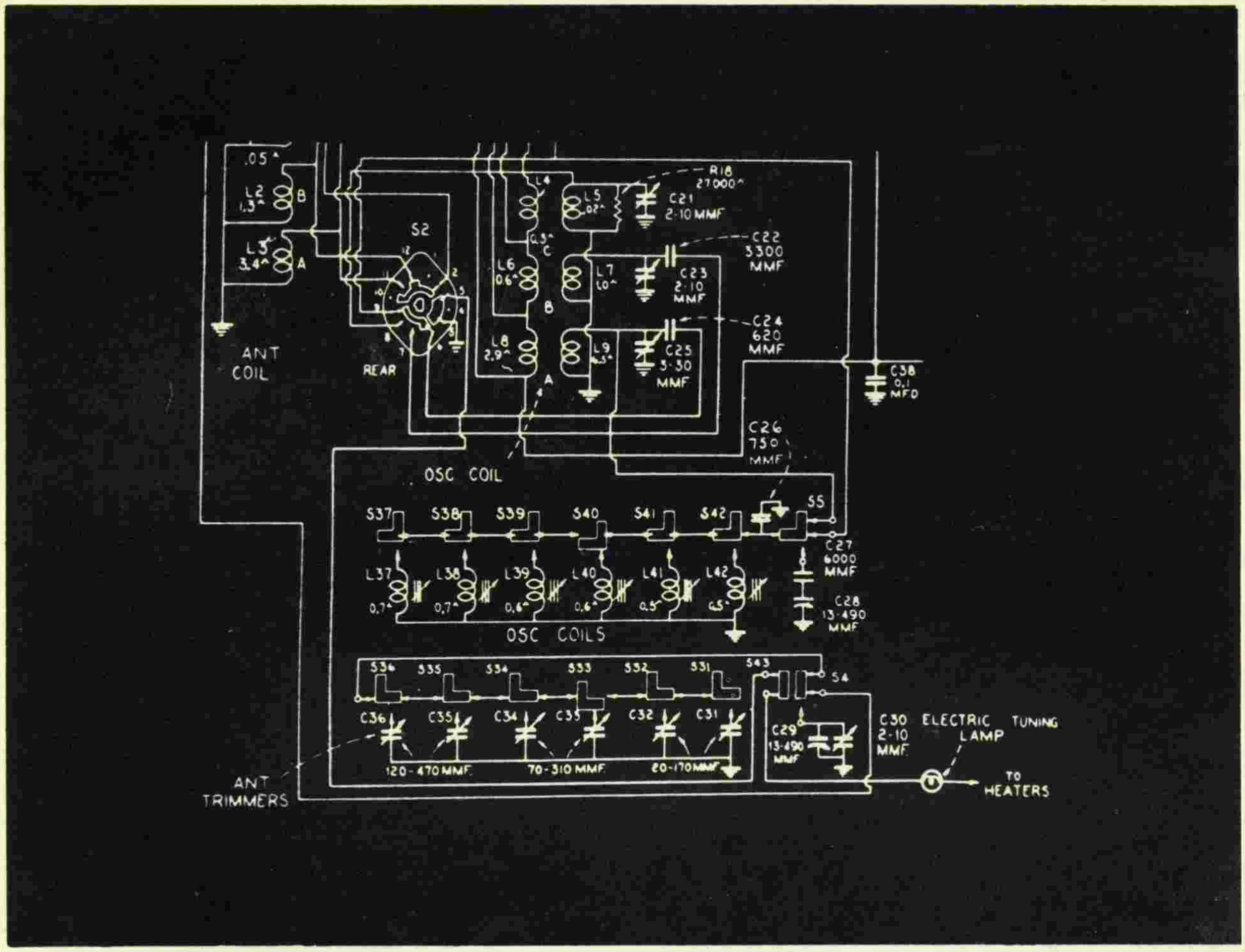


LESSON 43 RA

# AUTOMATIC ELECTRIC TUNING METHODS

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## Permeability Tuned Systems

PERMEABILITY TUNING. Permeability tuning is the method of tuning a circuit or adjusting its frequency response by varying the magnetic permeability of the coil and thus changing the inductance value. This converts the tuned circuit into a variable inductance shunted across a fixed condenser rather than a fixed inductance shunted by a variable condenser as has been customary practice.

Since the inductance of a coil depends not only on the number of turns of wire but also on the magnetic permeability of the core, increasing this permeability increases the inductance of the coil; or, in other words, less turns of wire are required for a given value of inductance. Iron has a much greater permeability than the usual air or wooden-dowel core, and a properly designed iron core permits of greatly improved coil construction.

The variable inductance feature can further be obtained by changing the position of the iron core within the coil, that is, the core can be operated like a movable plunger. As the core is inserted further into the coil, the permeability increases and the inductance becomes larger; and as the core is withdrawn, the permeability is decreased and the inductance value becomes smaller. If the coil is shunted by a condenser of suitable value, the frequency response of the circuit is varied by thus altering the position of the plunger.

## CORE CONSTRUCTION FOR PERMEABILITY TUNING

A solid iron core can not be used for tuning high-frequency coils such as R.F. and I.F. transformers on account of the excessive magnetic and eddy current losses. Instead, a high grade iron in a very fine granular condition is used. In the forming process each particle becomes individually insulated. These particles are then mixed with a suitable binding compound and moulded under great pressure and at high temperatures into whatever form or size they are needed. This construction gives the core good mechanical strength, high magnetic permeability, and reduces all high frequency losses to a minimum.

## APPLICATIONS OF PERMEABILITY TUNED COILS

Permeability tuned coils are used for radio and intermediate frequency transformers and as oscillator coils. The extremely high Q obtainable with these coils, results in a higher gain as well as in a higher signal-to-noise-ratio. Also, the coupling coefficient is much greater between primary and secondary and this means a higher operating efficiency.

Permeability tuned coils lend themselves especially well for use with automatic push-button tuning systems, for after the inductance is adjusted to a certain value, the tuning remains fixed, and any variations due to humidity and temperature changes are compensated for by a special fixed condenser consisting of silver surfaces sprayed on a special ceramic insulator so that the capacity changes in the opposite way from any changes in the coil.

With push-button tuners it is customary to employ an individual antenna and oscillator coil for each station button. To simplify the pre-setting operations as much as possible, the coils are arranged so that both plungers are mounted on a common shaft, that is, to adjust the coils to a given station only a single screw driver adjustment is necessary. The distance between the plungers is permanently set at the factory, and only in case the characteristics of the coils have been changed, is it necessary to alter this setting. In receivers that employ a tuned R.F. stage ahead of the 1st detector, three tuned coils are required, and the coils are so arranged that the three plungers operate in tandem and all three coils are tuned to a given station frequency by a single adjustment.

Some push-button tuning systems employ a set of trimmer condensers for the antenna coil and a set of iron core coils in the oscillator stage. Pressing in a station button on such a tuner then cuts in a pre-set trimmer across the antenna coil and a pre-tuned coil into the oscillator. Two adjusting operations are necessary with such a system, one to set the trimmer and the other to tune the oscillator coil.

However, with a movable plunger, it is not possible to vary the inductance of a coil through wide enough limits to cover the complete broadcast frequency band with a single coil and condenser, and two or three such circuits are needed to tune over the entire range. The tuning range of a set of coils (R.F. tuner and oscillator, for example) varies from 800 to 500 kilocycles, depending upon what portion of the broadcast band they are operating over. At the high frequency end, they will tune through a greater wavelength range than at the low frequency end.

