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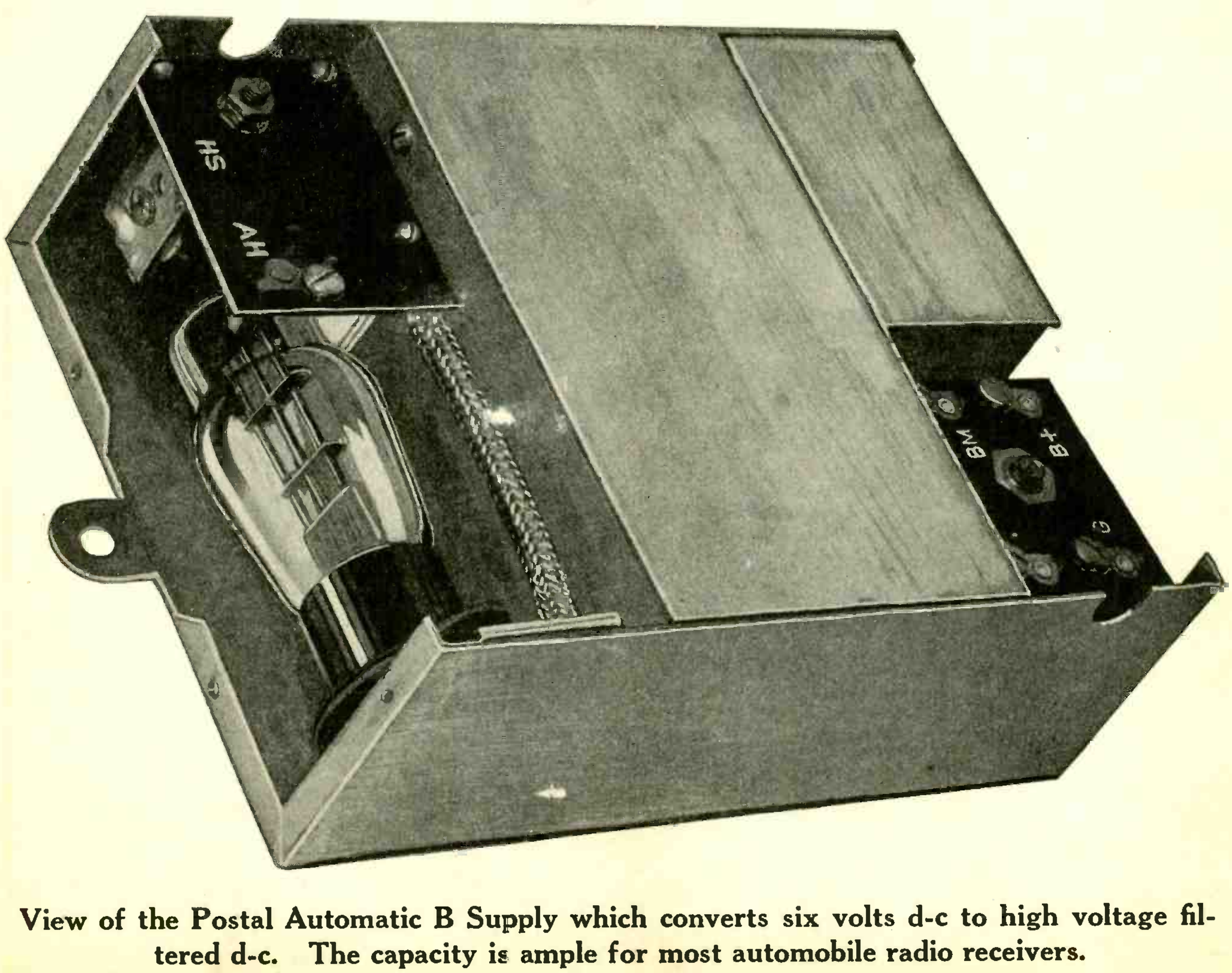

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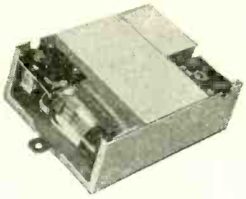

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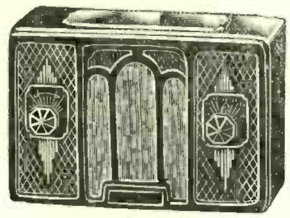

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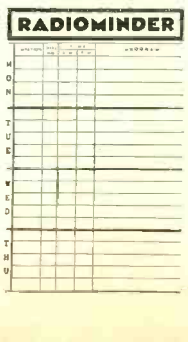

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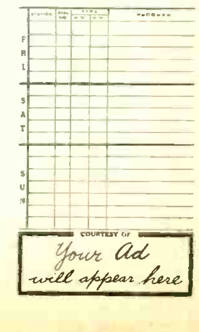

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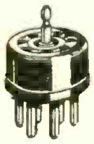

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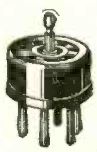

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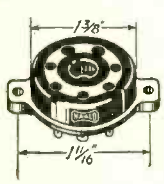

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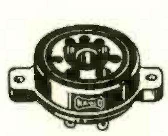

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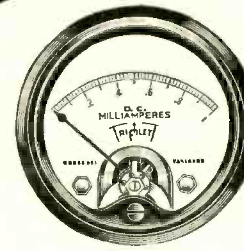

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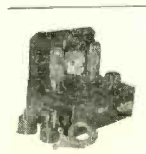

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ELEVENTH YEAR

J. E. ANDERSON
Technical Editor

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COUPLING METHODS

Familiar and Unfamiliar Designs and Their Objects

By J. E. Anderson

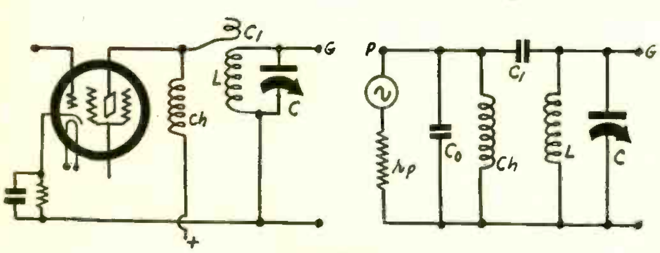


FIG. 1
A so-called high-gain coupler consisting of a plate choke, a plate to grid condenser, and a tuned grid impedance. At right is the equivalent circuit.

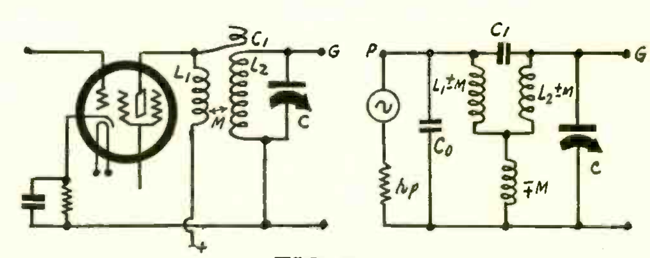


FIG. 2
This coupler is similar to that in Fig. 1, but the choke coil now is coupled inductively to the coil of the tuned circuit. The equvaleint circuit is shown at right.

COUPLERS between amplifiers are of many different types. Some are familiar while others are not. To understand what the various couplers do and why they do it, one must reduce them to equivalent circuits which show the various components in familiar relationships.

In many modern sets so-called high-gain couplers are used. The primary object of them is to increase the amplification on the lower frequencies in a given tuning range without losing the gain at the higher frequencies. In Fig. 1 is shown one of these couplers. At the left is the diagram as it appears on regular circuit drawings and at right is the equivalent circuit. In this r_p is the internal plate resistance of the tube, Co is the plate to cathode capacity, Cl is the capacity between the plate of the first tube and the grid of the second, L is the tuning inductance, C is the tuning capacity, and Ch a coupling choke.

The capacity Cl is that between an open turn or two of heavy wire over the grid end of the tuning inductance L. The value may be of the order of 10 mmfd. The equivalent circuit shows that this coupler is really of the direct type in which Cl is the stopping condenser, LC in parallel the grid impedance, and ChCo in parallel the plate impedance.

Why It Works

Why should this be effective on the lower frequencies when an ordinary transformer, secondary tuned, is not? The L/C ratio enters in the same way in the two cases and the smaller C is, that is, the higher the frequency, the greater is the value of L/C, and therefore the higher the voltage impressed on the grid of the second tube.

Moreover, Cl is in series with the line and therefore it will stop the lower frequencies more than it will the higher. We must look for some other effect to account for the higher gain on the lower frequencies. Co, the plate to cathode capacity of the tube, is across the line. It will therefore shunt the higher frequencies more than the lower. But this is a loss and not a gain. That is, the gain is cut down on the high frequencies rather than built up on the low. Ch is a radio frequency choke across the line. Its impedance is lower the lower the frequency and therefore that works exactly the opposite to the capacity Co. If we take the two together there is not much in favor of any frequency within the tuning band.

Yet the two taken together account for the desirable properties of the coupler. If Ch is chosen so that it forms a resonant circuit with Co at the low end of the tuning range, or just below, the plate impedance at the low frequency end is very high, and therefore the gain will be high. It will be built up actually rather than relatively. As the frequency is increased Co becomes more and more effective in shunting the high frequencies, but the rate of decrease is not great, because the capacity is very small. The impedance is kept up even off resonance by the fact that Ch is so large and the capacity so small.

It is clear that in order that the coupler in Fig. 1 be effective at the lower frequencies of the tuning range the inductance of the choke coil Ch must be chosen so that it forms a resonant circuit with the plate to cathode capacity of the tube just below the lowest frequency to be tuned in.

Inductive and Direct Coupling

Another coupler that is frequently seen in receivers is shown in Fig. 2. This is the same as that in Fig. 1 with the exception that the coupling choke is inductively related to the coil in the tuned circuit. The equivalent circuit of this arrangement is shown at the right of Fig. 2. Note that optional signs of M are indicated. As far as the coupler alone is concerned it makes no difference which sign is chosen but if the coupler is to be considered in conjunction with other couplers of similar design, then the sign must be taken into account.

The performance of the coupler in Fig. 2 is practically the same as that of the coupler in Fig. 1, with the exception that the mutual M makes the coupler somewhat more effective at the higher frequencies. The circuit CoL1 should be resonant at a frequency just below the range of the L2C tuner.

At left, Fig. 3, is a typical tuned grid coupler consisting of a primary L1, a secondary L2, a tuning condenser C, and mutual inductance M between L1 and

(Continued on next page)

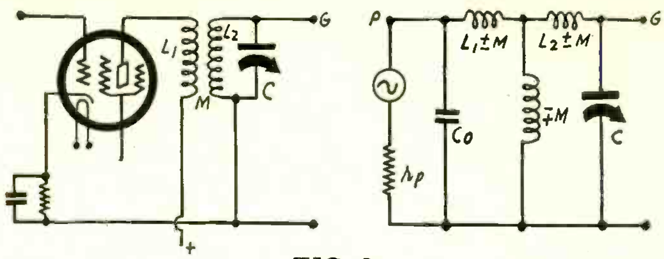


FIG. 3

A tuned grid coupler with its equivalent circuit. The plate to cathode capacity of the tube is represented by Co. This coupler is most effective on high frequencies.

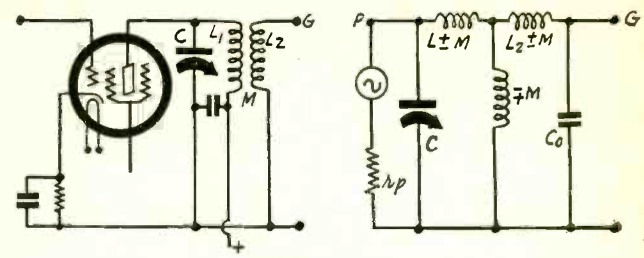


FIG. 4

A tuned plate coupler with its equivalent circuit. Here the grid to cathode capacity is represented by Co. This also is most effective on high frequencies.

(*Continued from preceding page*)

L2. The equivalent circuit is shown at right in the same figure, Co having been added to represent the plate to cathode capacity of the tube. The voltage that appears across the grid is proportional to the impedance of Co, to that of M, and to that of C.

In this coupler L2C is the tuned circuit. Since the signal voltage is induced in this circuit by mutual inductance the transfer is directly proportional to frequency and the frequencies at the high end are amplified much more than those at the low end. The distributed capacity Co, being across the line, tends to keep the gain on the high frequencies from increasing but it is so small that it has little effect.

Tuned Plate Coupler

In Fig. 4 is the tune plate coupler, which is practically the same as the tuned grid except that the two capacities have been reversed. The tuning capacity is now in the plate circuit and the distributed capacity Co is on the grid side. The gain when this coupler is used increases as the frequency goes up or as the tuning capacity goes down. The amplification at resonance is $uM/(L + RrC)$, in which u is the amplification constant of the tube, M the mutual inductance between the primary and secondary coils, L the inductance of the primary or tuned circuit, R the resistance of the primary coil, r the internal resistance of the tube, and C the tuning capacity across L. This neglects the effect of Co.

If the tube in question is a 58 the value of the amplification constant is 1,280 and the plate resistance is 800,000 ohms. The resistance of the tuning coil may be taken at 20 ohms and the inductance of the tuned circuit at 250 microhenries. Let us assume that the mutual inductance between the two windings is 25 microhenries. With these values the formula for the amplification reduces to $128/(1 + 0.064\,C)$, in which C is measured in micromicrofarads. This shows clearly that the amplification varies with the frequency, for C varies with frequency.

At 550 kc the value of C is 335 mmfd., assuming that the inductance is 250 microhenries. With this value of C in the formula the amplification is 5.7 times. At 1,500 kc the value of C is 45 mmfd. With this value of C in the formula the amplification turns out to be 33. The ratio of the amplification at 1,500 kc to that at 550 kc is 5.8 to 1.

No Criterion

The actual values of amplification obtained above should not be taken as figures of merit for this particular coupler because they depend on the assumed mutual inductance. It is quite possible to have a mutual inductance 10 times larger than that assumed, and then the amplification would be 10 times greater at all frequencies. But the ratio is true for all values of M. This shows that this type of coupler is not well suited to variable frequency receivers and also that in a fixed frequency receiver the condenser should be small and the inductance large. Further, the formula shows that the resistance of the tuned circuit should be small if the gain is to be high and fairly uniform, or that the plate resistance of the tube should be small.

The capacity Co between the grid and the cathode reduces the gain on the high frequencies a little so that the ratio is not quite so high as that obtained, but that it is far from unity is evident on every receiver equipped with this kind of coupler.

Tuned Plate, Tuned Grid

The tuned plate, tuned grid, or simply doubly tuned coupler is shown in Fig. 5. This is frequently used in intermediate frequency tuners and sometimes in radio frequency tuners. It is more adaptable to fixed frequency couplers and for that reason is almost standard in intermediate amplifiers. The circuit arrangement is given at left and the equivalent circuit at right in the figure.

If the two circuits L1C1 and L2C2 are tuned independently to the same frequency, that is, when one is not affected by the other, then there will in general be two frequencies at which the amplification is maximum, the distance between the two depending on the degree of coupling between the two coils, that is, on the value of M. The ratio of the two frequencies will be $(1 + k)/(1 - k)$, in which k is the coefficient of coupling. Because there are two maxima the coupler is usually rated as a band pass filter.

It is clear that the coefficient of coupling must be very small or the maxima will be far apart and the effectiveness of the coupler will be very low. Let us suppose that the frequency to be received is 175 kc and let the coupling be adjusted so that the two maxima fall at 170 and 180 kc. The $(1 + k)/(1 - k) = 180/170$, or k should be 1/35, or nearly 0.03.

Frequency Discrimination

While this coupler has two maxima the selectivity is excellent. The broadness is confined to the region immediately about the natural frequency of either circuit. Far off resonance the discrimination is high. Of course, this assumes that the coefficient of coupling has been made suitably low.

Even though the coupling must be loose, the gain with a circuit like this is usually very high as compared with the gain in the simpler couplers. Indeed, the coupling must be loose if the gain is to be high, to a certain point at least.

Constant Gain Couplers

By taking advantage of the fact that inductive and capacitive couplings work in opposite directions it is possible to make couplers with nearly constant gain over a given tuning band. For a given value of coupling inductance, whether mutual or self, the effectiveness of the coupling is directly proportional to the frequency. And for a given capacity coupling the effectiveness is inversely proportional to the frequency.

In constant gain couplers mutual and inductance capacity are used. One way is illustrated in Fig. 6. Here the tuned circuit is composed of L1, C, and C_m. The coupling between the secondary and the primary circuits is by the mutual between L1 and L2 and by C_m. The equivalent circuit is given at the right. It will be noticed that no choice of sign is offered in this instance. The mutual must be negative, for the reactance of C_m is negative and that of the mutual must have the same sense if the effects of the two are to operate in the same direction.

The condenser C_m will be the main coupler on the lower frequencies and the mutual M will be the main coupler on the higher frequencies. At some frequency between the extremes the coil and the condenser will be equally effective. This frequency is usually the geometric mean of the two extreme frequencies. For example, if the broadcast band extend from 540 to 1,500 kc, the geometric mean would be 900 kc.

Computation of Gain

The gain at resonance of the circuit in Fig. 6 is given by $u(C_mM + CL)/C_m(CrR + L)$, in which u is the amplification of the tube, C_m the coupling capacity, M the mutual inductance between the two coils, C the tuning capacity, L the tuning inductance, r the internal resistance of the tube, and R is the resistance of the tuning coil. The capacity Co is neglected.

In order to make the gain practically constant it is necessary to choose C_m and M properly. It is noticed that if $C_mM = L^2/rR$, the expression for amplification reduces to uL/rRC_m and it actually is independent of frequency. If $u = 1{,}280$, $L = 250$ microhenries, $r = 800{,}000$ ohms, and $R = 20$ ohms, the amplification reduces to $20{,}000/C_m$, the capacity being expressed in micromicrofarads. Therefore the gain depends on the coupling capacity.

If we are to retain selectivity we cannot make the capacity small and therefore we must be content with a moderate gain. In view of the small gain when the coupling capacity is large, it would seem that this constant gain coupler is of little practical use unless the resistance of the coil or the internal resistance of the tube, or both, can be made much smaller without at the same time making the amplification constant small. The resistance of the coil can be made smaller without trouble. Suppose that instead of 20 ohms it is only 2 ohms. In that case the gain becomes $200{,}000/C_m$ and the gain will be 200 even if we use a 1,000 mmfd. coupling condenser.

Tuned Grid Constant Coupler

The constant gain coupler may also be used in the tuned grid form. The circuit diagram and the equivalent circuit are the same as those in Fig. 6 except

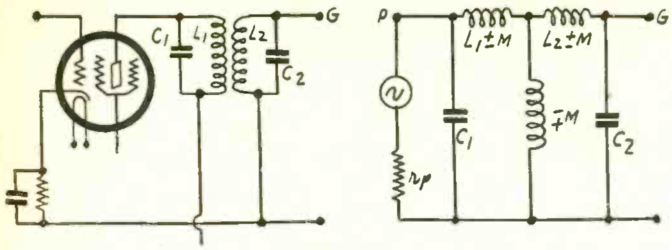


FIG. 5

A doubly tuned coupler in which both the plate and the grid coils of the transformer are tuned. Coupling must be loose for selectivity.

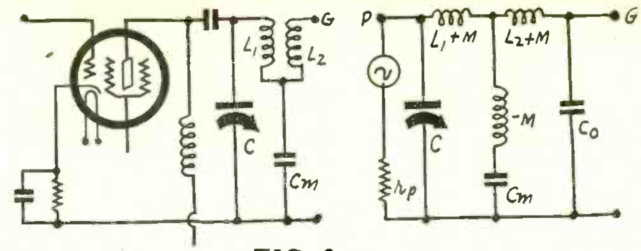


FIG. 6

A constant gain coupler in which mutual inductance and capacity coupling are combined. Under certain conditions the coupling is entirely independent of frequency.

that C and Co are interchanged. The transmission characteristic is not greatly different from that of the tuned plate circuit.

The fact the tuning condenser may be put either on the plate or the grid side of the coil suggests the possibility of putting a tuning condenser on each side. The coupler would then become doubly tuned and would be like that in Fig. 5, except that in series with minus M would be a condenser C_m. Loose coupling would then not be inconsistent with high gain.

In the constant gain coupler the mutual inductance was negative. What will happen if we make it positive? Referring to Fig. 6 we note that M and C_m are in series across the line. If M is positive it is possible to have a zero impedance shunt, which would occur when $Mw = 1/C_mw$. That, of course, would not do if the gain is to be constant. However, there are certain cases where a tuned shunt is useful. For example, suppose it is desired to suppress a certain frequency among many that are wanted. It would only be necessary to make the mutual positive and to adjust the values of M and C_m until the two resonated at the frequency to be suppressed. Such shunts are often used but in most cases the inductance is an actual coil instead of the mutual between two coils.

The coupling arrangement just discussed has been used for the measurement of frequency. Mutual inductance is easily measured accurately and capacity is also measured without much trouble. Hence the shunt M and C_m in Fig. 6 can be used for determining frequency. It is said to be more accurate because there is no resistance involved in the effective tuned circuit. Such circuits are popular.

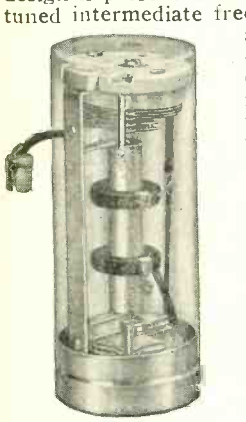
Standard Resistor Code

For First or Second Significant Figure		*Number of Ciphers After the Significant Figures*
Black	0	None
Brown	1	0
Red	2	00
Orange	3	000
Yellow	4	0000
Green	5	00000
Blue	6	000000
Violet	7	——
Gray	8	——
White	9	——

The color for the first or second significant figure follows this code: body color denotes first significant figure; end color denotes second significant figure; dot denotes number of ciphers after the first two significant figures.

Air Dielectric in New Intermediates

A radical departure from the present design is presented in a new group of air-tuned intermediate frequency transformer and oscillator units developed by the engineering department of the Hammarlund Manufacturing Company, 424 West 33rd Street, New York City. These special units, now being used in the Comet "Pro" high-frequency receiver, have been engineered to meet the growing demand for a superior component capable of meeting the precision requirements imposed by modern receiving systems designed primarily for use by experienced amateurs, professionals and advanced experimenters.



The transformer is of the tuned primary-tuned secondary type, with both plate and grid coils being tuned by air-dielectric variable condensers of special design. These condensers are mounted on an Isolantite panel 1 15-16 inches in diameter. The rotor is carried in a single bearing in the Isolantite panel and consists of two circular and three semi-circular brass plates of 3/4 inch radius riveted to the rotor shaft.

Tension Strong Enough

The stator, also of brass, consists of two circular and two semi-circular plates soldered to stator support rods which in turn are soldered in the bushings in the Isolantite panel. Contact is made to the rotor plates by phosphor bronze spring under considerable tension. No locking device is necessary, as the tension of the contact spring is sufficient to maintain the setting of the rotor even where extreme vibration is present. A screwdriver slot is provided in the end of the rotor shaft to facilitate tuning.

The use of these air variables practically eliminates the variations in gain and selectivity inherent in intermediate transformers in which the coils are tuned by means of adjustable condensers of the compression type using mica as dielectric. Even when such condensers are built on Isolantite bases and the highest grade mica is used, variations in temperature and relative humidity cause changes in both the capacity and power factor sufficient to render them unsuitable for use in precision equipment. The change in capacity is especially troublesome in transformers operating at the higher intermediate frequencies where a given percentage change in capacity causes a relatively great change of intermediate frequency, when expressed in kilocycles.

Frequency Variation Corrected

For instance, variations in capacity of as much as 3% between the six compression type mica condensers used in a two-stage (three-transformer) intermediate amplifier are not uncommon during a spell of high relative humidity. Since the percentage change of resonant frequency of a circuit is equal to one-half the percentage of capacity, for small changes only, this represents a frequency drift of 1½% or 7 kc in the case of a 465 kc amplifier such as is used in the "Pro." A large increase in losses invariably accompanies this capacity change due to moisture absorption. The mistuning plus the increase in power factor causes a marked decrease in both selectivity and amplification.

Accordingly, these air condensers provide increased selectivity and sensitivity since the peak setting is constant regardless of temperature or atmospheric conditions. Their use in the "Pro" provides a sensitivity better than ¼ microvolt per meter and high selectivity.

Frequency Stability

ABOUT how much does a radio frequency oscillator vary in frequency due to changes in the plate, filament, and grid voltages? I know it varies with the oscillator, but I just want an approximate value. State some specific examples, if possible.—P. C., Bronx, N. Y.

Some vary a great deal and others don't vary much. In one well-known oscillator in which the grid bias is such that no grid current can flow during any part of the cycle, the ratio of the actual frequency to the intended frequency is $1 + R/4r$, in which R is the resistance of the oscillating coil and r is the internal plate resistance of the tube. When the oscillator is first turned on, r is infinite and the frequency would be equal to the natural frequency of the circuit. That is, there is no deviation. We may assume that when the circuit starts oscillating, the resistance is still so high that $R/4r$ may be neglected. Now when the tube has settled down to steady operation, the plate resistance r may be 7,500 ohms. Then if the resistance of the oscillating coil is 10 ohms, the value of $R/4r$ is 1/3,000. Therefore, we may expect a change of frequency of one part in 3,000. If the oscillator generates a frequency of 1,000 kc, the total possible variation in frequency would be 3,333 cycles. In practice, of course ,the variation will be less. If the grid current had not been negligible to total variation might have been as high as 30,000 cycles, which is equivalent to 3 per cent. That the instability of the ordinary oscillator is more nearly of the order of 3 per cent. than one part in 3,000 is obvious when a test is made. Suppose two oscillators are tuned to zero beat. Then one of them is turned off by cutting off the heater current only. While the fifth heater is cooling, the beat note rapidly changes from zero to one above audibility. Therefore, the total change amounts to more than 10,000 cycles.

Modulator-Oscillator Tube Utilizes Electron Coupling

By Frank C. Raleigh

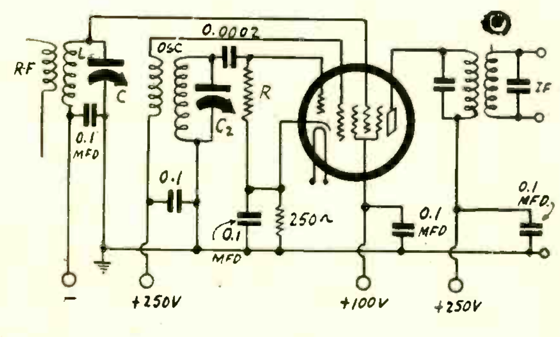


FIG. 1
A mixer circuit utilizing the new pentagrid tube in which one part acts as oscillator and another part as detector, the coupling between the two being electronic.

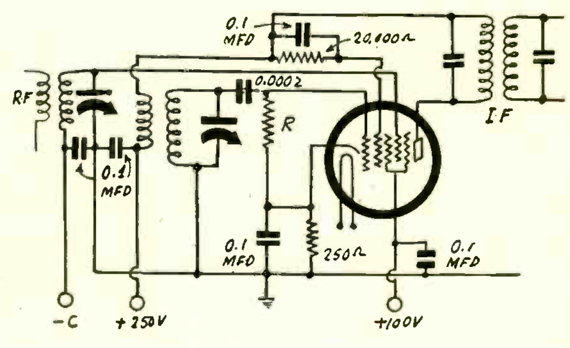


FIG. 2
A modified mixer circuit using the pentagrid tube. More uniform oscillator output is the advantage. The tickler here carries the current from both anodes.

THAT electron coupling for frequency changers in superheterodynes and converters should come was inevitable. But it was a long time coming, a long time after it was first suggested and after the superheterodyne was invented.

Van der Bijl reports in his book written in 1920 that Heising has used vacuum tubes with two and more grids for the purpose of modulation. One signal was put in at one grid and the other at the other. Both grids affected the plate current in such a way that the output of the tube was modulated. This idea of modulation by means of two grids has been applied to tubes already available. Thus when the oscillation from a local oscillator is applied to the screen grid of a screen grid tube and the signal is impressed on the regular control grid, the double grid method of modulation is used. In this case, however, the screen grid takes some current.

The same idea was applied to pentodes with accessible suppressor grid. Thus the 57 and the 58 were used for mixing by putting the oscillation in at the suppressor grid and the signal at the control grid. This had the advantage that the suppressor grid could be biased so that it would not draw any current.

Variable Emission

The application of electron coupling to mixing now has been carried a step farther by modulating the oscillator by means of an extra grid. This idea is also applicable to tubes having a plurality of grids. The tube can be used as oscillator in any one of several well-known oscillator circuits and the radio signal can be applied to one of the grids, for example, the suppressor grid in the 58.

No longer is there any need for such makeshifts, for special tubes have been developed for the dual function of oscillation and frequency changing. These tubes have many more grids than the ordinary tubes. Indeed, one tube has five grids and is called a pentagrid. It is a seven-element tube and for that reason should be called a heptode. The tube is first of all an oscillator and then it is a modulator.

The development of this tube is parallel to the development of the duplex diode triode. It will be recalled that a leaky condenser type of triode detector is a diode rectifier plus an audio amplifier. However, the flexibility of this device as a detector and amplifier was limited by the fact that the grid acted both as rectifier anode and as amplifier control grid. The duplex diode triode separated the functions of the grid-anode. One element was used for control grid in the audio amplifier and two other elements were used as anode in the rectifier. The separation permitted the operation of each under optimum conditions. This was a noteworthy advance.

Autodynes

Paralleling the old leaky condenser detector was the autodyne oscillator. It served first as an oscillator and then as a frequency changer. The dynatron was used for this purpose, but lately the 58 and the 57 have been used with better success. Similar tubes like the 239, 236 and the 224 have also been used. When these are used as autodynes electron coupling is not employed.

Now we have the next development in which the same tube is used as oscillator and frequency changer with electron coupling. There are, in a sense, two independent tubes except that they have the same cathode, just as the diodes and the triode in the detector share the same cathode.

The action of one of these frequency changers can be understood by considering the electron stream from the cathode. Suppose the tube were hooked up as an oscillator and then the cathode temperature were changed periodically. The output of the oscillator would then be modulated. The method of modulation would work all right if the modulating frequency were slow enough. For higher modulating frequencies it would be necessary to find some other means of controlling the cathode stream.

Explanation of Operation

Suppose we have a tube structure in which there are two grids close to the cathode, the closer one being used as control grid and the other as anode in an oscillating circuit. Also suppose there are other elements outside of these elements, a shielded control grid, a screen grid, and a plate. If the inner circuit were not oscillating the outer elements would act as an amplifier or bias detector, depending on the bias. Without any oscillation there would be a steady stream of electrons to the plate through the various grids. When the inner structure is oscillating the stream would be modulated by the frequency of oscillation. In other words, the cathode and two inner grids could be regarded as a complex cathode in which the emission varied with the frequency of oscillation.

This variable emission can be controlled with another grid on which a radio frequency signal impressed, just as a steady stream of electrons can be controlled by means of a grid. The coupling is primarily potential for only the potential of the control grid varies.

Typical Circuits

In Fig. 1 is a circuit showing one method of utilizing the pentagrid tube. If the grid next to the cathode is considered the control grid of a triode and the next grid is considered the anode, then the cathode and these two grids form the three elements in an oscillator of which L2C2 is the resonator. L1 is the tickler and R is the grid leak. The oscillator circuit is typical with the exception that the form of the plate is that of a grid which can let electrons get through to the outer elements.

