensers alone are inadequate for proper band width in the 5 mc to 1.5 mc range covered by the "CC" and "DD" coils. In this range, the 26 mmfd. condensers E and F (Fig. 1) are connected into the circuit also. However, no switch is necessary, as this additional connection is automatically made when the "CC" and "DD" coils are inserted in their sockets. The fifth coil prong (which is not used in Coils "AA" and "BB") is used for this purpose in Coils "CC" and "DD." In this frequency range the band width varies from approximately 1200 kc at 4.5 mc to 225 kc at 1.5 mc.

A further advantage of the "tank" system of tuning used in the Comet "Pro" lies in its ability to overcome "image" interference which may be encountered under certain conditions. As is well known, there are two settings of the heterodyne oscillator of a superheterodyne receiver which will beat with the incoming signal to produce the desired intermediate frequency, which in this case is 465 kc. One of these is the signal frequency plus the i.f., the other is signal frequency minus i.f. In the Comet "Pro" the design of the tuned circuits is based on the use of the higher of these two oscillator settings, that is signal frequency plus intermediate frequency. Image interference encountered at this setting may be avoided by reducing the heterodyne oscillator frequency by an amount equal to twice the intermediate frequency, or 930 kc. This is accomplished by reducing the dial reading of the left hand "tank" condenser which controls the heterodyne oscillator tuning. The right hand, or "W.L." dial should not be changed.

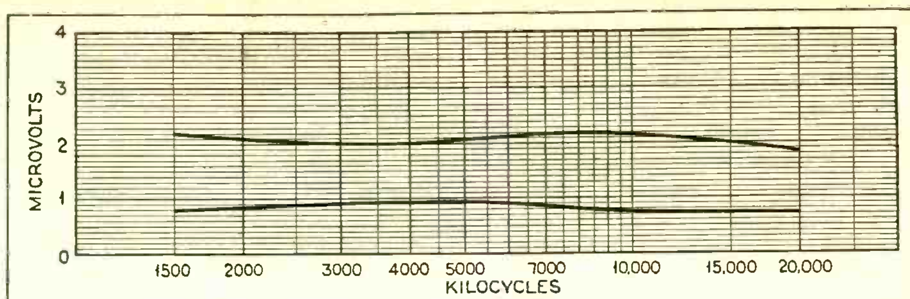


FIG. 2

Electric-Coupled Oscillator

As will be noticed by inspection of the circuit diagram of the receiver the high-frequency or heterodyne oscillator is of the "electric coupled" type. A 58 tube is used with its suppressor grid grounded directly to the chassis, thus more completely isolating its plate from the oscillatory circuit. A small condenser of about 0.6 mmfd. connected to the plate of the oscillator, couples a small amount of its output directly to the grid of the first detector. This type of coupling, together with the shielding of the "OSC" and "W.L." coils, effectively eliminates all interaction between these two circuits, even at frequencies as high at 20 mc.

The first detector is a 57 screen grid pentode. Its high detector sensitivity and high output impedance make it highly suitable to work into the high impedance primary of the first i.f. transformer. A further reason for its choice lies in its high input impedance and low effective input capacity, which together reduce the damping on the tuned input ("W.L.") circuit at the same time permitting a larger frequency range to be covered with a given coil and condenser.

The two intermediate amplifying stages employ 58 variable-mu pentodes, and the intermediate coupling transformers are of the twin-coil tuned plate tuned grid type. Since the intermediate amplifier provides most of the receiver's sensitivity and selectivity, no effort has been spared in the design and construction of the intermediate transformers. The transformer coils are wound with 10/41 Litz wire and have an inductance of 1.2 millihenries. At 465 kc, these coils have a power factor of .01 or a Q of 100. They are tuned by adjustable condensers with mica dielectric and Isolantite bases. As six of these low-loss tuned circuits are used in the three i-f transformers, it is not difficult to account for the extreme selectivity shown by the overall performance curves of the receiver.

The second, or i-f detector, is also a 57 screen grid pentode operated as a plate rectifier. Since its plate circuit contains a large i-f component in addition to the desired audio frequencies, a filter is necessary to remove it, otherwise undesirable feedback would result. This feedback can be very troublesome in a superheterodyne. As the tube is working as a rectifier, its plate circuit contains not only the fundamental intermediate frequency but also strong harmonic frequencies, especially the even ones. If not thoroughly suppressed these harmonics would induce voltages in the input circuit which would seriously hamper reception of signal frequencies at or near multiples of the intermediate frequency. In the Comet "Pro" this feedback has been minimized by exceptionally thorough filtering and shielding. A two-stage filter consisting of three 0.00025 mfd. by-pass condensers and two 85 millihenry chokes is used. In addition each stage of this filter is completely enclosed in a separate shield compartment.

High-Power Output

The output tube is a 47, resistance-capacity coupled from the second or intermediate frequency detector. The high amplification and great power handling capabilities of this type tube insure good loudspeaker volume even on very weak distant signals. An output transformer is mounted underneath the chassis with its secondary connected to the speaker terminal block at the rear edge of the chassis, and is designed to operate any speaker, either magnetic or dynamic (or permanent magnet dynamic), having an input impedance of the order of 4000 ohms. A tap on the secondary of the output transformer is connected through a resistor to the jack on the front panel, thus providing head-phone reception at reduced volume and with a minimum of hum. Due to the use of a built-in output transformer there is no direct current component at either the loudspeaker terminals or the phonejack. The jack is wired so that insertion of the phone plug breaks the circuit to the speaker terminals, which can therefore be permanently connected to the loud speaker.

The volume control, or more properly, the gain or sensitivity control, consists of a variable biasing resistor in the cathode circuits of the two 58 intermediate amplifier tubes. To obtain wide control without using an excessively high variable resistance, a steady current of approximately 5 milliamperes flows through this bias control in addition to the plate and screen currents of the two tubes. This additional current has but little effect at low bias voltages where the tube current is high, but its effect increases rapidly as the tube current falls off at the higher bias voltages. The combination provides smooth as well as wide control of the overall sensitivity of the receiver.

A very important feature of the Comet "Pro" is the intermediate oscillator, which can be started and stopped by the toggle switch on the panel. It consists of a "58" tube and associated circuits, permanently adjusted to oscillate at the intermediate frequency of 465 kc. Like the high-frequency oscillator it is also of the "electric coupled" type. This results in great stability of oscillation and entirely eliminates the "pulling into step" effect when receiving strong c-w signals. A small portion of its output is fed to the grid of the second or intermediate detector. Since all signals are changed to 465 kc by the combined action of the heterodyne oscillator and the first detector, it is evident that starting the intermediate oscillator which a signal is being received will result in two 465 kc voltages being impressed on the second detector grid, one due to the heterodyned incoming signal and the other due to the local oscillator. Theoretically, this would result in zero beat, but in practice the tuning of the incoming signal is seldom so accurate, and the result is generally a rather low-pitched whistle or audible beat note. It follows that by slightly readjusting the main tuning control, which in turn slightly varies the intermediate beat frequency generated by the first detector from the normal value of 465 kc, the audible beat note can be adjusted to any desired pitch. This is a desirable condition for the reception of pure c-w code signals, because no critical adjustments are necessary beyond the actual setting of the main tuning control. While it is unquestionably true that exceedingly weak c-w signals *can* be successfully received with a simple oscillating detector, it is equally well known that such reception cannot possibly be accomplished unless "everything" is just right, and the critical adjustment which is just right for one signal is rarely correct for another. With the Comet "Pro" the weakest signals can be tuned in merely by turning on the intermediate oscillator and then concentrating on the main tuning control. And, furthermore, once the weak signal is found, wide variations in its field strength, crashes of static or other electrical disturbances have no effect whatever on the adjustment of the receiver.

Intermediate Oscillator

While this feature (the intermediate oscillator) was designed primarily for the reception of pure c-w code signals, it is also extremely useful in other respects. When turned on, a whistle will be heard whenever any carrier wave is crossed during the process of tuning. By means of the zero beat method any such carried can be quickly tuned to precise resonance, after which the oscillator may be turned off. In case the carrier is that of a phone transmitter voice or music will then be heard.

The intermediate oscillator tube and its associated circuits are completely shielded from the rest of the receiver. In this way its action is entirely independent of the other receiver adjustments, especially the sensitivity control, which would not be the case if some of its output were allowed to couple with the first intermediate stage. Such independence of action is highly desirable for reliable c-w reception, since it is substantially constant irrespective of the field strength of incoming signals. Any operator accustomed to a regenerative receiver will appreciate this advantage. In addition, adequate shielding is necessary to prevent harmonics of the i-f oscillator from reaching the receiver input, where they might prove troublesome.

The whole question of shielding has been very carefully worked out and is culminated in an all-metal cabinet which encloses the entire receiver. Made of heavy gauge, patent levelled steel with black crinkle finish, this cabinet constitutes a handsome housing for the receiver and in addition limits all pickup to that afforded by the antenna itself. Fif-

(*Continued on next page*)

