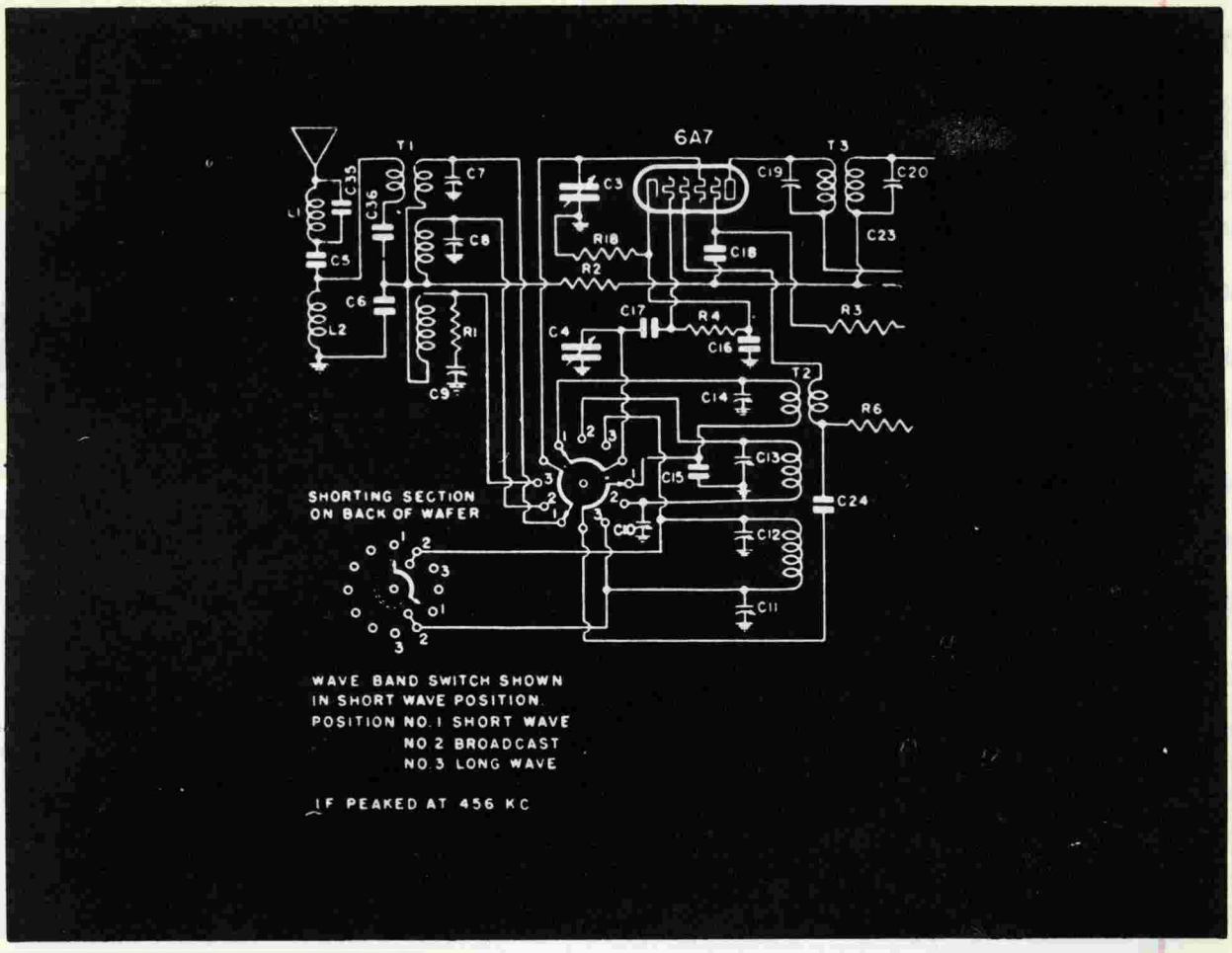

LESSON
45 R

ALL WAVE SUPERHETERODYNE RADIO RECEIVERS

RADIO-TELEVISION TRAINING SCHOOL, INC.
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LOS ANGELES

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ALL WAVE SUPERHETERODYNE RECEIVERS

The modern all-wave superheterodyne is similar in circuit arrangement and performance to the familiar broadcast superheterodyne receiver, except that in addition it is equipped with a tuning system that covers not only the broadcast frequencies of 540 to 1600 kilocycles, but also embraces the higher frequencies or short wave bands. Some receivers are designed to tune as high as 30,000 kilocycles (10 meters) and as low as 150 kilocycles (2000 meters).