There is a 250-ohm bias resistor, shunted with a 0.1 mfd. condenser, in the cathode lead. Its purpose, of course, is to bias a grid, but it does not affect the potential of the grid of the oscillator.

Outside the oscillator elements is a screen grid, a control grid and a plate. In the circuit of the control grid is a resonant circuit composed of an inductance L and a capacity C. These are tuned to the signal frequency. The control grid is biased by means of the 250-ohm resistor for it is placed between the cathode and the return of the grid. Actually the grid return is not made to ground by some negative voltage, which may be signal varied as in the case of automatic volume control. The 250-ohm resistor may be regarded as fixing the minimum bias.

In the anode circuit of the tube is the intermediate frequency load impedance, which consists of a regular doubly tuned r-f transformer. The frequency conversion efficiency may be varied by varying the bias on the control grid. By conversion efficiency is meant the ratio of i-f voltage output to the r-f input voltage.

Circuit Modification

Fig. 2 shows a modification of the same circuit, and an improvement. It differs from the first only in the connection of the plate to the voltage source. In Fig. 1 the connection is direct whereas in Fig. 2 the plate return is connected so that the r-f and oscillating currents that reach the plate are passed through the tickler. There is also a voltage dropping resistance of 20,000 ohms in series with the oscillator anode lead. This circuit is supposed to have a more uniform output than that in Fig. 1.

It should be noticed that when the connection in Fig. 2 is used the arrangement is about the same as if the 58 were used as previously suggested. That is, the control grid would be used for control grid of the signal and the suppressor would be used as oscillator control grid. The plate would be the common anode for the oscillator and the mixer and it would also contain the i-f transformer just as in Fig. 2. This similarity of arrangement does not mean that the new tube is not superior as an oscillator-mixer. It should be kept in mind that it has been designed especially for this service whereas the other tube was designed especially to perform a different function.

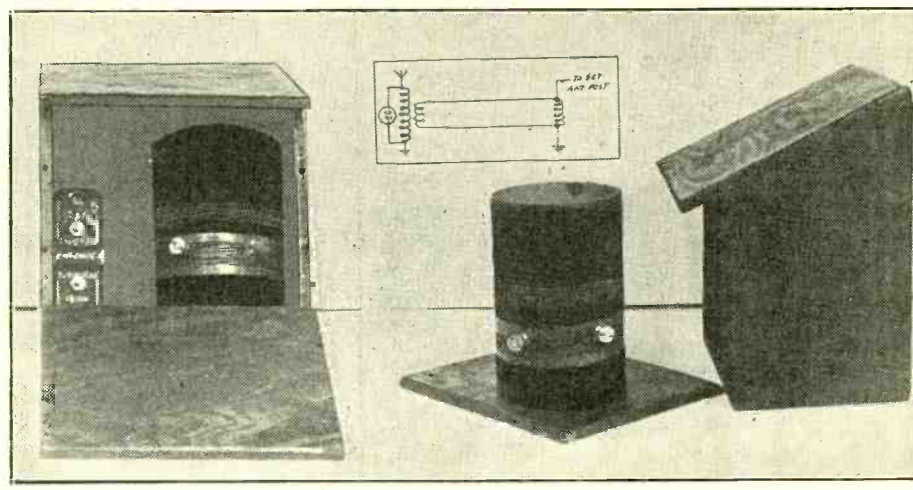
Voltages on Elements

The new tube has been built both for 2.5-volt and 6-volt service so that it can be applied to automobile, a-c operated, and d-c operated receivers. The maximum voltage on the plate and grid No. 2 is 250 volts and the maximum on the screen, or on grids Nos. 3 and 5, is 100 volts. If the voltage on the anodes is lower that on the screen is almost proportionately lower. If the anode voltage is 100 volts, as it might be in a d-c operated receiver, the screen voltage should be 50 volts. The grid leak resistance also depends on the voltages applied to the anode and the screen. It varies from about 100,000 ohms to 10,000 ohms, the lower values being used with the lower voltages.

The 2A7 and 6A7

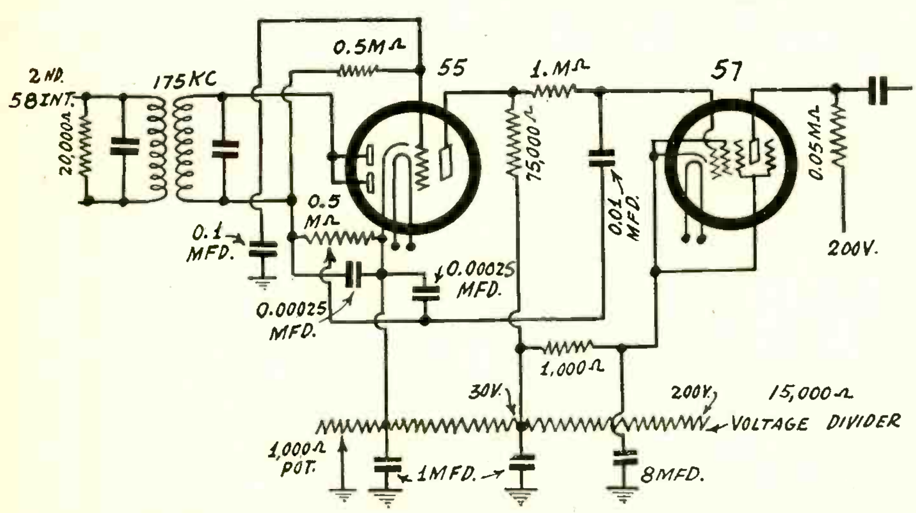
The new tube, called the 2A7 for 2.5 volts and 6A7 for 6.3 volts heaters, will require seven-contact sockets and a grid clip. Grid No. 4, which is the control grid of the radio frequency signal in a mixer circuit, is brought out at the top, while all the other elements are brought out in the base. Grids Nos. 3 and 5 are joined inside the tube and are brought out at the same prong in the base.

LONG-LINE TRANSMISSION



If a long transmission line is to be used, the effect of the length can be virtually eradicated by matching impedances. Hence (above) the secondary at left should be the same as the primary represented at right. Suitable housing may be provided for the impedance—matching coupler.

EXPERIENCE



How F. M. Tibbitts gets good noise-suppression results. He uses a 1,000-ohm-potentiometer to vary the suppression practically from zero to total blanking of all reception.

I HAVE BUILT a set consisting of a 58 r-f, a 57 first detector, a 56 oscillator, two stages of 175 kc intermediates (58 tubes), a 55 full-wave second detector, a 57 noise suppressor and output audio, with 280 as rectifier. Automatic volume control is tied to the r-f and i-f tubes.

I have found by experience that a circuit modification brings better results.

First, to avoid oscillation in the intermediate stages I put a 20,000-ohm resistor from plate B plus of the second intermediate tube, that is, across the primary of the last intermediate transformer. This seems better than increasing the cathode resistors. I am using a 300-ohm resistor in the cathode of the r-f stage and a 200-ohm resistor common to the cathodes of the intermediates, both of course by-passed.

Most diagrams show the cathode of the 55 connected to ground. I find that connecting it about 300 ohms from the grounded end of the voltage divider gives much better leveling of signals.

I found that with the cathode of the 55 grounded the noise suppression adjustment would cut out weak stations along with the between-station noise. As a noise suppression adjustment I tried a variable resistor in the plate of the 55, also tried varying the voltage on the 55 plate. This gave fair results.

The best solution I have found for good leveling of stations and good control of noise suppression was to put a 1,000-ohm potentiometer between the low end of the voltage divider and ground, connecting the movable arm to ground and one side of potentiometer to voltage divider and to cathode of the 55.

On page 14 of the March 4th issue you show 1,000-ohm resistor so connected. I have simply made this variable and thereby adjust to get what signal level I want and thus choose the degree of noise suppression.

With no resistance in, WJZ, a strong local, will be cut out. At 200 ohms all the locals and very strong distance stations will come in. With about 500 ohms every station substantially above the noise level as well as static and strong interference will come in. With much over 500 ohms there is no noise suppression.

Obviously these values will vary, depending on the bleeder current in the voltage divider, the plate resistor of the 55 triode and the voltages applied. I am using 75,000 in this plate and about 30 volts. The voltage divider is about 15,000 ohms with about 200 volts at the high end. Incidentally, I have found a filter in the triode grid absolutely necessary to get good manual volume control.

F. M. TIBBITTS,
333 East Fifty-third Street,
New York, N. Y.

Five Automotive Tubes in A BATTERY RECEIVER

By Warren J. Goodwin

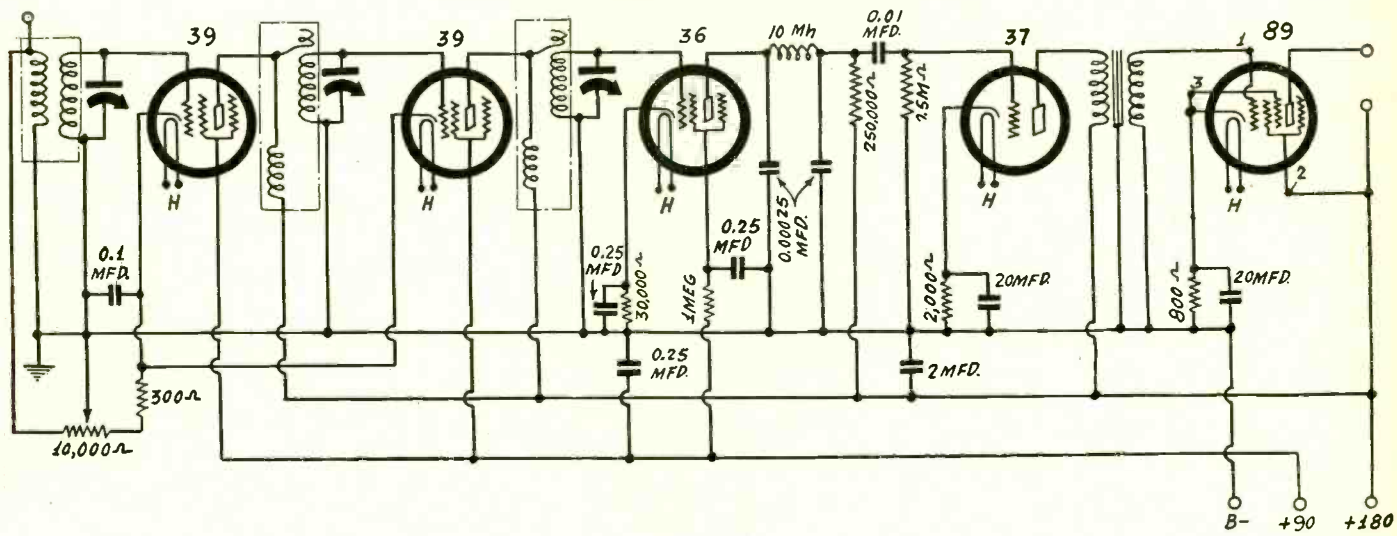


FIG. 1
This five-tube receiver is suitable for operation on batteries where a storage battery is available for the heater current. The use of B batteries is quite feasible.

ALTHOUGH this receiver employs five automobile type tubes, it is not supposed to be an automobile set. It does not have sufficient gain for the possible pick-up in the average car. Neither has it automatic volume control, which is now practically a necessity in a car receiver. The circuit is designed for those who live in non-electrified regions and who want a receiver comparable to a-c receivers, that is, a receiver that will put out considerably more sound power than sets using the small battery tubes, or even the larger battery tubes. The receiver has been requested by many.

The circuit may be operated with batteries throughout. Yet the design is such that it can also be operated on alternatin gcurrent, provided a suitable heater and rectified plate voltage are available. No change whatsoever is needed when switching from a. c. to batteries, or vice versa. The heater circuit H requires a six-volt storage battery or a six-volt transformer.

High Gain Couplers

The tuner contains through tuned circuits, all controlled by a single dial. The first r-f transformer is of the type usually referred to as an antenna coupler, which is a plain r-f transformer with a large primary winding. The next two are what are known as high gain couplers. These are not transformer at all by direct couplers, with a choke in the plate circuit o fthe first tube, a parallel tuned circuit in the grid circuit of the next tube, and a small condenser between the plate and the grid. This condenser is the capacity between a turn of large wire wound near the grid end of the tuned coil. The single turn is open so that it is just a simple form of a condenser.

The high gain feature of these couplers arises from the fact that the choke coil is chosen so that it resonates with the plate to cathode capacity of the tube ahead of the coupler at a frequency just below the lowest frequency covered by the tuner. The rated plate to cathode capacity of the 239 tube is 10 mmfd. A choke coil that would be suitable would have a capacity of about 5 mmfd., counting not only the capacity of the coil but that of the leads used in wiring it into the set. Thus the total capacity would be 15 mmfd. The frequency of resonance of this capacity and the coil might be 500 kc. Then the inductance of the choke should be 6.76 millihenries. The coils used have been determined experimentally to give the best results all around. It so happens that for one tube of the pentode type will work with another, because these tubes have nearly the same plate to cathode capacity and the tuning is not critical. The resonance point must fall below the lowest frequency of the tuner for otherwise oscillation trouble might be encountered at the low end of the tuner.

LIST OF PARTS

Coils

One shielded antenna coupler for 350 mmfd. condenser.
Two high gain r-f couplers for 350 mmfd. condensers.
One 10-millihenry choke coil.
One a-f transformer.

Condensers

One gang of three 350 mmfd. tuning condensers.
One 0.1 mfd. by-pass condenser.
Three 0.25 mfd. by-pass condensers.
One 2 mfd. condensers.
Two 20 mfd. electrolytic condensers, 30 volt rating.
Two 0.00025 mfd. condensers.
One 0.01 mfd. condenser.

Resistors

One 10,000-ohm volume control potentiometer.
One 300-ohm bias resistor.
One 30,000-ohm bias resistor.
One 800-ohm bias resistor.
One 2,000-ohm bias resistor.
One 250,000-ohm resistor.
One 0.5 megohm grid leak.
One 1-megohm resistor.

Other Requirements

Four grid clips.
Four five-contatc sockets.
One six-contact socket.
One vernier dial .
One dynami cspeaker with 6-volt field.
Two binding posts.
One three-lead voltage supply cable.

Controlling Volume

Controlling the volume is done in this set exactly as it is done in regular a-c operated sets. A potentiometer of 10,000 ohms is connected between the antenna and the cathode returns of the two 239 r-f amplifiers, the slider being connected to ground. A common 300-ohm bias resistor is used for the two tubes to limit the minimum bias to about 3 volts. A condenser of 0.1 mfd. connects the cathodes to ground for radio frequency currents so the common bias resistance entails no appreciable coupling between the two tubes.

The 236 detector has been designed to give maximum sensitivity with good quality. Correct grid bias is one essential for good detecting efficiency. The bias is provided by a 30,000-ohm resistor in the cathode lead, which has been found experimentally to give good results, provided that the plate and the screen voltages are properly adjusted.

It is always good practice to have the highest available voltage in the plate circuit of the detector and to prevent excessive current by means of a high load resistance. In this case the voltage is 180 volts and the load resistance is 250,000 ohms. The high voltage prevents overloading on strong signals and the high resistance insures that a large proportion of the detected voltage is impressed on the next tube.

In order that there should be no distortion in the detector, indeed, that there should be detection, it is necessary to insure that the screen voltage never exceeds the effective plat voltag. Since the effective plate voltage falls as the signal increases, there should be a corresponding drop in the screen circuit. For that reason a one megohm resistor is con-

(*Continued on next page*)

PUSH-PULL WIRING

By Conrad Forbes

IN wiring push-pull amplifiers it frequently occurs that the secondary leads are wired incorrectly. The reason is that the leads are not clearly marked and there is no visual way of telling which is the center tap and which are the two extreme terminals. Making this error makes a great deal of difference in the performance of the set.

Suppose one of the extreme terminals of the winding is mistaken for the center tap. Then one of the tubes gets the other extreme and the other gets the real center. The voltage impressed on one tube is twice that impressed on the other, and the two voltages are in phase. The fact they are in phase is more detrimental than the fact that the voltage is twice as great on one tube as that on the other.

What happens in the plate circuit when the input leads have been connected in this manner? Well, the output transformer, let us assume, has been connected correctly. Then the output is differential. That is, the current in the secondary of the output transformer, which gives rise to sound, is due to the difference between the currents flowing in the two halves of the primary, or the difference between the two plate currents. This is true even if the secondary of the input transformer has been connected in the wrong way.

Differential Output

When the grid voltage of one tube is twice that of the other the change in the plate current will also be about twice. If the change in plate current in the tube with the double voltage is 2I then the change in the plate current of the other tube is I. The current in the secondary of the output transformer is proportional to the difference, or to I. This is the amount that one of the tubes is able to send through in opposition to the other tube, which itself sends through I. The current in the secondary of the output transformer is proportional to 2I—I.

When the secondary of the input transformer has been wired correctly the input voltage to one tube is E and that to the other is —E, the two being exactly equal in value but opposite in direction. The current in the plate circuit of one tube is I and that in the other is —I. These two are equal and opposite. The current in the secondary of the output transformer is proportional to the difference between these currents, or to I— (—I), which is equal to 2I.

Thus when the transformer is connected correctly the output is twice as great as when it is connected incorrectly. One would suppose that this difference would hardly be noticeable since there is only a difference of about 6 decibels. But there is a greater difference than that. The distortion in one case amounts to a very large percentage of the total output whereas in the case of correct connection it amounts to very little. Therefore the wrong connection is first noticed by the fact that the signals are greatly distorted.

Error Detection

It is a simple matter to test the connections even if the secondary terminals are not clearly marked. If the center tap is accessible, measure the resistance between the center and each of the two extremes. These extremes are usually available at the caps of the tubes. If not, they are accessible at the sockets if the tubes are removed. The two resistances should be very nearly equal. If there is a wide difference chances are that the terminals have been connected wrongly. As a check measure the resistance between the two grids, or between the two supposed extreme terminals of the terminals. The resistance between the grids should be twice as great as between either grid and the center tap.

The test may be made with a voltmeter just as well as with a resistance meter provided that the resistance in the meter is of about the same magnitude as the resistance of the transformer. If the voltage of a battery is first measured directly and then measured through the resistance to be measured, an approximately value of the resistance can be obtained from the drop in the voltage. Indeed, if the only object is to discover the error in the winding it is only necessary to note between what two points the drop is greatest. For example, we may have a 0-6 voltmeter and a 3 volt battery. If the grid-to-grid circuit is included in the meter circuit the reading will not be three voltage, but perhaps only 1 volt. Then there has been a drop of 2 volts. Now if the voltage between the center tap, supposedly, and either grid be measured the drop in the voltage should be only 1 volt. If it is one volt between the center tap and either grid and two volts between grid and grid, then we may be reasonably sure that the connections are correct.

Testing Plate Circuit

It is possible that the input terminals are connected correctly and that the trouble lies on the output side. Sometimes output transformers, even though they be built into loudspeakers, may not be marked clearly. The result will be about the same as if the input side were incorrectly wired and the output side were correct. The test for this condition is the same as the test on the grid side. The highest resistance should now be between the two plates and the resistance should be only one half between either plate and the terminal that is connected to B plus. The resistance of the primary of the output transformer is likely to be much lower than that of the secondary of the input transformer, but the test may be made with the same meter. It is only necessary to observe deflections a little more closely to note the differences.

If there is any appreciable distortion in the output of the push-pull amplifier on moderately loud signals it is well to make the test of both the input and the output circuits, for if there is an error on either side the distortion will be severe.

A T-R-F Battery Receiver

(*Continued from preceding page*)

nected between the creen and the 90 volt tap on the battery.

A by-pass condenser of 0.25 mfd. across the bias resistor removes the r-f ripple as well as most of the audio from the bias resistance. A condenser of like capacity is connected from the screen of the tube to ground to maintain the screen voltage steady.

The Audio Amplifier

Following the detector is a low pass filter consisting of two 250 mmfd. condensers and one 10 millihenry choke coil. This helps not only to remove the radio frequency ripple but also to remove unwanted noises in the signal, noises having a frequency near the upper limit of audibility.

The coupling condenser between the plate and the grid is 0.01 mfd. and the grid leak of the first a-f tube is 0.5 megohm. These values are ample to insure the amplification of the low audio notes and the leak is low enough to insure that blocking shall not occur.

The 237 is biased by means of a 2,000 ohms resistor in the cathode lead. This resistor may be increased to 2,500 ohms, if desired. The result will be a greater saving in current. However, the gain will be less and that more than offsets the other advantage. An electrolytic condenser of 20 mfd. is put across the resistor to prevent reverse feedback.

Transformer coupling is used between the 37 and the output tube in order to get a higher gain. A ratio of about 2.5 to one should be all right.

Output Stage

The output amplifier is an 89 pentode, which, with 180 volts on the plate and the screen, is capable of putting out 1.5 watts with the usual low distortion. This supposes that the output transformer, which is usually built into the loudspeaker, has an impedance of 8,000 ohms. The signal voltage, peak value, required for this output is only 18 volts. There is no trouble getting this voltage on the grid even for very weak signal voltages at the antenna.

In view of the fact that the filaments may be heated with a six-volt storage battery, the field winding of the speaker should also be wound for six volts. It would be uneconomical to take the field power from the B battery. Of course, if the speaker has a six volt field it cannot be used when the tubes are heated with a-c. But the set will be built for one supply or the other and the speaker should be selected to suit the supply available.

The grid bias on the power tube should be 1 8volts, approximately. It is obtained through an 800-ohm resistor in the cathode lead. If the resistance is only 750 ohms it is all right, for the nominal value comes between these two values. If plate current must be saved, and that is likely if the set is to be used in a place remote from sources of supply, then the higher values should be employed. Indeed, it might be increased a little.

By-passing

The condenser across the bias resistance in this case is also 20 mfd. electrolytic.

A 0.25 mfd. condenser is put across the 90-volt supply to give the r-f currents a low impedance path to ground. A 2 mfd. by-pass is put across the high voltage as an aid against motorboating when the batteries near exhaustion. A much larger condenser would stave off motorboating a little longer, but if the batteries are so low as to require more by-passing, they are not worth keeping, for the sensitivity of the set will be low and the quality will be bad.

Full-Wave Automatic Postal "B" ELIMINATOR

By R. Epstein
Postal Radio Corporation

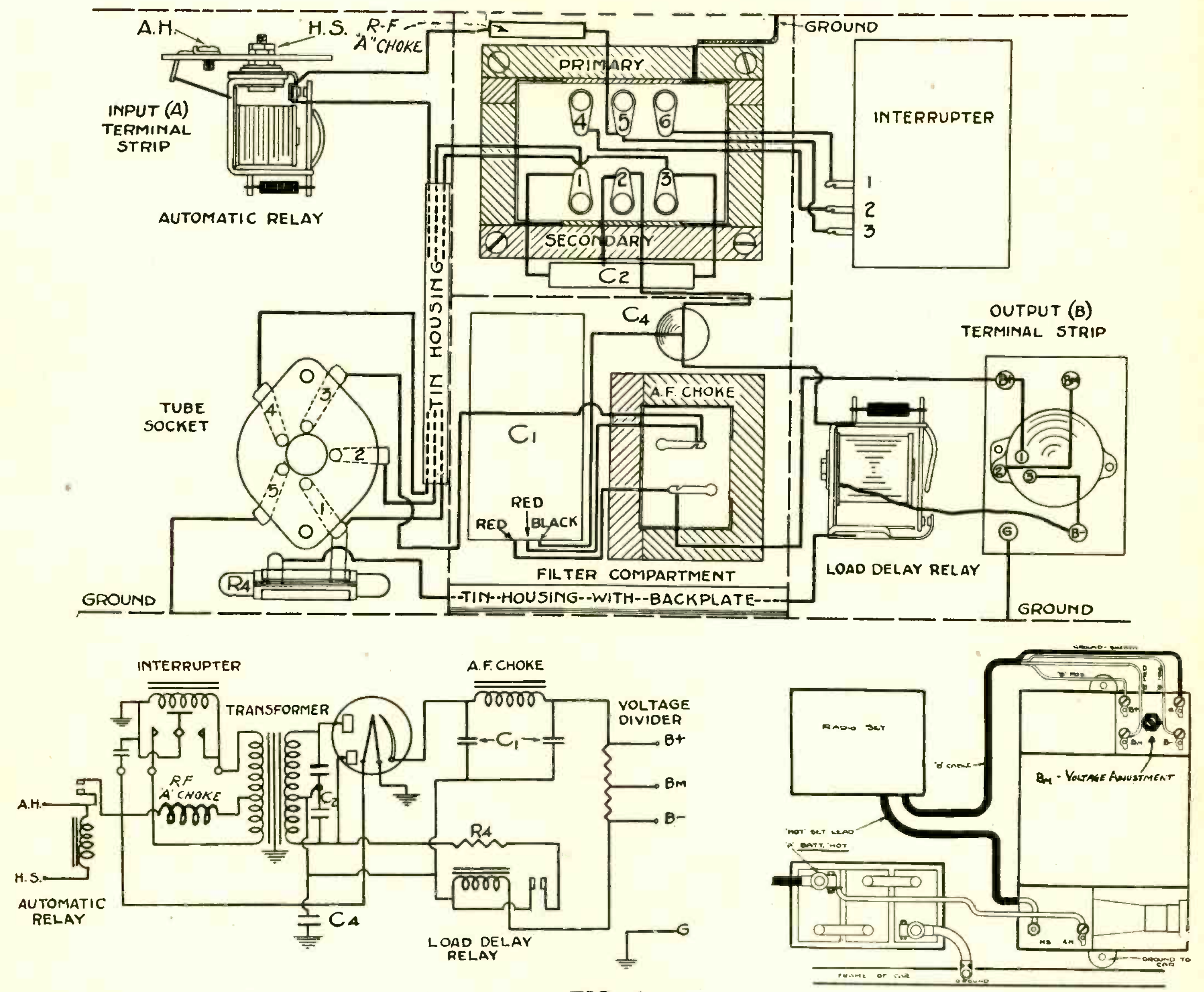


FIG. 1
Upper, layout of the Postal Automatic B supply, showing the main wiring; lower left, the circuit diagram of the B supply; lower right, diagram illustrating the installation of the B supply.

WELL, here is what you have been looking for, a B supply for automobile receivers operating from the six-volt battery. This is the first of its kind that we have described, so it is fitting that the description of the device and the explanation of the principle of its functioning should be given in detail.

In Fig. 1 are three separate drawings. At the top is the layout of the device, showing most of the wiring, at bottom left is the circuit diagram, and at bottom right is a sketch showing how to install it. Let us confine our attention to the circuit diagram.

Let us start with the power transformer. It appears to be a regular B supply transformer except that the primary winding is centertapped as well as the secondary. There is one wide difference not shown in the diagram; it has a very high step-up ratio. If we assume that there is an alternating current flowing in the primary of this transformer, it follows that the plates of the rectifier tube will receive, alternately, high voltage. There will be rectification just as in any other full-wave rectifier.

LIST OF PARTS

One full-wave transformer.
One full-wave vibrator.
One 15-milliampere load delay relay.
One 1.5-ampere On-Off relay.
One r-f "A" choke.
One dual 8 mfd. electrolytic condenser.
One 20 mfd. electrolytic condenser.
Dual 0.02 mfd. condenser.
One 7,500-ohm resistor.
One variable voltage divider.
One "B" terminal strip.
One "A" terminal strip.
One five-prong socket.
Miscellaneous hardware.

Optional Components

Three-piece case and chassis.
Mercury vapor rectifier.

Buffer Condensers

Two condensers C2, each of 0.02 mfd., are connected across the secondary, one across each half. Such condensers are not used in ordinary B supplies, but we recall that they were used in gaseous type rectifiers. In this case they are used for two reasons; first, because the peculiar shape of the input voltage wave and second, because the rectifier tube is of the mercury vapor type.

On the d-c side of the rectifier there is little unusual. There is first a filter consisting of an audio frequency choke and two large electrolytic condensers, C1, each of 20 mfd. There is also a voltage divider to provide an intermediate voltage Bm and also to cause some bleeder current to flow.

On the negative side of the line is a load delay relay, a special feature of this particular eliminator. The object of this relay is to delay the application of the full voltage on the tubes until the temperature of the cathodes have attained normal values. The feature is automatic in operation. This relay not only protects the receiver from excessive voltages but it also protects the vibrator, the power transformer, and the mercury rectifier.

The Vibrator

Above we assumed that there was an alternating current flowing in the center-tapped primary of the transformer. Actually there is only an interrupted current from a storage battery which flows through the primary, alternately in oposite directions. That is, a current pulse flows in one direction through one-half of the primary one moment and then a similar pulse flows through the other half in the opposite direction a moment later. These pulses induce an alternating voltage in the secondary and produce the same effect as if an alternating current were flowing in the primary.

The rapid switching is performed by a vibrator or interrupter. A field coil carrying dc pulls the armature toward one of the contactors and a spring pulls it the other way. If the proper balance is established between the pull of the spring and the pull of the magnet, the armature will not stay in either position but will vibrate back and forth.

Examining the Circuit

By examining the interrupter it will be noticed that if the magnet pulls the armature so as to contact at the right, a current pulse is sent through the upper half of the primary, but at the same time the field coil is short circuited. Hence it ceases its pull on the armature and the spring, which pulls toward the left, gains the upper hand and the armature contacts at the left. A current pulse is sent through the lower half of the primary. But while this is going on the field coil is taking current again and the magnet takes charge of the armature. Thus the electro-magnet and the spring take turns pulling the armature over to its own contactor and thus they keep the current flowing in alternating pulses through the primary.

Severe sparking at the break points is prevented by the fact that the circuit is really never opened. When the short across the field coil opens, the field coil remains and the energy stored in the transformer core is dissipated in the field winding. When the other contactor opens the field coil is still able to take the discharge, for it is still in the circuit. This is due to the fact that there is only one core for the transformer. Although the magnetizing current flowed in one half of the primary, the magnetic energy can dissipate in the other half if that is in a close circuit.

Choking Interference

Where there is interruption of heavy current, there will be some sparking, and sparking signifies the presence of high frequency currents, harmonics of the spark frequency. If these were not prevented from escaping, they would give rise to interference, for they would be picked up by the receiver served by the B supply. In this case a radio frequency choke has been inserted in the lead to the centertap of the primary of the power transformer. It is called an r-f "A" choke because its inductance is chosen with reference to radio frequency currents but the wire of which it has been wound is chosen with the view that it must carry the heavy current that must flow to the device to supply the power. Being put in the common lead, it serves both break points, and of course it is put in the "hot" side.

FIG. 2
Three views of the Postal Automatic B supply. Upper, the top cover of case; middle, assembled unit with the cover removed; bottom, the completely assembled unit.

The Automatic Relay

At the extreme left of the circuit diagram is an automatic relay. A relay is only a switch that is operated by an electromagnet. The relay is arranged so that when the filament current is turned on in the receiver, the power is automatically turned on the eliminator. That is, the power is turned on the interrupter and on the heater of the rectifier tube. The relay field is connected in series with the filament circuit in the receiver. HS should be connected to the "hot" battery lead on the receiver and AH should be connected to the "hot" terminal on the battery. That is, the relay field is merely cut into the "hot" line.

The automatic relay is rated at 1.5 amperes but it will stand more and it will operate on less, so that the device is adaptable to receivers of different requirements. It will be seen that the current taken by the B battery eliminator does not have to go through the relay field. If it did, there would be no need of the relay.

No Polarity

No polarity need be observed, which is made possible by the special design of the interrupter and the primary of the power transformer. The device may be installed in any type of car, regardless of the side that is ground. It is only necessary to observe "hot" and grounded sides. The method of installation is clearly shown in the lower right drawing of Fig. 1.