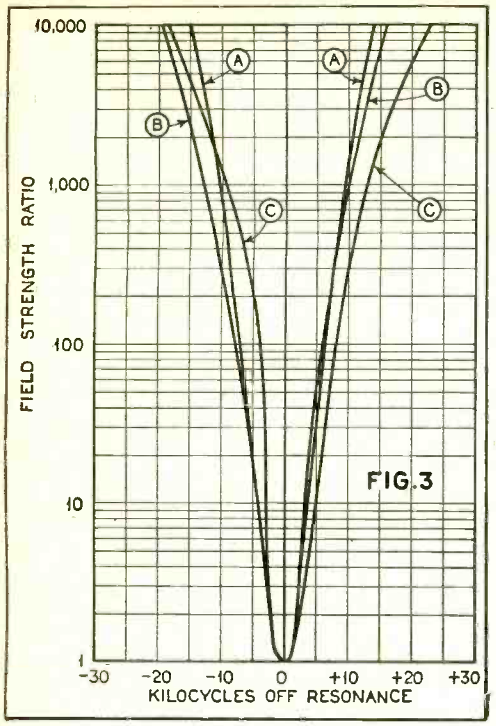


FIG. 3

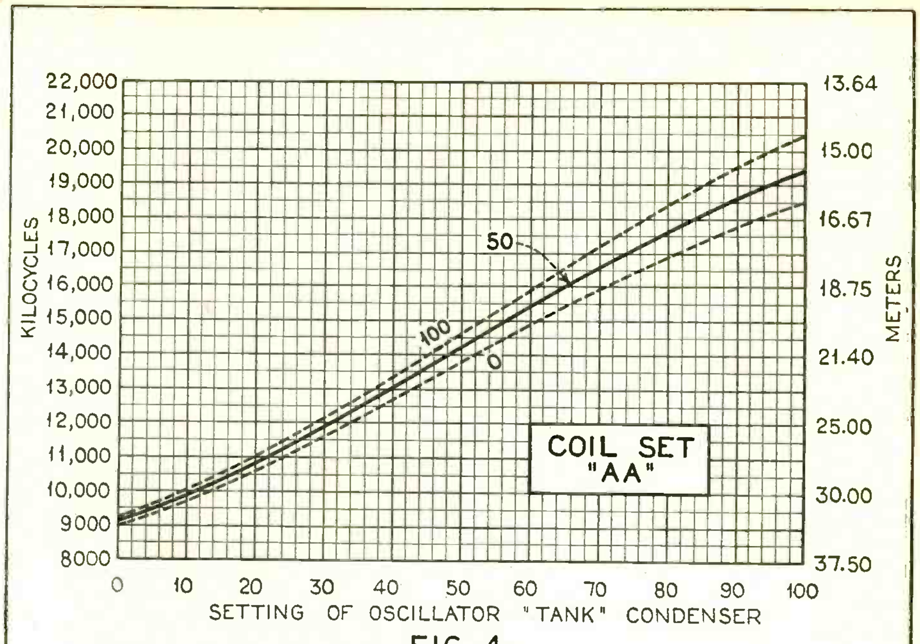


FIG. 4

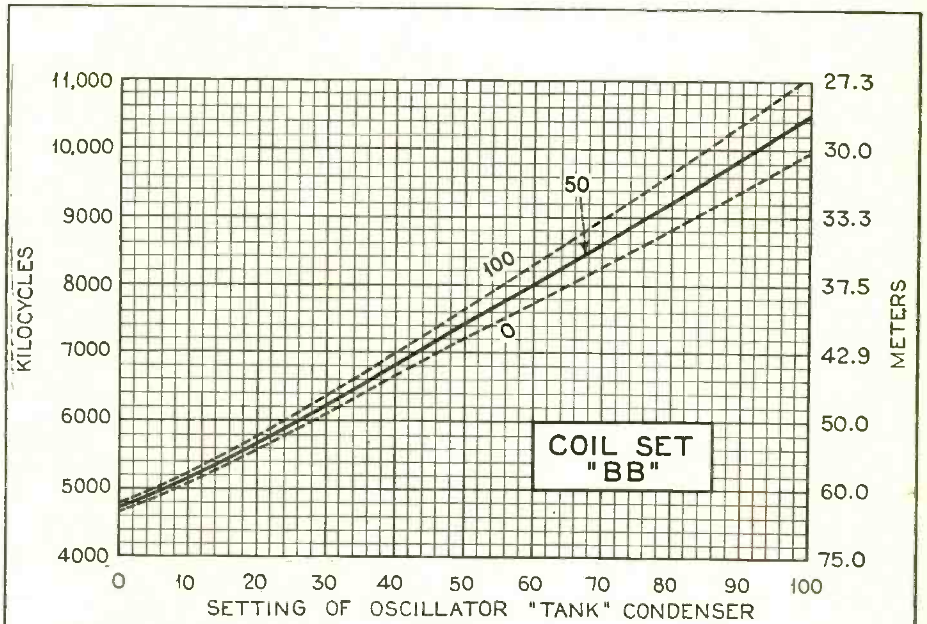


FIG. 5

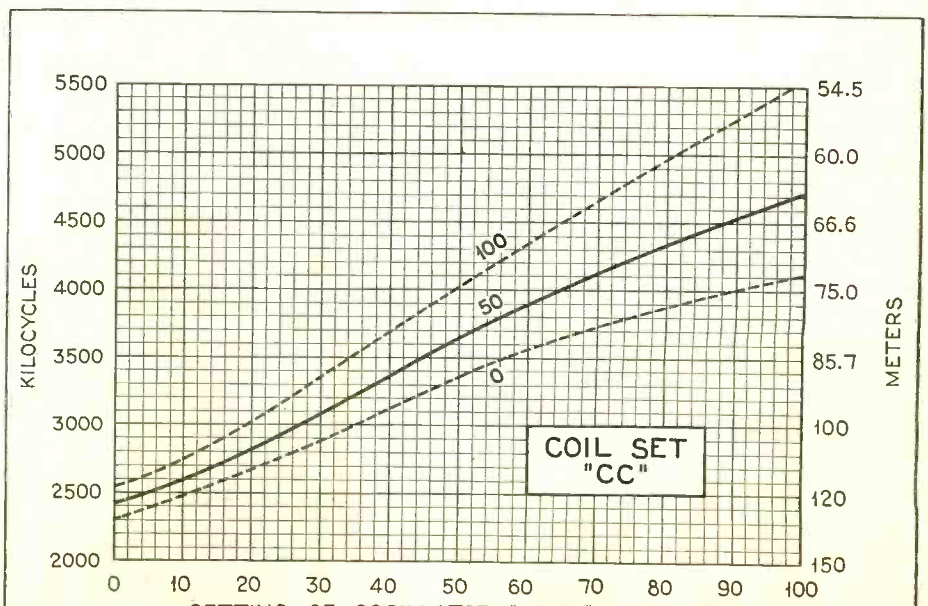


FIG. 6

(*Continued from preceding page*)
teen ventilating louvres provide ample circulation of air for heat dissipation.

Performance Data

In Fig. 2, is shown the sensitivity of the receiver throughout its tuning range. Both curves show actual output from the standard signal generator which was connected to the antenna and ground terminals of the receiver through a 200 ohm non-inductive resistor. They indicate the micro-volts input to the receiver necessary to produce the standard head-phone output of 0.006 watts, which in this case was 7.3 volts across a load of 8860 ohms. The upper curve, marked "I.c.w.," was made with 100 per cent modulation at 400 cycles, while the lower curve, indicating somewhat more than twice the sensitivity, was made with pure c-w heterodyned by the intermediate oscillator to an audio frequency in the neighborhood of 800 cycles. The higher sensitivity for c-w is accounted for by the increased efficiency of the second detector when its grid circuit is excited by the local intermediate oscillator. This increase in detector sensitivity is quite noticeable when the intermediate oscillator is started when no signal is being received, especially if the sensitivity control is advanced.

The selectivity of the Comet "Pro" is shown by the overall response curves of Fig. 3, which represents off-resonance field strength ratios required to produce standard output (0.006 watts). These curves were made with the receiver adjusted to maximum sensitivity, therefore the actual micro-volts input to the receiver at any point on a curve was approximately two times the indicated field strength ratio at that point. All curves were made with i.c.w., the modulation frequency being 400 cycles. Curve "A" was made at 1500 kc, using 30% modulation, curve "B" at 3750 kc with 70% modulation, and curve "C" at 19,000 kc also with 70% modulation. The substantial uniformity of these three curves taken at such widely different signal frequencies demonstrates very clearly one of the advantages of the superheterodyne circuit in high frequency radio reception.

Figs. 4, 5, 6, and 7 show the tuning characteristics of the four sets of coils, "AA," "BB," "CC" and "DD." As mentioned previously these charts are intended only as a guide to tuning, being exact only for the receiver from which they were made. However, the manufacturing variations between individual receivers are not

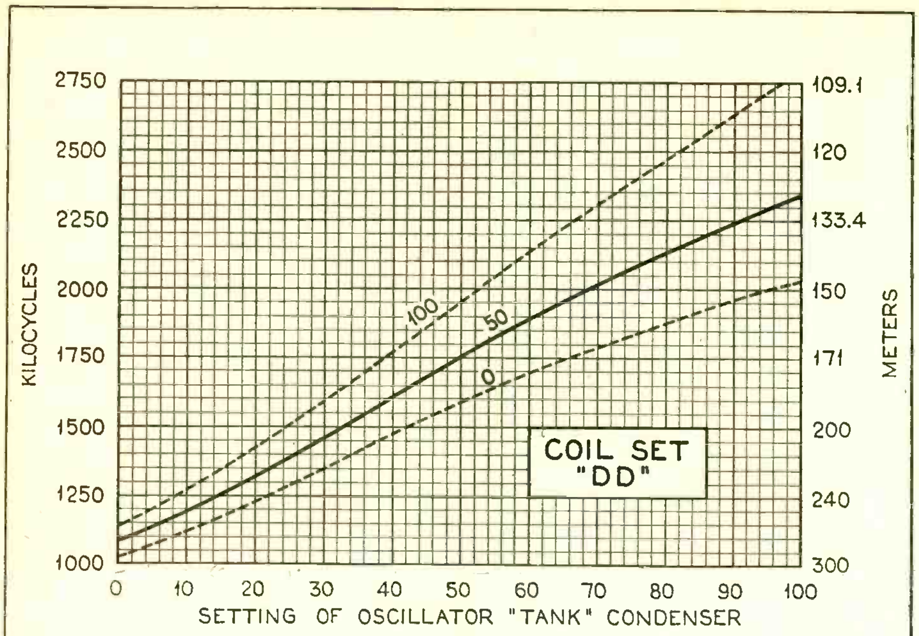


FIG. 7

very great, and therefore these charts will probably be correct within a few per cent for any receiver. To simplify the charts only the oscillator tank condenser tuning is shown. While the 'W.L." (or right hand) tank condenser setting will not track exactly, its proper setting will in general be within a few degrees of that of the oscillator. Its setting can easily be found by the rushing sound, which is loudest when the W.L. circuit is resonant to a frequency 465 kc below (or above in some cases) that of the oscillator. The solid line curves on these charts are the calibrations of the oscillator (left hand) tank condenser when the band spreading dial is set at 50. The upper and lower dotted line curves represent the calibrations when the band spreader dial is set at 100 and 0, respectively. Consequently, the vertical distance between these two dotted line curves at any given setting of the oscillator tank dial indicates directly the frequency range covered by the band spreading dial for that particular oscillator setting.

Installation

The standard Comet "Pro" is intended for use with 110-volt, 60 Cycle a-c current only, and should never be connected to any other source of supply. A protective fuse, rated at 1½ amperes, is mounted near the rear edge of the chassis at the left. This fuse is connected in series with the 110-volt line and should be examined in case the tubes fail to light. Where alternating current is available, but of different voltage or frequency, a suitable receiver can usually be supplied on special order. Where direct current only is available a small motor-generator of at least 75 watts capacity is recommended to supply the regular 110-volt, 60 Cycle a-c.

Each socket is plainly marked with its proper tube number. The standard receiver uses eight tubes, viz., one 80, one 47, two 57 and four 58.

No special selection of tubes is necessary, but actually defective tubes must of course, be avoided. This is especially true of the 58 used as the short-wave oscillator (to the left of the "OSC" coil). Occasionally a tube will be found with an abnormally high hum level, and when used as an oscillator will modulate all incoming signals with a low pitched hum or warble.