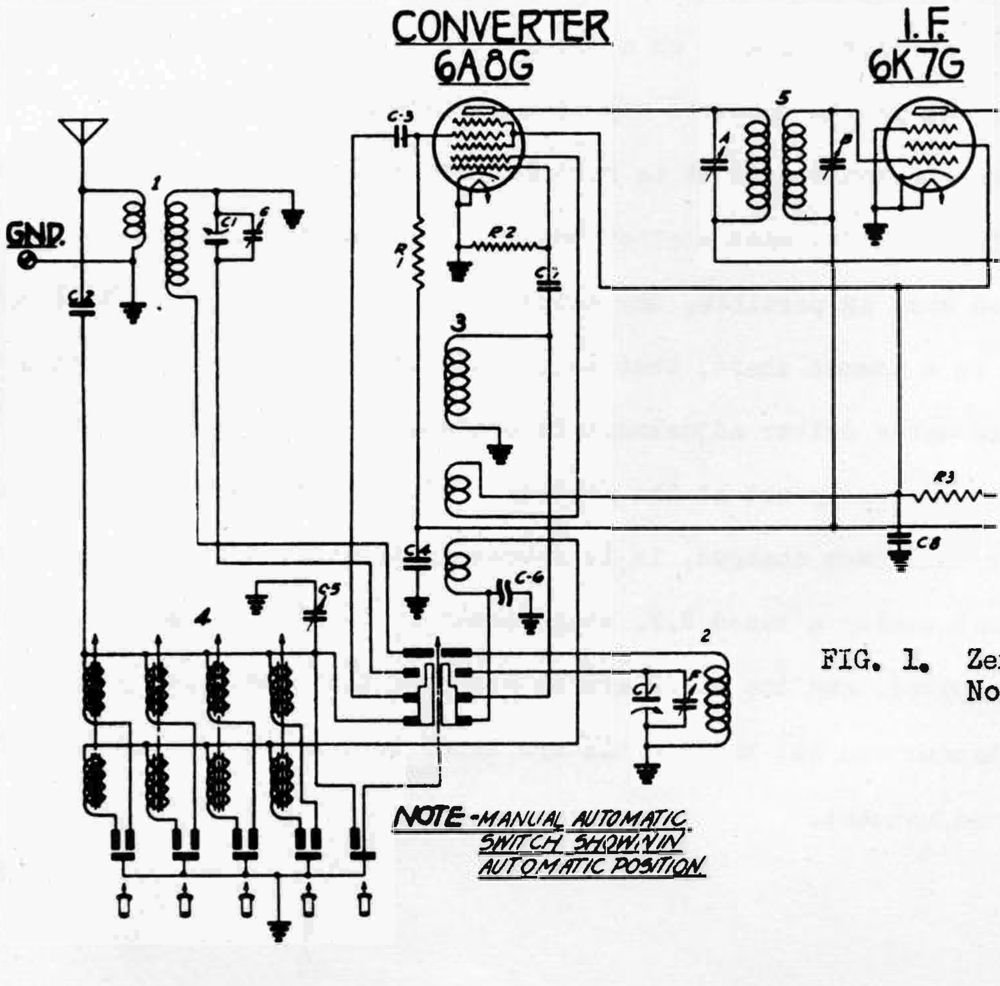



FIG. 1. Zenith Chassis No. 5528.

## ZENITH CHASSIS NO. 5528

The Zenith Chassis No. 5528 which is used in a series of their 5-tube receivers, is equipped with an automatic push-button station selector system that uses permeability tuned coils. Although this tuner has only four station buttons and one transfer button for shifting to manual tuning, other Zenith receivers employ similar automatic tuners that have as many as eight push-buttons. On receivers that are equipped with a short wave band, shifting from manual to automatic tuning is generally done with the band selector switch. This switch then has three positions: the first for the broadcast band manual tuning, the second for the short wave band manual tuning, and the third for the broadcast band automatic tuning.

On the Zenith No. 5528 Chassis the right-hand button serves to shift operation to manual tuning and allows the regular tuning system to function. When one of the automatic station selecting buttons is then pressed in, the latch on the tuner releases the manual button, and the receiver is instantly tuned to the station for which the button selected was previously adjusted. When the tuner is thus set for automatic operation, the antenna is coupled to the input of the 1st detector, a type 6A8G tube, through a 50-mmfd condenser C-2; and shunted across the grid tuning coils is the semi-fixed condenser C-5. This condenser also serves to compensate for variations in antenna capacity. It is pre-set at the factory and seldom requires re-adjustment.

In the oscillator system it is necessary to alter the tuning curve so as to provide tracking between the oscillator and 1st detector circuits; for since the oscillator operates at a higher frequency, the inductance of the oscillator coils must vary at a slower rate than the inductance of the R.F. coils as the receiver is being tuned. In capacity-tuned oscillator circuits it is common practice to connect a fixed condenser, called the padder, in series with the tuning condenser to reduce the rate of capacity change as the condenser is turned. Also, a small trimmer condenser is connected across the oscillator section of the tuning condenser for establishing proper "in step" tuning at the high frequency end of the dial.

Similarly, with inductance tuning it is necessary to use a padder coil for correcting the rate of inductance variation and a trimmer coil for "tying in" the oscillator and 1st detector tuning systems. However, an important point to bear in mind here is that where in a capacity tuned system the padder condenser is connected in series with the gang condenser to secure the proper tuning curve over the lower frequency range, in an inductance (permeability) tuned circuit the low frequency padder coil must be connected in parallel. Where the trimmer condenser is connected in shunt with the tuning condenser for establishing correct high frequency tracking, in an inductance tuned circuit the trimmer coil is connected in series.

In the Zenith circuit a small properly designed trimmer coil is connected in series with the grid end of the automatic tuning coils, but kept out of their magnetic influence, to establish the required instep tuning over the higher frequencies. Also, a padder winding, coil No. 3 in the circuit, is connected in shunt with the automatic tuning coils to produce the proper inductance variations, and the necessary tuning curve, for correct tracking over the low frequency range. In addition this coil No. 3 also serves as a means of coupling to the oscillator plate circuit. These two special windings thus function in the same manner as the padder and trimmer condensers in a capacity tuned system.

It is a simple matter to adjust and set the station selecting buttons on the automatic tuner. The receiver is turned on and allowed to warm up for at least 15 minutes so as to attain normal operating temperature. The desired stations are then selected and assigned to their respective buttons; the low frequency range button being at the left. Care must be taken, of course, that the station frequency falls within the tuning range of the selected button.

First the manual tuning button is pressed in, or the selector switch is set for manual tuning on the broadcast range, and the station with the lowest frequency is tuned in manually. This tuning should be very exact. Then the first button is pressed in and the corresponding adjusting screw is set until the same station is again heard clearly, or until the tuning indicator (if the set is equipped with one) indicates correct tuning. The manual tuning button is then pressed in again to permit checking the station response on the automatic tuner with the response on manual tuning, so that optimum setting is obtained.

The second station is next tuned in manually and the second button adjusted in a similar manner. The same procedure is followed for the remaining buttons. Never should it be attempted to adjust a button for a station the frequency of which lies just at the limit or slightly beyond the tuning range of the button. Also, in each case tuning should be switched back and forth from automatic to manual several times to insure accurate setting of each button adjustment.

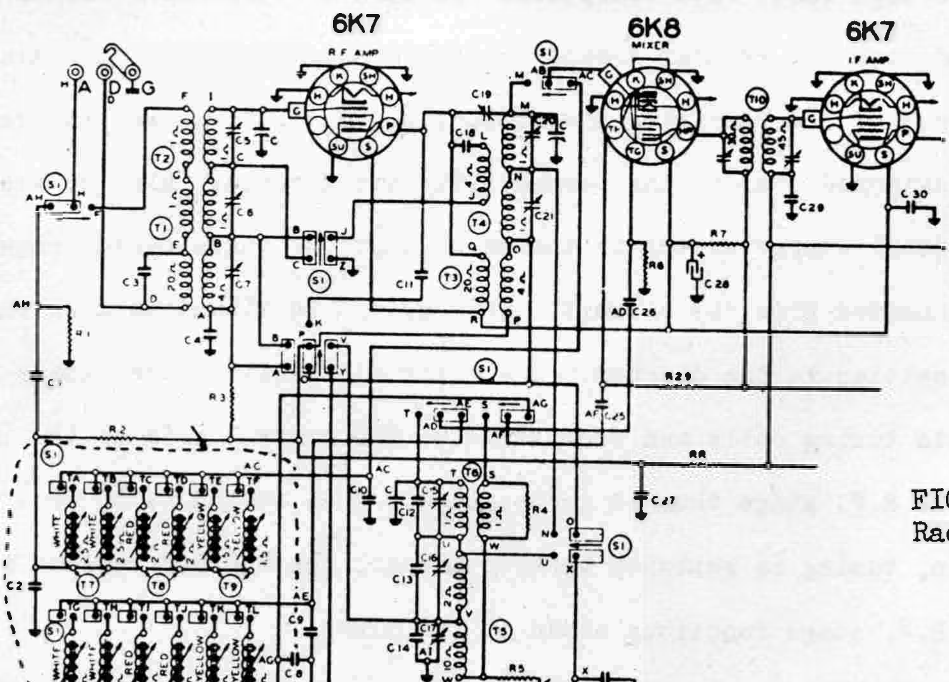



FIG. 2. Belmont Radio Model 1075

# BELMONT RADIO MODEL 1075

The Belmont Radio Corporation (abbreviated BRC on some receivers) Model 1075 is a 3-band superheterodyne receiver that is also equipped with an automatic push-button tuner employing permeability tuned coils. A tuned R.F. stage precedes the composite 1st detector which feeds into a single-stage I.F. amplifier peaked at 465 kc. A 6Q7G tube in the 2nd detector demodulates the signal and supplies the audio signal voltage and the A.V.C. potential. The triode section functions as a 1st audio stage and is resistance coupled to a 6J5G triode which together with another 6J5G as phase inverter feeds into a pair of 6K6G pentodes in resistance-coupled push-pull. A type 6U5 tuning indicator tube is provided to assist in manual tuning.

