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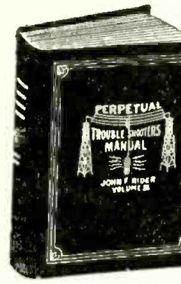

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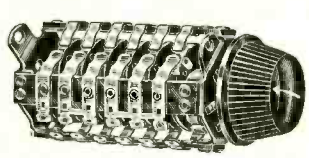

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TWELFTH YEAR

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EXCELLENT AMPLIFICATION OF LOW VOLTAGE IMPUT—A PUSH-PULL CIRCUIT WITH MORE THAN 40 WATTS OUTPUT

THE 37, 56, 57, and 77 type tubes may be operated as resistance-coupled amplifiers with high plate-supply voltages, of the order of 500 volts, to provide high audio input voltage for the operation of large power output tubes.

In the design of power amplifiers, the tubes, the coupling devices, and the operating voltages to obtain the highest output levels with the least amount of distortion must be carefully selected.

For representative tubes operated with a plate supply of 500 volts, a plate load of 250,000 ohms, and a grid leak of 500,000 ohms for the following tube, the voltages developed across the a-c load of 167,000 ohms are:

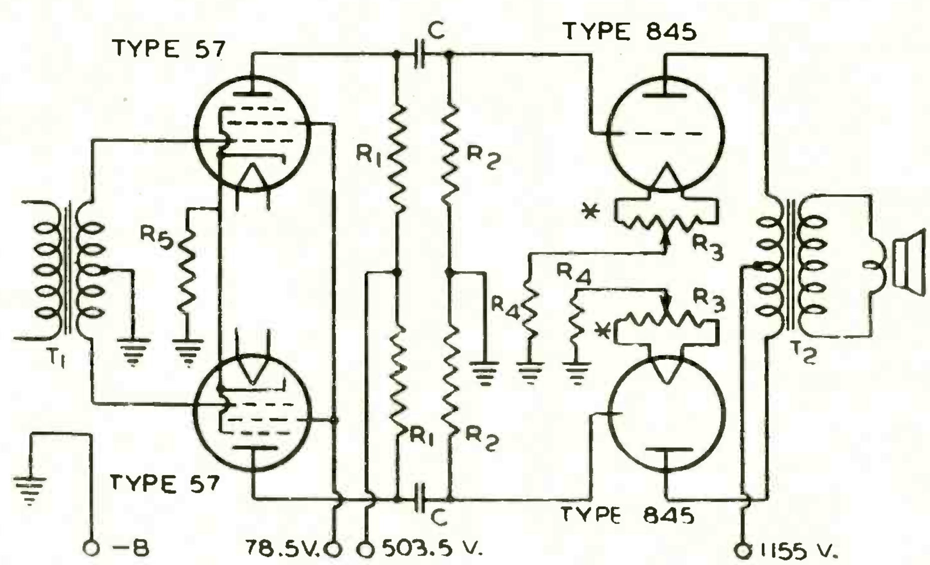
TABLE I

Tube Type	Grid-Bias Volts	Screen Volts	Peak-Output Volts	Distortion Per Cent
37	—22.5	—	172	3.5
56	—16.0	—	180	5.9
57	— 3.5	92	180	5.0
57	— 3.5	90	200	7.0
77	— 4.5	100	200	9.5

TABLE II

Tube Type	Grid-Bias Volts	Screen Volts	Peak-Output Volts†	Distortion Per Cent
37	—22.5	—	275	0.7
56	—16.5	—	255	1.1
57	— 3.5	75	300	1.0
57	— 3.5	75	350*	2.5*
77	— 3.5	70	293	1.5

†The peak-output voltage is that measured between plates.
*For the 350-volt output condition in the above table the input to the 57 tubes is sufficient to cause some grid current.



C = 0.1 µf
R_1 = 250000 OHMS
R_2 = 500000 OHMS
R_3 = 20–40 OHMS
R_4 = 2380 OHMS. SELF-BIASING RESISTOR FOR EACH 845
R_5 = 1400 OHMS, SELF-BIASING RESISTOR FOR 57'S
T_1 = INPUT TRANSFORMER
T_2 = OUTPUT TRANSFORMER

* SEPARATE WINDING ON POWER TRANSFORMER FOR EACH 845 FILAMENT
NOTE* R_4 PROVIDES 155 VOLTS BIAS FOR EACH 845
R_5 PROVIDES 3.5 VOLTS BIAS FOR 57'S

More than 40 watts output is obtainable from this double push-pull circuit, a pair of 57's driving a pair of 845's. This of course is not an amplifier for home use.

845 Output Suggested

From the viewpoint of distortion, the 37 is the most satisfactory. The 37, however, requires 6.5 times as great an input voltage as the 57 to yield the same output. From the viewpoint of gain, therefore, the 57 is to be preferred to the 37.

An excellent output tube for providing very large audio output of high quality is the 845. This tube operated as a self-biased audio amplifier with a peak-input voltage of 150 volts is capable of an a-f output of 21 watts. Any of the tubes shown in the table (the 37, 56, 57, and 77) may be used to provide the necessary grid excitation for the 845.

From the plate characteristics of the 57 and 77, one might expect that low distortion at high output voltages would be obtained from these tubes when the plate supply is 500 volts, plate load is 250,000 ohms, and grid resistor is 500,000 ohms for following tube. However, distortion increases rapidly with output at high plate-supply voltages and, although large outputs can be obtained, they may not be sufficiently free from distortion. This relationship is indicated in Table I. Distortion, incidentally, is somewhat critically dependent upon screen voltage.

Operation of any of these tubes in push-pull will provide greater output at lower percentages of distortion, say RCA Radiotron Co. and E. T. Cunningham, Inc. The accompanying tabulation shows self-biased push-pull operation for pairs of the same tubes as in Table I with the same condi-

(*Continued on next page*)

A SHORT-WAVE MODEL

B VOLTAGE FROM BATTERIES, HEATERS EXCITED BY D. C. OR A. C.

By Lemuel Imhof

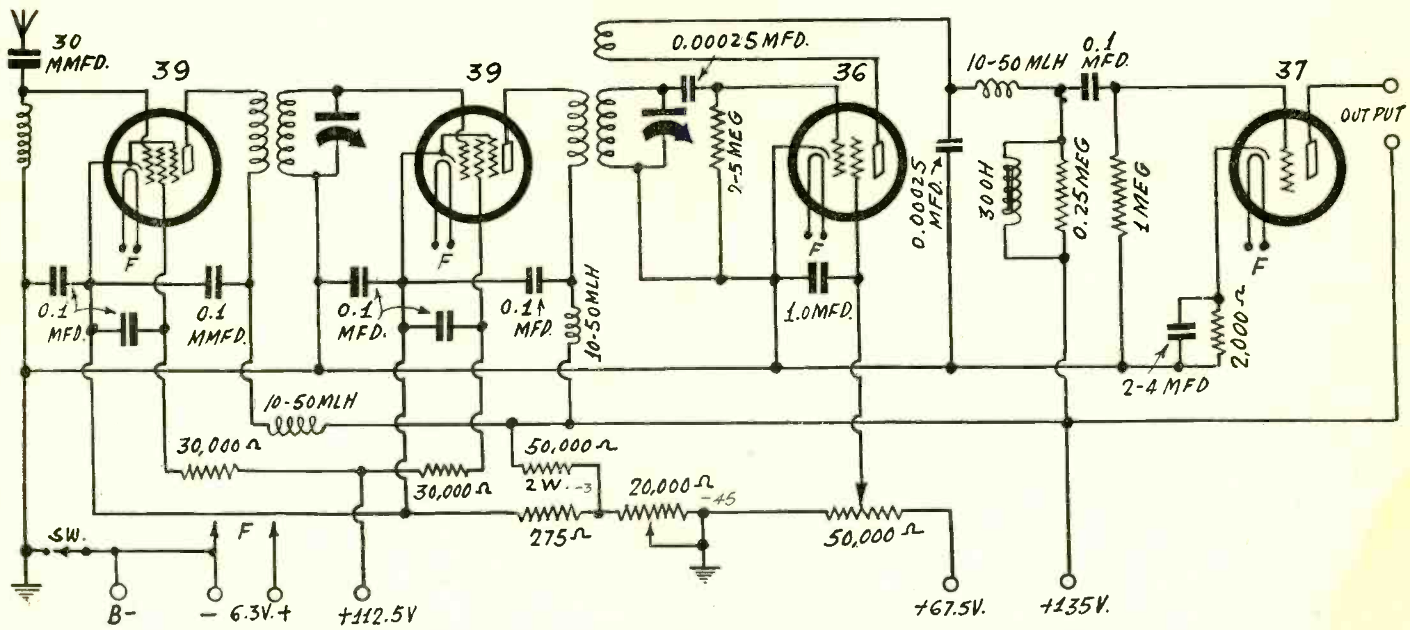


FIG. 1

This four-tube circuit has been designed for short-wave reception with plug-in coils. It may also be built with 2.5-volt tubes, provided the proper grid, plate, screen, and filament voltages are used.

GREAT INTEREST now centers on short waves. Many sets designed to receive them are being constructed, and here is one of them, suggested by RCA-Cunningham in their latest radio tube manual. The circuit assumes that a storage battery is to be employed for heating the filaments, and for that reason all the tubes in the receiver, which is shown in Fig. 1, are of the 6.3-volt, 0.3-ampere type. There are two radio frequency amplifiers of the 39 type, a regenerative detector of the 36 type, and an audio amplifier of the 37 type. Since each of the tubes requires 0.3 ampere, the entire receiver will take only 1.2 amperes. A comparatively small storage battery will suffice, just so the voltage is 6.3 volts, that is, just so there are three cells in series.

Since short-wave receivers usually pick a great deal of hum when there is any hum about, the present receiver is powered by plate batteries. A voltage of 135 volts is provided for the plates of all the tubes and 112.5 volts is provided for the screens of the two 39 radio frequency amplifiers. The screen voltage on the 36 detector is variable between zero and 67.5 volts, the variation being effected by means of a 50,000-ohm potentiometer connected across the 67.5-volt section of the battery. Thus the detecting efficiency and the regeneration are controlled by the screen voltage on this tube.

Filtering

A circuit like this one having two stages of radio frequency amplification in addition to regeneration must be thoroughly filtered if it is to be stable at the higher frequencies. For that reason by-pass condensers of comparatively large value are connected in all the leads and filter chokes or resistors in series. Thus we have a 0.1 mfd. condenser from the cathode of the first tube to ground. Another condenser of the same value is connected from the screen of that tube to the cathode, and still another of the same value from the plate return to the cathode. There are in addition a 30,000-ohm resistor in series with the screen supply lead and a 10 to 50 millihenry choke in series with the plate. The high frequency signal is effectively confined to the tube by these filter devices.

The second tube is treated exactly as the first, and therefore in this stage also the signal is confined to the tube.

The detector is of the regenerative type and has a stopping condenser of 0.00025 mfd., a grid leak of from 2 to 5 megohms, and a plate by-pass condenser of 0.00025 mfd. The screen of this tube is by-passed by a condenser of 1.0 mfd. The control of the regeneration, as has been stated already, is by screen voltage variation. The maximum screen voltage possible is more than enough and the minimum, which is zero, is too low for regeneration. Hence there is ample control latitude.

The Audio Amplifier

As a means of preventing the short wave signal from entering the audio amplifier, a 10 to 50 millihenry choke coil is put in the high potential lead to the amplifier. A high impedance load on the detector is essential for good detection efficiency. In this circuit we have a 300-henry choke coil shunted by a 250,000-ohm resistor. The main purpose of the choke coil is to provide a low resistance path for the d-c without at the same time lowering the effective load impedance appreciably. The low d-c resistance in the plate circuit insures regeneration and oscillation when that is required.

A stopping condenser of 0.1 mfd. and a grid leak of one megohm are employed in the grid circuit of the output tube. The high time constant of this combination insures high gain on the low audio frequencies. The output tube is a 37. The reason such a small tube is used is that on most short wave receivers a headset is used for listening. The 37 gives ample power for that, and even for a small magnetic or permanent field dynamic speaker.

The 37 is biased by a 2,000-ohm resistor in the usual cathode-ground position, and this resistor is shunted by a condenser of between 2 and 4 mfd. as a means of preventing reverse feedback.

Control of Volume

Aside from the volume control afforded by the variable screen voltage on the detector, there is a control of the radio frequency amplification by varying the bias on the two 39 tubes. In the combined cathode lead of these tubes is a 275-ohm resistor, which sets a minimum limit of the bias at 3 volts. Between this resistor and ground

(Continued on next page)

Single-Tube Amplifier

(Continued from preceding page)

tions, i. e., plate supply voltage of 500 volts with plate and a-c loads of 250,000 and 167,000 ohms respectively per tube. Screen voltage is given for minimum distortion.

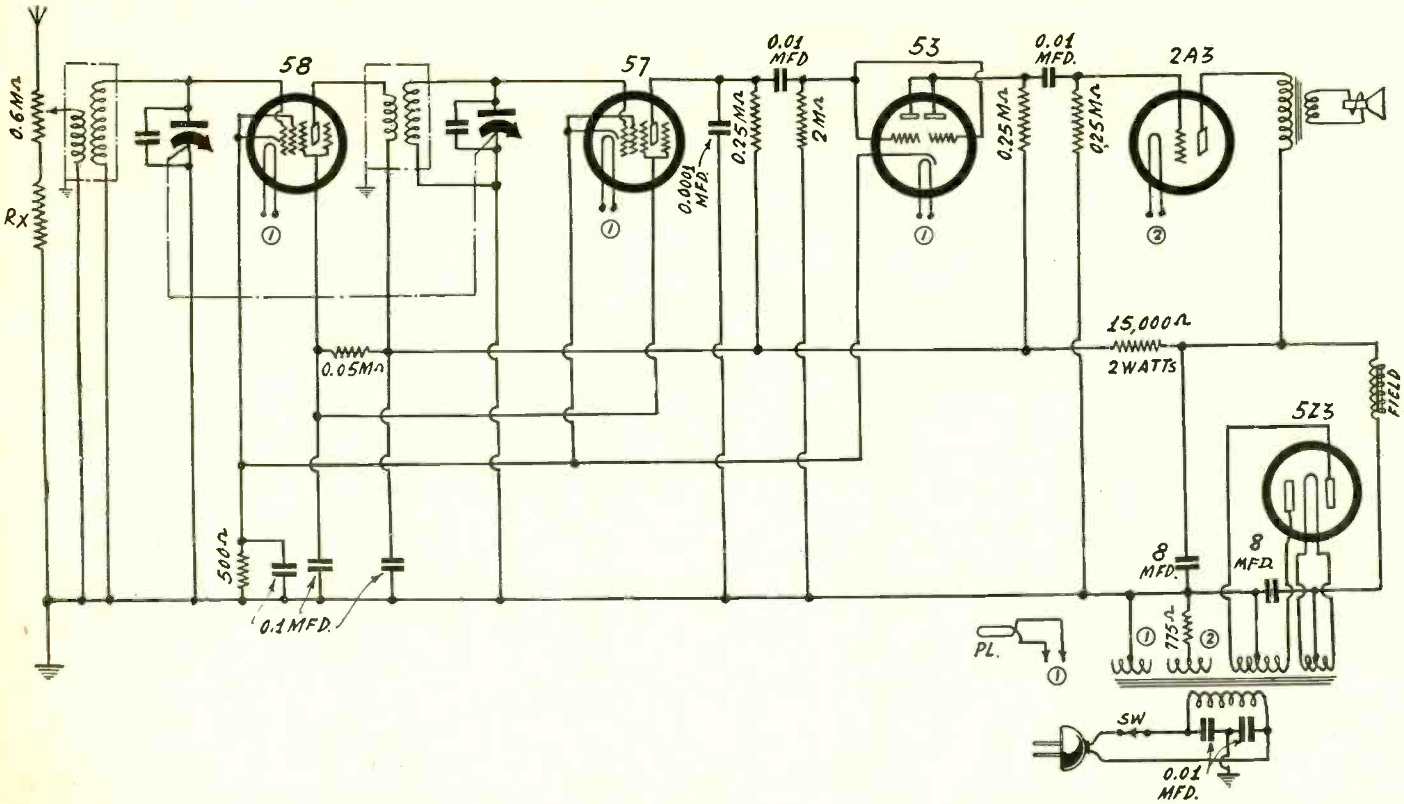
Considering both output voltage and distortion, the 57 provides the most satisfactory performance.

In cases where the grid leak of the power tubes is limited to 100,000 ohms, the maximum output of two 57's in push-pull with plate load of 250,000 ohms is 315 volts peak with distortion of 1.8%. Screen voltage of 75 volts is used. The input signal is that which will just start grid current.

Thus, if it is desired to o perate two 845's in push-pull with a plate voltage of 1,000 volts and grid voltage of 155 volts toprovide approximately 45 watts of power. very satisfactory results would be obtained by using a pre-amplifier stage of two 57's in push-pull with a plate-supply voltage of 500 volts and a control-grid voltage of 3.5 volts.

Where an amplifier is to be used in conjunction with low voltage inputs, the high gain of the 57 is a distinct advantage.

Requirements for Driving



The driver tube has to be carefully selected. Due to the very low a-c input signal that the 53 will stand, a signal less than the negative bias on the tube of course, the 53 would overload long before there would be any approach to loading up the output tube.

RESULTS obtainable from a set depend considerably on the driver. Assuming there are radio-frequency amplification and detection, and an extra tube is placed between the detector and the output, this extra tube is the driver of the last stage.

If the detector is of a sensitive type, then the driver has to be able to stand considerable a-c input voltage. In fact, it should be of power tube proportions. However, should the r-f amplification ahead of the detector be so small that there would be little likelihood of ever loading up the detector, then the driver could be of more modest proportions. Specific examples are: for the circuit illustrated, even with the scant r-f amplification, the 53 could not well be biased more than 4 volts, so for safety a maximum of 3 volts a-c input would be considered all right, but the output of the 53 would not load up the 2A3, which has about 50 volts negative bias and takes a 49-volt signal swing. Therefore a more suitable driver for the circuit shown would be a 56, with 250 volts on the plate, and a negative bias of around 8 volts. If there were more r-f amplification, say, two more stages, then the driver should be a 2A5, with a 20,000-ohm plate resistor of the 10-watt type, and the 2A3 output tube would be well fed from such a source. The 53 in the diagram is therefore not suitable from any viewpoint, except one contemplating the use of a very short aerial, so that even strongest locals will not overload the 53.

