PHILCO SERVICE

PHILCO Factory-Supervised Service

Shop Practices and Service Techniques

RADIO

NOVEMBER, 1951

SETTING DISCRIMINATOR TO EXACT CENTER FREQUENCY

There are two methods of using Model 7008 to set the discriminator to its proper center frequency. The first method described is recommended, for its more accurate and easily observed results. It consists of applying a modulated r-f signal of the correct center-frequency to the discriminator, and adjusting the discriminator secondary until the modulation disappears. In this method the modulation disappears because the output of the discriminator is zero at the center frequency. In the second method, a marker pip is made to appear on the discriminator response curve, and is set for the crossover point at the center frequency. However, the second method is less effective, because the marker pip disappears at the center frequency so that the center frequency is actually determined by noting when the marker disappears and where it reappears, and, because of the difficulty in observing the exact points of appearance of this pip, it sometimes leads to inaccurate results.

To employ the first method, connect the output of Model 7008 to the grid of the last i-f tube, and the oscilloscope input through the scope input leads to the sound-detector output (FM test jack in FM receivers). Set the MARKER FREQUENCY control for the correct center frequency, and the MASTER OSC. APPROXIMATE CENTER FREQ. control to the center frequency (MASTER OSC. BAND SWITCH to Band A). Adjust the HORIZ. GAIN control for a horizontal trace of about 20 crosshatch divisions, with the SWEEP WIDTH control at 1. Turn the FUNCTION switch to the AM RF position. Set the OUTPUT MULTIPLIER and the MASTER OSC. ATTEN. controls for a response curve covering at least 10 vertical crosshatch divisions, with the VERT. GAIN at position 2. Set the FUNCTION ATTEN. control to position 10.

If the discriminator secondary trimmer is correctly adjusted to the proper center frequency, only a typical S-shaped curve will appear. If it is not adjusted to the correct frequency, but close to it, a pattern similar to that in figure 1 will appear. Regardless of which pattern appears, adjust the secondary trimmer until figure 1 pattern appears, then vary the trimmer slowly in one direction, and then in the other direction, until the 400-cycle portion of the pattern disappears and then reappears with a further movement of the trimmer. Set the trimmer to the point at which the 400-cycle portion disappears and will reappear if the trimmer is moved slightly in either direction.

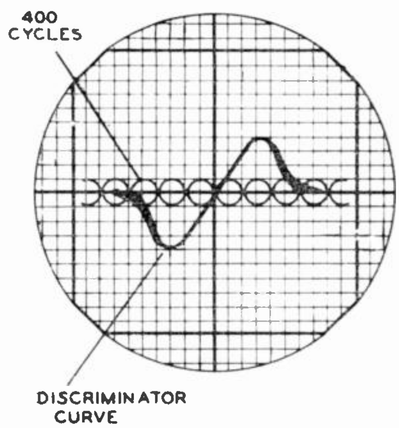

Figure 1. — Discriminator Center-frequency Pattern

NOTE: The setting of the FUNCTION ATTEN. control is critical in this application. Too much marker signal input will make the center frequency hard to find.

The user should note that the MASTER OSC. ATTEN. controls the height of the discriminator curve, while the FUNCTION ATTEN. controls the height of the 400-cycle pattern, and the OUTPUT MULTIPLIER and VERT. GAIN controls affect the height of both the curve and the 400-cycle pattern. This check should be performed a few times to enable the user to become familiar with the setting of controls.

To employ the second method, using the marker pip on the response curve, connect Model 7008 as outlined above. Control settings are the same, except that the FUNCTION switch should be set to the MKR position.

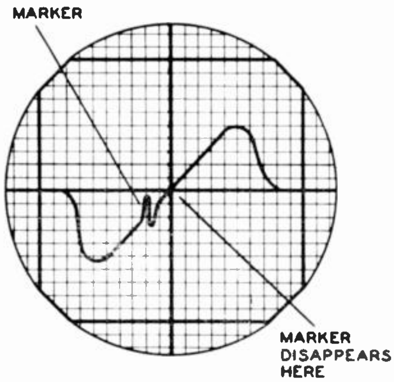

Figure 2. — Use of Marker for Locating Discriminator Center Frequency

Set the MARKER FREQUENCY control slightly off the center frequency, and adjust the controls until the marker pip is visible on the discriminator response curve. See figure 2. Then set the marker pip for the correct center frequency, and set the discriminator secondary trimmer until the pip disappears at the crossover point in the center of the response curve.

It will be found helpful to use the blanking circuit in both of the above checks, so that the crossover point can be easily determined. To use the blanking circuit, first adjust the PHASING control for a single image, then turn the BLANKING control clockwise until a single image appears with a horizontal line through the full width of the pattern retuning the MASTER OSC. APPROXIMATE CENTER FREQ. control slightly if necessary, to center the image on the scope. See figure 3.