The automatic tuner has 10 buttons numbered from left to right. Button No. 1 at the left is the Off button, and when pressed in shuts off the power supply to the set. When any one of the other nine buttons are pressed in, the latch releases button 1 and turns the power on. Button No. 2 adjusts the receiver for manual tuning or the broadcast band, button No. 3 for medium wave reception including the amateur, police and some commercial frequencies, and No. 4 for American and foreign short wave reception. On each of these three bands tuning is accomplished with the regular 3-gang condenser and associated coil system.

When any one of the remaining six buttons (5, 6, 7, 8, 9, 10) is pressed in, tuning is switched over to the permeability tuned coils. Also at the same time a 4-pole double-throw switch is thrown so that the tuned radio frequency stage is disconnected from the circuit. This switch is illustrated in the automatic tuning position in the diagram. The antenna it will be seen leads directly to the automatic tuning coils and from these to the control grid on the 6A8 mixer tube. The R.F. stage thus is inoperative. When button 2, 3, or 4 is pushed in again, tuning is switched back to manual, the 4 P.D.T. switch is thrown back, and the R.F. stage functions ahead of the mixer.

Each of the buttons from 5 to 10 controls a pair of coils consisting of an antenna tuner and an oscillator coil. Buttons 5 and 6 tune from 1550 to 1000 kc., buttons 7 and 8 from 1100 to 680 kc., and buttons 9 and 10 from 830 to 520 kc. The high frequency buttons are at the left and the low frequency at the right hand end.

To set the automatic tuner, six stations are selected and assigned to buttons that cover the tuning range within which the stations fall. A station is tuned in manually to exact resonance as indicated by the tuning eye,and then the assigned button is pressed in. The same station is tuned in again by adjusting the screw through the station tab opening directly above the button. To check on the tuning accuracy, tuning is switched back to manual tuning, and if the station appears with the same volume and clearness for either setting, the automatic tuning adjustment can be considered satisfactory. The station call letter tab is inserted in the opening, and the remaining buttons are set in a similar manner.

## WESTINGHOUSE MODEL WR-264

The Westinghouse Model WR-264 is an A.C. operated superheterodyne receiver that has three tuning bands, and is also equipped with an automatic push-button station selector. This automatic tuner has 7 operating buttons, the first six from left to right for station selecting, and the 7th (labeled Dial Tuning) for shifting from automatic to manual tuning. On this 7th button the gang condenser is connected across the antenna tuning and oscillator coil systems, and the automatic tuner is cut out of the circuit.

A dual tuning system is used with the automatic tuner--a series of pre-set trimmer condensers are used for tuning the antenna and a corresponding group of premeability tuned coils for the oscillator. In other words, capacity tuning is used for the antenna coupler, and inductance tuning for the oscillator system. Pressing in any of the six station selecting buttons then cuts in a trimmer across the antenna tuner and a pre-adjusted coil into the oscillator system.

Setting the automatic tuner for station selection is quite simple. After the set has been allowed to warm up for about fifteen minutes, the Dial Tuning Button is pressed in, and the first station (lowest frequency) is tuned in manually until the tuning indicator shows exact resonance. Button No. 1 at the left end is then pushed in and No. 1 oscillator core is adjusted until the station is heard best. No. 1 antenna trimmer is next adjusted for maximum output on this station. The two adjustments should be re-checked to insure optimum setting. Tuning is switched back to Dial Tuning and the station response compared for the two settings.

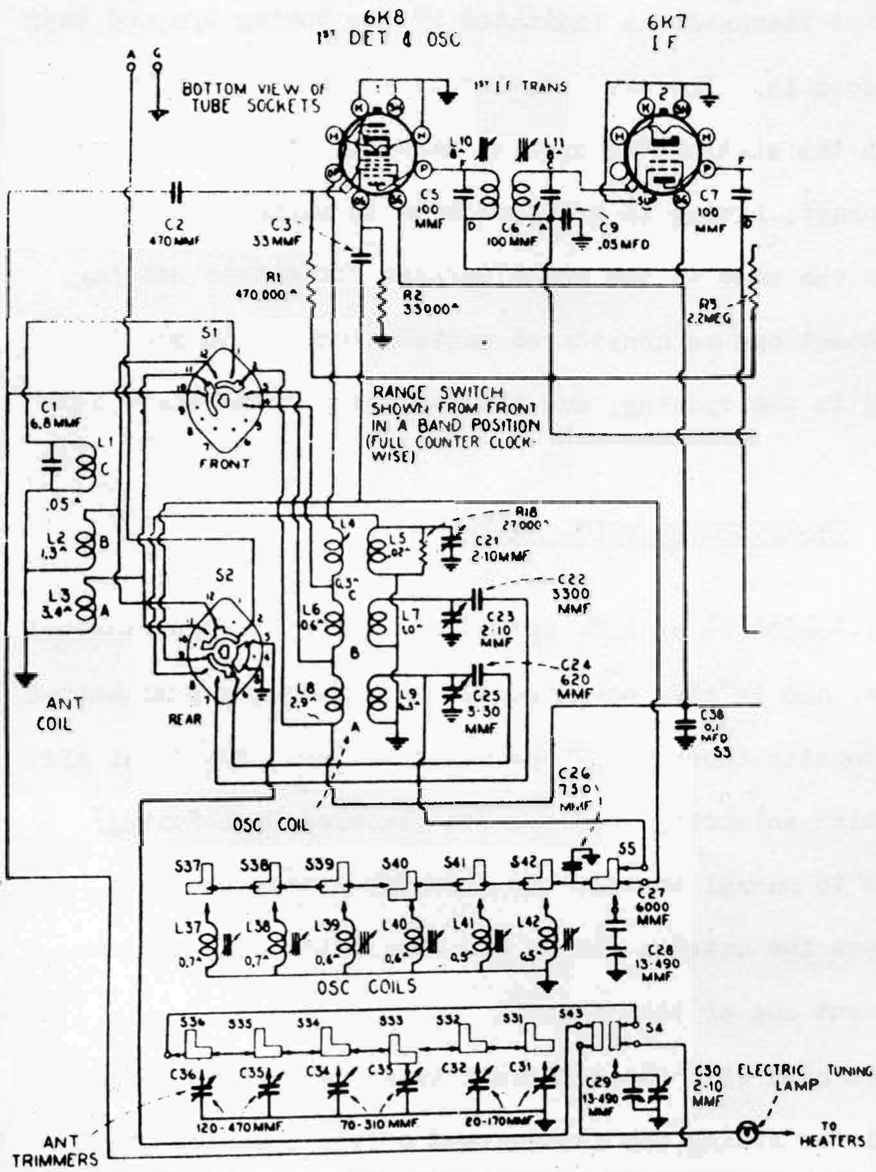



FIG. 3. Model WR-264

The next station of higher frequency is then tuned in manually and button No. 2 is pressed in. The same adjustments as for button No. 1 are made until the station appears with maximum response. The remaining four buttons are then set in a similar manner, the stations being arranged in the order of their increasing frequency.