A Sensitive Short-Wave Receiver

(*Continued from preceding page*)

is a variable resistor, taper type, of a maximum value of 20,000 ohms. By means of this resistor the bias on the two radio frequency tubes can be raised to 45 volts, which is sufficient to cut off the amplification in these tubes completely. Plate current alone cannot be depended on for the drop in this resistance. Hence a bleeder resistance of 50,000 ohms is connected between the high voltage and the variable bias resistor. Through this resistance a minimum current of 2 milliamperes flows, and it is that current which is depended on for the bias on the radio frequency amplifiers.

Switching

Between ground and B minus A minus is a switch Sw. This opens the B supply on the negative side. It does not, however, open the filament circuit, but it could be made to do that if one side of each filament were grounded and if the negative "arrow" at A minus were ignored. It is, perhaps, better to insert another switch in the filament circuit.

One precaution must be taken to prevent the plate battery from running down when the set is not in use. It will be noticed that the section of the plate battery which is between the 67.5 and 135 volt taps is in series with one 50,000-ohm resistor, one 20,000-ohm or less resistor, and another 50,000-ohm resistor, in all 120,000 ohms, or possibly only 100,000 ohms. This circuit is not affected by the switching as shown in the diagram. The current through the circuit may be as high as 0.675 milliampere and not less than 0.562 milliampere. To save the battery when the circuit is not in use this circuit should be opened, which may be done by removing the connection to the 67.5-volt tap on the battery. If desired, a switch controlling this circuit can be combined with the switch controlling the rest of the B supply and the filament supply. By grounding one side of all the heaters and utilizing the switch shown next the ground symbol, as was suggested above, a double pole single throw switch will control all the supply voltages and protect the 67.5-volt section of the plate battery besides.

This circuit can be built with 2.5-volt tubes by replacing the 39 by a 58, the 36 by a 57, and the 37 by a 56, provided that the proper plate, screen, filament, and grid voltages are used. The suppressors on the 57 and the 58 should be connected to the cathode. With these tubes it is best to use a 2.5-volt transformer for heating the filaments and to ground the center point of the 2.5-volt winding in place of one side as is done in the circuit in Fig. 1. The line from B minus to A minus should be cut and B minus connected to the center of the winding. Centering can be done either on the winding or by means of a 50-ohm potentiometer connected across it.

Coils and Condensers

In the grid circuit of the first tube is a small radio frequency choke coil the value of which has not been indicated. It may be any radio frequency choke of 10 millihenries or more. It should have the lowest possible distributed capacity. There are many coils available that have been designed for this purpose.

The values of the two tuning condensers are not given either. In many short-wave circuits they are 150 mmfd, which is a suitable value. The coils, of course, are of the plug-in type. The first has only two windings and requires a four-contact socket. The second coil has three windings and for that reason requires six-contact socket. The two tuning condensers and the two coil sets should be obtained to match each other. If small condensers are obtained and then the coils are for larger condensers, there will be certain frequency bands which cannot be tuned in, and if large condensers and coils for smaller condensers are obtained, there will be unnecessarily wide overlaps.

1-TUBE A-F AMPLIFIERS

ONE HIGH-GAIN, USING THE 57, OTHER LOW-GAIN, USING THE 56

By William C. Edwards

THE 57 TUBE can be used as a high-gain audio amplifier with satisfactory results, and a suitable circuit is shown in Fig. 1. Consistent with high gain we have an audio-frequency input transformer ahead of the circuit. The fact that one side of the primary is grounded suggests that the amplifier is to be used for a microphone, a phonograph pick-up, or, perhaps, a detector coupled with choke and condenser to the transformer. Of course, if the primary of the transformer is to be connected to the B supply it is only necessary to cut the ground line and connect the primary to the proper high voltage.

In a high-gain amplifier a good volume control is desirable. Accordingly, in this circuit we have a 250,000-ohm potentiometer across the secondary. One end of the winding is connected permanently to the grid of the 57 tube and the slider of the potentiometer is connected to the grid bias. By moving the slider to the grid input voltage to the tubes is zero and by sliding it to the other extreme of the potentiometer the input is the full output of the transformer.

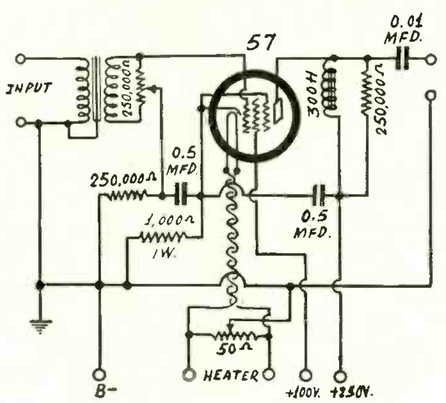


FIG. 1

A high-gain audio amplifier in which a 57 screen grid tube is employed. The gain is practically uniform over the entire audio band of frequencies.

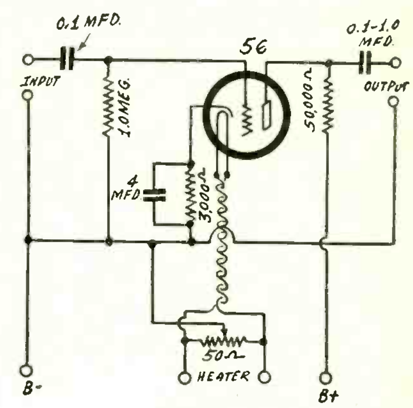


FIG. 2

A low-gain, resistance-coupled amplifier utilizing a 56 tube. It is self-biased, with the bias resistor shunted by a 4 mfd. condenser.

Filtering Bias

The tube is biased by a 1,000-ohm, one-watt resistor in the cathode lead. It is of utmost importance in a tube having such a high voltage gain as the 57 to prevent all reverse feedback. Ordinarily this would require an enormous by-pass condenser across the bias resistor. However, by a connecting a high resistor in series with the condenser and the resistor to be by-passed, adequate filtering can be obtained by means of a comparatively small condenser. In this circuit a 250,000 ohm resistor is used. The condenser, there, is actually across 251,000 ohms instead of 1,000 ohms. The effectiveness of the condenser is increased enormously and it need not be larger than 0.5 mfd. to effect adequate filtering.

There is also a 0.5 mfd. condenser from the cathode of the tube to the plate return. This aids greatly in keeping the signal component of the plate current from the bias resistor and hence to reduce reverse feedback.

The Output

In the output circuit of the tube we have a 250,000-ohm resistor and a 300-henry choke coil in parallel. It would seem that the choke would introduce frequency distortion and therefore would be an undesirable feature. It serves a very useful purpose. Its d-c resistance is comparatively low and for that reason the applied plate voltage, 250 volts, and the actual plate voltage on the tube, do not differ a great deal. The effect, then, is to decrease the internal plate resistance of the tube and hence to improve the mutual conductance. Moreover, it permits the use of a high screen voltage, which is another way of making the gain higher. With the resistor alone in the plate circuit we would have to use a very low screen voltage.

The inductance of the choke is sufficiently high to insure good amplification on even the lowest audio frequencies. The voltage gain, therefore, will be practically uniform throughout the audio band of frequencies.

In series with the high-potential output lead is a condenser of 0.01 mfd. If the output terminals were a transformer, this condenser would be too small. Hence the output of the amplifier is to be delivered to a power amplifier, with a grid leak across the output terminals.

As a means for eliminating hum from the amplifier, a 50-ohm potentiometer is connected across the heater voltage leads, and the slider is tied to the ground. By sliding the slider a point can be found where the hum is zero or an inappreciable minimum.

Resistance-Coupled Amplifier

In Fig. 2 we have a regular resistance-coupled amplifier utilizing a 56 tube. An amplifier of this type can be inserted in a circuit where an extra gain of about 10 is required, without introducing any appreciable amplitude or frequency distortion.

The input terminals are supposed to be connected across the plate load impedance of the tube preceding, and this may be either a high inductance choke or a high value resistance. As in the preceding circuit, the line that is grounded should be cut and connected to the required high positive voltage.

An 0.1 mfd. condenser is put in the high voltage lead and one megohm grid leak from grid to ground. The time constant of this combination is 0.1 second, which means that frequencies as low as 10 cycles per second are amplified nearly as much as those of 100 cycles per second. The grid stopping condenser should be one of very low leakage for if it is not, leakage from the positive voltage at the left of it may cause the grid of the tube to become positive.

The 56 is biased by a 3,000-ohm resistor between the cathode and ground. This high value is needed because of the low amplification factor of the tube and also because of the 50,000-ohm plate load. The internal plate a-c resistance of the 56 is rated at 9,500 ohms, and the amplification factor is 13.8. If we take these values together with the load resistance of 50,000 ohms, we get a voltage amplification of 11.6 times. No doubt, the internal resistance is higher than 9,500 ohms in this circuit, so a closer value of the actual amplification is 10 times, or it may be a little less.

Hum Elimination

In this amplifier also it is necessary to prevent reverse feedback as much as possible. For that reason a 4 mfd. condenser is connected across the bias resistor. Thus the reverse feedback on all essential audio frequencies is negligible.

Hum is eliminated by the expedient of connecting a 50-ohm potentiometer across the heater leads and grounding the slider. A point can always be found where the hum is a low minimum.

The output is delivered to the grid of the next tube through a stopping condenser which may vary in value from 0.1 to 1.0 mfd. Which value to use depends on the value of the grid leak that is put in the grid circuit of the next tube and also on the required amplification on the low audio frequencies. For broadcast reception or purely sound amplification a resistor as low as 50,000 ohms can be used when the stopping condenser has a value of 1.0 mfd. If the condenser has the lower value indicated the grid leak should have ten times the value, that is, 500,000 ohms.

The plate supply voltage should be 250 volts, that is, between ground and B plus. Somewhat higher values may safely be used but it is not necessary if another tube follows because the output of this stage will be more than enough to load up the largest power tube now in common use.

PEEP-HOLE TELEVISION

It is entirely practical to utilize a receiver that covers broadcasts and police waves for a peep-hole television receiver. There are several television transmitters near the police frequencies, and a small motor, either induction or synchronous type, may be used in conjunction with a small disc.

A 4-WATT OUTPUT

From a Power Amplifier Worked on 110-Volt D-C Line, with 48's in Push-Pull Output

By Einar Andrews

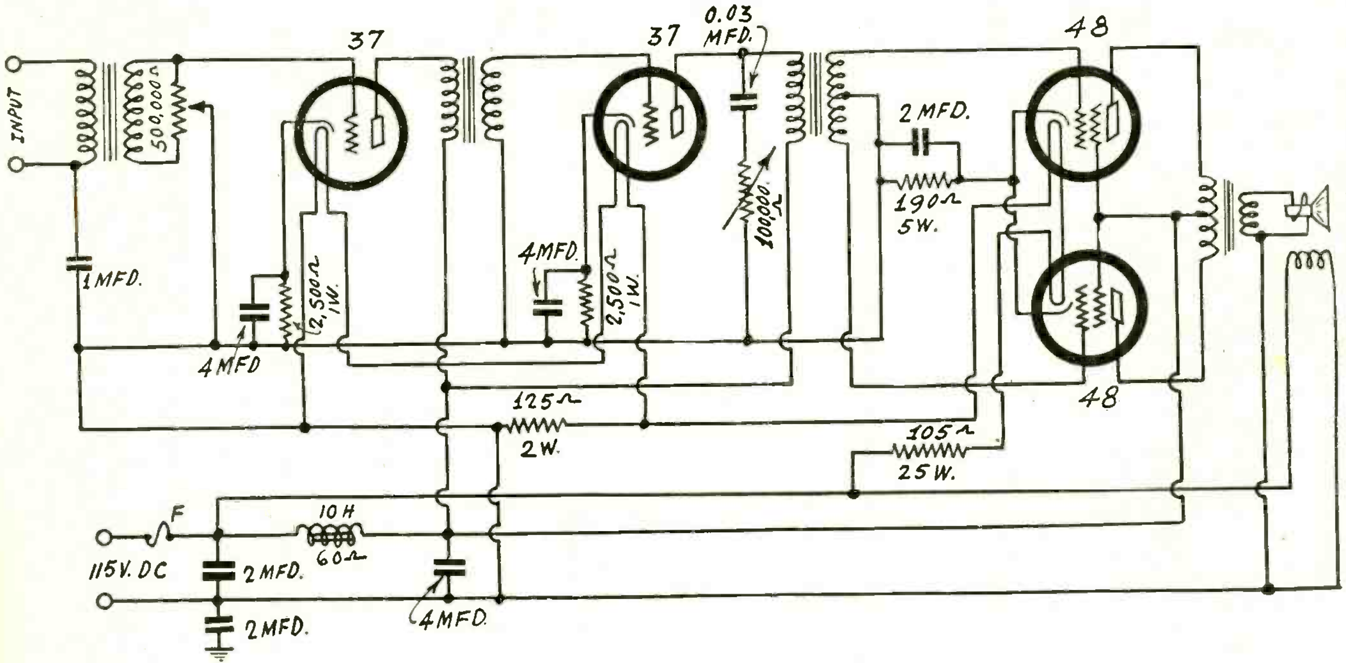


Fig. 1
A four-tube d-c amplifier utilizing two 37's and two 48's, the latter in push-pull. The circuit is capable of a high audio gain and an output of about four watts.

AN AMPLIFIER of considerable power output can be constructed with small heater tubes to be worked on a 115-volt d-c line, provided that the output stage utilizes two 48 tye power tubes. Allowing for a small voltage dro in the filter choke the output will be about 4 watts. This is comparable with the output of receivers using push-pull tubes with more than twice the voltage on the plates. The reason for the high power outut is the high plate current drawn by the 48 tubes.

In Fig. 1 is a four-tube, three-stage audio amplifier utilizing two 37's and two 48's, together with transformer coupling in all the stages, including one in front of the first tube. An amplifier of this sort is capable of a very high gain since there are three step-up transformers.

The primary of the first transformer is not conductively connected to anything, and for that reason it may be connected to any source of signal—microphone, phonograph pick-up, or radio detector. There is, however, a condenser of one microfarad connected between one side of the primary and ground, and therefore this side must be connected to the low potential side of the signal source.

Control of Volume

The volume of the output, or the gain of the amplifier, is controlled in the secondary of the first transformer. A 500,000-ohm potentiometer is connected across the winding and the slider of this is grounded. This connection makes it practical to mount the otentiometer on a grounded chassis or panel. To obtain a close control of the gain the potentiometer resistance should be tapered and the slow change in the resistance should be connected to the grid of the tube.

The first amplifier tube is biased by a resistance of 2,500 ohms of one-watt rating. It is shunted by a condenser of 4 mfd. This may be of the electrolytic type and if such is used it may also be of the low voltage rating kind, for the drop across the resistance will not be more than 10 volts at any time. The operating bias is about 7 volts.

Following the first 37 tube we have an interstage audio frequency transformer. This is a simple coupler with the primary going to the plate supply and the secondary to ground.

The second tube is also a 37 and it is biased by another 2,500-ohm resistance and this is shunted by another 4 mfd. condenser. It may be identical with the first by-pass condenser.

The Push-Pull Stage

In the plate circuit of the second 37 we have a tone control connected between the plate and ground. It consists of a 0.03 or 0.05 mfd. condenser in seies with a variable resistance having a maximum value of 100,000 ohms. The two elements of the tone control are connected so that one side of the variable resistor can be grounded. Therefore it may be mounted on a metal chassis or panel.

After the tone control we have a push-pull input transformer. It should be designed to work between a tube having a plate resistance of around 10,000 ohms and the grids of two tubes operating 180 degrees out of phase. Between the two cathodes of the 48's and ground is a bias resistance of 190 ohms and this iss hunted by a condenser of 2 mfd. The rating of the resistance should be 5 watts because the current is heavy.

The Filament Circuit

A regular dynamic loudspeaker with a 115-volt field and a push-pull input transformer attached, suitable for the 48s, should be employed. The field is put directly across the line and only the first 2 mfd. filter condenser smooths out the fluctuations in the current.

All the filaments of the circuit are connected in series. Since the total filament current is 0.4 ampere and the drop in the tubes is 72.6 volts, a series resistor of 105 ohms, of 25-watt rating is used as a ballast. To compensate for the difference in current taken by the 48s and the 37s, a 125-ohm resister, of 2-watt rating, is put across the two 37 filaments.

The plate current is filtered by means of a 10-henry choke coil and two shunt condensers, one of 2 mfd. across the line and one of 4 mfd. across the plate voltage line after the filter choke. In view of the fact that in most instances the negative side of the power line will be "hot" and the positive grounded, a 2 mfd. condenser is connected between the negative side and ground. What has been called ground previously, that is, the cathode side of the amplifier, is ground only for the high frequency signal. It was called ground out of habit. In a d-c amplifier of this type it may be the actual ground but in most instances it is not.

Electrolytic Precaution

If the three filter condensers are of the paper dielectric type there is no danger if the power plug is inserted the wrong way. The set will simply not function until the plug has been inserted the right way. If, however, electrolytic condensers are used proper polarity is essential if the electrolytic condensers are put across the line the wrong way, permanent damage will result. The positive sides of the two condensers in the filter proper should be toward the side containing the fuse and that of the two between the negative side and ground should be grounded.

A fuse F is put in the positive side of the line next to the plug. A one-ampere fuse will be sufficient protection.

