

Dec. 20

1930

\$15 REMOTE CONTROL BOX

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**WORLD**

The First and Only National Radio Weekly

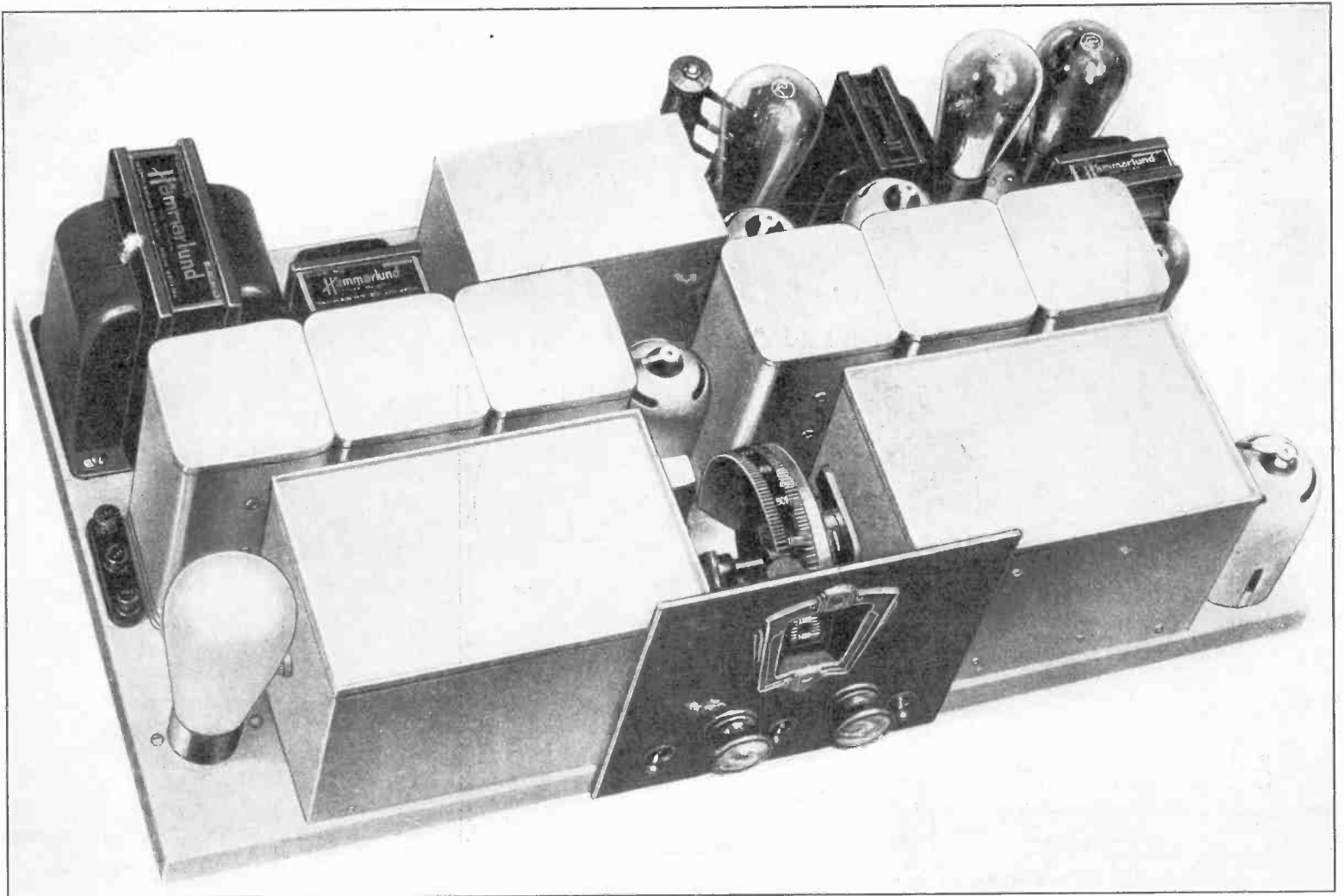
456th Consecutive Issue—NINTH YEAR

Diagrams of the New  
Philco Sets

Transmitting Circuits

Battery Victoreen  
Changed to AC

# THE HI-Q 31 CUSTOM-BUILT RECEIVER



A Real Performer, the New HI-Q 31. See Article on Pages 5, 6 and 7

RADIO WORLD, Published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

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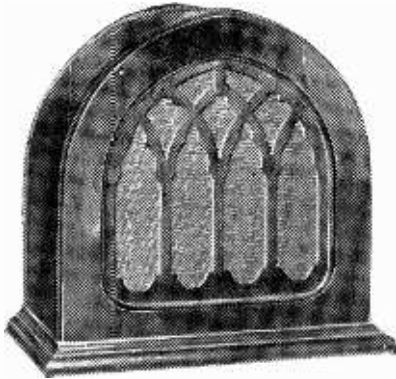
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Magnetic speaker in genuine, beautiful walnut cabinet. Order Cat. AN-G at \$3.95.

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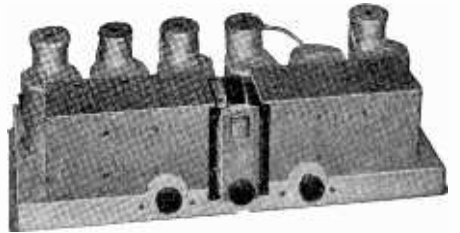
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.0001 mfd. .... 10c	.006 ..... 20c
.00025 mfd. .... 10c	.00025 with clips. 20c
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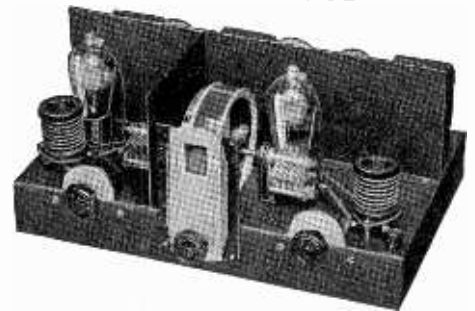
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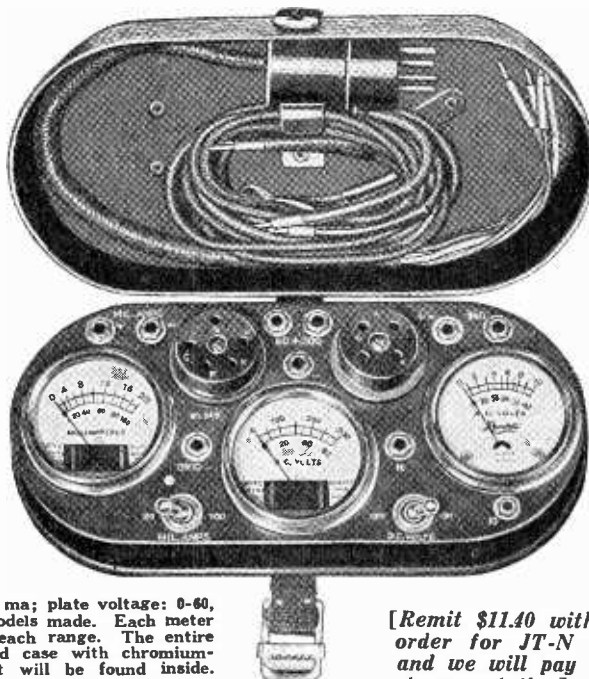
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Jiffy Tester, Model JT-N, consists of three double-reading meters, with cable plug, 4-prong adapter, test cords and screen grid cable, enabling simultaneous reading of plate voltage, plate current and filament or heater voltage (DC or AC), when plugged into the socket of any set. The ranges are filament, heater or other AC or DC: 0-10 v, 0-140 v; plate current: 0-28, 0-100 ma; plate voltage: 0-60, 0-300 v. It makes all tests former models made. Each meter is also independently accessible for each range. The entire device is built in a chromium-plated case with chromium-plated slip-cover. Instruction sheet will be found inside. Order Cat. JT-N.



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Call letters, power and frequency given for each station.

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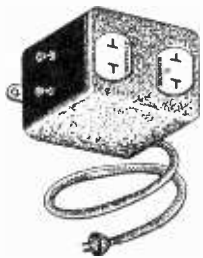
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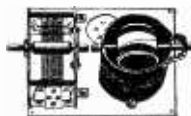
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Connect relay's cable plug to 105-125 volt AC line. Connect B eliminator cable plug to relay socket so marked; connect trickle or other charger's plug to relay socket so marked; connect one side of A battery to binding post, other side to A set. Then turning on your set turns on B eliminator and turns off charger and turns off B eliminator.

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For interstage coupling for 232 and 222, order cat. BT-R-DC ..... @ \$1.25

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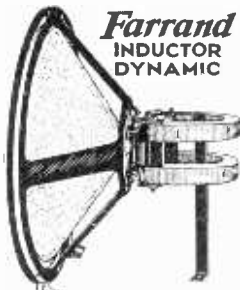
The inductor dynamic offers high sensitivity and true tonal response. It requires no exciting field current, unlike other dynamics. Order model R for 112 or 112A, and Model G for all other output tubes.

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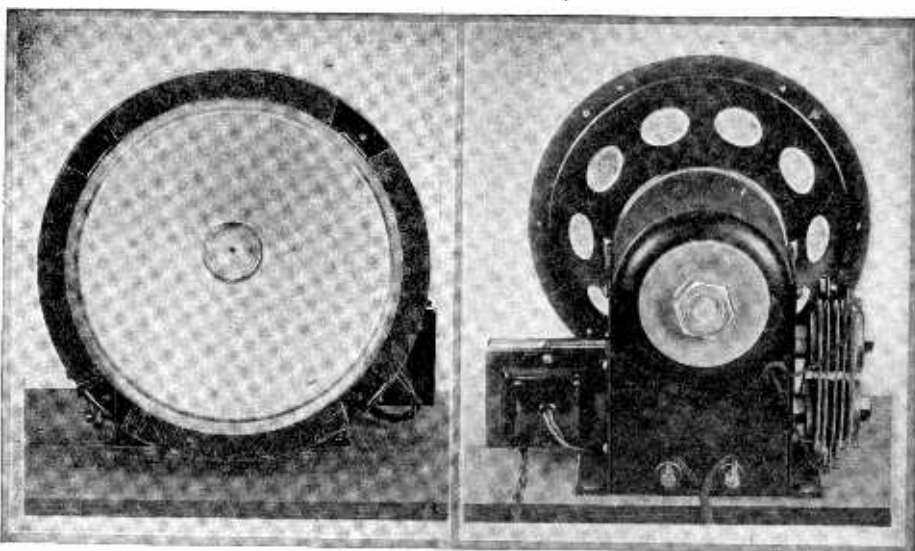
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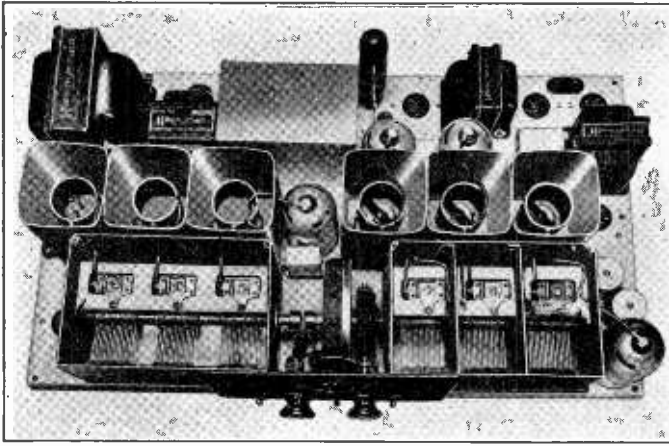
**POWERS PACKS**, 110 volts, 60 cycle. Supply 1½, 2½ and 5 volts AC, 165 volts DC. Complete with 280 tube \$6.25. Cash Radio, 1013 N. McDonel St., Lima, Ohio.

**OUR CONVERTER** makes your radio public address system. Bay Laboratories, Box 1183, San Francisco, Calif.

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**HORN UNIT**, \$2.25—This is the Fidelity Unit and has stood the test of time. Guaranty Radio Goods Co., 143 W. 45th St., New York.





TOP VIEW OF HI Q-31

The voltages on the elements, with respect to signal variations, are kept exceedingly constant, insuring stability, as far as feedback through the voltage supply is concerned, due to the aid of these by-pass condensers.

#### Large Copper Shields Used

Going back again to the shielding. The isolation of the bias resistors, screen and plate circuits would be futile if no provision were made for eliminating capacitive and inductive back coupling. Since it is imperative to carry the isolation of the various stages to the coils, to the tuning condensers and to the tubes, to prevent this back coupling every coil as previously mentioned is placed in a copper shield, of as large dimensions as is practical. This eliminates all possible capacity coupling between the coils, eliminating also the possibility of oscillation. Inductive coupling is accordingly prevented, so that no coupling between the coils remains.

