Television ALIGNMENT

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Compact television receiver to retail at approximately $150. It incorporates a 7 inch picture tube and has two tuning bands which cover the entire spectrum of assigned television channels. According to the manufacturer, Belmont Radio Corp. of Chicago, delivery is expected to start immediately.

Part 15. Covering test equipment and procedures involved in the alignment of television receivers.

CAREFUL alignment of the television receiver is a tedious task. Fortunately, the attentive consideration given to r.f. and i.f. circuit stability by manufacturers make only occasional alignment necessary. In fact, with the more stable receivers, the original factory alignment suffices for a number of years. The best policy for servicemen to adopt is not to attempt alignment unless they have the specialized test equipment necessary to do the job. If equipment is available, first test to see if alignment is necessary before touching an aligning adjustment.

Specialized Test Equipment

The special test equipment required for television alignment are; cathode-ray oscilloscope, i.f. wide-band sweep generator, and r.f. wide-band sweep generator. Both sweep signal generators should have associated marker systems for identifying band limits and various frequencies within the band.

1. Cathode-ray Oscilloscope: The oscilloscope should have an associated vertical amplifier with sufficient gain to amply the relatively weak output of a video detector to a level sufficient for application to the vertical deflection plates. An incorporated horizontal amplifier and sweep generator is required. A sync system and phasing adjustment is helpful in producing a stationary, clean pattern on the oscilloscope screen.

2. I.F. Signal Generator: The i.f. signal generator should have a range between 7.5 and 15 mc., and should be capable of sweeping back and forth across this range at an audio rate. The conventional sweep generator uses an audio sine-wave to frequency modulate its output. The same generator must also generate a low amplitude, short duration signal each audio cycle for synchronizing the horizontal oscillator of the test oscilloscope.

3. R.F. Signal Generator: The r.f. signal generator should also be a sweep generator and capable of sweeping over a six megacycle band. The signal generator should have an r.f. band switch to permit choice of operation on either of the five lowest channels.

Alignment Objectives

The four major objectives of alignment are to (1) obtain utmost in gain without sacrificing bandwidth; (2) position r.f. and i.f. response characteristic on correct frequencies; (3) prevent entrance of spurious signals; and (4) set the relative amplitudes of the picture carrier and sidebands. The most accurate and direct method of alignment employs the test oscilloscope and sweep generator, connected as shown in Fig. 2. Notice the following points:

1. Frequency-modulated output of sweep oscillator is capacitively-coupled to the grid of the i.f. amplifier stage. Thus, a signal which is constant in amplitude but varying in frequency is applied to the i.f. amplifier. The frequency is made to vary between 7.5 and 15 mc. for receivers which have an 8.25 mc. sound carrier and a 12.75 mc. picture carrier frequency.

2. Output is taken directly off the diode detector load resistor and applied to the vertical deflection circuit of the oscilloscope. This output represents the instantaneous diode currents for the band of frequencies swept by the signal generator. Thus, the instantaneous output at any one instant is proportional to the amplification of the i.f. amplifier at the particular frequency the sweep is crossing—being maximum, of course, over the flat part of the bandpass and tapering off at the ends of the i.f. amplifier band-pass.

3. Audio sweep voltage output from the sweep oscillator is applied to the horizontal input of the oscilloscope. This sweep voltage is identical in character to the sweep voltage which fre-

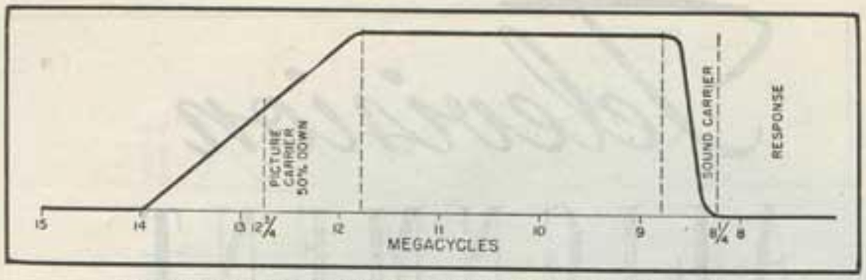


Fig. 1. Idealized band-pass characteristic of television i.f. amplifier.