MUCH FROM SEVEN TUBES

LATEST ADVANTAGES, INCLUDING PENTAGRID MIXER, DIODE DETECTION, A.V.C. and HEATER OUTPUT VALVES

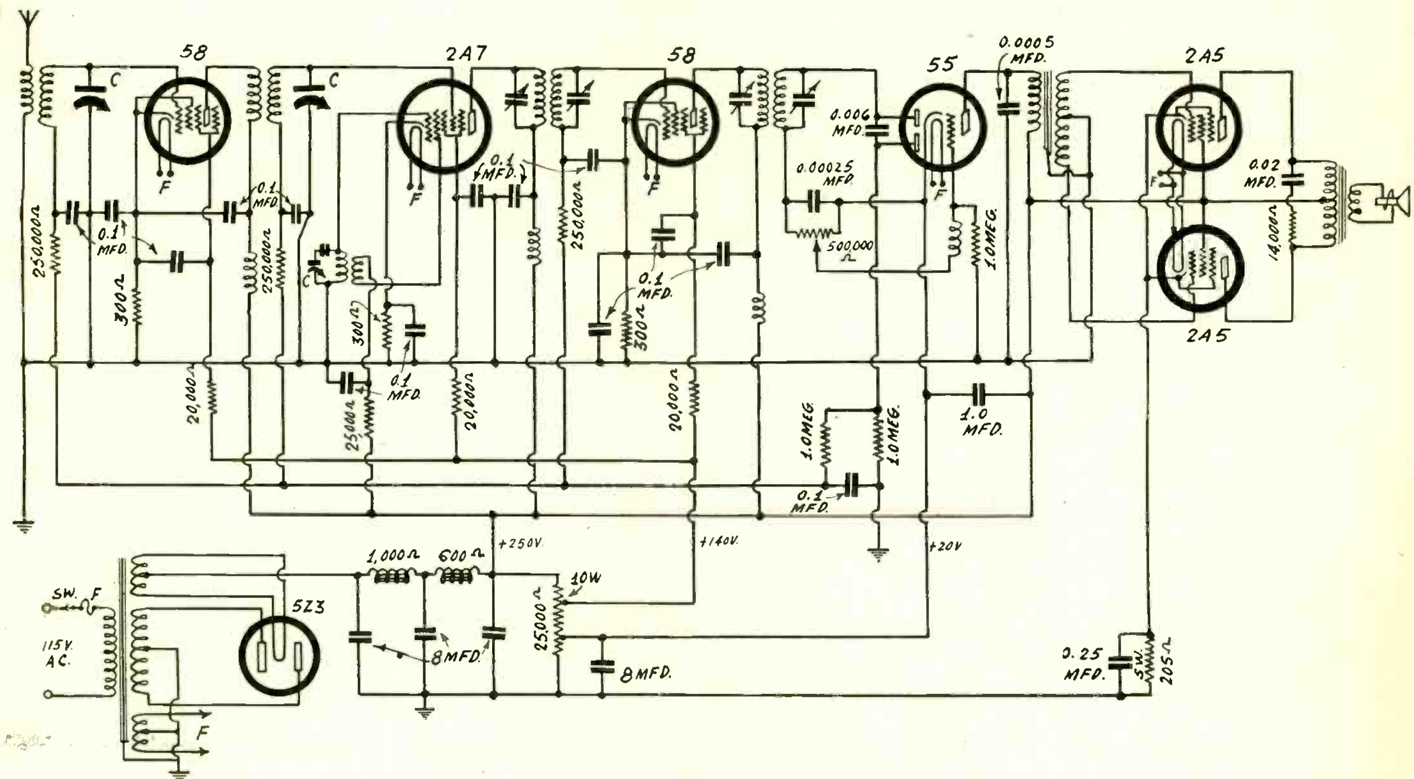


FIG. 1

A typical seven-tube superheterodyne incorporating the latest special purpose tubes, diode detection, a. v. c., and push-pull pentode audio amplification.

A TYPICAL seven-tube superheterodyne incorporating all the latest features and suggested in the RCA Radiatron-Cunningham radio tube manual is shown schematically in Fig. 1. The first tube is a 58 radio frequency amplifier, the second is a 2A7 penagrid detector and oscillator, the third is a 58 radio frequency amplifier, the fourth is a 55 diode detector, audio amplifier, and automatic volume control, the fifth and sixth tubes are 2A5 pentode power amplifiers in push-pull connection, and the seventh is a 5Z3 full-wave rectifier.

The circuit has two radio frequency selectors ahead of the first detector, each being of the straight radio frequency transformer type with tuned secondary. The oscillator is of the tuned grid type with grid leak and stopping condenser, and the tuner is of the padded type. The padding condenser is C1 in series with the tuning condenser, one of the sections of the three gang condenser.

Two doubly tuned intermediate frequency transformers are employed, each tuned to 175 kc. Since this intermediate frequency is used, the inductance in the tuned circuit of the oscillator must be designed for this frequency and the broadcast band, and the padding condenser likewise must be proportioned to fit this frequency. It should be variable over a range about 1,000 mmfd.

A Notable Feature

A notable feature of the receiver is the thorough filtering to avoid interaction among the various stages. First note that the screen and plate returns are made to the cathode, and not to ground. This applies to the radio and intermediate frequency amplifiers. In the plate return lead of each of these tubes is a radio frequency choke coil, which may have a value of 85 millihenries for each. In the screen of each of these tubes is a resistor of 20,000 ohms. The bypass condenser that is connected to the cathode in each instance is 0.1 mfd. These filters, therefore, are adequate in preventing any appreciable signal currents from getting into the plate supply and thence into the other tubes.

There is also a condenser of like value across each bias resistance and another of still the same value across each automatic bias filter resistor. The condensers associated with the bias are connected to ground. Thus for each of the amplifier stages there are four 0.1 mfd. condensers. The automatic bias filter resistor in each circuit is 250,000 ohms, and this taken in conjunction with the 0.1 mfd. condenser makes a satisfactory filter combination.

Filtering Detectors

In the first detector the screen and plate returns are by-passed to ground, in each case with a condenser of 0.1 mfd. In the plate lead is a radio frequency choke, which may have a value of 85 millihenries, and in the screen lead is a resistor of 20,000 ohms. Again there is thorough filtering. In this circuit also there is a 0.1 mfd. bypass condenser across the bias resistor.

One feature should be noticed about the oscillator in conjunction with the bias on the detector part. The grid leak of the oscillator, which may have any value between 10,000 and 50,000 ohms, is connected so that the oscillator grid is also biased by the bias resistor on the mixer. Sometimes this prevents oscillation. Hence if the oscillator should fail to function, the grid leak should be connected directly to the cathode. That makes the circuit start oscillating in every instance if other conditions are correct. The grid stopping condenser has the usual value of 250 mmfd.

In the second detector the load resistance is shunted by a condenser of 250 mmfd., the load resistor is a potentiometer of 500,000 ohms. This potentiometer serves as an audio frequency volume control. It will be observed that the load resistance is connected directly to the cathode, thus eliminating the handicap on the detector occurring when the bias on the amplifier part of the detector tube is included in the rectifier circuit. The grid of the triode is biased by returning the cathode to a point on the voltage divider 20 volts above ground and then by returning the grid to ground. Thus fixed bias is employed on the triode.

Stopping the Intermediate

Two things are done to prevent the intermediate frequency signal from entering the audio amplifier. In series with the stopping condenser next the slider of the potentiometer, which has a value of 0.01 mfd., is a radio frequency choke coil, which may have a value of 85 millihenries, or even as high as 250 millihenries. This choke prevents the carrier frequency from reaching the grid of the triode and hence from being amplified. The other thing that has been done is to connect a condenser of 500 mmfd. across the output of the triode, that is, from the plate to ground. The series choke and this condenser together are effective in stopping the carrier frequency.

The grid leak of the triode is one megohm. Considering that the stopping condenser has a value of 0.01 mfd., the time constant of the combination is 0.01 second, and this is

LIST OF PARTS

Coils

Two radio frequency transformers for 350 mfd. tuning condensers.
One oscillator coil for 350 mmfd. condenser and 175 kc intermediate.
Two doubly tuned intermediate frequency transformers, 175 kc.
One push-pull audio input transformer.
One audio push-pull output transformer (part of speaker).
Four radio frequency choke coils, about 85 millihenry each.
One 600-ohm filter choke.
One loudspeaker with 1,000-ohm field coil.
One power transformer.

Condensers

One gang of three 350 mmfd. tuning condensers.
Thirteen 0.1 mfd. by-pass condensers.
One 250 mmfd. condenser.
One 500 mmfd. condenser.
One 0.02 mfd. condenser.
One 0.02 mfd. condenser.
One 0.25 mfd. condenser.
One 1.0 mfd. by-pass condenser.
Four 8 mfd. electrolytic by-pass condensers.

Resistors

Three 300-ohm bias resistors.
One 205-ohm, 5-watt bias resistor.
Three 20,000-ohm resistors.
One 25,000-ohm resistor.
One 25,000-ohm voltage divider, 10-watt rating.
Three 0.25-megohm resistors.
One 0.5-megohm potentiometer (audio volume control).
Three 1.0-megohm resistors.
One 14,000-ohm resistor.

Other Requirements

One four-contact socket.
Five six-contact sockets.
One seven-contact socket.
One line fuse.
One vernier dial.
Four grid clips.

high enough to insure full amplification of even the lowest audio frequencies that are essential to natural reproduction.

The Audio Amplifier

The push-pull input transformer is connected to the triode of the 55. This is one reason why fixed bias is used on the triode, for if diode bias were used on it the plate current would be excessive on no signal, and both the tube and the transformer would be damaged.

The two tubes in the push-pull stage are biased by a single resistor of 205 ohms, of 5 watts rating. This is shunted by a condenser of 0.25 mfd. As a by-pass this condenser is not very effective except on the very highest audio frequencies. However, the stage is push-pull and it does not need a by-pass condenser across the bias resistor. Unbalance is more likely to occur on the higher audio frequencies than on the lower, and therefore the condenser serves a useful purpose.

Across the primary of the output transformer is a tone filter consisting of a 14,000-ohm resistor in series with a 0.02 mfd. condenser. This combination cuts down the output on the higher audio frequencies more than it does on the low. One effect of this is to reduce the hiss which ordinarily occurs when the set is at its maxmum sensitivity. The large condenser across the load resistance also helps to discriminate against the noise as well as other high frequencies in the output.

Output Transformer

The output transformer should have a plate-to-plate impedance of 14,000 ohms, and, of course, its primary should be centertapped. The ratio depends on the resistance of the voice coil, and to get the best combination the speaker used should have the transformer built in and it should have been designed for the 2A5 tubes.

Automatic Volume Control

Only one of the diode plates of the 55 is used for detection. The other is used for the automatic volume control rectifier. The input to the second rectifier is obtained from the last intermediate frequency transformer secondary by connecting a condenser of 0.006 mfd. between the two diode plates. Virtually, therefore, the same voltage is impressed on both rectifiers. The load resistance of the second rectifier is connected between the anode plate and ground, and has a value of one megohm. Another resistor of the same value is used as a filter resistor in the common grid return lead, and this is shunted to ground by a condenser of 0.1 mfd.

The grid returns of the two high frequency amplifiers and of the mixer part of the 2A7 are connected to the automatic bias. Hence all these tubes are controlled automatically. In the lead to each is a resistor of 250,000 ohms. The signal controlled bias governs the amplification efficiency of the radio and intermediate frequency amplifiers and the detecting efficiency of the mixer portion of the 2A7.

The B Supply

The power supply is built around a 5Z3 tube used as a full-wave rectifier. This requires one five-volt centertapped winding on the power transformer and one high voltage centertapped winding. The high voltage winding should be such that when the line voltage is 115 volts, the r.m.s. voltage across each half of the secondary should be 400 volts. This will make the rectified voltage across the first filter condenser 430 volts when all the tubes in the circuit are functioning. The value of this condenser is 8 mfd. and it should be of the electrolytic type with a 500-volt rating.

L1 is the field of the loudspeaker and it should have a resistance of 1,000 ohms. Besides serving as a field for the speaker it also serves as the first filter choke. Another condenser of 8 mfd. and the same voltage rating is put across the line after the field coil. Then follows another filter choke. This should have a resistance of 600 ohms and an inductance of 20 or 30 henries. After this choke there is another by-pass condenser of the same capacity and voltage rating as the other two.

Besides the two rectifier windings on the power transformer is a 2.5-volt winding to serve the heaters of all the tubes. The total current drawn from this winding will be 7.3 amperes and its rating should be accordingly.

The receiver is protected by a one-ampere fuse in the primary circuit.

Voltage Division

Across the last filter condenser is a voltage divider having a total resistance of 25,000 ohms and a wattage rating of 10 watts. The voltage across the total resistance is 250 volts, and that is the voltage applied to the plates of all the tubes, as well as on the screens of the two power tubes. It is also applied to anode of the oscillator, but through a resistance of 25,000 ohms. The screens of the first three tubes are returned to a point 100 volts from ground. The point to which the cathode of the 55 is connected is 20 volts above ground.

The current that flows into the tap for the screens is 4.2 milliamperes and that coming back at the cathode connection is 5 milliamperes. With these currents and the known voltage drops in the three resistance sections and the known total voltage across the total 25,000 ohms, it is possible to determine what the resistance of each section should be. Without going through the computation they are, counting from the bottom up, 15,000 ohms, 8,000 ohms, and 2,000 ohms. The bleeder current through the middle section is 10 millamperes.

Power Consumption

The total current drawn by the plates and screens and the bleeder is 122 milliamperes. A small amount may be drawn by leakage through the electrolytic condensers. Let us say that the total current is 125 milliamperes. The voltage drop across the first condenser is 430 volts. Hence the power expended in the plate supply circuit, exclusive of the loss in the rectifier, is 53.75 watts. This includes the power required for the loudspeaker field.

The power expended in the heaters of the amplifier tubes is 18.25 watts and that expended in the filament of the rectifier is 15 watts. Hence the total power of the filaments is 33.25 watts, and the total power required by the set, exclusive of transformer losses and loss in the rectifier, is 87 watts. If we add 20 per cent. for these losses the total power requirement by the set is nearly 105 watts.

Cost of Operation

Now if the line voltage is 115 volts and the set takes 105 watts, the current in the primary should be at least 0.9 ampere. The fuse used is rated at one ampere and therefore there is not much latitude. But it is better to have such a narrow range than to have a fuse that passes so much current that it does not protect the receiver. Moreover, we assumed a 20 per cent. increase in the losses to allow for transformer and rectifier tube losses. These may be higher than the actual losses are. This would make the current a little less than 0.9 ampere.

At 10 cents per kilowatt hour the cost of operating the receiver, exclusive of depreciation, is approximately one cent per hour. If the receiver is operated four hours every day, it will add about $1.25 to the monthly electric bill.

Power Output

The maximum undistorted power output of this receiver is six watts. That is double the output of a single tube of the 2A5 type. A push-pull stage will actually put out more without increasing the harmonic distortion.

The sensitivity of the receiver is very high as compared with former models of receivers having the same number of stages. If we were to count each tube that performs two functions as two tubes, this receiver would be a nine-tube set, for the oscillator and mixer functions are performed by the 2A7 and the detector and first audio amplifier functions are performed by the 55. The sensitivity of the circuit compared favorably with a nine-tube set in which each tube performs a single function and in which the last stage is push-pull. Facts that make the sensitivity high are the step-up in the transformer following the 55, the high gain of the 2A5 tubes, the efficient mixing in the 2A7, and the doubly tuned intermediate frequency transformers.

High Selectivity

The selectivity is also high because first we have two radio frequency transformers with tuned secondaries and then again, we have the two doubly tuned intermediate frequency couplers. The two radio frequency transformers are adequate for suppressing all frequencies that might cause heterodyning which would get through the intermediate amplifier at the resonant frequency of the four tuned circuits, and these in turn have adequate selectivity for eliminating interference by stations nearer in frequency. Since the intermediate frequency is 175 kc, the frequencies that might cause heterodyning are removed from the desired frequency by 350 kc.

A TYPICAL UNIVERSAL

25Z5 Used on A.C., Floated on Line for D.C.

By Brunsten Brunn

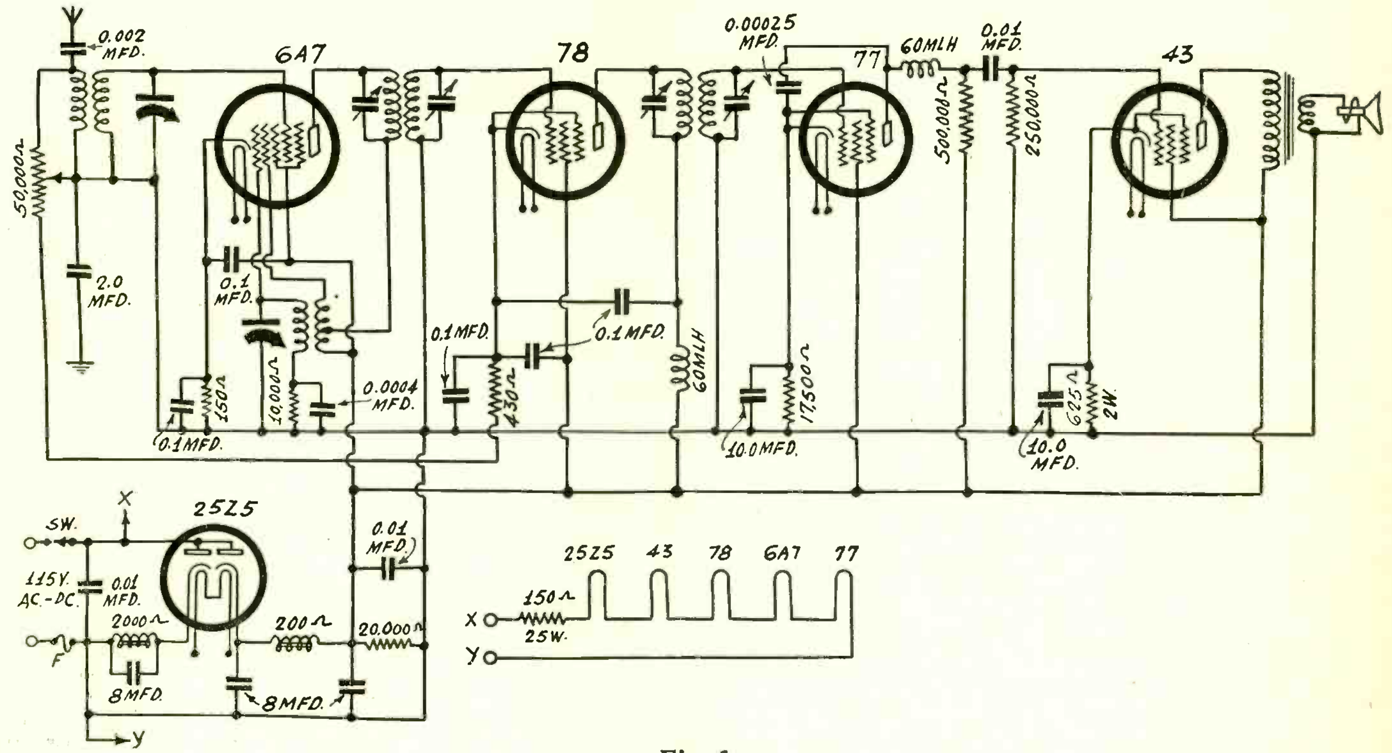


Fig. 1

A typical universal receiver utilizing 0.3-ampere tubes and a 25Z5 rectifier. It is a superheterodyne with manual control of the volume.