The layout of the B supply is shown in the upper portion of Fig. 1. Note that there are three shielded compartments. That to the left contains the rectifier tube, the automatic relay, and the input terminal strip. In the center compartment are the power transformer, the filter choke, and the by-pass condensers. In the right compartment are the interrupter, the load delay relay, the output terminal strip, and the voltage divider.

Thorough Shielding

The shielding is thorough. The interrupter, which might give rise to interference, is separately shielded, and since the device as a whole is shielded, the interrupter is really doubly shielded. The same applies to the parts contained in the center compartment.

The entire device is smaller than a single 45-volt block of B battery, measuring only 2¾ x 6 x 7¾ inches. These dimensions are exclusive of mounting lugs necessary for bolting the unit to the car chassis.

Two rubber-grommeted holes are provided in the metal case for the input and output leads. Since these leads will be shielded, provision is made for grounding the metal sheath at the B supply end. Of course, the sheath will also be grounded at the set end.

The device can also be operated from a 32-volt farm lighting battery. In this case it is necessary to have a ballast resistor to cut the excess voltage down to about six volts. Just how high this resistance should be depends on the service the B supply is to render and it should be determined for each installation.

[Other Illustration on Front Cover]

AUDIO AMPLIFICATION

A-F with Screen Grid Tubes

IS IT possible to get good quality out of an amplifier using a screen grid tube in a resistance-coupled circuit? I have tried many times and every time the distortion has been terrific.—W. E. W., Trenton, N. J.

Yes, it is as easy to get good quality out of such a circuit as out of a resistance-coupled amplifier using three-element tubes. It may be that you are overloading th epower tube. You know, the gain in a screen grid tube is high and it does not take much of a signal on its grid to give the tube after much more than it can stand. One of the essentials for good quality from a screen grid tube resistance-coupled amplifier is that the screen voltage be low. It must never exceed the actual plate voltage on the tube, and this voltage may be very low, due to the high drop in the coupling resistance. Experiment with the screen voltage to see what is required to give good amplification with good quality. Do not be surprised if the voltage needed is as low as 6 volts even though the applied plate voltage is of the order of 250 volts.

* * *

Effective Amplification of Power Tube

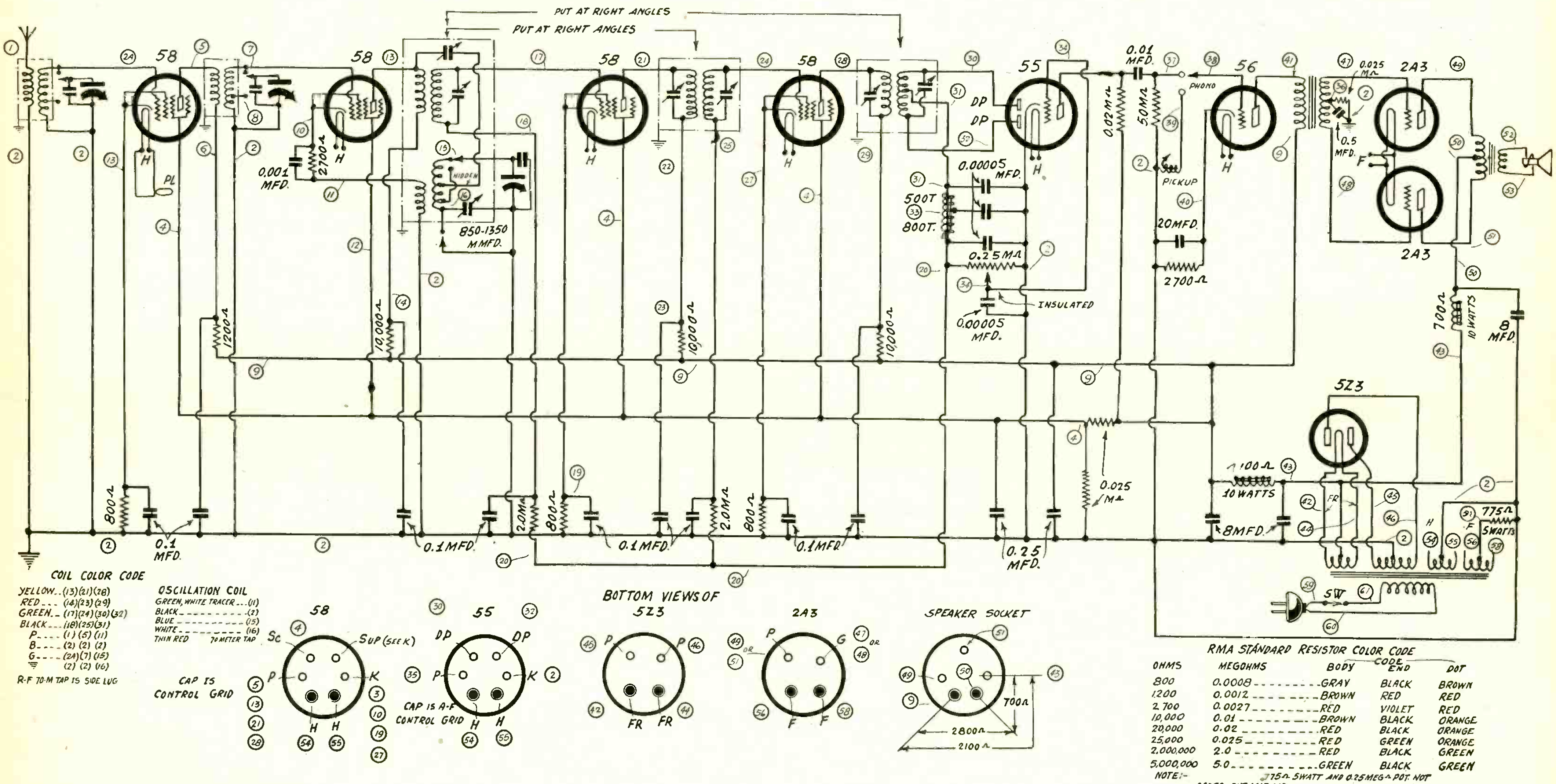
HOW IS the amplification in a power tube affected by the bias resistance in the tube in a single sided amplifier? Does the bias resistance increase or decrease the output?—B. W. C., Madison, Wis.

If m is the amplification constant of the tube, R the load resistance, rp the internal resistance, and r the bias resistance, then the output power for each volt input is $m^2R/(rp+r+R+mr)^2$. If the tube is a 245 the value of R should be 3,900 ohms, rp is 1,750 ohms, r is 1,500 ohms, and m is 3.5. Putting these values into the formula, we obtain 0.311 milliwatt. If the bias is obtained from a battery or some resistance in which no part of the plate current flows, or if there is an infinite capacity across the grid bias resistance, then the output wattage per volt input is 1.5 milliwatts. The ratio of the first to the second is 0.207. Hence the output is only about 1/5 as great when the bias resistance is allowed to reduce it. Part of this drop is due to the fact that the bias resistance itself dissipates some power, uselessly, but most of the drop is due to the fact that there is reverse feedback.

TWO-TUBE S-W SET

A two-tube battery-operated short-wave set will be described in next week's issue, March 25th.

THE PUSH-PULL SUPER DIAMOND



RMA STANDARD RESISTOR COLOR CODE

OHMS	MEGOHMS	BODY	END	DOT
800	0.0008	GRAY	BLACK	BROWN
1,200	0.0012	BROWN	RED	RED
2,700	0.0027	RED	VIOLET	RED
10,000	0.01	BROWN	BLACK	ORANGE
20,000	0.02	RED	BLACK	ORANGE
25,000	0.025	RED	GREEN	ORANGE
2,000,000	2.0	RED	BLACK	GREEN
5,000,000	5.0	GREEN	BLACK	GREEN

NOTE:- 775Ω 5WATT AND 0.25MEGΩ POT. NOT CODED, BUT MARKED.

The resultant direct current voltages on the Push-Pull Super Diamond will depend largely on the voltage obtained from the power transformer and the d-c resistance values of the field coil. The diagram assumes that there will be 375 volts between center of rectifier filament FR and grounded B minus, allowing for an assumed 50-volt drop in the rectifier tube. Then the field coil would be 2,800 ohms, tapped at 700 ohms, with 2,100 ohms of field winding to the forward part of the set, and 700 ohms between field tap and power tube feed. This arrangement requires that the winding of either section of the field coil be reversed in direction from the winding of the other section. Three 8 mfd. are shown. A fourth may be put next to the rectifier (FR to ground) to increase voltage, if necessary, otherwise from output transformer's primary center tap to ground.

Push-Pull Super Diamond Construction, Trouble Shooting and PICTURE DIAGRAM

By Herman Bernard

QUITE some leeway is provided for constructors of the Push-Pull Super Diamond as to the speaker requirements, assuming a dynamic speaker with field coil used for B filtration. As diagramed, a speaker of 2,800 ohms would be used, tapped at 700 ohms. Thus there are two sections, one of 2,100 ohms, the other of 700 ohms, to constitute the 2,800 ohms. The power actually expended in the 2,100-ohm section is 3.36 watts, and in the 700-ohm section 4.48 watts, and fields with commercial ratings of 5 watts are often used in such circumstances, although it would be better to have 10-watt fields. The special speakers for the circuit are in the 10-watt field class.

It can be seen, therefore, that the speaker comes under the heavy-duty classification, and, of course, so does the power transformer. The heater type tubes require 15 watts for their heaters, the power tubes' filaments require 12.5 watts, the rectifier filament requires 15 watts, the B supply uses 45 watts, the pilot light takes nearly a watt, and there you have 88.5 watts. Add 20 per cent. for loss in the power transformer and you get 96 watts. So a 100-watt primary is needed. This rating is usually actual, and that is, commercially it is equal to the amount of power used, whereas resistors and field windings are usually overestimated commercially, and one adds something to the actual power to obtain the value of commercial rating to be used.

One Cent an Hour for Juice

Assuming 10c a kilowatt-hour, although in some locations electricity costs considerably less, while in other locations it costs more, the juice consumed by the set would cost one cent an hour.

So, though the wattage sounds high, and is high, the expense of running the set is not very large, especially as one considers the number of tubes, and particularly the heavy-duty power tubes and rectifier. The necessity of having adequate power transformer and speaker field windings, however, becomes more obvious, if anything.

The circuit does not require just the type of speaker recommended, as it is immaterial to the performance, if the windings are a separate choke of around 700 ohms, 100 ma rating, and a 2,100-ohm field of an existing speaker. However, the output transformer must be for push-pull and moreover the impedance of the primary should be around 5,000 ohms, plate to plate. A somewhat different impedance may be used at lower power output rating, which is not serious, since the 15 watts need not be realized fully, most listening being at under 3 watts, the extra reserve being to support loud passages of low notes in orchestral renditions, or the louder passages of energetic speech. So, a speaker designed for 245's in push-pull at optimum operating voltages, may be used, as the impedance, if correct for this condition, would be around 3,900 ohms. So, too, a speaker with a 500, 600, 700 or 800-ohm field may be used in the other position, with the field between rectifier filament center and center of the primary of the output-transformer, and the 2,100 ohms consist of a choke or a choke and a resistor in series, to make up the d-c resistance requirement. Thus, a 2,000-ohm heavy-duty resistor may be used in series with the usual choke of 200 or 300 ohms d-c resistance, and almost any such choke would do, since the current here is only 40 ma. Besides, if twin speakers are to be used (not standard for the circuit) the tapped field (diagramed as if it were two fields) may actually be two fields, one on each speaker, at d-c values not far removed from those specified.

Overload Produces Hum

The reason for stressing the capacity of power transformer and speaker is not just because they should not get too hot, for one doesn't keep his hands on them, but because when they are overloaded they set up very large magnetic fields, and these fields carry the second harmonic of the 60-cycle line frequency as well as the fundamental. So there would be considerable hum with overloaded speaker and power transformer windings.

Particularly is it undesirable to have any coupling between such a field and the audio transformer or the output transformer in the speaker. Not much could be done about the output transformer, as that is permanently in place on the speaker, and its relationship to the field coil that is also in the speaker is fixed, although the audio transformer may be turned experimentally until it is at minimum or zero coupling in respect to the source of trouble, which then most likely would be the power transformer. This remedy is suggested to those who will use an undersized power transformer anyway, as always some will at least take a chance with a transformer of lower capacity transformer they have.

The common return of the grids of the audio transformer is made through a resistor of 25,000 ohms, bypassed by a condenser of 0.5 mfd., and this is intended as a phase shifter, to reduce the amount of hum, but in some small percentage of instances the phases will be right for minimum hum originally, and the addition of this filter will merely introduce hum where perhaps none was formerly. Therefore, though the filter is helpful in most instances, short it out experimentally. If the hum is less in the short test, omit the filter.

Test of Overloaded Field

A test as to whether the 700-ohm section is overloaded may be made by shorting it out, too. The voltage will not rise seriously, and besides the current increase will raise the negative bias voltage. If this winding is overloaded the set will hum, and when the winding is shorted, the hum will be reduced. That proves the choke is doing just the opposite to what was intended. Instead of reducing the ripple voltage in the output, the choke then would be increasing it, because of the large hum-laden field it introduces.

An extra 8 mfd. is suggested, the fourth

(*Continued on page 18*)

LIST OF PARTS

Coils

One antenna coupler, primary wound over secondary; enclosed in an aluminum shield, for 0.00041 mfd.; tapped for 70-200 meters.
One interstage r-f coupler, primary wound over secondary; enclosed in an aluminum shield, for 0.00041 mfd.; tapped for 70-200 meters.
One combination oscillator coupler for padded 0.00041 mfd. and one 175 kc first intermediate transformer, both enclosed in one high aluminum shield; oscillator tapped for 70-200 meters.
One 175 kc intermediate transformer enclosed in aluminum shield.
One 175 kc intermediate transformer with center-tapped secondary; enclosed in aluminum shield.
One tapped 20-millihenry r-f choke.
One 12-inch heavy-duty dynamic speaker, field coil, 2,800 ohms, tapped at 700 ohms, field windings reversed, output transformer (5,000 ohms impedance) matched to the 2A3's in push-pull, 32-inch cable and five-pin plug attached.
One heavy-duty power transformer: primary, 110 volts, 50-60 cycles; secondaries: 2.5 volts at 8 amperes center tapped (H); 2.5-volt 5 amperes, c.t., for output tubes (F); 5 volts at 2 amperes, c.t.; high voltage at 375 volts d-c between rectifier filament and ground at 120 ma.
One push-pull input transformer.

Condensers

One three-gang 0.00041 mfd. tuning condenser with compensators built in and with attached screws for mounting purposes; high shield walls between sections.
(*Note: the condensers across primaries and secondaries of intermediate coils are built into these transformers.*)
One 0.001 mfd. fixed condenser.
Four 0.00005 mfd. fixed condensers.
One 0.01 mfd. mica fixed condenser.
Four 8 mfd. electrolytic condensers. These come two in a can; total, two cans.
One dry 20 mfd. electrolytic, 30 volts.
One 850-1,350 mmfd. padding condenser, isolantite base; brass plates.
One shielded block containing nine 0.1 mfd. condensers and two 0.25 mfd. condensers. Equipped with mounting lugs. Shield is to be grounded. Black lead goes to ground. Two outleads colored differently than others are the 0.25 mfd. Rest are 0.1 mfd. Block to be fitted on chassis front wall.
One separate 0.5 mfd.
Two seperate 0.1 mfd.

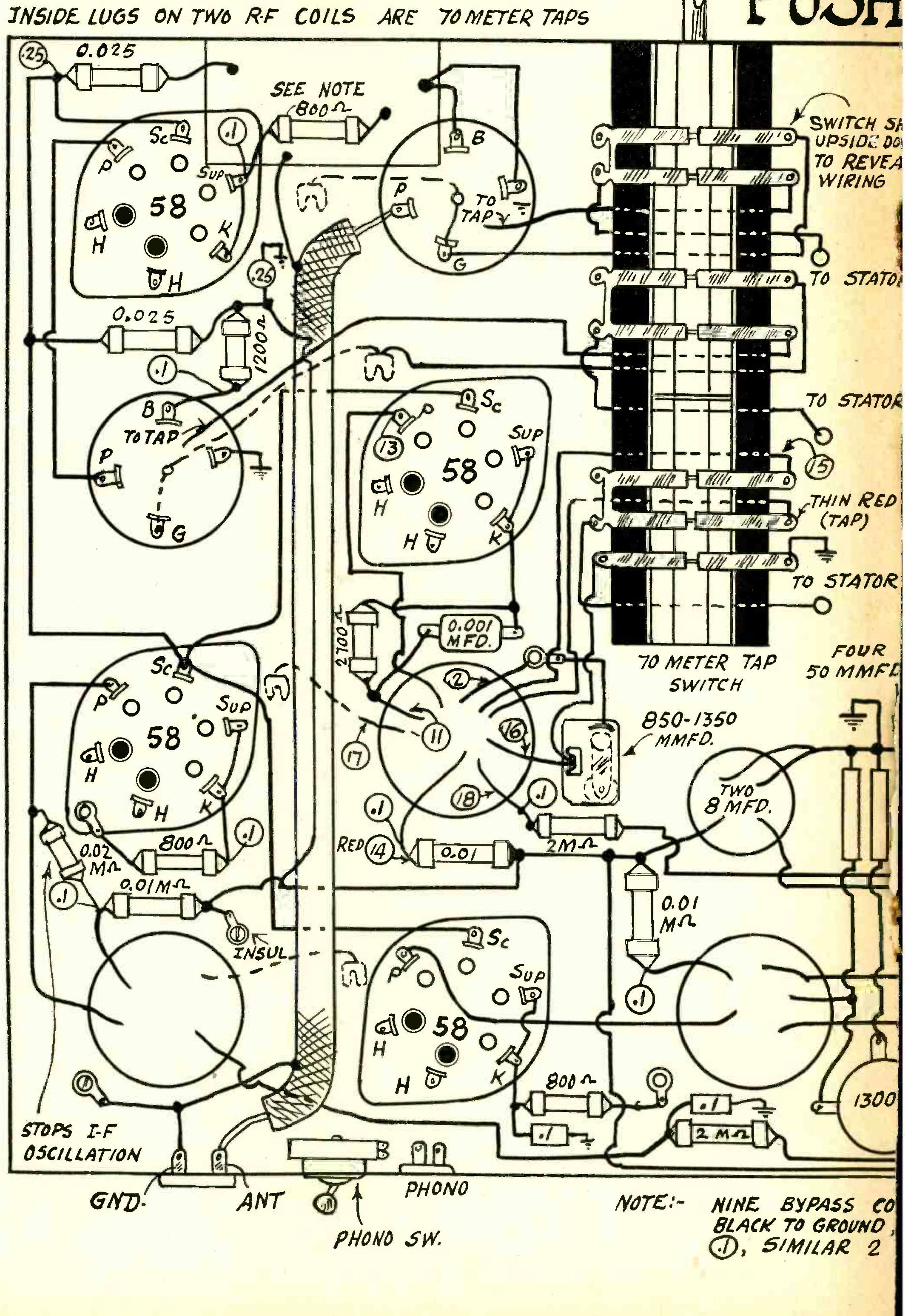
Resistors

Three 800-ohm pigtail resistors.
One 1,200-ohm pigtail resistor.
Two 2,700-ohm pigtail resistors.
Three 10,000-ohm pigtail resistors.
One 0.02 meg. pigtail resistor.
Three 0.025 meg. pigtail resistors.
Two 2.0 meg. pigtail resistors.
One 5.0 meg. pigtail resistor.
One 0.25 meg. potentiometer, insulated shaft type; tapered; a-c switch attached.
One 775-ohm 5-watt resistor.

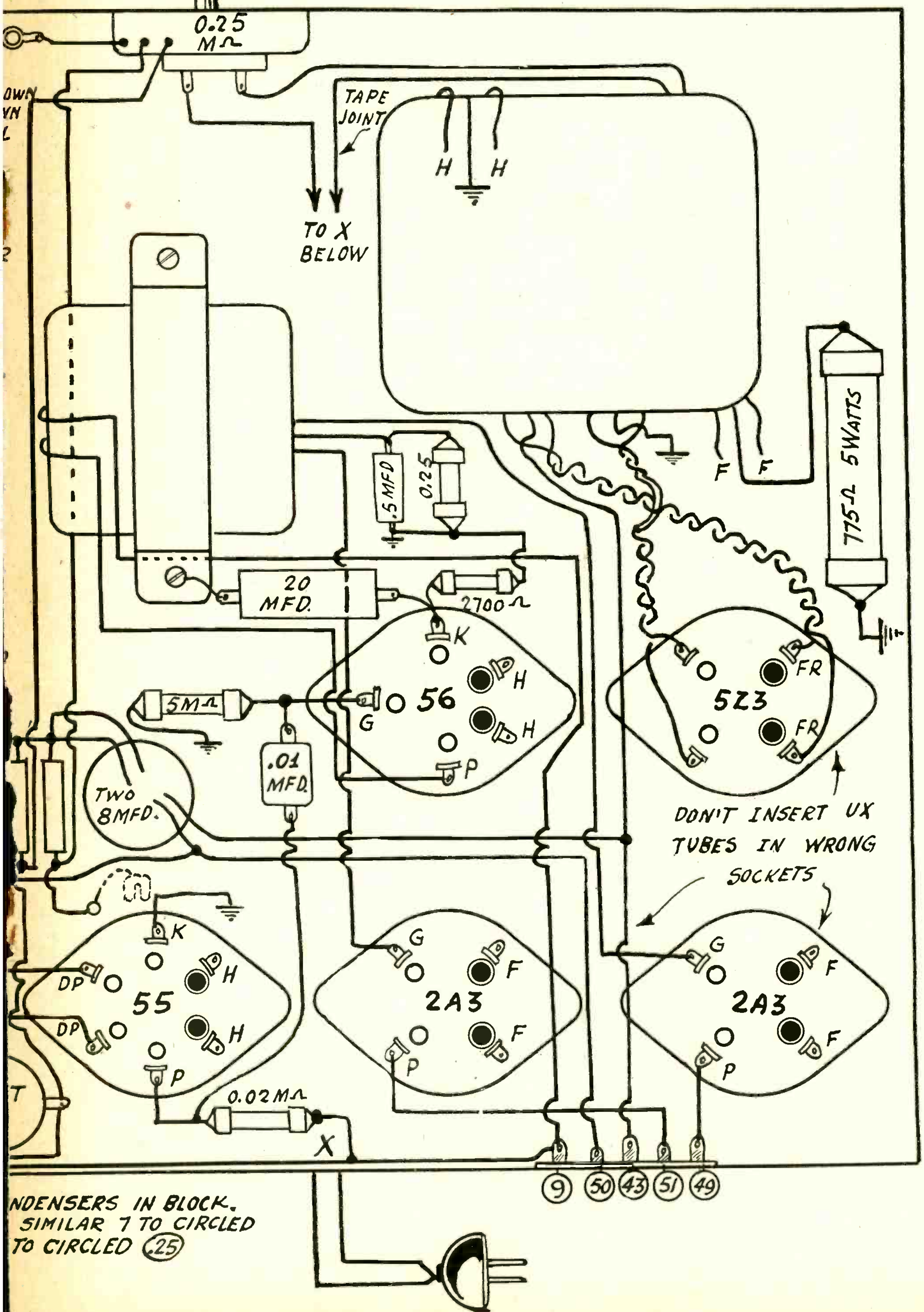
Other Requirements

One chassis, 13.5 x 3 x 8.75 inches overall, drilled for sockets, coils, tuning condenser, for electrolytics and for power transformer.
One steel front panel, finished in walnut color.
12 insulated bushings, ends tapped for 6/32 machine screws, so that bushings may be used as if nuts on socket mounting screws, and maintain insulation for parts mounted on top of bushings by means of lugs held by short 6/32 screws.
One frequency-calibrated dial with pilot lamp, and extension bushing.
One dozen lugs.
Two dozen 6/32 machine screws.
One roll of hookup wire.
Six aluminum tube shields.
Five grid clips.
One foot of shielded wire to be used between antenna post of set and antenna lug of antenna coupler; overall diameter ½-inch due to thick cotton insulation to prevent loss of signal to ground.
Five six-prong sockets, two UY sockets and three four-prong sockets (the extra UY is for speaker plug).

PUSH


INSIDE LUGS ON TWO R-F COILS ARE 70 METER TAPS
0.025
SEE NOTE
800Ω
Sc
P
SUP
58
K
H
B
TO TAP
G
.25
.1
0.025
1200Ω
SWITCH SH
UPSIDE DO
TO REVEA
WIRING
TO STATO
TO STATOR
15
THIN RED
(TAP)
TO STATOR
13
2700Ω
0.001 MFD.
70 METER TAP SWITCH
FOUR
50 MMFD
12
11
16
17
18
850-1350 MMFD.
TWO 8 MFD.
0.02 MΩ
800Ω
RED 14
0.01
2MΩ
0.01MΩ
INSUL
0.01 MΩ
800Ω
2 MΩ
1300
STOPS I-F OSCILLATION
GND.
ANT
PHONO
PHONO SW.
NOTE:- NINE BYPASS CO
BLACK TO GROUND,
.1, SIMILAR 2

-PULL SUPER DIAMOND



NDENSERS IN BLOCK.
SIMILAR 7 TO CIRCLED
TO CIRCLED .25

(*Continued from page* 15)
one, and may be placed next to the rectifier, in parallel with another 8 mfd., or in parallel with the one from center of output transformer primary to ground.

The 775-ohm resistor will dissipate 5 watts, and if constituted of a conservatively-rated resistor may be of a 5-watt rating, but if there is any doubt, use a 10-watt rating. The special resistor for this position is rated conservatively at 5 watts and does not get too hot.

The purpose of this resistor is to bias the output tubes. The standard recommendations are 300 volts on the plate, 62 volts, negative bias, at whereupon about 40 ma will flow in each tube, or 80 ma through the biasing resistor. However, the voltage may be somewhat under 300, as measured between the center of F and the center of the output transformer's primary, that is, between (57) and (50). The number (57) is not plain on the circuit diagram, but is between (56) and (58).

Summary of Features

The various features of the circuit have been discussed in connection with previous models, if not stated in last week's issue, but a brief summary will be given for the benefit of those who have not read what has gone before.

The sensitivity of the circuit with volume control full-on is better than 0.5 microvolts per meter.

The selectivity is adequate to enable the enjoyment of a weak, distant station without interference from a local that is on a channel 10 kc removed from the distant station, though the input voltage at antenna post is 100 times greater for the local than for the distant station.

The tone quality is excellent throughout the useful range of frequencies, the response measured from 50 cycles to 7,500 cycles. The sibilants are as strong as highest intelligibility of speech requires, while the reserve power is all-sufficient for the loudest low-note passages.

The volume control will cut out any signal completely, and permit increase of volume from barest audibility to 400,000 times barest audibility.

Has Automatic Volume Control

The two intermediate frequency amplifiers are automatically volume-controlled, so that fading is minimized, if not completely eradicated, and the a. v. c. is such that weakest signals obtain fullest amplification and strongest signals least amplification, so that the a. v. c. is not of the type that eliminates the reception of very weak signals.

Full-Wave Detector

The second detector is of the full-wave type, for best quality and largest voltage-handling capability without distortion, and the a. v. c is derived from the second detector tube so that unity relationship exists between the a. v. c. action and the detector requirements.

The second detector is a 55, of which the two diode plates are used for full-wave detection, and the triode unit or amplifier of this tube is direct-coupled from the detector load (250,000-ohm potentiometer). Therefore, at no signal there is no bias on the tube, and no amplification, no matter where the volume control is set, and particularly if it is set at zero resistance or a few hundred ohms resistance, for then there is a virtual short of input to the triode unit.

Noise Suppression

This situation results in noise suppression control, which does not mean elimination of interference caused by static, electric machines, etc., but suppression of noise at between-channel positions of the dial, which otherwise would be heard because not kept out of the audio amplifier. This type of noise, the origin of which is in the set, as distinguished from the excepted interference which arises outside the set, would be associated with any type of a. v. c., unless squelched. Systems of squelching, using an extra tube, are effective, but the present method does not require an extra tube. However, at no bias at all there would be grid current, causing a noise at all settings for any no-carrier position, or for weak carriers, and therefore some threshold voltage must be introduced, and this is done by using an antenna of at least 10 feet, but of course better results will be obtained with an outdoor aerial.

Lining Up

For purposes of lining up, the procedure may be as follows: Adjust the intermediate frequency to 175 kc by connecting the output of a modulated test oscillator to the plate of the first detector. If necessary, remove the first detector and insert the test oscillator's output wire into the plate prong of the socket. Use a screwdriver on the r-f condensers. Next restore the tube, put the oscillator trimmer half way in, have the set working in its entirety, and feed 600 kc to the antenna post from a test oscillator, or use a station of 600 kc, or as close thereto as possible, and adjust the padding condenser until response is maximum. The r-f level need not be calibrated, because the dial is frequency-calibrated, and the 600 kc setting is the one that reads 60 on the dial.

Final Check-up

Next tentatively set the trimmers on the r-f and autodyne input (two front sections of tuning condenser) but do not adjust the oscillation trimmer (rear section). Then turn the set to 145 on the dial, feed 1,450 kc from test oscillator to antenna post, or use a station, and adjust the oscillator trimmer for maximum response, or greatest needle deflection if an output meter is used. The r-f and autodyne input trimmers (front two) should be readjusted then for maximum response. Then return to 600 kc, feed that frequency to the set, and make any padding condenser readjustment necessitated by the change, if any, in the oscillator trimmer.

Too Sensitive?

The rest of the frequencies also will come in as registered on the dial, except that at some points there may be an unavoidable deviation of 10 kc, and at the lowest frequency portion, from 570 to 530 kc, there will be a little more deviation, but this part of the tuning spectrum is unimportant from the viewpoint of accuracy of frequency representation on a calibrated dial.

It may be found that the receiver is so sensitive that virtually all the stations you desire to listen to come in with too much volume, unless the volume control is near minimum position. In that case you may use a shorter aerial, or put a series condenser of 0.00005 mfd. between aerial and antenna post of receiver, or put a resistor between the extreme of potentiometer shown to ground, and the actual ground. The value of resistor will depend on the desired value of reduction of working sensitivity, and around 50,000 to 100,000 ohms is suggested.

Intermediate Oscillation

The only trouble that may be expected consists of hum and of oscillation. The hum question has been discussed. The intermediate amplifier is the place where oscillation may exist, although the filter resistors, 10,000 ohms, are high enough to render peril of oscillation scant. Yet line voltages may differ, resistance values be somewhat other than specified, and the result is at least the possibility of oscillation. This may be cured by finding out which intermediate tube oscillates, for pinching the control grid wire will stop the oscillation. Put a 20,000-ohm resistor or more across the primary in the plate circuit of the tube or tubes that oscillate. Do not detune to cure oscillation, although this will do it, as it has too serious an effect on selectivity.

Cabinet

It is assumed that a high-powered receiver like this will be used in a console, and usually the builder has the console, yet the chassis is small enough to fit in a mantel type cabinet, and such a cabinet is commercially obtainable. However, an 8-inch speaker would have to be used then, while the 12-inch speaker for console use is preferable.

Two-Stage Intermediate Raises Selectivity Much

In the construction of superheterodynes excellent results may be obtained with only one stage, if a screen grid tube is used as the amplifier. Then two coils would be required, one to connect the modulator output to the intermediate input, the other to connect the intermediate output to the second detector input. There is therefore always one more transformer than amplifier stage.