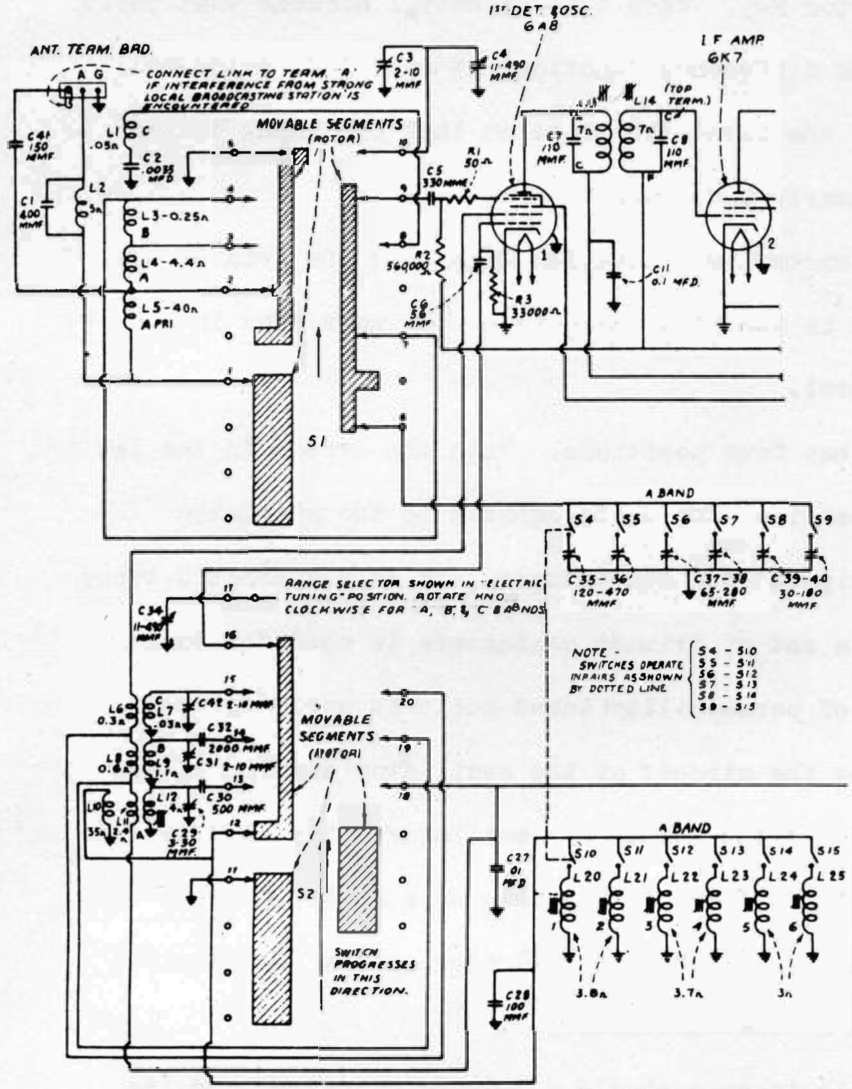



FIG. 4. RCA Victor Model 87K1

## RCA VICTOR MODEL 87K1

The RCA Victor 87K1 is an A.C. operated 3-band superheterodyne receiver equipped with seven tubes including a tuning indicator. The circuit is of standard design and construction, but contains an interesting feature in the second detector for providing the residual bias for the I.F. amplifier and mixer tubes. One diode of the 6H6 tube serves as the second detector and also provides the audio voltage as well as the A.V.C. potential.

The plate of the other diode is connected to the ground through resistor R-5, while the cathode is brought to a point on the voltage divider below ground potential. As long as no signal is coming in, a steady current thus flows through this second diode and develops a potential across R-5, and this drop serves as the normal grid bias for the I.F. and mixer tubes. When a signal is received, rectified current flows through the first diode and also builds up a potential across the load resistor R-5. When this potential exceeds that built up by the no-signal current, the difference functions as an A.V.C. potential that reduces the sensitivity of the first two tubes so that the input to the 2nd detector is maintained at nearly a constant level.

A bass-compensated volume control supplies the signal to the grid of the 1st audio tube, a type 6F5, and in the plate circuit of the same tube is a continuously variable tone control.

The range selector switch has four positions. With the switch in the 1st or extreme counter-clockwise position, tuning is shifted to the automatic push-button tuner, which is equipped with six buttons. In this automatic tuner a dual system is used, in that a set of trimmer condensers is used for tuning the antenna tuner, while a set of permeability tuned coils is used for the oscillator system. Upon tracing the circuit of the oscillator section of the 6A8 mixer tube it will be seen that the series of oscillator coils L-20 to L-26 is shunted by a special coil L-10 which functions as a padder coil to insure proper low-frequency tracking. The same coil also serves for coupling the system to the plate circuit of the oscillator.

Each button on the automatic tuner controls a trimmer condenser and its associated oscillator coil. This means that there are two adjustments necessary for the proper setting of each button. The successive buttons are set for station selection in the following manner. The buttons are numbered from left to right. Buttons 1 and 2 tune from 540 to 1160 kc., buttons 3 and 4 from 600 to 1260 kc., and buttons 5 and 6 from 770 to 1550 kc. The stations should be assigned so that their frequency falls well within the tuning range of the selected button.

The receiver is turned on and allowed to warm up for about fifteen minutes, after which the range Selector Switch is turned into the second or Broadcast position and the first low frequency station tuned in. The Selector is then set into the Electric Tuning position and button 1 pressed in. The same station is again tuned in by carefully adjusting first L-20 the oscillator coil and then C-35 the antenna trimmer. It is well to shift the Selector back to manual tuning in the Broadcast position and compare the station response on both electric and manual tuning.

In making the various adjustments the tuning indicator should always be observed carefully, and tuning corrected for minimum width of the dark sector of the eye. If the trimmer adjustments appear to be broad due to A.V.C. action in the set, a very short antenna of only a few inchss in length should be used, just enough to not more than half close the magic eye. This keeps the signal below the level at which A.V.C. cuts in.

## MOTOR DRIVEN AUTOMATIC TUNING SYSTEMS

Motor driven automatic tuning systems, as the name suggests, employ a small electric motor for turning the main tuning condenser to a pre-determined setting to bring in a given station. The automatic station selector again includes a series of push-buttons according to the number of stations for which the tuner is designed, and pressing any one button closes the circuit to the motor and sets it in motion. The motor then continues to turn the condenser until a position is reached where contact for the selected station is made. Here the circuit is broken, the motor stops, and through the action of a spring becomes mechanically disengaged from the main tuning mechanism. If another

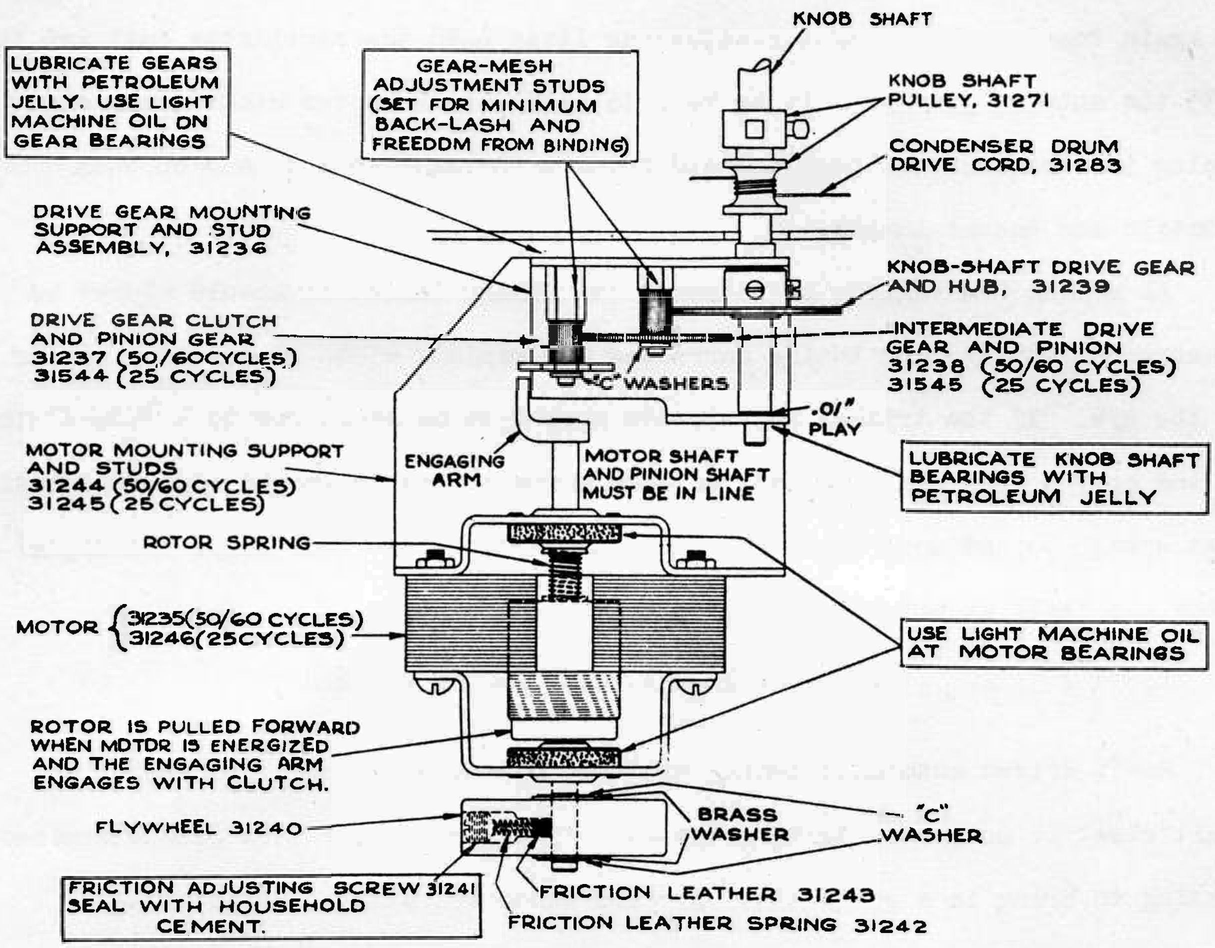



FIG. 5. Electric Tuning Mechanism

button is later pressed in, the previous button is released, and the motor turns the condenser into the position for which a pre-setting has been established for this particular button.