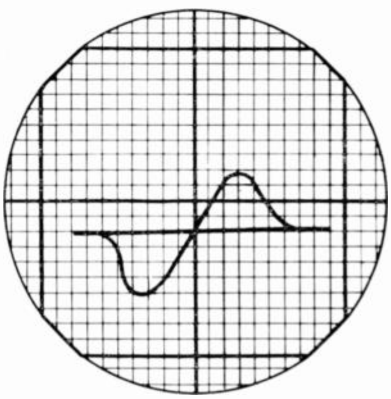

Figure 3. — Discriminator Curve—BLANKING Control Properly Set

Aligning R-F and Oscillator Stages

1. Connect the output cable of Model 7008 to the aerial terminals of the FM receiver, using an appropriate matching network if the input impedance is other than 75 ohms. Leave the oscilloscope input cable connected to the output of the detector (FM test jack).

NOTE

If the radio is equipped with an external, all-purpose aerial-matching transformer, remove this transformer and feed the signal directly into the ANT. coil.

2. Set the MASTER OSC. APPROXIMATE CENTER FREQ. control and the FM radio dial for 105 mc., and set the SWEEP WIDTH control for a total deviation of approximately 200 kc.

3. Adjust the shunt (high-frequency) trimmer of the oscillator circuit for maximum output.

4. Set the FM radio dial to 88 mc., and adjust the MASTER OSC. APPROXIMATE CENTER FREQ. control to 88 mc. Use a tuning wand and observe the oscilloscope pattern. If the signal amplitude decreases when either end of the wand is inserted in the oscillator coil, the tracking is satisfactory. If the output increases with the brass end of the wand inserted, spread the turns of the oscillator coil; if the output increases with the iron end of the wand inserted, compress the turns of the coil.

NOTE

Do not bend the coil excessively, as only a slight physical change is necessary at this frequency.

5. Repeat steps 3 and 4 until no further change is noted. The last adjustment made should be that of the shunt (high-frequency) trimmer.

6. Set the radio dial and Model 7008 to 105 mc., and adjust the shunt trimmer of the mixer grid circuit for maximum output. If an r-f stage is employed, also adjust the shunt trimmer of the r-f stage for maximum output.

7. Set the radio dial and Model 7008 to 92 mc., and check the tracking of the mixer and r-f grid circuits with the tuning wand. If the output increases with the brass end inserted in the coil, spread the coil turns; if the output increases with the iron end inserted, compress the coil turns. If the output decreases when either end is inserted, the tracking is correct. Do this for both the mixer and r-f coils.

8. Repeat the foregoing adjustments of the r-f and mixer circuits, both at 105 mc. and 92 mc., until no further improvement is noted. Make the 105-mc. adjustments last.

CHECKING R-F AND MIXER RESPONSE

The response of the r-f and mixer sections of an FM receiver may be observed with Model 7008. Connect the output of Model 7008 to the receiver aerial input through an appropriate matching network, if the input impedance of the receiver is other than 75 ohms. Connect the oscilloscope input of Model 7008 through the scope input leads to the mixer plate decoupling filter. Be sure to remove first i.f. tube. If a decoupling network is not supplied, connect the oscilloscope through the high-frequency probe to the plate of the mixer.

Set the MASTER OSC. APPROXIMATE CENTER FREQ. control to the center-channel frequency, and the FUNCTION switch to the MKR position. Adjust the SWEEP WIDTH control for the desired deviation (between 0 and 1 for FM receivers). Set the OUTPUT MULTIPLIER and MASTER OSC. ATTEN. controls for the desired pattern height, with the VERT. GAIN control at position 2. Use the MARKER FREQUENCY control to vary the marker pip along the response curve, to determine the cutoff points; the FUNCTION ATTEN. control determines the amplitude of the marker pip.

In some instances, it may be necessary to set the VERT. GAIN control to another position; it is generally good practice to keep this control near position 2, and adjust the output from Model 7008 so that the pattern is of a satisfactory height.

FM receivers will have a front-end response similar to figure 4. It will be found, generally, that the width of this front-end response curve will be from 150 to 200 kc., since it is more or less fixed by the "Q" of the circuit; that is, while alignment may change the shape of the response curve, it can vary considerably in amplitude and appear as a high narrow, peaked curve, and yet retain the band width for which it was designed.

Therefore, any adjustments of front-end response should be attempted with due consideration for both the r-f and i-f over-all response, rather than that of the r-f response alone, since it is only necessary that the frequencies within the i-f band pass are passed. The main purpose of the r-f stage is to provide good image rejection and to minimize any spurious responses which can occur. It is important, however, that the r-f response be wide enough to prevent chopping off any signal; this can be easily checked by observing the front-end response curve, and running the marker along the curve to determine the cutoff points.