The shielding, as you have noted, is also carried to the condensers, and even to the screen grid tubes, so that capacity and inductance coupling between the elements of any two tubes is zero. As to the tuning condensers, this shielding serves to reduce back coupling, and in the RF unit, where there are shields between each section. It is necessary here, due to the tube circuits involved. In the band filter there are no tubes.

#### Tube Shields Slotted

That the shielding has been carried out to an extent found only in the most elaborate experimental receivers is certainly evident. This thorough shielding with the excellent circuit design, affords titanic amplification throughout the band, with no distorting effects.

A point about the tube shields. Since these shields closely surround the tubes, some means must be taken to provide ventilation and prevent overheating. This is accomplished by slots on the sides as well as a hole on the top. The heat thus generated is carried away in a continuous air draught.

The antenna coupler primary is tapped for long and short antenna, to equalize the characteristics of different antennas with respect to the receiver.

In combination with these units and the screen grid detector, a newly designed volume control, and a local-distance switch are used. This switch permits the selection of local or distant station with ease and correspondingly affords smooth control of the volume.

#### Resistance Audio Stage

To further the quality of reproduction, a specially designed stage of resistance coupled audio amplification is used after the -24 detector tube. A -27 tube is used in this audio stage. This is followed by a stage of push-pull audio, two -45 tubes being used. The volume obtainable is enormous it being about 5,000 milliwatts. The transformers used in this stage have extremely large cross section cores of treated laminations. This permits high primary currents without saturation. Coupled with the heavy windings and a 1:1 winding ratio, absolute true response from as low as 50 kilocycles to as high as 8,000 cycles, is afforded. These transformers are completely shielded in an enameled steel case, with terminal lugs for sub-panel connections.

For those who have a penchant for a predominance of bass notes, or the treble, there is a tone control switch. This may also be used to minimize interference, particularly in the reception of distant stations.

The power supply is designed for 110 volts, 60 cycles. Automatic voltage regulation is used, here, to preserve the efficiency of the tubes, and also maintain a constant volume level.

#### Husky Power Transformer

The power transformer has a very large core and has very large size windings, to permit continuous operation, without the slightest degree of overheating. The primary of this transformer

is tapped at 90 volts for the voltage regulator. The chokes also use heavy cores, and fixed air gaps, as well as over sized windings to insure perfect filtering action.

There are two type chokes, one having an inductance of 30 henries, and the other an inductance of 40 henries. The 30 henry choke has a resistance of 320 ohms, and is rated at 100 milliamperes, while the 40 henry choke has a resistance of 600 ohms, and is rated at 60 milliamperes. The 30 henry choke is a permanent part of the supply the use of the 40 henry choke being dependent upon the type of speaker used. This point will be discussed shortly.

The condenser has six sections: 2, 4, 4, 1, 1, and 2 mfd., rated at 600, 500, 400, 200, 200, and 200 volts respectively. They are mounted in a steel case with pig-tail connections.

#### How Speaker is Used

And now as to the speaker. The receiver is designed to permit the use of a special direct current speaker, to effect a saving of power and afford absolute hum-free reproduction. There are two windings in this speaker for field excitation, a 3,000 ohm coil being used as the second filter choke in the B supply and an 850 ohm coil used as a grid biasing resistance for the -45 tubes. Due to the energizing of the speaker field direct from the power supply of the receiver, there is absolutely no hum, permitting reproduction of a striking brilliance.

Alternating current speakers can also be used, it only being necessary to use the special choke having an inductance of 40 henries, and to change a few connections on the voltage divider, where such provisions are made.

The receiver also has provision for phonograph connection. When the dial is brought up to the lowest setting, automatic connection for the playing of the records is made.

#### Balanced Phonograph Pickup

The special phonograph pickup used here is delicately balanced, affording correct needle position for minimum needle scratch and perfect reproduction. Powerful cobalt magnets further afford excellent pickup and fidelity over the entire audible range.

A special phonograph motor and turntable is also provided, this being of the induction type. It is hum-free and noiseless. It has a high starting torque, providing exact turntable speed from the moment the switch is turned on. An extremely efficient governor is provided, insuring absolutely no change or variation in the turntable revolutions per minute.

#### Built on Metal Chassis

The speaker, pickup, and motor are the special accessories, which have been designed particularly for the HiQ-31.

The complete HiQ-31 is built on a strong metal chassis, 12 $\frac{3}{4}$ " x 23 $\frac{3}{8}$ ". All the wiring is of the sub-panel type. This together with the unit construction, exact wiring and testing of each and every unit and part, provides extreme building simplicity.

The standard size of the chassis permits an unrestricted choice of cabinets. Nine types are offered, in period styles with and without provision for phonograph. The panel arrangement, with its two handsome knob controls, three tiny bronze toggle switches and statuary dial escutcheon, is certainly most attractive for the simplest or most elaborate cabinet or console.

#### The Technical Side

Thus far a general outline of the HiQ-31 has been offered. Now, a detailed study of every component of this receiver will be presented.

When a receiver is operated close to a broadcasting station comparatively large voltages may be developed in the antenna circuit. If these large radio frequency voltages reach the voltage of the first radio frequency amplifying tube, they will cause partial rectification or detection, as it is more popularly known, to take place. The amount of rectification is dependent in this case upon the strength of the radio frequency voltage impressed on the grid as well as the operating characteristics of the tube. If detection does occur, the first radio frequency tube will act like a mixing tube and accordingly cause the modulation of one station to be impressed on the carrier of the station to which the set is tuned. The evident result is interference between the two stations, interference which is known as "cross talk." That it is not a case of ordinary poor selectivity is clearly shown by the fact that as soon as one station signs off the interference from the other station will also disappear. As long as excessive radio frequency voltages are impressed on the grid of the first tube, this trouble will be experienced, no matter what degrees of selectivity may be present in the circuits following the tube.

Therefore if this trouble is to be eliminated the circuits between the antenna and the grid of the first tube must be sufficiently selective to reduce the voltage from any interfering station to a point where it will be so small that rectification does not occur. The following tuned circuits will then further reduce the interfering voltages to negligible values.

#### Avoidance of First-Tube Detection

Now, it is impossible to design a practical singly tuned circuit that will have sufficient selectivity to prevent detection from occurring in the first tube. Even a very low loss circuit would cause a reduction of about 25 to 1 in the voltage of a carrier

# Right or Wrong?

*Try to Answer Correctly and Verify Result*

## QUESTIONS

(1)—If stations tune in and out completely on one division of the tuning control dial, that is an infallible indication that the circuit is very selective.

(2)—It makes no difference whether the oscillator in a superheterodyne is coupled to the grid or the screen circuit of the modulator in a superheterodyne.

(3)—The fact that a superheterodyne is possible proves conclusively the existence of side-bands because the intermediate frequency is either the higher or the lower side frequency of the carrier.

(4)—If it is desired to spread out a narrow band of frequencies over the entire scale of the tuning condenser it can be done by using a relatively small tuning capacity and a large zero setting capacity.

(5)—When the circuit is designed in the manner suggested in (4) the selectivity is sacrificed for convenience in tuning.

(6)—A step-down transformer having two heavy leads and two thin-wire leads should be connected so that the heavy leads go to the high voltage line and the thin to the low voltage filaments.

(7)—The sensitivity of a photo-electric cell is the same for all colors of light so that the output is the same no matter what the light is provided that the amount of light is the same.

(8)—There is a loss of signal voltage in the modulator of a superheterodyne so that if the receiver is to be sensitive it is necessary to add another stage of intermediate frequency amplification to compensate for the loss.

(9)—A shore-wave converter of the superheterodyne type or any superheterodyne may fail because the voltage impressed on the modulator by the oscillator overloads the modulator and the other tubes in the circuit.

(10)—When the modulator of the superheterodyne overloads, either because the signal voltage or the oscillator voltage is excessive, the receiver will have many repeat points.

(11)—The more sensitive a voltmeter the less current it takes to operate it and the more accurate will the readings be when taken with that meter.

## ANSWERS

(1)—Wrong. All it may mean is that the capacity in the circuit changes rapidly as the dial is turned. This apparent selectivity occurs when the capacity in the circuit is small and the inductance relatively large.

(2)—Right. It may be coupled to the grid circuit, the screen circuit, or the plate circuit and the result will be about the same provided the effective degree of coupling between the oscillator and the modulator is the same in all cases. If the coupling is

in the grid circuit the effectiveness of a given coupling between the oscillator and the pick-up is greater than when the coupling is in the plate circuit because of the amplification factor of the tube. The coupling in the screen circuit falls between the other two.

(3)—Wrong. The fact that a superheterodyne works proves that a tube distorts considerably if it is adjusted to do so but it proves nothing about the existence or non-existence of side bands.

(4)—Right. This method is used by amateurs and special condensers are made for the purpose. For example, in one condenser used by amateurs there are four rotor plates, two of which are complete circles. Thus only two plates are effective in changing the capacity, the two circular plates serving as a large zero setting capacity.

(5)—Wrong. The selectivity remains the same as it would be if all the plates were cut so as to cause a change in the capacity, but stations appear on the dial much farther apart, which has nothing to do with selectivity.

(6)—Wrong. If the transformer is connected in this manner the high voltage line will be practically short-circuited and the fuses in the house are sure to go. The winding to be connected to the power line is always made of finer wire than the winding that is to be used for heaters and filaments. In a power transformer in which there is a high voltage winding, this winding is made of still finer wire because it will operate at much lower current. The size of the wire is determined by the current it will carry and not by the voltage across it.

(7)—Wrong. The sensitivity of a photo-electric cell depends greatly on the color of the light, usually being greater the shorter the wavelength of the light, that is, the farther it is away from the red in the direction of the blue.

(8)—Right. The loss may be the equivalent of the amplification in two tuned stages, but the actual loss depends on the efficiency of the first detector or modulator.

(9)—Right. If the signal voltage is weak and the radio frequency voltage from the oscillator is strong the modulator as well as most of the succeeding tubes may overload before the signal is audible. All that is heard under these conditions is a terrific roar.

(10)—Right. If the overloading is not so strong as to paralyze the circuit, any one station will come in strongly at many settings of the dial, especially the strong local stations.

(11)—Right. High sensitivity in a voltmeter simply means that it requires a very small current to operate it. The sensitivity may be expressed in terms of ohms per volt but that does not alter the fact. A sensitive meter always has a high resistance per volt.

## Fine Selectivity in the HiQ-31

*(Continued from preceding page)*

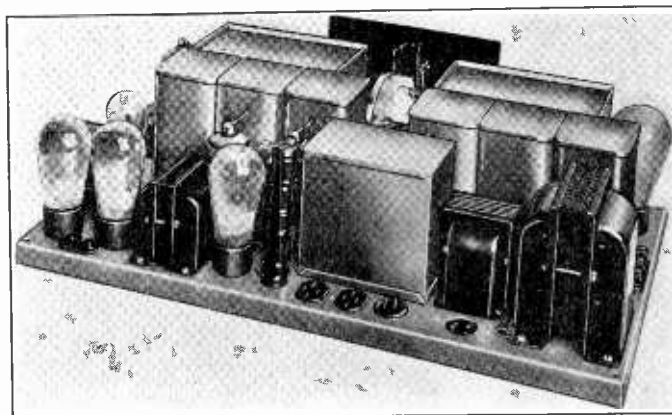
cycles from the resonant frequency of the circuit is attenuated only by a factor of 10 if a single circuit is used. On the other hand, the three tuned circuits used in the HiQ-31 pre-selecting method, produce under the same conditions an attenuation of the order of 500. This degree of attenuation is sufficient to reduce any interfering voltages to a point where they cannot cause rectification to occur in the first tube. In this manner all possibility of cross talk is eliminated.

### Flat Top Curve

Another salient point is that the tuning curve has a flat top over a band ten kilocycles wide. The flat top and steep sides of this curve are a characteristic of coupled circuits. If we calculate or measure the characteristics of a simple tuned circuit, we obtain a resonance curve. If we couple two tuned circuits together very loosely, we obtain the same type of curve although the selectivity will be greater. By suitably altering the coupling between the two tuned circuits we can obtain a number of different characteristics. The question of which is most desirable now makes its appearance.

Suppose we go back a bit. It will be recalled that the wave radiated by a broadcasting station consists of a carrier and two side bands which extend in frequency to either side of the carrier by an amount equal to the highest audio frequency modulation. At the present time the modulation of radio broadcasting stations is limited by law to a maximum of 5,000 cycles. Accordingly the transmitter wave consists of a band of frequencies ten kilocycles or 10,000 cycles wide. If the carrier frequency is 1,000 kilocycles, then the two sidebands cause the transmitter wave to extend over a band from 995 to 1,005 kilocycles.