Antenna Systems

No special type antenna is required, and almost any length will prove satisfactory, except in locations where severe interference is encountered. Under such conditions a rather short antenna will generally improve matters. However, too much stress cannot be put on the need for experiment in the matter of antenna lay-outs for short wave reception. Each receiving location has its own peculiarities and since the receiver noise level in the Comet "Pro" is so exceptionally low, any improvement in the signal to noise ratio of the antenna system will pay big dividends in the form of improved weak signal reception. Ground connections are also a matter for experiment. All variable or high resistance joints must be carefully avoided in both antenna and ground systems.

Various types of balanced antenna systems such as doublets often provide improved reception at high frequencies. For proper operation of such a system the primary of the antenna coupler in the receiver should not be grounded. In the Comet "Pro" a three terminal "Ant-Gnd" block is used. The two "A" terminals are connected to the ends of the primary of the W.L. coil and the "G" terminal is connected to the chassis. The two leads from any balanced antenna systems may therefore be connected to the two "A" terminals. When the conventional Antenna and Ground arrangement is used a jumper should be connected from the "G" terminal to the adjacent "A" terminal, and then to the ground wire. The remaining "A" terminal should then be connected to the antenna. When using a balanced antenna system connected to the two "A" terminals, the "G" terminal may or may not be connected to ground depending on which condition yields better results.

Operating Details

The set is turned on and off by means of the lower left-hand knob. This knob is a combination switch and tone control; the tone control attenuates the higher audio frequencies and serves to reduce the noise

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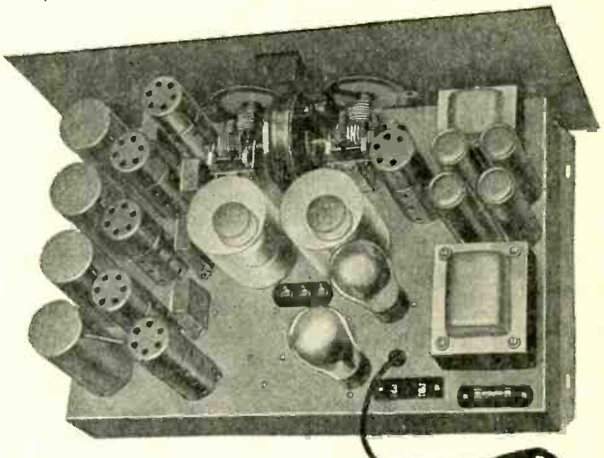

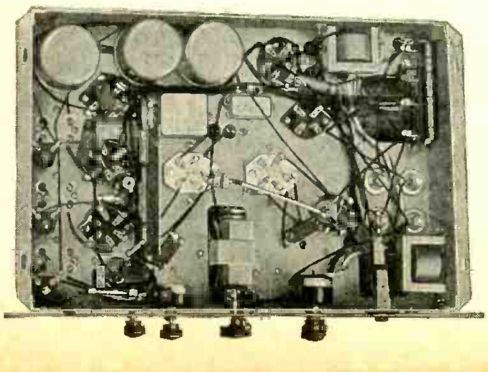

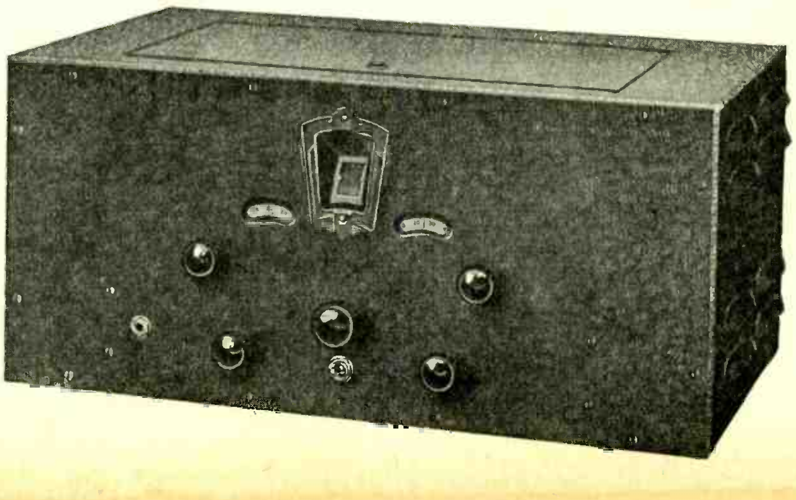

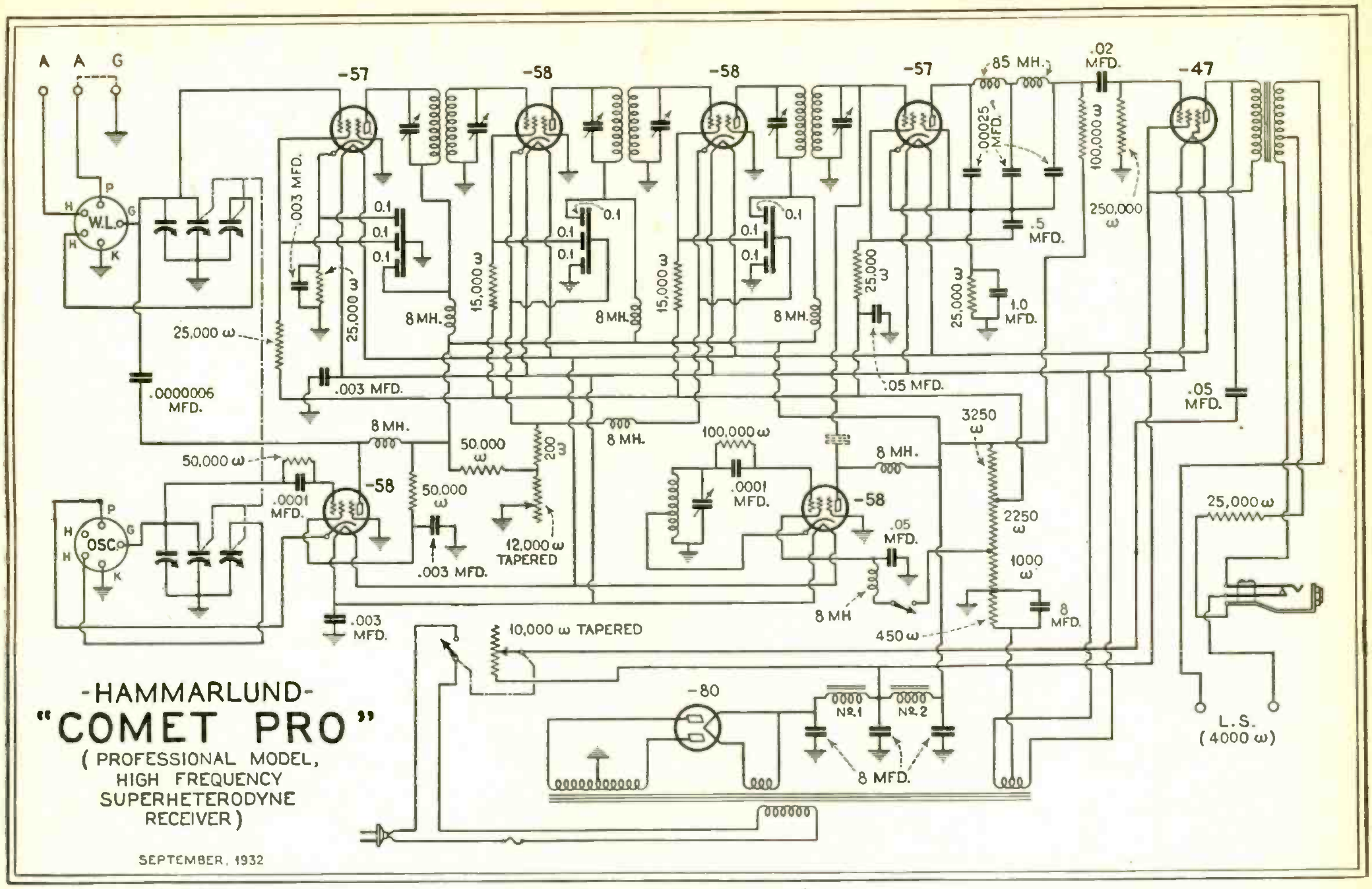

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under certain receiving conditions. The lower right-hand knob is the sensitivity control and should be advanced to the point where a slight rushing sound is heard when searching for stations.

The toggle switch at the center of the panel below the main tuning knob controls the intermediate oscillator which enables the reception of C.W. code signals and greatly facilitates searching for "phone" carrier waves.

The two Isolantite sockets in the center of the chassis are for the interchangeable tuning coils. Coils marked "OSC" go in the left-hand socket (looking at the receiver from the front) and those marked "W.L." go in the right-hand socket. Although the receiver will not function properly no damage will be done if a coil is accidentally inserted in the wrong socket.

Although the tuning system of the receiver has already been described in detail an actual illustration is given below. To set the receiver to the 3.5 to 4 mega-cycle amateur band, proceed as follows:

Plug in the "CC" coils, (CC-OSC) in the left-hand Isolantite socket.

Set the band spread dial at 50.

Set the two "tank" dials at 53 (per Fig. 6).

The receiver will then be tuned to approximately 3700 kc and the band spreading dial alone, after slight readjustment of both "tank" dials, will cover the entire band of frequencies between 3500 kc (at about 10) and 4000 kc (at about 90). In the same manner the receiver can be set to any other band.

Of course, if desired, the receiver can be tuned just like any other two dial receiver, merely by ignoring the band spreader dial and rotating the two tank condenser dials approximately in step with each other. If the band spreader dial is set at 50 during this operation, it can be used as a vernier after a station is located. Thereafter, any other stations known to be on frequencies but slightly different from that of the station tuned may easily be located by the band spreader dial alone.

The following list of approximate voltages is given for checking purposes. All circuit constants are given in the circuit diagram. A d-c voltmeter having a resistance of at least 1,000 ohms per volt should be used for checking. With the negative terminal of the meter connected to the chassis the following readings should be obtained:

Location	*Approximate Volts*
Top terminal of voltage divider	250
Second terminal of voltage divider	130
Third terminal of voltage divider	40
Fourth terminal of voltage divider	0
Bottom terminal of voltage divider	17
K terminal of first detector	6
K terminal of first and second I.F. (Max.)	45
(Varies with volume control) (Min.)	3
K terminal of second detector	6
P terminal of second detector	165
P terminal of H.F. oscillator, first and second I.F., first detector, and I.F. oscillator	250
G terminal of first detector, second detector, and first and second I.F.	110
G terminal of H.F. oscillator	100

Adjusting I-F

Tune in a steady carrier, preferably about 200 meters, and not too weak. Connect a high resistance voltmeter across the cathode bias resistor of the second detector. This meter should read around 7 or 8 volts with no signal. Then adjust the volume control, after tuning in a signal, so that the meter reads about 2 volts greater than the "no signal" reading. Carefully tune the main dial for greatest voltmeter reading. Then readjust each intermediate frequency tuning condenser for greatest voltmeter reading. After adjusting each condenser the volume control should be reduced slightly if the voltmeter goes much over 10 volts. When all six intermediate frequency oscillator condensers have been peaked, the intermediate frequency oscillator condenser should also be reset. This condenser can be reached through the hole in the shield in the corner of the underside of the chassis. Adjustment should be made for zero beat or nearly so. During all the foregoing adjustments, the main tuning dial should not be disturbed.