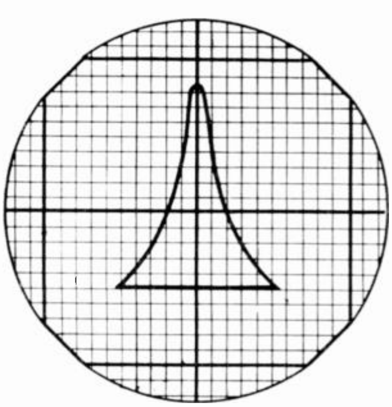

Figure 4. — R-F and Mixer Response of FM Receiver

MODERN RATIO DETECTOR

While the "locked-in" oscillator system, such as the Philco Advanced FM Detector, accomplishes FM detection without the necessity of first transforming the signal to AM, it has several limitations. It is sensitive to impulse noise to the extent that a noise pulse will upset the circuit for a short period until the oscillator can adjust itself. This effect by the AM pulse lasts only a portion of the total duration of the noise but is a factor that detracts from its performance.

There is a minimum signal (or threshold) value below which the locked-in oscillator slips out of control and returns to its free-running frequency. This is a good feature in view of the elimination of inter-station noise but its disadvantage lies in the failure to receive weak stations. However, this loss of weak stations was not a detriment to operation several years ago because the systems then in use gave rather noisy reception on weak signals.

Because of the additional oscillator, the circuit is that much less stable; such conditions as tube aging and temperature variations upset the circuit balance, causing noisy or distorted operation and requiring re-alignment. Trouble is sometimes encountered by a mis-matched tube and transformer — the circuit being critical enough that if the two components tend toward opposite ends of their allowable tolerances, the circuit either will not tune properly or will not stay in alignment over a long period. The alignment itself is considerably more critical than that of the now commonly used FM detector circuits.

At the time of its conception, the Advanced FM Detector offered several advantages over the balanced discriminator and the ratio detector. However, the action of the ratio detector has been improved to such an extent that it is now almost universally used as an FM detector.

The ratio detector circuit remains about the same as for the 1946 sets as shown in last month's article. The advancements are not readily apparent from the schematic since they are mostly in the design of the component parts. Noise rejection has been greatly improved by careful design of both the detector circuit and the discriminator transformer. The liniarity of the discriminator response curve has been improved by the design and use of tubes having superior diode characteristics. The transformers require no loading networks when aligning, as the bandpass characteristics are designed into the single peaked units. All that is required is the adjustment of the primary and secondary slugs (powdered iron cores) for maximum.

A typical, modern, ratio detector circuit is shown in Figure 5. To understand how this circuit operates, it is necessary to review the operation of the standard ratio detector. The two diodes are connected in series and a controlling voltage is established in the circuit which is dependent upon the average value of the incoming carrier. Due to the long time constant of the R-C filter in the network, instantaneous changes in signal amplitude are prevented from affecting the audio output voltage. Furthermore, this control voltage sets the limit to the maximum audio voltage that can be obtained. Thus, if a small condenser is connected in series with each tube, the voltage appearing across each will depend upon the input frequency. However, at all times, their sum is equal to the control voltage. Changes in signal frequency will merely alter the ratio of their voltages. Since the audio output is taken from across one of these condensers, the audio can vary in amplitude from zero to the value of the control voltage.

In the modified form of the above, see Fig. 5, the same control voltage is maintained, but the two condensers are replaced by one which is in series with both tubes. In order to understand the operation of the circuit without C_1, it must be kept in mind that the voltage across C_2, is determined by:

1. The potential of R & C. This in turn, is fixed by the average amplitude of the incoming FM signal.
2. The frequency of the incoming signal.
3. The relative currents flowing through V_1 and V_2. This, of course, depends upon #2 above.

Referring to Figure 5, the voltage applied to V_2 is the vector sum of E_{L_4} and E_3. Similarly, the voltage active across V_1 is composed of E_{L_4} and from the mid-IF value at which point the voltages of V_1 and V_2 are E_2. As the frequency shifts equal and opposite in response to modulation, the total voltages at V_1 and V_2 will follow suit.

Consider, now, the current paths for each of the tubes. V_1 is part of the complete path AFEDCBA. Its current can also flow through the path AFEDGBA. For V_2, the two paths are: GBAFEDG and ABCDG. In other words, currents from each tube can flow around the outer path (GBAFEDG) or part of each can be diverted through L_4 and C_2 of the center path.

When the total voltages applied to each tube are equal (at mid-frequency), no current flows through L_4 and C_2 because of equal and opposite currents. This is true of all ratio detectors. At points other than mid-frequency the current of one tube is greater and a portion of it does pass through L_4 and C_2. Hence, the voltage across C_2 will be a function of frequency. Due to the fact that each tube is connected into the circuit in an opposite manner, their currents (from V_1 and V_2) flowing through L_4 and C_2 will likewise be opposite. Therefore E_{C_2} will possess one polarity for frequencies above resonance and the opposite polarity for frequencies below resonance. An audio voltage is then obtained from across C_2.