If the receiver is to give high quality reproduction, these side-



REAR VIEW OF THE HIQ-31

band frequencies must not be suppressed in any part of the receiver. The characteristics of a perfect tuning system would therefore be one which was flat over a band of frequencies 10 kilocycles wide, so that all the sideband frequencies would be passed without loss, and which had perfectly straight sides, so that all other frequencies would be completely suppressed. That such characteristics can be closely approached is our own accepted fact.

[This concludes the first instalment. Next week, in the December 27th issue, the second and concluding instalment will be published.—Editor.]





# the Tuning of TRF Set

Bernard

## LIST OF PARTS For Fig. 2

- One 2-inch dial
- Mixer coils on one form for .00025 and .0001 mfd.
- One 50-millihenry radio frequency choke
- One .00025 mfd. tuning condenser
- One .0001 mfd. tuning condenser
- One .00035 mfd. fixed condenser
- One .0001 mfd. (100 mmfd.) equalizing condenser (E)
- Three 0.1 mfd. fixed condensers in one case (250-volt rating; black lead is common; unite the three reds to constitute 0.3 mfd.)
- Two 4-ohm filament resistors with mountings
- One .00025 mfd. fixed condenser with grid leak clips
- One 5 meg. grid leak to fit in grid condenser
- One A battery switch
- One 5-lead cable, 6 feet long
- Two knobs, one for AC switch, other for .00025 mfd. modulator tuning condenser
- One walnut finish wooden cabinet 6½x5x2¾ inches wide
- One panel to match

neglected, as it arises at only the extremely high frequency settings, fortunately. Then we have to choose between the high or low frequency oscillator settings, and of course will choose the high, mainly because it is the more sensitive, and also because the low would restrict the tuning range.

### Oscillator Range

Therefore, having decided on the high oscillator frequency, we know that the oscillator always must be tuned to a frequency that exceeds the incoming carrier frequency by 1,580 kc, for the given example. The lowest broadcast frequency is being 550 kc, the oscillator setting for this is 550 plus 1,580, or 2,130 kc. The other extreme of the broadcast band, 1,500 kc, requires an oscillator frequency of 3,080. Therefore the oscillator should tune from 2,130 to 3,080 kc, which is, again, a range of 1,050 kc.

With any given tuning condenser, the smaller the inductance of the coil the larger the frequency range that may be tuned in, so with a normal condenser for broadcast work, .0005 mfd., the broadcast stations would be crowded on the dial, and this congestion would be even greater as short waves were brought in with the same inductance-capacity arrangement. Not only would it be easier to skip the short-wave station than to get it, but this inverse difficulty even would exist as to broadcasting stations, other than strong locals.

The solution lies in the choice of a small tuning capacity, since the coil must be small anyway, while proportioning the two. Even so, a higher minimum capacity is desired than for normal broadcast reception. The trimmer will supply as much of this as is needed, as its total capacity is equal to the capacity of the oscillator tuning condenser.

### Band-Spanning Characteristic

The use of a high minimum capacity for high frequency work is desirable, indeed perhaps necessary, and it is common practice with radio amateurs to use such capacity arrangements, so that a given frequency, whether of carrier or oscillator, will be audible over a greater width of the dial scale. This helps in finding stations. Particularly is this of advantage when a smaller band of frequencies than now considered is the total desired to be tuned in, and for this reason the high-minimum-capacity types are called band-spanning condensers.

The required frequency range of the oscillator, 2,130 kc to 3,080 kc in the cited instance, requires that the tuning circuit cover only 1,050 kc.; whereas the coil-.0001 mfd. combination as given afforded oscillator frequencies of 1,900 to 3,500 kc, so that the broadcast band levied no difficult tax on the oscillator, which exceeded demands by 3-to-1, on a frequency basis. This 3-to-1 ratio of itself need not be taken as indicative of dial crowding, since the frequencies change fast at the low capacity settings and it is easy to "get a ratio" when really there isn't much excess.

### Few Turns, Big Change

The situation as it exists in the oscillator circuit is fully depicted so that it will be realized there is ample leeway, and that no hesitancy need be felt if the intermediate frequency you must use is one lower than the cited instance of 1,580 kc. Also, from the foregoing discussion of the oscillator, it is obvious that the number of oscillator secondary turns is critical, since the frequencies are high. For instance, two more turns on the oscillator secondary than actually necessary will change the dial setting for 660 kc

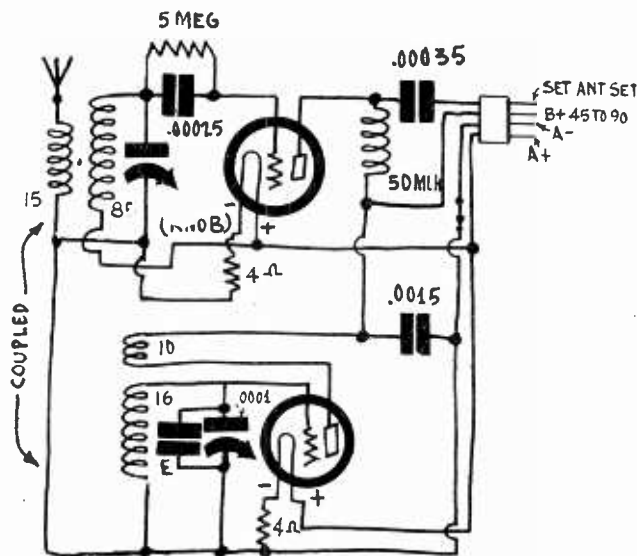


FIG. 2  
THE BATTERY-OPERATED COUNTERPART USES TWO 201-A TUBES. A 6-VOLT STORAGE BATTERY IS ASSUMED, AS IS B- CONNECTION TO "A" BATTERY

(WEAF) from the 80th division to the 56th division of the dial scale. Would you suspect that merely two turns would have such an effect?

Hence, if the station settings are too low on the oscillator, as judged by standards familiar to you, then remove turns from the oscillator secondary. There need be no concern over the other end of the oscillator tuning spectrum. The oscillator frequency necessary to bring in the highest frequency broadcast station certainly will be reached, provided less than full setting of the equalizer is used.

The Superheterodyne converter works real well, and it increases the selectivity over what you normally would enjoy. The sensitivity under the new arrangement may be equal to or less than the sensitivity of the receiver worked alone, but even so, more distance is usually attainable, due to higher selectivity killing off interference that would prevent or spoil distance reception.

With proper sensitivity in the receiver, it may be necessary to use an aerial, or to alter the aerial connection on the set.

The installation data are:

(1)—Connect the output of the converter to the antenna post of the tuned radio frequency receiver or Neutrodyne, and leave the aerial where it was, at the antenna post of the set.

(2)—Connect the ground lead of the converter to the ground post of the set, and leave the ground at the post on the set where you found it.

(3)—Connect the B plus lead of the converter to a positive B voltage of from 45 to 180 volts, which ever is handiest, which voltage may be obtained from the receiver.

[Continued next week, with additional coil data and constructional details.]

## Advantages Listed In Converter Operation

Advantages obtainable from use of a Superheterodyne converter of the simple designs depicted in Figs. 1 and 2 are the following:

- (1) Convenience in tuning.
- (2) Remote control of tuning, volume and switching.
- (3) Improvement in selectivity.
- (4) Assurance of full coverage of the broadcast band of wavelengths.
- (5) Improved conditions for the reception of distant stations.
- (6) Equalized sensitivity over the full broadcast spectrum, due to the same amount of intermediate frequency amplification, applicable to the fixed intermediate carrier generated in the converter.
- (7) Opportunity to have only a small tuning arrangement in sight, while the broadcast receiver is hidden in a closet, or table recess, or placed in the cellar.
- (8) Extremely low cost, as the device can be built for AC operation, of parts costing less than \$12, affording 6-foot radius, and for battery operation at less than \$10.





# The Latest Philco Receivers

## Philco Models 20 and 20A

PHILCO Models 20 and 20A are for AC supply and the two differ only in that the 20A has been designed for line frequencies as low as 25 cycles. These circuits are shown diagrammatically.

The circuit incorporates three screen grid tubes of the 224 type, one 227 AF amplifier and two 171A tubes in the push-pull output stage. The rectifier tube is of the 280 type.

The volume control in these circuits consists of two potentiometers on the same control, one of which varies the radio frequency input to the first stage and the other the grid bias on the RF amplifiers.

The detector tube is one of the 224 screen grid tubes and it works into a resistance-capacity coupler. A filter consisting of a resistance (18) in series with the coupling resistor (17) and a condenser (14) is used to prevent audio frequency oscillation.

The filter in the B supply contains two chokes, one of which is the field winding of the dynamic speaker. The other choke is tuned with a condenser to the principal hum frequency so that the hum is trapped out. The plate current for the power stage flows through the first choke only.

## Philco Models 77 and 77A

Models 77 and 77A of this line are practically the same as Models 20 and 20A, respectively, except that the power stage contains two 245 tubes. The diagrams of both of these circuits is given in Fig. 2. Of course, the grid bias resistance for the two power tubes has a value appropriate to the tubes used, that for the 245 being 800 ohms and that for the 171A being 1,400 ohms. A tone control is built into the 77 and 77A models and it consists of a butterfly switch for cutting in different capacities across the 227 amplifier.

## Philco Models 96 and 96A

These two receivers are essentially the same but the 96 is designed for use on an AC line having a frequency from 50 to 60 cycles while the 96A is for any line having a frequency from 25 to 60 cycles, the voltage in each case falling within the 100-130 volt range. The two differ mainly in that the 96A has larger by-pass condensers in certain positions in the filter. Both receivers are diagrammed in Fig. 3.

There are several noteworthy features in this circuit. Note especially the type of detector that is used. The plate and the grid of the 227 tube are joined together so that the detector is really a diode, or Fleming oscillation valve. A small polarizing voltage is impressed on the rectifying circuit, and this voltage is the drop in that portion of the voltage divider which lies between F and E. The first audio amplifier is coupled directly to the detector without any stopping condenser and the necessary bias for the amplifier is obtained through the drop in the coupling resistor, or more accurately, it is the steady potential across the condenser marked (26). The coupling resistance is the sum of (20) and (21).

The coupling between the first and second audio tubes is standard resistance-capacity, but there is also a resistance-capacity filter in series with the plate resistor and another in series with the grid return. The grid leak at this point is a high resistance potentiometer which is used as volume control.

In the plate circuit of the second audio tube is a tone control consisting of a butterfly switch which may be used for connecting different capacities across the line and thus shunt out different proportions of the high frequencies.

### The Output Stage

The output stage is a standard 245 tube push-pull amplifier, which is coupled to the dynamic speaker with a regular push-pull output transformer. The field winding of the speaker constitutes the second choke in the filter, but the current for the power tubes does not flow through it.

The grid bias for the various amplifier tubes ahead of the detector is obtained from drops in resistance associated with that tube and the grid returns are so connected that the volume is automatically held at a nearly constant value once the manual control has been set at the desired value.

## Philco Models 296 and 296A

These two models differ only in that the 296A is for line frequencies between 25 and 60 cycles while the 296 is for frequencies of 50 to 60 cycles. These are also the same as the 96 and 96A, respectively, except that provision has been made for a phonograph pick-up. The complete circuit diagram is given in Fig. 4.

The pick-up is connected so that when the radio signal is to be amplified the phonograph pick-up is shortened and when the

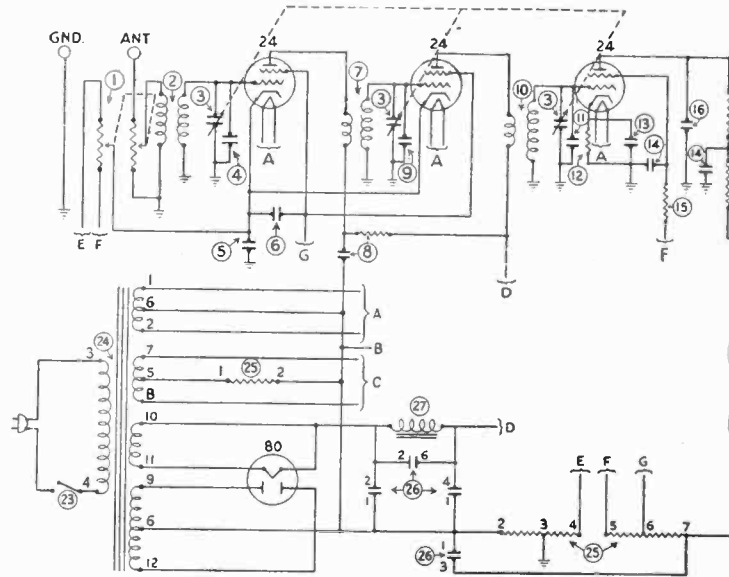


FIG. 1 COMPLETE DIAGRAM OF MODELS THE PHILCO LINE OF RECEIVERS. A 224 TUBE AS A DETECTOR AND TWO OUTPUT TUBES. A DUAL, MANUAL CONTROL IS USED, ONE CONTROLLING THE FIRST RADIO FREQUENCY THROUGH OTHER THE GRID BIAS ON THE FIRST

phonograph signals are to be amplified the unit is cut into the grid circuit of the 227 amplifier tube, the connection being made between the grid and ground. Thus the bias on the tube remains the same for both radio and phonograph amplification.