Some systems have been tried that omit the amplifier stage entirely, that is, a transformer connects the first detector to the second detector. In such a circumstance the second detector is made regenerative, and fair results are obtained, but since beats will result with carriers, the system is not the best.

Better Selectivity

The single amplifier tube has been successfully used in many circuits, and the results in selectivity have been much better than with tuned radio frequency systems.

When a second intermediate stage is used there is a great increase in selectivity, and also perhaps in amplification, although the principal concern is selectivity. The amplification may be only a little more than from the single stage, due to the necessity of working the channel well below the oscillation point.

Oscillation Cures

The danger of oscillation at the intermediate level is always present, and may be overcome by putting the coils at right angles to each other, considering respective stages, or any coils that are closest together; by reducing the screen voltage; or by putting a fixed resistor from plate to B plus of the primary of the transformer in the plate circuit of the oscillating tube. This resistor should be as high as practical, consistent with elimination of oscillation, and while 20,000 ohms usually does the trick, it may do it too well, and 30,000 or 50,000 ohms should be tried, though usually higher values are not helpful.

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Hiss in Receivers

MANY MODERN receivers develop a very strong hiss. Superheterodynes, apparently, are worse offenders than t-r-f sets. Just why are modern sets worse in this respect than older sets, and why are superheterodynes worse than t-r-f sets?—W. E. W., New York, N. Y.

It appears to be a matter of sensitivity. The older sets were not sensitive enough to bring out the hiss. Neither are many t-r-f sets sensitive enough to do it. However, most superheterodynes are. Most of the noise comes from the tubes and those tubes having a high gas residue are worse than high vacuum tubes. It is customary now to suppress the hiss by means of audio filtering. This is quite feasible because the hiss contains mostly high frequencies that are not essential to music and speech. Objectionable hiss was first noticed in circuits utilizing the 200A tube, which was a gassy tube and at the same time had a high gain.

* * *

Filter Cut-off

A LOW PASS filter having a 10 millihenry choke in series and two 250 mmfd. condensers in shunt cuts off at what frequency, assuming that it is working between the proper impedances? Is such a filter to be regarded as having mid shunt or mid-series termination?—T. E. W., Chicago, Ill.

The cut-off frequency is 142,000 cycles per second. The filter is mid-shunt terminated. If you are to use a filter of this type to reduce hiss and other noises the cut-off frequency should be put at about 10,000 cycles. This would require considerably higher by-pass capacities and series inductance than values ordinarily used.

* * *

Different Types of Blocking

IN PLAYING with oscillators I have noticed that there are different kinds of blocking. In some cases there is a high pitch note, in other cases a low pitch note, in still others a gradual choking up and letting go, and in still others there is a terrific roar. Will you please explain why there should be these differences?—D. T. F., Detroit, Mich.

The different ways in which blocking manifests itself depends largely on the degree of blocking, and that in turn depends on the time constant of the grid leak and the stopping condenser, on the ratio of the inductance to capacity, on the plate, grid, and filament voltages, and on the excellence of the coil. The frequency of the note heard, when it is a clear note, is determined almost entirely by the time constant of the grid leak and the stopping condenser, that is, on the product CR, where C is in farads and R is in ohms. If this product is large the frequency of blocking will be low. If it is small the frequency will be high. The roar that is often heard is usually due to overloading and it may happen independently of the blocking.

* * *

Wattless Power

WHAT is meant by wattless power in electrical engineering and in radio? If there is electrical power can it not be measured in watts and if it is how can it be wattless unless it is zero?—T. N. J., Memphis, Tenn.

By wattless power is meant the power that is associated with current that flows in quadrature with the voltage. It is all right to call it wattless even though expressible in watts as long as we have no more appropriate term for it. Most of the power involved in a resonant circuit is wattless, and the more it is wattless the better the resonant circuit. In a power circuit the reverse is the case. If the wattless component is large, that is, if the power factor is low, there is a great deal of useless current flowing in the line, current that does no work because it is out of step with the voltage. The extra current increases the losses in the line because they are proportional to the square of the current. While the losses are not wattless they are just losses.

* * *

Behavior of Push-pull Amplifier

THERE is a stage of push-pull audio in my automobile receiver, with two 238 tubes. I have noticed that if I remove either tube the signal level goes up but the remaining tube overloads quickly. If I merely remove a grid clip it behaves the other way but not as much as expected. Can you give an explanation?—W. E. C., Omaha, Neb.

When a tube is removed the bias becomes less, assuming that the tubes are self-biased, in whole or in part, and it may be that the single tube will work better with a lower bias. That is conceivable if the bias on the two tubes is much too great. When you remove a grid one tube is removed, as before, in so far as the amplification is concerned, but the plate current in that tube continues to flow. Indeed, it may be much higher than it was before and the bias on the remaining tube is higher than it originally was. That would account why the signal level drops. That is, not only is a tube removed in effect but the remaining tube is given a higher bias, which may have been too high before.

* * *

Function of Noise Eliminator

HAVING been bothered a great deal by noise in my receiver I decided to instal a noise suppressor. I did so, following a circuit that was supposed to have been tried out. Well, I am still bothered with noise. Now, why are such devices recommended if they don't work, and if they do work why are circuits published purporting to be noise suppressors?—J. H., Greenwich, Conn.

There are no static eliminators. A noise suppressor is not supposed to eliminate static or similar noises. Its only function is to prevent the amplification of any noise when the receiver is not tuned to a carrier. They have no meaning unless they are used on sets equipped with automatic volume control. These devices work but they are not intended to be static eliminators nor do they eliminate it, except so far as they eliminate everything when there is no carrier present to keep the circuit in proper working condition.

The Multivibrator

WHAT is a multivibrator and for what purpose is it used? You have never described one as far as I know. If it is a radio oscillator or measuring device, let us have a description of it.—F. W. J., Milwaukee, Wis.

A multivibrator is a special type of oscillator used as a generator of harmonics. Its principle use is the measurement of frequency. Two tubes are required and the frequency of oscillation is determined by the time constant of certain resistors and condensers. The wave it generates is characterized by sharp pulses. Such a wave is extremely rich in harmonics and it is for that reason that the multivibrator has found a place in all radio laboratories. Devices similar to the multivibrator have been used as driven harmonic producers. That is, they have been driven by a generator of accurately known and highly constant frequency. The device may be driven in this way if a harmonic of its lowest frequency coincides with the driving frequency.

* * *

Receiver Hums

WHEN a loudspeaker field of high inductance is used for filter choke in the B supply could a strong hum in the output be attributed to it? I have a set that has been very carefully put together out of the best parts, but for all the care the receiver hums entirely too much. I am sure, from various tests and comparisons, that the circuit is all right with the possible exception of the speaker field. —T. R. B., Troy, N. Y.

If the plate current is so heavy that the field core is strongly saturated, its inductance, in so far as the ripple in the B supply is concerned, may be practically nothing even though the inductance on low current may be very high. If the saturation has gone far enough, the field becomes no more effective to the a-c ripple than an equivalent air core coil would be. In other words, the permeability has fallen to practically unity.

* * *

Beat Note Oscillator

I WISH to construct a beat note oscillator that will cover the audio band up to 10,000 cycles. What frequency do you recommend for the fixed oscillator and what tuning capacity in the variable oscillator? I have planned to use Hartley oscillators, both stabilized for frequency, with heater type tubes so that I can ground the variable condensers. Is this all right? How would you provide a means for adjusting the oscillators so that the calibration will mean something? —T. C. J., Springfield, Ill.

What frequency you use depends largely on the capacity of the variable condenser you have. About 100 kc should be all right. Make two equal oscillators. Put a tiny adjustable condenser across the tuning condenser of the fixed-frequency oscillator and a larger variable condenser across a fixed condenser in the variable frequency oscillator. The small trimmer across the fixed frequency oscillator is used for adjusting the fixed frequency in case it drifts so as to upset the calabration. The check may always be done against some fixed known frequency, say the 60 cycle line frequency or the 120 cycle harmonic of it. The variable condenser across the fixed condenser is used for varying the audio frequency and its dial should be calibrated very carefully. If the fixed frequency is 100 kc and the tuning condenser is 1,000 mmfd. the inductance should be very nearly 2.5 millihenries. If the variable frequency oscillator is to tune 10 kc lower, or to 90 kc, the variable condenser across the 1,000 mmfd. should be 234.6 mmfd. This is not a convenient value but it is always possible to adjust the inductance so that some convenient condenser is just right. This varies the frequency and there

(*Continued on next page*)

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should be a corresponding change in the frequency of the other oscillator. In the above case if the capacity is made 250 mmfd. the beat frequency is variable over a wider range. The reason for using two similar oscillators is that if there is any frequency drift the two will drift in the same direction and there will be a slight change in the beat frequency.

* * *

IF I HAPPEN to have an oscillator coil that is not of just the right inductance, and my intermediates can be tuned from 200 to 150 kc, is it practical to alter the intermediate frequency from 175 kc, and if so, in which direction should the alteration be made?—A. O. P., Ames, Ia.

If the oscillator coil of your superheterodyne has the incorrect inductance the intermediate frequency may be changed to meet the conditions imposed by the oscillator winding, and this is an excellent procedure to follow, provided the coil is not so far off that you can not strike the right intermediate frequency for it. Just in which direction to move can not be stated without presentation of all the facts by you, but if the oscillator inductance is too low, increase the intermediate frequency, and if the oscillator inductance is too high, decrease the intermediate frequency. Of course, the absence of tracking will evidence itself, and in general you may tell by dial observation whether the oscillator has too much or too little inductance, for if it has too little it will tune to too high frequencies compared with the r-f, and if it has too much it will tune to too low frequencies, compared with the r-f. The observation should be made at some point from about 1,300 to 1,500 kc, that is, somewhere near or at the high frequency extreme. The many squeals attendant on poor tracking will disappear as soon as the intermediate frequency is matched to the oscillator coil, done at a high frequency as stated, whereas the circuit would have to be repadded at 600 kc, and if the inductance was too high at first, the padding capacity may have to be increased, and if the inductance was too low, the padding capacity may have to be increased.

* * *

Echoes in Short-Wave Reception

MANY times I have seen references to signal echoes, some echoes requiring half a minute, others about 1/7 second, and still others a small fraction of a second to appear. If they are echoes they must be waves reflected from some surface. What could reflect the signals to account for these multiple responses?—R. E. B., Covington, Ky.

While some of these signals are called echoes, they are not such at all. The 1/7 second "echo" is due to the fact that the signals has traveled all the way around the world and comes to the receiver in the same direction as the original signal. That is, if the original signal came from the East, so does the second signal that has traveled around the earth. Other multiple signals are due to the fact that any two points on the earth may be reached in two ways over great circle routes. Suppose the transmitter and receiver are 7,000 miles apart. Then they are also 18,000 miles apart in the opposite direction. A signal will travel each way to the receiver. It will take it about 0.04 second for the signal to get to the receiver by the shorter distance and about 0.1 second by the longer. Therefore, one signal will arrive 0.06 second later than the other. The cause of the long delay of some signals is not definitely understood.

* * *

Stabilized Oscillator

IN YOUR February 18th issue you had a stabilized oscillator in which both plate circuit stabilization and automatic amplitude control were used. Could this oscillator be used in a padded circuit of a superheterodyne? If so, what changes would be necessary?—R. V. L., Chicago, Ill.

Yes, it could be used in a superheterodyne. Condenser C2 which is now only a by-pass condenser could be used as the series padding condenser. However, in order to use C2 for this purpose, it would be necessary to put a radio frequency choke in the B plus lead and to make the inductance of this choke so high that it would not change the tuned circuit materially. Probably a 10 millihenry choke would be all right if C2 is a regular padding condenser of about 900 mmfd. Of course, the padding condenser could also be put on the high side of the tuning condenser. In that case C2 would be left as it is and the choke in the B lead would not be necessary. L1 in the oscillating circuit would have to be adjusted to the value of C1 and the intermediate frequency used in the super. And whatever L1 in the tuned circuit is, L1 in the plate lead should have the same value. This latter statement applies particularly to the case when the series condenser is put on the high side of the tuning condenser.

* * *

Detecting Slow Beats

TWO frequency-stable oscillators have been constructed and adjusted to very nearly the same frequency. The frequencies were so nearly equal that the beats cannot be heard. It is important to know how much one of these oscillators varies with respect to the other. Can you suggest a very sensitive method of measuring the beat?—W. R. M., Rochester, N. Y.

If the beat is so slow that it is away below audibility, the best way of detecting and measuring it is to employ visual means. Impress voltages from both oscillators on the grid of a vacuum tube voltmeter or a diode rectifier. Connect a suitable milliammeter in the plate or anode circuit and note the behavior of the meter pointer. If the beat is less than about 10 per second it can be followed and the number of beats per second can be counted. The slower the beat the more accurate will the measurement be. It is possible to get a beat so slow that the needle will move back and forth once an hour. Of course, that requires highly stable oscillators. In case the beats are too slow to be measured comfortably, harmonics of the two oscillators may be selected, amplified, and then mixed. The beat will be multiplied by the order of the harmonic selected. Thus if the 20th harmonics are selected and beaten, a given comparison can be made in one minute what it would have required 20 minutes to do had the fundamentals been compared directly.

* * *

Explanation of Blocking

WILL you kindly explain the phenomenon of blocking in an oscillator? Just what happens to give the high pitched noise?—L. W. A., Atlanta, Ga.

Blocking is a regular stopping and starting of oscillation. At a given bias, oscillation stops because the conditions for oscillation are not satisfied. The regular process is about as follows: Oscillation starts at a given bias and the amplitude builds up rapidly. As the amplitude builds up a negative charge accumulates on the grid condenser because the grid leakage is not sufficient to drain the condenser. The bias on the grid, therefore, gradually builds up. Finally, a point is reached where oscillation cannot continue, and the circuit stops. As soon as oscillation has stopped the leakage discharges the grid condenser, and the grid voltage falls to a value where oscillation can start again. The process is repeated. The rate at which the stopping and starting occur depends on the leakage and on the capacity of the condenser, mainly, but also on the plate voltage, the filament voltage, the feedback and on the ratio of the inductance to the capacity in the tuned circuit. The time constant of the grid leak resistance and the grid stopping condenser practically determine the rate. Thus if the time constant is 0.0001 second the frequency of the squeal is 10,000 cycles. This checks approximately with practical circuits.

* * *

Parasitic Oscillation

WHAT are parasitic oscillations and how can they be recognized? Do they only occur in oscillators or do they also occur i namplifiers?—E. S., New York, N. Y.

Parasitic oscillations are undesired oscillations in either oscillators or amplifiers. Motorboating in audio amplifiers might be called parasitic. However, in most cases the term is applied to high frequency oscillations in oscillators arising from chance resonance circuits. For example, there may be a short piece of wire in the plate circuit and a similar piece of wire in the grid circuit with a little stray capacity between them. The high frequency circuit thus formed might give rise to oscillation. Such oscillations might be discovered by tuning a wavemeter to them, or they might be discovered by the hum or distortion which they might cause, or by the heat developed on the grid or the plate. It all depends on their frequency and on their intensity. To stop such oscillations sometimes a very tiny choke is put in the grid lead, say a few turns of wire wrapped around a pencil.

* * *

Connections of the 239

IF THE 239 is a remote cut-off tube and a pentode, where is the fifth element? The tube has only six terminals, one on top and five in the base. Two of these are for the heater and do not count as far as the number of elements is concerned. Therefore, there are only four elements. Should not the tube be called a tetrode?—W. G. A., Stamford, Conn.

The tube is a pentode, all right. The fifth element is permanently connected to the cathode inside the tube. It is a suppressor grid and corresponds to the extra grid in the 58. The 239 was the first of this type of tube.

* * *

Universal Set

IN YOUR February 25th issue you have a Universal receiver with the new 25Z5 rectifier. The cathodes are tied together and so are the plates. Would it not be all right to use one of the cathodes for the field of the loudspeaker and the other for the B supply? What is against that scheme? Could you suggest any other way of energizing the field?—S. E., Baltimore, Md.

If the field is put on one of the cathodes and the set on the other, the rectifier providing the plate current will deliver so heavy a current that it would not be quite safe, whereas the rectifier serving the speaker would not deliver a greater deal. To equalize the load on the two cathodes the connections may be left as they are and the speaker field may be connected in parallel with the filter. That is, one side of the field could be connected to the two cathodes and the other side of it to ground. This connection would have the other advantage that the field current would not help to saturate the 30-henry choke. Of course, the speaker field resistance would have to be high enough to make the connection safe.

* * *

Class B Amplifier

IS IT possible to have a Class B amplifier in which there is no grid current in the power tubes? Is not the operation at zero bias the criterion for Class B amplification?—H. L. Y., Youngstown, Ohio.

The criterion for Class B is operation of the two tubes near the plate current cut-off points. Whether this is at zero bias or at a high negative bias, makes no difference. If it takes a high negative bias to reach the point the grids of the tubes will not draw current, but the circuit is Class B just the same. There is one difference between Class B when a high bias is used and when no bias is used. When no bias is used it requires a power driver, but when a high bias is used it only takes a voltage driver.

RCA INDORSES ULTRA WAVES FOR TELEVISION

Radio Corporation of America, in its 1932 annual report to stockholders, just issued, sets forth the following regarding television:

The attention and time devoted to experimental television transmission and reception in the laboratories of your corporation makes desirable a concise statement of the present status of this development.

Progressive experimentation and research have been conducted over a period of years with sight transmission by radio. This research has demonstrated the technical feasibility of television and has confirmed the hopes of your corporation that a practical service of television broadcasting will be possible. Experimental television receiving sets have been constructed that give a type of reception comparable to sound broadcasting reception in the early days of radio. A point was reached last year where the results of this research were demonstrated to the patent licensees of your corporation.

Unsolved Problems

Television transmission of a nature that will permit entertainment and information broadcasting on a national scale still presents unsolved problems, although much progress in the technical development of program transmission was made during the year. Public interest in this promised phase of radio service has remained keen, but much additional work must be done in the transmission and program field before this new art is suited for commercial use. Your corporation has adhered to the conviction that the introduction of purely experimental equipment of mere novelty interest would not provide a satisfactory source of general entertainment on the basis of a regular service to the public.

Television transmission, at the present stage of development, seems most practical on ultra-short radio waves. Not only have these waves given best results in the quality of picture reception, but they also promise the opportunity of creating a new service without the further overcrowding of the already congested short, intermediate and long wave sections of the radio spectrum. For that reason, an important phase of engineering and research work was directed in 1932 toward making ultra-short waves more serviceable.

These waves were given their first practical, commercial function in the inter-island Hawaiian telephone system developed in 1931 by RCA engineers. This system has since been in successful and continuous commercial operation. The service range of these waves has been limited sharply, however, because of their resemblance to light waves, which do not tend to follow the curvature of the earth. Experimental stations have been operated by your corporation in the ultra-short wave band for a number of years.

Automatic Repeater

An important new aspect was given to this work in 1932 by the successful operation of an automatic repeater or relay station for ultra-short waves. Although the practical results of these tests have not yet been confirmed, they appear at this stage to have overcome the limitations of range that formerly seemed inherent in ultra-short wave communication. Active engineering work is being continued in this field.

When the technical problems of television transmission are more nearly solved, there will remain the necessity of constructing transmission facilities, calling for vast capital outlay by those interested in promoting this new art, before television receiving instruments can render service in homes throughout the country. Nevertheless so much of fundamental value is expected from this development that every effort is being directed toward the solution of the remaining technical problems. Your corporation believes that because of the intensive nature of its research into these questions, and because of its patent rights, it will have a strong position in this new and promising field.

TRADIOGRAMS

By J. Murray Barron

Kay Radio opened at 179 Greenwich Street, N. Y. City. It will specialize in small parts, replacement parts and general radio merchandise. W. Kessler and associates are known to the downtown retail trade.

* * *

The demand for the new "Pro" booklet as issued by Hammarlund Mfg. Co. has been very large and there will be a slight delay in filling booklet requests. In it is a description of the new air type tuned intermediate frequency transformer and oscillator units as well as the new 2A5 tube. It might be well to get your request in at once. Address The Hammarlund Mfg. Co., Inc., 424 West 33rd Street, N. Y. City.

* * *

As the Spring approaches an increased interest is shown in auto radios and essentials. Just now there is an added interest in a B battery eliminator for car use. Some of the retail stores have literature. Postal Radio, 135 Liberty Street, N. Y. City, will send interesting literature about its new and unique B battery eliminator. It is entirely different and extremely efficient.

* * *

There has been on demonstration at Thor's, 167 Greenwich Street, N. Y. City, a very clever short-wave converter. Downtown is considered a very poor location for short-wave reception, yet some very fine catches were recorded. When in the neighborhood it's worth a call. Those out of town may receive information by mail.

* * *

Hammarlund-Roberts Inc., 424 West 33rd Street, N. Y. City, is now extending a cordial invitation to those interested in a fine laboratory-built all wave receiver to visit their laboratories for an actual demonstration, 2 to 5 p. m. week days, 9 to noon Saturdays. It has also issued a guarantee of world-wide reception in your home on the Comet All-Wave Receiver.

* * *

Those who experiment in short-wave reception find that while stranded enamel-covered wire acts very efficiently for broadcast reception, the solid wire of larger size is more efficient for short-wave reception. This statement is not made to start any discussion, but only to give out the findings of many who have experimented along these lines.

A THOUGHT FOR THE WEEK

THE radio business in general is waiting to see what the Roosevelt administration is going to do with the various problems that face the Radio Commission. Let's hope that when it's all over everybody will be satisfied. Several folk are getting their axes ready for the ever-revolving grind stone at Washington.

W2XE RETURNS, VARIES THREE WAVES DAILY

With completion of its new transmitter at Wayne, N. J., operating with double the former power, W2XE, the Columbia Broadcasting System's short-wave unit in New York, has returned to the air. Its signals were broadcast recently for the first time in several months and a special program by Nino Martini and the Columbia Symphony Orchestra was heard.

Whereas the old transmitter operated on a frequency of 6,120 kilocycles (49.02 meters), the new one will alternate between three different frequencies each day. It will be on the air daily from 11:00 a.m. to 1:00 p.m. on 15,270 kc (19.646 m); from 3:00 to 5:00 p.m. on 11,830 kc (25.36 m), and from 6:00 to 11:00 p.m. on 6,120 kc (49.02 m). This alternation of frequencies has been arranged to give optimum results in transmission. The frequency of 15,270 kc will be used on conjunction with a special antenna directional to England.

Union News Co. Takes Space in Radio City

The Union News Company, oldest and largest operator of newspaper and periodical stands in the United States, and established in 1872, has taken sizeable ground floor space in the 31-story RKO Building in Rockefeller Center.

The Union News Company will open late in March a modern soda-luncheonette and a complete newspaper, magazine and book store on the Sixth Avenue front of the RKO Building. Special services offered by the shop will include out-of-town newspapers, new fiction, a lending library and a complete line of nationally advertised cigarettes, cigars, tobaccos, candies and confectionaries. A staff of ten persons will man the shop, which will be open from eight o'clock in the morning to one o'clock in the morning every day in the year.

The new shop represents an expansion of the company's existing facilities, which already total approximately 2,300 retail stores and stands throughout the United States. The company is contemplating still further expansion, both in New York and the country at large, according to F. C. C. Boyd, advertising and merchandising manager, who is in charge of contracts.

Several innovations in newsstand practice and display will be introduced in the RKO Building shop.

Literature Wanted

Stephen Clark, 42 Lapham St., Rochester, N. Y.
Wm. Michael, 117 No. 3rd St., Missoula, Mont.
Mr. Charles R. Drum, 715 3rd Ave., California, Penna.
George A. Brown, 286 arding Ave., Clifton, N. J.
Frank Lange, 157 West 111th St., New York City.
Lee Alseth, 123 Pontius Ave., Seattle, Wash.
Louis Rossi, 291 E. Dom. St., Rome, N. Y.
Nile A. Tarbert, Box 245, Brilliant, Ohio.
Arthur Johnson, 1061 77th St., Brooklyn, N. Y.
C. G. Capps, 1469 Palmetto St., Jacksonville, Fla.
Louie W. Schick, R. 5, Box 94, Norwalk, Ohio.
John B. Sullivan, 264 Brunswick St., Rochester, N. Y.
Eduardo Coromina, Marquette Apartments, 965 Geary St., San Francisco, Calif.
John G. Cowell, 218 Mason St., Calumet City, Ill.
Edward A. Renz, 729 N. Washington Blvd., Fort Wayne, Ind.

STATION SPARKS

By Alice Remsen

Orpheus

WLW; Tuesdays, 11:30 P. M.

For "Vox Humana"

When Orpheus tuned his lovely lute,
And Thracian hills and valleys filled
With sound; he made the birds all mute,
So beautiful the songs he trilled.

He charmed the furious forest beast,
And every tree bowed down its head;
He moved the rocks. From west to east,
And north and south his music spread.

Its echo wanders through the spheres,
A mighty everlasting strain;
And evermore throughout the years
His melody is heard again.

O Orpheus! Sweet Orpheus!
Thy lute will never silent be!
O Orpheus! Sweet Orpheus!
Thy music sounds eternally!

—A. R.

* * *

A sweet half hour for music lovers is "Vox Humana," a period of restful organ music and vocal harmonization under the inspiring directorship of Grace Clauve Raine. If you have not already heard this beautiful period, tune in by all means. I'm sure you'll like it. At this time of the evening, eleven-thirty, Eastern Standard Time, it is very easy to get WLW almost anywhere east of the Rockies.

* * *

The Radio Rialto

First of all I must thank my Baltimore friend, Bissell Brooke, for thinking of me when she was in New York. Yes, dear Bissell; I am still in Cincinnati, and am enjoying it. Have taken a cute little flat and am cooking 'n' everything. I haven't forgotten you; just frightfully busy, that's all. One of these days I shall surprise Gene and you with a long letter. . . . It looks as though spring, taking a leaf from prosperity, is just around the corner. Quite warm here. . . . The action of the Cincinnati banks in calling a moratorium with a five per cent withdrawal plan, is merely a preventive measure, according to the bankers; people don't seem to be very much worried around here, anyhow. . . .

See where another vaudeville act has joined the radio comedy ranks. Jack "Professor" McLallen, with Sara and Sasafrass, may now be heard over the NBC-WJZ network each Tuesday and Friday at 10.45 p. m., E. S. T. . . . Frank Parker, the handsome A. and P. Gypsy tenor, will be twenty-seven on April 29th; Frank has purchased a new polo pony, in readiness for a few chukkers this coming season. . . . There is a rumor around the rialto that those heavy cigarette accounts will go off the air. Chesterfield may keep one night a week, at least during the summer months. . . . Have you heard Willard Robison, the Evangelist of Rhythm, and his fine orchestra, over WJZ and network, on Tuesdays, at 9:30 p. m.? If not, you've missed a treat! Willard has a good sense of humor; he told me a story once about a maestro who was famous for his ego; this man, summoned to court to give expert testimony in a law suit, described himself as "the greatest conductor in America"; later, a friend protested the extravagance of his claim. "It may have sounded conceited," said the conductor, "but, my dear fellow, you forget I was under oath!" . . .

William H. Woodin, our new Secretary of the Treasury, wrote "The Fire Chief March," which he dedicated to Ed Wynn; just heard it on the Fire Chief program; a fine, stirring piece of music; Mr. Woodin has written many excellent things, including those cute little children's tunes in the Raggedy Ann series, and the lovely melody of "Spring Is in My Heart Again," a popular ballad, to which I had the pleasure of listening before publication, when Mr. Woodin kindly played it for me up at the Miller Music Company; even though Mr. Woodin is an artist to his finger tips, he is still a great business man; until recently he was the head of a big industry, and he is, I may add, one of the sweetest-natured men I ever met. . . .

And speaking of songs, our own William C. Stoess, the maestro of "Dance Nocturne," heard over an NBC-WJZ network, from WLW each Sunday at midnight, had two of his own compositions on a recent program: "I've Got the Jigsaw Puzzle Blues," and "Save America Now"; what's more, the next day wires came in from New York for the songs; so you may hear them soon on other programs. . . . The popularity of the Myrt and Marge program does not wane, especially out in the Middle West, where the girls are great favorites. . . . In answer to quite a few inquiries: the "hot" guitarist, who strums each night on the Chesterfield series for Ruth Etting, Bing Crosby, and Jane Froman, is Eddie Lang; he was born in Philadelphia in 1902, and has served as featured instrumentalist in numerous noted orchestras; has dark hair and eyes, and a flashing smile; stands five feet, eight inches, and weighs one hundred and fifty-seven pounds; is the husband of Katherine Rasch, former "Follies" girl. . . .

The Four Eton Boys, Columbia's crack harmonizing quartet, are playing vaudeville dates in and around New York and New Jersey; they also manage to sandwich in broadcasts and a series of motion picture shorts. . . . One of Columbia's most versatile conductors is Victor Young, whose novel orchestra shares program honors with the Mills Brothers; an excellent conductor, violinist and pianist Young specializes in arrangements which feature instrumental solos and unusual orchestral coloring; above all, he is a prolific composer of popular song hits; some of his outstanding compositions include "Street of Dreams," "Lord, You Made the Night Too Long," "Waltzing in a Dream," "Can't We Talk It Over," "South in My Soul," and his first song, "Sweet Sue." His latest number is a foxtrot, "I Bring a Song." . . . Roy Atwell, whose word-scrambling has been one of the most amusing features of Fred Allen's CBS Revue, is now making his customary hit with the new Broadway production, "Strike Me Pink"; he is starring with such high lights of the amusement world as Jimmy Durante, Lupe Velez, Hal Le Roy and Hope Williams. . . .

Among the clever CBS character actors are Carl Mathieu, top tenor of the Travellers Quartet, who enacts German roles, and Herb Rice, writer and director of the CBS Bobby Benson programs, who plays the roles of both Buck Mason and Wong Lee in that presentation; Mr. Rice also plays upwards of ten additional character roles in the course of a week's run of radio dramatizations, which certainly beats even the old stock company days. . . . Many people have wondered if Fred Allen's wife, the featured comedienne of his program, used a fictitious name; no; Portland Hoffa is her real name, and she was named after her native city, Portland, Oregon—and that's not the half of it; her brother was born in Lebanon, Pennsylvania, and hence was named Lebanon; a third child was christened Harlem, because Harlem, New York, was her birthplace; the fourth, who was expected to be the last, was named Lastone (Last One); but, there came a fifth—so he was given the name of Period; it's quite evident that Portland's parents have a unique sense of humor. . . . And now Dale Wimbrow has really gone into the business of producing for profit; he has opened a factory down on the Bowery (of all places) and is manufacturing his own invention, "Wimbrola," a novel guitar with six strings which features a harmonic bass. . . . Did you know that the Dorsey Brothers, noted instrumentalists of Leonard Hayton's Chesterfield Orchestra, are twins—at least, almost; born just about a year apart, the sons of a Shenandoah, Pa., band master; they have been musical twins ever since they could handle an instrument; Jimmy, twenty-eight, plays the saxophone; Tommy, twenty-seven, plays the trombone. . . .

Station WHAM, Rochester, New York, has been given an increase in power, from 5,000 to 25,000 watts; their new transmitter is designed for 50,000 watt output, but will be used as 25,000 watts as specified by the Federal Radio Commission; the station is situated eighteen miles southeast of Rochester, in Victor Township; its old 5,000-watt transmitter has been retained intact for use in emergencies; uses 225-foot steel towers atop a 400-foot elevation, Western Electric equipment; William Fay, who came to WHAM in 1928 from WMAK, Buffalo, is the manager of this growing station, which is owned by the Stromberg-Carlson Telephone Manufacturing Company; by the way, it was in 1927 that I made my air debut on the Stromberg-Carlson Hour over WJZ, with Rosario Bourdon as conductor; WHAM was built in 1922, by two Rochester newspapers, the Times-Union and The Democrat and Chronicle, and was taken over by its present owners in 1927. . . .