TRADIOGRAMS

By J. Murray Barron

United Radio Service Co., announced their removal to 320 Jackson Avenue, Long Island City, N. Y. The new place is especially suited for the company's business and offers greater facilities. H. R. Williams also announces the removal of the Brunswick Engineers Inc. to the same address. The Brunswick organization specializes in export business.

* * *

The Radio Secretaire, a superheterodyne radio receiver, has made its appearance. It is especially attractive and suitable for the office and professional man. Besides housing a radio receiver the metal cabinet contains accommodation for stationery and filing records and the top may be used as a desk or typewriter table. The General Fireproofing Co., 500 Fifth Avenue, New York City, is manufacturing the product.

* * *

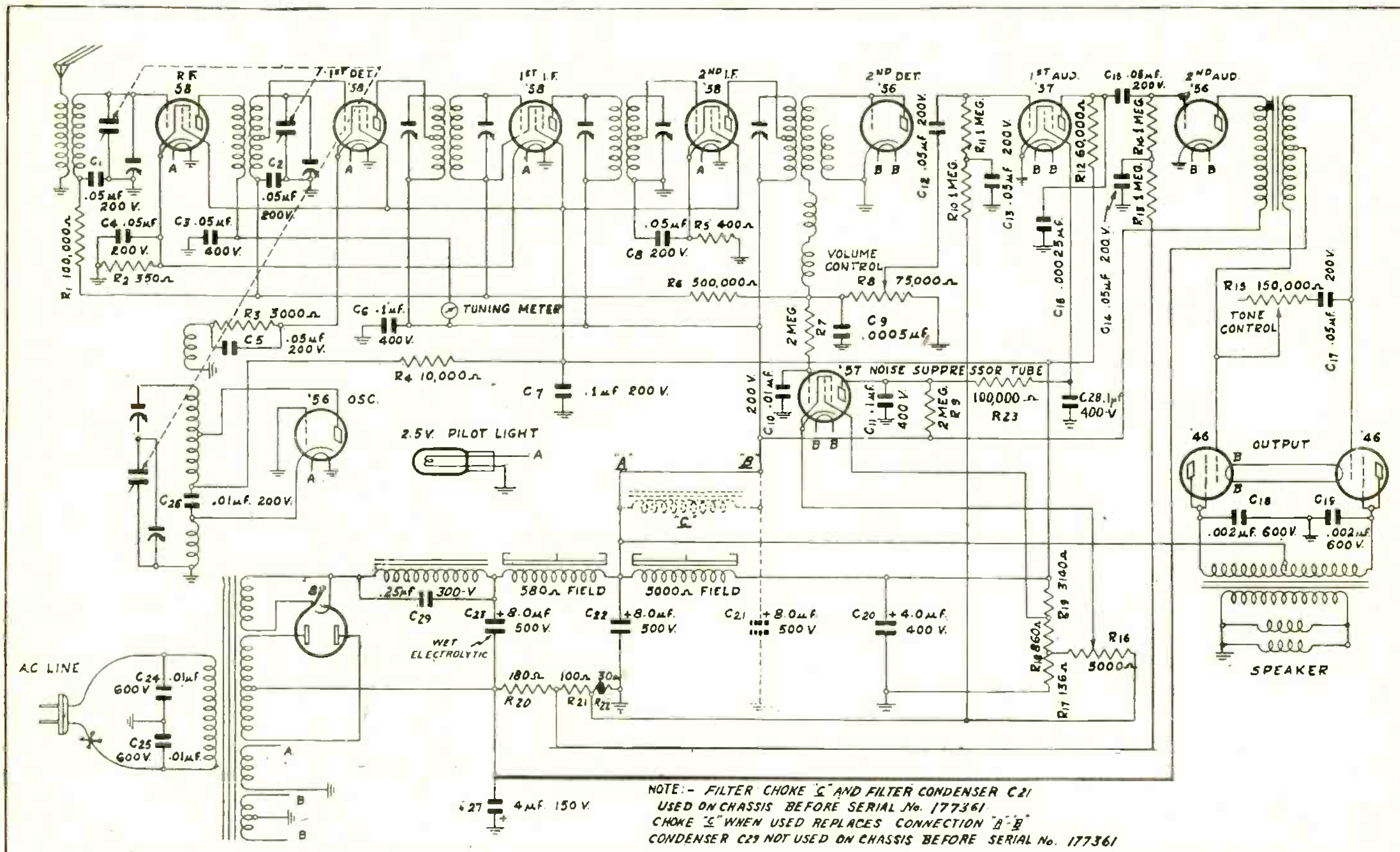
Wholesale Radio Equipment Co., 902 Broadway, New York City, is now distributing the Pilot line. It also distributes the Bosch and the new Essex receivers.

* * *

Nat Haynes, of Postal Radio, 135-137 Liberty Street, N. Y. City, reports a large demand for the Pix, a unique device that comes from Europe. He announces new uses for it daily as reported to him, until now there are more than a dozen different purposes for which it may be used with more expected. There is some free literature on the Pix.

GULBRANSEN SERIES 322

12-Tube Superheterodyne with Special Features



THE Gulbransen, No. 322 Series, 12-tube superheterodyne has automatic volume control and noise suppressor. The input circuit consists of an r-f transformer with tuned secondary, feeding into a type 58 tube. The output of this tube is fed through a second r-f transformer with tuned secondary into another 58 tube which functions as the first detector or mixer. The secondary of this interstage r-f transformer is tapped to provide a better image frequency ratio.

A 56 tube is used in a separate oscillator circuit. The oscillating circuit is tuned by one of the sections of the three-gang condenser and is always resonant at 175 kc above the frequency to which the r-f amplifier is tuned. The oscillator circuit is provided with the customary 1400 kc and 600 kc trimmer condensers to provide satisfactory tracking with the r-f tuned circuits. The oscillator frequency is fed into the cathode circuit of the 58 first detector tube. This results in the intermediate or beat frequency of 175 kc being present in the plate circuit of this tube.

Two I-F Stages

Two stages of i-f amplification are employed, using two 58 tubes. The primaries and secondaries of the first and second i-f transformers and the primary of the third i-f transformer are tuned by small adjustable condensers located in the i-f assembly cans. The tapped first and third i-f transformer primaries and second i-f secondary provide greater selectivity.

A 56 tube functions as the second detector or demodulator and also as the automatic volume control tube. The plate and grid of this tube are connected together externally so that it operates as a diode or two-element rectifier. During the positive portion of each cycle, current flofs in the grid-plate circuit of this tube. The voltage drop established by this current flowing through a resistor is paplied through isolating resistors to the control grids of the r-f 58, first detector 58 and first i-f 58 tube, increasing the bias voltage on these tubes and thus reducing the amplification. As the signal increases, the control voltage applied increases in such a manner as to give constant output as set by the manual volume control.

The Manual Volume Control

The control voltage is also applied to the control grid of the noise suppressor tube as explained later.

The audio component of the signal is developed across a resistor connected as a potentiometer which serves as the manual volume control. The audio signal is applied through the movable arm which is connected through a coupling condenser to the control grid of the 57 first audio tube. The amount of audio voltage transmitted depends on the setting of the movable arm.

A capacity winding in the third i-f transformer serves as a bypass condenser to ground. This condenser, in conjunction with the two chokes in the grid-plate circuit of the 2nd detector tube acts as an i-f filter.

Noise suppressing action, when tuning between stations, is very ingeniously obtained in this receiver by controlling the screen voltage of the 57 first audio tube.

Referring to Fig. 1, consider the movable arm of the noise suppressor potentiometer, R-16, at the extreme left (knob at extreme clockwise position). Assume no signal being received, which would bring the control grid of the noise suppressor tube to ground potential. The cathode of this tube is sufficiently positive at this setting of the noise suppressor knob to cause cut-off in the tube. No plate current flow. The screen voltage of the 57 first audio tube is not reduced and the tube amplifies normally. Additional bias voltage impressed on the noise suppressor tube due to a signal

Now consider the movable arm of the extreme right (knob at extreme counter-clockwise position). At this setting, the noise suppressing action is at a maximum. noise suppressor potentiometer, R-16, at the The cathode of the noise suppressor tube is now negative, relative to the grid. Plate current flows in this tube and the plate voltage drops due to the drop across resistor R-9. The screen voltage of the 57 first audio tube also drops, as it feeds through has no further effect, as the tube is already at cut-off.

the same line. This screen voltage of this tube differs from the plate voltage of the noise suppressor tube only by the drop across resistor R-23. Under no signal conditions the screen voltage of the 57 first audio tube is sufficiently low to prevent this tube from amplifying.

Noise Suppressor's Action

When a weak signal (noise) is received, the control voltage applied to the grid of the noise suppressor tube makes this grid more negative. Less plate current flows and the voltage of the plate of the noise suppressor tube and the screen of the first audio tube rises. If the signal is weak, the screen voltage will not be raised sufficiently to allow the 57 first audio tube to amplify.

When a strong signal (station) is received, there is sufficient control voltage to bring the noise suppressor tube to cut-off. This allows the screen voltage of the first audio tube to rise to its full amount and the tube amplifies fully.

Three Audio Stages

The audio amplifier has three stages. The first stage uses the type 57 tube mentioned above. It is resistance-coupled to the second audio stage which uses a 56 tube. The second audio tube is transformer-coupled to the output stage, which uses two 46 tubes in a stage of semi-Class B amplification. At low volume the amplifica-

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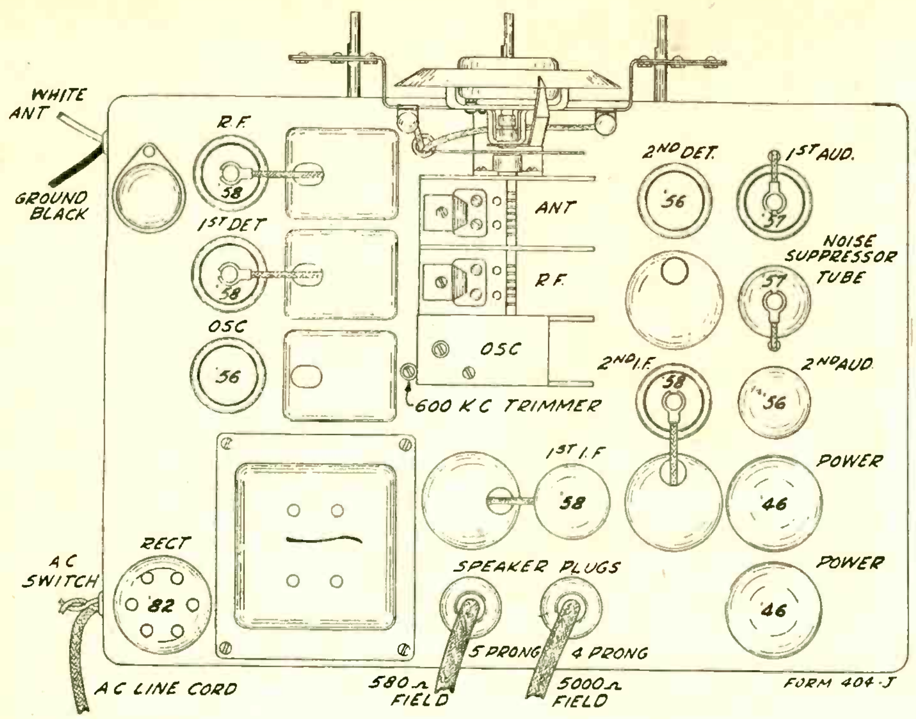

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tion is Class A for better tone quality, while at large volume, the output changes to Class B in order to get large output.