There are three terminals at the input of Models 96 and 296, one for local stations, another for distant stations, and a third for the ground connection. The ground and the distant antenna are standard but the connection for the reception of local stations is unique. The lead is connected through a condenser to one side of the 110 volt line. To the lead either the antenna or the ground may be connected.

One feature in Models 296 and 296A not present in Models 96 and 96A is the ground of the heater winding center, as shown at A in Fig. 4. Two equal condensers are connected in series and then connected across the 2.5 volt winding serving all the heater

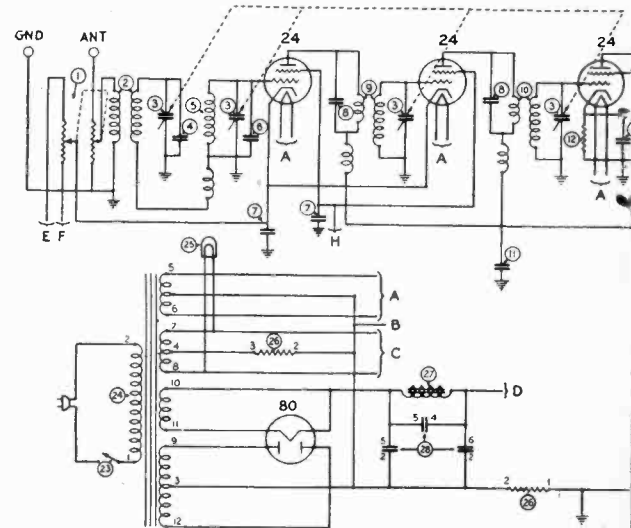
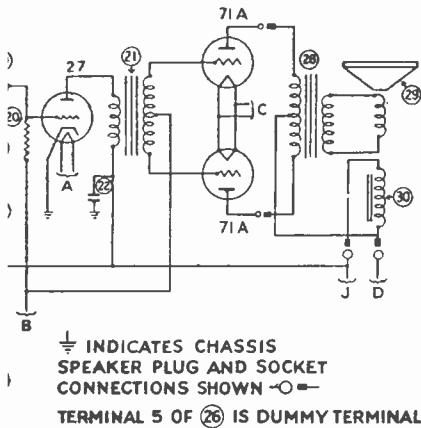


FIG. 2 THIS IS THE CIRCUIT DIAGRAM OF MODELS 77 AND 77A, WHICH ARE THE SAME AS MODELS 20 AND 20A, EXCEPT THAT THE POWER STAGE CONTAINS TWO 245 TUBES. A TONE CONTROL IS BUILT INTO THE 77 AND 77A MODELS AND IT CONSISTS OF A BUTTERFLY SWITCH FOR CUTTING IN DIFFERENT CAPACITIES ACROSS THE 227 AMPLIFIER.

# Models 20, 77, 96, and 296

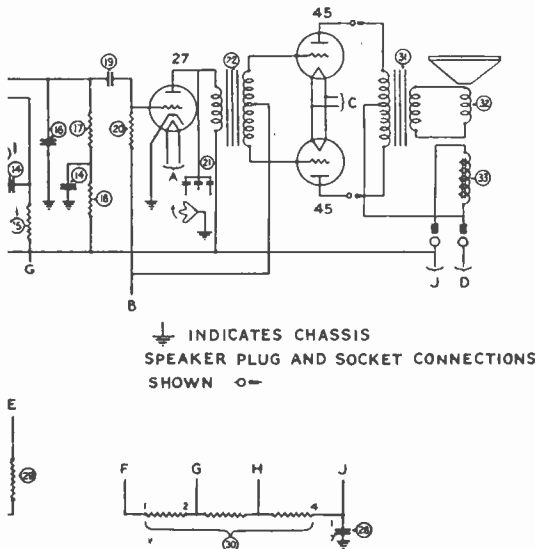


AND 20A OF HIS EMPLOY S VO 171A FOUR VOLUME CON HE INPUT TO 3E AND THE TWO TUBES.

s. The object of these condensers is to prevent hum by estab- g a ground at the neutral point in the heater circuits. This ure is especially valuable at the higher broadcast frequencies. center point on this winding, it will be noted, is connected to same point as the grid returns of the power tubes and the most tive point in the circuit. Thi sis usually grounded but in this nce a higher potential point is ground in. order to get the er voltages on the detector and the automatically controlled s.

will be noted that many of the by-pass condensers are coned to ground instead of to the lowest potential point. This is to eliminate as far as possible interaction among the stages he amplifier, such as would cause oscillation at radio frequency motorboating at audio frequency.

1 all of these models the filter circuit is the same. First there



RAM OF THE PHILCO RE ESSENTIALLY THE A EXCEPT THAT THE RE 245S. IT CONTAINS ON TO THE VOLUME

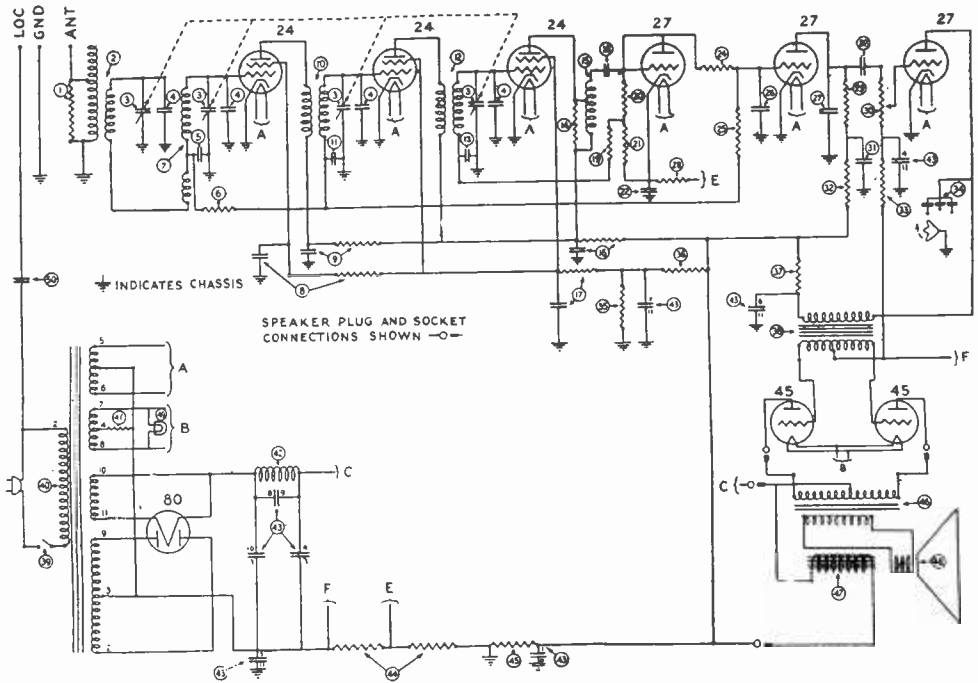


FIG. 3 PHILCO MODELS 96 AND 96A WHICH IS DIA- GRAMMED HERE IS SIMILAR TO MODELS 77 AND 77A IN MOST RESPECTS BUT IT EMPLOY S A TWO-ELE- MENT DETECTOR, THE 227 TUBE BEING USED FOR THE PURPOSE. THIS DETECTOR IS ARRANGED SO THAT IT SERVES AS AN AUTOMATIC VOLUME CONTROL.

is a shunt condenser, thee follows a tuned choke coil, and then an- other shunt condenser. This is followed by the field coil of the dynamic speaker. In no case does the plate current of the power stage flow through the second choke, that is, the field coil. A tuned filter such as is used in these circuits is very effective in suppressing hum provided that the circuit is tuned to the principal hum frequency, which is 120 cycles for a 60 cycle line and 50 cycles for a 25 cycle line.

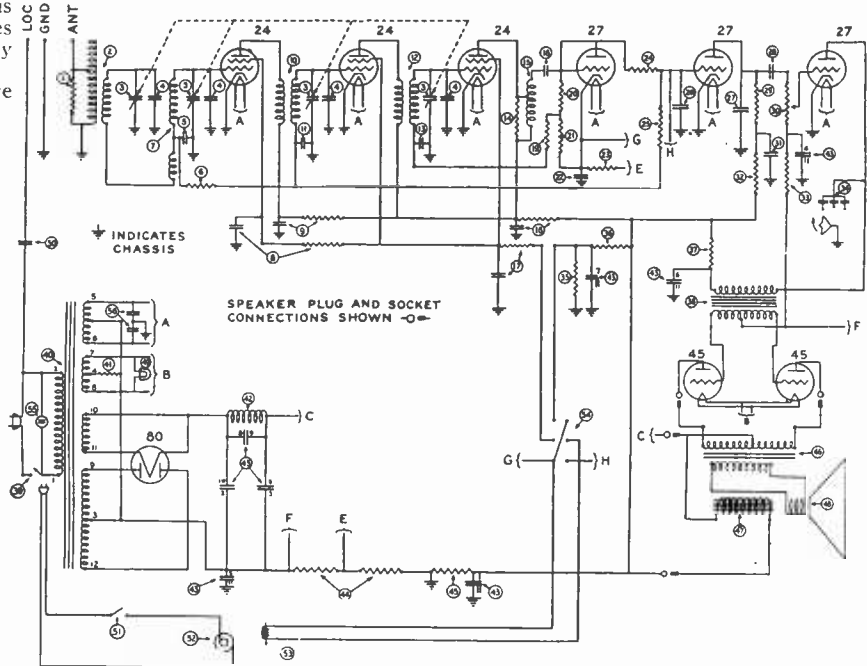


FIG. 4 THE DIAGRAM OF PHILCO MODELS 296 AND 296A. THESE CIRCUITS DIFFER FROM MODELS 96 AND 96A IN THAT THEY ARE ARRANGED FOR USE WITH A PHONOGRAPH PICK-UP UNIT, WHICH IS CUT INTO THE GRID CIRCUIT OF THE FIRST AUDIO AMPLIFIER TUBE.

**T**RANSMITTING tubes are available in many different power ratings, ranging from 7.5 watts for the 210, which is also a receiving tube, to large 5,000-watt tubes and even larger. The 210 tube, which has already been described, is usually rated at 7.5 watts when used as an oscillator in a small transmitting set.

The small 210 tube has been used extensively by amateurs in low power transmitters, not only to radiate the rated wattage of 7.5 watts but considerably greater wattage. This they did by increasing the voltage to higher values than the rated value of 350 volts. In Fig. 1 is a transmitting circuit in which two of these relatively small tubes may be used, although the somewhat sturdier tubes of similar ratings to be described below would be preferable. In this circuit the 210 tubes are used as modulator and crystal controlled oscillator. The characteristics of this tube were given in connection with receiving tubes.

The De Forest Audion 510 is a 15-watt transmitting tube which has been designed with special emphasis on its stability

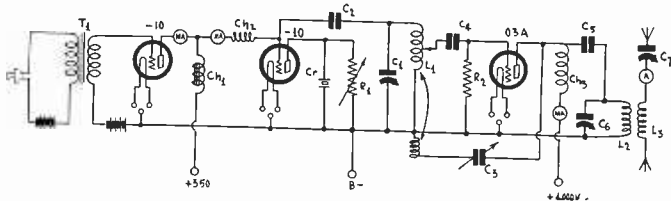


FIG. 1

A THREE-TUBE PHONE TRANSMITTING CIRCUIT CONTAINING TWO TYPE -10 TUBES FOR MODULATOR AND OSCILLATOR AND ONE TYPE -03A FOR RADIO FREQUENCY POWER AMPLIFIER. THE OSCILLATOR IS CRYSTAL CONTROLLED. THE HEISING SYSTEM OF MODULATION IS USED.

with changing temperature, that is, stability of frequency of oscillation. Because of this fact it is especially suitable for use as a self-exciter oscillator when the tube is to be in continuous service and the frequency is to remain constant. It may be used in circuits of frequencies up to 30 megacycles. While it is particularly suitable for use in self-exciter oscillators, it is also useful when the frequency of the circuit is maintained constant by means of a quartz crystal.