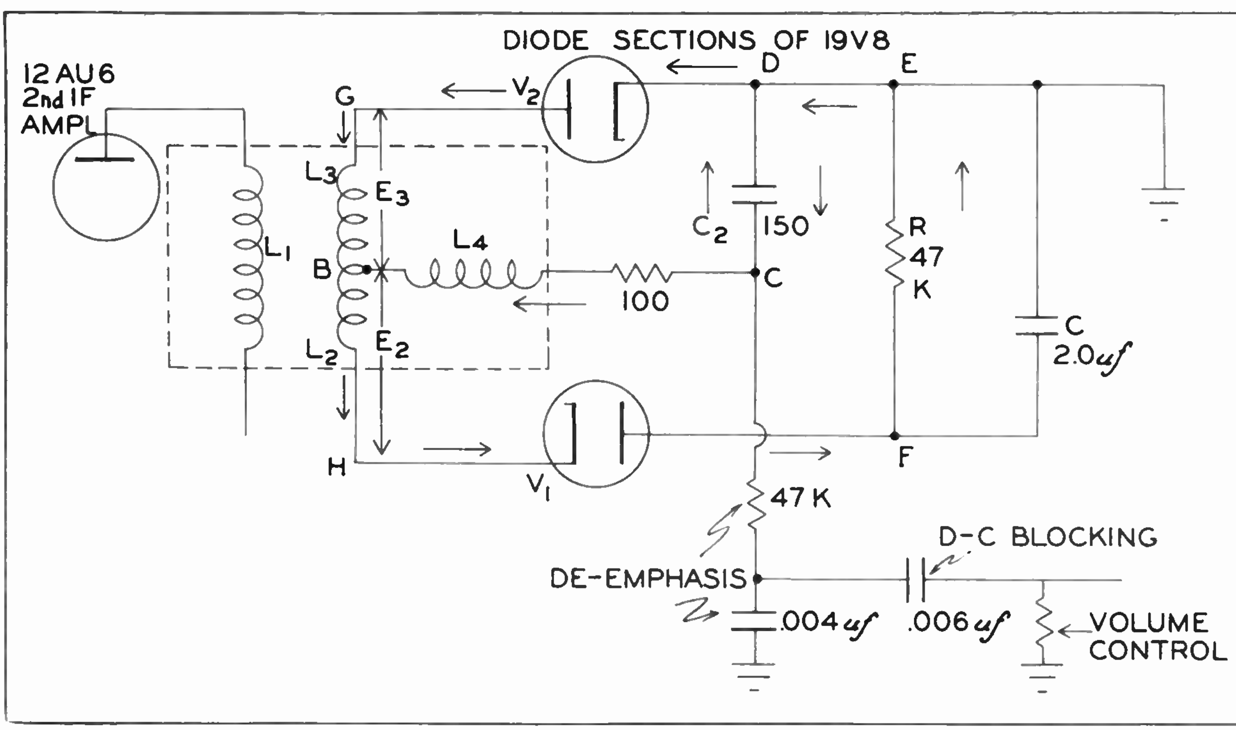

FIGURE 5.

PHILCO SERVICE

New Product News

RADIO

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ALIGNMENT OF RECEIVERS

FM RECEIVER ALIGNMENT

The following article is a discussion of the alignment of FM receivers using a sweep generator and an oscilloscope. A Philco Visual Alignment Generator, Model 7008 will be used to indicate the ease of operation of this unit. A complete alignment will be made to show the proper sequence of adjustments. This information can also be applied to the use of other comparable equipment.

There are three types of FM detectors that are in general use; other special types which are not generally used will not be discussed. The three general types are the limiter-type detector, the ratio detector, and the Philco Advanced FM Detector; the type of detector determines the procedure to be followed.

Model 7008 possesses high signal output and unusual oscilloscope sensitivity, together with more than sufficient sweep deviation. Therefore, it is not necessary in most cases to align the i-f stages before aligning the discriminator; instead, the discriminator may be aligned first, and the remainder of the set aligned to the discriminator. Since the effect of the adjustments are visible at all times, no guess work is involved. Regardless of whether the stages are single or double peaked, the adjustments are easily made for symmetrical response. While it may be found that the visual alignment produces less audio output than other previously employed methods of alignment, it will also be found that, after visual alignment for true symmetry, better sound quality and noise reduction are obtained.

The r-f (marker) generator should be used to check the maximum and minimum points of the response curve, but it is not good practice to leave it set to one of these points, because insertion of the marker signal produces some distortion of the response curve. Use the crosshatch screen as a graph, locating the desired change points at some easily determined crosshatch line. For example, the center or crossover point may be located at the intersection of the heavy horizontal and vertical crosshatch lines in the middle of the screen, and the peaks of discriminator response can be located 5 divisions either side of center. Thus true symmetry can be determined by counting the number of divisions to the right and left and above and below the center lines.