Voltage Check Up

Check the voltages at the sockets to see if the power unit is delivering the correct voltages. The antenna and ground should be disconnected and the antenna and ground leads from the set connected together.

All of the d-c voltage readings as shown on the chart are read with a 1,000-ohms-per-volt meter. As high a range as possible should be used. In general, the higher the resistance of the meter, the more accurate the reading will be.

The voltage chart gives the voltages with all tubes in, the speaker connected and the set in operating condition. These voltages are typical of the sets but will vary slightly with variations in individual receivers and variations in tube characteristics. All voltages in the chart are taken with a line voltage of 115. Differences in line voltages as well as differences in test equipment used will introduce other variations in the voltage readings.

Condenser Alignment

Misalignment or mistracking of condensers generally manifests itself in broad tuning and lack of volume at portions or all of the broadcast band. The receivers are all properly aligned at the factory with precision instruments and realignment should not be attempted unless all other possible causes of the faulty operation have first been investigated and unless the service technician has the proper equipment. A signal generator that will provide an accurately calibrated signal of 175 kc. and accurately calibrated signals over the broadcast band, and an output indicating meter, are necessary. The procedure is as follows:

Set the signal generator for 175 kc. Connect the signal lead from the signal generator to the grid of the first detector tube through a 0.05 mfd. condenser. Turn the tuning condenser rotor until the plates are completely out. The ground lead from the signal generator goes to the ground lead of the receiver. Then adpjust the five intermediate frequency condensers for maximum output. The adjusting screws for these condensers are reached from the bottom of the chassis.

Next set the signal generator for a signal of exactly 1400 kc. The antenna lead from the signal generator is, in this instance, connected to the antenna lead of the receiver. Set the dial pointer on the 1400 kc. mark on the dial scale and adjust the three trimmer condensers on the gang tuning condenser for maximum output, adjusting the oscillator trimmer first.

Next set the signal generator for a signal of 600 kc. and adjust the oscillator 600 kc. trimmer. The adjusting screw for this condenser is reached from the top of the chassis and is between the tuning condenser and the coil cans. A non-metallic screwdriver is necessary for this adjustment. Turn the tuning condenser rotor until maximum output is obtained. Then turn the rotor slowly back and forth over this setting, at the same time adjusting the 600 kc. trimmer screw until the highest output is obtained.

Then set the signal generator again for a signal of 1400 kc. and check the adjustment of the tuning condenser trimmers at this frequency for maximum output.

Setting the Noise Suppressor

The action of the noise suppressor is to establish a certain signal strength level below which all signals are cut out, and above which all signals come through without being reduced in intensity.

The general method of using the noise suppressor is to first turn the knob to the "Power" or right hand position. At this point there is usually considerable noise received. Turn the knob to the left until the noise is eliminated, and then continue to tune the set in the regular manner to whatever stations are wanted.

When tuning for far-distant stations, the knob should be turned to the extreme right hand or "Power" position, as the weak station signals may be cut out along with the noise signals if the noise suppressor is used.

When tuning in local stations the knob ma ybe turned well toward the left hand or "Quiet" position, as the station signals are very powerful compared with the noise signals.

If the signal of a station is distorted, turn the noise suppressor knob to the right until the signal becomes clear.

Low Volume

Probably the most common cause of low volume is defective tubes. In any case of low volume, therefore, procure a new set of tubes that have been tested or have been operating satisfactorily in another receiver. Insert these in the chassis one at a time and note any difference in performance.

Although a short inside antenna is sometimes satisfactory, a good outside antenna 50 feet or more in length is recommended. If the antenna system is faulty or in a shielded location, the volume may be low on distant or weak stations. This is particularly true if the antenna is in or near a steel building. In a case of this kind the antenna and lead-in should be inspected for poor connnections and ground. In a shielded location try a longer antenna in a different location.

Misalignment or mistracking of variable tuning condensers is another possible cause of low volume. Instructions for realigning are contained in this mannual. Do not, however, attempt realignment unless other causes of low volume have first been investigated.

Other causes of low volume are defective speaker, defective power unit, causing low voltages to be supplied, excessively low line voltage, defective a. v. a. system, defective noise suppressor, and various opens, grounds and shorts in the receiver assembly.

Excesive Hum

Defective tubes are very often the cause of excessive hum. Try out a complete new set of tubes and note any difference. The hum may be due to external pick-up. Disconnect the antenna and ground and see if the hum disappears.

A shorted filter choke, speaker field, or open filter condenser can cause excessive hum. Inspect these items for the defects named. Other causes of excessive hum are shorted choke tuning condenser, unequal rectifier plate currents, defective hum filter resistors and condensers, defective grid circuits and defective power transformer.

If microphonic hum or howl is encountered, switch the tubes of the same type around in the sockets and try out some new ones.

Distorted Reproduction

Defective tubes are a very common cause of distortion. Try out a new set of tubes that have been tested O.K. or have been operating satisfactorily in another receiver.

Distortion may be due to one or both

VOLTAGES AT SOCKETS

Line Voltage 115—Antenna Shorted to Ground—Noise Suppressor at Maximum Clockwise Position

Tube of Tube	Function	Across Filiment or Heater	Cathode to Plate	Cathode to Screen	Cathode to Grid	M.A. Plate Normal
46	Power	2.4	242	90	4 (1)	4
58	R.F.	2.4	250	86	7 (1)	2
58	1st. Det.	2.4	24	..	0	8
56	Osc.	2.4	252	90	4 (1)	4
58	1st I.F. (2) ..	2.4	254	91	3	5.7
58	2nd I.F. (2) ..	2.4	0	..	0	0
56	2nd Det.	2.4	65	55	4 (3)	.4
57	1st Audio ..	2.4	55	20	3 (1)	0
57	Noise Sup...	2.4	255	..	14 (4)	3.3
56	2nd Audio ..	2.4	260	260	34	23
82	Rectifier	2.4	880 volts plate to Plate			53*

*Per plate.

(1) *Read from cathode to ground.*
(2) *If I.F. readings are made with a cord and plug, ground the control grid through a condenser to prevent oscillation and motor boating.*
(3) *Read across 30 ohm section of voltage divider.*
(4) *Read across 30 ohm and 100 ohm section of voltage divider.*

of the speakers being out of adjustment. Check the speakers and try out new ones if they are available. Another cause of distortion is high or low grid voltages. Check the voltages as given in the voltage chart for this receiver.

Incorrect tuning of the receiver is a very common cause of distorted reproduction. The signal should be carefully tuned to resonance for best reproduction.

Distortion may be encountered in the case of a distant or weak station when the noise suppressor is being used, due to the fact that the signal is not strong enough at all times to be fully reproduced. If this cause of distortion is suspected, turn the noise suppressor knob in a clockwise direction to reduce or eliminate the noise suppressing action.

If there is a rattle see if all of the rubber cushions supplied are inside of the tube shields.

There are two additional causes of distortion not due to any fault of the receiver. One is due to the broadcasting station which may vary considerably in the audio quality of the signal. The other cause is due to quality fading in the signal transmission which may at times result in very bad audio distortion.

Oscillation and Whistle

Should the set oscillate on being connected up, it may be due to tubes whose characteristics vary considerably from the standard. In case of oscillation, therefore, change the tubes around and try out some new tubes.

See if the receiver is properly grounded and if it is, try out a new ground. Investigate the line voltage to see if it is excessively high.

The tube shields must all be on and the control grid leads to the top grid connection tubes firmly in place. Otherwise oscillation may result.

An open bypass condenser or open leads to the bypass condensers are a common cause of oscillation. Check the bypass condensers for capacity and the leads to them for continuity of circuit. A quick way to check bypass condensers for opens is to take a good condenser with test leads attached to the terminals and connect the new condenser across the condenser in the chassis. Oscillation may also be caused by poor chassis ground connections, by poor tuning condenser ground contacts. It may also be caused by shorted isolating resistors.

Differences in Early Models

In the first models of this receiver a slightly different filter system was used in the power unit. Condenser C-29, which tunes the separate choke, was not used. Condenser C-21, shown with dashed lines and the choke shown with dashed lines above the 5,000 ohm speaker field in Fig. 1 were used.

In the first models of this receiver individual tubular condensers were used instead of Condenser Block No. 80922. The condensers which make up this block are shown in the parts list. If replacements of any of the condensers are required, it is recommended that the individual tubular condensers be used.

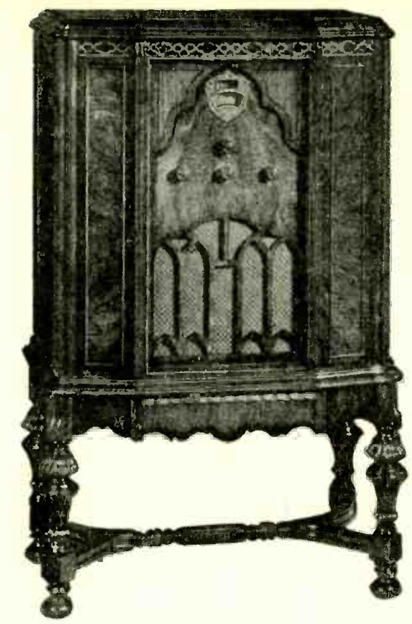
In the early models, a vitreous enamel, six-section voltage divider resistor was used instead of the wire wound type used at the present time.

25-Cycle Receivers

The 25-cycle receiver differs from the 60-cycle receiver only in the fact that a different power transformer is used. The correct power transformer is shown in the parts list.

The 25-cycle chassis can be operated satisfactorily from a 60-cycle power supply. However, the 60-cycle receiver cannot be operated from a 25-cycle power supply.

A 110-220-volt, 40-60-cycle power transformer is also available for this model.



The front view of the console of the Gulbransen 12-tube superheterodyne.