THE CIRCUIT diagramed in Fig. 1 is a typical universal receiver. It contains five tubes, one of which is a 25Z5 rectifier. The rest of the circuit is a four-tube superheterodyne in which the volume is controlled manually by controlling the input to the first tube and the gain in the second tube. The type of volume control employed in this circuit has been found the most satisfactory in a small set, that is, in a set that employs the minimum number of tubes.

High-gain tubes as amplifiers and detectors and a double function tube as oscillator and mixer makes the receiver much more sensitive than a four tube superheterodyne ordinarily is. The double function tube is the 6A7, which first serves as a highly efficient detector, or mixer, and second serves as oscillator. The mixer portion of the tube is biased by a 150-ohm resistor in the cathode lead, and this is shunted by a condenser of 0.1 mfd.

The Oscillator

The oscillator is of the tuned grid type, with the tuning condenser connected directly between the grid and ground. The coil is connected between the grid and the series padding condenser, across which is a 10,000-ohm grid leak. The low value of the series condenser, namely, 0.0004 mfd., suggests that the circuit has been designed for a high intermediate frequency. Of course, it can be used for any intermediate frequency by selecting the proper oscillator inductance and the proper value of the series padding condenser. In this case the grid leak is connected so that the operating bias on the oscillator is the same as the bias on the mixer element. In case this should not result in oscillation all that is necessary is to connect the 10,000-ohm grid leak to the cathode instead of to ground.

For anode of the oscillator the second grid is used and for that reason the plate coil is connected between this element and the highest available positive voltage. It will be noticed that the plate return of the mixer is connected to a tap on the plate coil of the oscillator, and that, therefore, the plate of the mixer gets the same voltage as the anode of the oscillator. The screen of the mixer also gets the same voltage. The screen is by-passed directly to the cathode by means of a 0.1 mfd. condenser.

In the intermediate frequency amplifier, which is a 78 tube, all by-passing is done to the cathode of the tube. Thus there is a 0.1 mfd. condenser between the plate return and the cathode, another of the same value between the screen and the cathode, and still another of the same value between ground and the cathode. In the plate lead below the condenser is a 60 millihenry choke as an aid in filtering the circuit. A 430-ohm bias resistor is connected in the cathode, and this determines the minimum bias and hence the maximum amplification. The bias resistor is connected to one end of the 500,000-ohm control potentiometer in the grid circuit of the first tube. The other end of this potentiometer is connected to the antenna end of the primary coil of the first radio frequency transformer.

The slider on the volume control potentiometer is connected to the cathode side of the circuit, but it is not grounded. Instead a condenser of 2 mfd. is connected between ground and the slider. This condenser serves to protect the receiver against a possible short and at the same time as a filter. In the antenna lead is a condenser of 0.002 mfd., the purpose of which is to protect the circuit against a possible short of the line through the antenna.

The Detector

The detector is a 77. In its cathode lead is a bias resistance of 17,500 ohms shunted by a condenser of 10 mfd. This should be an electrolytic, with its positive side to the cathode. A condenser of 0.00025 mfd. is connected between the plate of the tube and the cathode, and the suppressor is also connected to the cathode. A 60-millihenry choke coil stops the carrier from passing on the audio frequency amplifier. The plate load on the detector is 500,000 ohms. It is noticed that the screen is connected to the highest voltage, the same as the plate return, and that there is no resistance in the screen lead. Thus the screen voltage is much higher than the effective plate voltage.

The stopping condenser between the plate of the detector and the grid of the power amplifier is 0.01 mfd., and the grid leak is 250,000 ohms. The power tube is biased by a resistance of 625 ohms, of 2 watts rating. A shunt condenser of 10 mfd. is across it, and this condenser should be of the electrolytic type. A dynamic type speaker with a suitable transformer for the 43 tube completes the circuit.

The Power Supply

Since the circuit is to be used on either alternating or direct current, a rectifier must be used, and this is of the 25Z5 type. One side of this tube is used solely for the field of the dynamic speaker while the other is used for the plate supply. The field coil has a resistance of 2,000 ohms and is seen in the left cathode lead of the tube. This coil is shunted by an 8 mfd. electrolytic condenser. In the right cathode lead is a 200-ohm choke coil which is used for filtering the rectifier current. Two 8 mfd. electrolytic condensers are used in the filter. Across the line is a 20,000-ohm bleeder resistor and also a 0.01 mfd. by-pass condenser, which is for the purpose of shunting radio and intermediate frequency currents. There is no voltage divider as all the screens and plates are returned to the highest available voltage.

DIODE TO PUSH-PULL

How the Split Relationship is Developed

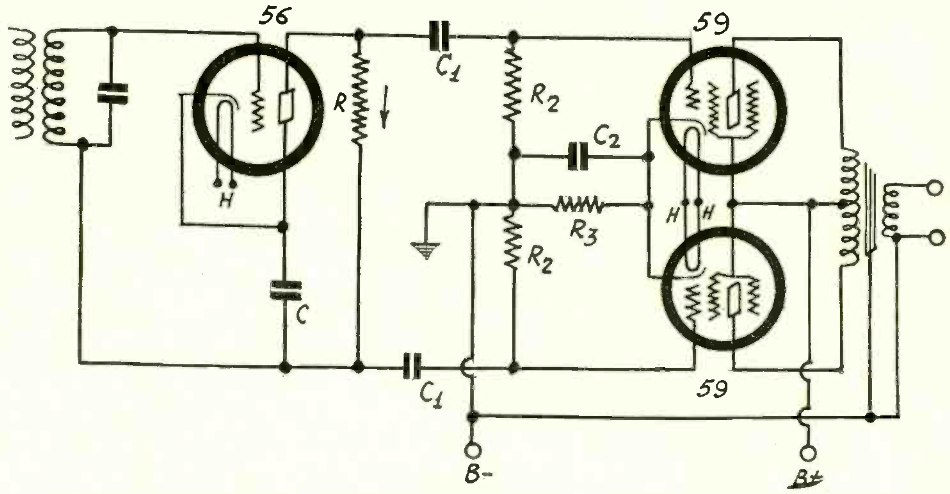
By C. L. H. Ames

IF THE DETECTOR is of the diode type, it may be coupled to a push-pull amplifier without difficulty, provided we use stopping condensers to prevent the voltage across the load resistance on the diode from upsetting the operating biases on the amplifier tubes. The method of coupling is shown in Fig. 1.

The 36 tube is used in this instance as the diode. The grid is utilized as the anode of the rectifier and the cathode and plate tied together as the cathode. A load resistance R of high value, say 500,000 ohms, is connected across the output and this resistor in turn is shunted by the condenser C for taking out the carrier fluctuations.

The audio signal voltage across R is divided equally between the two grids of the push-pull stage indirectly. The two stopping condensers C1 are connected between the ends of the load resistance and the two grids. Then two equal resistors R2 are connected, in series, between the two grids. These resistors really divide the voltage.

The two 59 tubes are biased by a resistance R3 placed in the common cathode lead and one side is grounded and connected to B minus. The bias resistor is shunted by a condenser C2.



The tube at left is a triode used as a diode. The extremes of R being of equal voltages opposite in phase, the push-pull relationship obtains. The output must consist of pentodes for sensitivity reasons.

Dividing the Signal

If the signal voltage across R is of the order of 40 volts, peak value, both of the output tubes will receive all the signal voltage that they can handle. Although the direct current in R flows in only one direction, the audio signal current in the two R2 resistors will flow first in one direction and then in the other. But at any instant the current will flow in both in the same direction. Hence when the upper grid becomes less negative the lower grid becomes more negative, and vice versa. That is, the two grids receive the signal voltages 180 degrees out of phase, which is the condition for push-pull operation.

The operating bias is not in any way affected by the direct current in the load resistance and it is determined only by the plate and screen currents in the two 59 tubes. Since these currents increase in one of the tubes at about the same rate as they decrease in the other, there is virtually no change in the current in the bias resistor. Therefore the operating bias is constant and there is no reverse feedback through the bias resistance. It is for this reason that a by-pass condenser is often omitted from a push-pull amplifier. When the condenser C2 is used it does not have to be large for it is only effective at the higher audio frequencies where some unbalance is likely to occur.

Choice of Condensers

The value of the filter condenser across the load resistance depends on the frequency of the carrier and on the value of the load resistance. If the signal is of an intermediate frequency, the condenser might be as high as 250 mmfd., assuming a load resistance of half megohm. If the signal carrier falls in the broadcast band the condenser might be of about 100 mmfd. For any value of R, the higher the condenser across it the more will the high audio frequencies be reduced, and the smaller it is the less will the detection efficiency be. If the gain in the receiver with which this detector amplifier is used is very high so that there is considerable tube noise, it is well to use a condenser as large as 250 mmfd. because this will cut down the noise to a very noticeable degree. It might, therefore, be used as a tone control.

The choice of the two condensers C1 depends on the value of R2 and also on how well the amplification is to be maintained on the very lowest audio frequencies. Suppose that each resistance in the grid circuit of a tube is half megohm, then the condenser should not be less than 0.02 mfd. and it would be better to use as high a value as 0.05 mfd. There is no reason why they should not be larger provided that leaky condensers are not used. Leakage will unbalance the biases on the two tubes.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

O. K. Radio Service, 228 Erie Blv'd, Schenectady, N. Y.
G. B. Brandon & Bro., West Middlesex, Penna.
Lloyd Schmidt, Lodge Pole, Nebr.
V. Battegelli, 15380 Monica Ave., Detroit, Mich.
Oliver F. Klein, 2235 N. 39th St., Milwaukee, Wisc.
Arthur K. Woodman, P. O. Box 337, Palm Beach, Fla.
Arthur L. Dallin, Box 67, Fairfield, Idaho.
J. D. Hayden, 317 S. First St., Winterset, Iowa.
L. E. Gandia, Santurce, P. R.
Morley S. Deller, Brownsville, Ont., Canada.
E. M. Neofsey, 634 Monroe Ave., Elizabeth, N. J.
Joseph M. Schubeck, 3860 Norwalk Street, Hamtrack, Mich.
T. R. Jones, 835 No. 2nd St., Camden, N. J.
John Wrable, 845½ Washington St., Rear, Braddock, Pa.
Alfred Zimiga, 2938 22nd St., San Francisco, Calif.
Vernon A. Douglas, 8 Second Ave., Garwood, N. J.
Morris M. Joyce, 415 E. Sycamore St., Vincennes, Ind.
F. Avenia, 77 Main St., White Plains, N. Y.
Kurt Wilde, 2255 Irving Park Blvd., Chicago, Ill.
A. Voris, 716 Main Street, Daytona Beach Peninsula, Fla.
Otto Krause, 59 West Forest Ave., Detroit, Mich.
Kenneth E. Gould, 110 East Third St., Prophetstown, Ill.
F. L. Sprayberry, 132 Bryant St., N. W., Washington, D. C.
Robert J. Clark, Dawe's Farm, Lachine, Que., Canada.
Francisco Perez Rodriguez, Aguilera alta 42, Santiago de Cuba.
A. J. Petchkis, Center Moreland, Penna.
Harold E. Boutillier, 58 Alexandra St., Sydney, N. S., Canada.
Joseph L. Berry, 140 Reiman St., Buffalo, N. Y.
Edward B. Sutherland, Central Fire Station, West Palm Beach, Fla.
K. A. Maxwell, 216 Elysian St., Pittsburgh, Pa.
W. H. Bailey, 515 Bay State Bldg., Lawrence, Mass.

Pilot Radio Renewed

Pilot Radio Corporation has opened new quarters at Long Island City, comprising two large floors. Isidore Goldberg is president and Sylvester T. Thompson vice-president and general manager. Mr. Goldberg founded the Pilot business in Brooklyn years ago. Mr. Thompson was vice-president of Kolster Radio Corp., and has a radio history dating away back to the early days.

CORPORATION ACTIVITIES

Crosley Radio Corporation: Net profit for the six months ended Sept. 30, 1933, after depreciation, Federal taxes, royalties and other charges, $169,805, equalling 31 cents a share on 545,800 shares of no-par capital; contrasted with net loss of $300,700 last year, for the same period. For the quarter ended Sept. 30, 1933, there was a net profit of $64,894, after the same charges, or 12 cents a share, compared with $104,911, or 19 cents a share in preceding quarter, and net loss of $223,002 in third quarter of last year. The sales were $2,294,950, compared with $2,338,028 in preceding quarter.

Griggsby-Grunow Company and Subsidiaries: Net loss for the quarter ended Sept. 9, 1933, after amortization, depreciation, taxes, and other charges, $760,640. The net loss for the thirty-six weeks ended Sept. 9, were $2,215,530, after same deductions.

United American Bosch Corpoartion Net profit for the quarter ended Sept. 30, 1933, after depreciation and other charges, of $75,994, equal to 27 cents a share on $278,399 no-par capital shares, compared with $41,590 or 15 cents a share in preceding quarter, and net loss of $176,586 in third quarter of 1932. Net income for the nine months ended Sept. 30, 1933, after the same charges, $41,079, or 15 cents a share, contracsted with net loss in the previous year, of $647,115. Sales for nine months, $2,216,800, compared with $2,227,953 last year; and $981,600 in third quarter of this year against $777,400 in same period of last year.

A SEMI-PRECISION TY

50 to 1,600 kc Range

By Herma

THERE are four-tube a-c broadcast receivers, and they do not work so poorly at that, therefore why a test oscillator that has six tubes?

The device is a-c operated, therefore it has a rectifier, VT-6. It is an oscillator, and therefore a tube is used for generating the test frequencies, VT-2. It is necessary to have modulation, and in a high-class outfit the audio oscillator would be a separate tube, VT-5. A stage of amplification serves two purposes: (a) increasing the output and (b) rendering the generator free from detuning due to the load imposed by the measured circuit. Hence amplifier tube VT-3. It is helpful to have some idea of the output voltage, hence a vacuum tube voltmeter is used, VT-4. Many are the times that the user of a test oscillator desires a standard of frequency, and since broadcasting stations serve that purpose, an oscillator that covers part of the broadcast band, in the low-frequency region, provides an immediate check on the test oscillator, which accounts for the sixth tube, VT-1.

Stability Achieved

A single principle is applied to both r-f oscillators. The circuit is that of the Hartley as modified by Edward M. Shiepe. Grid leak and condenser are used, and if the capacity ratio in the tuning circuit is large, the stability is high, meaning considerably better than 1 per cent.

With the aid of the frequency-standard broadcast oscillator the closeness can exceed 0.5 per cent.

The operation of the grid current oscillator with enlarged tuning capacity results in frequency stability that is close to that of a crystal. When the capacity ratio becomes high the frequency stability becomes poor, and the amplitude stability wretched. However, with large capacity the amplitude stability is most excellent, and the two (frequency and amplitude) seem to go hand in hand. The frequency stability is maintained against both wobbulation and drifting.

In fact, so excellent is the amplitude stability that a neon lamp is included across the tuned circuit, and it may be used as pilot lamp, so that one will have constant confirmation of this stability while the oscillator is in operation. The lamp will glow with a steady orange illumination. The eye can not perceive any change in illumination whatever, and the neon lamp is so sensitive and so quick in response that even small differences could be noted visually.

Since the current through the lamp is constant, the lamp's resistance is constant, and no varying detuning effects are introduced.

Standard Practice

The lead from the circuit to the lamp's high potential should be of shielded wire and the shield grounded. The extra capacity is of no consequence, though unexpectedly large. We are dealing with a special type of circuit wherein a large minimum capacity is purposely introduced.

The circuit is almost entirely standard, except for the extra stability thus provided, and it has the standard accoutrements of modulation attenuator and output attenuator, plus means of switching the coils and switching the broadcast oscillator and audio oscillator on and off for instantaneous results, as heaters are kept going, and likewise provision for independent use of the VTVM in the output circuit of the tested device.

The dial may be calibrated in frequencies, and since there is a low ratio of maximum to minimum capacity, the frequency ratio will be small. It would be very convenient to have a 2-to-1 frequency ratio, which would require a 4-to-1 capacity ratio. For some overlap the capacity ratio may slightly exceed 4 to 1. The inductance has to be selected on some single ratio, and if this is made 1 to 4 (the reciprocal of the nominal capacity ratio), a dial may be calibrated from 100 to 200, and could represent frequencies of 50 to 100 kc (halving the scale); 100 to 200 kc directly; 200 to 400 kc, doubling the scale; 400 to 800, quadrupling the scale, and 800 to 1,600 kc, octupling the scale. Five tiers could be arranged on the dial, if preferred, and the different rows of numbers written in for the single radial scale. If different colors are used for this numbering, and the switch points corresponding to the frequency range on the dial are colored likewise, the switch would be visibly co-ordinated with the scale. Actually, if a neon lamp is used, the coloring of the switch points would have to take into consideration the orange hue contributed by the lamp.