Well, it's time for me to put on the stew; am keeping house for myself now and trying my best to emulate Octavia—but shouldn't be surprised if I had to send for her in a hurry.

* * *

Biographical Brevities

ABOUT LEONARD HAYTON

In the public eye (or should I say "ear"?) at the moment, is the youthful Chesterfield maestro, Leonard Hayton. Born in New York City, on February 13th, 1908, the son of a Manhattan restaurateur. Developed a penchant for the piano when six years old. Left high school to become pianist with Cass Hagen's orchestra. Graduated from there to Paul Whiteman's, was with him for two and a half years. Met Bing Crosby during this time and they struck up a friendship, which remained intact when Bing leaped to radio fame. This resulted in Hayton being engaged as one of the pianists for the Crosby radio and stage unit, which in turn resulted in Hayton emerging, at the age of twenty-four, not only as arranger and conductor for the popular baritone, but as musical director for the entire Chesterfield series.

Is known as "Lennie" to his friends. Is slender . . . of medium height; has dark hair and a trim little mustache. Likes a real game of ping-pong and is a football enthusiast; isn't superstitious and believes that everything happens for the best; hopes some day to write a serious symphony; believes that popular arrangements should faithfully represent the original melodies; lives in a bachelor apartment; divides his spare time between sports, symphonic concerts and the movies, especially the news reels.

Short-Wave Broadcast Stations

(We are indebted to the International Short-Wave Club, with headquarters at Klondyke, Ohio, U. S. A., for permission to publish this list, which includes stations authentically reported active.)

All times are given in Eastern Standard Time, add five hours for G.M.T. Wavelength only is given.

(Note—The following group of stations broadcasts musical programs. Commercial stations we listed separately.)

Wave Length Call	Location
14.47—LSY	Buenos Aires, Argentina. Near 4 P.M. Sundays.
15.93—PLE	Bandoeng. Java. Tuesdays 8:40-10:40 A.M.
16.87—W3XAL	Boundbrook, N. J. Week days. 7 A.M. to 3 P.M.
19.57—W2XAD	Schenectady, N. Y. 3 to 6 P. M. daily. Sat. & Sun. 1 to 6 P.M.
19.68—	Pontoise, France. 7 A.M. to 10 A.M. daily.
19.73—DJB	Zeesen, Germany. 8 A.M. to 12 noon daily.
19.84—HVJ	Vatican City. Broadcasts daily 5 A.M. to 5:15 A.M.
19.90—T14-NRH	Heredia, Costa Rica. Saturday 11 A.M. to noon, 4-5 P.M. and 10-11 P.M. Sun. and Mon., 11 A.M. to noon and 4-5 P.M.
20.60-HBJ	Geneva, Switzerland. Testing.
20.95—G2NM	Sonning-on-Thames, England. Sundays.
23.38—	Rabat, Morocco. Broadcasts Sunday, 7:30 to 9 A.M.
25.20—	Pontoise, France. 10.30 A.M. to 1:30 P.M. daily.
25.25—W8XK	Pittsburgh, Pa. 3 P.M. to 9 P.M. Daily.
25.34—W9XAA	Chicago, Ill. Relays WCFL, irregularly.
25.40—12RO	Rome, Italy. Broadcasts 11 A. M. to 12:30 and 3 to 5:30 P.M.
25.42—W1XAL	Boston, Mass. testing, irregularly.
25.53—G5SW	Chelmsford, England. Monday to Friday, 6:45 A.M. to 7:30 A.M. and 12:30 to 6:10 P.M. Sat. 7-8 A.M. and 12:30 to 6:10 P.M.
25.60—	Pontoise, France. 3 P.M. till 6 P.M. Daily.
25.60—VE9JR	Winnipeg, Canada. Daily exc. Sat. and Sun., 11:45 A.M. to 1:30 P.M.
26.83—CT3AQ	Funchal, Madeira. Tues.-Thurs., 5 to 6:30 P.M.; Sun. 10:30 A.M. to noon.
28.98—LSX	Buenos Aires, Argentina. Daily, 8 to 9 P.M.
29.26—DIQ	Zeesen Germany. Used irregular.
30-40—EAQ	Madrid, Spain. 6:30 to 8 P.M. daily. Sat. 1 to 3 P.M.
31.00—T14NRH	Heredia, Costa Rica. Daily exc. Sunday 9 to 10 P.M.
31.25—CT1AA	Lisbon, Portugal. Heard Tues., Thurs., Fri., 4 to 7 P.M.
31.28—VK2ME	Sydney, Australia. Saturday midnight to Sunday 2 A.M., 4:30 to 8:30 A.M. and 1:30 to 3:30 P.M.
31.30—HBL	Praquins, Switzerland. Testing near 4 P.M.
31.36—W1XAZ	Springfield, Mass. 3:30 P.M. to 11:30 P.M. Daily.
31.38—DJA	Zeesen, Germany. 2 P.M. to 6:30 P.M. daily.
31.40—VK3ME	Melbourne, Australia. Wed. 5 till 6:30 A.M., Sat. 5-7 A.M.
31.48—W2XAF	Schenectady, N. Y. Relays WGY daily 5 P.M. to 11 P.M.
31.51—OXY	Skamleback, Denmark. Broadcasts 2 to 6:30 P.M.
31.58—PRBA	Rio de Janeiro, Brazil. Heard between 6 P.M. and 8:30 P.M.
32.26—	Rabat, Morocco, broadcasts, Sundays, 3 to 5 P.M.
33.50—TGX	Guatemala City, Guatemala. Saturdays 10 P.M. till midnight.
34.68—VE9BY	London, Canada. Mondays 3 to 4 P.M. and irregular times.
38.60—HBP	Geneva, Switzerland. Testing.
39.40—HJ3ABF	Bogota, Colombia. 7 P.M. to 11 P.M.
40.50—HJ3ABD	Bogota, Columbia. Tues., Thur., Sat., 8 to 11 P.M.
41.00—CM5RY	Matanzas, Cuba. Saturdays 10:45 to 11:30 P.M.
41.60—EAR58	Teneriffe, Sat. and Sun., 4:30 P.M. to 6:00 P.M.
42.00—HJ4AAB	Manizales, Colombia. Thur. and Sat. 7-9 P.M. and 11-12 P.M.
42.20—HKN	Medellin, Colombia. 8 P.M. till 10 P.M. 8:30-10:30 P.M. Earlier Sun.
45.31—PRADO	Riobamba, Ecuador. Thursdays, 9 P.M. till 11 P.M.
46.60—REN	Moscow, U. S. S. R. Relays Moscow, 1 P.M. to 6 P.M.
46.67—VE9BY	London, Canada. Wednesday 8:30-9:30 P.M. Friday 7:00-7:55 A.M. and Saturdays 8-11 P.M.
46.96—W3XL	Boundbrook, N. J. No regular schedule.
47.00—HKS	Cali, Colombia. Irregular, near 10 P.M.
47.00—HCIDR	Quito, Ecuador. 8 P.M. till 10 P.M.
47.50—TITR	San Jose, Costa Rica. 10 to 12 A.M., 4 to 9:30 P.M.
48.00—HKA	Barranquilla, Col. 8 P.M. to 10 P.M. Daily.
48.85—VE9CL	Winnipeg, Canada. Daily except Sun., 6 P.M. till 8:30 P.M.
48.86—W8XK	Pittsburgh, Pa. 4 P.M. to 11 P.M., daily. Late Saturdays.
48.95—YV11BMO	Maracaibo, Venezuela. Broadcasts, 8 to 11 P.M.
49.18—W9XF	Chicago, Ill. 3:30 P.M. to 1 A.M. daily.
49.18—W3XAL	Boundbrook, N. J. Saturday 4 P.M. to midnight.
49.20—JB	Johannesburg, South Africa.
49.22—VE9GW	Bowmanville, Can. Week days, 3-9 P.M., Sun. 11 A.M.-7 P.M.
49.29—VE9BJ	St. John, N. B. Near 5 P.M. and 11 P.M.
49.34—W9XAA	Chicago, Ill. Relays WCFL, Sun. 11 A.M.-9 P.M.; Wed., Sat., 8:30 A.M. to 9 P.M.; Tues, and Thurs., 8:30 A.M. to 8 P.M.
49.42—VE9CS	Vancouver, B. C. Sun. 3:30 P. M. to Midnight. Fri. at 0 to 1:30 A.M.
49.50—W8XAL	Cincinnati, Ohio. 5 A.M.-9:30 A.M., 12:30-2:30 P.M. and 6 P.M. to 12:30 midnight.
49.50—VQ7LO	Nairobi, Kenya, Africa. Daily 11 A.M.-3:30 P.M. Tues. 3 A.M.-4 A.M. Thursday 8 A.M. to 9 A.M.
49.50—CMCI	Havana, Cuba. 9 P.M.-11 P.M.
49.51—ZL2ZX	Wellington, N. Z. Mon., Wed., Thur., Sat., 2:15 to 6:15 A.M.
49.59—VE9HX	Halifax, N. S. Mon., Tues., 6-10 P.M. Other days 6-7 P.M.
49.96—VE9DR	Drummondville, Can. Relays CFCF, 7 P.M. to 12 Midnight.
50.00—RW59	Moscow, U.S.S.R. 9 A.M.-11 A.M., 2 P.M.-5 P.M. Daily.
50.00—HKD	Barranquilla, Col. Daily 8-10 P.M.
50.26—HVJ	Vatican City. Broadcasts daily, 2-2:15 P.M., Sun. 5-5:30 A.M.
50.60—HKO	Medellin, Colombia. Mon., Wed., Fri. 8 to 10 P.M., Tues., Thurs., Sat. and Sun., 6 to 8 P.M.
51.00—HKB	Tunja, Colombia. Irregular near 10 P.M.
51.72—VK3LR	Victoria, Australia. Heard 2 A.M. to 6:30 A.M.
52.70—FIUI	Tananarive, Madagascar. Sat., Sun. 1-3 P.M. Other days 9:15-11:15 A.M.
58.00—PMY	Bandoeng, Java. 12:40 to 2:40 A.M. and 6:40 to 9:40 A.M.
62.50—W2XV	Long Island City, N. Y. Wed. and Fri. 8 till 10 P.M.
62.56—VE9BY	London, Canada. Saturday midnight on.
70.1—RV15	Khabarovsk, U.S.S.R., 3 A.M.-9 A.M.
109.60—VE9CI	London, Ontario. Daily 9 to 11 P.M. Sun. 11 A.M.-7 P.M.

Short-Wave Commercial Stations

(Note—These stations are used for relaying telephone messages between countries, ships at sea and shore stations, and aircraft and airport stations. These stations oftimes may be on the air for hours without anything taking place on them, with the exception of the aircraft stations which come on the air and back off again in an instant, or as soon as a message is delivered. They are also sometimes rented to relay radio programs. Wavelength only is given.

Wave Length Call	Location
14.01—WKK	Lawrenceville, N. J. Phones 8 A.M. till 4 P.M. LSN.
14.19—LSM	Buenos Aires, Arg. Phones Europe, mornings.
14.24—WKA	Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M.
14.27—LSN	Buenos Aires, Arg. Phones WLO, 8 A.M.-4 P.M.
14.47—LSY	Buenos Aires, Arg. Phones 10 A.M. to 2 P.M., irregular.
14.55—PMB	Bandoeng, Java. 3:10 A.M.-4:40 A.M. and 8-9:20 A.M., PCK.
14.70—GBA	Rugby, England. Phones to ships and LSN, irregular.
14.97—DHO	Nauen, Germany. Phone to LSG., 7 A.M.-11 A.M., Irreg.
14.97—OPL	Leopoldsville, Belgian Congo. Phones ORG mornings.
15.07—LSG	Buenos Aires, Arg., phone to FTM 10:30 A.M.-3:30 P.M.
15.13—WKN	Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M.
15.23—EAQ	Madrid, Spain. Phones to LSY 7-11 A.M., Irreg.
15.24—CEC	Santiago, Chile. Phones LSR HJY near 11 A.M. and 4 P.M.
15.50—FTM	St. Assise, France, 10 A.M.-2 P.M. LSG.
15.57—PPU	Rio de Janeiro, Brazil. Phone to FTM, 10:30 A.M.-3 P.M.
15.58—DFA	Nauen, Germany. Phone to XDA, Irreg., 10 A.M.-2 P.M.
15.61—WKF	Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M.
15.62—ORG	Brussels, Belgium. Testing phone, 11 A.M.-11:30 A.M.
15.77—WKW W2XBJ	Rocky Point, N. Y. Testing, mornings.
15.82—LSR	Buenos Aires, Arg. Phones HJY, CEC, 11 A.M. and 4 P.M.
15.90—ZSB	Cape Town, South Africa, 3 A.M. to 8 A.M. GAA.
15.93—PLE	Bandoeng, Java. Tues., Fri., 5:40-10:40 A.M. PCK.
16.06—OCI	Lima, Peru. Testing with HJY near 2 P.M.
16.11—GBU	Rugby, England. 6 A.M.-2 P.M. WMI.
16.25—HJY	Bogota, Col. Phones CEC, LSR, 11 A.M. and 4 P.M.
16.35—WLA	Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M.
16.35—ZLW	Wellington, New Zealand. Phones VK2ME irregularly.
16.38—GBS	Rugby, England, 6 A.M.-2 P.M. WND.
16.39—YVQ	Maracay, Venezuela. Testing, near 10 A.M., irregular.
16.44—FTE	St. Assise, France. Phones to FZR, 5 to 9 A.M.
16.50—PMC	Bandoeng, Java. Phones PCV, 3:10-9:20 A.M.
16.54—GBW	Rugby, England, 6 A.M.-2 P.M. WNC.
16.57—GBK	Bodmin, England, 6 A.M.-2 P.M. CGA.
16.67—KQJ	Bolinas, California. Testing.
16.82—PCV	Kootwijk, Holland, 6 A.M.-9 A.M. Java.
17.05—Ships	Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).
17.52—WOO	Ocean Gate, N. J. Phones ships, irregularly.
18.06—DAN	Norden, Germany. Testing with ships, 9 A.M.-12 noon.
18.44—WLK	Lawrenceville, N. J. Phones England.
18.56—GBX	Rugby, England, 4 P.M.-11 P.M. VK2ME.
18.71—KKP	Kaunuku, Hawaii. Phones KWO, 2 P.M.-7 P.M.
18.90—FTK	St. Assise, France. Phones to FZS, 9 to 10 A.M.
19.03—J1AA	Kemikawa-Cho, Japan. Experimental. Heard early morn'gs.
19.46—KWO	Dixon, California. Phones Hawaii 2:00 till 7:00 P.M.
19.54—KWU	Dixon, California. Phones Hawaii 2:00 till 7:00 P.M.
20.27—WKU W2XBJ	Rocky Point, N. Y. Testing in daytime.
20.42—PSS	Rio de Janeiro, Brazil. Testing with LSN, near 6 P.M.
20.56—WMN	Lawrenceville, N. J. Phones England, daylight.
20.70—LSN	Buenos Aires, Argentina. Phone WLO, afternoons.
20.73—WMF	Lawrenceville, N. J. Phones England, daylight.
20.75—GBW	Rugby, England. Phones WNC 6 A.M.-6 P.M.
20.97-21.26—	Amateur phones heard in daylight.
21.63—WTY W2XBJ	Rocky Point, N. Y. Testing irregular.
21.70—SUZ	Cairo, Egypt. Phones GAA 7 A.M. to 3:30 P.M.
21.77—KKW	Bolinas, Calif. Used for experimenting.
21.90—KKZ	Bolinas, Cal., testing irregularly.
22.06—GBB-GBC	Rugby, England. Phones CGA and ships, afternoons.
22.26—WAJ	Rocky Point, N. Y. R. C. A. test station.
22.40—WMA	Lawrenceville, N. J. Phones England, daylight.
22.55—CGA	Drummondville, Canada. Phones GBC 8 A.M. to 2 P.M.
22.68—Ships	Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).

(Continued on next page)

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Wave Length	Call	Location
22.93	J1AA	Kemikawa-Cho, Japan. Experimental tests, irregularly.
23.00	German ships	11:15 A.M. and 1:30 P.M.
23.36	WOO	Ocean Gate, N. J. Phones ships, irregularly.
23.38	CNR	Rabat, Morocco. Phones St. Assise, 5 A.M., 8 A.M.
23.45	IAC	Coltana, Italy. Tests irregularly.
24.00	DAN	Norden, Germany. Phones ships, noon to 3 P.M.
24.40	PLM	Bandoeng, Java. Phones VK2ME near 6:30 A.M.
24.40	ZLW	Wellington, New Zealand. Phone VK2ME, 3 to 8 A.M.
24.41	GBU	Rugby, England, 2 P.M.-7 P.M. WMI.
24.46	FTN	St. Assise, France. Testing with USA, daytime, irregularly.
24.60	GBX	Rugby, England, 4 A.M.-9 A.M. VK2ME-VLK.
24.6	GBS	Rugby, England, 2 P.M.-7 P.M. WND.
25.05	KKQ	Bolinas, California. Testing irregularly.
25.50	XDA	Mexico City. Testing with XAM near 1 and 6 P.M.
25.65	KIO	Kauhuku, Hawaii. Phones to KES, 2 to 8 P.M. Irregular.
25.67	YVQ	Maracay, Venezuela. Testing with Germany, 5-7 P.M.
25.75	PPQ	Rio de Janeiro, Brazil. Testing near 6 P.M. irregularly.
26.80	XAM	Merida, Yucatan, test with XDA, near noon and 6 P.M.
27.35	OCI	Lima, Peru. Phone HJY evenings.
27.68	KWV	Dixon, California. Phones Hawaii, irregularly.
27.80	GBP	Rugby, England. Phones VLK and J1AA, 9 P.M. and 6 A.M.
28.09	WNB	Lawrenceville, N. J. Phones Bermuda, daytime.
28.09	GBP	Rugby, England. Testing with J1AA and others.
28.12	CEC	Santiago, Chile. Testing with HJY, evenings, irreg.
28.44	WOK	Lawrenceville, N. J. Phones LSN, evenings.
28.5	VK2ME	Sydney, Australia, 1 A.M.-7 A.M. GBX.
28.80	KEZ	Bolinas, California. Testing.
28.80	PKP	Medan, Sumatra. Phones Java and VLK, 3 A.M. to 8 A.M.
29.04	ORK	Brussels, Belgium. Phones OPM 2-4, 9-11 A.M. and 3-6 P.M.
29.35	PSH	Rio de Janeiro, Brazil. Testing with W2XBJ, evenings.
29.58	OPM	Leopoldville, Belgian Congo. Phones ORK 9-11 A.M., 3-6 P.M.
29.80	VRT ZFB	Hamilton, Bermuda. Phones WNB in daytime.
29.83	SUV	Cairo, Egypt. Phones GAA after 3:30 P.M.
30.10	LSL	Buenos Aires, Arg. Works irreguarly.
30.15	GBU	Rugby, England, 5 P.M.- 11 P.M. WMI.
30.20	HJY	Bogota, Colombia. Phones OCI irreguarly, evenings.
30.3	LSN	Buenos Aires, Argentina, 6 P.M.-6 A.M. WLO.
30.40	WON	Lawrenceville, N. J. Phones England, evenings.
30.60	GCW	Rugby, England. Phones America, evenings.
30.75	VK2ME VLK	Sydney, Australia. Phones Java, 4 A.M.-8 A.M.
30.77	WOF	Lawrenceville, N. J. Phones England, evenings.
31.60	WEF W2BJ	Rocky Point. N. Y. Testing irregularly, evenings.
31.63	PLW	Bandoeng, Java. Phones Australia, 3 A.M.-8 A.M., irregular.
31.74	WES W2XBJ	Rocky Point, N. Y. Testing irregularly, evenings.
31.86	PLV	Bandoeng, Java. Phones Australia and Sumatra, 4 A.M.-8 A.M.
32.1	CGA	Drummondville, Can., 6 P.M.-6 A.M. GBK.
32.21	GBC	Rugby, England. Phones to ships, irregularly.
32.4	GBK	Bodmin, England, 6 P.M.-6 A.M. CGA.
32.72	WNA	Lawrenceville, N. J. Phones England, evenings.
33.25	GBS	Rugby, England, 6 P.M.-6 A.M. WND.
33.27	KEJ	Bolinas, California. Testing irregularly.
33.52	WEL W2XBJ	Rocky Point, N. Y. Testing irregularly, evenings.
33.70	ZLT	Wellington, New Zealand. Phones VLK 1 A.M.-9 A.M.
33.95	Ships	Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).
35.02	WOO	Ocean Gate, N. J. Phones ships, irregularly.
36.00	DAN	Norden, Germany. Phones ships 2-4 A.M. and 3-9 A.M.
36.00	German ships	2:30 A.M., 4:45 P.M. and 9:30 P.M.
36.65	PSK	Rio de Janeiro, Brazil Heard phoning WOK.
37.76	VK2ME	Sydney, Australia, tests, 3:00-7:00 A.M. GBX.
38.07	J1AA	Kemikawa-Cho, Japan testing with KEL irregularly.
38.86	KEE	Bolinas, California. Testing, irregularly.
39.42	KWX	Dixon, California. Phones Hawaii, nights.
39.65	KWY	Dixon, California. Phones Hawaii nights.
39.89	KDK KKH	Kauhuku, Hawaii. Phones KWO 9 P.M.-2 A.M.
40.54	WEM W2XBJ	Rocky Point, N. Y. Testing irregularly, evenings.
42.9	GBS	Rugby, England, 6 P.M.-6 A.M. WND.
43.54	KEQ	Kauhuku, Hawaii, Phones California, nights.
44.41	WOA	Lawrenceville, N. J. Phones VRT, nights.
44.41	WOB	Lawrenceville, N. J. Phones England, nights.
44.54	WEJ W2XBJ	Rocky Point, N. Y. Testing irregularly, evenings.
44.91	DGK	Nauen, Germany. Heard testing with WEJ near 9 P.M.
45.10	IAC	Coltano, Italy. Testing irregularly.
51.00	XDA	Mexico City, Mexico. Testing with XAM, 10 A.M.-8 P.M., irr.
51.09	WNB	Lawrenceville, N. J. Phones Bermuda nights.
52.00	XAM	Merida, Yucatan. Testing with XDA, 10 A.M.-8 P.M., irreg.
58.30	PMY	Bandoeng, Java. Phones Australia, near 11 A.M.
59.42	VRT ZFA	Hamilton, Bermuda. Phones WNB and GMBJ, nights.
60.26	GBC	Rugby, England. Phones to ships, irregularly.
62.70	CGA	Drummondville, Canada. Phones ships irregularly.
63.13	WOO	Ocean Gate, N. J. Phones ships, irregularly.
71.82	Ships	Majestic (GFWV); Olympic (GLSQ); Belgenland (GMJQ); Homeric (GDLJ); Leviathan (WNBN); Monarch of Bermuda (GTSD); Minnetonka (GKFY); Empress of Britain (GMBJ).
75—75.8	Amateurs	on voice.
118.06	WOX	Bell Telephone test station. Irregularly.

Aircraft Stations

(Note—This group of stations is used to relay messages to and from airplanes, such as location of a plane, storms coming and other things. They come on the air suddenly, deliver a message and go right off again. Airplanes in flight may be found on the same wavelength. They will be found between 53.00 and 54.00).

Police Stations

(Note—These stations are used by police departments to relay messages to police cars that patrol the cities. They come on the air, deliver their message and go right off again. When one is tuned in, just keep the dials at the same place and ofttimes many others may be heard. They will be found between 119.71 and 124.27 also between 175.23 and 192.55.)

Identifying Stations

Here are a few tips on identifying stations that may be heard on a short wave receiver. The call letters of each station are given and then the identification signal.

PLE—Announces in English, Dutch, and French as "Bandoeng Radio."
Pontoise—Plays "Marseillaise" at start and close of program.
DJA and DJB—Announces all stations in chain broadcast like "Berlin, Dresden, Hamburg, Stuttgart."
HVJ—Announces "Hillo, Hillo, Radio Vaticano."
RABAT—Announces "Radio Rabat." Uses beat of Mentronome.
2RO—Lady announces "Radio Roma" or "Radio Roma Napoli."
G5SW—Announces "London Calling" or G5SW, Chelmsford."
EAQ—Announces "Hillo, Ay ah, coo., Transradio, Madrid."
T14-NRH—Bugle Call or Tic-Tac between selections.
VK2ME—Laughing notes of Kookaburra Bird open and close programs.
CT1AA—Six Cuckoo calls between selections.
VK3ME—Broadcasts 9:00 o'clock chimes at 6 A.M., E. S. T.
OXY—Broadcasts midnight chimes at 6 P.M., E. S. T.
TGX—Announces "Tay, hay, aykis, Guatemala."
HKF—Announces "Achay, kah, effay, Bogota."
PRADO—Announces "Estacion El Prado, Rio Bamba, Ecuador."
HSP2—Strikes six notes on piano between selections.
HKM—Announces "Achay, kah, emmie, Bogota, Colombia."
HKA—Announces "Achay, kah, ah, Barranquilla." Uses whistle.
F3ICD—Striking of gongs and symbols between selections.
CMCI—Announces in Spanish and English.
HCJB—Announces in Spanish and English.
HKD—Announces "Achay, kah, day, Barranquilla, Colombia."
HKO—Announces "Achay, kah, oh, Medellin, Colombia."
LSG—Calls "Allo, Allo, Paree, ici Burnos Aires."
FTM—Calls "Allo, Allo, Buenos Aires, ici Paree."
IAC—Calls "Pronto, Pronto, heir is Roma."
LSX—Announces "Ellie, essie aykiss, Transradio Buenos Aires."
YV11BMO—Announces "La Vox de Lago."
GENEVA—Announces in English and French.
PRBA—Announces "Radio Club de Brazil."
American Stations—Identified by the stations they relay.

Most telephone stations can be identified by the station or city they are heard calling and judging the wavelength it is heard on. For example, if you hear a station near 17 meters calling "Hillo Bandoeng" you are almost certain it is PCV, Kootwijk, Holland, who works with the Bandoeng telephone stations on 16.82 meters.

Precautions Against Hum in Heavy-Duty Receivers

When building a circuit that is a-c operated and has three stages of audio, special precautions must be taken for prevention of hum. As likely there will be numerous tubes, it is necessary to have a power transformer that can handle the power adequately, for if that transformer is overloaded it sets up a terrific field, which carries the hum frequency. Thus there could be easy but undesirable coupling to an audio transformer, and besides static coupling may result in other directions.

Also, the filtration should be better than is often provided. Since the effectiveness of a choke is approximately inversely proportional to the current, the inductance should be high enough for the purpose, since large current is passing through the choke. An expedient is to use two chokes, wherein the power tubes' current passes through one, and the current for the other tubes through the other.

In a multi-stage set of this type no doubt a push-pull output stage would be used, and the input transformer should be accurately center-tapped at its secondary. The output transformer is no doubt built into the speaker, and the accuracy has to be as good here as in the input.

Then, the filter capacities should be adequate, although it will be found that after a certain value has been attained, higher values may increase the hum, instead of decreasing it. Usually 8 mfd. at any filter capacity position is sufficient, although if more capacitv is available it may be used to the following effect: If added next to the rectifier (filament of rectifier to B minus or ground), the d-c voltage will increase somewhat, and the hum will go down, but there is an enlarged starting drain on the rectifier tube; if added at the B plus feed to the power tubes, it increases the low-note power-handling capacity, or rather, builds up a greater reservoir of power, so that sudden drains will be taken care of, but these usually have to do with powerful passages with large low-note accentuation in orchestral renditions.

Besides, hum filters of the resistor-capacity type may be tried. They are not always effective. They shift phases, and if the shift is right, the result is good. In the power tube grid circuit the resistance should be small, due to grid current possibilities, the capacity large, e.g., 25,000 ohms and 0.5 mfd. may be used. In earlier audio grid circuits or in plate circuits the resistors may be larger, for resistance-coupled audio, and the capacities smaller, except that in triode or quardrode detector circuits the capacity may be 1 mfd. The connection is to interrupt the lead to B plus or grid return with the extra resistor and put the condenser from juncture of the two impedances to ground. Try different condenser values.

STATIONS BY FREQUENCIES

United States, Canadian, Newfoundland, Cuban and Mexican Transmitters Listed

Corrected to March 8th, 1933

The stations listed herewith are in the order of frequencies, with equivalent wavelengths given. The call, location, owner, and power are stated. The location is that of the main studio, for United States stations. If the transmitter is located elsewhere it is indicated additionally, preceded by T. The power given is the licensed maximum. Some stations use maximum power in daytime only. These are identified by an asterisk after the power figure (*). Usually in such cases the night power is half the day power. CP means construction permit, license awaited.

—EDITOR.

540 KILOCYCLES—555.6 METERS

CKWO—Windsor, Ont., Can.; Essex Bdcsters Lmt. 5 KW.

550 KILOCYCLES—545.1 METERS

WGR—Buffalo, N. Y.; T—Amherst, N. Y.; Buffalo Broadcasting Corporation; 1 KW.
WKRC—Cincinnati, Ohio; WKRC (Inc.); 1 KW.
KFUO—St. Louis, Mo.; Concordia Theo. Sem.; 1 KW.*
KSD—St. Louis, Mo.; Pulitzer Publishing Co.; 500 W.
KFDY, Brookings, S. Dak.; South Dakota State College, 1 KW.*
KFYR—Bismarck, N. Dak.; Meyer Broadcasting Co., 2½ KW.*
KOAC—Corvallis, Oreg.; Oregon State Agricultural College, 1 KW.

560 KILOCYCLES—535.4 METERS

WLIT—Philadelphia, Pa.; Lit Bros. Bdcg. System, Inc.; 500 W.
WFI—Philadelphia, Pa.; WFI Bdcg. Co.; 500 W.
WQAM—Miami, Fla.; Miami Broadcasting Co.; 1 KW.
KFDM—Beaumont, Tex.; Sabine Bdcg. Co., Inc.; 1 KW.*
WNOX—Knoxville, Tenn.; WNOX, Inc.; 2 KW.*
WIBO—Chicago, Ill.; T—Des Plaines, Ill.; Nelson Bros. Bond & Mortgage Co.; 1½ KW.*
WPCC—Chicago, Ill.; North Shore Church; 500 W.
KLZ—Denver, Colo.; Reynolds Radio Co. (Inc.), 1 KW.
KTAB—San Francisco, Calif.; T—Oakland, Calif.; The Associated Broadcasters (Inc.), 1 KW.

570 KILOCYCLES—526.0 METERS

WNYC—New York N. Y.; City of N. Y.; 500 W.
WMCA—New York, N. Y.; T—Hoboken, N. J.; Knickerbocker Broadcasting Co. (Inc.); 500 W.
WSYR-WMAC—Syracuse N. Y.; Clive B. Meredith; 250 W.
WKBN—Youngstown, Ohio; WKBN Broadcasting Corp.; 500 W.
WEAO—Columbus, Ohio; Ohio State University; 750 W.
WWNC—Asheville, N. C.; Citizen Broadcasting Co.; 1 KW.
KGKO—Wichita Falls, Tex.; Wichita Falls Broadcasting Co., Inc.; 500 W.*
WNAX—Yankton, S. Dak.; The House of Gurney (Inc.); 2.5 KW (CP).
KMTR—Los Angeles, Calif.; KMTR Radio Corporation; 500 W.
KVI—Tacoma, Wash.; Puget Sound Bdcg Co.; 500 W.