To properly cover these extended frequency ranges a divided or split tuning system is employed, for it is impossible to design a tuner that is continuously variable and that will tune effectively over such a wide range. In practice a number of individual tuners are used, consisting generally of a group of coils each of which can be switched at will across a common tuning condenser. Each tuning combination can then be designed to tune efficiently over a certain band of frequencies.

FREQUENCY RANGES AND TUNING BANDS

It is a common practice to divide the entire frequency spectrum into four slightly overlapping bands: the first extends from 540 to 1600 kc. (555.5-187.5 meters), the second from 1600 to 5000 kc. (187.5-60 meters), the third from 5000 to 12,000 kc. (60-25 meters), and the fourth from 12,000 to 30,000 kc. (25-10 meters). With different manufacturers the limits of these bands may vary somewhat up or down, but the values given are about the average used.

Some receivers tune only over two of these bands, some over three, others over all four, and a few include a fifth band, from 150 to 410 kilocycles (2000 to 732 meters). A rather common arrangement is the use of two bands one of which tunes over the American broadcast frequency range of 540 to 1600 kc. (555.5-187.5 meters) and the second covers the European and other foreign broadcast frequencies of 5,800 to 16,200 kc. (about 54 to 18 meters). Sometimes such a

system is referred to as a skip-band receiver, since it skips the band of frequencies between 1600 and 5800 kc. Multi-wave sets designed to cover three tuning ranges generally include in addition to the American broadcast and foreign broadcast ranges a third band that tunes from 1600 to 4500 kc. or in terms of wave length 187.5 to 75 meters. This 75 to 200 meter band covers the amateur radiophone and police transmitting frequencies, as well as the aviation phone communication frequencies. The two most interesting and popular bands, of course, are the American broadcast frequencies from 540 to 1600 kc. and the foreign broadcast frequencies from 5800 to 16,200 kc.

RECEIVERS WITH TWO AND THREE TUNING BANDS

Multi-wave receivers designed to operate over two tuning ranges are probably the most popular and will be encountered more frequently in radio service work. The double-range tuning systems used in these receivers are of two kinds--in one a single coil is used tuned by a condenser, but the coil is tapped and the tap brought out to a short-circuiting switch. For the broadcast frequency range the entire coil is used and tuned by the condenser, but for the higher frequency or short wave range a part of the coil is shortcircuited so that a smaller number of turns are tuned by the condenser. This permits the system to tune through the higher frequencies. Of course, both the antenna coupler and the oscillator coil must be tapped in this manner, and if a preliminary radio frequency stage is used, the R.F. transformer secondary must be similarly tapped so that all will track properly, that is, tune to the same frequency at each setting of the condenser.

The other type of double range tuner employs two individual coils for each unit or stage, and by means of a suitable gang switch either coil can be connected across the tuning condenser. With one coil the tuning range extends

through the American broadcast frequencies and with the other coil it extends through the foreign broadcast frequencies or whatever range it was designed to cover. Two sets of coils or windings are thus needed for the antenna coupler and two for the oscillator coil, and if a radio frequency amplifier stage is used, two more coil sets are needed for the R.F. transformer. As will be seen from the circuits that are discussed in the following paragraphs some of these coil sets have a common primary while others have an individual primary for each tuned coil.