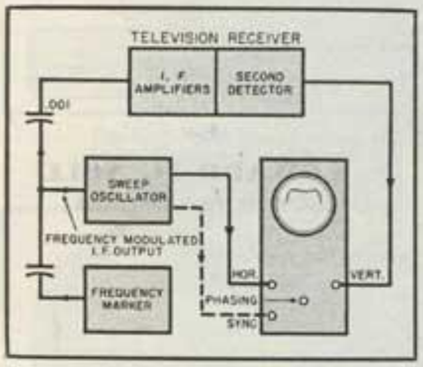


Fig. 2. Block diagram illustrates set-up for alignment of i.f. amplifiers.

quency modulates the i.f. output of the sweep oscillator. It is amplified by the horizontal amplifier of the oscilloscope and causes horizontal deflection of the oscilloscope beam.

Thus, the sweep signal (generally a sine-wave) applied to the horizontal input of the oscilloscope, causes horizontal deflection of the beam; signal applied to the vertical input from the receiver detector, vertical deflection of the beam. The pattern traced on the oscilloscope screen, therefore, is the actual band-pass characteristic of the i.f. amplifier. The horizontal axis of the trace (base line of the characteristic) can be calibrated in terms of frequency, for each point represents one particular frequency because the same sweep voltage which is sweeping the beam horizontally also frequency modulates the i.f. output, changing its frequency correspondingly. Now the vertical deflection of the beam is a relative measure of the gain of the i.f. amplifier at each particular frequency over which the i.f. signal is swept. If the gain of the i.f. amplifier were uniform over the 7.5 to 15 mc. range, only a straight horizontal line would appear on the screen. Inasmuch as the gain is not uniform, the characteristic appears straight and maximum over the flat portion of the i.f. characteristic and tapers off at the ends of the band-pass where the i.f. gain falls off and the rectified component of receiver diode current decreases.

A clearer picture of the pattern is afforded by Fig. 1, which shows how the trace would appear (heavy dark line) on the oscilloscope screen for a picture i.f. amplifier with an idealized perfect band-pass characteristic. Let us take a few typical points along the line:

When the frequency-modulated output of the sweep oscillator is on the 15 mc. point, the oscilloscope beam is at the extreme left of the screen. Inasmuch as 15 mc. is off the band-pass characteristic of the i.f. amplifier, there is no rectified component of diode detection current and, consequently, no vertical deflection of the oscilloscope beam. Now at the instant the frequency modulated output of the sweep oscillator is on 14 mcs., the beam has been moved horizontally to the right a short distance, Fig. 1. At this frequency point there is some small trace of amplification in the i.f. system and the beam is deflected vertically a bit. By the time the sweep output reaches the picture carrier frequency, the beam has moved horizontally almost to the center of the screen. At this frequency there is considerable i.f. amplification (50% point), causing appreciable vertical deflection. Just beyond 12 megacycles, the i.f. amplification reaches maximum, producing peak diode current and maximum vertical deflection of the scope. This level is held until the frequency-modulated output of the sweep oscillator has swept below 9 megacycles. Beyond 9 megacycles, the gain of the i.f. amplifier falls off rapidly and there is a sharp drop in vertical deflection. In fact at 8¼ megacycles, the i.f. gain must drop to practically zero to prevent the 8¼ megacycle sound signal from interfering with the picture signal.

It is apparent that the test equipment becomes very useful both in adjusting and checking the performance of the picture i.f. system. We have a means of checking bandwidth, relative amplitudes, proper positioning of picture carrier, response at sound carrier and response at adjacent sound carrier points.

4. To use the oscilloscope pattern successfully it must be calibrated in frequency. A frequency marker system is, therefore, installed with the sweep oscillator and is generally incorporated in the same case. Frequency markers are of two types. One type is a simple calibrated resonant circuit which is mutually coupled to the i.f. output of the sweep oscillator. On the frequency to which a resonant circuit is tuned, it will absorb some of the sweep oscillator output and reduce slightly the input to the receiver, causing a small dip to appear in the oscilloscope pattern at that frequency. With this type of marker, the pattern is first properly positioned on the screen using oscilloscope controls and, then, the marker is used to locate specific frequencies on the pattern which can be noted with crayon marks on the scope glass surface. After the marks have been set-up (such as shown in Fig. 4) do not touch the horizontal controls of the oscilloscope because they will have to be recalibrated and marked if the pattern is shifted horizontally. In the better sweep oscillators, a series of built-in marker circuits are used which can be switched in and out at will. This system permits the markers to appear on the pattern at all times, permitting ease in adjustment and not requiring recalibration, when changing test positions or oscilloscope controls.