Use the blanking circuit to furnish a reference line, being certain to first adjust the PHASING control for a single image with the BLANKING control in the OFF position, and to turn the BLANKING control clockwise until a single image with base line appears.

Adjust the SWEEP WIDTH and VERT. GAIN controls to keep the image on the c-r tube at a convenient size. Figure 1 shows insufficient sweep width, while

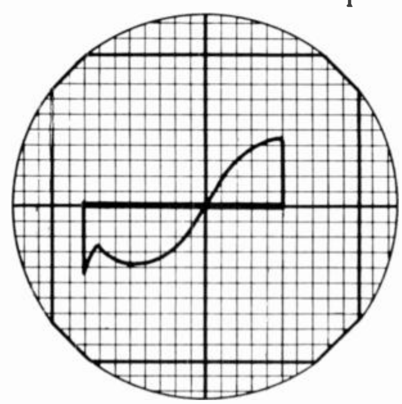

Figure 1. — SWEEP WIDTH Control Set Too Low

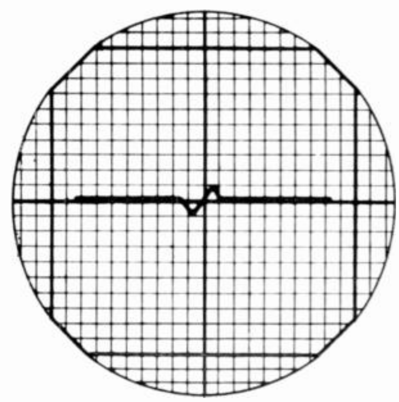

Figure 2. — SWEEP WIDTH Control Set Too High

figure 2 shows too great a sweep width. As a general rule, changes in symmetry may be more easily determined when the response curve is large than when it is small. Once proper sweep setting is obtained, blanking must be removed and the PHASING control reset for curve coincidence.

Connect the output cable of Model 7008 to the stage ahead of the one being checked, through a .01-mf. blocking condenser, and connect the input through the scope leads to the detector audio output (FM test jack in Philco receivers). Where it is desired to check individual stages ahead of the detector, connect the input of

Model 7008 through the high-frequency probe to the grid of the stage following the one being checked.

NOTE

Before starting the actual alignment, allow Model 7008 and the FM receiver to warm up for a period of at least 15 minutes.

Limiter-Type Detector

1. Referring to figure 3, connect the output cable of Model 7008 between test point B and ground; connect the input through the scope input leads between test point A and ground.
2. Set the MASTER OSC. APPROXIMATE CENTER FREQ. control to the desired center frequency; set the MASTER OSC. BAND SWITCH to position A.
3. Set the SWEEP WIDTH control for approximately 200 kc. total deviation, and adjust the discriminator primary condenser C2 for a curve of maximum amplitude, which will appear somewhat S-shaped if the secondary is not too far detuned. It will be necessary to keep the OUTPUT MULTIPLIER and MASTER OSC. ATTEN. controls set for an output below that at which limiting occurs.
4. Adjust the discriminator secondary trimmer condenser C1 for an S-shaped symmetrical response curve set to exact center frequency (see SETTING DISCRIMINATOR TO EXACT CENTER FREQUENCY).
5. Retune C2 for a symmetrical response curve with greater amplitude than in step 4, if possible.
6. Connect the output cable of Model 7008 to the grid of the last i-f stage preceding the limiter stage, and adjust trimmer C3 for a symmetrical response curve of maximum amplitude.
7. Connect the output cable of Model 7008 between the grid of the mixer tube and ground, and, if the output can be kept below the receiver limiting point, adjust each i-f secondary and primary in order, proceeding from the last i-f back to the first i-f stage, for a symmetrical response curve of maximum amplitude. Should limiting occur, that is, no change in amplitude occur as trimmers are adjusted, connect the input of Model 7008 through the high frequency probe between test point B and ground, and adjust each i-f stage as stated. Then, when C3 is reached, connect the scope input leads to test point A, move the output cable of Model 7008 to the grid of the stage preceding C3, and adjust C3 and the discriminator as directed in steps 1 through 5 above.

NOTE

As each i-f trimmer is adjusted, the MASTER OSC. ATTEN., OUTPUT MULTIPLIER and VERT. GAIN controls should be retarded to keep the pattern within the limits of the screen.

8. Align the r-f and oscillator circuits as explained in the "Shop Practices and Techniques" of this month (r-f alignment is similar for all types of detectors).

Philco Advanced FM Detector

This type of FM detector requires that the i-f stages be adjusted first; then the detector is adjusted to the i-f center frequency. Any other procedure is not recommended.