580 KILOCYCLES—516.9 METERS

WDBO—Orlando, Fla.; Orlando Bldg. Co., 250 W.
WTAG—Worcester, Mass.; Worcester Telegram Publishing Co. (Inc.), 250 W.
WOBU—Charleston, W. Va.; WOBU (Inc.), 250 W.
WSAZ—Huntington, W. Va.; WSAZ (Inc.); 250 W.
WIBW—Topeka, Kans.; Topeka Broadcasting Association (Inc.), 1 KW.
KSAC—Manhattan, Kans.; Kansas State Agricultural College; 1 KW.*
KMJ—Fresno, Calif.; Jas. McClatchy Co.; 500 W.
CFCY—Charlottetown, Prince Edward Island, Canada; Island Broadcasting Co., Ltd.; 500 W.
CHMA—Edmonton, Alberta, Can.; Christian & Missionary Alliance, 250 W.
CKCL—Toronto, Ontario, Can.; Dominion Battery Co., Ltd.; 500 W. (Uses call CFCL on Sundays), 500 W.
CKUA—Edmonton, Alberta, Can.; University of Alberta; 500 W.

590 KILOCYCLES—508.2 METERS

WGCM—Gulfport, Miss.; T—Mississippi City, Miss.; Great Southern Land Co.; 1 KW.
WEEI—Boston, Mass.; T—Weymouth, Mass.; Edison Electric Illuminating Co. of Boston; 1 KW.
WKZO—Berrien Springs, Mich.; WKZO (Inc.); 1 KW.
WCAJ—Lincoln, Nebr.; Nebraska Wesleyan University; 500 W.
WOW—Omaha, Nebr.; Woodmen of the World Life Insurance Association; 1 KW.
KHQ—Spokane, Wash.; Louis Wasmer (Inc.), 2 KW.*
CMW—Havana Cuba; Columbus Commercial & Radio Co.; 1400 W.

595 KILOCYCLES—503.9 METERS

CJGC—London, Ontario, Can.; T—Strathburn, Ontario, Can.; London Free Press & Ptg. Co., Ltd.; 5 KW.
CNRL—London, Ontario, Can.; T—Strathburn, Ontario, Can. (Uses Transmitter of CJGC); Canadian National Railways; 5 KW.

600 KILOCYCLES—499.7 METERS

WICC—Bridgeport, Conn.; T—Easton, Conn.; Bridgeport Broadcasting Station (Inc.); 250 W.
WCAC—Storrs, Conn.; Connecticut Agricultural College; 250 W.
WCAO—Baltimore, Md.; Monumental Radio (Inc.), 250 W.
WREC—Memphis, Tenn.; T—Whitehaven, Tenn.; WREC (Inc.), 1 KW.*
WMT—Waterloo, Iowa; Waterloo Broadcasting Co.; 500 W.
KFSD—San Diego, Calif.; Airfan Radio Corporation (Ltd.); 1 KW.*
CNRO—Ottawa, Ontario, Can.; Canadian National Railways; 500 W.

610 KILOCYCLES—491.5 METERS

WJAY—Cleveland, Ohio; Cleveland Radio Broadcasting Corporation; 500 W.
WIP—Philadelphia, Pa.; Penna. Bdcg. Co., Inc.; 500 W.
WDAF—Kansas City, Mo.; Kansas City Star Co.; 1 KW.
KFRC—San Francisco, Calif.; Don Lee (Inc.); 1 KW.
WFAN—Philadelphia, Pa.; Keystone Broadcasting Co.; 500 W.
XETR—Mexico, D. F.; Cia Difusora Mexicana, S. A.; 2½ KW.

620 KILOCYCLES—483.6 METERS

WLBZ—Bangor, Me.; Maine Broadcasting Co. (Inc.); 500 W.
WFLA-WSUN—Clearwater, Fla.; Clearwater Chamber of Commerce and St. Petersburg Chamber of Commerce; 2½ KW.*
WTMJ—Milwaukee, Wis.; T—Brookfield, Wis.; The Journal Co. (Milwaukee Journal), 2½ KW.*
KGW—Portland, Oreg.; Oregonian Publishing Co.; 1 KW.
KTAR—Phoenix, Ariz.; KTAR Broadcasting Co.; 1 KW.*

630 KILOCYCLES—475.9 METERS

KGFX—Pierre, S. D.; Dana McNeil; 200 W.
WMAL—Washington, D. C.; M. A. Leese Radio Corp.; 500 W.*
WOS—Jefferson City, Mo.; Missouri State Marketing Bureau, 500 W.
KFRU—Columbia, Mo.; Stevens College; 500 W.
WGBF—Evansville, Ind.; Evansville on the Air (Inc.); 500 W.

630 KILOCYCLES—475.9 METERS (Continued)

CFCT—Victoria, British Columbia; Victoria Broadcasting Asso.; 50 W.
CJGX—Winnipeg, Manitoba; T—Yorkton, Saskatchewan; Winnipeg Grain Exchange; 500 W.
CHCS—Hamilton, Ont., Can.; T—Fruitland; Spectator; 1 KW.*
CKOC—Hamilton, Ont., Can.; T—Fruitland; Wentworth Bdcg Co.; 1 KW.*
CKTB—St. Catherine's, Ont., Can.; T—Fruitland; Taylor & Bate, St.; 1 KW.*
CNRA—Moncton, New Brunswick; Canadian National Railways; 500 W.
CMCJ—Havana, Cuba; Rafael Rodriquez; 250 W.
XETA—Veracruz, Ver., Mex.; Manuel Espinosa Tagle; 500 W.
XETF—Veracruz, Ver., Mex.; Manuel Angel Fernandez; 500 W.
CMQ—Havana, Cuba; Jose Fernandez; 250 W.

640 KILOCYCLES—468.5 METERS

WAIU—Columbus, Ohio; Associated Radiocasting Corp.; 500 W.
WOI—Ames, Iowa; Iowa State College of Agriculture and Mechanic Arts; 5 KW.
KFI—Los Angeles, Calif.; Earle C. Anthony (Inc.), 50 KW.

645 KILOCYCLES—464.8 METERS

CHRC—Quebec, Quebec, Can.; CHRC, Ltd.; 100 W.
CKCI—Quebec, Quebec, Can. (Uses transmitter of CHRC); Le Soleil, Inc.; 100 W.
CKCR—Waterloo, Ontario, Can.; Wm. C. Mitchel & Gilbert Liddle, 100 W.

650 KILOCYCLES—461.3 METERS

WSM—Nashville, Tenn.; National Life & Accident Insurance Co.; 50 KW.
KPCB—Seattle, Wash.; Queen City Broadcasting Co.; 100 W.

660 KILOCYCLES—454.3 METERS

WEAF—New York, N. Y.; T—Belmore, N. Y.; National Broadcasting Co. (Inc.); 50 KW.
WAAW—Omaha, Nebr.; Omaha Grain Exchange; 500 W.
CMCO—Havana, Cuba; J. L. Stowers; 250 W.
CMDC—Havana, Cuba; Juan Fernandez de Castro; 500 W.

665 KILOCYCLES—450.9 METERS

CHWK—Chilliwack, British Columbia, Can.; Chilliwack Broadcasting Co., Ltd.; 100 W.
CJRM—Moose Jaw, Saskatchewan; T—old city Moose Jaw, Can.; James Richardson & Sons, Ltd.; 500 W.
CJRW—Winnipeg, Manitoba; T—Fleming, Saskatchewan, Can.; James Richardson & Sons, Ltd.; 500 W.

670 KILOCYCLES—447.5 METERS

WMAQ—Chicago, Ill.; T—Addison, Ill.; WMAQ (Inc.); 5 KW.

675 KILOCYCLES—444.2 METERS

VOWR—St. John's, N. F.; Wesley United Church; 500 W.

680 KILOCYCLES—440.9 METERS

WPTF—Raleigh, N. C.; Durham Life Insurance Co.; 1 KW.
KFEQ—St. Joseph, Mo.; Scroggin & Co. Bank; 2½ KW.
KPO—San Francisco, Calif.; Natoinal Bdcg. Co.; 5 KW.
XFG—Mexico City, Mex.; Sria de Guerra y Marina; 2 KW.

685 KILOCYCLES—437.7 METERS

VAS—Glace Bay, Nova Scotia, Can.; Canadian Marconi Co.; 2 KW.

690 KILOCYCLES—434.5 METERS

CFAC—Calgary, Alberta, Can.; The Calgary Herald; 500 W.
CFRB—Toronto, Ontario, Can.; T—King, Ontario, Can.; Rogers Majestic Corp., Ltd.; 10 KW.
CJCJ—Calgary, Alberta, Can.; Albertan Pub. Co., Ltd.; 500 W.
CNRX—Toronto, Ontario, Can.; T—King, Ontario, Can. (Uses transmitter of CFRB); Canadian National Railways; 4 KW.
XET—Monterrey, N. L., Mex.; Mexico Music Co., S. A.; 500 W.

700 KILOCYCLES—428.3 METERS

WLW—Cincinnati, O.; T—Mason, Ohio; Crosley Radio Corporation; 50 KW.

710 KILOCYCLES—422.3 METERS

WOR—Newark, N. J.; T—Kearny, N. J.; Bamberger Broadcasting Service (Inc.); 5 KW. (50 KW. C. P.)
KMPC—Los Angeles, Calif.; R. S. MacMillan; 500 W.
XEN—Mexico City, Mex. (Actual frequency 711 KC., 421.9 Meters); Cerveceria Modelo, S. A.; 1 KW.

720 KILOCYCLES—416.4 METERS

WGN-WLIB—Chicago, Ill.; T—Elgin, Ill.; WGN, Inc.; 25 KW.

730 KILOCYCLES—410.7 METERS

CHLS—Vancouver, British Columbia (Uses transmitter of CKCD); W. G. Hassell; 50 W.
CHYC—Montreal, Quebec, Can.; T—St. Hyacinthe, Quebec, Can. (Uses transmitter of CKAC); Northern Elec. Co., Ltd.; 5 KW.
CKAC—Montreal, Quebec, Can.; T—St. Hyacinthe, Quebec, Can.; LaPresse Pub. Co.; 5 KW.
CKCD—Vancouver, British Columbia, Can.; Vancouver Daily Province; 100 W.
CKFC—Vancouver, British Columbia, Can.; United Church of Canada; 50 W.
CKMO—Vancouver, British Columbia, Can.; Sprott-Shaw Radio Co.; 100 W.
CKWX—Vancouver, British Columbia, Can.; Western Broadcasting Co., Ltd.; 100 W.
CNRM—Montreal, Quebec, Can.; T—St. Hyacinthe, Quebec, Can. (Uses transmitter of CKAC); Canadian National Railway; 5 KW.
XER—Villa Acuna, Coah., Mex. (Actual frequency 735 KC., 408.1 Meters); Compania Radiodifusora de Acuna, S. A.; 75 KW.
CMK—Havana, Cuba; Cuban Bdcg. Co.; 3150 W.

740 KILOCYCLES—405.2 METERS

WSB—Atlanta, Ga.; Atlanta Journal Co.; 5 KW. (50 KW.—C. P.).
KMMJ—Clay Center, Nebr.; The M. M. Johnson Co.; 1 KW.
WHEB—Portsmouth, N. H.; Granite State Bldg. Corp.; 250 W. C. P.

(*Continued on next page*)

(Continued from preceding page)

745 KILOCYCLES—402.4 METERS

CJCA—Edmonton, Alta., Can.; Edmonton Journal; 500 W.

750 KILOCYCLES—399.8 METERS

WJR—Detroit, Mich.; T—Sylvan Lake Village, Mich.; WJR, The Goodwill Station (Inc.), 10 KW.
KGU—Honolulu, Hawaii; M. A. Mulroney and Advertiser Pub. Co., Ltd.
XEQ—C. Jaurez, Coah., Mex.; Feliciano Lopez Islas; 5 KW.

760 KILOCYCLES—394.5 METERS

WJZ—New York, N. Y.; T—Boundbrook, N. J.; National Broadcasting Co.; Inc.); 30 KW.
WEW—St. Louis, Mo.; St. Louis University; 1 KW.

770 KILOCYCLES—389.4 METERS

KFAB—Lincoln, Neb.; KFAB Broadcasting Co.; 5 KW. (25 KW. C. P.).
WBBM-WJBT—Chicago, Ill.; T—Glenview, Ill.; WBBM Broadcasting Corp. (Inc.); 25 KW.

780 KILOCYCLES—384.4 METERS

WEAN—Providence, R. I.; Shepard Broadcasting Service (Inc.); 500 W.
WTAR-WPOR—Norfolk, Va.; WTAR Radio Corporation; 500 W.
WMC—Memphis, Tenn.; T—Bartlett, Tenn.; Memphis Commercial Appeal, Inc.; 1 KW.*
KELW—Burbank, Calif.; Magnolia Park, Ltd.; 500 W.
KTM—Los Angeles, Calif.; T—Santa Monica, Calif.; Pickwick Broadcasting Corporation; 1 KW.*
CKY—Winnipeg, Manitoba, Can.; Manitoba Telephone System; 5 KW.
CNRW—Winnipeg, Manitoba, Can. (Uses Transmitter of CKY); Canadian National Railways; 5 KW.
XEZ—Mexico, D. F., Joaquin Capilla; 500 W.

790 KILOCYCLES—379.5 METERS

WGY—Schenectady, N. Y.; T—South Schenectady, N. Y.; General Electric Co.; 50 KW.
KGO—San Francisco, Calif.; T—Oakland, Calif.; National Broadcasting Co. (Inc.); 7½ KW.
CMBT—Havana, Cuba; E. Perera; 500 W.
CMBS—Havana, Cuba; Enrique Artalejo; 150 W.
CMHC—Tuinucu, Cuba; Frank H. Jones; 250 W.

800 KILOCYCLES—374.8 METERS

WBAP—Fort Worth, Tex.; Carter Publications (Inc.); 10 KW.
WFAA—Dallas, Tex.; T—Grapevine, Texas; Dallas News and Dallas Journal A. H. Belo Corporation; 50 KW.

810 KILOCYCLES—370.2 METERS

WPCH—New York, N. Y.; T—Hoboken, N. J.; Eastern Broadcasters (Inc.); 500 W.
WCCO—Minneapolis, Minn.; T—Anoka, Minn.; Northwestern Broadcasting (Inc.); 5 KW. (50 KW. C. P.)
VOAS—St. John's, N. F.; Ayre & Sons, Ltd.; 75 W.
XFC—Aguascalientes, Ags., Mex.; Gobierno Edo. Aguascalientes; 350 W.

815 KILOCYCLES—367.9 METERS

CHNS—Halifax, N. S., Can.; Maritime Bdcg Co., Ltd.; 500 W.
CNRA—Halifax, N. S., Can.; Can. Natl Railways; 500 W.

820 KILOCYCLES—365.6 METERS

WHAS—Louisville, Ky.; T—Jeffersontown, Ky.; The Courier Journal Co. and The Louisville Times Co.; 25 KW.
XFI—Mexico City, Mex.; Sria Ind. Com. y Trabajo (Actual frequency 818.1 KC—366.7 Meters); 1 KW.

830 KILOCYCLES—361.2 METERS

WHDH—Saugus, Mass.; T.—Gloucester, Mass.; Matheson Radio Co. (Inc.); 1 KW.
WRUF—Gainesville, Fla.; University of Florida; 5 KW.
KOA—Denver, Colo.; National Broadcasting Co. (Inc.), 12½ KW.
WEEU—Reading, Pa.; Berks Broadcasting Co.; 1 KW.

840 KILOCYCLES—356.9 METERS

CJBC—Toronto, Ontario, Can.; T—Bowmanville, Ontario, Can. (Uses transmitter of CKGW); Jarvis St. Baptist Church; 5 KW.
CKGW—Toronto, Ontario, Can.; T—Bowmanville, Ontario, Can.; Gooderham & Worts; 10 KW.
CKLC—Calgary, Alberta, Can.; T—Red Deer, Alberta, Can.; Alberta Pacific Grain Company; 1 KW.
CNRD—Red Deer, Alberta, Can. (Uses transmitter of CKLC); Canadian National Railways; 1 KW.
CPRY—Toronto, Ontario, Can.; T—Bowmanville, Ontario, Can. (Uses transmitter of CKGW); Canadian Pacific Railway Co.; 5 KW.

842 KILOCYCLES—356.1 METERS

CMC—Havana, Cuba; Cuban Telephone Co.; 500 W.
XEFD—Tiajuana, Mex.; Carlo de la Sierra; 300 W.

850 KILOCYCLES—352.7 METERS

KWKH—Shreveport, La.; T—Kennonwood, La.; Hello World Broadcasting Corporation; 10 KW.
WWL—New Orleans, La.; Loyola University; 10 KW.

860 KILOCYCLES—348.6 METERS

WABC-WBOQ—New York, N. Y.; T—West of Cross Bay Blvd., Queens Co., N. Y.; Atlantic Broadcasting Corporation; 5 KW.
WHB—Kansas City, Mo.; T—North Kansas City, Mo.; WHB Broadcasting Co.; 500 W.
XFX—Mexico City, Mex.; Sria de Educacion Publica; 500 W.

870 KILOCYCLES—344.6 METERS

WLS—Chicago, Ill.; T—Crete, Ill.; Agricultural Broadcasting Co.; 50 KW.
WENR—Chicago, Ill.; T—Downers Grove, Ill.; National Broadcasting Co., 50 KW.
XFF—Chihuahua, Mex.; Estado de Chihuahua; 500 W.

880 KILOCYCLES—340.7 METERS

WGBI—Scranton, Pa.; Scranton Broadcasters (Inc.); 250 W.
WQAN—Scranton, Pa.; E. J. Lynett, prop., The Scranton Times, 250 W.
WCOC—Meridian, Miss.; Mississippi Broadcasting Co. (Inc.); 1 KW.*
WSUI—Iowa City, Iowa; State University of Iowa; 500 W.
KLX—Oakland, Calif.; The Tribune Publishing Co.; 500 W.
KPOF—Denver, Colo.; Pillar of Fire; 500 W.
KFKA—Greeley, Colo.; The Mid-Western Radio Corporation; 1 KW.*
CHML—Mount Hamilton, Ontario, Can.; Maple Leaf Radio Co., Ltd.; 50 W.
CJCB—Sydney, Nova Scotia, Can.; N. Nathanson; 50 W.
CKCV—Quebec, Quebec, Can.; Vandry, Inc.; 50 W.
CKPC—Preston, Ontario, Can., Cyrus Dolph; 100 W.
CNRQ—Quebec, Quebec, Can. (Uses transmitter of CKCV); Canadian National Railways; 50 W.

890 KILOCYCLES—336.9 METERS

CMX—Havana, Cuba; Francisco Lavin; 1 KW.
WJAR—Providence, R. I.; the Outlet Co.; 500 W.
WKAQ—San Juan, P. R.; Radio Corporation of Porto Rico; 500 W.*
WMMN—Fairmount, W. Va.; Holt-Rowe Novelty Co.; 500 W.*
WGST—Atlanta, Ga.; Georgia School of Technology; 200 W night, 500 W day.
KGJF—Little Rock, Ark.; First Church of the Nazarene; 250 W.

890 KILOCYCLES—336.9 METERS (Cont.)

WILL—Urbana, Ill.; University of Illinois; 500 W.*
KARK—Little Rock, Ark.; Ark. Radio & Equip. Co.; 250 W.
KFNF—Shenandoah, Iowa; Henry Field Co.; 500 W.
KUSD—Vermillion, S. Dak.; University of South Dakota; 750 W.*
KFNF—Shenandoah, Iowa; Henry Field Co.; 1 KW.*
CFBO—St. John, New Brunswick, Can.; C. A. Munro, Ltd.; 500 W.
CKCO—Ottawa, Ontario, Can.; Dr. G. M. Geldert; 100 W.
CKPR—Port Arthur, Ontario, Can.; Dougall Motor Car Co., Ltd.; 50 W.
XES—Tampico, Tams., Mex.; Difusoral Portena; 500 W.
CMCF—Havana, Cuba; Raoul Karman; 250 W.

900 KILOCYCLES—333.1 METERS

WBEN—Buffalo, N. Y.; T—Martinsville, N. Y.; WBEN, Inc.; 1 KW.
WKY—Oklahoma City, Okla.; WKY Radiophone Co.; 1 KW.
WJAX—Jacksonville, Fla.; City of Jacksonville; 1 KW.
WLBL—Stevens Point, Wis.; State of Wisconsin, Department of Agriculture and Markets, 2 KW.
KHJ—Los Angeles, Calif.; Don Lee (Inc.); 1 KW.
KSEI—Pocatello, Idaho; Radio Service Corp.; 250 W. C. P. 500 W.
KGBU—Ketchikan, Alaska; Alaska Radio and Service Co. (Inc.) 500 W.

910 KILOCYCLES—329.5 METERS

CFQC—Saskatoon, Saskatchewan, Can.; The Electric Shop, Ltd.; 500 W.
CNRS—Saskatoon, Saskatchewan, Can. (Uses transmitter of CFQC); Canadian National Railways; 500 W.
XEW—Mexico City, Mex.; Mexico Music Co.; S. A.; 5 KW.

915 KILOCYCLES—327.7 METERS

CFLC—Prescott, Ontario, Can.; Radio Association of Prescott; 100 W

920 KILOCYCLES—325.9 METERS

WBSO—Needham, Mass.; Babson's Statistical Organization (Inc.); 500 W.
WWJ—Detroit, Mich.; The Evening News Association (Inc.); 1 KW.
KPRC—Houston, Tex.; T—Sugarland, Texas; Houston Printing Co.; 2½ KW.
WAAF—Chicago, Ill.; Drovers Journal Publishing Co.; 500 W.
KOMO—Seattle, Wash.; Fisher's Blend Station (Inc.); 1 KW.
KFEL—Denver, Colo.; Eugene P. O'Fallon (Inc.); 500 W.
KFXF—Denver, Colo.; Colorado Radio Corporation; 500 W.

925 KILOCYCLES—324.1 METERS

CMCD—Havana, Cuba; Angel Bertematy; 250 W.
CMCN—Havana, Cuba; Antonio Ginard; 250 W.

930 KILOCYCLES—322.4 METERS

WIBG—Glenside, Pa.; St. Paul's P. E. Church; 25 W.
WDBJ—Roanoke, Va.; Times-Royal Corp.; 500 W.*
WBRC—Birmingham, Ala.; Birmingham Broadcasting Co. (Inc.); 1 KW.*
KGBZ—York, Nebr.; Dr. George R. Miller; 1 KW.*
KMA—Shenandoah, Iowa; May Seed & Nursery Co.; 1 KW.*
KFWI—San Francisco, Calif.; Radio Entertainments (Inc.); 500 W.
KROW—Oakland, Calif.; T—Richmond, Calif.; Educational Broadcasting Corporation; 1 KW.*
CKX—Brandon, Manitoba, Can.; Manitoba Telephone System; 500 W.
CFCH—North Bay, Ontario, Can.; Northern Supplies, Ltd.; 100 W.
CFRC—Kingston, Ontario, Can.; Queens University; 250 W.*
CMJF—Camaguey, Cuba; John L. Stowers; 225 W.

940 KILOCYCLES—319.0 METERS

WAAT—Jersey City, N. J.; Bremer Broadcasting Corporation; 300 W.
WCSH—Portland, Me.; T—Scarboro, Me.; Congress Square Hotel Co.; 1 KW.
WFIW—Hopkinsville, Ky.; WFIW (Inc.); 1 KW.
WHA—Madison, Wis.; University of Wisconsin; 750 W.
WDAY—Fargo, N. Dak.; T—West Fargo, N. Dak.; WDAY (Inc.); 1 KW.
KOIN—Portland, Oreg.; T—Sylvan, Oreg.; KOIN (Inc.); 1 KW.
XEO—Mexico City, Mex.; Partido Nacional Rev.; 5 KW.

950 KILOCYCLES—315.6 METERS

WRC—Washington, D. C.; National Broadcasting Co. (Inc.); 500 W.
KMBC—Kansas City, Mo.; T—Independence, Mo.; Midland Broadcasting Co.; 1 KW.
KFWB—Hollywood, Calif.; Warner Bros. Broadcasting Corporation; 1 KW.
KGHL—Billings, Mont.; Northwestern Auto Supply Co. (Inc.); 2½*.
VONA—St. Johns, N. F.; Lane, Gillard & Avery; 30 W.
CMHD—Caibarien, Cuba; Manuel Alvarez; 250 W.

960 KILOCYCLES—312.3 METERS

CHCK—Charlottetown, Prince Edward Island, Can.; W. E. Burke & J. A. Gesner; 100 W.
CHWC—Regina, Saskatchewan, Can.; T—Pilot Butte, Saskatchewan, Can.; R. H. Williams & Sons, Ltd.; 500 W.
CJBR—Regina, Saskatchewan, Can. (Uses transmitter of CKCK); Saskatchewan Co-operative Wheat Producers, Ltd.; 500 W.
CKCK—Regina, Saskatchewan, Can.; Leader Publishing Co., Ltd.; 500 W.
CKNC—Toronto, Ontario, Can.; Canadian National Carbon Co.; 500 W.
CNRR—Regina, Saskatchewan, Can. (Uses transmitter of CKCK); Canadian National Railways; 500 W.
XED—Reynosa, Tams., Mex. (Actual frequency 965 KC—310.8 Meters); Cia. Int. Dif. Reynosa, S. A.; 10 KW.

965 KILOCYCLES—310.7 METERS

CMBC—Havana, Cuba; Domingo Fernandez; 150 W.
CMBD—Havana, Cuba; Luis Perez Garcia; 150 W.

970 KILOCYCLES—309.1 METERS

WCFL—Chicago, Ill.; Chicago Federation of Labor; 1½ KW.
KJR—Seattle, Wash.; Northwest Broadcasting System (Inc.); 5 KW.

980 KILOCYCLES—305.9 METERS

KDKA—Pittsburgh, Pa.; T—Saxonburg, Pa., Westinghouse Electric & Manufacturing Co.; 50 KW.

985 KILOCYCLES—304.4 METERS

CFCN—Calgary, Alberta, Can.; T—Strathmore, Alta., Can.; W. W. Grant & H. G. Love; 10 KW.

987 KILOCYCLES—303.8 METERS

CMGF—Matanzas, Cuba; Bernabe R. de la Torre; 50 W.

990 KILOCYCLES—302.8 METERS

WBZ—Springfield, Mass.; T—East Springfield, Mass.; Westinghouse Electric & Manufacturing Co.; 25 KW.
WBZA—Boston, Mass.; Westinghouse Electric & Manufacturing Co.; 1 KW
XEK—Mexico City, Mex.; Arturo Martinez; 100 W.

1000 KILOCYCLES—299.8 METERS

WHO—Des Moines, Iowa; Central Broadcasting Co.; 5 KW. (C. P. 50 KW.)
WOC—Davenport, Iowa; Central Broadcasting Co.; 5 KW. (C. P. 50 KW.).
KFVD—Culver City, Calif.; Los Angeles Broadcasting Co.; 250 W.
XEA—Guadalajara, Jal., Mex; Alberto Palos Sanza; 100 W.
XEC—Toluca, Mex.; Jesus R. Benavides; 50 W.
XEE—Oaxaca, Oax., Mex.; Alfonso Zorrilla B.; 105 W.
XEFE—N. Laredo, Tams., Mex.; Rafael T. Carranza; 100 W.
XEFI—Chihuahua, Chih., Mex.; Feliciano Lopez Islas; 100 W.
XEFS—Queretaro, Quer., Mex., Salvador Sanchez, 40 W.
XEI—Morelia, Mich., Mex.; Carlos Gutierrez; 100 W.
XEJ—C. Juarez, Chih., Mex.; Juan G. Buttner; 100 W.
XEL—Saltillo, Coah.; Antonio Garza Castro; 25 W.
XETC—Jalapa, Ver., Mex.; Juventino Canchez; 100 W.
XETG—Torreon, Coah., Mex.; Feliciano Lopez Islas; 100 W.
XEU—Veracruz, Ver., Mexico.; Fernando Pazos; 100 W.
XEV—Puebla, Pue., Mex.; Ciro Molino; 100 W.
XEY—Merida, Yuc., Mex.; Partido Socialista S. E.; 105 W.

1010 KILOCYCLES—296.8 METERS

WORK—York, Pa.; York Bdcg. Co.; 1 KW.
WQAO—New York, N. Y.; T—Cliffside, N. J.; Marcus Loew Booking Agency; 250 W.
WHN—New York, N. Y.; Marcus Loew Booking Agency; 250 W.
WPAP—New York City; Palisades Amusement Park; 250 W.
WRNY—New York, N. Y.; T—Coytesville, N. J.; Aviation Radio Station (Inc.); 250 W.
KGGF—Coffeyville, Kans.; Hugh J. Powell and Stanley Platz, doing business as Powell & Platz; 500 W.
WNAD—Norman, Okla.; University of Oklahoma; 500 W.
WIS—Columbia, S. C.; Station WIS, Inc., 1 KW.*
KQW—San Jose, Calif.; Pacific Agricultural Foundation Ltd.; 500 W.
CHCS—Hamilton, Ontario; T—Fruitland, Ontario (Uses transmitter of CKOC—630 KC. temporarily); Hamilton Spectator; 1 KW.*
CKIC—Wolfville, Nova Scotia; Acadia University; 50 W.
CKOC—Hamilton, Ontario; T—Fruitland, Ontario (Uses 630 KC temporarily); Wentworth Radio Broadcasting Co., Ltd.; 1 KW.*
CKTB—St. Catharines, Ontario; T—Fruitland, Ontario. (Uses transmitter of CKOC, 630 KC., temporarily); Taylor & Bates, Ltd.; 1 KW.*
CMBZ—Havana, Cuba; Manuel y G. Salas; 150 W.

1017 KILOCYCLES—293.73 METERS

CMJH—Ciego de Avila, Cuba; Luis Marauri; 15 W.

1020 KILOCYCLES—293.9 METERS

WRAX—Philadelphia, Pa.; WRAX Broadcasting Co.; 250 W.
KYW-KFKX—Chicago, Ill.; T—Bloomingdale Township, Ill.; Westinghouse Electric & Manufacturing Co.; 10 KW.
XEFD—Tijuana, B. C., Mex.; Carlos de la Sierra, 300 W.

1030 KILOCYCLES—291.1 METERS

CFCF—Montreal, Quebec, Can.; Canadian Marconi Co.; 500 W.
CNRV—Vancouver, British Columbia, Can.; T—Lulu Island, British Columbia, Can.; Canadian National Railways; 500 W.
CMHI—Santa Clara, Cuba; Lavis y Paz; 30 W.

1034 KILOCYCLES—290 METERS

CMKC—Santiago de Cuba; M. P. Martinez; 150 W.

1,040 KILOCYCLES—288.3 METERS

WMAK—Buffalo, N. Y.; T—Grand Island, Buffalo, N. Y.; Buffalo Broadcasting Corporation; 1 KW.
WKAR—East Lansing, Mich.; Michigan State College; 1 KW.
KTHS—Hot Springs National Park, Ark.; Hot Springs Chamber of Commerce; 10 KW.
KRLD—Dallas, Tex.; KRLD Radio Corporation; 10 KW,
CMGH—Matanzas, Cuba.

1050 KILOCYCLES—285.5 METERS

KFBI—Albilene, Kans.; Farmers & Bankers Life Insurance Co.; 5 KW.
KNX—Hollywood, Calif.; T—Los Angeles, Calif.; Western Broadcast Co.; 5KW.
XEFC—Merida, Yuc., Mex.; Hugo Molina Font.; 10 W.
CMJG—Camaguey, Cuba; Pedro Nogueras; 50 W.