**CHARACTERISTICS OF THE 510**

Normal rating watts.....	15
Filament voltage.....	7.5
Filament amperage.....	1.25
Amplification factor.....	8.0
Max. plate current, amperes.....	.06
Max. DC plate voltage, modulated.....	425
Max. DC plate voltage, unmodulated.....	500
Average plate resistance, ohms.....	5,450
Average mutual conductance, micromhos.....	1,550
Type of base, UX.	
Type of filament, oxide coated.	
Use, oscillator or amplifier.	

**THE 503A**

The De Forest Audion 503A is a 50-watt tube which may be used as an oscillator or a radio frequency amplifier in small transmitting sets. It may also be used as a modulator or audio frequency amplifier, provided that the plate wattage dissipation does not exceed 75 watts. It requires a grid bias of 25 volts when used as amplifier, provided that the plate voltage does not exceed 1,200 volts.

**CHARACTERISTICS OF 503A**

Normal rating, watts.....	50
Filament voltage.....	10
Filament amperage.....	3.25
Voltage amplification factor.....	25
Max. plate current, amperes.....	0.175
Max. DC plate voltage, modulated.....	1,000
Max. DC plate voltage, unmodulated.....	1,250
Max. plate power dissipation, watts.....	100
Plate resistance, ohms.....	5,000
Mutual conductance, micromhos.....	5,000
Base, Standard 50-watt base.	
Type filament, special thoriated tungsten.	
Use, oscillator.	

**The De Forest Audion 511**

The 511 Audion is similar to the 503A in most respects but it has a lower amplification factor and may be used as oscillator, modulator and amplifier.

# Transmitti

By J. E.

**CHARACTERISTICS OF 511**

Normal rating, watts.....	50
Filament voltage.....	10
Filament amperage.....	3.25
Amplification factor.....	12
Max. plate amperage.....	0.175
Max. DC plate voltage, modulated.....	1,000
Max. DC plate voltage, unmodulated.....	1,200
Max. plate dissipation, watts.....	100
Plate resistance, ohms.....	3,400
Mutual conductance, micromhos.....	3,530
Base, standard 50-watt.	
Type filament, special thoriated tungsten.	

When used as AF power amplifier or modulator—

Max. plate voltage.....	1,250
Normal plate voltage.....	1,000
Grid bias, volts.....	55
Plate current, milliamperes.....	72
Normal output, watts.....	10

When this tube is used as an oscillator, a negative bias is required to prevent damage to the tube, due to the relatively low output impedance. Normal grid bias, as an oscillator, is obtained by using a grid leak of about 5,000 ohms.

**The De Forest Audion 545**

The 545 Audion is another 50-watt tube which is essentially an audio frequency amplifier for use in the output stage of a high power public address system and also for use as modulator in a medium power transmitter.

**CHARACTERISTICS OF THE 545**

Normal rating, watts.....	50
Filament voltage.....	10
Filament amperage.....	3.25
Amplification factor.....	5
Max. plate voltage.....	1,250
Max. plate dissipation, watts.....	75
Normal plate voltage.....	1,000
Grid bias, volts.....	150
Plate current, milliamperes.....	75
Normal output, watts.....	20
Plate resistance, ohms.....	2,100
Mutual conductance, micromhos.....	2,380
Base, standard 50-watt.	
Type filament, special thoriated tungsten.	
Use, AF amplifier and modulator.	

**De Forest Audion 552**

The De Forest 552 is a 75-watt tube designed especially for use as an oscillator or radio frequency amplifier up to frequencies as high as 30 megacycles. It has a standard UX base, but the plate lead is brought out on the side of the glass envelope and the grid at the top by means of flexible leads. This arrangement of the high potential terminals is used to minimize the capacity between the grid and the plate, as well as between either of these and the filament. It also increases the insulation of the high potential terminals.

**CHARACTERISTICS OF THE 552**

Normal rating, watts.....	75
Filament voltage.....	10
Filament amperage.....	3.25
Amplification factor.....	12
Max. plate current, amperes.....	0.1
Max. DC plate voltage, modulated.....	2,000
Max. DC plate voltage, unmodulated.....	3,000
Max. plate dissipation, watts.....	100
Plate resistance, ohms.....	6,000
Mutual conductance, micromhos.....	2,000
Base, UX and two flexible leads.	
Type filament, special thoriated tungsten.	
Use, oscillator in short-wave transmitters.	

**De Forest Audion 504A**

The De Forest 504A Audion is a 250-watt transmitting tube designed especially for oscillator or radio frequency power amplifier in transmitting sets of medium power, but it is also

# ng Circuits

Anderson

useful as a modulator. Due to its sturdy construction and the manner in which the leads are brought out, it can be used on frequencies up to about 15 megacycles. At the higher frequencies it is necessary to take extreme precautions against excessive grid current.

### CHARACTERISTICS OF THE 504A

Normal rating, watts.....	250
Filament voltage.....	11
Filament amperage.....	3.85
Amplification factor.....	25
Max. plate current, amperes.....	0.20
Max. DC plate voltage, modulated.....	2,000
Max. DC plate voltage, unmodulated.....	2,500
Max. plate dissipation, watts.....	250
Plate resistance, ohms.....	5,000
Mutual conductance, micromhos.....	5,000
Base, standard 250-watt base.	
Type filament, special thoriated tungsten.	
Use, Oscillator and RF power amplifier.	

The De Forest 504 Audion is like the 504A in all respects, except that its filament is of pure tungsten and that consequently the required filament current is 14.75 amperes.

### De Forest Audion 520B

The De Forest Audion is a 5,000-watt transmitting tube that may be used as oscillator, modulator, or radio frequency power amplifier in high power broadcast and short-wave transmitters. It can also be used in heavy-duty tube bombarders and in radio frequency furnaces and in similar applications.

The tube is water cooled by means of a water jacket construction which allows a large quantity of water to circulate slowly at low pressure. This permits the use of tap water as the cooling agent. The large quantity of water takes care of sudden overloads which would normally damage the anode.

### CHARACTERISTICS OF THE 520B

Normal rating, watts.....	5,000
Filament voltage.....	11
Filament amperage.....	30
Amplification factor.....	15
Max. plate current, amperes.....	0.8
Max. DC plate voltage, modulated.....	10,000
Max. DC plate voltage, unmodulated.....	10,000
Max. plate dissipation, watts.....	5,000
Plate resistance, ohms.....	2,600
Mutual conductance, micromhos.....	5,770
Base, flexible leads.	
Type filament, tungsten.	
Use, oscillator or RF amplifier.	

### De Forest Audion 500

Audion 500 has been designed especially for use in tube bombarders and radio frequency furnaces, and may be used either as oscillator or as modulator. It is so constructed that the inter-electrode capacities are very small and it may be used as an oscillator on frequencies as high as 15 megacycles. It is air cooled and when used as oscillator will dissipate 300 watts. It is not provided with a base, the elements being connected with flexible leads.

### CHARACTERISTICS OF THE AUDION 500

Normal rating, watts.....	500
Filament voltage.....	15
Filament amperage.....	8.5
Amplification factor.....	15
Max. plate current, amperes.....	0.35
Max. DC plate voltage, modulated.....	2,000
Max. DC plate voltage, unmodulated.....	2,000
Max. plate dissipation, watts.....	300
Plate resistance, ohms.....	3,800
Mutual conductance, micromhos.....	3,950
Base, none, flexible leads.	
Type filament, tungsten.	
Use, oscillator, modulator.	

### Crystal Controlled Phone Transmitter

In Fig. 1 is a three-tube transmitting circuit employing a —10 type modulator tube, a similar oscillator tube, crystal con-

trolled, and an —03A type radio frequency power amplifier. There is a milliammeter in the plate circuit of each tube to measure the plate current and an AC ammeter in the antenna to measure the radio frequency output. The modulator is of the Heising type and the oscillator the tuned plate type.

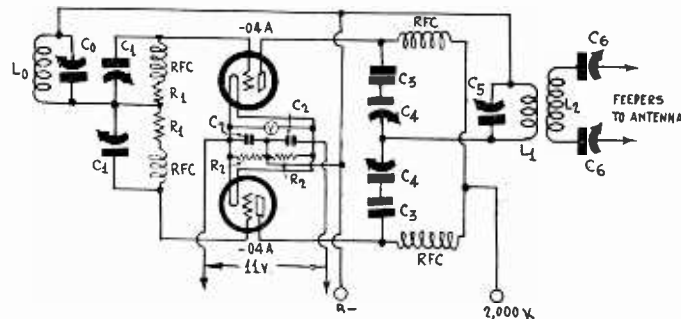


FIG. 2  
A TWO-TUBE TRANSMITTING CIRCUIT IN WHICH THE TWO TYPE —04A TUBES ARE CONNECTED IN PARALLEL. THE OSCILLATOR IS OF THE TUNED GRID, TUNED PLATE TYPE.

### List of Parts

- T1—One microphone-to-tube transformer.
- Ch1—One 30-henry choke coil.
- Ch2, Ch3—Two radio frequency choke coils consisting of 150 turns of No. D.C.C. on a one-inch form.
- Cr—One quartz crystal.
- C1, C6, C7—Three 250 mmfd. tuning condensers.
- C3—One 250 mmfd. tuning condenser, double spaced.
- C2, C4, C5—Three 250 mmfd. fixed condensers.
- L1—Twenty-five turns of No. 18 DCC wire on a 3.5-inch form.
- L2, L3—Twelve turns of 1/4-inch ribbon 4 inches in diameter.
- R1—A variable grid leak.
- R2—One 2,500 ohm resistance.

### A Power Transmitter

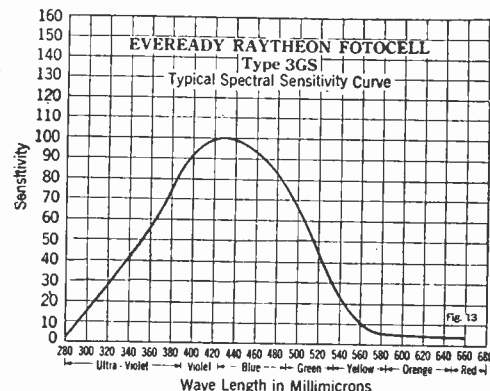
In Fig. 2 is a transmitting circuit employing two —04A type tubes connected in parallel. The oscillator is of the tuned grid, tuned plate type. The values of the different inductances, condensers and resistances are as follows:

### List of Parts

- Co. C5—Two 280 mmfd. tuning condensers.
- C1, C4—Four 100 mmfd. variable condensers.
- C2—Two 0.08 mfd. fixed condensers.
- C3—Two 0.002 mfd. fixed condensers.
- C6—Two 250 mmfd. variable condensers.
- Lo—Eleven turns of 5/16-inch copper tubing 3.75 inch diameter (inside) for 3,500kc., and 5 turns for 7,000kc.
- L1—Twelve turns of 5/16-inch copper tubing, 3.75 inch diameter (inside) for 3,500kc., and 7 turns for 7,000kc.
- L2—Ten turns of 5/16-inch copper tubing, 3.75 inch inside diameter.
- R1—Two 5,000-ohm resistors.
- R2—Two 20-ohm resistors.
- RFC—Four radio frequency chokes.

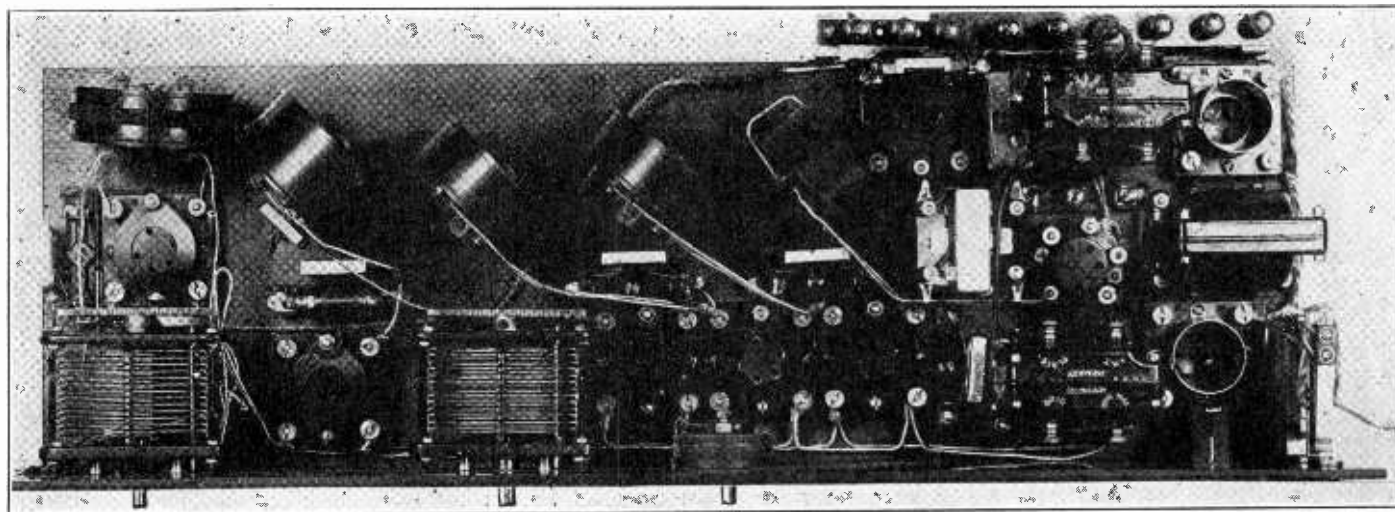
Condensers C1 in this circuit are grid condensers and resistances R1 are grid leaks. The two radio frequency chokes in series with the grid leaks might be called grid chokes and their object is to provide a higher impedance than would be afforded by a resistance alone. In a transmitting circuit high value grid leaks cannot be used successfully, due to the high grid current that flows. Condensers C3 and C4 are connected in series for safety since the voltage across the two is 2,000 volts.