## EARLY MOTOR SYSTEMS VERY COMPLEX

The early motor driven systems were very complex in their mechanical design and operation. They included a series of circuit making contactors, reversing switches, delicate relays, and other gadgets, all of which not only invited endless trouble but to a great extent helped to defeat the very purpose of automatic operation for which they were intended. When a button is pressed in on one of these systems, it closes the motor circuit, and the motor starts in the direction it was last turning. It continues until it touches the selected station contact, or until the condenser rotor reaches its limit of rotation. At this instant the mechanism trips a reversing switch and the motor is caused to rotate in the opposite direction until contact is made with the selected station segment.

Such operation requires considerable time, for often the motor must turn through nearly twice its range before the selected station contact is reached. Also, unless all adjustments are absolutely perfect, the reversing switch will not function correctly, and the motor will jam and clog up the entire mechanism. Should some of the points on the contactors become corroded or the relays not respond instantly, the receiver becomes inoperative. As a result, these first motor driven tuners proved anything but satisfactory. However, they served as a good introduction, and means and ways were soon devised for eliminating these sore spots and developing a tuner that really is automatic.

## PRESENT DAY MOTOR DRIVEN TUNING SYSTEMS

Present day motor driven tuning systems have really been greatly simplified in construction and operation. The push-button station selectors are also of the latch release type but when a button is pushed in and the circuit closed, the motor turns immediately in the direction toward the station contact selected by the button. This is accomplished by having the successive station selector segments contact a brass disc or drum that is mounted on the rear of the condenser shaft. This selector disc, as it is called, is separated or split into two segments by a layer of insulating material.

The tuning motor has two separate field windings, one for causing rotation in one direction, and the other for rotation in the opposite direction. One half of the selector disc is connected to one of these field windings and the other half to the second field winding. The station contacts which touch this selector disc are mounted on suitable circular supports and each is connected by means of a flexible wire to a button on the automatic tuner. The circuit from the automatic tuner to the motor is thus closed through this divided brass disc.

Also, each contactor is set in such a position on the circular support that as the motor turns the tuning condenser and also the selector disc, the insulating strip will come under the contactor at the condenser setting for which the desired station is tuned in. At this point the circuit to the motor is thus opened, the motor comes to rest, and the receiver responds to the station frequency to which the tuner is adjusted for this condenser setting. When another station button is now pressed in, its contactor on the selector disc lies either to the right or the left of the contactor to which the tuner was last adjusted, and, therefore, the motor will turn either to the right or left until the insulating segment comes under the newly selected contactor. Here the motor circuit is opened again, the motor comes to rest, and the tuner is adjusted to the new station frequency.

This direct motion of the motor hastens the tuning process, eliminates the need of reversing switches at each extremity of rotation, and in addition greatly simplifies the circuit wiring. The arrangement and action of such a motor driven mechanism will be understood more clearly from a study and analysis of Fig. 4, which illustrates the tuning equipment used in a current RCA Victor receiver.

## MOTOR CLUTCH AND RELEASING MECHANISM

The method of engaging and disengaging the driving motor from the tuning mechanism is quite simple in the newer motor tuning systems. As long as the circuit is open and the motor is not energized, the armature or rotor is pushed back out of its magnetic center by a spring coiled around the shaft. This releases the engaging arm from the driving gear clutch, so that the tuning mechanism can be turned freely through the manual control knob.

When the circuit is closed and current flows through the motor, the magnetic pull draws the armature forward into the center of rotation against the action of the spring. This allows the engaging arm to meet with the driving clutch; and as the armature turns, it rotates the driving gears and these in turn rotate the tuning condenser until the pre-determined setting is reached.

## MUTING SYSTEMS ON MOTOR TUNED RECEIVERS

All modern electric motor tuned receivers are also equipped with muting systems for silencing the receiver during the time the electric tuner is in operation. In some sets this muting is accomplished by having the motor trip a switch that in turn grounds the grids of the audio amplifier tubes, or renders these tubes inoperative in some otherway.

Another system that is used in some of the newer receivers is to impress a portion of the motor voltage on one of the diode plates of the second detector. This causes the diode to draw a heavy current through a suitable load resistor in the return circuit, and the voltage built up across this resistor is then used as a biasing potential on the first audio tube to bring it down to the cutoff point and thus render the receiver silent. As soon as the motor circuit is opened, the diode current stops, the cutoff bias is removed, and the receiver becomes operative again. This action is quite similar to that employed in some of the earlier squelch or quiet automatic volume control systems.

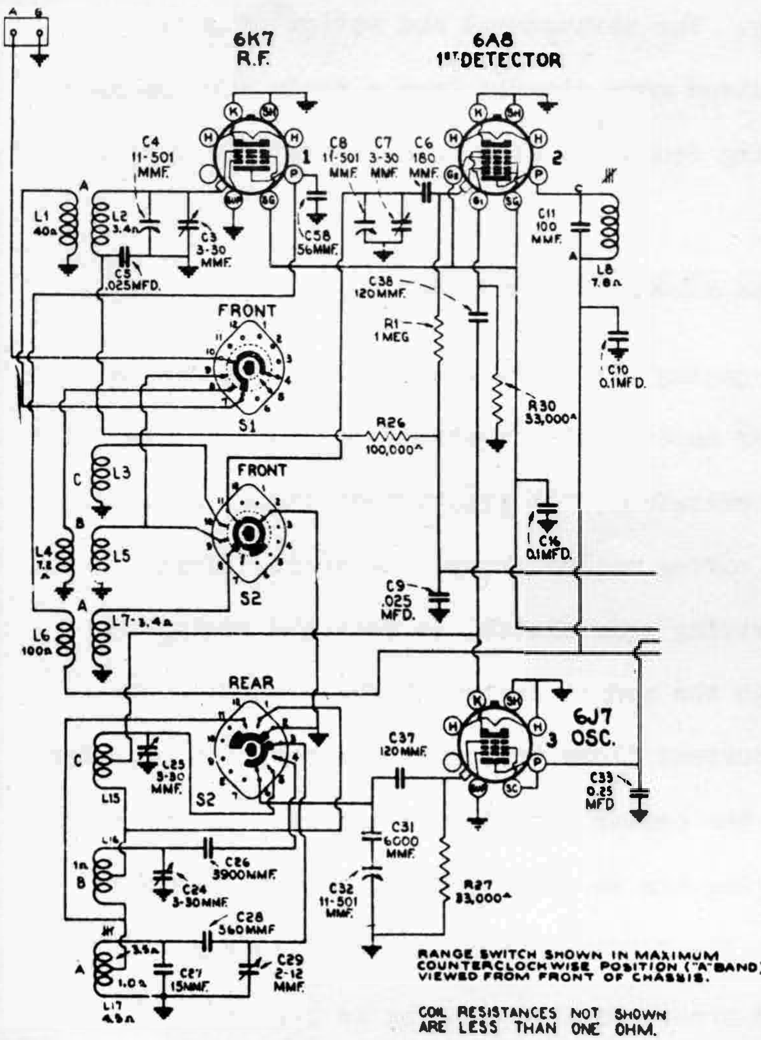



FIG. 6. Westinghouse Model WR-368

## WESTINGHOUSE MODELS WR-366 AND WR-368

The Westinghouse Model 368 is a 10-tube A.C.-operated superheterodyne receiver equipped for manual tuning and push-button selected electric motor tuning. The manual system tunes over three ranges for which a 3-position band selector switch is used, illustrated in the diagram in the A-band (extreme counter-clockwise position). An electron ray tuning indicator is also used, called a Precision Eye by the set manufacturer.

The circuit is of conventional design, with a tuned radio frequency stage ahead of the 1st detector-oscillator in the broadcast or A-band. But in the B and C-bands this stage is shunted out and the antenna is coupled directly to the 1st detector. This is followed by an I.F. stage with permeability tuned transformers peaked at 455 kc. The 2nd detector stage employs a 6Q7G tube that serves as demodulator, supplies the necessary automatic volume control (A.V.C.) potential, operates as a 1st audio stage, and also provides muting for the audio amplifier during electric tuning operations. It feeds into a resistance coupled push-pull stage with a phase-inverter tube included for providing the proper signal phase relations.

The Model WR-366 is similar in all respects to the Model 368, but employs only a single tube in the output stage. This also eliminates the need of the phase inverter tube.

The automatic push-button tuner is equipped with ten buttons, nine for station selecting and one for shifting to manual or dial tuning. The circuit arrangement of this automatic tuner is illustrated in the lower right-hand corner of the diagram. A special winding on the power transformer supplies the 24-volt potential for operating the motor. The nine push-buttons are connected in series, and from each button a connection also leads to the split selector disc mounted on the condenser shaft. From this disc the circuit continues through the motor field and armature windings.