1060 KILOCYCLES—282.8 METERS

WBAL—Baltimore, Md.; T—Glen Morris, Md.; Consolidated Gas, Electric Light & Power Company of Baltimore; 10 KW.
WTIC—Hartford, Conn.; T—Avon, Conn.; Travelers Broadcasting Service Corporation; 50 KW.
WJAG—Norfolk, Nebr.; Norfolk Daily News; 1 KW.
KWJJ—Portland, Ore.; KWJJ Broadcast Co. (Inc.); 500 W.

1070 KILOCYCLES—280.2 METERS

WTAM—Cleveland, Ohio; T—Brecksville Village, Ohio; National Broadcasting Co. (Inc.); 50 KW.
WCAZ—Carthage, Ill.; Superior Broadcasting Service (Inc.); 50 W.
WDZ—Tuscola, Ill.; James L. Bush; 100 W.
KJBS—San Francisco, Calif.; Julius Brunton & Sons Co.; 100 W.
XEG—Mexico, D. F.; Miguel Yarza; 250 W.
CMBG—Havana, Cuba; Francisco Garrigo; 225 W.
CMCB—Havana, Cuba; Antonio Capablanca; 150 W.

1080 KILOCYCLES—277.6 METERS

WBT—Charlotte, N. C.; Station WBT (Inc.); 5 KW.
WCBD—Zion, Ill.; Wilbur Glenn Voliva; 5 KW.
WMBI—Chicago, Ill.; T—Addison, Ill.; The Moody Bible Institute Radio Station; 5 KW.

1090 KILOCYCLES—275.1 METERS

KMOX—St. Louis, Mo.; Voice of St. Louis (Inc.); 50 KW.

1100 KILOCYCLES—272.6 METERS

WPG—Atlantic City, N. J.; WPG Broadcasting Corporation; 5 KW.
WLWL—New York, N. Y.; T—Kearny, N. J.; Missionary Society of St. Paul the Apostle; 5 KW.
KGDM—Stockton, Calif.; E. F. Peffer; 250 W.

1110 KILOCYCLES—270.1 METERS

WRVA—Richmond, Va.; T—Mechanicsville, Va.; Larus & Brother Co. (Inc.); 5 KW.
KSOO—Sioux Falls, S. Dak.; Sioux Falls Broadcast Association (Inc.); 2½ KW.

1120 KILOCYCLES—267.7 METERS

WDEL—Wilmington, Del.; WDEL (Inc.); 350 W.*
WTAW—College Station, Tex.; Agricultural and Mechanics College of Texas; 500 W.
KTRH—Houston, Tex.; Rice Hotel; 500 W.
WISN—Milwaukee, Wis.; American Radio News Corp.; 250 W.
WHAD—Milwaukee, Wis.; Marquette University; 250 W.
KFSG—Los Angeles, Calif.; Echo Park Evangelistic Association; 500 W.
KRKD—Inglewood, Calif.; Fireside Bdcg. Co.; 500 W. (1 KW. C.P.)
KRSC—Seattle, Wash.; Radio Sales Corporation; 100 W.
KFIO—Spokane, Wash.; Spokane Broadcasting Corporation; 100 W.
CFCA—Toronto, Ontario, Can.; Star Publishing & Printing Co.; 500 W.
CFJC—Kamloops, British Columbia, Can.; S. D. Dalgleish & Sons, Ltd.; 100 W.
CHGS—Summerside, Prince Edward Island, Can.; R. T. Holman, Ltd.; 500 W.

1120 KILOCYCLES—267.7 METERS (Cont.)

CJOC—Lethbridge, Alberta, Can.; H. R. Carson; 100 W.
CNRT—Toronto, Ontario, Can.; (Uses transmitter of CFCA); Canadian National Railways; 500 W.

1125 KILOCYCLES—266.6 METERS

CMHJ—Cienfuegos, Cuba; Arturo Hernandez; 40 W.

1130 KILOCYCLES—265.3 METERS

WOV—New York City; T—Secaucus, N. J.; International Broadcasting Corporation; 1 KW.
WJJD—Mooseheart, Ill.; WJJD, Inc.; 20 KW.
KSL—Salt Lake City, Utah; Radio Service Corporation of Utah; 5 KW. (50 KW.—C. P.).
XEH—Monterrey, N. L., Mex.; Constantino Tarnaca; 1 KW. (Actual frequency 1,132 KC.—265 Meters).

1140 KILOCYCLES—263.0 METERS

WAPI—Birmingham, Ala.; WAPI Broadcasting Corp.; 5 KW.
KVOO—Tulsa, Okla.; Southwestern Sales Corporation; 5 KW. (25 KW.—C.P.).
CMBW—Havana, Cuba; Modesto Alvarez; 150 W.
CMCQ—Havana, Cuba; Andres Martinez; 1 KW.
XETA—Mexico, D. F.; M. E. Taglo; 500 W.

1150 KILOCYCLES—260.7 METERS

WHAM—Rochester, N. Y.; T—Victor Township, N. Y.; Stromberg-Carlson Telephone Manufacturing Co.; 5 KW.
CMGI—Colon, Cuba; Armando Lizama; 30 W.

1160 KILOCYCLES—258.5 METERS

WWVA—Wheeling, W. Va.; West Virginia Broadcasting Corporation; 5 KW.
WOWO—Fort Wayne, Ind.; Main Auto Supply Co.; 10 KW.

1170 KILOCYCLES—256.3 METERS

WCAU—Philadelphia, Pa.; T—Byberry; WCAU Broadcasting Co.; 10 KW.

1180 KILOCYCLES—254.1 METERS

WINS—New York, N. Y.; T—Astoria, L. I., N. Y.; American Radio News Corp.; 500 W.
WDGY—Minneapolis, Minn.; Dr. George W. Young; 1 KW.
KEX—Portland, Ore.; Western Broadcasting Co.; 5 KW.
KOB—State College, N. Mex.; New Mexico College of Agriculture and Mechanic Arts, 20 KW.
WMAZ—Macon, Ga.; Southern Broadcasting Co., Inc.; 500 W.
CMJE—Camaguey, Cuba; Manuel Fernandez; 30 W.

1190 KILOCYCLES—252.0 METERS

WOAI—San Antonio, Tex.; T—Selma, Tex.; Southern Equipment Co.; 50 KW.

1200 KILOCYCLES—249.9 METERS

WRBL—Columbus, Ga.; WRBL Radio Station Inc.; 100 W.
WABI—Bangor, Me.; Universalist Society of Bangor; 100 W.
WNBX—Springfield, Vt.; First Congregational Church Corporation; 10 W.
WCAX—Burlington, Vt.; Burlington Daily News; 100 W.
WORC-WEPS—Worcester, Mass.; T—Auburn, Mass.; Albert Frank Kleindeinst; 100 W.
KERN—Bakersfield, Calif.; Bakersfield Bdcg. Co.; 100 W.
WIBX—Utica, N. Y.; WIBX (Inc.); 300 W.*
WFBE—Cincinnati, Ohio; Post Publishing Co.; 250 W.*
WHBC—Canton, Ohio; St. John's Catholic Church; 10 W.
WLBG—Petersburg, Va.; T—Ettrick, Va.; WLBG Inc.; 250W.*
WNBO—Washington, Pa.; John Brownlee Spriggs; 100 W.
WCOD—Harrisburg, Pa.; Keystone Broadcasting Corporation; 100 W.
WNBW—Carbondale, Pa.; WNBW, Inc.; 10 W.
KMLB—Monroe, La.; J. C. Liner; 100 W.
WABZ—New Orleans, La.; Samuel D. Reeks; 100 W.
WJBW—New Orleans, La.; C. Carlson; 100 W.
WBBZ—Ponca City, Okla.; C. L. Carrell; 100 W.
WFBC—Knoxville, Tenn.; Virgil V. Evans; 50 W.
KGHI—Little Rock, Ark.; O. A. Cook; 100 W.
KBTM—Paragould, Ark.; W. J. Beard, Beard's Temple of Music; 100 W.
WJBC—La Salle, Ill.; Wayne Hummer & H. J. Dee, doing business as Kaskaskia Broadcasting Co.; 100 W.
WJBL—Decatur, Ill.; Commodore Broadcasting Corporation; 100 W.
WWAE—Hammond, Ind.; Hammond-Calumet Broadcasting Corporation; 100 W.
KFJB—Marshalltown, Iowa; Marshall Electric Co. (Inc.); 250 W.*
WCAT—Rapid City, S. Dak.; South Dakota State School of Mines; 100 W.
KFWF—St. Louis, Mo.; St. Louis Truth Center (Inc.); 100 W.
KGDE—Fergus Falls, Minn.; Jaren Drug Co.; 250W.*
WCLO—Janesville, Wis.; WCLO Radio Corporation; 100 W.
WHBY—Green Bay, Wis.; T—West De Pere, Wis.; St. Norbert College; 100 W.
WIL—St. Louis, Mo.; Missouri Broadcasting Corporation; 250 W.*
KGFJ—Los Angeles, Calif.; Ben S. McGlashan; 100 W.
KGVO—Missoula, Mich.; Mosby's (Inc.); 100 W.
KFXD—Nampa, Idaho; Frank E. Hurt, trading as Service Radio Co.; 500 W.
KFXJ—Grand Junction, Colo.; Western Slope Bdcg. Co., 100 W.
KWG—Stockton, Calif.; Portable Wireless Telephone Co. (Inc.); 100 W.
KGEK—Yuma, Colo.; Elmer C. Beehler, trading as Beehler Electrical Equipment Co.; 100 W.
KGEW—Fort Morgan, Colo.; City of Fort Morgan; 100 W.
KVOS—Bellingham, Wash.; KVOS (Inc.); 100 W.
WFAM—South Bend, Ind.; South Bend Tribune; 100 W.
WBHS—Huntsville, Ala.; The Hutchens Co.; 100 W.
CKOV—Kelowna, British Columbia, Can.; J. W. B. Browne; 100 W.
10AB—Moose Jaw, Saskatchewan, Can.; Moose Jaw Radio Assn.; 25 W.
10AK—Stratford, Ontario, Can.; Classic Radio Club; 10 W.
10BJ—Prince Albert, Saskatchewan, Can.; Prince Albert Radio Club; 25 W.
10BP—Wingham, Ontario, Can.; Wingham Radio Club; 15 W.
10BQ—Brantford, Ontario, Can.; Telephone City Radio Assn.; 5 W.
10BU—Canora, Saskatchewan, Can.; Canora Radio Association; 15 W.

1205 KILOCYCLES—248.8 METERS

CMGB—Matanzas, Cuba; Jose Anorga; 30 W.

1210 KILOCYCLES—247.8 METERS

WMRJ—Jamaica, N. Y.; Peter J. Prinz; 100 W.
WJBI—Redbank, N. J.; Monmouth Broadcasting Co.; 100 W.
WGBB—Freeport, N. Y.; Harry H. Carman; 100 W.
WCOH—Yonkers, N. Y.; T—Greenville, N. Y.; Westchester Broadcasting Corporation, 100 W.
KGY—Olympia, Wash.; KGY Inc.; 100 W.
WOCL—Jamestown, N. Y.; A. E. Newton; 50 W.
WLCI—Ithaca, N. Y.; Lutheran Association of Ithaca, N. Y.; 50 W.
WPAW—Pawtucket, R. I.; Shartenberg & Robinson Co.; 100 W.
WSEN—Columbus, Ohio; Columbus Broadcasting Corporation; 100 W.
WJW—Mansfield, Ohio; John F. Weimer (owner Mansfield Broadcasting Association); 100 W.
WALR—Zanesville, Ohio; WALR Broadcasting Corp.; 100 W.
WBAX—Wilkes-Barre, Pa.; T—Plains Township, Pa.; John H. Stenger, Jr.; 100 W.
WJBU—Lewisburg, Pa.; Bucknell University; 100 W.
WBBL—Richmond, Va.; Grace Covenant Presbyterian Church; 100 W.
WMBG—Richmond, Va.; Havens & Martin (Inc.); 100 W.

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1210 KILOCYCLES—247.8 METERS (Cont.)

WSIX—Springfield, Tenn.; Jack M. and Louis R. Draughon, doing business as 638 Tire and Vulcanizing Co.; 100 W.
WSOC—Gastonia, N. C.; WSOC (Inc.); 100 W.
WJBY—Gadsden, Ala.; Gadsden Broadcasting Co. (Inc.); 100 W.
WQDX—Thomasville, Ga.; Stevens Luke; 50 W.
WRBQ—Greenville, Miss.; J. Pat Scully; 250 W.*
KWEA—Shreveport, La.; Hello World Broadcasting Corporation; 100 W.
KDLR—Devils Lake, N. Dak.; KDLR (Inc.); 100 W.
KGCR—Watertown, S. Dak.; Greater Kampeska Radio Corp.; 100 W.
KFOR—Lincoln, Nebr.; Howard A. Shuman; 250 W.*
WHBU—Anderson, Ind.; Anderson Broadcasting Corp.; 100 W.
WEBQ—Harrisburg, Ill.; Harrisburg Bdcstg Co.; 100 W.
—Troy, Ala.; Troy Bdcg. Co.; 100 W.
WSBC—Chicago, Ill.; World Battery Co. (Inc.); 100 W.
WCRW—Chicago, Ill.; Clinton R. White; 100 W.
WEDC—Chicago, Ill.; Emil Denemark (Inc.); 100 W.
WCBS—Springfield, Ill.; Chas. H. Messter and Harold L. Dewing; 100 W.
WTAX—Springfield, Ill.; WTAX (Inc.); 100 W.
WHBF—Rock Island, Ill.; Beardsley Specialty Co.; 100 W.
WOMT—Manitowoc, Wis.; Francis M. Kadow; 100 W.
WIBU—Poynette, Wis.; William C. Forrest; 100 W.
KGNO—Dodge City, Kans.; Dodge City Broadcasting Co. (Inc.); 100 W.
KGRS—Amarillo, Tex.; E. B. Gish; 1 KW.
KFXM—San Bernardino, Calif.; J. C. & E. W. Lee (Lee Bros. Broadcasting Co.); 100 W.
KFVS—Cape Girardeau, Mo.; Oscar C. Hirsch, trading as Hirsch Battery & Radio Co.; 100 W.
KPPC—Pasadena, Calif.; Pasadena Presbyterian Church; 50 W.
KFJI—Klamath Falls, Ore.; KFJI Broadcasters, Inc.; 100 W.
WPRO—Providence, R. I.; Cherry & Webb Broadcasting Co.; 100 W.
KGMP—Elk City, Okla.; Bryant Radio & Electric Co.; 100 W.
KGY—Olympia, Wash.; KGY, Inc.; 100 W.
CFCO—Chatham, Ontario, Can.; John Beardall; 100 W.
CFNB—Fredericton, New Brunswick, Can.; Jas. S. Neill & Sons, Ltd.; 50 W.
CJOR—Vancouver, British Columbia, Can.; T—Sea Island, British Columbia, Can.; G. C. Chandler; 500 W.
CKMC—Cobalt, Ontario, Can.; R. L. MacAdam; 100 W.
XEX—Mexico City, Mex.; Excelsior; 500 W.

1220 KILOCYCLES—245.8 METERS

WCAD—Canton, N. Y.; St. Lawrence University; 500 W.
WCAE—Pittsburgh, Pa.; WCAE, Inc.; 1 KW.
WDAE—Tampa, Fla.; Tampa Publishing Co.; 1 KW.
WREN—Tanganoxie, Kans.; Jenny Wren Co.; 1 KW.
KFKU—Lawrence, Kans.; University of Kansas; 500 W.
KWSC—Pullman, Wash.; State College of Washington; 2 KW.*
KTW—Seattle, Wash.; First Presbyterian Church; 1 KW.

1225 KILOCYCLES—244.8 METERS

CMBY—Havana, Cuba; Callejas-Cosculluela; 350 W.

1230 KILOCYCLES—243.8 METERS

WNAC-WBIS—Boston, Mass.; T—Quincy, Mass.; Shepard Broadcasting Service (Inc.); 1 KW.
WPSC—State College, Pa.; The Pennsylvania State College; 500 W.
WSBT—South Bend, Ind.; South Bend Tribune; 500 W.
WFBM—Indianapolis, Ind.; Indianapolis Power & Light Co.; 1 KW.
KGGM—Albuquerque, N. Mex.; New Mexico Broadcasting Co.; 500 W.*
KYA—San Francisco, Calif.; Pacific Broadcasting Corporation; 1 KW.
KFQD—Anchorage, Alaska; Anchorage Radio Club; 250 W.
XETQ—Mexico City, Mex.; Carlos G. Caballero; 100 W.

1235 KILOCYCLES—242.8 METERS

CMCA—Havana, Cuba; Manuel Cruz; 150 W.

1240 KILOCYCLES—241.8 METERS

WXYZ—Detroit, Mich.; Kunsky-Trendle Broadcasting Corporation; 1 KW.
KTAT—Fort Worth, Tex.; T—Birdville, Tex.; S. A. T. Broadcast Co.; 1 KW.
WACO—Waco, Tex.; Central Texas Broadcasting Co. (Inc.); 1 KW.
KGCU—Mandan, N. Dak.; Mandan Radio Assn.; 250 W.
KLPM—Minot, N. Dak.; John B. Cooley; 250 W.
KTFI—Twin Falls, Idaho; Radio Bdcg. Corp.; 500 W.

1249 KILOCYCLES—240 METERS

CMAB—Pinar del Rio, Cuba; Francisco Martinez; 20 W.

1250 KILOCYCLES—239.9 METERS

WGCP—Newark, N. J.; May Radio Broadcast Corporation; 250 W.
WODA—Paterson, N. J.; Richard E. O'Dea; 1 KW.
WAAM—Newark, N. J.; WAAM (Inc.); 2 KW.*
WDSU—New Orleans, La.; T—Gretna, La.; Joseph H. Uhalt; 1 KW.
WLB—Minneapolis, Minn.; T—St. Paul, Minn.; University of Minnesota; 1 KW.
WRHM—Minneapolis, Minn.; T—Fridley, Minn.; Minnesota Broadcasting Corporation; 1 KW.
KFMX—Northfield, Minn.; Carlton College; 1 KW.
WCAL—Northfield, Minn.; St. Olaf College; 1 KW.
KFOX—Long Beach, Calif.; Nichols and Warriner (Inc.); 1 KW.
XEFA—Mexico City, Mex.; Manuel F. Murguia; 250 W.

1260 KILOCYCLES—238.0 METERS

WNBX—Springfield, Vt.; First Congreg. Church Corp., 250 W. day.
WLBW—Erie, Pa.; Broadcasters of Pennsylvania, Inc.; 1 K*
KWWG—Brownsville, Tex.; Frank P. Jackson; 500 W.
WTOC—Savannah, Ga.; Savannah Broadcasting Co. (Inc.); 500 W.
KRGV—Harlingen, Tex.; KRGV (Inc.); 500 W.
KOIL—Council Bluffs, Iowa; Mona Motor Oil Co.; 1 KW.
KVOA—Tuscon, Ariz.; Robert M. Riculfi; 500 W.

1270 KILOCYCLES—236.1 METERS

WEAI—Ithaca, N. Y.; Cornell University; 1 KW.
WFBR—Baltimore, Md.; Baltimore Radio Show (Inc.); 500 W.
WASH—Grand Rapids, Mich. (Uses transmitter of WOOD); WASH Broadcasting Corporation; 500 W. (1 KW.—C.P.).
WOOD—Grand Rapids, Mich.; T—Furn-Kunsky-Trendle Broadcasting Corp.; 500 W.
WJDX—Jackson, Miss.; Lamar Life Insurance Co.; 1 KW.
KWLC—Decorah, Iowa; Luther College; 100 W.
KGCA—Decorah, Iowa; Charles W. Greenley; 100 W.
KOL—Seattle, Wash.; Seattle Broadcasting Co. (Inc.); 1 KW.
KVOR—Colorado Springs, Colo.; Reynolds Radio Co., Inc.; 1 KW.
CMCU—Havana, Cuba; Jorge Garcia Serra; 150 W.

1280 KILOCYCLES—234.2 METERS

WCAM—Camden, N. J.; City of Camden; 500 W.
WCAP—Asbury Park, N. J.; Radio Industries Broadcast Co.; 500 W.
WOAX—Trenton, N. J.; WOAX (Inc.); 500 W.
WDOD—Chattanooga, Tenn.; T—Brainerd, Tenn.; WDOD Broadcasting Corporation; 1 KW. (5 KW.—C.P.).
WRR—Dallas, Tex.; City of Dallas, Tex.; 500 W.
WIBA—Madison, Wis.; Badger Broadcasting Co.; 500 W.
KFBB—Great Falls, Mont.; Buttrey Broadcast (Inc.); 2½ KW.*

1285 KILOCYCLES—233.4 METERS

CMCW—Havana, Cuba; Jose Lorenzo; 150 W.

1290 KILOCYCLES—232.4 METERS

WNBZ—Saranac Lake, N. Y.; Earl J. Smith and William Mace, doing business as Smith & Mace; 50 W.
WJAS—Pittsburgh, Pa.; T—North Fayette Township, Pa.; Pittsburgh Radio Supply House; 2½ KW.*
KTSA—San Antonio, Tex.; Southwest Broadcasting Co.; 2 KW.
KFUL—Galveston, Tex.; News Publishing Co.; 500 W.
KLCN—Blytheville, Ark.; Charles Leo Lintzenich; 50 W.
WEBC—Superior, Wisc.; Head of the Lakes Broadcasting Co.; 2½ KC.*
KDYL—Salt Lake City, Utah; Intermountain Broadcasting Corporation; 1 KW.

1300 KILOCYCLES—230.6 METERS

WBBR—Brooklyn, N. Y.; T—Rossville, N. Y. (Staten Island); Peoples Pulpit Association; 1 KW.
WFAB—New York, N. Y.; T—Carlstadt, N. J.; Defenders of Truth Society (Inc.); 1 KW.
WEVD—New York, N. Y.; T—Forest Hills, N. Y.; Debs Memorial Radio Fund (Inc.); 500 W.
WHAZ—Troy, N. Y.; Rensselaer Polytechnic Institute; 500 W.
WIOD—WMBF—Miami, Fla.; T—Miami Beach, Fla.; Isle of Dreams Broadcasting Corporation; 1 KW.
WOQ—Kansas City, Mo.; Unity School of Christianity; 1 KW. Corporation; 1KW.
KFH—Wichita, Kans.; Radio Station KFH Co.; 1 KW.
KFJR—Portland, Ore.; Ashley C. Dixon, trading as Ashley C. Dixon & Son; 500 W.
KALE—Kale, Inc.; 500 W.
KTBR—Portland, Ore.; M. E. Brown; 500 W.
KFAC—Los Angeles, Calif.; Los Angeles Broadcasting Co.; 1 KW.
XEM—Mexico City, Mex.; Maria T. de Gutierez; 250 W.

1310 KILOCYCLES—228.9 METERS

WKBS—Galesburg, Ill.; S. E. Yaste and Burrell Banash; 100 W.
WKAV—Laconia, N. H.; Laconia Radio Club; 100 W.
WEBR—Buffalo, N. Y.; Howell Broadcasting Co. (Inc.); 250 W.*
WMBO—Auburn, N. Y.; WMBO, Inc.; 100 W.
WNBH—New Bedford, Mass.; T—Fairhaven, Mass.; Irving Vermilya, trading as New Bedford Broadcasting Co.; 100 W.
WOL—Washington, D. C.; American Broadcasting Co.; 100 W.
WGH—Newport News, Va.; Hampton Roads Broadcasting Corporation; 100 W.
WEXL—Royal Oak, Mich.; Royal Oak Broadcasting Co.; 50 W.
WFDF—Flint, Mich.; Frank D. Fallain; 100 W.
WBEO—Marquette, Mich.; Lake Superior Broadcasting Co.; 100 W.
WHAT—Philadelphia, Pa.; Independence Broadcasting Co.; 100 W.
WTEL—Philadelphia, Pa.; Foulkrod Radio Engineering Co.; 100 W.
WJAC—Johnstown, Pa.; Johnstown Automobile Co.; 100 W.
WFBG—Altoona, Pa.; William F. Gable Co.; 100 W.
WRAW—Reading, Pa.; Reading Broadcasting Co.; 100 W.
WGAL—Lancaster, Pa.; WGAL, Incorporated; 100 W.
WSAJ—Grove City, Pa.; Grove City College; 100 W.
WBRE—Wilkes-Barre, Pa.; Louis G. Baltimore; 100 W.
WKBC—Birmingham, Ala.; R. B. Broyles, trading as R. B. Broyles Furniture Co.; 100 W.
WTJS—Jackson, Tenn.; Sun Pub. Co.; 100 W.
WTRC—Elkhart, Ind.; Elkhart Daily Truth; 50 W.
WTSL—Laurel, Miss.; G. H. Houseman; 100 W.
WROL—Knoxville, Tenn.; Stuart Broadcasting Corporation; 100 W.
KRMD—Shreveport, La.; Radio Station KRMD, Inc.; 100 W.
WSJS—Winston-Salem, N. C.; Winston-Salem Journal Co.; 100 W.
KTLC—Houston, Tex.; Houston Broadcasting Co.; 100 W.
KFPM—Greenville, Tex.; Dave Ablowich, trading as The New Furniture Co.; 15 W.
KTSM—El Paso, Tex.; Tri-State Bdcstg Co., Inc.; 100 W.
WDAH—El Paso, Tex.; Tri-State Bdcstg Co., Inc.; 100 W.
KFPL—Dublin, Tex.; C. C. Baxter; 100 W.
KFXR—Oklahoma City, Okla.; Exchange Avenue Baptist Church; 250 W.*
WKBS—Galesburg, Ill.; Permil N. Nelson; 100 W.
WCLS—Joliet, Ill.; WCLS (Inc.); 100 W.
WKBB—Joliet, Ill.; Sanders Brothers Radio Station; 100 W.
KFGQ—Boone, Iowa; Boone Biblical College; 100 W.
KGFW—Ravenna, Nebr.; Central Nebraska Broadcasting Corporation; 100 W.
WBOW—Terre Haute, Ind.; Banks of Wabash (Inc.); 100 W.
WJAK—Marion, Ind.; Marion Broadcast Co.; 50 W.
WLBC—Muncie, Ind.; Donald H. Burton; 50 W.
KGBX—St. Joseph, Mo.; KGBX (Inc.); 100 W.
KFBK—Sacramento, Calif.; James McClatchy Co.; 100 W.
KCRJ—Jerome, Ariz.; Charles C. Robinson; 100 W.
KGCX—Wolf Point, Mont.; First State Bank of Vida; 250 W.*
KGEZ—Kalispell, Mont.; Donald C. Treloar; 100 W.
KMED—Medford, Ore.; Mrs. W. J. Virgin; 100 W.
KXRO—Aberdeen, Wash.; KXRO (Inc.); 100 W.
KIT—Yakima, Wash.; Carl E. Haymond; 100 W.
KFYO—Lubbock, Tex.; Kirksey Bros.; 250 W.
WIAS—Iowa Bdcstg Co., Ottumwa, Ia.; 100 W.

1320 KILOCYCLES—227.1 METERS

WADC—Akron, Ga.; Allen T. Simmons; 1 KW.
WSMB—New Orleans, La.; Saenger Theatres (Inc.) and Maison Blanche Co.; 500 W.
KID—Idaho Falls, Idaho; KID Broadcasting Co.; 500 W.*
KGHF—Pueblo, Colo.; Curtis P. Ritchie and Joe E. Finch; 500 W.*
KGMB—Honolulu, Hawaii; Honolulu Broadcasting Co. (Ltd.); 250 W.

1330 KILOCYCLES—225.4 METERS

KMO—Tacoma, Wash.; KMO, Inc.; 250 W.
WDRC—Hartford, Conn.; T—Bloomfield, Conn.; WDRC (Inc.); 500 W.
WSAI—Cincinnati, O.; T—Mason, Ohio; Crosley Radio Corporation (lessee); 1 KW.*
WTAQ—Eau Claire, Wis.; T—Township of Washington, Wis.; Gillette Rubber Co.; 1 KW.
KSCJ—Sioux City, Iowa; Perkins Brothers Co.; 2½ KW.*
KGB—San Diego, Calif.; Don Lee, Inc.; 500 W.

1340 KILOCYCLES—223.7 METERS

....Chas. W. Phelan (Casco Bay Bdcstg. Co.) 250 W day, 500 W night (CP).
KGIR—Butte, Mont.; KGIR (Inc.); 500 W.
WSPD—Toledo, Ohio; Toledo Broadcasting Co.; 1 KW.
KFPW—Fort Smith, Ark.; Southwestern Hotel Co.; 50 W.
WCOA—Pensacola, Fla.; Pensacola Bdcg. Co.; 500 W.
KFPY—Spokane, Wash.; Symons Broadcasting Co.; 1 KW.
KGDY—Huron, S. Dak.; Voice of S. Dak., 250 W. (CP).

1345 KILOCYCLES—223 METERS

CMCR—Havana, Cuba; Aurelio Hernandez; 150 W.
CMCY—Havana, Cuba; M. D. Autran; 250 W.

1350 KILOCYCLES—222.1 METERS

WAWZ—Zarephath, N. J.; Pillar of Fire; 250 W.
WMSG—New York, N. Y.; Madison Square Garden Broadcast Corporation; 250 W.
WCDA—New York, N. Y.; T—Cliffside Park, N. J.; Italian Educational Broadcasting Co. (Inc.); 250 W.
WBNX—New York, N. Y.; Standard Cahill Co. (Inc.); 250 W.
KWKK—St. Louis, Mo.; T—Kirkwood, Mo.; Greater St. Louis Broadcasting Corporation; 1 KW.

1350 KILOCYCLES—222.1 METERS (Cont.)

WEHC—Emory, Va.; Emory & Henry College; 500 W.
KIDO—Boise, Idaho; Boise Broadcasting Station; 1 KW.

1360 KILOCYCLES—220.4 METERS

WFBL—Syracuse, N. Y.; Onondaga Radio Broadcasting Corporation; 1 KW.
WQBC—Vicksburg, Miss.; Delta Broadcasting Co. (Inc.); 500 W.
WCSC—Charleston, S. C.; South Carolina Broadcasting Co., Inc.; 500 W.
WJKS—Gary, Ill.; Johnson-Kennedy Radio Corporation; 1¼ KW.*
WGES—Chicago, Ill.; Oak Leaves Broadcasting Station (Inc.); 1 KW.*
KGER—Long Beach, Calif.; Consolidated Broadcasting Corp.; 1 KW.