Condenser Values

Examples have been worked out for two capacities of tuning condenser, one rated 0.00035 mfd. and the other rated 0.0005 mfd. The smaller condenser is practically standard and obtainable almost everywhere, but the usual capacity is really nearer 0.00036 mfd. The larger one also is widely distributed, being General Radio type 247, the actual maximum being 0.00059 mfd.

Taking the 0.00036 mfd. condenser, the first problem to solve is what parallel capacity must be added to yield a capacity ratio slightly greater than 4. We find the parallel capacity, Cx, for the VT-2 circuit, and this tuning condenser, should be 80 mmfd. This is easily attained by inserting in the circuit, perhaps anchored to the chassis top, though not accessible from the front, an air-dielectric condenser of 100 mmfd. rating, and adjusting it for the proper ratio. The minimum capacity in circuit will be 105 mmfd., due to the tuning condenser's minimum and to the stray capacities, including the coil's distributed capacity. The maximum capacity would be the sum of the tuning condenser's maximum, the coil's distributed capacity and the stray capacities, 450 mmfd. The capacity ratio would be 4.3 and the utilized frequency ratio 2, though the attainment is 2.07.

For this condition, the following inductive values are required:

Kc	*Microhenries*	*Remarks*
50-100 kc	22,960	Honeycomb coil
100-200 kc	5,740	Honeycomb coil
200-400 kc	1,440	Honeycomb coil
400-800 kc	360	Solenoid
800-1600 kc	90	Solenoid

For the larger condenser, 0.00059 mfd., Cx should be 150 mmfd., so a 200 mmfd. air-dielectric condenser may be used in parallel with the tuning capacity, and adjusted as explained in a separate discussion. The minimum capacity would consist of 25 mmfd. (coil's distributed capacity, condenser's minimum and strays) and 150 mmfd. external, or 175 mmfd., and the maximum the tuning condenser's capacity (really 590 mmfd.) plus the distributed capacities (10 mmfd.) plus the parallel condenser (150 mmfd.), or a total of 750 mmfd. The frequency and amplitude stabilities will be better when the larger condenser is used, as the actual minimum in circuit is 175 mmfd. compared to 105 mmfd. in example of the smaller tuning condenser.

Data for Larger Condenser

For the larger tuning condenser the following values apply:

kc	*Microhenries*	*Remarks*
50- 100 kc	13,360	Honeycomb
100- 200 kc	3,340	Honeycomb
200- 400 kc	840	Honeycomb
400- 800 kc	210	Solenoid
800-1,600 kc	52.5	Solenoid

Winding Data for the Solenoid Coils

There are five solenoid coils. One is for VT-1. Two each of the others are for VT-2, depending on whether the tuning condenser is 360 mmfd. or 590 mmfd.

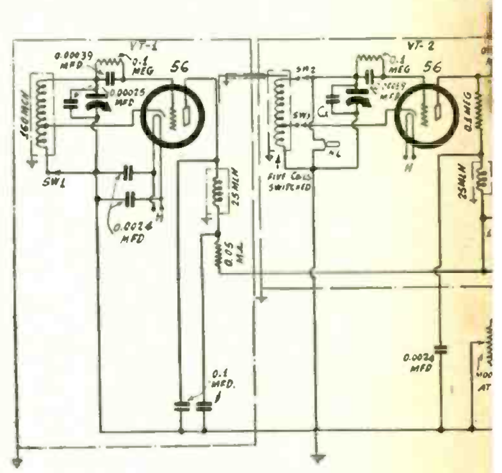
In any instance the VT-1 coil is the same, consisting of 160 microhenries, which may be wound of 91 tight turns of No. 32 enamel wire on 1-inch diameter tubing, tapped at the center, or a little off center toward the ground end. For the same diameter tubing the number of turns for No. 28 enamel wire would be 115.

For the 360 mmfd. condenser the data are:

360 microhenries (the two numbers just happen to come out the same), 125 turns of No. 32 enamel wire on a 1 1-4 inch diameter tubing; 90 microhenries, 75 turns of No. 28 enamel wire on 1-inch diameter tubing.

590 mmfd. condenser: 210 microhenries, 95 turns of No. 32 enamel wire on 1-inch diameter tubing; 52.5 microhenries, 50 turns of No. 28 enamel wire on the same diameter.

In all instances there is a tap at center or slightly off center toward the ground end, all wire is wound tight or close, and it is intended that aluminum shields be used, 2 1-16 inches O.D., 2 1-2 inches high, and the numbers of turns specified take into account the inductance drop due to the shielding, hence the numbers of turns are slightly in excess of those for unshielded inductances

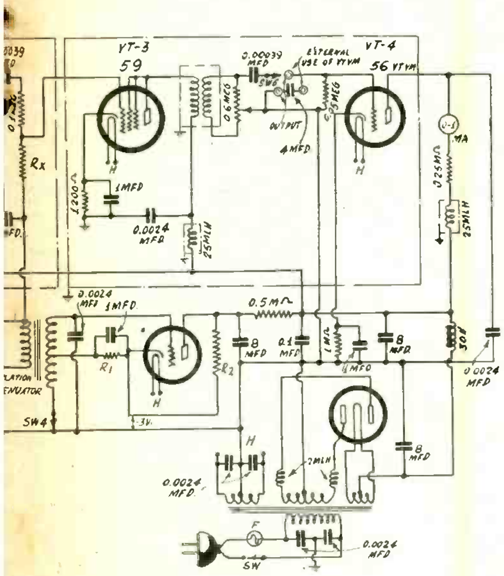


A test oscillator with a monitor, separa lation and output controls, and output may be co

PE TEST OSCILLATOR

in a Quality Instrument

n Bernard



e audio oscillator, amplifier stage, modu- meter. Effective percentage modulation nputed also.

The honeycomb coils may be prepared by the constructor from existing coils of too much inductance. One example is the 25-mlh tapped choke commercially obtainable, this value of inductance representing no shielding, so at first use it without shield for testing. For the 0.00036 mfd. condenser, with paralleled capacity included (total 450 mmfd.), the lowest frequency should be 47.5 kc, which will beat harmonically with 950 kc. For the larger condenser, with parallel capacity, total 750 mmfd., the lowest frequency should be 34 kc, identifiable by a beat with 680 or 1,360 kc (twentieth and fortieth harmonics of test oscillator).

For the smaller condenser turns may be removed from this coil, after the coil is shielded, until the lowest frequency registered in 50 kc. This may be achieved by using as standards two local broadcasting stations 50 kc apart, for a beat produced with one will not recur between the dial spaces of the receiver used in this work, until the other local is tuned in by the set. Or, the broadcast oscillator of the present unit may be used as the "receiver," or another test oscillator used at 50 kc, if it goes that low, or at 100 or 200 kc, whereby harmonics of the present 50 kc would beat with those frequencies, and also beat with a broadcasting station operating on a multiple of 50 kc, as a frequency-standard monitoring assistance.

Inductance Assistance

The coil just discussed has 1,300 turns originally. for the larger capacity condenser much fewed turns are needed, as the inductance is 13,360 mch, which is accomplished with around 1,000 turns, and it is little trouble to remove 300, though tests should be made so that not too many are taken off in one operation.

Thus for both condensers the lowest-frequency limit can be reached accurately.

As for the other honeycombs listed, there is too much inductance in the following instances, and turns removal should be resorted to, with honeycombs of the cited number of turns in series to improvise the tap, the guide being maximum tuning capacity in VT-2:

5,740 mch, two 400-turn coils in series aiding, remove turns from one until beat is struck with VT-1's 600, 700 and 800 kc.

1,440 mch, two 200-turn coils in series aiding, remove turns from one until beat is struc with VT-1's 600 and 800 kc.

13,360 mch, two 800-turn coils in series aiding, remove turns from one until beat is struck with VT's 600, 650, 700, 750 and 800 kc.

3,340 mch, two 300-turn coils in series aiding, remove turns from one for beats with VT-1's 600, 700 and 800 kc.

840 mch, two 500-turn coils in series aiding, remove turns from one until kc beat is struck with kc.

840 mch, two 100-turn coils in series aiding turns removed from one until beats are registered with VT-1's 600 and 800 kc.

All of the above result in a tap nearer to ground than to grid, but the tap location is not critical, so the inevitable result, based on another inductive requirement, is nevertheless entirely satisfactory.

Dial Readings Spread Out

The dial readings will be well spread out, particularly at the high frequency part, where such elongation is most desirable. Fractions of kilocycles in low-frequency ranges may be distinguished readily. All calibration should be done most carefully, because of the stability of the oscillator, which should be capitalized at every point.

Taking the tubes in order, the first, VT-1, is a 56, and also has a large capacity-to-inductance ratio in the tuned circuit. Assuming that a commercial type mica 0.00025 mfd. condenser is used with a 0.00036 mfd. tuning condenser, and allowing for the fixed capacity being even 15 per cent. too low, the coil could consist of an inductance of 160 microhenries, wound on a solenoid, and tapped at one-quarter the number total of turns, tap being nearer the grounded end. In the present instance the tuning range would be from below 540 kc to about 800 kc, the region of most extreme stability for such a combination. Reduction of the parallel capacity may be required to strike 800 kc, due to absence of precision in the fixed condenser rating.

As harmonics are plentiful, the 540-800 kc tuning may be checked carefully, as to fundamentals, against broadcasting stations, and harmonics of VT-1 used any time they are desired, for comparing the accuracy of calibration or setting of the main test oscillator, VT-2.

Capacity Values for the VT-1 and VT-2

VT-2

Use of a 0.00036 mfd. condenser (360 mmfd.)

Minimum capacity, 105 mfd., consisting of 15 mmfd. for tuning condenser, 10 mmfd. for distributed capacities, and a parallel capacity of 80 mmfd.

Maximum capacity, 450 mmfd., consisting of condenser maximum of 360 mmfd., distributed capacities of 10 mmfd. and the parallel capacity of 80 mmfd.

Capacity ratio, 4.3.

Frequency ratio, 2.07.

Use of 0.00059 mfd. condenser (590 mmfd.)

Minimum capacity, 175 mmfd., consisting of 15 mmfd. for tuning condenser, 10 mmfd. for distributed capacities, and a parallel capacity of 150 mmfd.

Maximum capacity, 750 mmfd., consisting of tuning condenser maximum of 590 mmfd., 10 mmfd. distributed capacities, and 150 mmfd. parallel capacity.

Capacity ratio, 4.3.

Frequency ratio, 2.07

VT-1

Minimum capacity, not critical.

Maximum capacity, 570 mmfd., consisting of 360 mmfd. of tuning condenser, 10 mmfd. strays and 210 mmfd. parallel capacity. The parallel may be a mica condenser rated 0.00025 mfd.

Calibration of VT-1

The calibration of VT-1 is one of the simplest tasks. Some means of loose coupling to a tuned radio frequency receiver is provided, as by wrapping an insulated wire a few times around the first 56 tube and running it near the aerial wire of the set, not necessarily touching. Then as known frequencies of broadcasting stations are tuned in, the VT-1 condenser is turned until the squeal is heard, and then zero beat established, or close to it. Since the approximate region of frequencies is known, stations between 540 and 800 kc would be used as references, but no stations between 1,080 and 1,500 kc, which also would yield responses due to harmonics of 540 to 750 kc of the VT-1 circuit and might prove confusing at this juncture.

As many points as possible should be registered, at least a quarter the number of channels, or, roughly, seven points. More would be most welcome. The points may be registered as frequency-identified numerical values ascertained from a dial with numbers on it, and the results transcribed on plotting paper, but the points from the paper should not be extrapolated without confirmation from broadcasts, unless absolutely necessary.

Further Confirmation

Such confirmation can be extended almost 100 per cent. after the rest of the circuit is built, by beating harmonics of the lower frequencies in VT-2 with fundamentals in VT-1 and stations to locate by zero beats the points not actually obtained from standards. The plotting should be accepted as indicative, not as final, as protraction does not yield the highest degree of accuracy.

If the intended scale of the VT-1 dial is a blank, the frequencies may be located directly, so far as obtainable from the air, and as some such frequencies will be multiples of 50 kc, the points for frequencies 50 kc removed in either direction can be obtained by beating with 50 kc from VT-2, the station being used as well as the VT-2 oscillator at the same time.

Such frequencies as can not be obtained at once may be registered later, for filling in the blank dial for VT-1, but every effort should be made to get frequencies of 600, 700 and 800 kc, and also, if possible, 550, 650 and 750 kc, that is, multiples of 50 are preferable, multiples of 100 at least acceptable.

Some estimating is practical, if done judiciously, and should yield no error. Suppose that a station operates on 710 kc. This

(Continued on next page)

WIDE-USE OSCILLATOR

With Full Data on Coil Construction

(*Continued from preceding page*)
may be registered, but is not an even multiple of 100 or of 50. However, the next channel, 700 kc, adjoins 710, with more capacity in circuit, since 700 is lower than 710 kc, so with VT-2 generating 50 kc, the point for 700 kc is that one near 710 kc that produces the squeal or zero beat.

Using Harmonies of VT—1

Harmonics of VT-1 may be utilized, of course, by beating with frequencies of stations on 1,080 to 1,500 kc, the equivalent frequencies in VT-1 being 540 to 750 kc, since second harmonics of VT-1 are concerned. However, t-r-f receivers are none too selective in this region, and this harmonic method should not be used unless necessary, or as an auxiliary. The response points are not definite enough, due to two or more frequencies getting by the set tuner, and even though the actual zero beat can be with only one of them. Zero beat as an actuality is unlikely, and any finite beat may be between oscillator harmonic and any one of a few station fundamentals.

VT-1 is coupled to VT-2 by a shielded wire, from which the sheath or shield is removed for 2 inches at extremes and held next to the plate lead from VT-1 by spaghetti, similar capacity connection to the grid circuit of VT-2 being introduced. The shield of the wire is grounded.

VT-1 is in a separate shield compartment, so is VT-2, with its input and output circuits. The two other tube circuits are in a single shield. The rectifier tube and its associated apparatus need not be shielded.

Switching

There is no switching for VT-1, except to open the plate circuit (SW-1), when no service is to be rendered by this tube. Only the one range of frequencies is used, or harmonics thereof, though the harmonics are almost without limit, and the main test oscillator therefore could be extended to higher frequencies, if desired, although this is not necessary, either, because the main oscillator, VT-2, also has plentiful harmonics, hence may be used for short waves.

The switching in the VT-2 circuit alone consists of connecting grid and tuning condenser to one coil extreme and tap to cathode, hence there are two switch points. The grounded ends of coils are not shifted. The switch would be a double-pole, five-throw type, that is, one that moves two circuits at a time to five different positions for each.

Since the main oscillator will provide an amplitude sufficient to light the 110-volt neon lamp, it is clear that, in view of the observed brilliance, the oscillation amplitude is 100 volts or so. There would be no ready means of utilizing the resultant plate cutout to feed an amplifier, so less than the total is put into the grid circuit of the amplifier, which is a 59.

Adjustment for the 59

This tube, used here as a triode, with control grid in normal connection, two other grids tied to plate, will take a negative bias of a little under 30 volts, at 250 plate volts, output 1.25 watts. With VTVM the maximum rms input to the 59 may be adjusted by resistor selection (Rx) so that the voltage across this resistor is 2 volts less than the bias.

The voltage at the output is measured by VTVM, which has to be calibrated in root-mean-square values.

The audio oscillator represents a special use due to J. E. Anderson. Although the heater supply voltage is 2.5 volts, as used on the other tubes in the oscillator proper, the audio oscillator is a 37, which ordinarily requires 6.3 volts. The application of a little more than one-third of the specified heater voltage is intentional, and not a makeshift arising from a single voltage source for the tubes. The plate resistance is greatly increased and the audio oscillator becomes vastly stable.

Hints as to Resistors

No values are ascribed to Ry, the cathode-leg biasing resistor, and Rz, the bleeder resistor that insures some stability of bias despite any change in the audio oscillator circuit conditions, as the bias voltage has to be attained critically. First, the tube may not oscillate if the bias is not just so, and, second, if it does oscillate, the purity of the wave may not be so great as intended, until the bias voltage is shifted a bit. For 135 volts on the plate, the bias should be close to 3 volts, but to read the voltage a static voltmeter is almost necessary, due to small current in the measured circuit, so VTVM may be used for that purpose. Values of 50,000 ohms for Ry and 500,000 ohms for Rz are suggested as trials.

The Audio Oscillator Coil

The oscillation transformer in the VT-5 circuit may be a filament transformer with primary unwound so that tap may be made to its center in rewinding. The primary of the filament transformer as a filament transformer becomes the secondary for use in this circuit. A push-pull output transformer designed for a magnetic speaker may be used just as it is found, secondary as secondary, and this is the preferred method. A push-pull input transformer would not give a note high enough in pitch, unless it was a very bad transformer, with small inductance, and whether it is bad enough (or for this purpose really good enough) may be ascertained readily by experiment.

VT-4, the vacuum tube voltmeter, should be calibrated on the basis of a.c., applied to the input. Switch SW-5 should be open, the 80 rectifier, the 59 and the VTVM in their sockets, as the 59's current drain is necessary to maintain the B voltage at the value it will have in operation of the complete equipment.

High Bias on the 56

The 56 is given a negative bias so high the plate current is reduced to the lowest value readable on the plate meter. If this is a 0-1 milliammeter the current value may be fixed at 10 microamperes, as the half-way position between two bars 20 microamperes apart may be considered readable, though by estimation. Then the line a.c. may be applied to the primary of a transformer that yields 100 volts output, or somewhat less, and a potentiometer placed across the secondary, arm connected to grid of the tube, one end of the secondary grounded. An a-c voltmeter calibrated in rms values is put between arm and ground and the corresponding plate current in the 0-1 milliammeter is read for the voltage input values, and a curve run, relating input volts to output currents.