THE SPECTRAL SENSITIVITY OF A TYPICAL GASEOUS PHOTO-ELECTRIC CELL, SHOWING MAXIMUM SENSITIVITY IN THE BLUE-VIOLET REGION. THE PHOTO CELL WAS DISCUSSED LAST WEEK, ISSUE OF DECEMBER 13TH.



# Conversion of Batt

By John C.



THE A. C. SUPERHETERODYNE LAYOUT

[Last week the first instalment was published of this article on converting a battery-operated Victoreen Superheterodyne to AC operation. An external power pack is used, with a tuned choke to trap out the hum. The pack is the featured discussion this week. Next week the final instalment will be printed.—Editor.]

**I**N constructing the external power pack with which the set is to be operated, a departure from the usual assembly detail is the use of three voltage divider resistors. Two of them total 17,000 ohms (a multi-tap voltage divider) and the additional one is about 7,000 ohms, making a grand total of 24,000 ohms, and providing five extra voltage taps in addition to the twenty of the first group. These resistors are seen to be mounted vertically.

The location of the transformer with respect to the double choke is such that the leakage field of the transformer is practically nil at the place where the double choke is located. This placement acts to reduce the residual hum.

With some ordinary tuned radio frequency circuits that are not overly sensitive this precaution is not as assential as in the case where the set is a sensitive Superheterodyne.

Another feature is the incorporation of a tuned series choke placed in the negative lead, adjacent to the plug-in connection for the field of the dynamic speaker, across which field is placed a small bleeder resistor. The choke inductance value is not as great as that of the double choke which is customary in power pack circuits and is around ten henries.

The parts list herewith will enable the fan to duplicate this described pack, and it is suggested that the arrangement of the parts be adhered to, as it has been tested out thoroughly from all aspects and will not be found lacking in the degree of precision necessary to insure success.

#### Placement of the Parts

Looking down on the top of the assembly with the cable exits facing you, the power transformer is found at the extreme left-hand upper corner, and immediately in front of it is the dry condenser block, and at the lower left-hand side is found the Polo double henry choke, 30 henries in each section.

At the upper right-hand corner are the voltage divider resistors all connected in series and directly to the front of these is the 280 tube socket with the high tension terminals facing the resistors.

The tuned choke that is connected in the negative side of the circuit is located at the lower center directly behind the cable exit.

Spanning over two-thirds of the length of the assembly are two bakelite assembly strips. Finally there are four two mfd condensers of the high voltage type mounted to the Polo double choke. The connections are shown in the circuit diagram.

The load voltage of the high voltage system of this assembly is 360 volts, and as the resistance of the divider is 24,000 ohms the divider current is 15 milliamperes. It is customary in some assemblies to use a somewhat heavier bleeder current when the demands of the particular system require it, but 15 milliamperes are plenty in this instance. The steady load of the seven 227s as used in this set plus the plate load of the two 245s will provide more current than the dynamic field will require, hence the field is bypassed with a shunt resistor to handle the difference.

A short shaft that projects directly in front of the switch operates a compression type carbon disc resistor for the minute regulation of the detector plate voltage where such regulation is required.

The Polo PT-245 transformer is one that will operate up to ten 227s, and two 245s at their rated heated and filament voltages, the primary input being 96 watts, at 120 volts.

#### 10/32 Screws for Transformer Mounting

The case of the power pack mounts an extra switch placed in series on the 110-volt line so as to preclude the accidental turning on of the AC switch on the set if you are making voltage adjustments of the pack circuit. This switch is open when the case or the top is removed from the assembly, thus assuring safety.

All the parts that are provided with mounting lugs are to be attached to the bottom of the case, the transformer with 10/32 machine screws and nuts and the balance with 6/32 machine screws and nuts.

The connecting cable between the power pack and the set is the type popular some years ago, and has twelve leads. Both the set and the power pack are provided with similar terminal boards that carry terminals lettered consecutively from A to L. These letters correspond to colored cable wires, and include two that are of the metal mesh shielded type. These two carry the 110 volts AC to the switch in the set, the shielded mesh being grounded to prevent the cable acting as an antenna, and also to prevent the picking up of line noises.

The preliminary test of the converted Superheterodyne showed this to be an absolute necessity, and the wiring diagram of the power pack will reveal the connecting of a condenser to one side of the 110-volt line. This condenser also helps to bypass line noises.

#### Cable Details

The case of the power pack, and that of the associated apparatus, are likewise grounded for the same purpose. The cable is four feet in length from end to end, which is ample for most needs, and the voltage drop in the 16-ampere lead wires that feed the heaters of the seven 227s if less than 1/10th of a volt, but you must remember to have low resistance joints on this line especially, and the 245 power tube filament supply as well.

These leads are respectively of No. 12 and No. 16 cotton covered wire.

The leads of the 16 ampere winding on the transformer should be led to the terminal posts on the board of the pack. These are 14/20 brass screws, with two nuts and two washers each, and the terminals, of the high density current cable, are made of four pieces of 1/2 inch by 1/16th inch brass strip an inch long, to which the wire is securely soldered, and a 1/4 inch screw "body hole" is drilled near the end of the strips that fit the above posts in the power pack. The other terminals are slotted to fit over the regular binding posts on the terminal board of the set.

The leads that are for the 245 filaments, i.e., 2 1/2 volts at 3 amperes, are supposed to be of the same current carrying capacity. Accordingly these are to be of No. 16 DCC wire and are to be securely soldered to (two of) the binding posts of the terminal board above the lead outlet of the transformer.

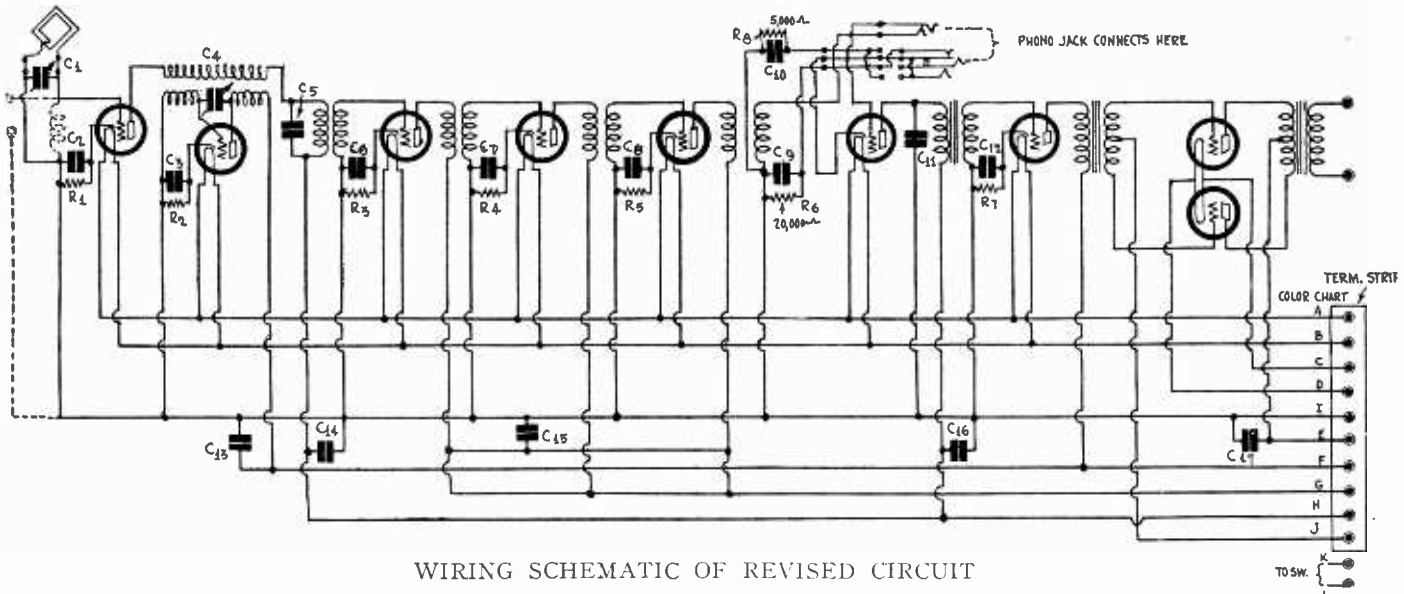
The cable wires that convey this current to the set are to be of the same size wire, and in addition to the regular cotton covering are to be insulated with a single layer wrapping of friction tape.

The No. 12 DCC wire leads are to be similarly treated, and



# ery Victoreen to AC

Williams



WIRING SCHEMATIC OF REVISED CIRCUIT

these two pairs of leads are to be separately twisted, in the same direction.

**Color Designations**

The alphabetical designations for the wires of the cable are as follows:

		Color
A.....	} No. 12 DCC 2½ volts, 16 amperes.	.....
B.....		.....
C.....		.....
D.....		.....
E.....	} No. 16 DCC 2½ volts, 3 amperes	.....
F.....		.....
G.....	} 250 volts PWR B+.....	Red, Black tracer
H.....		Black
I.....	} 110 volts first audio B+ .....	Blue
J.....		Blue, Yellow tracer
K.....	} 90 volts RF and oscillator B+ .....	Green
L.....		Blue, Yellow tracer
M.....	} Common return .....	White
N.....		White
O.....	} C—PWR .....	.....
P.....		.....
Q.....	} Twisted shielded mesh for 110	.....
R.....		.....
S.....	} Volts (4 feet doubled.....	.....
T.....		.....

To handle the above there are twelve binding posts on the binding post assembly on the set.

It is not necessary to observe the particular order outlined above, the prime requisite being to obtain correct connections, properly identified, and good insulation in the completed set assembly.

The conversion of the battery-operated set to the AC form does not involve changes that in any way impair its operational characteristics, except for the improvement due to the addition of the push pull 245 power amplifier.

The alterations, as previously forecast, are the general shifting of the parts toward the left-hand end of the subpanel as a comparison of this week's picture with that of last week's will show.

The coils of the intermediate amplifier are not affected by the shift of the parts, that is, they are not made to cover less space than before, but the oscillator coil is close to the left-hand margin of the subpanel, necessitating the exchange of the positions of the loop and the oscillator tubes and at the same time making the left-hand tuning condenser the oscillator tuner and the right hand one the loop tuner.

The second change is consequent upon the first, but it results in the wiring arrangement that ultimately works out to be good. The picture shows the arrangement of the parts, but it may be of some assistance to the reader if the placement is re-counted again with the present arrangement.

Beginning at the extreme left-hand end, the oscillator tuner condenser, tube socket and coil are seen to have a common center, and the grid bias resistor mount for this tube is at the immediate left, with the shunt condenser in position.

**Distance Recounted**

The next common center to the right is that of the input transformer of the intermediate frequency amplifier and the loop tube socket, with its grid bias resistor mount directly adjacent and the shunt condenser in position. Next, to the right, is the center of the second intermediate transformer and the loop tuning condenser.

The two tuning condensers are seven inches apart, with the tube socket in between them.

Two and three-quarter inches to the right from the second

condenser center, on the subpanel, is the first of three intermediate tube sockets mounted close together. The external size of the tube sockets is 2 3/16 inches square. The three grid bias resistor mountings with shunt condensers attached are seen adjacent to the sockets.

The four intermediate frequency coils are separated just 3½ inches each.

The disposition of the rest of the apparatus is made in accordance with the room available with due regard to the influence of the external fields of the audio transformers.

**The Audio End and the Power Amplifier**

The first audio transformer is at the center of the subpanel, with its primary terminal board facing the detector tube, and directly at the top to the left is seen the second audio stage tube socket, with its grid bias resistor and 1 mfd. shunt fixed condenser, and to the immediate right is the input transformer, and lastly, at the extreme right, is a 245 power tube socket.