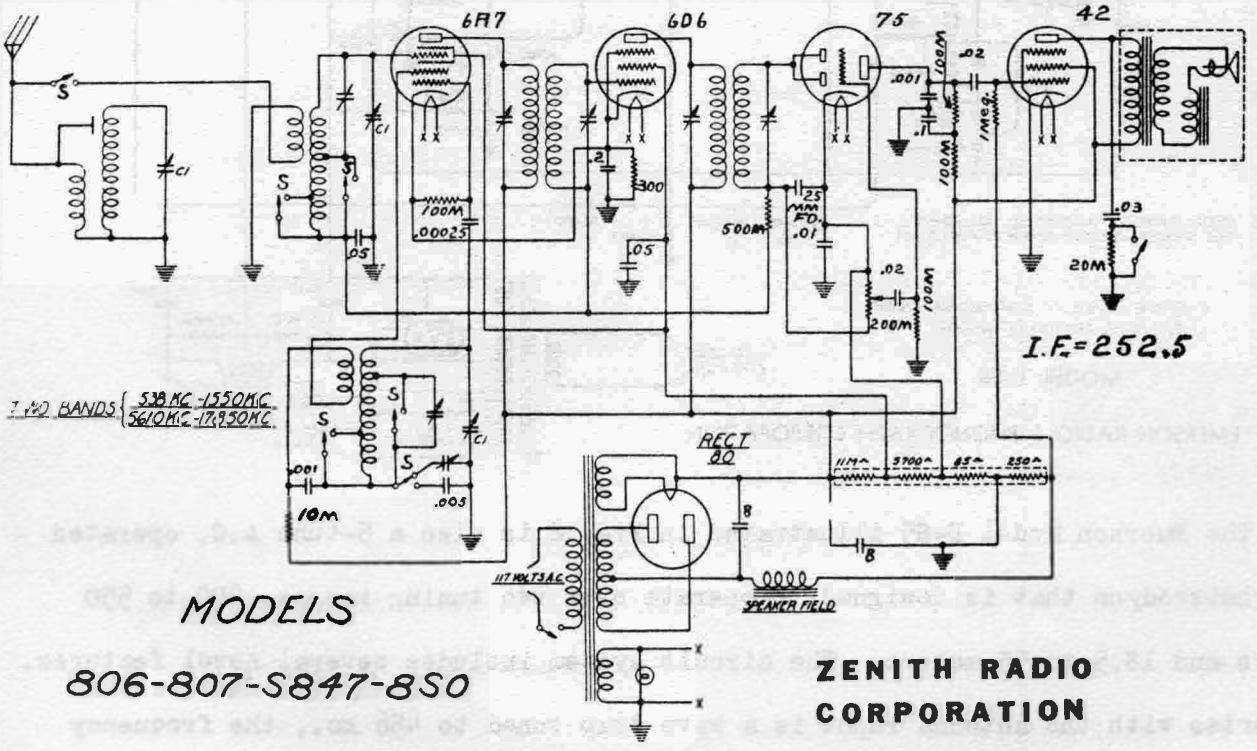
Receivers designed to operate over three tuning ranges always employ individual tuning coils for each frequency band, each coil consisting of a primary and a secondary. In this manner most efficient response is obtained over the respective tuning bands. Usually each coil is wound on a separate form, but in some sets the coils are individually shielded while in others the whole assembly is housed in a shielded compartment. In every case each coil or each coil section is shunted by a trimmer condenser so that proper tracking can always be established with the oscillator tuning system. The number of trimmers used in some sets thus runs rather high.

THE ZENITH MODELS 806 - 807

The Zenith Models 806 and 807 illustrated in Fig. 1 are a good example of a 2-band receiver that operates over the American broadcast and foreign or shortwave frequencies, 538 to 1550 kc. and 5610 to 17,850 kc. The tuning system employs two tapped coils, one in the 1st detector input and the other in the oscillator circuit. By means of a 6-point 2-position switch labeled S i n the diagram either the entire coils are thrown into use or only a portion of them.

As illustrated in the diagram, the switches are in the broadcast position. In this position a pre-selector coil is operative in the input system to

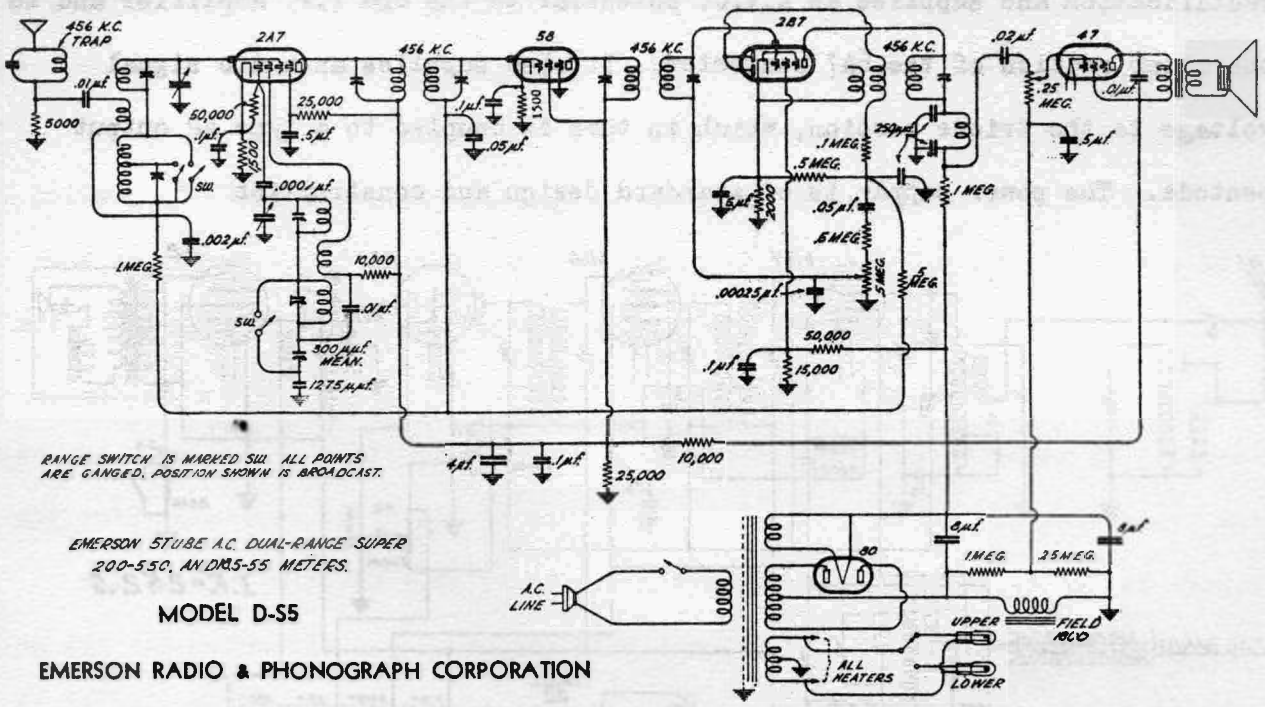
improve the tuning selectivity over the broadcast frequencies. A 3-gang condenser C-1 is used, one section tuning the selector coil, another the detector coil, and the third the oscillator coil. The receiver operates as a standard broadcast superheterodyne with one intermediate frequency amplifier stage. A type 75 tube in the 2nd detector provides half-wave double diode rectification and supplies an A.V.C. potential to the 6D6 I.F. amplifier and to the mixer section of the 6A7 converter. It also supplies an audio signal voltage to the triode section, which in turn is coupled to a type 42 output pentode. The power supply is of standard design and construction