GENERAL DATA ON RECEIVER

The 12-tube chassis used in connection with Series No. 322 radio receivers is of the advanced superheterodyne type licensed under Radio Corporation of America and Hazeltine patents. Chassis dimensions are 17⅛" wide, 12⅛" deep, and 9" high. Eight tuned circuits are used and the tube complement includes:

Two 46 Class B type amplifier used in the modified push push (semi-class B) third audio frequency stage.

Thre 56 improved triode used in the oscillator stage, in the second detector stage and in the second audio-frequency stage.

Two 57 improved screen grid used in the cut-out stage for automatic interference suppressor and in the first audio frequency stage.

Four 58 improved vari-mu used in the radio frequency stage, in the mixer (first detector) stage, in the first intermediate frequency and second intermediate frequency stages.

One 82 mercury vapor used as alternating current rectifier.

(1)—MODIFIED CLASS B AMPLIFICATION is used, which not only allows for the great undistorted output of the Class B type of audio circuit at high volume but which will also reproduce with the same outstanding fidelity at low output or volume. The special modified Class B amplification used thus removes the one objection to the common type of Class B circuit.

(2)—AUTOMATIC INTERFERENCE SUPPRESSOR by means of which in-between-station noise is eliminated, thus removing the one objection to automatic volume control and assuring silent tuning.

(3)—THE MANUAL INTERFERENCE CONTROL by means of which the action of the automatic interference suppressor is regulated. By setting this control at a point just above the interference level, which point will vary with atmospheric conditions and location of the receiver, only broadcast signals of a greater strength than the interference will be allowed passage through the receiver, thus assuring a pure reproduction of the program.

(4)—AUTOMATIC VOLUME CONTROL (diode type) which assures steady volume of reception and easy tuning and which further eliminates the blasting effect caused by tuning from weak to strong station signals. The diode or linear type of detector circuit used in connection with this control eliminates the harmonic distortion common to the "power" type of detector.

(5)—IMPROVED TWIN VOICE DYNAMIC SPEAKERS which are specially designed to carry the great output of the receiver. One speaker is pitched for high notes and the second for low notes which arrangement results in an overall fidelity of practically 100% within the extremes of 70 to 4500 cycles. Diameter of both speakers is 8".

(6)—ILLUMINATED TUNING METER which enables the operator to obtain a visibly perfect setting of the dial when tuning to a station, thus not only simplifying tuning but assuring an accurate adjustment of the tuning condenser to the exact resonance point of the station signals.

(7)—FULL RANGE TONE CONTROL which allows complete graduation of tone from low bass to brilliant highs.

Sensitivity, Selectivity, Fidelity

The sensitivity or ability to pick up weak and dstant stations is rated at less than one microvolt (one millionth of one volt) per meter. Despite this extreme sensitivity the programs are kept above the normal noise level of the receiver.

The selectivity or ability to separate stations is carefully adjusted to ten kilocycles separation. This will allow the segregation of all stations operating on their allocated Government wavelengths and despite the great degree of selectivity, the common complaint of sideband cutting, so destructive to tone quality, is eliminated by the precision adjustment of the intermediate frequencies.

The tone fidelity or ability to exactly reproduce programs is outstanding. Many engineering improvements such as the rubber cushion mounting of the tuning condenser, the oversize power supply, the use of four chokes for the elimination of hum and distortion, the three stages of audio frequency including the modified Class B stage and the improved twin voice speakers contribute to the tonal purity to such an extent that a new criterion of tone value results.

The output of the receiver is potentially 18 watts but for reasons of stability and protection of the speakers, the regular output has been reduced to approximately 10 watts, which assures a volume sufficient to fill a medium sized auditorium without distortion. Current consumption of the receiver is 110 watts.

The stability and consistent quality of the receiver are assured through the use of extremely close tolerances, as for instance an allowance of only a fraction of 1% variation in the capacity of the tuning condenser, and by the use of broad safety factors, such as specification voltages in the fixed condensers 60 to 100% higher than the actual operating voltages. Further 40% of all factory labor is devoted to testing.

The dial panel includes lighted fan dial with illuminated tuning meter and four knobs—one for tuning, another for manual volume control, another for the adjustment of the automatic interference suppressor and the fourth for the tone control. On-and-off switch is arranged for installation on the side of the cabinet.

Net weight of chassis only is 28 lbs. and of chassis with two speakers 37 lbs. Shipping weight of chassis only 40 lbs. and of chassis with two speakers 52 lbs.

COMMERCIAL RECEIVER DIAGRAMS

A regular feature of RADIO WORLD is the publication of the circuit diagrams of the latest commercial receivers, with full technical data. Such publication is usually several months in advance of the printing of the diagrams in general circuit manuals and keeps one abreast of the very latest developments as reduced to practice. Therefore read RADIO WORLD every week.

STATION SPARKS
By Alice Remsen

Nocturne
For Arthur Chandler, Jr.
WLW, Sunday, noon, Monday, 9:45 a.m.

Resounding through the purple halls of night,
Perfect as tides that softly rise and fall,
Sweet melody and harmony in flight,
Speaking in language understood by all.

Bringing to each of us a different dream,
Of days long past, or hours yet to come.
To some it brings the thrill of love supreme,
To others, rumble of a distant drum.

It brings sweet surcease to an aching heart,
Or homeward turns the wayward mind of youth;
It calms the brain upset by troubled mart,
And teaches that the path of life is truth!

For music is the heavenly aureole
Encompassing the essence of our soul.
—A. R.

* * *

The organ music of Arthur Chandler, Jr. will waft you to another world—a world of a happiness and peace. Listen in to these programs; you'll like them.

* * *

The Radio Rialto

Well, I must say that they know how to spend the holidays in Cincinnati. They have the old German idea of decoration; houses, trees, garden gates—all are outlined in multi-colored lights, and very pretty they look. Every home has its Christmas tree—and, what is more, the holiday spirit in abundance. At the Netherland Plaza Hotel a huge tree was set up in the grand lounge, and on Christmas Eve it was unveiled, with a special service of choral singing by a vested choir, and suitable music by a string trio from WLW, under the direction of William Stoess. Maurice Franklin described the ceremony over the air; it was very impressive, and when the choir, holding lighted tapers, marched slowly down the staircase and around the lobby, singing "Adeste Fideles," it reminded of me of Roxy's vested chorus at his old theatre . . . William Stoess played first violin; his wife, Rosemary was at the piano, Dorothy Kemp was cello, and Carl Payne, was second violin. Dorothy Kemp, by the way, is the very charming hostess at WLW. . . .

I had the pleasure of singing with Joe Emerson on Christmas day; it was a special program, which took the place of Gene and Glenn, while the latter folk were holiday-making . . . Joe Emerson, as you probably remember, is the man who used to sing with Archer Gibson and his organ over WJZ and the network. He has made quite a reputation for himself out here as "The Bachelor of Song," a fifteen minute program on which you may hear his mellow baritone voice Mondays, Tuesdays, Wednesdays and Fridays at 3:15 p.m. He accompanies himself at the piano, chatting to his audience in an informal manner. A very good commercial bet. . . .

Things are beginning to stir in the radio world; several commercial auditions are scheduled for after the first of the year, and it looks like a big season for radio. WLW is in an unique position, with an immense coverage of fine territory, making it a chain in itself; should get plenty of business this year. . . .

My time has been shifted again to make room for commercials coming in from New York. Here is my new schedule: Mondays, Wednesdays, Thursdays and Saturdays at 5:45 p.m.; Tuesdays at 7:45 p.m.; Sundays at 7:00 p.m. and midnight; Eastern Standard Time. So listen in to your girl friend, will you? . . . Phil Davis, a nice, round, rosy young man, conducts for me a great deal; he's all right and willing to share a sandwich with a hungry lady at any time. . . . The Armour Hour, the Corn Cob Pipe Club, and the Voice of Firestone are among the new network periods listed here—that is, new for WLW. The Flying Dutchmen program has been slightly changed far as musical arrangement is concerned; it will be known in the future as Midnight Reflections. It will still be under the direction of William Stoess and go over the chain as usual; and I think I shall still be singing on the program. . . . Thelma Kessler has gone back to New York. . . . Announcer Joseph Ries of WLW. is serving as an adviser on the Cincinnati YMCA Vocational Guidance Committee, a group made up of representative professional and business men. Mr. Ries has had a very interesting career for so young a man and I shall run his biography one of the fine days for your pleasure. . . . And now for some NBC news. . . .

Ohman and Arden, who mingle piano duets with accompaniments for Beth Challis, the diminutive songstress, and Phil Rapp's jokes, for the U. S. Industrial Alcohol Company, will take their seats before the microphone for their broadcast over an NBC-WEAF network each Sunday night at a later hour—10:00 p.m. EST. . . . The American Album of Familiar Music, with Frank Munn, Veronica Wiggins and the Bayer Quartet, will be heard fifteen minutes later than usual on Sundays—9:30 p.m., EST, over a Coast-to-Coast NBC-WEAF network. . . . Am glad to see Bill Daly getting "the breaks"; he is a fine musician and conductor; I have had the pleasure of singing under his baton, and cannot speak too highly of his work. He is now conductor for the Voice of Firestone programs, which present Lawrence Tibbett and Richard Crooks over an NBC-WEAF network on Monday nights at 8:30, EST. I suggest this program as one of the high lights of your radio evening; don't miss it. . . . Alice Joy is back on the networks, every Monday and Wednesday night, WJZ at 10:00 p.m. She is assisted by the Rollickers Quartet. . . .

Now let's see what we can find over at WABC and the Columbia network. . . . David Ross is now featured in two C. B. S. series. On Saturday nights he conducts the interviews on the Grub Street program, and the following day he will have his own delightful "Poet's Gold." David hopes to present an occasional guest poet of high ranking to read some of his own verse. He also will cooperate with the American Poetry Society and read selections by young authors who have been accorded recognition. . . .

Harry Frankel, "Singin' Sam," preceded himself on December 28th, when he took Whispering Jack Smith's place on the Musterole program. Jack was sick. Harry did right well—and then followed himself right on. He's a jolly good performer, and one of the best of fellows. . . . Trade and Mark, the Smith Brothers' musical comedians who in private life are Scrappy Lambert and Billy Hillpot, have moved from their Wednesday night spot to Friday evenings, 8:00 p.m. They have another twelve weeks to go on their present contract. In addition to the 22 stations of Columbia's basic network, this program is also carried over Columbia outlets in Denver, Salt Lake City, and Minneapolis. . . . The new Pontiac program, with Stoopnagle and Budd, is presented each week direct from the stage of the Chamber Music Hall in the Carnegie Hall Building, New York, with an audience of 500 persons in attendance; Thursdays at 9:30 p.m. I have wondered how long it would be before Columbia decided to emulate NBC with an outside studio of capacity for accommodating a large audience. . . .