1. Referring to figure 4, connect the output cable of Model 7008 to the grid of the last i-f stage, test point B; connect the oscilloscope input through the scope input leads to the detector output (FM test jack) test point A.
2. Set the MASTER OSC. APPROXIMATE CENTER FREQ. control to 9.1 mc., the MASTER OSC. BAND SWITCH to Band A, and the FUNCTION switch to the MKR position.
3. Short pin 2 of the FM1000 tube to ground, to render the oscillator inoperative. Set the SWEEP WIDTH control for approximately 200 kc. total deviation, and the OUTPUT MULTIPLIER, MASTER OSC. ATTEN., and VERT. GAIN controls for a pattern of desired height on the c-r tube.
4. Adjust the last i-f secondary trimmer C2 for a symmetrical i-f response curve of maximum amplitude and then adjust the last i-f primary trimmer C3 for a similar response. Move the output cable to the grid of the preceding i-f stage, and adjust the secondary and primary trimmers in order. Continue to move the output cable to the preceding stage and adjust each i-f transformer until all i-f transformers have been aligned.
5. Remove the short from pin 2 of the oscillator tube, and adjust trimmer condenser C1 for a hooked curve, as shown in figure 5.

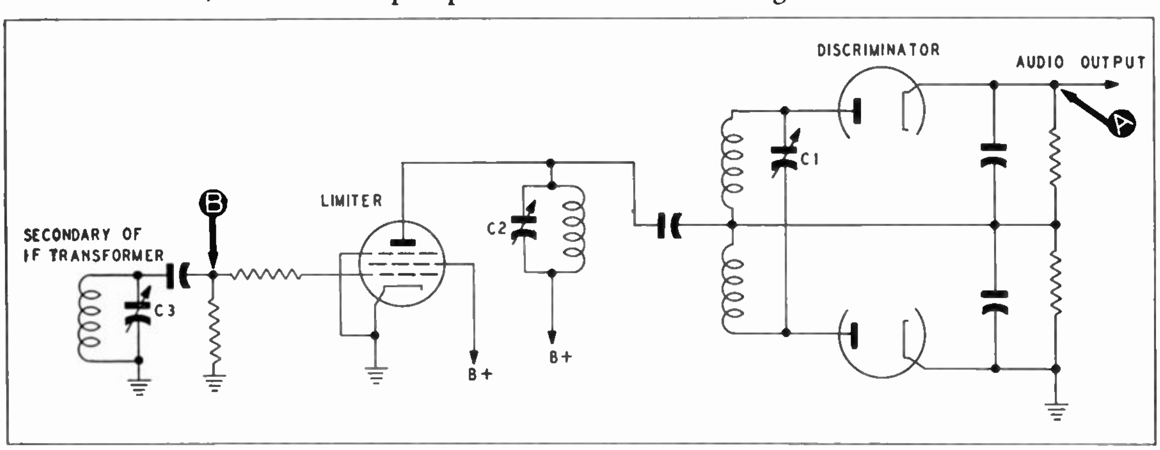

Figure 3. — Limiter-Type Detector Schematic