When a button is pressed in, as No. 5 in the diagram, the circuit to the motor is closed, the rotor is pulled forward and engages the driving gear clutch, and the motor turns until the insulating strip reaches the button contact. Here the circuit is broken, the motor stops, and the receiver is tuned to the station for which the condenser gang was pre-set. However, due to the inertia of the flywheel floating on the motor shaft, the insulation line is carried past the station contact, which then touches the other half of the disc and causes the motor to reverse. The floating flywheel is still turning in the original direction and, therefore, slows down the reversing movement. As a result the selector disc is moved back slowly until the insulation line is well under the station setting contact. If these reversal movements are too slow or too rapid, they can be corrected by adjusting the friction tension screws on the flywheel. These screws should always be sealed with a good binding cement. The button contacts, it will be seen, are arranged so that the motor will always start in the right direction and turn directly to the station selected.

To render the receiver silent during these tuning operations, a muting circuit is arranged. This is accomplished by feeding the motor-supply voltage (a tap is shown taken off at terminal 3 on the motor) to one of the diode rectifier plates of the 6Q7G tube. As diode current flows, it builds up a potential across the 470,000 ohm load resistor R-8, and this potential biases the grid of the triode section to the cut-off point and makes the tube silent. When the motor circuit is opened, this bias is removed, and the receiver becomes operative again.

The brass selector disc is fastened to the rear shaft of the tuning condenser by means of two set-screws. It must be set so that when the condenser is at maximum (plates fully meshed) the insulation strip is horizontal, with the bevelled operating end at the left when viewed from the rear. The disc should also be set so that the contact tip plungers in the station setting contacts project not more than 1/16th inch from the body of the contacts.

The nine station selecting buttons are adjusted in the following manner:

The extreme right hand button is for dial tuning. 1--While the receiver is turned on and allowed to warm up for ten minutes, the nine desired stations are arranged in order from low to high frequencies, and the range selector switch is thrown into the A-band position. 2--The dial tuning (right-hand) button is pressed down, and the first station on the list tuned in accurately as indicated by the Precision Eye. 3--Hold down the dial-tuning button, and press down station button No. 1 at the left. Both buttons will stay down, and the central dial lamp will light either brightly or dimly. 4--Move station setting contact No. 1 to the insulating strip on the selector disc, and if the contact is properly centered on the insulation, the central dial lamp will go out. 5--Press down any other button in order to release the dial-tuning button and button No. 1. Then press down station button No. 1 again. The electric tuning mechanism will function to tune in the station and the central dial lamp will stay on. 6--Repeat the same process for station button No. 2 and the remaining buttons in their proper order.

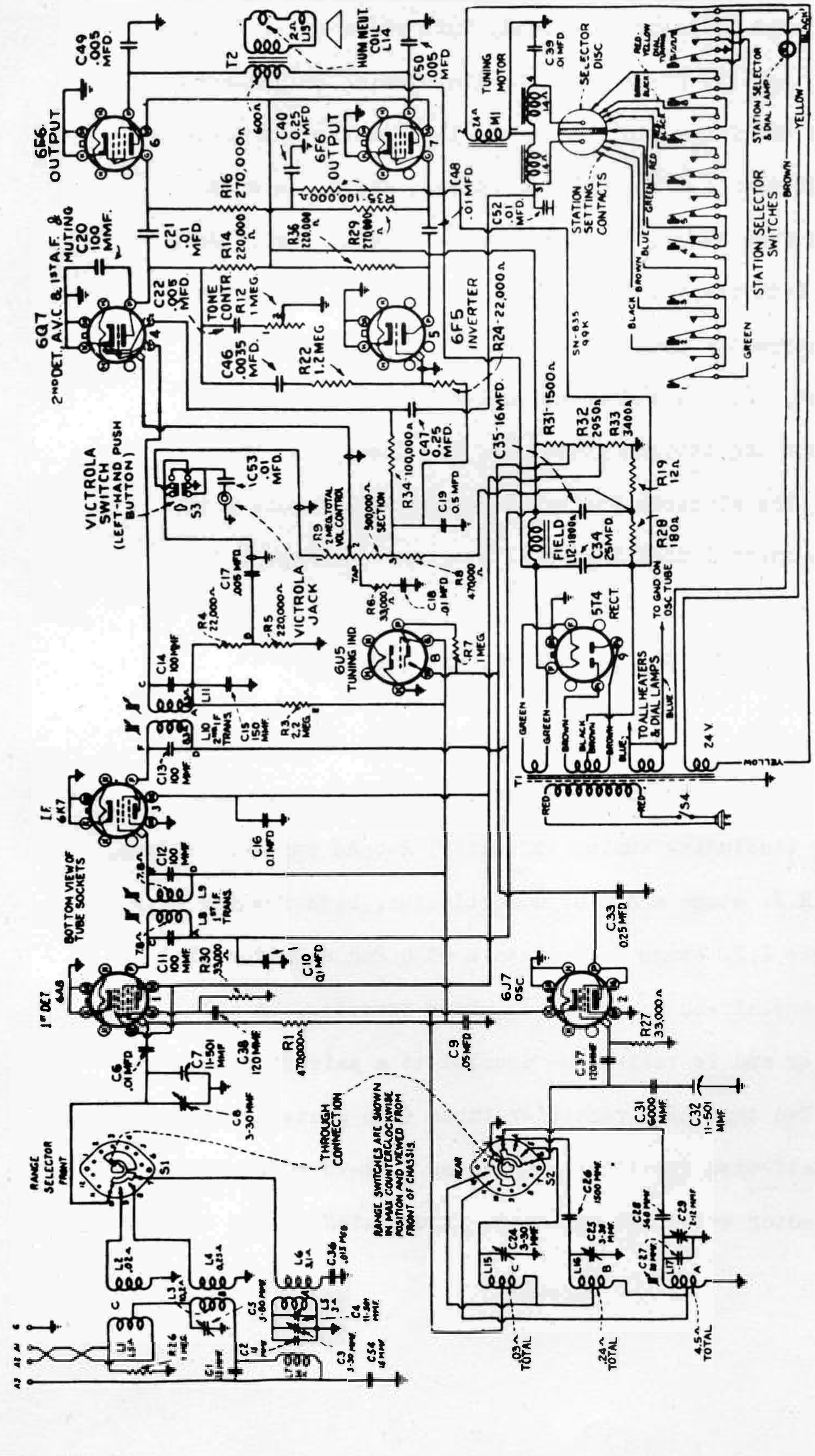
## RCA VICTOR MODELS 99K AND 99T

The RCA Victor Models 99K and 99T are A.C.-operated 9-tube superheterodyne receivers equipped with both manual tuning and push-button controlled electric motor tuning. On manual tuning three frequency ranges are available controlled by a 3-position band selector switch. This switch is illustrated in the extreme counter-clockwise or A-band position in the diagram. To assist in manual tuning a tuning inductor tube labeled Magic Eye is provided.

The circuit is of conventional design, except that it employs a separate oscillator tube, with a magnetite core coil for the broadcast or A-band. The I.F. transformers are also permeability tuned. In the 2nd detector stage a 6Q7G tube provides demodulation, supplies the required A.V.C. potential, operates as 1st audio amplifier, and also functions to mute the audio amplifier during the time the electric tuning motor is in operation. A resistance-coupled push-pull stage with a pair of 6F6 tubes is used in the audio output with a 6F5 tube functioning as phase inverter.

Electric tuning is controlled by an 8-button station selector, the button at the extreme right being used for shifting to manual or dial tuning. These automatic controls are illustrated in the lower right hand corner on the circuit diagram. A special winding on the power transformer provides the 24-volt potential for operating the tuning motor. The 8 station buttons are connected in series, and each is also in contact with the divided selector disc mounted on the condenser shaft. From this point the circuit is completed through the motor field and rotor windings.

When a station button is pushed in, the motor circuit is closed through the corresponding station-setting contact and half of the selector disc. The rotor is pulled forward, it engages the driving gear clutch, and turns the tuning condenser. Rotation continues until the insulation strip comes under the particular station setting contact, and the motor circuit is broken. But the inertia of the flywheel floating on the condenser shaft carries the insulation strip past the station contact so that it now touches the other half of the disc. This reverses the motor, but the floating flywheel is still turning in the original direction and, therefore, slows down the reversing motion of the motor. As a result the selector disc is moved back slowly until the insulation strip is again under the station contact. This breaks the circuit and stops the motor mechanism. The flywheel adjustment screws should always be set to give the least number of reversals with the chassis in the normal horizontal position.