At the center, directly to the right of the first audio transformer is the detector tube with its resistor mount directly adjacent, and to the extreme right center is the push-pull output transformer.

Below the detector tube is the other input transformer and to its right is the second 245 tube socket. Right below it, mounted on the front panel, is the AC switch, from which two wires are to be run to the terminal strip at the upper right-hand side of the subpanel.

Mounted on the rear side of the front panel at the lower right are seen three jacks, the one nearest the subpanel being the one for the phonograph pickup plug.

When the Superheterodyne was in the battery-operated form there was a second jack for cutting in on the output of the first audio stage, when reduced volume was desired. This jack will be used for the same purpose in the present hookup, but the connection will not be detailed on the sketch, to avoid confusion. The third jack was for the speaker output connection and it is to be connected to the two terminals of the output transformer, the actual connection not being detailed.

The grid bias for the 245s is obtained via cable lead J from the power pack, directly from the voltage divider. All the other bias voltages are obtained from the condenser-bypassed resistors in the set assembly.

**Completing the Cable**

The connection cable consists of twelve wires. It has been found that it is advisable to run the short 110-volt leads from the terminal board of the set to the AC switch with the shielded lead wire, as there was some line noise pickup from this short run, the shielded coating is to be grounded.

Another connection refinement to reduce line pickup is to connect a .01 mfd condenser in series between the B minus and ground. This has been done on the power pack, but the average fan might not be aware of it in this particular case, so it is mentioned for his convenience. The cable wires are to be grouped together and tied at intervals with good twine which is preferably waxed, and then the whole is to be carefully taped with friction tape so that when you are through there is an equivalent of two layers. This makes a permanent job and a good electrical one as well.

(Continued next week)



**A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Those not answered in these columns are answered by mail.**

# RADIO UNIVERSITY

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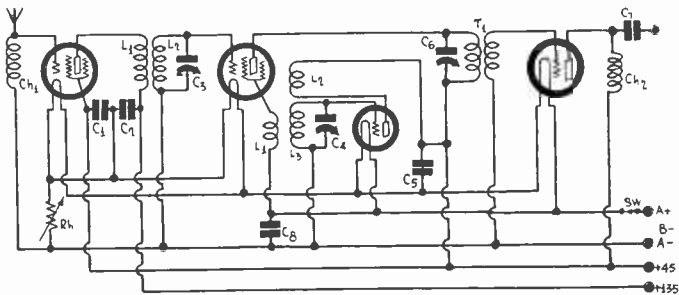


FIG. 871

A DIAGRAM OF A FOUR-TUBE SHORT-WAVE CONVERTER DESIGNED FOR USE WITH SMALL BATTERY TUBES.

### All-Wave Super

**W**OULD it be possible to build a receiver on the superheterodyne principle capable of covering all the waves from the broadcast to the shortest used with an intermediate frequency of 250 kilocycles? If not, please explain why it is not practical.—W. H. J.

It is quite possible and many such circuits have been built and they are now receiving stations from all over the world. Of course, not all of these have intermediate frequencies in the neighborhood of 250 kc but the IF is not all important. The only thing to watch out for is to see that the coupling between the oscillator and the radio frequency tuned circuit is not so close that the two interlock at the higher signal frequencies. If the coupling is made variable by means of an adjustable pick-up coil the scheme is quite feasible with an IF of 250 kc. Also, if the plug-in coil system is such that the pick-up coil is wound on the oscillator form the system is practical because a pick-up coil can be chosen for each coil so that there will be no interlocking at the higher frequency end of the tuner.

### Best Type of Band-pass Filter

**T**HERE are many types of band-pass filter and I am wondering which is the best to use in an intermediate frequency amplifier using 224 type screen grid tubes. Will you kindly describe one which you believe is the best.—B. F. L.

There is no best band-pass filter because the same effect can be obtained with many different ones. The simplest is probably the ordinary radio frequency transformer with tuned primary and tuned secondary. It is only necessary to adjust the mutual inductance between the two coils, tune the two circuits to the same frequency when each is unaffected by the other, and to see that the filter so formed works between equal impedances. Since it works between the plate circuit of one tube and the grid circuit of the next, there should be a grid leak across the second tuned circuit to match the plate resistance of the first tube. Since there is some grid conductance at AC it is well to make the grid leak, which is in shunt, a little higher than the plate resistance of the first tube. For example, if the plate resistance is 800,000 ohms the grid leak might be one megohm. An absolute match is not essential. It is not easy to get an exact match because the tube impedance should also match the input impedance to the filter and it is practically impossible to match them.

### Coupling Between Coils

**I**S there any mutual inductance between two solenoids placed side by side or must one be inside the other or end to end, in order that there should be mutual inductance between them.—C. D.

There is mutual inductance between the coils no matter how they are placed with respect to each other, except when the fields of the two coils are at right angles. The fields are at right angles when the axes of the coils are at right angles and when the center line of one cuts the center line of the other in the middle. There are also certain other positions when the fields are at right angles.

### 226 Versus 227 Tube

**K**INDLY state the advantage of using type 227 tubes in a set instead of type 226 tubes.—N. C.

The 227 tubes use a heater element and are practically free of hum. The 226 tubes, on the other hand, may cause a slight hum.

### Full-Wave Rectification

**I** UNDERSTOOD that it took two tubes for a full-wave rectifier, and I know some use two tubes. Is it possible to do it with one?—M. L.

Yes, the 280 tube is a full-wave rectifier, containing two rectifying plates. This tube will serve up to about 300 volts. For higher voltages, it is advisable to use two separate tubes of the 281 type, each having only one rectifying plate.

\* \* \*

### How Coil Range is Determined

**H**OW do you determine the inductance of an oscillator coil when the intermediate frequency is nearly equal or even greater than the frequencies to be covered?—B. C. F.

The first thing that is done is to decide on the intermediate frequency and then on the lower frequency limit to be reached by the tuner in which the coil is placed. Then these two are added to give the lower limit of the tuning range of the oscillator. For example, suppose that the intermediate frequency is 1,500 kc and the lowest frequency to be tuned in is 550 kc. The sum of these two is 2,050 kc. Now to get the required inductance we have to know the capacity of the tuning condenser to be used across the coil. Suppose this is 250 mmfd. Since there will be some distributed capacity in the circuit we have to make allowance for this, and in this assumed case it is reasonable to allow 25 mmfd. Hence our total capacity is 275 mmfd. From the frequency and the capacity we can apply the well known formula for calculating the inductance. It turns out to be 21.9 microhenries. This is a very small coil and it would be better to use a condenser of only 125 mmfd., making the coil twice as large.

\* \* \*

### Tuned Input on Short-wave Converter

**I**S there any advantage in having an untuned stage of RF ahead of the tuned modulator over connecting the antenna directly to the primary of the transformer ahead of the modulator tube? If there is any advantage is it sufficient to offset the disadvantages?—B. F. E.

The untuned amplifier adds a little to the sensitivity and it also eliminates the uncertainties of the antenna characteristics from the tuned circuit. The increased sensitivity alone is probably not enough to justify the extra tube but the elimination of the characteristics of the antenna from the tuned circuit does with some to spare.

\* \* \*

### High Vacuum Photo-Electric Cell Ionization

**I**N your curves on the photo-electric cells you gave an ionizing voltage for the gaseous cells but not for the high vacuum cells. Is there no voltage at which the high vacuum cells ionize and if not, why?—J. R. H.

The ionization occurs because of gas in the cell, and the greater the amount of gas, within limits, the lower is the ionization voltage. Since it is impossible to get a perfect vacuum even the high vacuum cells contain some gas, so that if the illumination and the applied anode voltage are high enough there will be ionization. But in the high vacuum cells the ionizing point is so high that it is not met with in ordinary practice. Amplifier tubes are supposed to be high vacuum devices but they often ionize when the voltage on the plate is too high. The same is true of photo-electric cells.

\* \* \*

### Four Tube Converter for Battery Tubes

**W**ILL you please publish a diagram of a short-wave converter for DC tubes. I have in mind a four-tube circuit like the one you published in the Nov. 15 issue, but it should be for battery tubes, preferably the new 2-volt tubes.—K. L. P.

You will find the diagram of such a converter in Fig. 871. It may be built with two 232 tubes and two 230. The coils and condensers may be exactly the same as the corresponding parts in the de luxe circuit published in the Nov. 15 issue, except that the leads on the oscillator coil are not brought out in the same manner, the change being necessary because of the different voltages impressed on the modulator tube. Ch1 may be one of the small 1/4 millihenry choke coils specified in many short-wave converters or it may be a grid leak. Still a better arrangement is to use a 500,000 ohm potentiometer, connecting the grid to the slider. This provides a means for varying the input for controlling the volume. It is more convenient to control the volume at the converter than at the radio receiver. Rh must be adjusted to suit the applied filament voltage. If this is 3 volts Rh should be set at 4 to 5 ohms.

# INTERFERENCE IN TELEVISION STIRS EXPERTS

Washington.

A description of a process by which commercial television may be established has been presented to the engineering conference of the Federal Radio Commission.

Dr. C. B. Jolliffe, the Commission's Chief Engineer, was in charge of the meeting, which was addressed by Philo T. Farnsworth, of San Francisco, inventor of the process. The present picture transmissions are made with from 40 to 60 lines. The new system makes possible the transmission of 300 line pictures on a 6-kilocycle channel.

## Working on Interference Trouble

Impending plans for the reallocation of the country's television transmitters was one of the subjects brought up. Dr. Jolliffe said that ways and means were being worked out to redetermine the extent of interference that exists between the present television transmitters, and also there was a discussion of the method of combining the visual and voice transmissions.

## Resolution Adoption

The following resolution was voted unanimously.

"Resolved, that it is the sense of this conference that the following principles shall be followed in making allocations on the frequency bands allocated to experimental visual broadcasting between 1,500 and 3,000 kilocycles.

"1. No assignments for simultaneous operation shall be made within 150 miles of an experimental visual broadcast station, and within the same 100 kilocycle band.

"2. The staggering of carrier frequencies within the licensed band is permitted by arrangement among the licensees provided no interference results in neighboring channels.

"3. Engineering principles should take precedence over management details in the allocation of channels.

"The adoption of this resolution shall have no prejudicial effect in the consideration of future applications for visual broadcast stations which are shown not to respond to its requirements."

Mr. Farnsworth gave a brief technical talk about the new system, but did not go into details about circuits and transmission methods. Mr. Farnsworth explained how it would make facsimile transmission possible on frequency bands one-one-hundredth of present band widths, or 100 facsimile messages with the same facilities now required for a single message or picture.

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What  
Results  
with Television?

## Sees No Entertainment in It

FOR quite a number of months I have been conducting experiments on the fascinating subject of television. As a matter of fact, I've been in the field for two years. Naturally, at first, this picture reception was very unsatisfactory. It was so poor that out of two hours of operation I could not expect more than 10 or 15 minutes of reception. Of course, I might not have been using the right equipment for such reception.

But the question was to decide what was adequate.

Practically all short wave receivers were of the regenerative type. Although performing the trick they would not prove to be fully satisfactory. I was even to a certain degree disappointed with a special non-regenerative receiver, yet it proved to be the most reliable of all.

Unless one has a very sensitive receiver here in Detroit the reception is bound to be interfered with by continuous police broadcasts of three stations, of which WCK is the strongest. Secondly, the second harmonic (1840 kc) of WMBC (1420 kc) is constantly interfering with the reception of the Jenkins' transmitter W2XCR.

By the way, I've read somewhere that the sw. band from 100-150 meters is reserved for television transmission exclusively. Are police broadcasts in this line?

Now to the stations and their quality of pictures.

W3XK is the only station which I can receive without difficulty and with 100 per cent reliability. There was no night this station has disappointed me. When W2XCR, W2XR and W9XAP have given no results, W3XK came as the old standby. Of late W9XAP, the Chicago Daily News' station, comes in, too, with regularity but not by far what I've expected after all the newspaper stories.

The quality of the pictures of the different stations received by me is about the same all the way around with the exception of more or less static which will bring more distortion. In my judgment there is no entertaining value in any of the present broadcasts to justify the expense. It's all right for an amateur to sit and fish for good reception but no one else will find satisfaction except for a point which cannot be overlooked, namely, that he is privileged to follow television development as he has followed radio broadcast development in former years.

All in all, I receive regular television broadcasts from four stations: W3XK, W2XCR, W2XR and W9XAP.

HENRY HEFNER,  
17303 Goulburn Avenue,  
Detroit, Mich.