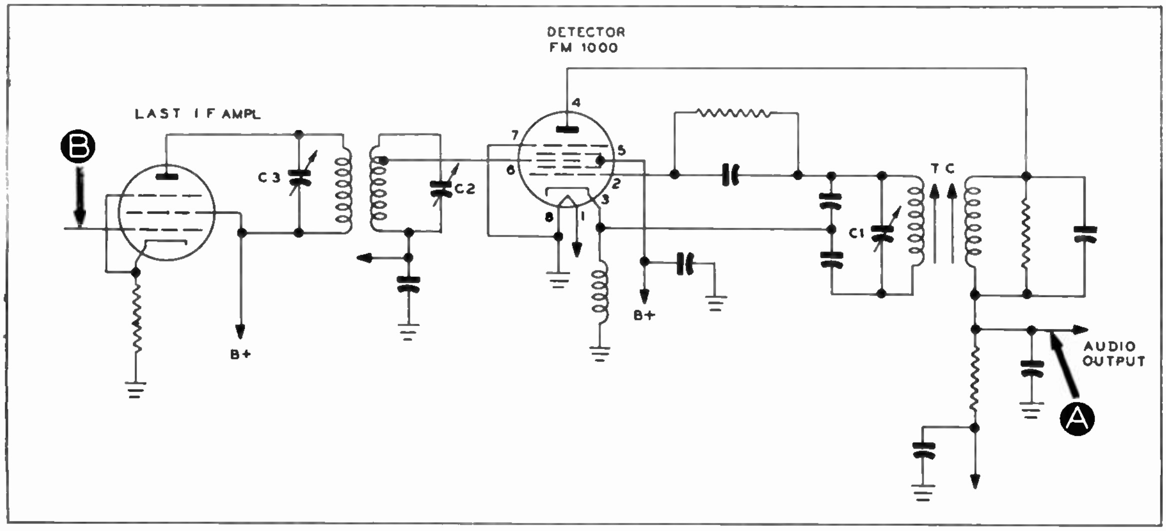

Figure 4. — Philco Advanced FM Detector Schematic

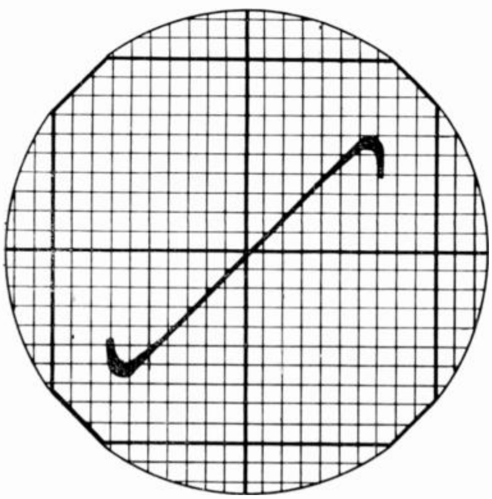

Figure 5. — Primary Set To Center Frequency

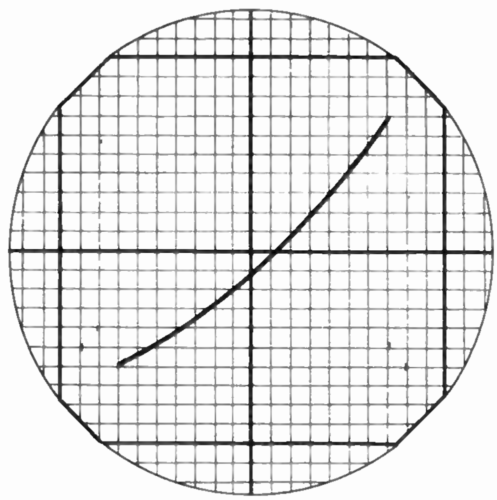

Figure 7. — Tuning Core Requires Turning Out

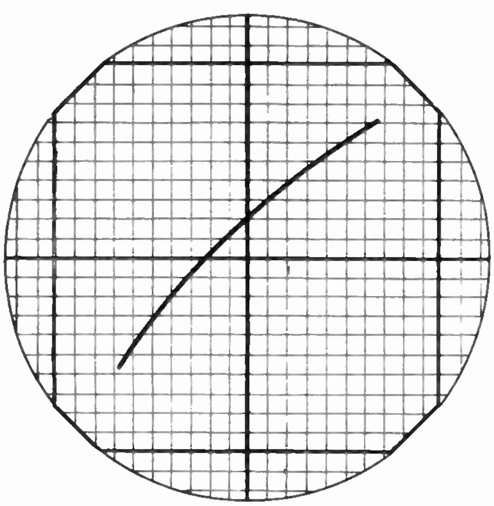

Figure 6. — Tuning Core Requires Turning In

NOTE

It will be necessary to decrease the receiver input to threshold value to secure the hooked curve. Be certain that the curve is symmetrical about the center.

6. Increase the output of Model 7008 until the hooked curve straightens out and becomes an almost straight line (see figures 6 and 7), then adjust the secondary tuning core TC (figure 4) for a straight line. Figures 8 and 9 indicate incorrect primary adjustments, while figures 6 and 7 indicate incorrect secondary adjustments.

NOTE

If the c-r tube pattern is not observed directly from the front of the oscilloscope, it is possible to adjust for what appears to be a straight line, which when checked with a straight-edge is found to be bowed.

If the blanking circuit is used, be sure to first adjust the PHASING control for a single image with the blanking circuit off, and then adjust the BLANKING control for a base line along the full width of the pattern.