Well, must call it a day and get out to the studio for rehearsal. As look out of the window I think of dear old London in the winter time. Banks of fog crawling around corners and drifting over the roof-tops—a nasty all-enveloping damp mist. . . . That makes no difference, time and radio wait for no one, so here goes. So long until next week.

* * *

Biographical Brevities
ABOUT ROSARIO BOURDON

That great little conductor, Rosario Bourdon, was born in Montreal, Canada, on March 6, 1881, and learned music almost as soon as he could recognize his parents. His father, Rosario Bourdon, Sr., was organist at the Notre Dame church in Montreal; his mother, Caroline Dubois, is one of Canada's best known pianists. For thirteen years young Rosario remained in Canada, attending the Montcalm School and the Jesuit College in Montreal; at the same time he attended the Quebec Musical Academy, which appealed to him much more than his other school studies. Then he went to Ghent, Belgium, to study cello, theory, harmony and piano. A year later he became soloist at the Kursal Orchestra, at Ostend, Belgium. Then came a tour of Europe for several seasons.

After that he came back to the States and stayed for three years with the Cincinnati Orchestra, and four more years with the Philadelphia Symphony Orchestra. Engagements followed with opera companies, and then he went to the Victor Company plant at Camden, N. J., as cellist and pianist. It wasn't long before he became musical director for the Victor enterprises. This connection finally brought him to radio, and he conducted for many of the famous artists on the air under the Victor banner.

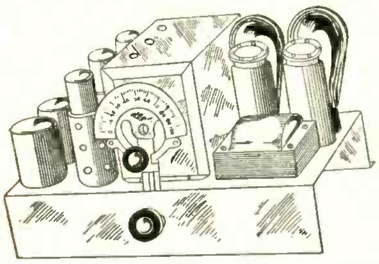
When first I met Mr. Bourdon he was conducting the Stromberg-Carlson Orchestra and the Cities Service Orchestra; this was in 1927. He is still conducting the latter organization. I had the pleasure of making my very first radio debut at that time with Mr. Bourdon and the Stromberg-Carlson Orchestra and was I scared to death? Well, rather. . . . Mr. Bourdon is married to a very charming lady, and has three children, Charles, eighteen, John, seventeen, and Rosaire, fifteen. Away from his work he is a very conscientious father, husband and student. He has composed many fine things. He likes baseball, football, golf and tennis. Plays bridge and sometimes dances for exercise.

Try-Mo Increases Space For Its Retail Display

Not only has there been excellent business in the radio section of N. Y. City, but there are indications for bigger business in 1933. At Try-Mo Radio Fair, 85 Cortlandt Street, there is much activity in increased retail space. A large center display room in the rear of the store, and which was the largest of the kind in the metropolitan section, has been rearranged with display shelves and counters, doubling the display space.

DIAMOND PARTS

FIVE-TUBE MODEL



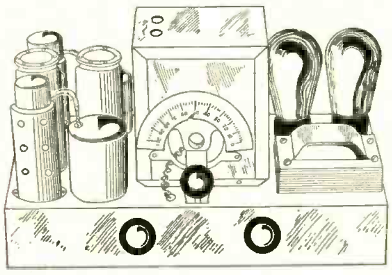
A-C operated circuit, 50-60 cycles, 105-120 volts, using two 58 t-r-f stages, 57 power detector and 47 output, with '80 rectifier. Three gang shielded condenser and shielded coils in a sensitive, selective and pure-tone circuit. Dynamic speaker field coil used as B supply choke. Complete kit of parts, including 8" Rola speaker and all else (except tubes and cabinet). Cat. D5CK @...........$15.69
Wired model, Cat. D5CW (less cabinet) @.... 17.19

Kit of five Eveready-Raytheon tubes for this circuit. Cat. D5T 4.97

FOUNDATION UNIT, consisting of drilled metal subpanel, 13¾ x 8⅝ x 2¼"; three-gang Scovill 0.00035 mfd., brass plates, trimmers, full shield; shields for the 58 and 57 tubes; six sockets (one for speaker plug); two 8 mfd. electrolytic condensers; set of three coils. Cat. D5FU....... 6.19

Super Diamond parts in stock.

FOUR-TUBE MODEL

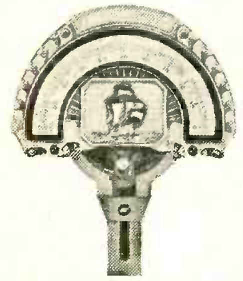


The four-tube model is similar, except that there is one stage of t-r-f, and a two-gang condenser is used. Tubes required, one 58, one 57, one 47 and one '80. Complete kit, including 8" Rola dynamic speaker (less tubes, less cabinet). Cat. D4CK $13.58

Kit of four Eveready-Raytheon tubes for this circuit. Cat 4D.TK 3.89

FOUNDATION UNIT, consisting of drilled metal plated subpanel 13¾ x 2½ x 7"; two-gang 0.00035 mfd. SFL condenser; full shield; two shields for 58-57; center-tapped 200-turn honeycomb coil; five sockets (one for speaker plug); two 8 mfd. electrolytics; set of two shielded coils; 20-100 mmfd. Hammarlund equalizer for antenna series condenser. Cat. D4FU $5.48

INDIVIDUAL PARTS



Travelling light vernier dial, full-vision, 6-to-1 vernier, projected indication prevents parallax; takes ¼" or ⅜" shaft; dial, bracket, lamp, escutcheon.

0-100 for 5-tube Diamond, Cat. CRD-0, @ $0.91.

100-0 for 4-tube Diamond, Cat. CRD-100, @ $0.91.

[If dial is desired for other circuits state whether condenser closes to the left or to the right.]

8 mfd. Polymet electrolytic, insulating washers, extra lug. Cat. POLY-8 @..................$0.49
Three 0.1 mfd. in one shield case, 250 volt d-c rating. Cat. S-31 @........................ .29
Rola 8" dynamic for 47, with 1800 ohm field coil tapped @ 300 ohms. Cat. FP @........ 3.83
2 coils for 4-tube. Cat. DP @.................. .90
3 coils for 5-tube. Cat. DT @.................. 1.35

DIRECT RADIO CO.

143 WEST 45th STREET
NEW YORK, N. Y.

SUPER DIAMOND

Complete parts, including speaker (less tubes, less cabinet).
Cat. SD-CMP @.............. $16.22

Set of shielded coils, consisting of antenna coil, modulator input coil and combination oscillator and first 175 kc intermediate coil (latter two in one shield), and separate intermediate coil with center-tapped secondary. Cat. SDCK. $3.95

Combination oscillator and 175 kc only, in one shield. Cat. OSN @.............. $1.80

Three-gang 0.00037 mfd. condenser with trimmers built in; ⅜ inch shaft, 1⅛ inches long. Cat. DJA3G $1.80

250,000-ohm potentiometer with switch. Cat. R25S @............................ $ .72

Pigtail resistors, 9c each; Rola speaker, $3.83; tube shields, 11c each; UX, UY sockets, 10c; six-pin, 11c; 7-pin, 15c.

DIRECT RADIO COMPANY

143 West 45th St. N. Y. City

BLUEPRINTS

627. Five-tube tuned radio frequency, A-C operated; covers 200 to 550 meters (broadcast band), with optional additional coverage from 80 to 204 meters, for police calls, television, airplane, amateurs, etc. Variable mu and pentode tubes. Order BP-627 @ ....25¢

628-B. Six-tube short-wave set, A-C operated; 15 to 200 meters; no plug-in coils. Intermediate frequency, 1,600 kc. Variable mu and pentode tubes. Order BP-628-B @ ....25¢

RADIO WORLD
145 WEST 45TH ST., NEW YORK, N. Y.

RADIO WORLD and "RADIO NEWS"

BOTH FOR ONE YEAR **$7.00** Canadian and Foreign $8.50

You can obtain the two leading radio technical magazines that cater to experimenters, service men and students, the first and only national radio weekly and the leading monthly for one year each, at a saving of $1.50. The regular mail subscription rate for Radio World for one year, a new and fascinating copy each week for 52 weeks is $6.00. Send in $1.00 extra, get "Radio News" also for a year—a new issue each month for twelve months. Total, 64 issues for $7.00.
RADIO WORLD, 145 West 45th Street, New York, N. Y.

Quick-Action Classified Advertisements

7c a Word — $1.00 Minmium
Cash With Order

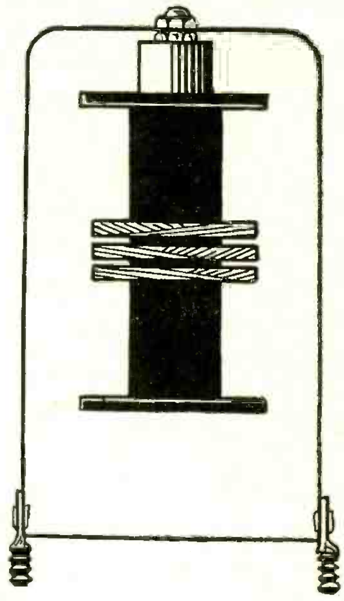
NEW AMERICAN BOSCH VIBRO POWER RADIO. Only American Bosch has vibro power, new discovery in radio. Get our prices before buying elsewhere. We will save you 25% on your radio purchase. McGuire Distributing Co., Bosch Radio From Factory to Customer, Doeville. Tennessee.

BARGAINS IN FINEST PARTS! — Highest grade, new parts, few of each on hand. National dial, flat type, modernistic escutcheon, type G, clockwise, $2.19; Pilot drum dial No. 1285 @ $1.89; a-c toggle switch, 19c; triple pole, four-throw Best switch, insulated shaft, $1.62; double pole, four throw, $1.08. Direct Radio Co., 145 West 45th St., N. Y. City.

"THE CHEVROLET SIX CAR AND TRUCK" (Construction—Operation—Repair) by Victor W Pagé, author of "Modern Gasoline Automobile." "Ford Model A Car and AA Truck," etc., etc 450 pages, price $2.00. Radio World, 145 W. 45th St N Y City.

"MATHEMATICS FOR SELF STUDY," by J. E. Thompson, B.S. in E.E., A.M. A complete course in four inexpensive books: Arithmetic, Algebra, Trigonometry, Calculus, for the Practical Man. 1240 pages, cloth, illustrated, $7.65. Radio World, 145 W. 45th St., New York City.

Semi-Tuned Coupler



Special semi-tuned coupler, for a variety of uses. It consists of three inductively related windings in an aluminum shield, 1¾ inches diameter, 3 inches high overall, broadly resonant at the lower frequency extreme of the broadcast band. Secondary is center-tapped.

The semi-tuned transformer may be used as a so-called untuned stage of r-f feeding the detector, to make the amplification more nearly even throughout the band of radio frequencies by increasing the gain at the low frequency end. For general use the effected center tap on the secondary may be ignored.