The divided selector disc which is fastened on the rear shaft of the condenser with two set-screws, should have the insulation strip in a horizontal line at maximum condenser capacity (plates fully meshed), and with the operating end at the left when viewed from the rear. The operating end has black insulating material and the brass is bevelled. Also, it should be set so that the contact-tip plungers do not project more than 1/16th of an inch from the body of the contacts.

While the electric tuning mechanism is in action, the motor-supply voltage is fed to one of the diode plates, and the diode current, in flowing through the 470,000-ohm load resistor R-8, sets up a voltage drop that biases the first audio stage to the cutoff point. This renders the audio amplifier mute or silent. When the motor circuit is opened, this bias is removed, and the amplifier is operative again.

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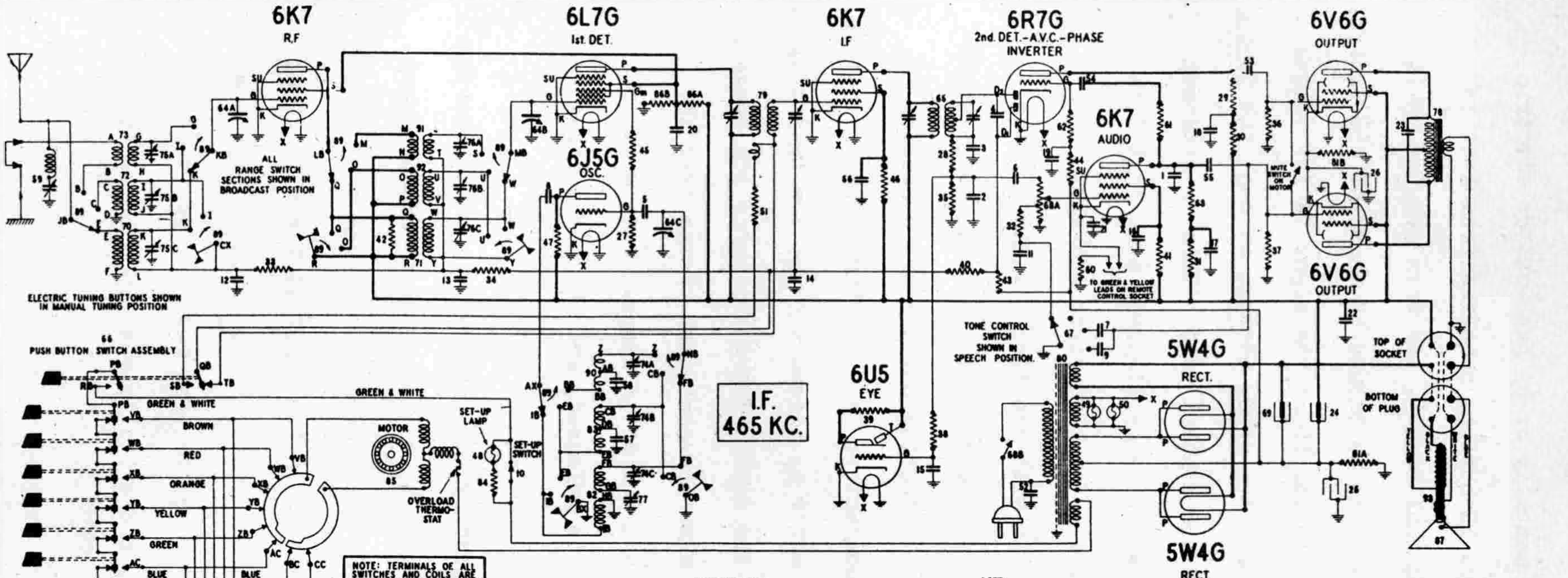
FIG. 7. Models 99K and 99T.

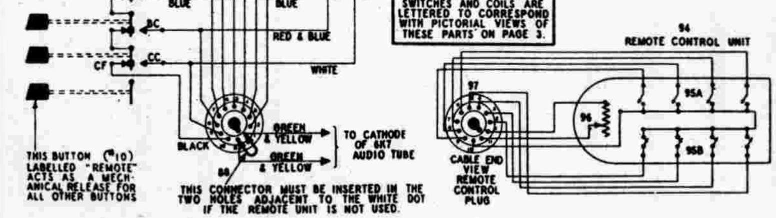
The eight station selecting buttons are adjusted in the following manner: 1. Make a list of the desired eight stations, arranged in order from low to high frequencies. 2. Turn range selector to A-band, turn power on, and allow 10 to 15 minutes for warming up. 3. Press down the dial-tuning (right-hand) button. 4. Manually tune in the first station on the list, using the Magic Eye for accurate tuning. 5. Hold down the dial-tuning button, and press down station button No. 1 (second from left). Both buttons will stay down. Move station-setting contact No. 1 to the insulating line on the disc at rear of gang. When the contact is correctly centered on the insulating line, the central dial lamp will go out. 6. Press down any other button in order to release the dial-tuning button and station button No. 1. Then press down station button No. 1 again. The electric tuning mechanism will function to tune in the station, and the central dial lamp will stay on. 7. Repeat this process for the remaining stations.

## STEWART-WARNER MODELS 91-111, 98-111, AND 91D-111

The Stewart-Warner chassis No. 91-111, 98-111 and 91D-111 all are alike in circuit arrangement, and differ only in their power supply rating. The circuit system is an 11-tube (including tuning indicator) 3-band superheterodyne, employing a preliminary 6K7 R.F. stage and a 6J5G oscillator, both feeding into a 6L7G 1st detector. A single I.F. stage feeds into a 6R7G 2nd detector that also supplies the A.V.C. potential and functions as phase inverter. A 6K7 is used as 1st audio amplifier and is resistance coupled to a pair of 6V6G output tubes in push-pull. Two type 5W4G rectifier tubes (the plates of each ties together) are used as half-wave rectifiers to render full-wave rectification. A 3-position band selector switch is employed, illustrated in the diagram in the broadcast position.