With the switch S in the short wave position, the pre-selector becomes inoperative and a special primary is cut in for the detector coil. At the same time a portion of the detector coil and of the oscillator coil is shortcircuited so that the tuning system responds to a range of higher frequencies. The rest

of the circuit is unaffected and operates as formerly. Special trimmer and padding condensers, it will be seen, are provided for both the broadcast and short wave frequency settings. The receiver is balanced and aligned like a regular broadcast superheterodyne.

THE EMERSON MODEL D-S5



The Emerson Model D-S5 illustrated in Fig. 2 is also a 5-tube A.C. operated superheterodyne that is designed to operate over two tuning ranges, 200 to 550 meters and 18.5 to 55 meters. The circuit system includes several novel features. In series with the antenna input is a wave trap tuned to 456 kc., the frequency of the intermediate amplifier. The trap rejects all signals at this frequency, and thus prevents interferring signals from riding through into the I.F. amplifier.

The detector and oscillator coil each consists of two sections connected

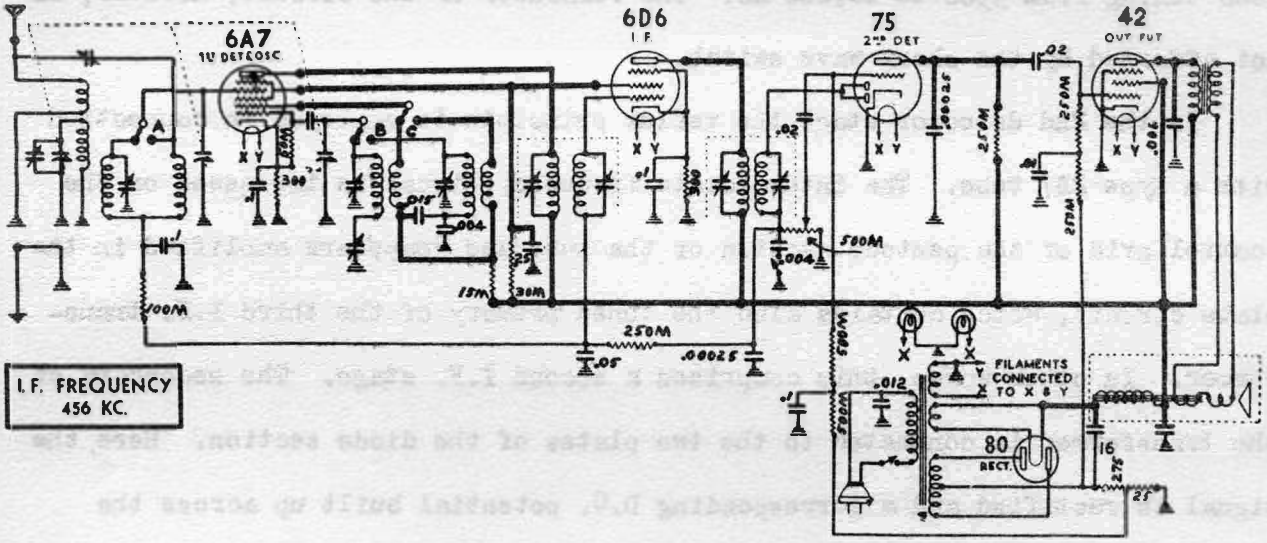
in series and arranged so that a section of each can be shortcircuited by means of a 2-position switch. As illustrated in the diagram, this switch is in the broadcast position and the full inductance value of each coil combination is effective across the main tuning condenser. When the switch is thrown into the short wave position, one section of each coil is short circuited, and the tuning condenser is connected across the remainder of the coil, this combination then tuning from 5500 to 16,200 kc. The remainder of the circuit, however, is not affected by the short wave switch.