If the duplex diode-triode is to be used in t-r-f sets, this transformer may be connected for full-wave detection with primary in preceding plate circuit, extremes of secondaries (green and green with white tracer) to anodes of the diode (55, 85), center (see below) to cathode through a resistor of 0.5 meg. This is one of the most practical ways of applying the diode to t-r-f sets, with or without automatic volume control, as the problem of a grounded rotor of a condenser and a return that cannot be directly grounded is avoided.

The coil also may be used for a-v-c pickup, by putting one choke winding in the plate circuit of the detector, with no condenser from plate to ground, but condenser from other end of this coil to ground, and thus using the pickup of the secondary to feed the a-v-c circuit.

The transformer may be used as antenna coupler. The windings consist of special honeycomb coils of low distributed capacity, with wire not too fine for this the intended purposes. The color code: red and yellow are primary; green and blacks are one secondary; green with black tracer and black with red traced other secondary. Connect black and black with red tracer for center-tapped secondary. Cat. STC @.................75c

Short-Wave Plug-in Type

Cat. SWB—Four plug-in coils, 6-pin base; primary, secondary, fixed tickler............$1.70
Cat. SZ—Six-spring wafer socket for use as coil receptacle for six-pin coils.................11c
Cat. SWA—Four plug-in coils, UX base, primary and secondary; primary may be used for feedback if condenser connects aerial to grid....$1.35
Cat. SX—Four-spring (UX) wafer socket for use as coil receptacle for four-pin coils......10c

CONDENSERS

Cat. DJA-14—Single 0.00014 mfd. condenser with compensator built-in. ¼-inch shaft. Supplied with bushing to take ⅜-inch dial hub..98c
Cat. DJA-25—Single 0.00025 mfd. feedback condenser. Useful where 0.0002 or 0.00025 mfd. is specified $1.02
Cat. DJA-14-D—Double (two-gang) 0.00014 mfd. condenser with compensators built in, ¼-inch shaft. Supplied with bushing to take ⅜-inch dial hub $1.96

SPECIALS

Two coils for 4-tube Diamond. Cat. DP...$ .90
Three coils for 5-tube Diamond. Cat. DT..$1.35
Five coils in four shields for Super Diamond. Cat. SDCK $3.95
Two r-f coils and separate oscillator coil for Anderson's Auto Super. Cat. AUSU........$1.45
Two r-f coils and separate oscillator for 175 kc. supers. Cat. 175-SU.....................$1.45

Screen Grid Coil Co.

145 W. 45th St., N. Y. City

Modulated Oscillators

Covering Both Broadcast and Intermediate Frequencies

KIT

(Not Calibrated)

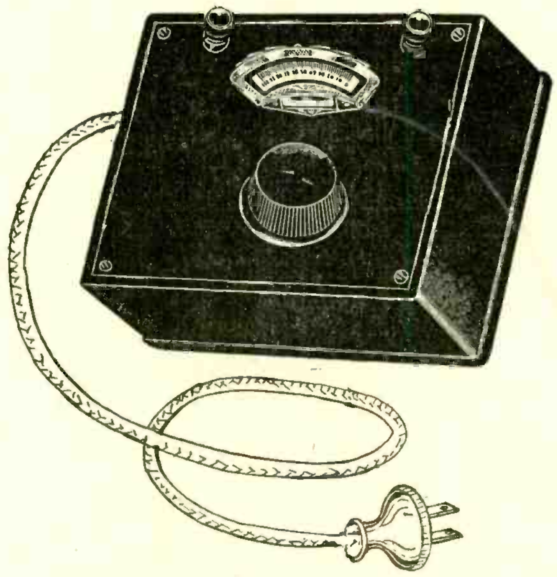
COMPLETE Parts including cabinet (less tube) for building an a-c operated (110-volt, 50-60 cycle) modulated test oscillator, with wiring diagram. Fundamental frequencies of oscillation will be from about 100 to 300 kc, so that some intermediate frequencies may be tested on the fundamental, others on the second harmonic, while the broadcast band is taken care of by the fifth harmonic. Sharp tuning, clear squeals in heterodyning, and strong modulation by the 60-cycle line frequency. No hum except at resonance. Frequency stability is of a high order, due to stabilized grid circuit. The oscillator is Shiepe's modification of the Hartley. Either a 56 or a '27 tube is to be used.

No calibration is provided, but a 0-100 vernier dial, 6-to-1 ratio, and directions given for calibrating against broadcasting stations.

Complete parts, diagram and calibration instructions free with a one-year subscription for RADIO WORLD (52 issues, one each week) at the regular rate, $6.00. Order Cat. PRE-ACOK.

Same as above, except for a tuned grid oscillator for battery operation, indicator-escutcheon of smaller size, with high audio frequency modulation, and requiring 3-volt dry battery and 22.5 volt B battery (not furnished). Tube (not supplied) is the '30. Free with one year's subscription at $6. Order Cat. PRE-BATOK.

[*Those desiring wired, calibrated models are asked, please, to read the details in the opposite column.*]



The modulated oscillator has vernier dial calibrated directly in frequencies, covering broadcasts and intermediate. The tube is inserted by removing the panel. Output post is at left, ground post at right.

WIRED

(Calibrated)

THE built-up a-c operated modulated test oscillator has dial calibrated in broadcast frequencies (little above 1500 kc to little below 540 kc), and also has the calibration, on another tier of the same scale, of the principal commercially used intermediate frequencies, e. g., 115, 130, 172.5, 175, 177.5, 260, 400, and 450 kc. There is no need to read a numerical dial setting and then refer to a curve to obtain the frequency, because, as stated, the frequencies are imprinted right on the dial scale, made possible by adjusting both for the capacity and the inductance in the construction of the oscillator. The frequency standards used in calibrating are accurate to better than 1 per cent., while the oscillator itself is accurate to a higher degree than a dial can be read. Moreover, the grid-stabilized circuit renders the oscillator accuracy immune from frequency change due to normal differences in a-c line voltage.

The parts alone are supplied by us on the basis of the kit offer (Cat. PRE-ACOK, see opposite column), while we would have the wiring and calibration done for you at a precision laboratory at $1.50 extra. If wired, calibrated a-c model is desired, send $7.50, of which $6 is for subscription (parts free) and extra $1.50 is turned over by us to the outside laboratory. Order Cat. PRE-ACOW.

The battery model (for '30 tubes), wired, calibrated, same terms as above. Order Cat. PRE-BATOW.

Necessary for Construction and Servicing

THE type of oscillators covered by the subscription premiums as listed above is exceptionally valuable, in that the fundamental frequencies are low, and therefore harmonics are readily useful. The intensity of oscillation is sufficient to provide a good response up to about the fiftieth harmonic, to establish a recognizable beat with a carrier of equal amplitude.

Primarily the oscillators are intended for service work and home, shop and school construction of receivers, and therefore the broadcast band calibration is given first preference as to detail, with frequencies in numerical order, while the intermediate frequencies registered are fundamentals or second harmonics of the oscillator, therefore will not appear in numerical order.

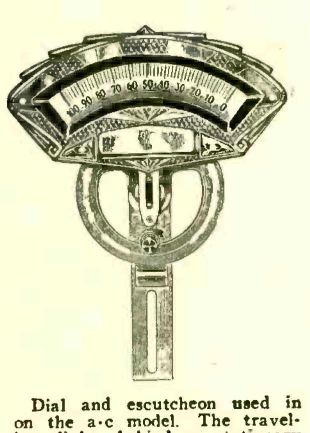
The test oscillators may be used for lining up tuned radio frequency sets, and also r-f, oscillator and intermediate frequency levels of superheterodynes. With the test oscillator as input, receivers may be lined up or otherwise tested either by listening or by using an output meter, since the modulation is steady.

Particularly in constructing and servicing superheterodynes are oscillators necessary. In fact, it is folly to attempt to build or service a superheterodyne without an oscillator.

While the intermediate and broadcast frequencies are stressed, of course the oscillator may be used for all frequencies up to the fiftieth harmonic (15,000 kc, 20 meters), but some idea of the frequency range of the tested circuit then is necessary, as well as some experience in determining harmonics.

While out of all comparison to the usual cost involved, these oscillators nevertheless are of a very high order of excellence, having been designed and developed by Herman Bernard, managing editor of RADIO WORLD, especially for subscribers.

Individual Parts for the Oscillators



Dial and escutcheon used in on the a-c model. The traveling light, behind a stationary scale, casts a shadow.

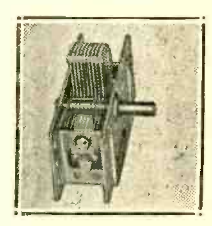
DIAL (a-c use). Traveling light type vernier dial, 6-to-1 ratio, enabling accurate dial reading because of projected shadow that prevents parallax. Equipped with bracket and 2.5-volt pilot light. The scale is stationary. The light and index move. Same dial takes ⅜ or ¼ inch shafts. Escutheon supplied. Sent free with a 16-weeks subscription (16 issues) at $2. Order Cat. PRE-DJDAC. and state whether condenser closes to left or right.

DIAL (battery use). On account of the high current drain of a pilot lamp the traveling light type of dial is not economically suitable for battery operation, therefore the same dial mechanism is used with self-visible outside pointer. The same dial takes ⅜ or ¼ inch shaft. Escutheon supplied. Sent free with a 16-weeks subscription (16 issues) at $2. Order Cat. PRE-DJDBAT and state whether condenser closes to left or right.

CONDENSER.. The tuning condenser used in the test oscillators is of 0.000375 mfd. maximum capacity. 23 mmfd. minimum capacity (not including equalizer capacity). The condenser, however, is equipped with a 35 mmfd. equalizer. Moreover, the brass shaft rotates in a ball race at front and back, thus giving the smooth turning for which ball bearings are noted. The aluminum plates close to the right. The frequency curve is approximately midline. The shaft is ⅜ inch diameter, ⅝ inch long. Sent free with three months subscription (13 issues, one each week) at $1.50. Order Cat. PRE-DJAS.

OSCILLATION TRANSFORMERS. For the a-c model a special combination of duolateral wound coils is used, consisting of two separate coils to be placed on end with holes through their dowel cores, enabling both to be mounted with a single screw. Sent free with an 8-weeks trial subscription at $1. Order Cat.. PRE-ACCH. For the battery model, $1 subscription, order Cat. PRE-BATCH.

FILAMENT TRANSFORMER. Primary, 105 to 120 volts; secondary 2.5 volts, not center-tapped. For 50-60 cycles. Free with $1.50 for three months subscription (13 issues, 13 weeks). Order Cat. PRE-FLT.



Here is an especially attractive offer of a 3-to-1 frequency ratio capacitance.

The tuning condenser used in the test oscillators has shaped plates that lend themselves admirably to the harmonic type of oscillators concerned, because of the better distribution of frequencies across the dial than ordinarily prevails. There are three bottom-mounting holes tapped for 8/32 and two plain holes for front panel engagement. The extreme plates are slotted for any special compensation the constructor desires to make.

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