The series resistor of 0.25 meg. may be made more or less, as circumstances require, to get the minimum reading, and if one is handy at such things, the meter scale may be removed and one drawn by the constructor, calibrated in volts, may be used. The 0-1 milliammeter, by the way, is a d-c instrument.

The effective percentage modulation can be computed if VTVM is calibrated as a peak voltmeter. This would be an additional calibration to the rms values. The calibration as a peak instrument would be done as follows:

Leave the 56 VTVM plate circuit intact. Connect the 5.0 meg. resistor return only to the arm of a potentiometer across which potentiometer are 135 volts of B battery. One side of this potentiometer and one side of batteries go to cathode, other side to ground. Put a high-resistance d-c voltmeter between arm and ground. Move the arm until the plate current reads zero. Read the bias voltage on the voltmeter. Apply a-c across the 5.0 meg. resistor, slide arm to negative until plate current reads zero, note the bias voltage, and the difference is the peak a-c voltage. From various a-c inputs run a curve.

Effective Percentage Modulation

The effective percentage modulation, and in this case also the percentage modulation, as a single tone is involved, may be computed from the following formula, values obtained from the peak voltmeter calibration:

$$M\% = 100\left(\frac{Em}{E} - 1\right)$$

where Em is the reading taken with modulation applied and E is the reading taken with modulation removed, i.e., carrier alone. Not only the present oscillator but any other single-tone-modulated a-c carrier may be measured.

Moving Arms Grounded

The two potentiometers, one for modulation the other for output attenuation, are hooked up a bit unusually, the reason being the advisability of having the moving arm grounded.

This is not so important in the instance of the audio oscillator as it is in regard to the output, where a high radio-frequency voltage exists.

The method used for grounding the arm is to put the total resistance of the potentiometer across the secondary, leaving one end of the secondary returned through so much of the resistance as is between that end of the secondary and ground.

The more obvious method, of using the potentiometer as a rheostat, with a total resistance across the secondary a varying factor, depending on adjustment, is not good, because of the severe variation in load.

That is, at low-volume settings the secondary is partly short-circuited.

External Use of VTVM

The three binding posts associated with the input to VTVM consist of (1), an on-off switch point; (2), at lower left, a grounded post; and (3), at lower right, a post connected to one side of a 4mfd. condenser, the other side of which is grounded.

The switch enables independent use of VTVM for external measurements. As some of these may be to a low point other than equivalent B minus of the present circuit, external measurements should be made between the right-hand lower post and the grid.

Laboratory Use

The oscillator is good enough for laboratory use, in that it has sufficiently high frequency stability and covers a wide enough range.

The Review

Questions and Answers Based on Articles Printed in Last Week's Issue

Questions

1. May the oscillator padding be close, even though the oscillator inductance is somewhat off for the low-frequency requirement? If close padding is practical even then, what is the reason.

2. If the radio-frequency and oscillator inductances are not exactly what the tuning condenser capacity requires, is a completely satisfactory result obtainable if the inductive ratio of the r-f and oscillator coils is correct? If your answer is yes, state why this is true.

3. What is the current rating of a 1.5-volt No. 6 dry cell? What course yould you pursue if the current drain imposed in 1.5-volt dry cell is 0.5 ampere?

4. How is a voltmeter connected to a measured circuit? Should it be of high or low resistance? If low, will it read the circuit voltage correctly? A current meter is connected how?

5. In a battery-operated set, state why a voltage divider is used for providing negative biases, describe in general the polarity of the grid return in respect to the cathode, and state what precaution is necessary to avoid overtaxing the B batteries.

6. If a given tuning condenser is used, and a dial calibrated in frequencies when a certain inductance is used with that condenser, will the calibration hold for higher frequencies, when the proper smaller inductance is used, and on what basis? If the calibration holds, state why.

7. What is an advantage of having coils safeguarded against humidity changes?

8. Are local oscillators in superheterodyne circuits as built today stable or unstable?

9. Why are honeycomb coils used in intermediate transformers, and why are the dowels or forms on which the coils are wound preferably of some non-moisture-absorbing insulation?

10. May as great selectivity be obtained from the transformer with single-tuned circuit as from the one with both primary and secondary tuned? If so, what about the coupling between primary and secondary?

11. Is the shielding complete in highly-sensitive superheterodyne circuits as usually made? What bearing has the sensitivity on the effectiveness of the shielding?

12. What is stage shielding? State some of its advantages.

13. State two causes of noises in a radio receiver and define what the terms mean.

14. In what direction, and by how much, does the space stream change one of the noise conditions in the answer to Question 13?

15. In what tube circuit does noise largely originate? Under what condition may some subsequent tube contribute largely to noise?

16. State three remedies for noise in a receiver.

17. Is a transposed leadin effective as a noise-reducer? Under what condition is it most effective?

18. Define a frequency-stable oscillator.

19. How much may the amplitude of the carrier be varied by the modulation to constitute 100 per cent. modulation?

20. Does loose coupling of local oscillator to modulator in a superheterodyne increase or decrease the apparent selectivity?

21. State the general principle of voltage-doubling as used with the 25Z5.

22. State the theory of a beat-note oscillator.

23. Can the 53 be used as a Class B output tube? How?

24. Should the resistance of the air to a speaker be large or small, and why?

25. If you know the inductance of a coil, and have it in a tuned circuit with known capacity, how may the inductance of an unknown coil be determined?

* * *

Answers

1. Padding may be close, even though the oscillator inductance is somewhat different from the theoretical low-frequency requirement, because the padding condenser may be used for adjusting the tuning condenser to proper tracking. Close padding is possible because it has to do with the low radio-frequency setting, the inductances being satisfactory for this purpose if selected closely for the high-frequency requirement.

2. Yes, if the r-f and oscillator inductances are properly proportioned the results will be completely satisfactory, although the condenser is not of just the capacity intended, provided one may still cover the wave band. The condenser capacity being off a bit from the expected value, merely causes the dial reading to be a bit different for the frequencies covered.

3. The current rating of a No. 6 dry cell is 0.25 ampere (250 milliamperes), which means that no more current than that should be drawn from the cell. If 0.5 ampere is to be drawn, then two such cells should be connected in parallel, as that doubles the current rating.

4. A voltmeter is connected in parallel with a measured circuit. The resistance of the voltmeter, in general, should be large so that the meter will not draw so much current from the measured circuit as to change the voltage. The voltage that the meter reads is the correct voltage, although if the meter is of too low resistance the voltage read will be less than the circuit voltage, unless the meter is kept in the operating circuit all the time. A current meter is connected in series and therefore should have a low resistance.

5. A voltage divider, consisting of a tapped resistor, or a series of resistors across the B supply, is used in a battery-operated receiver so that there will be a uniform proportion of negative bias to positive bias, i.e., grid-plate voltage relationship. If a biasing battery is used, though the B battery voltage would become less with time, because of drain, the C bias would be reduced much more slowly, if at all, because no current is drawn from the C battery. The grid return is negative in respect to the cathode, hence the cathode is tied to a juncture of the resistance network, and not to an extreme. To prevent overtaxing the B batteries when the resistance network is used, the switch should turn off the set and disconnect the resistance network at the same time, so that no B current will be drawn when the receiver is not being used.

6. If a given calibration is made of a tuning circuit, it will hold for higher bands of frequencies if the smaller inductance for that coverage is reduced by the reciprocal of the capacity ratio (maximum to minimum), and the frequencies will be increased by the square root of that ratio. So if the capacity ratio is 9 to 1 the second inductance would be one-ninth the first and the frequencies would be three times as great. The reason is that the frequency changes with changes in capacity, and for a given dial position the same capacity will exist always.

7. Coils safeguarded against humidity changes will not change in inductance.

8. Unstable, in general.

9. Honeycomb coils are used in i-f transformers because that type of winding makes for compactness and yet for an excellent coil in the frequency region for which such transformers are intended. Dowels are preferably non-hygroscopic so that the inductance will stay put.

10. Yes, if the coupling is made loose enough.

11. The shielding is incomplete in highly-sensitive circuits. If the sensitivity is very high, the coils have a large magnetic field, and the shields satisfactory for small fields do not screen the large fields enough.

12. Stage shielding consists of putting into one shield compartment the tube, coil, condensers, etc., and filtering the output leads, so that greater selectivity and amplification may be obtained with no more tubes or tuned circuits.

13. Thermal agitation and shot effect are two causes of noise in a receiver. Thermal agitation is supposed to be due to the random movement of electrons within a conductor. Shot effect is produced by the emission of electrons and is ascribed to irregular pulses in the bombardment.

14. Space charge reduces the shot effect by about one-half, with vacuum tube filament at normal voltage. Space charge is the quantity of free electrons.

15. Noise largely originates in the first r-f tube, but if the gain in that stage is low, the second tube may also contribute considerable noise.

16. High gain in the first tube decreases noise considerably. Select as first-stage tube one rated at low plate current and work it to the safe limit of its plate current. Operate the first stage with paralleled tubes.

17. Yes, particularly where the aerial is a considerable distance from the receiver.

18. A frequency-stable oscillator is one that maintains frequencies accurately despite changes in grid, plate and other voltages, and changes in load.

19. The carrier amplitude may be altered 50 per cent. to constitute 100 per cent. modulation. The percentage modulation is the maximum permissible to use. More than 100 per cent. modulation is distortion.

20. Increases selectivity.

21. The general principle of voltage doubling is that a double rectifier tube is used. One filter condenser is connected between cathode of one diode and one side of the line, other filter condenser between plate of other diode and same side of the line, remaining cathode and plate pointed to other side of the line. So the rectified voltage is discharged in one circuit when the other is conducting. Thus the resultant voltage is twice the rectified voltage, and not exactly twice the a-c input voltage.

22. The theory of a beat-note oscillator is that two frequencies are put into a tube and the difference between the frequencies is utilized at the output as a note.

23. Yes. By using a special push-pull input transformer and zero bias.

24. Large, because, as in r-f radiation, the efficiency of radiation is proportional to the radiation resistance.

25. The unknown may be put in parallel with the known, the new, higher frequency measured, and, since the capacity has not been changed, and is known, the net resultant inductance can be computed. When the net resultant is known the inductance of the unknown single coil can be computed. Multiply the known inductance of the single coil by the net inductance when the two coils are paralleled, and divide this quantity by the difference between the two inductances. The answer is the inductance of the unknown single coil.

Dead Spot Remedies for Short-Wave Receivers

In a short-wave set, if there are dead spots, greatly increase the value of the grid leak. Regeneration then should be present. If not, then put a small condenser in series with the aerial. The latter remedy is almost infallible.

Radio University

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

Construction of Dynatron Oscillator

DUE TO THE SIMPLICITY of the dynatron oscillator I desire to construct one to cover the broadcast band. I have tried many but I have never been able to get one that is satisfactory. What is the secret of this type of oscillator and how can it be made to work every time?—G. B.

Select the proper tube. A—24 is all right. The grid of the tube can be grounded or left floating. The screen voltage should be considerably higher than the plate voltage and the tuned circuit should be put in the plate lead. The circuit will not oscillate unless the two voltages are properly proportioned. Judging by the curves for the —24, if the screen voltage is 90 volts the plate voltage should be 20 volts. The circuit will not oscillate even when the optimum combination of screen and plate voltages is used unless the L/RC ratio of the tuned circuit is high—it should be equal to the negative resistance of the plate circuit. To make the ratio high, the condenser capacity C should be small, the inductance L should be large, and the resistance R of the coil should be small. A negative bias on the cap grid will require a higher value of the ratio, and for that reason it may be better to ground the grid rather than leave it floating, for the floating grid may assume a negative voltage. Giving the cap grid a low positive value will help oscillation. The condition for starting oscillation is that r_p should be less than L/RC. If that condition is satisfied the oscillation will build up until $r_p = L/RC$, in which r_p is the absolute value of the negative resistance of the plate circuit.

* * *

Trend in Superheterodynes

CAN WE EXPECT in the near future superheterodynes with frequency stabilized and harmonic free oscillators? It seems to me that the introduction of such oscillators would be a distinct advance in superheterodyne design.—F. W. N.

Undoubtedly, these improvements will be introduced into superheterodynes before many seasons have passed. Perhaps frequency stability is not so important by itself, for any of the ordinary oscillators are reasonably stable for superheterodyne application, but the fact that harmonics and frequency instability are closely related makes a stabilized oscillator desirable. That more attention will be given to the elimination of harmonics there can be no question. It is just barely possible that oscillators in the future will be of the push-pull type so that the even harmonics will not be present.

* * *

Voltages from Oscillator

HOW HIGH VOLTAGES can be obtained from a radio frequency oscillator, that is, the a-c voltage across the resonant circuit?—W. E. N.

That depends entirely on the voltages applied to the plate of the tube and the design of the oscillator. There is no difficulty in getting amplitudes equal to the applied d-c voltage on the plate circuit. That very high voltages can be obtained can easily be tested with a neon lamp. Such a lamp might have been designed to start glowing at 85 volts, a-c. If the lamp glows when it is connected across the tuning condenser we know that the voltage is at least 85 volts. With a vacuum tube voltmeter the actual voltage can be measured. In most instances a surprisingly high voltage is obtained. But it is also possible to arrange the oscillator so that a voltage of only two or three volts is obtained. A grid leak type of oscillator usually gives the highest oscillating voltage, for a given applied plate voltage.

* * *

Design of Universal Sets

IS IT NECESSARY in a universal type of receiver to use a rectifier tube? It is not needed when direct current is used and it seems to me that just a filter would be required when a-c is used.—C. S.

It is quite necessary to use a rectifier tube. It is true that it is not needed when the power supply is direct, but it is essential when the power supply is alternating. The rectifier does no particular harm when it is one the d-c line.

* * *

Negative Resistance

WHAT IS MEANT by negative resistance? It is difficult to conceive such a thing. If resistance is something that obstructs current flow, I should think that negative resistance is something that helps it to flow, that is, an electromotive force.—R. H.

In a way you are right in your conclusion, but electromotive force and negative resistance are not the same because they do not have the same physical dimensions. If you multiply the negative resistance by the current you get a quantity that has the same physical dimensions and that you might call an electromotive force. If you have a circuit such that as you increase the applied voltage, or electromotive force, the current decreases, and as you decrease the electromotive force the current increases, then you have a negative resistance in the circuit. A few devices have this property. One is the electron tube in which there are two positive elements, the one nearer the cathode having a higher positive potential than the other. The negative resistance is in the circuit containing the electrode that is at the lower positive potential. Another device having a negative resistance characteristic is the carbon arc. The dynatron oscillator operates by virtue of the negative resistance characteristic in the plate circuit, where the resonator is placed, and the singing arc operates by virtue of the negative resistance characteristic in the carbon arc. Any tube can be made to have a negative resistance characteristics by giving the electrode nearer the cathode a higher positive potential than the other electrode. For example, if the grid be given a higher positive potential than the plate, then the plate circuit will have a negative resistance characteristic.

* * *

Plotting Push-Pull Curves

HOW CAN YOU plot the characteristics of a push-pull amplifier to show that the harmonics are eliminated? In discussions of push-pull amplifiers it is usually stated that the even harmonics are eliminated but it is never shown how it happens.—T. M.

Start with a plate current grid voltage curve. Select the grid bias at which the tube is to be operated; and mark this on the curve. Call this voltage zero and measure biases in both directions from this point. Now read the current at some positive voltage E_1. Suppose it is I_1. Also read the current at $-E_1$. Suppose it is $-I^1$. Then on a new curve plot $I_1 - I_1$ against E_1. Do this for other values of the grid voltage until there are enough values to plot a curve. This will be nearly straight. Using one plate current grid voltage curve only assumes that the two tubes in the push-pull amplifier have identical characteristics. The more nearly straight the line is the less strong will be the harmonics. It will be seen that if the curve is plotted on both sides of the operating point it will be symmetrical about that point. That means that there will be no even order harmonics. The fact that the curve will bend over for large values of signal voltage shows that odd harmonics will be present.

* * *

Measurement of Inductance

PLEASE OUTLINE a method of measuring inductance with the aid of a calibrated condenser and a calibrated oscillator. I understand that this is possible.—E. E. D.

Hook the coil to be measured in series with the calibrated condenser and also in series with a thermomilliammeter. Couple the calibrated oscillator loosely to the coil to be measured. Set the calibrated condenser at maximum and then vary the frequency of the oscillator until the deflection is greatest. Note the capacity on the calibrated condenser and also the frequency. Obtain $1/(2\pi F)^2$ and then enter this quantity and C on a curve, with C as abscissa and the frequency function as ordinate. Reset the calibrated condenser and obtain another frequency of resonance. Get a pair of other points in the same way as before. Do this many times for different values of the calibrated condenser. When all the points have been entered on the curve draw a straight line through all the points. The slope of this line is the inductance. The curve will not pass through the origin because of the presence of capacities not taken into account in the calibrated condenser. If the curve crosses the horizontal axis to the left of the origin, the distance between the origin and the point where it does cross is the unaccounted for capacity. If the line crosses to the right of the origin, the calibration of the condenser was not right.

* * *

Detuning an Oscillator

IN MEASURING selectivity by the detuning method a very small frequency change is required when the selectivity is high. Since the measurement depends on the frequency change it is necessary to have some means of making the change and accurately measuring it. Can you suggest a method for doing it?—R. E. M.

It is usually done by connecting a small condenser in shunt with a variable condenser on the oscillator and then calibrating the vernier condenser. Suppose we want to make a measurement at 1,000 kc and that we want to detune not more than 50 kc. The formula relating the frequency, the frequency change, the capacity, and the capacity change is $dC=2CdF/F$, in which dC is the capacity change, C the capacity in the oscillator circuit, F the frequency and dF the change in frequency. Let us assume that $C=100$ mmfd., that $dF=50$ kc, and that $F=1{,}000$ kc. Putting these in the formula we have $dC=10$ mmfd. This should be the capacity of the midget condenser. If it is a variable condenser it can be calibrated so that the frequency change is obtained for any setting. By this small vernier in shunt with the large condenser small frequency changes can be measured accurately.