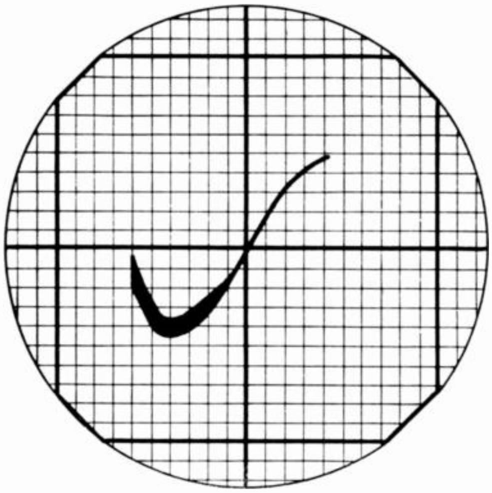

Figure 8. — Primary Set Below Center Frequency

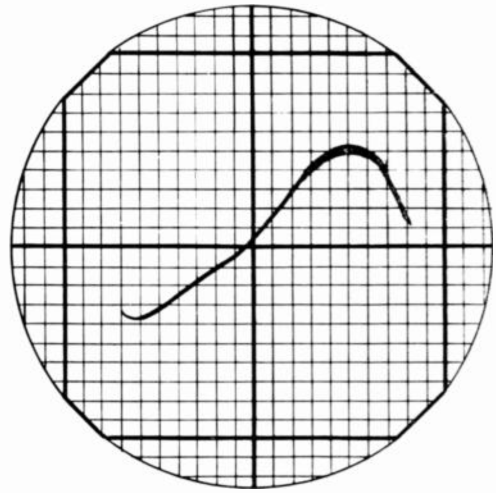

Figure 9. — Primary Set Above Center Frequency

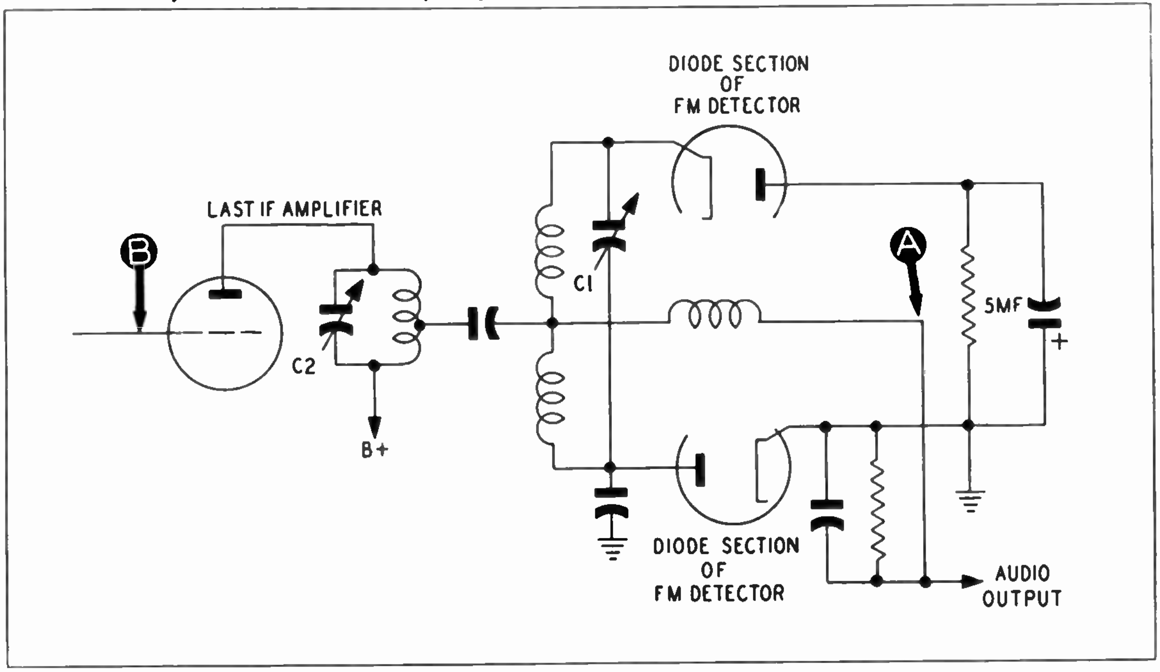

Figure 10. — Ratio Detector Schematic

Ratio Detector

1. Referring to figure 10, connect the output cable of Model 7008 between test point B and ground; connect oscilloscope input through the scope input leads between test point A and ground.

2. Set the MASTER OSC. APPROXIMATE CENTER FREQ. control to the desired center frequency (9.1 mc. for Philco FM receivers, and 22.1 mc. for Philco television receivers); set the MASTER OSC. BAND SWITCH to position A.

3. Set the SWEEP WIDTH control for approximately 600 kc. deviation for TV receivers. Adjust the discriminator primary trimmer condenser C2 for a response curve of maximum amplitude; the curve will be S-shaped if the secondary trimmer is near the proper adjustment.

4. Adjust the discriminator secondary trimmer condenser C1 for an S-shaped symmetrical response curve set to the exact center frequency (see SETTING DISCRIMINATOR TO EXACT CENTER FREQUENCY).

5. Remove the output cable from test point B, and advance it one stage toward the mixer, tuning the secondary and then the primary of the last i-f transformer for a symmetrical S-shaped response curve of greater amplitude than in step 4.

6. Proceed to adjust each i-f stage in order until the mixer is reached, adjusting the OUTPUT MULTIPLIER, MASTER OSC. ATTEN., and VERT. GAIN controls to retain the pattern on the screen.

7. Align the r-f and oscillator stages as explained in this month's "Shop Practices and Techniques."

For a further discussion of FM alignment covering the RF and oscillator stages and the setting of the discriminator to exact center frequency; see this month's "Shop Practices and Techniques".