(Continued on next page)

1370 KILOCYCLES—218.7 METERS

WRDO—Augusta, Me.; WRDO, Inc.; 100 W.
WQDM—St. Albans, Vt.; A. J. St. Antoine and E. J. Regan; 100 W.
WLEY—Lexington, Mass.; Carl S. Wheeler, trading as Lexington Air Stations; 250 W.*
WSVS—Buffalo, N. Y.; Elmer S. Pierce, principal, Seneca Vocational High School; 50 W.
WBGF—Glens Falls, N. Y.; W. Neal Parker and Herbert H. Metcalfe; 50W.
WCBM—Baltimore, Md.; Baltimore Broadcasting Corporation; 250 W.*
WBTM—Danville, Va.; L. H., R. G. and A. S. Clarke, doing business as Clarke Electric Co.; 100 W.
WLVA—Lynchburg, Va.; Lynchburg Broadcasting Corporation; 100 W.
WHBD—Mount Orab, Ohio; F. P. Moler; 100 W.
WHDF—Calumet, Mich.; Upper Michigan Broadcasting Co.; 250 W.*
WJBK—Highland Park, Mich.; James F. Hopkins (Inc.); 100 W.
WIBM—Jackson, Mich.; WIBM (Inc.); 100 W.
WRAK—Williamsport, Pa.; Clarence R. Cummins; 100 W.
WHBQ—Memphis, Tenn.; Broadcasting Station WHBQ (Inc.); 100 W.
KGFG—Oklahoma City, Okla.; Oklahoma Broadcasting Co. (Inc.); 100 W.
KCRC—Enid, Okla.; Enid Radiphone Co.; 250 W.*
WMBR—Tampa, Fla.; F. J. Reynolds; 100 W.
KMAC—San Antonio, Tex.; W. W. McAllister; 100 W.
KFJZ—Fort Worth, Tex.; Ralph S. Bishop; 100 W.
KONO—San Antonio, Tex.; Mission Broadcasting Co.; 100 W.
KGKL—San Angelo, Tex.; KGKL (Inc.), 100 W.
KFLX—Galveston, Tex.; George Roy Clough; 100 W.
WGL—Fort Wayne, Ind.; Fred C. Zeig (Allen-Wayne Co.); 100 W.
KGDA—Mitchell, S. Dak.; Mitchell Broadcasting Corporation; 100 W.
KICA—Clovis, N.M., Southwest Broadcasting Co.; 100 W.
KFJM—Great Forks, N. Dak.; University of North Dakota; 100 W.
KWKC—Kansas City, Mo.; Wilson Duncan, trading as Wilson Duncan Broadcasting Co.; 100 W.
WRJN—Racine, Wis.; Racine Broadcasting Corporation; 100 W.
KGAR—Tucson, Ariz.; Tucson Motor Service; 250 W.*
KRE—Berkeley, Calif.; First Congregational Church of Berkeley; 100 W.
KOOS—Marshfield, Ore.; H. H. Hansetly (Inc.); 100 W.
KFBL—Everett, Wash.; Otto Leese and Robert Leese, doing business as Leese Bros.; 50 W.
KVL—Seattle, Wash.; KVL, Incorporated; 100 W.
KGFL—Raton, N. Mex.; KGFL, Inc.; 50 W.
KUJ—Walla Walla, Wash.; KUJ, Inc.; 100 W.
WRAM—Wilmington, N. C.; Wilmington Radio Asso.; 100 W.
WJTL—Tifton, Ga.; Oglethorpe University; 100 W.
WPFB—Hattiesburg, Miss.; Hattiesburg Bdcg. Corp.; 100 W.
CMGH—Matanzas, Cuba; Alberto Alvarez; 150 W.

1375 KILOYCLES—218 METERS

CMAC—Pinar del Rio, Cuba; Oscar S. Mechoso; 30 W.
CMGE—Cardenas, Cuba; Genaro Sebater; 30 W.

1380 KILOCYCLES—217.3 METERS

WSMK—Dayton, Ohio; Stanley M. Krohn, Jr.; 200 W.
KQV—Pittsburgh, Pa.; KQV, Inc.; 500 W.
KSO—Clarinda, Iowa; Iowa Broadcasting Co.; 100 W. night, 250 W. local sunset
WKBH—LaCrosse, Wis.; WKBH (Inc.); 1 KW.
KOH—Reno, Nev.; The Bee, Inc.; 500 W.
KQV—Pittsburgh, Pa.; KQV Broadcasting Co.; 500 W.
XETB—Torreon Coah., Mex.; Jose A. Berumen; 125 W.

1382 KILOCYCLES—217.25 METERS

CMJC—Camaguey, Cuba; Feliciano Isaac; 75 W.

1390 KILOCYCLES—215.7 METERS

WHK—Cleveland, Ohio; T—Seven Hills, Ohio; Radio Air Service Corporation; 1 KW.
KLRA—Little Rock, Ark.; Arkansas Broadcasting Co.; 1 KW.
KUOA—Fayetteville, Ark.; Southwestern Hotel Co.; 1 KW.
KOY—Phoenix, Ariz.; Nielsen Radio & Sporting Goods Co.; 500 W.

1395 KILOCYCLES—215 METERS

CMCG—Havana, Cuba; Jose Justo Moran; 30 W.

1400 KILOCYCLES—214.2 METERS

CMCH—Havana, Cuba; Hernani Torralbas; 20 W.
CMCM—Havana, Cuba; Martinez-Madicu; 15 W.
WCGU—Brooklyn, N. Y.; United States Broadcasting Corporation; 500 W.
WFOX—Brooklyn, N. Y.; Paramount Broadcasting Corporation; 500 W.
WLTH—Brooklyn, N. Y.; Voice of Brooklyn (Inc.); 500 W.
WBBC—Brooklyn, N. Y.; Brooklyn Broadcasting Corporation; 500 W.
KOCW—Chickasha, Okla.; J. T. Griffin; 500 W.
WCMA—Culver, Ind.; General Broadcasting Corporation; 500 W.
WKBF—Indianapolis, Ind.; T—Clermont, Ind.; Indianapolis Broadcasting (Inc.); 500 W.
WBAA—West Lafayette, Ind.; Purdue University; 1 KW.*
KLO—Ogden, Utah; Peery Building Co.; 500 W.
XEP—N. Laredo, Tams., Mex.; Asociacion Radiodifusora Latino-Americana, S. A.; 200 W.

1410 KILOCYCLES—212.6 METERS

WRBX—Roanoke, Va.; Richmond Development Corporation; 250 W.
WBCM—Bay City, Mich.; T—Hampton Township, Mich.; James E. Davidson; 500 W.
KGRS—Amarillo, Tex.; E. B. Gish (Gish Radio Service); 1 KW.
WDAG—Amarillo, Tex.; National Radio and Broadcasting Corporation; 1 KW.
WODX—Mobile, Ala.; T—Springhill, Ala.; Mobile Broadcasting Corporation; 500 W.
WSFA—Montgomery, Ala.; Montgomery Broadcasting Co. (Inc.); 500 W.
KFLV—Rockford, Ill.; Rockford Broadcasters (Inc.); 500 W.
WHBL—Sheboygan, Wis.; Press Publishing Co.; 500 W.
WAAB—Boston, Mass.; Bay State Broadcasting Corp.; 500 W.
WHIS—Bluefield, W. Va.; Daily Telegraph; 250 W.

1420 KILOCYCLES—211.1 METERS

WTBO—Cumberland, Md.; Associated Broadcasting Corporation; 210 W.*
WILM—Wilmington, Del.; T—Edge Moor, Del.; Delaware Broadcasting Co. (Inc.); 100 W.
WMAS—Springfield, Mass.; Albert S. Moffat; 100 W.
WPAD—Paducah, Ky.; Paducah Broadcasting Co.. Inc.; 100 W.
WJMS—Ironwood, Mich.; WJMS, Inc.; 100 W.
KWCR—Cedar Rapids Bdcg Co.; Cedar Rapids, Ia.; 250 W.*
WERE—Erie, Pa.; Erie Dispatch-Herald Broadcasting Corporation; 100 W.
WMBC—Detroit, Mich.; Michigan Broadcasting Co.; 210 W.*
WELL—Battle Creek, Mich.; Enquirer-News Co.; 50 W.
WFDW—Anniston. Ala. T—Talladega, Ala.; Raymond C. Hammett; 100 W.
WJBO—New Orleans, La.; Valdemar Jensen; 100 W.
KGFF—Shawnee, Okla.; D. R. Wallace (owner KGFF Broadcasting Co.); 100 W.
KABC—San Antonio, Tex.; Alamo Broadcasting Co. (Inc.); 100 W.

WSPA—Spartanburg, S. C.; Virgil V. Evans, trading as The Voice of South Carolina; 250 W.*
KICK—Red Oak, Iowa; Red Oak Radio Corporation; 100 W.
WLBF—Kansas City, Kans.; The WLBF Broadcasting Co.; 100 W.
WMBH—Joplin, Mo.; Edwin Dudley Aber; 250 W.*
WEHS—Evanston, Ill.; WEHS (Inc.); 100 W.
WHFC—Cicero, Ill.; WHFC, Inc.; 100 W.
WKBI—Chicago, Ill.; WKBI, Inc.; 100 W.
KFIZ—Fond du Lac, Wis.; The Reporter Printing Co.; 100 W.
KFXY—Flagstaff, Ariz.; Albert H. Scherman; 100 W.
KGIX—Los Vegas, Nev.; Los Vegas Radio Corp.; 100 W.
KGIW—Trinidad, Colo.; Leonard E. Wilson; 100 W.
WMBH—Joplin, Mo.; W. M. Robertson; 250 W.*
KGKX—Sandpoint, Idaho; Sandpoint Broadcasting Co., 100 W.
KGGC—San Francisco, Calif.; The Golden Gate Broadcasting Co.; 100 W.
KXL—Portland, Ore.; KXL Broadcasters, Inc.; 100 W.
KBPS—Portland, Ore.; Benson Polytechnic School; 100 W.
KORE—Eugene, Ore.; Frank L. Hill and C. G. Phillips, doing business as Eugene Broadcast Station; 100 W.
WJMS—Ironwood, Mich.; Morris Johnson; 100 W.
WDEV—Waterbury, Vermont; Harry C. Whitehall; 50 W.
WENC—Americus, Ga.; Americus Broadcasting Co.; 100 W.
WAGM—Presque Isle, Me.; Aroostock Broadcasting Corp.; 100 W.
WHDL—Tupper Lake, N. Y., Tupper Lake Bdcg. Co., Inc.; 100 W.

1430 KILOCYCLES—209.7 METERS

WHP—Harrisburg, Pa.; T—Lemoyne, Pa.; WHP (Inc.); 1 KW.*
WBAK—Harrisburg, Pa.; Pennsylvania State Police, Commonwealth of Pennsylvania; 1 KW.*
WCAH—Columbus, Ohio; Commercial Radio Service Co.; 500 W.
WNBR—Memphis, Tenn.; Memphis Broadcasting Co.; 500 W.
KGNF—North Platte, Nebr.; Great Plains Broadcasting Co.; 500 W.
KECA—Los Angeles, Calif.; Earle C. Anthony, Inc.; 1 KW.
WFEA—Manchester, N. H.; New Hampshire Broadcasting Co.; 500 W.
WHEC—Rochester, N. Y.; WHEC, Inc.; 500 W.
WOKO-WABO—Albany, N. Y.; T—Mount Beacon, N. Y.; WOKO (Inc.); 500 W.

1440 KILOCYCLES—208.2 METERS

WCBA—Allentown, Pa.; B. Bryan Musselman; 250 W.
WSAN—Allentown, Pa.; Allentown Call Publishing Co. (Inc.); 250 W.
WBIG—Greensboro, N. C.; North Carolina Broadcasting Co. (Inc.); 1 KW Daytime.
WTAD—Quincy, Ill.; Illinois Broadcasting Corporation; 500 W.
WMBD—Peoria Heights, Ill.; E. M. Kahler (owner Peoria Heights Radio Laboratory); 1 KW.*
KXYZ—Houston, Tex.; Harris County Broadcast Co.; 250 W.
KLS—Oakland, Calif.; E. N. and S. W. Warner, doing business as Warner Bros.; 250 W.
WMBD—Peoria Heights, Ill.; Peoria Bdcg. Co.; 1 KW.
WTAD—Quincy, Ill.; Ill. Bdcg. Corp.; 500 W.
KDFN—Casper, Wyo.; Donald L. Hathaway; 500 W.
CMBI—Havana, Cuba; Francisco Mayorquim; 30 W.
CMBN—Havana, Cuba; Armado Romeu; 30 W.
CMBL—Havana, Cuba; Julio C. Hidalgo; 20 W.

1450 KILOCYCLES—206.8 METERS

WSAR—Fall River, Mass.; Doughty & Welch Elec. Co., Inc.; 250 W.
WHOM—Jersey City, N. J.; New Jersey Broadcasting Corporation; 250 W.
WSAR—Fall River, Mass.; Doughty & Welch Electric Co. (Inc.); 250 W.
WGAR—Cleveland, Ohio; WGAR Broadcasting Co.; 500 W.
WTFI—Athens, Ga.; Liberty Broadcasting Co.; 500 W.
KTBS—Shreveport, La.; Tri State Broadcasting System (Inc.); 1 KW.

1460 KILOCYCLES—205.4 METERS

WJSV—Alexandria, Va.; T—Mt. Vernon Hills, Va.; Old Dominion Broadcasting Co.; 10 KW.
KSTP—St. Paul, Minn.; T—Westcott, Minn.; National Battery Broadcasting Co.; 25 KW.

1470 KILOCYCLES—204.0 METERS

WLAC—Nashville, Tenn.; Life and Casualty Insurance Co.; 5 KW.
KGA—Spokane, Wash.; Northwest Broadcasting System (Inc.); 5 KW.

1480 KILOCYCLES—202.6 METERS

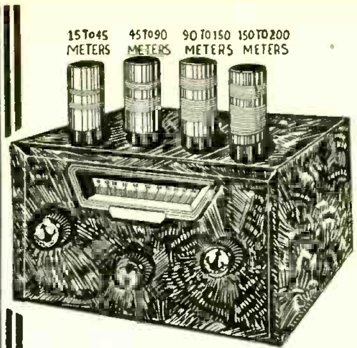
WKBW—Buffalo, N. Y.; T—Amherst, N. Y.; Buffalo Broadcasting Co.; 5 KW.
KFJF—Oklahoma City, Okla.; National Radio Manufacturing Co.; 5 KW.

1490 KILOCYCLES—201.2 METERS

WCKY—Covington, Ky.; T—Crescent Springs, Ky.; L. B. Wilson (Inc.); 5 KW.
WCHI—Chicago, Ill.; T—Batavia, Ill.; Midland Broadcasting Co.; 5 KW.

1500 KILOCYCLES—199.9 METERS

WFDV—Rome, Ga.; Rome Broadcasting Corp.; 100 W.
WMBA—Newport, R. I.; LeRoy Joseph Beebe; 100 W.
WLOE—Boston, Mass. T—Chelsea, Mass.; Boston Broadcasting Co. 250 W.
WNBF—Binghamton, N. Y.; Howitt-Wood Radio Co. (Inc.); 100 W.
WMBQ—Brooklyn, N. Y.; Paul J. Gollhofer; 100 W.
WLBX—Long Island City, N. Y.; John N. Brahy; 100 W.
WWRL—Woodside, N. Y.; Long Island Broadcasting Corporation; 100 W.
WSYB—Rutland, Vt.; H. E. Seward, Jr., and Philip Weiss, doing business as Seward & Weiss Music Co.; 250 W.
WKBZ—Ludington, Mich.; Karl L. Ashbacker; 50 W.
WMPC—Lapeer, Mich.; First Methodist Protestant Church of Lapeer; 100 W.
WPEN—Philadelphia, Pa.; Wm. Penn Broadcasting Co.; 250 W*.
WWSW—Pittsburgh, Pa.; Walker & Downing Radio Corp.; 250 W Daytime.
WOPI—Bristol, Tenn.; Radiophone Broadcasting Station WOPI (Inc.) 100 W.
KNOW—Austin, Tex.; A. P. Miller; 100 W.
WRDW—Augusta, Ga.; Musicove (Inc.); 100 W.
KGFI—Corpus Christi, Tex.; Eagle Broadcasting Co. (Inc.); 250 W*.
KGKB—Tyler, Tex.; East Texas Bldg. Co.; 100 W.
KGIZ—Grant City, Mo.; Grant City Park Corporation; 100 W.
KGKY—Scottsbluff, Nebr.; Hillard Co. (Inc.); 100 W.
WKBV—Connersville, Ind.; William O. Knox, trading as Knox Battery & Electric Co.; 150 W*.
KGFK—Moorehead, Minn.; Red River Broadcasting Co. (Inc.); 50 W.
KPJM—Prescott, Ariz.; Scott and Sturm; 100 W.
KXO—El Centro, Calif.; E. R. Irey and F. M. Bowles; 100 W.
KDB—Santa Barbara, Calif.; Santa Barbara Broadcasters. Ltd.; 100 W.
KREG—Santa Ana, Calif.; The Voice of the Orange Empire, Inc., Ltd.; 100 W.
KPQ—Wenatchee, Wash.; Wescoast Broadcasting Co.; 50 W.
WMIL—Brooklyn, N. Y.; Arthur Faske; 100 W.
XETZ—Coyoacan, D. F., Mex.; Manuel Zetina; 100 W.
CMBQ—Havana, Cuba; Gali-Sardinas; 50 W.
CMBR—Havana, Cuba; Tomas Basail; 15 W.



The New ECONOMICAL A-C Short-Wave Set

Earphone Model, Covers 15 to 200 Meters

THRILLING DISTANCE! ALL ON THREE TUBES!

NO matter if you are a fan interested in the whole wide sweep of the short-wave band from 15 to 200 meters, or an amateur interested only in the "ham" bands, you will enjoy the results from the new ECONOMICAL A-C Short-Wave Set. This receiver has a sensitized 57 detector and a stage of 56 audio, while the rectifier is an '80. The filtration is fine, so that the pleasure of listening to far-distant stations, including foreign ones, is not marred by hum.

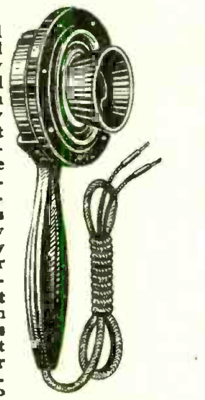
The highest efficiency was the aim in designing the set, therefore plug-in coils were used, and these are specially wound to insure adequate overlap of wavelengths between coils for succeeding bands, and to provide highest sensitivity. One coil is used for each of the four bands.

The receiver is housed in a crackle-finish shield cabinet, with back open so that the desired plug-in coil may be handily inserted in the receptacle provided for it on the chassis proper.

The circuit consists of a sensitized detector tuned by a Hammarlund junior midline short-wave condenser with stage of audio and B supply. The same high quality of parts and workmanship prevail throughout. The coupling between detector and audio tube is through a transformer, the plate current being at a low value to hold up the primary inductance, which is of itself high, and therefore make practical the use of a gainful transformer working out of a 57.

The ECONOMICAL Short-Wave A-C Receiver is a brand-new, specially-made product, now offered to the public for the first time, and bringing within the reach of all a dependable short-wave outfit that has an easy-tuning full-vision dial, with knob below; a sensitivity control and a switch. The receiver is sold complete with tubes (one 57, one 56 and one '80). Order CAT. TMACSW-T (price includes tubes)........................ **$18.95**

KELLOGG MICROPHONE



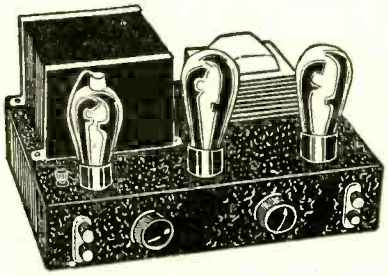
Kellogg Switchboard Company is well known for the quality of its products, and the microphone from its precision factory is one of excellent performance, representing one of the best bargains in microphones. The response curve renders this microphone fully suitable for use by amateurs and for home recording or reproduction. It is not to be confused with toy microphones, as this is a real product from a manufacturer of real standing. Order CAT. TM-TMP at **$1.95**

MICROPHONE FLOOR STAND

Here is a chrome-plated microphone floor stand, of rigid construction, that will neither sway nor vibrate. The top ring is 6½ inches in diameter. The height can be adjusted from 40 to 70 inches. The clamp lock is engaged by a simple but tightly-gripping thumb screw.

Not only in professional work is this microphone floor stand an advantage, but owing to the extremely low price many who have microphones in their homes, for use with the audio amplifier of their radio set, will want this stand. Order CAT. TM-MFS at **$4.50**

POWER AMPLIFIERS



THERE is money to be made in renting or selling power amplifiers, as churches, academies, auditoriums, clubs, societies, stores, rinks and the like are constantly using and buying such equipment. Moreover, as the user's business grows, larger-sized power amplifiers are required, and you grow with your customers. Therefore it is profitable to get organizations and businesses started in the use of power amplifiers, and they will be surprised at the very low cost at which you can sell and install them.

In the design and construction of these public address systems a liberal safety factor has been allowed. They may be used with single or twin speakers.

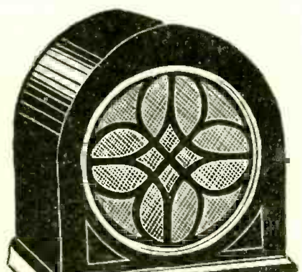
Each one consists of a first stage of '24 audio transformer coupled to a single-sided output, and includes a husky B supply fully filtered.

CAT. TM-PA-45, consisting of a power amplifier and B supply, using one '24, one '45 and one '80. Power consumption, 40 watts. Maximum undistorted power output, 2 watts. Suitable for gatherings of up to 500 persons. Price (less tubes)........**$10.95**

CAT. TM-PA-47, consisting of a power amplifier and B supply, using one '24, one '47 and one '80. Power consumption, 40 watts. Maximum undistorted power output, 3 watts. Suitable for gatherings of up to 700 persons. Price (less tubes).........**$12.95**

CAT. TM-PA-50, consisting of a power amplifier and B supply, using one '24, one '50 and one '81. Power consumption, 50 watts. Maximum undistorted power output, 5 watts. Suitable for gatherings of up to 1,000 persons. Price (less tubes)........**$15.95**

BOSCH CABINET



An elegantly-finished cabinet to house either a dynamic or a magnetic speaker of 8-inch diameter cone. This is an excellent cabinet into which to put a spare speaker. Order CAT. TM-BCAB at **$2.25**

RESISTORS

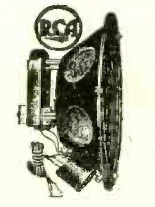
WE have a wide assortment of the finest types of commercial pigtail resistors made. These are manufactured for us in quantity and are sold at prices far below those prevailing elsewhere. Each resistor is guaranteed to be in excellent condition, and is of the type that does not change in resistance value appreciably with temperature. The rating is 1 watt except where otherwise specified.

	Color Code Body	End	Dot		Color Code Body	End	Dot
175 ohms	Brown	Violet	Brown	50,000 ohms	Green	Black	Orange
350 ohms	Orange	Green	Brown	60,000 ohms	Blue	Black	Orange
800 ohms	Gray	Black	Brown	100,000 ohms	Brown	Black	Yellow
1,200 ohms	Brown	Red	Red	250,000 ohms	Red	Green	Yellow
3,500 ohms	Orange	Green	Red	500.000 ohms	Green	Black	Yellow
10,000 ohms	Brown	Black	Orange	2,000.000 ohms	Red	Black	Green
20,000 ohms	Red	Black	Orange	5,000,000 ohms	Green	Black	Green

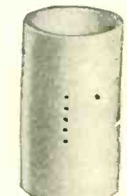
ANY FOUR OF ABOVE RESISTORS, 30c

3,500 ohms, 2 watts, for reducing the maximum B voltage to about 180 volts for r-f tubes. Price. 11c.

SPECIALS



The magnetic chassis used in the RCA 100B, 100A and 103 speakers. Built-in output transformer permits use of up to 400 volts. Corrugated cone, 9 inches diameter. Large permanent magnets. CAT. TM-RCA **$3.75**



For the construction of short-wave plug-in coils, Isolantite forms permit of high efficiency, due to minimized losses. These forms have UX (four-pin) bases and strongly - embedded prongs. CAT. TM-ICF (each)........**39c**

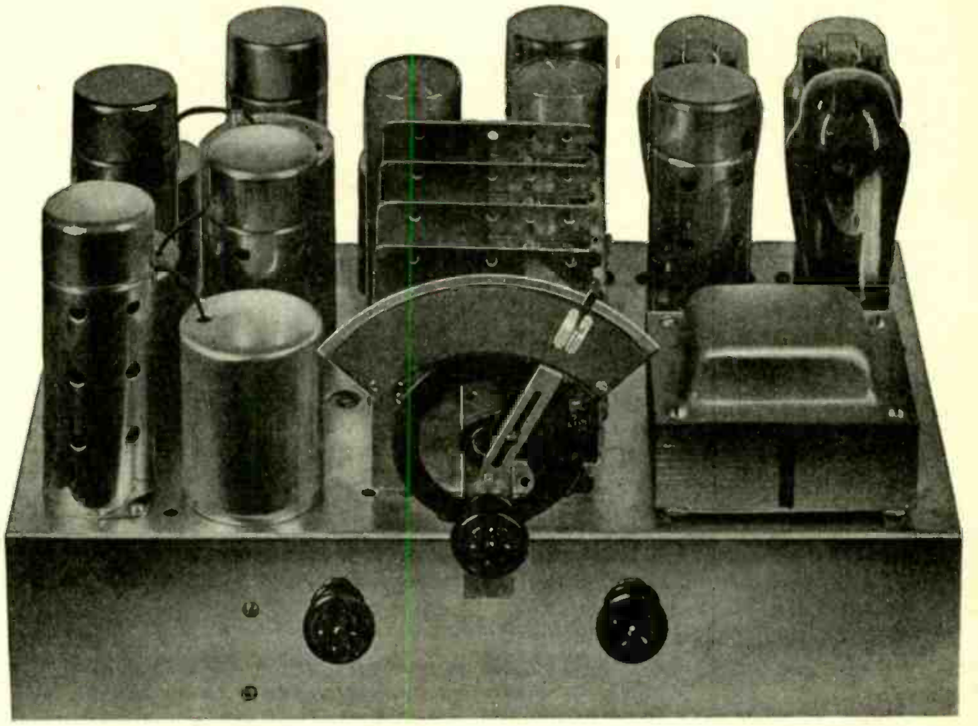
DIRECT RADIO CO.

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

The Greatest DIAMOND *of them All!*

Designed by Herman Bernard and Indorsed by Us as the Greatest Circuit We've Ever Offered

1. Push-Pull 15-watts undistorted output, the great power serving as a reserve that avoids distortion on strong low notes of orchestras.
2. New tubes. The heavy-duty 5Z3 rectifier and the 2A3 output tubes are used. The power stage is a cross between Class A and Class B, but of the no-grid-current type.
3. Full wave duplex diode linear second detector. Stands up to 60 volts signal on second detector.
4. Noise suppression control without an extra tube. This means no interchannel hiss or "hash" without elimination of which a.v.c. is a nuisance.
5. Two stages of intermediate frequency amplification, both subject to full automatic volume control.
6. Selectivity affording non-interfered reception from a distant station through a local 10 kc away delivers 100 times as much antenna voltage.
7. Sensitivity of beter than 0.5 microvolt per meter.
8. Volume control can completely eliminate signal, and has sound volume range from bare audibility to 400,000 times bare audibility.
9. Dual range. Broadcast and police bands by throwing a front-panel switch. Some amateurs, short-wave music and television can be received.



The knob at left is for throwing a switch, so 1,500-530 kc or 4,300 to 1,500 kc can be tuned in. At right is the combination a-c switch and volume control.

The Push-Pull Super Diamond

ON a chassis only 13.5 x 3 x 8.75 inches is built one of the finest a-c dual-range receivers any one could desire—the Push-Pull Super Diamond, using nine tubes, with eleven-tube performance. The reason for the extra performance is the use of a single tube as oscillator and modulator, and two tubes in one envelope as second detector and first audio amplifier (55).

The push-pull output stage uses two of the new 2A3 tubes, affording 15 watts output (5 per cent. total harmonic distortion), and the output stage is driven by a 56, which will load up the 2A3's. The gain is built up tremendously at the intermediate frequency level, where it may be done without distortion. Then follows a distortionless full-wave detector, the full-wave feature being protection of quality. The audio stages are worked well within their power-handling capacity, to a total gain at audio frequencies of less than 1,000.

The performance of the receiver is such that you never need worry about interference due to a strong local spoiling reception of a distant station on an adjacent channel, or interference due to cross-modulation, for there is no cross-modulation.

The controls are limited to the tuning dial, which is frequency-calibrated, the combination a-c switch and volume control, and the wave-band switch. Total, three controls. Result, utter simplicity. Any one in the family can tune the set without any trouble. No tuning indicator, be it meter or neon lamp, is necessary, due to noise suppression control.

You may use as long an aerial as you desire on this receiver, yet you will get an abundance of results from even remotely-distant stations on only ten feet of wire. The only precaution necessary is that the aerial be long enough to cause some voltage to exist in the second detector at all times, as on this voltage alone depends the bias on the first audio amplifier, (triode of 55). Without any bias there would be grid current, and consequent hiss at all settings, but 10 feet of wire as aerial, wherever placed, is usually sufficient to overcome this, and besides every one uses an aerial longer than that. Any type of outdoor aerial will meet the requirement of 55 triode grid current elimination.

The circuit was designed by Herman Bernard, has been carefully tested out by us in all particulars, and is unhesitatingly recommended as an outstanding circuit that will satisfy those who want "something better." The Push-Pull Super Diamond is distinctly "better."

Wired Model of Push-Pull Super Diamond, including speaker, tubes and everything else, except cabinet. Lined up and padded by experts. Licensed. Cat. WM-PPSD - - - - - $36.27

Complete parts, speaker, tubes, everything except cabinet. Cat. K-PPSD. $32.77

Direct Radio Co.

143 West 45th Street

New York, N. Y.

FOUNDATION UNIT

The Foundation Unit for the Push-Pull Super Diamond consists of a shielded antenna coil, a shielded interstage r-f coil, a comibnation oscillator and 175 kc assembly in one high shield, a shielded regular 175 kc transformer, and a shielded 175 kc transformer with center-tapped secondary; also a 0.00041 mfd. tuning condenser, three-gang, with compensators; an 850 to 1,350 mmfd. padding condenser, a frequency-calibrated dial and a drilled chassis. Cat. FU-PPSD @ **$6.55**

[The coils for r-f and oscillator are wound exactly according to specifications of Herman Bernard and are of a higher order of accuracy than in commercial practice, and moreover provide for matching the tuning to the scale of the frequency-calibrated dial that bears Mr. Bernard's name.]

ADDITIONAL PARTS

The nine 0.1 mfd. and two 0.25 mfd. bypass condensers for the Push-Pull Super Diamond are specially made up in one shield, with three mounting lugs for which the chassis is drilled. Cat. CU-PPSD @........................$1.20

Three-gang 0.00041 mfd. tuning condenser, compensators. Cat. TC-PPSD @ $1.80

Cadmium-plated drilled steel chassis for the Push-Pull Super Diamond. Cat. CH-SD7 @ .... .98

The tube kit consists of four 58, one 55, one 56, two 2A3 and one 5Z3, total 9 tubes. The radiotron tube kit is Cat. TK-PPD @....$10.62

850 to 1,350 mfd. padding condenser...... .50

Knobs for ¼ inch shafts.............. 7¢ each

Bernard's frequency-calibrated dial........ .90

Four electrolytic 8 mfd condensers, two in one case, two in the other. to occupy top panel positions, ...$2.36

Bypass condenser, 0.5 mfd.................. .29

70-meter switch $1.56

Heavy-duty power transformer, 150 ma rating, correct voltages and windings..............$2.95

Heavy-duty push-pull 2A3 speaker, 2800-ohm field, tapped @ 700 ohms and reverse-wound. Rola or Magnavox at our selection........$7.05

Complete kit of the 17 one-watt resistors..$1.87

250,000 - ohm tapered potentiometer with switch .... .62

Complete set of ten sockets (one for speaker) .... .92

0.00005 mfd. mica condensers, 50 mmfd..36c each

Push-pull input transformer, unshielded..$1.87

775-ohm, 5-watt resistor..........................42c