* * *

Modulation Capability

WHAT is the difference between percentage modulation and modulation percentage capability? When a station carrier is modulated 100 per cent., what is the relation between the amplitude of the carrier and the modulating signal?—F. G.

When a carrier is modulated 100 per cent. the signal amplitude changes between zero and twice the unmodulated amplitude. That would make the amplitude of the modulating signal equal to the amplitude of the carrier. The definition of percentage of modulation is expressed as follows: Percentage modulation is the ratio of half the difference between the maximum and minimum amplitudes of the modulated wave to the average amplitude, expressed in per cent. When the wave is modulated 100 per cent. the maximum amplitude is 2E, where E is the amplitude of the carrier wave, and the minimum amplitude is zero. Hence the difference between the two is 2E and the average is E, that is, the carrier amplitude. Modulation percentage capability is the highest permissible modulation percentage for the particular transmitter. It never exceeds 100 per cent. and it may be as low as 30 per cent. In case the actual modulation exceeds the modulation capability much distortion occurs. Modulation capability has nothing to do with the actual modulation it only fixes a limit of percentage modulation that must not be exceeded. Most of the time a carrier is on the air the percentage modulation is zero or very low, but a very high modulation percentage may occur at any instant.

* * *

Zero Level

IN CERTAIN discussions on telephone transmission I have seen the expression "zero level," yet it was not zero at all. What is it all about?—C. D. Q.

Zero level is any arbitrary level of power, except zero. It is merely a convenient reference base. It is used when one power is expressed as a ratio of another, as so many times greater or less than zero level power. It is because the term is used with ratios that zero cannot be used, for the ratio of any finite quantity to zero is infinite.

* * *

Constant Coupling

IN THE OCT. 21 issue you described a constant-gain coupler. Just what does "constancy mean in this case? Is the voltage across the tuning condenser the same for all frequencies or is it the coupling between the primary and secondary circuits constant? These two concepts are not the same, are they?—W. B. L.

No, the two ideas are not the same. The constancy refers to the coupling between the primary and secondary circuits only. The voltage across the tuning condenser is the input voltage to the grid of the second tube, and this voltage is less the larger the condenser. Hence the gain is not constant even though the coupling is constant.

* * *

Current Rating of Rectifier

CAN MORE CURRENT be drawn from a 25Z5 when the two elements are in parallel than when they are in series, as when the tube is used as a voltage doubler? What determines the current rating of the rectifier tube?—D. J.

Twice as much current can be drawn from the tube when the two elements are in parallel than when they are in series, as in the voltage doubler. The current that can be drawn safely depends on the emission from the cathodes and the heating of the plates. If too much current is drawn the plates will get red hot and permanent damage will result.

* * *

Audio Oscillator

WILL YOU KINDLY give me the design of a transformer that will work as the oscillating coil in an audio frequency oscillator which is to generate a frequency around 400 cycles per second? What circuit would you recommend for such an oscillator?—R. W. V.

A push-pull output transformer designed for 171A tubes, or other tubes of low output resistance, makes an excellent oscillator coil if it is used in a Hartley circuit. The center tap of the primary winding would be connected to the cathode of the tube, one side to the grid condenser, and the other to ground. The plate of the tube would be connected directly to the plate voltage source. A small condenser can be connected across the entire primary winding if the frequency generated without it is too high. More likely it will be too low, and in that case there is nothing to do but accept it or select another transformer. The reason a transformer designed for low impedence tubes was suggested is that the inductance is likely to be low enough to give a fairly high frequency. The transformer will have another winding, which may be used for utilizing the oscillation. If it is small, such as one designed for a dynamic speaker, it can be connected in the grid circuit of an amplifier tube, but if it is large as it would be if designed for a magnetic speaker, It can be connected in the plate circuit of a tube for modulation purposes, or a potentiometer can be connected across it so that any portion of the voltage may be applied to the grid of a tube. The writer has never yet found a push-pull output transformer that would not work as an oscillator in the Hartley hook-up. Interstage transformers can also be used, but almost without exception the frequency generated is too low.

* * *

Twisted Pair as Leading

IS IT PRACTICAL to use twisted pair as leadin in place of a transposed line? How should such a line be used if it is practical?—R. N.

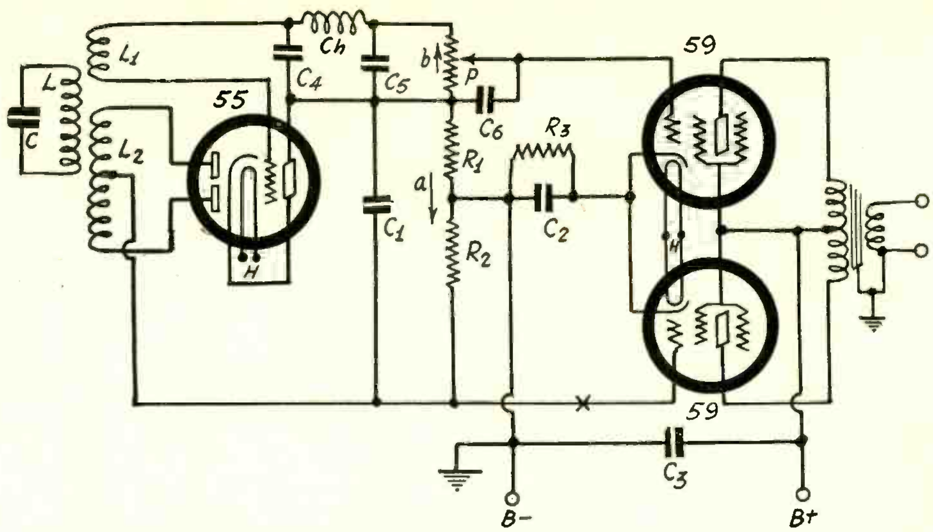
It has been used. The grounded wire is grounded at one end only but it is twisted together with the antenna all the way from the antenna to ground. The open end of the antenna wire, near ground, is taped, and the open end of the grounded wire, near the antenna, is also taped. The whole line should be weatherproof. The antenna and ground posts on the set are connected to the appropriate leads at a point somewhat above the ground end of the line. Whether this arrangement is entirely satisfactory we cannot say, as there is not much information available on the subject.

* * *

Push-pull Resistance Coupling

PLEASE SHOW how a diode detector can be coupled to a push-pull amplifier without the use of stopping condensers, if this is possible?—F. W. R.

The method shown above is about the only way that it can be done. The output voltage of the detector is divided equally between the two tubes. In order to compensate for the positive bias on one of the amplifiers a voltage, proportional to the carrier and twice the value of the drop in either half of the load resistance, is put in series with one grid in the proper direction so that the operating bias is the same on both tubes.



This illustrates a method of coupling a detector to a push-pull amplifier by means of resistance and using diode bias on the amplifier.

Factors in Varying Talking Speed Before Microphone

The following is from "The Art of Teaching by Radio," published by the Department of the Interior:

Vary the rate of delivery according to your own style and the thought being expressed. It should never be so rapid as to prevent distinct enunciation. Regarding the rate of delivery, Borden considers an average rate of about 165 words per minute as being most effective. While a brisk rate of delivery, provided the enunciation is good, is more likely to hold the attention of a radio listener than a more deliberate rate, other writers are of the opinion that 165 words a minute is a little too fast, especially for instructional purposes. Clark recommends 140 to 160 words, and Lawton says that the only blanket rule that can justifiably be made with regard to the rate of delivery is that the speaker should talk as briskly as is consistent with good enunciation and proper employment of the *variety stimuli*. He thinks it should lie somewhere near 135 or 140 words per minute. This is considerably slower than Lowell Thomas or Edwin C. Hill speaks.

News Broadcasts

According to Dr. Hillis Lumley, of the Bureau of Educational Research of the Ohio State University, news broadcasts are broadcast at the rate of almost 200 words per minute; educational talks for adults about 160 words per minute. The rate for a small sampling of school broadcasts was 170 words per minute. Of course, the rate varies with the material and the audience being addressed. The rate should be somewhat slower for children than for adults. The same instructor who would speak at the rate of 140 words per minute, when he was telling some interesting story, might drop to 90 words per minute in giving directions for the listeners to follow. The broadcaster should be deliberate in order to be at ease, but not slow enough to appear lazy. Of course, if slowness is overdone, the delivery will sound stilted. For instructional purposes the thought must be attuned to the powers of perception of the listeners. The tempo and pitch of the voice should be suited to the idea being presented and the personality of the speaker.

The foregoing opinions are in accord with better practice in broadcasting, but the writer believes that Dr. Burt is right when he says that microphone technique must be made the subject of a scientific investigation rather than be left to the empirical maxims of practitioners themselves.

Diction

Diction, as used by the American Academy of Arts and Letters, includes pronunciation, articulation, quality of tone, accent, and general cultural effect.

The term is used here in the same sense. Good diction includes those qualities of voice and delivery that enable the speaker to project his personality through the microphone in such a way that the listeners will be able to understand and suffer the minimum handicap from the lack of the visual presence of the speaker. They should be stimulated to think and act on the subject under discussion. Good diction—an effective vocal exposition—is of paramount importance to the broadcasting teach, since it must do such heavy duty in instruction by radio. Lambert remarks that speakers with charm of manner and voice may succeed at broadcasting even though they do not have much to say. Diction should be pleasing but not overelaborate or stilted. Since it is simply the convevor of the ideas, it should not detract the attention of the listener from the content of the message.

Too much stress cannot be placed on proper diction. In radio the word and a few supporting sound effects alone must be relied upon. No visual aid or motion is possible. The speaker's diction should be precise without suggesting specific effort. Most good radio speakers talk softly and distinctly.

Pronounce correctly. The speaker should pronounce correctly the words he uses in the broadcast and avoid the use of words he is likely to mispronounce. Wrong pronunciation is worse than no pronunciation. Carpenter roughly classifies mistakes in pronunciation under the following types: words easily mispronounced through carelessness; tongue twisters; foreign words; foreign names; and those words which all of us see repeatedly in print, but which we have never spoken aloud and probably have never heard pronounced. Cosmopolitan English, using pronounciation which conforms to the standards of best usage, involves knowledge of the phonetics of English, the ability to use the phonetic pronouncing dictionary. Intensive study should precede the presentation involving the extensive use of foreign names.

Perhaps the worst fault in pronunciation and enunciation comes from speaking too rapidly and dropping the voice near the end of sentences. Final consonants, especially s, d, and t, should be watched. The hissing of sibilants executed with a slight whistle is disagreeable over the air. By keeping the tongue as far as possible from the roof of the mouth, the sibilant may be uttered softly. The harshness of the letter r may be avoided by giving it a slight roll and almost dropping it at the end of a word.

Warning on Formulas

If formulas or important figures are to be quoted, give the listener warning if it is especially desired that he get them. Speak slowly and distinctly in giving the information, assuming that some of the listeners are writing it down. Finally, repeat for good measure. Proper names should be emphasized if important and spelled out if there is a likelihood of their being misunderstood.

Articulate distinctly. Clear, cleancut, crisp enunciation and finely articulated sounds are important in the effective use of the voice over the air. Borden says that the importance of speaking distinctly over the radio cannot be overemphasized, but that the speaker should not enunciate pedantically. Fleck states that emphasis should be given to clear, clean-cut enunciation, but not to the extent that the delivery becomes stilted or unnatural. Sutton points out that clear enunciation demands the control of the tongue from the front, the shaping of the syllable in speech, without mouthing or jawing or using the back of the tongue.

In speaking clearly it is necessary to open the mouth well. Tone vowels should be held and final consonants cracked off crisply and clearly. Lazy lip motion creates an at-ease attitude, but leads to poor articulation of certain sounds. For example, the letter w becomes dub-u instead of double-you.

Writers point out that the broadcaster should be capable of shading the voice to meet the requirements of the manuscript. Important points should be emphasized and climaxes approached with a rising inflection of the voice. The speaker should not become so enthusiastic, however, that he slurs his words and runs his sentences together; neither should be let his voice trail off at the end of sentences. Special modes of enunciation, such as dialects and other speech variations, should never be permitted to interfere with the clearness, forcefulness, and the pleasingness of the message.

Use a pleasing and natural tone of voice. The National Voice Technique Committee recommends that the speaker strive for an average pitch of low middle range. Van Campen considers that Graham McNamee has thousands of admirers because his wonderful voice, full of melody, friendliness, enthusiasm, and sincerity, is a flexible instrument that conveys every light and shade of feeling and thought. The words: Good, pleasing, clear, are frequently used by local teachers and principals in describing desirable radio voices. Other descriptive terms used include: Strong, buoyant, soft, low-pitched, well-modulated, well-directed, heavy, audible, convincing, attractive, full, expressive, earnest, magnetic, flexible, deep, natural, live, friendly, low-toned, warm, sincere. The words: Rough, harsh, raucous, squeaky, shrill, high, sharp, tense, throaty, clacky, flat, explosive, jerky, rasping, are used to describe undesirable radio voices. Shouting, shrill intonations, and superior tones are objectionable.

Voice Improvement

There is considerable variation of opinion regarding the improvement of poor radio voices. Campbell says that if a prospect's voice line is erratic there is little that can be done about it. Clark, Bushman, and Van Campen believe in voice training for broadcasting. Good health and vitality are of great importance, as fatigue and nervousness show quickly in the voice.

The tone of the ideal radio talk is not the tone of the public address. The radio talk has a friendly, intimate tone. It makes the listener feel he is being visited with rather than lectured at.

Emphasize important points. Accent of emphasis is an important factor in instruction by radio. Through meaningful variations in pitch and rate of delivery, changing inflections, volume, etc. the invisible speaker interprets his thoughts to the listeners. If his emphasis is properly placed, his broadcast will be meaningful and effective. If his emphasis is not properly placed, confusion and dissatisfaction will result. Some pitfalls to be avoided include the affectation of so-called English or Oxford accents, colloquialisms and sectional speech.

Use a smooth, yet intimate and animated, style of delivery with a pleasing variety of pitch and intonation appropriate to an accurate portrayal of the ideas being presented. Smoothness in delivery should not be interpreted as even-flowing, monotonous presentation with well-rounded sentences. Not at all. It does imply, however, that an abrupt, explosive style with extreme frequencies in pitch and clumsy pauses should be avoided. Stammering and hesitation, except for desired dramatic effect in characterizations, annoy the listener. The listener wants to know every minute what is happening. Therefore, cues should be followed quickly and smoothly.

Dead Air

Various program directors warn against awkward pauses or "dead air" during a broadcast. They point out that a few seconds of silence over the air may seem like minutes to the listener. There are times, however, when silence may be very effective. Pauses and changes of emphasis can be used advantageously to overcome the disturbing effect of abrupt transitions from one idea to another. Dramatic pauses and an atmosphere of mystery are important aids in creating suspense and firing the imagination in certain dramatic situations. As a rule, however, pauses over the air should be shorter than pauses on the stage. A good pause, properly timed, is much more effec-

(*Continued on next page*)

Station Sparks

By Alice Remsen

WITH THE COMMERCIALS

The American Rolling Mills will go NBC through WLW on November 10th, with a half-hour musical show, fifty-five-piece orchestra and a dramatic script titled "The Iron Master"—Friday night, WJZ, WLW and Blue NBC network; Bennett Chappell will be the narrator, and it's quite likely that William Stoess will be the conductor. . . . A million copies of the Swift Comedy News, presumably edited by Olsen and Johnson, are now being released through Swift dealers. Oh, yes, you'll get your copy with your meat! . . . Thursday, Friday and Saturday, on WJZ, at 7:15 p. m., are given over to a radio version of Duma's masterpiece, "The Three Musketeers," sponsored by the Jeddo-Highland Coal Company. Very good program! . . . Did you ever see such a man in your life for picking tunes as Archie Fletcher of the Joe Morris Music Company! Their "Good Night, Little Girl of My Dreams," which you hear so frequently on the air nowadays has been out only a little over a month and it has already sold over fifty-two thousand copies! . . . Harriet Lee is a lucky girl; she no sooner leaves the Happy Wonder Bakers than she opens on another commercial for Ruppert's Beer on WOR, with Dick Robertson, Arthur Boran and Louis Katzman's Orchestra; an hour's broadcast, titled "The Invisible Microphone," with a ghost announcer to keep up the idea; a variety bill with something for everyone in its grabbag; Fridays at 9:00 p. m., WOR. . . . If you have wondered what happened to Ernie Stanton of the vaudeville team Val and Ernie Stanton, he is located now in Fort Worth, Texas, and has been appearing on the "Feel of the Ford" program, which originates in Dallas; he will probably take a unit show out for a tour of the East Texas oil towns. . . .

WHERE JERRY WENT

Another chap who disappeared from our ken a while ago is Jerry Wald, erstwhile radio critic; Jerry is now on the Pacific Coast, writing for pictures and making money at it, too. . . . Albert Spalding, the noted American violinist, who broadcasts each week over a WABC-Columbia network, plays a Joseph Guarnerius del Jesu violin, which is an instrument even more rare than a Stradivarius; it is insured for thirty thousand dollars, a mere fraction of its worth; it is so extremely valuable that Spalding treats it as he would a child; takes its temperature, puts it to bed, and even gives it birthday parties; if the violin is subjected to a drastic change in temperature, Spalding gives it a novel treatment; he puts it in a bed which has just been vacated by some person; he explains that the warmth of a human body is good for the violin; if no bed, properly warmed, is available, he takes it to bed himself and warms it with his own body; rather far-fetched, but quite probable; the instrument will celebrate its two hundredth birthday very shortly; Spalding then intends to give a party in its honor. . . .