## A THOUGHT FOR THE WEEK

SOMEbody has invented an electric car for the purpose of having one sound kill another and thus reduce unwelcome noise to a minimum. Herewith is our order for a couple of electric ears if the makers can guarantee they will murder the unheavenly noises made by some marauding banjoints who usually cut in and spoil our joy in listening to Rubinstein's melody in F. We wouldn't object even if a trio of Zylphonists who blab effectively if not sweetly somewhere out in the West were silenced forever and for aye.

# WARN STATIONS BEFORE SHIFT COURT ADVISES

Washington.

A recent opinion of Chief Justice George E. Martin of the Court of Appeals of the District of Columbia holds that radio stations should be forewarned of impending changes in frequency assignments. This opinion was delivered during the course of the oral arguments in the case of the Louisville "Courier Journal" versus the Federal Radio Commission in which the newspaper's station, WHAS, appeals from the decision of the Commission putting it in the list of twenty-six station operating shifted in frequency and "demoted." The order was blocked on a stay issued by the Court of Appeals.

Counsel for the Kentucky station contended that the Commission's original order was in violation, not only of the terms of the radio law requiring a formal hearing, but also conflicted with the due process provisions of the Fifth Amendment of the Constitution.

## No Hearing, He Says

He said the Commission had ordered the shift before any hearing was held, but subsequently amended this order to provide for a hearing.

Duke M. Patrick, Assistant General Counsel for the Commission, contended that the original procedure was not now involved in the case, since the Commission had amended the general order, and has scheduled a hearing preparatory to placing the shift in effect. He said the sole purpose of the Commission's order was to eliminate objectionable cross-talk interference for listeners, entailed by inadequate geographical separation among the stations for the kilocycle or "geographical separation" between them.

## Cites Big Investment

The substance of the Chief Justices opinion was that, due to the term of the license being restricted to 90 days, and also because of the large financial investment involved, it was his opinion that a station should not be shifted from one channel assignment to another before it has been given opportunity to present a case before the regulatory body.

## Tube-Operated Piano Demonstrated

A new kind of musical instrument has appeared on the scene in the form of an electrical device with a keyboard that resembles a small piano. The instrument consists essentially of a stretched copper wire arranged in the field of an electromagnet activated by an amplifier.

The keys of the keyboard control tunable oscillators that influence the of vibration of the copper wire and thus oscillators can be made to emit a wide variety of sounds that range from the flute and piccolo to the lower tones of the organ.

This instrument is known as the Martenot, after its inventor, Maurice Martenot, a pianist of note. The instrument was demonstrated before the Philadelphia Symphony Orchestra recently, and it is expected that a recital will be given at Carnegie Hall, New York City.

# OUT A THIRD OF ALL ON AIR, PLEA TO HOUSE

Washington. Representative White of Lewiston, Maine, thinks that there are too many broadcasting stations and accordingly has introduced at a recent session of the House of Representatives a resolution calling for the investigation of the manner and reasons why the several broadcasting stations have obtained licenses. Representative White said:

"I introduced this resolution because several of the Merchant Marine and Fisheries committee are of the opinion that there are too many radio stations, and we desire to get a survey of the situation to determine why some licenses have been granted.

"Under the original radio act it was the belief of the Committee that it would give the Federal Radio Commission a chance to cut down the number of radio stations, but since that time there has been no decrease in number.

"In fact, even where a radio station's license has lapsed the Federal Radio Commission has not taken advantage of the opportunity to keep a station off the air, but instead has issued licenses to fill the gaps.

"It has been our contention that it has not eliminated stations from the air because the Commission is not certain of its power, and is afraid of getting into too much litigation.

### Wants 1/2 or 1/3 Ousted

"Whether or not the Commission has the power to take a station from the air has never been decided, and at present such a case is before the courts.

"The excuse for not attempting to eliminate some stations is not well founded. There should be a reduction of one-third to one-half of them."

## Big Progress Made in Airplane Beacons

The contributions of radio science to the advancement of aerial signalling is noteworthy. Not the least of these is the directional radio beacon of which there have been several important improvements made in the past few months.

In the beginning the type of beacon installed operated a visual indicator, and with that came the demand for automatic volume control. This was developed at the Bureau of Standards, and it relieved the airplane pilot of the necessity of manual manipulation of the direction-finding loop.

Later in connection with the above an additional device was developed which served as a distance indicator. This device is still in more or less of an experimental stage of but with it the pilot can estimate the location of the landing field with reasonable accuracy.

A type of receiving circuit by means of which a pilot can fly a chosen course is one in which the variation of a current in a shunt circuit affects two independent reeds of an indicating device to which is associated a pointer and scale. The deviation of the pointer off the scale is the measure of the deviation of the plant from the chosen course. Only by continuous experimental work are improvements possible.—J. C. W.

# Forum

## WHO-WOC Synchronization

IN your magazine have occurred several times statements to the effect that the synchronization of WHO and WOC is a complete success.

I can assure you that such is not the case and that anyone who made the least attempt to check up the matter in areas where the power of the two stations is somewhere nearly equal would be forced to my conclusion.

Radio dealers tell me they do not dare to tune in WHO-WOC when demonstrating a set because the bad reception is likely to be blamed on the set.

I carry a portable radio around Eastern Iowa and have plenty of opportunity to test the reception. In locations where one of the stations is relatively strong the reception is not bad because the other station is too weak to affect it much. At a place like Grinnell or even at Iowa City the reception is often so poor that there is no pleasure in listening to it. Right now the signal is coming in loud and then fading to a fuzzy effect about every six seconds.

The best one could say of the WHO-WOC synchronization, as I have observed it, is that in certain areas rather near one or the other station, or beyond it on the far side, the reception is not seriously interfered with, but for areas in between the two stations or fairly equi-distant north or south (e. g. Grinnell, Marshalltown, Cedar Falls) the reception is not satisfactory but is good enough at times so that it seems as if the perfection of some automatic device to hold the synchronization more closely would make it really the success which has been mistakenly claimed for it.

GEORGE H. ROGERS,  
4943 Winthrop Avenue,  
Chicago, Ill.

## WHO OWNS ETHER? IS BEFORE COURT

Washington.

The Supreme Court has recently been asked to decide in a case involving regulatory rights that has been brought before it by three Chicago broadcasters. The issue here is, Who owns the Air?? The complainants, whose case is before the Court on appeal claim that their broadcasting station represents an investment and property right executed before the Federal regulations came in to being, and, according to the Government, cannot impose confiscatory regulation upon them now, for to do so would violate the Constitution. Solicitor-General Thatcher, representing the Government, states that the air is free for the use of all, and there can be no vested or property rights in the use of the ether.

The following is an excerpt from the Solicitor-General's brief

### Opinion Given

"The doctrine of prior appropriation can have no application to broadcasting because the ether, whatever its unknown physical properties may be, cannot be appropriated, possessed, owned or controlled.

"Even the courts are powerless to protect the appellants' asserted right to exclude others from its use. Foreign stations may invade with impunity his alleged right to broadcast without interference on the wavelength he employs."

# WJZ-WBAL AND WEA-F-WTIC IN A WAVE TIE-IN

Washington

The Federal Radio Commission has recently been petitioned by the representatives of the National Broadcasting Company to grant it permission to engage in synchronizing experiments during the regular operating hours, the aim being to supplement the elaborate experiments already under way. The first practical application of the proposed synchronization would be the simultaneous operation of station WBAL, Baltimore, and station WJZ of New York. Also WEA-F of New York is to operate with WTIC of Hartford, Conn.

### Now Share Frequency

The application also asks permission to make the alterations to enable WBAL and WTIC, which now share time equally on the 1,060 kilocycle channel, operating, in effect, on alternate days, to broadcast full time. The Hartford station uses 50,000 watts power, while WBAL is licensed for 10,000 watts.

WJZ, which would be linked on the 760 kilocycle channel it now occupies with the Baltimore station, uses 30,000 watts, and is one of the N. B. C. "key" stations.

### Two for 660 kc

WEAF, employing 50,000 watts power, would operate simultaneously with WTIC on its wavelength of 660 kilocycles.

Synchronization is the operation of two or more broadcasting stations on the same wave length without distorting interference, regardless of the fact that high power might be used.

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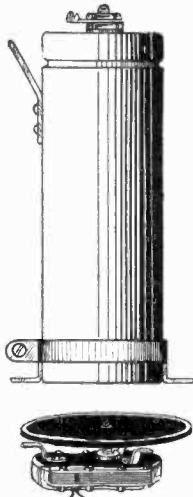
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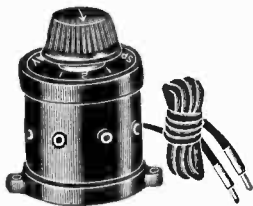
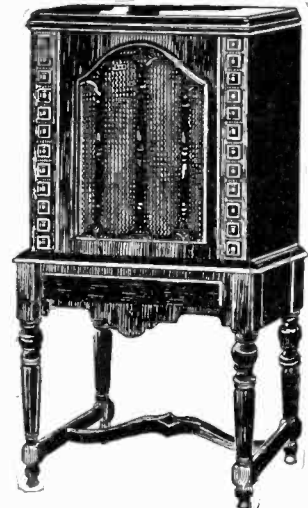
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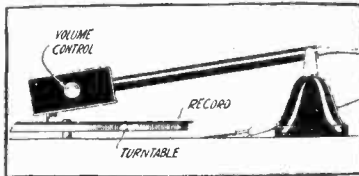
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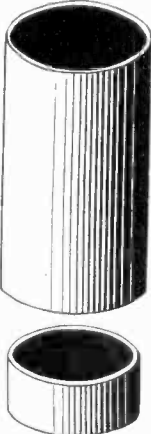


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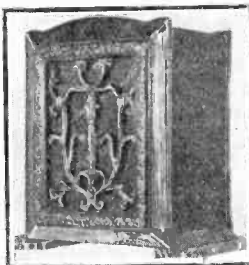
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## Temple Dynamic \$15.34

Beautiful Carved Wood Grille Front



This is one of the finest dynamic speakers ever made, and is highly recommended by us. AC switch is provided. A knob is built in for adjusting the speaker impedance to that of your set. An output transformer and dry rectifier are built in. Connect plugged AC cable to 110 volts AC, 50 to 60 cycles and connect tipped cords to speaker post of receiver. This remarkable speaker chassis in the fascinatingly decorative walnut cabinet, with carved grille ornament, as illustrated; both front and back finished. (Cabinet not sold separately.) Order Cat. TEM @ \$15.34



0-600 volts, high resistance; AC and DC (same meter reads both types). DC readings accurate to 2%, also AC readings 2% at 50-60 cycles, but accuracy is less on AC at substantially different frequencies. Order Cat. F-600 @ \$4.95  
0-300 volts, high resistance. Accuracy, 2%. Case is full nickel finish. Long connecting cords have especially ornamental tip holders. Meter should be read in perpendicular position. Order Cat. F-300 @ \$2.59  
0-500 volts, same as above in appearance, but the range is greater. Order Cat. F-500 @ \$3.73

### EXTRA-SPECIAL SPECIALS!

- (Cat. SPEC-1)—Erla DC dynamic chassis, 9-inch cone, for operation from 8-volt storage battery. Connect speaker-tipped cords to output of set, and connect twisted pair to 8-volt storage battery. Draws 1/2 amp. from battery. Price... \$9.00
- (Cat. SPEC-2)—Wave trap, for cutting out interferences. Connect aerial to one side of the trap, other side to antenna post of receiver from which aerial was removed, and tune out interfering stations. A great selectivity booster. Price... .87
- (Cat. SPEC-3)—Rider's Supplement No. 1, containing diagrams supplemental to those in Rider's "Trouble Shooting Manual," and an invaluable addition, for completeness, to any who possess Rider's manual. Price... 1.22
- (Cat. SPEC-4)—AC blueprint library, consisting of a book containing AC circuits for home construction, with actual blueprints therein, list of parts, coil-winding data, etc. Also encyclopedic information on radio. Price... .25
- (Cat. SPEC-5)—Dubilier .01 mfd. fixed mica condenser... .16
- (Cat. SPEC-6)—Dubilier .0025 mfd. mica fixed condenser, with clips for grid leak mounting... .11
- (Cat. SPEC-7)—.0001 mfd. Dubilier fixed condenser, for connection in series with aerial to improve selectivity... .11
- (Cat. SPEC-8)—Power transformer, with two chokes built in for B filtration. Primary, 105-125 volts, 50-60 cycles; secondaries, all center-tapped with red leads, are for high voltage for 280 to work 245 tubes, single or push-pull, and rest of tubes in set up to 100 mba; 300 volts DC output; 2 1/2 volts 2 amps. for 245s, single or push-pull; 2 1/2 volts 14 amperes, for 227s and 224s, up to 8 of these; 5 volts for filament of 280. All, including chokes, in one cadmium plated steel case. Leads identified. Chokes are 30 henries each. Price... 7.50

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