In the 2nd detector stage the reflex principle is employed in connection with a type 2B7 tube. The intermediate frequency signal is impressed on the control grid of the pentode section of the tube and reappears amplified in the plate circuit, which contains also the tuned primary of the third I.F. transformer. In other words, this comprises a second I.F. stage. The secondary of the transformer is connected to the two plates of the diode section. Here the signal is rectified and a corresponding D.C. potential built up across the .5-megohm load resistor. This potential is then employed for automatic volume control and is impressed on the control grid of the type 58 1st I.F. amplifier and the pentode section of the type 2A7 converter.

The same potential is also transmitted through the .05-mfd condenser and the .5 megohm resistor, and built up across the .5-megohm potentiometer. The position of the slider of this potentiometer determines how much of this potential is picked up and in turn re-impressed on the grid of the pentode section of the tube. Here the signal is again amplified, but this time at an audio frequency, and relayed to the plate circuit where it passes through the I.F. transformer secondary and the low-pass filter and builds a potential across the 1-megohm plate load resistor. It is then passed on through the .02-mfd condenser

to the grid of the type 47 output pentode. The low-pass filter keeps the I.F. signal out of the audio coupling unit. The 2B7 tube thus performs as a 2nd I.F. amplifier, a half-wave rectifier detector, and a 1st audio amplifier, in addition to providing the A.V.C. potential. The manual volume control consists of a 250,000-ohm potentiometer in the grid circuit of the output pentode.

THE STEWART-WARNER MODEL R-130 CHASSIS



The Stewart Warner Model R-130 chassis is another excellent example of a 2-band receiver. The circuit diagram is illustrated in Fig. 3. A 3-point 2-position switch is used for shifting the tuning from the broadcast to the short wave range.

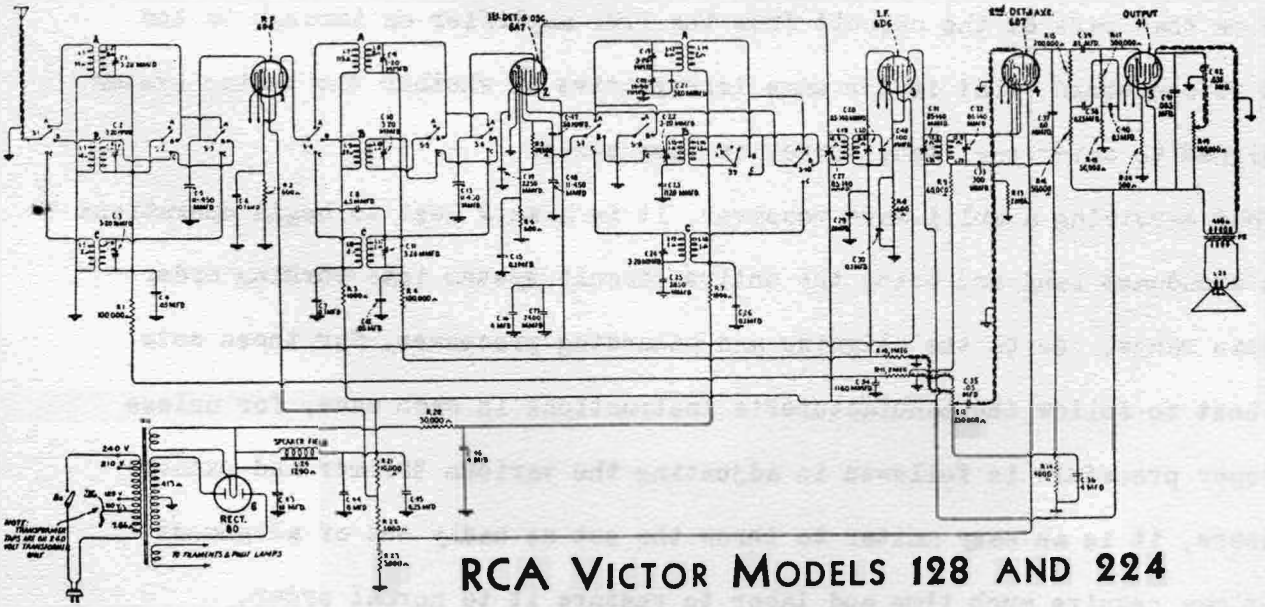
With the switch as shown in the broadcast position, the antenna is coupled through a pre-selector coil for improved selectivity to the tuned secondary which feeds into the control grid of the pentode section of the type 6A7 converter. Each of these coils is equipped with individual trimmers for aligning purposes. The oscillator also has two coil assemblies, one for the broadcast

range and another for the short wave range. Each coil has its own feedback winding in the anode grid circuit for sustaining oscillations.