VERSATILE HELEN MORGAN

Did you know that Helen Morgan was born in Danville, Illinois, and brought up in Chicago? The glamorous Helen has had many jobs during her life; she started out at the age of fourteen working in a Chicago mail-order house for five dollars a week; among other occupations, Helen was a manicurist's helper, a child's nurse, a cracker packer, a button seller, a stockroom girl, a tea sorter, a taffy roller, and a cloak-and-suit model. . . . Edward d'Anna and his concert band of more than fifty pieces will inugurate their seventh consecutive season on the WABC-Columbia network Saturday, November 11th, from 9:30 to 10:00 p. m. EST; this feature, as heretofore, will be presented every Saturday under the sponsorship of the Carborundum Company; this band is unusual among radio and concert organizations; the majority of its members have been playing together for almost thirty years and none is a professional musician; one of the featured soloists, Romeo Greene, trombonist, is a full-blooded Tuscarora Indian; Conductor d'Anna is a native of the Island of Malta; he received his musical education from his father and grandfather, both of whom directed military bands attached to the British Army post on the Mediterranean island; he has been prominent in cultural circles in Northern New York State for the past twenty-five years; the programs will again originate in the ballroom of the Niagara Hotel, at Niagara Falls, N. Y. . . . Very glad to hear that Evelyn MacGregor has at last achieved stardom at WABC, something which she has merited for some time; Evelyn has a very beautiful contralto voice, which has been heard in ensemble numbers on the Cathedral Hour and many other outstanding Columbia programs; she is to be starred now on "Andre Kostalanetz Presents," Thursdays at 9:00 p. m.; jolly good luck, Evelyn, you deserve it! . . . A new colored female singer has been added to the radio roster; Aida Ward, singing star of the Cotton Club Revue, may now be heard on the "Harlem Serenade" program, together with the Hall-Johnson choir and Claude Hopkin's Orchestra, each Thursday at 8:30 p. m. EST. . . . And speaking of colored stars reminds me that Duke Ellington has written a new masterpiece of ryhthm, "Rude Interlude." He and his famous orchestra have just recorded the number for RCA-Victor. . . . Gertrude Niesen is singing at the Central Park Casino with Eddie Duchin's Orchestra, and Gypsy Nina is being featured with her accordian at the El Garron. . . .

PETER DIXON KEEPS CLIMBING

Peter Dixon, author of those intriguing kid scrips, "Bobby Benson and Sunny Jim," daily CBS feature, knows whereof he writes, for he spent several years in Texas and the Southwest as a newspaper man before coming East to do his chores for the NBC press department, which chucked him into radio via that old script act of his, "The Cub Reporter." From there it was a step to big money and stardom in his other beloved series, "Raising Junior," and now the lad is gaining more laurels. More power to him! . . . By-the-way—"yours truly" may be featured in a series of comedy shorts soon—if she's lucky—my fingers are crossed—and how! . . . My eye caught an item sent out by the Columbia press department about Molly Pollock ("Muriel" to NBC) and I thought she had deserted NBC for CBS, but find out that Muriel and Vee have just been loaned to CBS by NBC for the Happy Wonder Bakers program; and ain't that sumpin'; . . . "Zeke" Mannis, member of the WMCA hill-billy act, who disappeared for twelve days, was found in Pittsburgh, where he had been arrested for vagrancy; his foster-father, "Pappy," of the same act, was notified by the Bureau of Missing Persons and sent someone down by airplane to get the lad; when "Zeke" left New York he had only ten dollars in his pocket; the act was about to be cancelled by WMCA when the boy was found, and now all is peace and harmony; "Pappy" has forgiven him for running off, and "Zeke" has promised never to do it again. . . . Al Shayne is back on WMCA again; he may be heard each day at 5:00 p. m. on Sally's Studio Party. . . .

MORTON DOWNEY CHANGES

Morton Downey has changed his manager. Jim Doane; has gone into business for himself and Hugh C. Ernst replaces Doane as Downey's representative. . . . Ruth Etting has also change; Ruth signed recently with Thomas Rockwell. . . . Uncle Don has a new commercial, Borden's Milk. . . . John Babb is back at his desk over at NBC; John was sick for several weeks. . . . Anthony Frome, NBC Poet Prince, comes by tenoring quite naturally; his dad was and still is a tenor. . . . Frank Novak, the one-man-band of WEAF and "Wizard of Oz" programs, is another radio artist who comes by his talents through heritage; Frank's dad owned a music store in Chicago. . . . Carmel Myers is the latest possibility for radio, following her excellent debut on the Rudy Vallee broadcast. . . . And now it's time for me to ooze over to Manhattan and prevent my editor from having a fit if this copy should be late.

A THOUGHT FOR THE WEEK

WHEN M. H. Aylesworth, President of the National Broadcasting Company, helped celebrate the fourteenth anniversary of radio broadcasting at the new NBC studios recently, he placed a new feather in the cap of good old Station KDKA of Pittsburgh. November 2, 1920, was the date of the first scheduled program at KDKA designed for general reception, and the occasion was the sending out of the first returns in the Harding-Cox presidential election. Incidentally, Mr. Aylesworth has done some progressing himself since those early days, when his name was not known in radio—and today he is president of the leading radio broadcasting system in the world.

Talking on the Air

(*Continued from preceding page*)

tive in a radio address than any amount of shouting. The mental reactions of the listener must be studied in order to understand the function of the dramatic pause. Sound is a stimulus which stirs the imagination. The imagination makes use of all five of the special senses. Frequently an appeal to the auditory sense alone makes a stronger appeal to the imagination than if a direct appeal is made to several senses at one time. On this point, Vernon Radcliffe, of the National Broadcasting Co., says: "If you hear a footfall in your darkened room after midnight, you receive a much more violent shock and stimulus than if you see a face, for the reason that the imagination is widely and instantly stirred. It is a fact, therefore, that radio audiences react much more violently and quickly—provided they react at all."

Avoid dullness. Broadcasters are frequently urged to be natural and at ease when they are on the air. Naturalness that tends to disturb or annoy the listeners should be sacrificed for effectiveness. Natural dullness may be used as an example. Dullness has no place on the air.

A number of writers are of the opinion that the speaker should vary his voice and exercise some freedom as to his position before the microphone. Burt says that in delivering a talk, monotony is the one unpardonable sin. The delivery must be as varied as possible; pitch speed, stress, and intonation must be continually changing. Busse says that a monotonic delivery is a perfectly deadly thing and one not calculated to inspire the radio listeners to continue hearing the lecture. Lawton states that animated delivery can be aided by meaningful variations in pitch, volume, and rate; but that extreme care should be taken that these variations should not become manneristic or uninterpretative.

STATIONS BY FREQUENCIES

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

Corrected to October 31st, 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

CKLW—Windsor, Ont., Can.; Essex Bdcsters Lmt. 5 KW.
XEY—Merida, Yuc., 105 W.

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

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.
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.
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

WEEI—Boston, Mass.; T—Weymouth, Mass.; Edison Electric Illuminating Co. of Boston; 1 KW.
WKZO—Berrien Springs, Mich.; WKZO (Inc.); 1 KW.
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.

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.*

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.
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—Phoeniz, 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

CJGX—Winnipeg, Manitoba; T—Yorkton, Saskatchewan; Winnipeg Grain Exchange; 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.

670 KILOCYCLES—447.5 METERS

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

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.

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.
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.

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.

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.

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.*

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.

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.

(Continued on next page)

(*Continued from preceding page*)

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.
WNYC—New York, N. Y.; 500 W.

820 KILOCYCLES—365.6 METERS

WHAS—Louisville, Ky.; T—Jeffersontown, Ky.; The Courier Journal Co. and The Louisville Times Co.; 25 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

XFX—Mexico City, Mex.; Sria de Educacion Publica; 500 W.

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.

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.

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.*

890 KILOCYCLES—336.9 METERS

CMX—Havana, Cuba; Francisco Lavin; 1 KW.
WJAR—Providence, R. I.; the Outlet Co.; 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.

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.*
CKPR—Port Arthur, Ontario, Can.; Dougall Motor Car Co., Ltd.; 50 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.
KGBU—Ketchikan, Alaska; Alaska Radio and Service Co. (Inc.) 500 W.

910 KILOCYCLES—329.5 METERS

XEW—Mexico City, Mex.; Mexico Music Co.; S. A.; 5 KW.

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.
XFEL—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.

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.*
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.*
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.
XEFO—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*.
CMHD—Caibarien, Cuba; Manuel Alvarez; 250 W.

965 KILOCYCLES—310.7 METERS

CMBC—Havana, Cuba; Domingo Fernandez; 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.

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 Sauza; 100 W.
XEC—Toluca, Mex.; Jesus R. Benavides; 50 W.
XEFS—Queretaro, Quer., Mex., Salvador Sanchez, 40 W.
XEL—Saltillo, Coah.; Antonio Garza Castro; 25 W.

1010 KILOCYCLES—296.8 METERS

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.
CKIC—Wolfville, Nova Scotia; Acadia University; 50 W.
CMBZ—Havana, Cuba; Manuel y G. Salas; 150 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.

1030 KILOCYCLES—291.1 METERS

CMHI—Santa Clara, Cuba; Lavis y Paz; 30 W.

1,040 KILOCYCLES—288.3 METERS

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—Abilene, 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

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.
CHGS—Summerside, Prince Edward Island, Can.; R. T. Holman, Ltd.; 500 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).

1120 KILOCYCLES—267.7 METERS (Cont.)

WTAW—College Station, Tex.

(*Continued on next page*)

(Continued from preceding page)

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.

1150 KILOCYCLES—260.7 METERS

WHAM—Rochester, N. Y.; T—Victor Township, N. Y.; Stromberg-Carlson Telephone Manufacturing Co.; 5 KW.

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.

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.
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.
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.
WJBC—La Salle, Ill.; Wayne Hummer & H. J. Dee, doing business as Kaskaskia Broadcasting Co.; 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.
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.
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.
10AK—Stratford, Ontario, Can.; Classic Radio Club; 10 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.

1210 KILOCYCLES—247.8 METERS

WJBI—Redbank, N. J.; Monmouth Broadcasting Co.; 100 W.
WGBB—Freeport, N. Y.; Harry H. Carman; 100 W.
KGY—Olympia, Wash.; KGY Inc.; 100 W.
WOCL—Jamestown, N. Y.; A. E. Newton; 50 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.
WBBL—Richmond, Va.; Grace Covenant Presbyterian Church; 100 W.
WMBG—Richmond, Va.; Havens & Martin (Inc.); 100 W.

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.

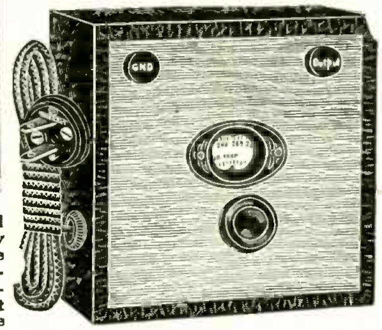
(Concluded next week)

Valuable Gifts with Subscriptions for RADIO WORLD

A *NEW* TEST OSCILLATOR

That Works A.C., D.C., or Batteries!

SHOWN ONE-THIRD ACTUAL SIZE



Over-All Size Is Only 5x5x3"! Dial Reads Frequencies Directly!

A NEW TEST oscillator, Model 30, has been produced by Herman Bernard, so that all the requirements for lining up broadcast receivers, both tuned radio frequency and superheterodyne types, will be fully and accurately met. This device may be connected to 90-120-v a.c., any commercial frequency, without regard to polarity of the plug, and will function perfectly. It may be used also on 90-120-volt d.c. line, but plug polarity must be observed. One of the plug prongs has a red spot, denoting the side to be connected to positive of the line. If you don't know the d.c. line polarity, you may connect either way, without danger. The oscillator will work on d.c. only when the connection is made the right way. Moreover, 90 volts of B battery may be used instead of either of the foregoing, simply by connecting two wires between the plug at the batteries, observing polarity. No separate filament excitation is required. The oscillator is modulated with a strong, low note under all circumstances. It uses a 30 tube.

THE dial of the Bernard Model 30 Test Oscillator is directly calibrated in kilocycles, so there is no awkward necessity of consulting a chart. The fundamental frequencies are 135 to 380 kc, so that nearly all commercial intermediate frequencies as used in present-day superheterodynes are read on the fundamental. The points for other intermediate frequencies, e.g., 400, 450, 456 and 465 kc, are registered on the dial also, two harmonics, with which the user need not concern himself, being the basis of these registrations. Besides, the broadcast band is taken care of by the fourth harmonic and the dial is calibrated for that band, also.

The divisions on the dial for the fundamental band, 135 to 380 kc, are 1 kc apart from 135 to 140 kc, 2 kc apart for 140 to 180 kc and 5 kc apart for 180 to 380 kc. For the broadcast band, 10 kc apart from 550 to 800 kc, 20 kc apart from 800 to 1,500 kc.

The test oscillator may be used also for short waves, by resorting to higher harmonics.

Send $12 for 2-year subscription for RADIO WORLD and order Cat. BO-30 sent free, with tube (prepaid in United States and Canada).

Another model, BO-30-S, same as above, except frequencies are ten times as high, hence instrument is for short-wave work only, is available on same basis.

540-4,500 kc Tuning Units

The Tuning Units consist of a four-gang 0.00046 mfd. condenser, with trimmers on it, ⅜-inch diameter shaft, 1⅛ inches long, mounting spades, condenser closing to the left; and a set of four shielded coils. The condenser is the same for tuned radio frequency sets or superheterodynes, but for superheterodynes a series padding condenser is supplied also. For t-r-f sets the four coils are alike. For supers three coils are alike and there is a different coil for the oscillator, with a selection for 175 kc, 456 kc or 465 kc intermediate frequency.

For t-r-f construction, three stages of t-r-f and tuned detector input, four equal shielded coils, tapped for the police band and properly matched to the tuning condenser which is supplied also. Order Cat. TRFTU, which will be sent free, postpaid, on receipt of $10.00 for 86-week subscription for RADIO WORLD (86 issues).

For superheterodyne construction, two stages of t-r-f, tuned oscillator and tuned input to modulator, three identical coils and an oscillator coil, with the proper padding condenser and the four-gang condenser, are supplied as noted below:

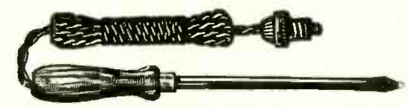
175 kc—For use with 175 kc intermediate frequency. Unit includes four-gang condenser, three r-f coils, the proper oscillator inductance and 800-1,350 mmfd. padding condenser. Send $12.00 for two-year subscription and order Cat. SUTU-175, which will be sent postpaid.

456 kc—For use with 456 kc i.f. order Cat. SUTU-456. Padding condenser is 350-450 mmfd.

465 kc—For use with 465 kc order Cat. SUTU-465. Padding condenser is 350-450 mmfd.

Those desiring to use the short-wave feature will want a switch, which is sold outright and separately. This is a long switch that has sections very close to where the wiring would have to be, and thus insures short leads. The switch is Cat. 4GSW @ $2.25 postpaid.

SOLDERING IRON



A reliable soldering iron of 40-watt capacity, suitable for radio work, and equipped with a long cable and a snappy plug. This iron may be used in either alternating current or direct current, 85 to 135 volts. It is a serviceable iron and has stood up well, as we have been offering this iron for three years and have yet to receive a complaint about its value and dependability. Send $2.00 for 16-week subscription for RADIO WORLD, order Cat. SO, and get this soldering iron free (postpaid). Please remit with order.

"The Inductance Authority"

By EDWARD M. SHIEPE, B.S., M.E.E.

THE ONLY BOOK OF ITS KIND IN THE WORLD. "The Inductance Authority" entirely dispenses with any and all computation for the construction of solenoid coils for tuning with variable or fixed condensers of any capacity, covering from ultra frequencies to the borderline of audio frequencies. All one has to do is to read the charts. Accuracy to 1 per cent. may be attained. It is the first time that any system dispensing with computation has achieved such very high accuracy and at the same time covered such a wide band of frequencies.

A condensed chart in the book itself gives the relationship between frequency, capacity and inductance, while a much larger chart, issued as a supplement with the book, at no extra charge, gives the same information, although covering a wider range, and the "curves" are straight lines. The condensed chart is in the book so that when one has the book with him away from home or laboratory he still has sufficient information for everyday work, while the supplement, 18 x 20 inches, is preferable for the most exacting demands of accuracy and wide frequency coverage.

From the tri-relationship chart (either one), the required inductance value is read, since frequency and capacity are known by the consultant. The size and insulation of wire, as well as the diameter of the tubing on which the coil is to be wound, are selected by the user, and by referring to turns charts for such wires the number of turns on a particular diameter for the desired inductance is ascertained.

There are thirty-eight charts, of which thirty-six cover the numbers of turns and inductive results for the various wire sizes used in commercial practice (Nos. 14 to 32), as well as the different types of covering (single silk, double silk, single cotton, double cotton and enamel) and diameters of ¾, ⅞, 1, 1⅛, 1¼, 1⅜, 1½, 1¾, 2, 2¼, 2½, 2¾ and 3 inches.

EACH turns chart for a given wire has a separate curve for each of the thirteen form diameters.

The two other charts are the tri-relationship one and a frequency-ratio chart, which gives the frequency ratio of tuning with any inductance, when using any condenser the maximum and minimum capacities of which are known.

The book contains all the necessary information to give the final word on coil construction to service men engaged in replacement work, home experimenters, short-wave enthusiasts, amateurs, engineers, teachers, students, etc.

There are ten pages of textual discussion by Mr. Shiepe, graduate of the Massachusetts Institute of Technology and of the Polytechnic Institute of Brooklyn, in which the considerations for accuracy in attaining inductive values are set forth. These include original methods.

The curves are for close-wound inductances, but the text includes information on correction factors for use of spaced winding, as well as for inclusion of the coils in shields. The book therefore covers the field fully and surpasses in its accuracy any and all mechanical aids to obtaining inductance values.

The publisher considers this the most useful and practical book so far published in the radio field, in that it dispenses with the great amount of computation otherwise necessary for obtaining inductance values, and disposes of the problem with speed that sacrifices no accuracy.

The book has a flexible colored cover, the page size is 9 x 12 inches and the legibility of all curves (black lines on white field) is excellent.

Send $4.00 for 34-week subscription for RADIO WORLD and order Cat. PIA sent free, with supplement, postpaid in United States and Canada.

RADIO WORLD
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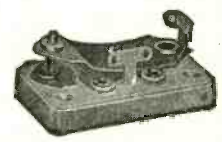

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