# STEWART-WARNER CHASSIS MODELS 91-III 98-III AND 910-III

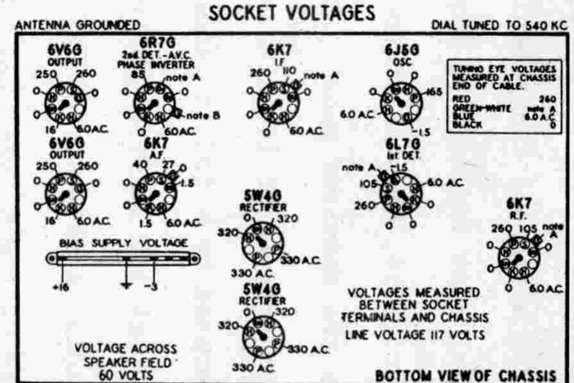



## PARTS LIST

| DIAGRAM NUMBER | PART NUMBER | DESCRIPTION | LIST PRICE |
|---|---|---|---|
| 1 | 83539 | Condenser - mica 250 mmfd. | $ .20 |
| 2-3-4 | 83783 | Condenser - mica 110 mmf. | .20 |
| 5 | 85061 | Condenser - mica 51 mmfd. | .15 |
| 6 | 88028 | Condenser - paper .02 mfd. 400 V. | .25 |
| 7 | 88029 | Condenser - paper .004 mfd. 400V. | .25 |
| 8-9 | 88030 | Condenser - paper .01 mfd. 400 V. | .25 |
| 10 | 88054 | Switch - for set up | .30 |
| 11 | 88185 | Condenser - ceramic tube .006 mfd. 600 volt | .25 |
| 12-13-14-15 | 88189 | Condenser - paper .05 mfd. 200 V. | .25 |
| 16-17-18 | 88191 | Condenser - paper .1 mfd. 300 V. | .25 |
| 19 | 88990 | Condenser - paper .5 mfd. 150 V. | .35 |
| 20 | 89421 | Condenser - paper .1 mfd. 200 V. | .25 |
| 21 | 89532 | Condenser - paper .25 mfd. 200 V. | .32 |
| 22 | 89643 | Condenser - paper .25 mfd. 300 V. | .40 |
| 23 | 89826 | Condenser - paper .004 mfd. 750V. | .24 |
| 24 | 89937 | Condenser - elect. 30 mfd. 450 V. | 1.60 |
| 25-26 | 110377 | Condenser - elect. 10 mfd. 25 V. | .80 |
| 27-28-29-30-31-32 | 110552 | Resistor - carb. 47,000 ohms ½ W. | .12 |
| 33-34-35-36-37 | 110553 | Resistor - carb. 220,000 ohms ½ W. | .12 |
| 38-39-40-41 | 110554 | Resistor - carb. 1 meg. 1/4 watt | .12 |
| 42 | 110557 | Resistor - carb. 4,700 ohm 1/4 W. | .12 |
| 43-44 | 110559 | Resistor - carb. 470,000 ohms ½ W. | .12 |
| 45 | 110560 | Resistor - carb. 100 ohm ½ watt | .12 |
| 46 | 110564 | Resistor - carb. 100,000 ohm ½ W. | .12 |
| 47 | 110568 | Resistor - carb. 15,000 ohm 1 W. | .15 |
| 48-49-50 | 110629 | Lamp - 6.3 volt - .25 amps. | .15 |
| 51 | 110975 | Resistor - W.W. 33 ohm 1/2 watt | .12 |
| 52 | 111214 | Condenser - paper .01 mfd. 600 V. | .24 |
| 53-54-55-56 | 111252 | Condenser - paper .05 mfd. 400 V. | .13 |
| 57 | 112426 | Condenser - mica 1650 mmfd. (3%) | .30 |
| 58 | 112427 | Condenser - mica 4050 mmfd. (3%) | .40 |
| 59 | 112796 | Coil - wave trap (with trimmer) | .50 |
| 60 | 112955 | Resistor - carb. 1000 ohms 1/4 watt (10%) | .12 |
| 61 | 112956 | Resistor - carb. 220,000 ohms 1/4 watt (10%) | .12 |
| 62 | 112958 | Resistor - carb. 18,000 ohms 1/4 watt (10%) | .12 |
| 63 | 112959 | Resistor - carb. 120,000 ohms 1/4 watt (10%) | .12 |
| 64A to C | 113219 | Condenser - variable gang | 6.80 |
| 65 | 113229 | Transformer - 2nd I. F. | 1.64 |
| 66 | 113256 | Push-Button Switch Assem. | 3.75 |
| 67 | 113257 | Switch - Tone control | .70 |
| 68A-68B | 113258 | Volume Control - 250,000 ohms with off-on switch | .95 |
| 69 | 113261 | Condenser - elect. 30 mfd. 450 V. | 1.40 |
| 70 | 113295 | Coil - antenna (B.C.) | 1.20 |
| 71 | 113296 | Coil - R. F. (B.C.) | 1.30 |
| 72 | 113298 | Coil - antenna (Police) | .50 |
| 73 | 113301 | Coil - antenna (S.W.) | .52 |
| 74A to C | 113319 | Condenser - trimmer - 3 section | .54 |
| 75A to C, 76A to C | 113320 | Condenser - trimmer - 3 section | .54 |
| 77 | 113346 | Condenser - padding | .38 |
| 78 | 113361 | Transformer - output | 2.90 |
| 79 | 113382 | Transformer - 1st I.F. | 2.40 |
| 80 | 113394 | Transformer - power 117 volt 60 cycle | 9.00 |
| 81A-81B | 113399 | Resistor - Bias Strip, Section A - 20 ohms, Section B - 200 ohms | .38 |
| 82 | 113411 | Coil - oscillator (B.C.) | .50 |
| 83 | 113412 | Coil - oscillator (Police) | 1.20 |
| 84 | 113430 | Resistor - candohm 90 ohms | .26 |
| 85 | 113450 | Motor - for electric tuning (supplied with tuning shaft & gear) | 7.80 |
| 86A-86B | 113469 | Resistor - Bleeder, Section A - 6800 ohms, Section B - 5600 ohms | .92 |
| 87 | R-113482 | Cone - voice coil for R-115016 speaker | 2.10 |
| 88 | 113499 | Connector Link - for remote control plug | .01 |
| 89 | 113529 | Switch - range | 2.10 |
| 90 | 113607 | Coil - oscillator (S.W.) | .52 |
| 91 | 113608 | Coil - R.F. (S.W.) | .60 |
| 92 | 113609 | Coil - R.F. (Police) | .50 |
| 93 | R-115018 | Speaker - dynamic 12" | 10.00 |

## SOCKET VOLTAGES




REAR OF CHASSIS

Use a high resistance voltmeter of at least 1000 ohms per volt.

NOTE A: The bias for the control grids of the 6L7-G, 6K7-R.F., 6K7 I.F. and the diode plate (D) of the 6R7-G tubes is -3.0 volts measured across resistor 81A.

NOTE B: The bias for the control grid of the audio section of the 6R7-G is -3.0 volts measured across resistor 81A.

These receivers can be tuned either manually or by push-button electric motor tuning. The automatic tuner employs 10 buttons numbered from left to right. Button No. 1 at the left is for manual tuning, and when pressed in it opens the motor circuit, and the condenser gang is turned by means of the control knob provided on the receiver panel. Button No. 10 at the right is for remote control, and when pressed in it releases all the other buttons so that the tuning motor can be operated by a remote push-button control unit. This is attached to a 20-ft. cable at the receiver end of which is an 11-prong plug that fits into a corresponding socket at the left rear of the receiver chassis.

The motor is of the direct turning type with two field windings, each connected to one section of a divided brass drum which is mounted on the rear of the condenser shaft. The eight station selecting buttons are connected in series and through color-coded wires to contactors on this drum. When a station button is pressed in, the circuit to the motor is closed through the lead that connects this button to the contactor on the drum. The motor turns the condenser toward the active station contactor; and when the contactor passes over the insulated divider, the circuit is opened and the motor stops. When another button is pressed in, the previous button is released, and the motor turns the condenser to the new active contactor

A muting system is also used for silencing the receiver while the electric tuner is in action. While the motor is at rest, the rotor is forced backward out of the magnetic center by the action of a coiled spring. When the motor circuit is closed, the rotor is pulled forward by the magnetic field, causing it to close a switch which short-circuits the grids of the output tubes, and this silences the receiver. As the motor comes to rest when the desired station is tuned in, the rotor slides back again, the switch opens, and the receiver is operative.

Two degrees of selectivity are provided in these receivers. Pushing in button No. 1 at the left for manual tuning provides maximum selectivity. But if one of the eight automatic station selecting buttons is pushed in, the manual button is released, and through the action of a double-throw switch mounted on this button an additional coupling coil and series resistor are connected into the secondary of the 1st I.F. transformer. This broadens the tuning appreciably during automatic operation and overcomes the need of automatic frequency control. If this broader tuning is wanted for manual operation, button No. 10 (the button at the right for remote tuning) is pushed in. This clears all the other buttons, cuts out the motor, and inserts the broadening I.F. coil.

The eight station selecting buttons are set up in the following manner: A good antenna system is necessary to provide ample signal voltage. 1. Turn on the set and allow it to heat up for at least 15 minutes. 2. Select the 8 desired stations and arrange them in order for increasing frequencies. 3. Move the "set-up switch" which is mounted on the back of the chassis to the right. 4. Push in the manual button No. 1 at the left, and with the tuning knob tune in the first station (lowest frequency) on the list, carefully observing the tuning eye for accurate adjustment. 5. Push in button No. 2, the first automatic station selecting button. The lamp mounted on the back of the chassis to the right of the selector drum should light, unless the tuner is already set for this station and then it will not light. 6. Adjust the contactor for this button by loosening the knurled nut about one-half turn and sliding the contactor along the bridge to the point indicated by the white arrowhead on the side of the round drum. At this point the lamp at the rear of the chassis will go out. When the setting is as accurate as possible, tighten the knurled nut again.

This completes the set up for button No. 2, the first automatic station button.

7. Button No. 3 (the second automatic station selector) is then set up in a similar manner, as are the six remaining buttons from No. 4 through No. 9. The station frequencies should all increase from left to right. 8. After all eight buttons have been set up according to the above procedure, throw the "set-up switch" at the rear of the chassis to the left again so that the white dot shows. This closes the tuning motor circuit, and makes the automatic push-button tuner ready for operation.

Provisions are also made so that these receivers can be tuned from a remote position to within 20 feet of the receiver cabinet. The remote control unit contains eight station selecting push-buttons and a volume control. This unit is connected by a flat flexible cable to an 11-prong plug which fits into a corresponding socket at the left rear on the chassis.

To connect this remote control unit proceed as follows: Turn off the radio set, and remove the wire connector that joins the two holes next to the white dot on the 11-hole socket. Important--if the remote control unit is later to be disconnected and the 11-prong plug is removed, this wire connector must be returned into the two holes in the socket adjoining the white dot, for as can be seen from the circuit diagram, this wire connector closes the cathode circuit of the 6K7 1st audio tube when the 11-prong plug is not in the socket.

After the wire connector is removed, insert the plug into the socket and locate the remote control unit wherever it is desired within range of the cable. The remote control unit buttons, it can be seen from the diagram, are in parallel with the buttons on the set tuner, and correspondingly numbered buttons will tune in the same stations.

The remote volume control is in addition to the regular manual control on the receiver, and the remote control can never increase the volume above that permitted by the control on the set. Therefore, the control on the set must be adjusted for the maximum volume that may be wanted from the remote control, and the latter is then used merely to reduce the volume to the level desired.

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