When the switch is thrown into the short wave position, the pre-selector becomes inoperative and the antenna is coupled through a small trimmer condenser to the short wave coil which is now across the main tuning condenser. In the oscillator section the short wave coil is also connected across the oscillator tuning condenser, and the anode grid circuit is switched through the short wave feed back coil.

The remainder of the circuit is of standard design and arrangement and is not affected by the position of the short wave switch. Automatic volume control is provided for the I.F. amplifier and the pentode section of the type 6A7 converter. The manual volume control is a 500,000-ohm potentiometer that at the same time comprises the load resistor for the diode rectifier of the type 75 2nd detector tube. The triode section of this tube operates as a 1st audio amplifier and is resistance coupled to a type 42 output pentode.

R. C. A. VICTOR MODELS 128 and 224



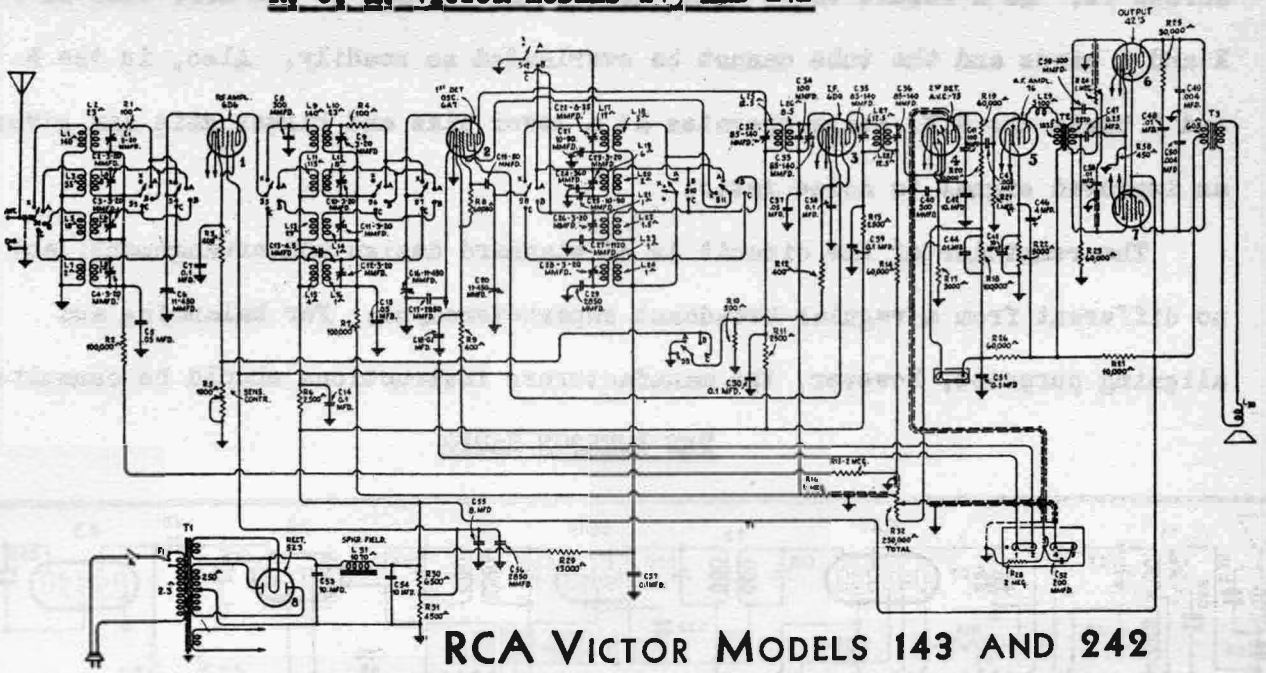
RCA VICTOR MODELS 128 AND 224

The R. C. A. Victor Model 128 is a good example of a multi-wave receiver designed to operate over three tuning bands or frequency ranges. As illustrated in the circuit diagram in Fig. 4, a preliminary R.F. stage is used ahead of a composite 1st detector oscillator stage and these are followed by an I.F. amplifier, 2nd detector, and audio output stage.

Three groups of tuned circuits are used, one group for each tuning band. A 10-point 3-position selector switch is provided for selecting the desired frequency band. At the same time it will be seen by tracing the circuit that the switch also short-circuits the preceding lower frequency R.F. and detector coils and the two preceding oscillator coils. This is done to prevent dead spots due to absorption effects by the coils, the natural periods of which, with the tuning condenser disconnected, fall in the next higher frequency band. Each tuned coil is also equipped with an individual trimmer for aligning and balancing purposes.

The tuned circuits are easy to trace through, and for each position of the band selector switch the set operates as a straight superheterodyne system. As far as that part of the circuit from the I.F. amplifier on through to the output is concerned, that is the same irrespective of whether the tuning system is designed to cover one, two, three, or four bands.

When servicing a multi-wave receiver, it is always best to begin operations on the broadcast band and bring the entire circuit system into working order over this range. As to the aligning and balancing processes, for these sets it is best to follow the manufacturer's instructions in each case, for unless the proper procedure is followed in adjusting the various trimmer and padder condensers, it is an easy matter to throw the set so badly out of alignment that it may require much time and labor to restore it to normal order.



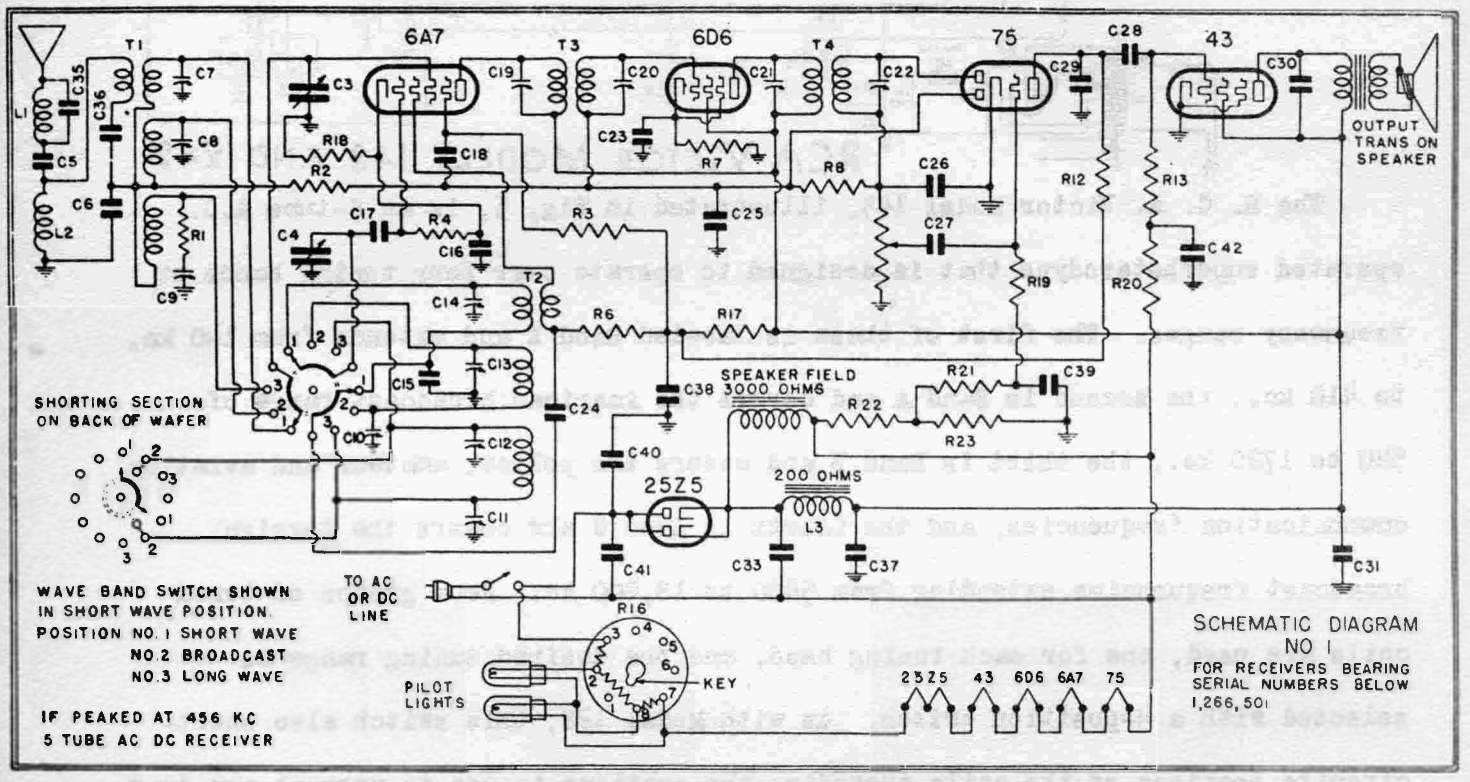
The R. C. A. Victor Model 143, illustrated in Fig. 5, is an 8-tube A.C. operated superheterodyne that is designed to operate over four tuning bands or frequency ranges. The first of these is labeled Band X and extends from 140 kc. to 410 kc., the second is Band A and covers the American broadcast range of 540 to 1720 kc., the third is Band B and covers the police, amateur and aviation communication frequencies, and the fourth is Band C and covers the foreign broadcast frequencies extending from 5400 to 18,000 kc. Four groups of tuned coils are used, one for each tuning band, and the desired tuning range is selected with a 4-position switch. As with Model 128, this switch also short-circuits sections of the coils preceding the sections in use to prevent any dead spots throughout the tuning range.

In the cathode circuit of the R.F. amplifier tube is a 1000-ohm potentiometer that serves as a sensitivity control by regulating the grid bias voltage on the R.F. tube while the selector switch is set for Bands X and A. However, on Bands B and C the switch brings the cathode return of the I.F. amplifier tube also through the potentiometer, and at the same time shunts a 500-ohm resistor

across it. As a result there is a higher bias voltage on the R.F. tube in the X and A bands and the tube cannot be overloaded so readily. Also, in the B and C bands the R.F. stage operates at a lower bias and higher gain and gives an improved signal to noise ratio.

The remainder of the circuit is of standard design and arrangement, and no different from a regular broadcast superheterodyne. For balancing and aligning purposes, however, the manufacturers instructions should be consulted.

THE EMERSON RADIO



The Emerson Radio illustrated in Fig. 6, is a 5 tube, 3-band, long wave, A.C.-D.C. superheterodyne having frequency ranges of:

150- 375 kc	2000--800 meters
540-1600 kc	555--187 meters
5.7-17.5 mc	52.5--17.1 meters

This set does not use an R.F. section but the signal is fed directly into the 6A7 which is a pentagrid oscillator modulator. This first detector or oscillator modulator produces the intermediate frequency which is then amplified in the intermediate frequency transformers (which are peaked at 456 kc) and coupled to the 6D6 which is the first I.F. amplifier tube. (At this point we should take notice of the fact that the first and second I.F. transformers marked T3 and T4 respectively are double tuned.) The signal is then sent through the second I.F. transformer and fed to the second detector which is a number 75 diode detector and A.V.C. audio amplifier. The second detector is resistance coupled to the number 43 which is a pentode power output tube.

This set also uses a 25Z5 dual half-wave rectifier. You will notice that this set employs a 200-ohm choke which supplies additional filter in conjunction with the 3,000-ohm speaker field. One side of the power line is indirectly grounded to the chassis base and under no circumstances should a ground wire be permitted to come in contact with any metal part of the receiver. The power supply for this receiver may be either A.C. or D.C. The standard line voltage rating is 105 to 125 volts. When operating this receiver on a D.C. line it maybe necessary to reverse the line plug to obtain correct polarity so that the receiver may operate properly. This set is equipped with a wave band switch which is shown in the short wave position. This wave band switch is known commercially as a band switch. As the name implies the wave band switch simply switches from one band of frequency to another.

The bias for the 75 and 43 tubes is developed across resistors R-22 and R-23 which is shown in the schematic diagram. The voltage across R-22 is 11 volts and the voltage across R-23 is one volt. This receiver is equipped with a wave trap which is also peaked at 456 kc which will reject all frequencies

of this value. It also employs the plug-in type of ballast resistor which is labeled R-16. The antenna coils for the three bands are wound on one form and mounted underneath the chassis deck to the right of the variable condenser. The trimmers for these coils are easily accessible through three holes in the top of the chassis. The trimmer fartherest from the front of the chassis is for the long wave antenna coil, the trimmer closest to the front chassis is for the medium wave antenna coil, and the center trimmer is for the short wave antenna coil. The oscillator coils for the three bands are wound on one form and also mounted on the inside of the rear chassis wall. The trimmers for these coils are also accessible through holes in the rear chassis wall. The trimmer fartherest from the end of the chassis is for the long wave oscillator coil, the trimmer nearest the end of the chassis is for the medium wave oscillator coil, and the center trimmer is for the short wave oscillator.

This receiver is typical of AC-DC receivers and reception with this type of receiver is excellent.

EXAMINATION QUESTIONS ON FOLLOWING PAGE.