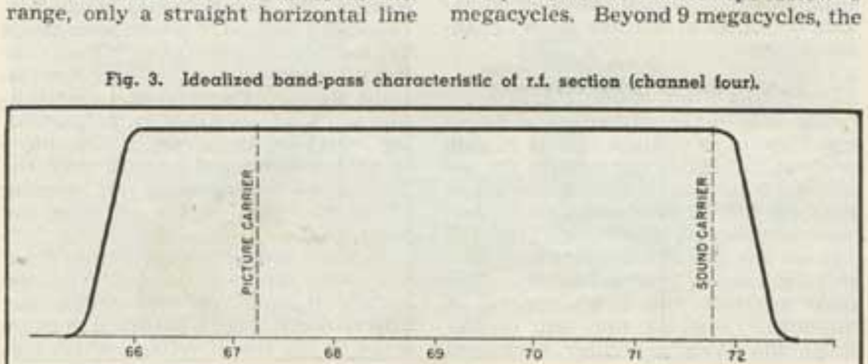
A second marker system uses a small calibrated signal generator, the output of which is also fed into the receiver along with the output of the sweep oscillator. This output also places a mark on the oscilloscope response pattern at the frequency to which it is tuned.

In using external marker systems always loose couple to prevent distortion of the sweep pattern. In fact, the smallest discernible marker signal serves as the most accurate calibration.

5. A phasing knob on the oscilloscope is adjusted until pattern is stationary and dual response patterns, if they exist on the oscilloscope screen, coincide. Instability or dual patterns are caused by incorrect phase relation between detected signal, applied to the vertical deflection circuit, and direct signal applied to the horizontal deflection circuit from the sweep oscillator. This relation is corrected with the oscilloscope phasing control.

6. An alternative method, used when

Fig. 3. Idealized band-pass characteristic of r.f. section (channel four).



the sweep oscillator has no direct sweep output for the oscilloscope horizontal circuit, is indicated by the dashed line of Fig. 2. In this type of sweep oscillator there is a pulsed output in synchronism with the frequency-modulated sweep cycle which can be used to synchronize the internal horizontal sweep of the oscilloscope. With this method consequently, the oscilloscope internal sweep must be turned on.

7. The latest sweep oscillator and oscilloscope combination for television receiver alignment requires no external connections between sweep oscillator and oscilloscope—entire alignment system is synchronized by the 60 cycle primary line voltage. The sweep oscillator output is frequency modulated at a 60 cycle rate and the horizontal sweep oscillator of the oscilloscope is locked-in on 60 cycles. Thus, the only external connections necessary are those between sweep oscillator output and receiver in, and between receiver out and vertical input of oscilloscope.

R.F. Alignment

The block diagram for alignment of the r.f. section of the receiver, Fig. 5, differs only slightly from that of the i.f. alignment. Alignment of the r.f. section differs in the following respects:

1. Frequency-modulated high-frequency output of the sweep oscillator is coupled directly to the antenna terminals. Output for the vertical input of the oscilloscope is generally taken off the plate or screen circuit decoupling network of the converter. Inasmuch as the d.c. component of current in the converter circuit is proportional to the strength of the r.f. signal, this stage affords a convenient point to check response of the r.f. section.

2. The response characteristic, Fig. 3, of the r.f. section, since it passes picture and sound, must be flat over a six megacycle band and fall off rapidly at the ends to reduce pick-up from adjacent channels or images.

Is Alignment Necessary?

The radio serviceman can save time and effort by first setting up his test gear to see if alignment is necessary. It has been customary in the better repair shops to align a broadcast set whether it appears necessary or not, to be certain the radio is giving the utmost in performance. However, we can be reasonably certain, in the case of the television receiver, that if the response pattern is correct the receiver is aligned properly.

With the r.f. pattern on the oscilloscope screen, check the following:

1. Six megacycle r.f. bandwidth.
2. Band-pass properly centered on each channel.
3. Response falls off rapidly at outer extremities of channel.

With the i.f. pattern on the oscilloscope screen, check the following:

1. Band-pass properly positioned on i.f. characteristic.
2. Proper four megacycle bandwidth. Small five inch receivers will not usually be flat over this great a range.
3. Response at picture carrier frequency will be down 50%.
4. Response at sound carrier frequency should be practically zero.
5. Response at adjacent sound carrier image frequency (14¼ mc.) should be practically zero.

Alignment of G.E. Model 90 Receiver

I.F. Alignment:

1. Connect vertical input cable of oscilloscope across diode load resistor R_1, Fig. 8.

2. Connect output of sweep oscillator to control grid of 2nd picture i.f. amplifier (oscillator to be sweeping between 7.5 and 15 mcs.). Adjust oscilloscope controls to give suitable horizontal deflection. Pattern on oscilloscope screen should appear as shown in curve C (less markers) of

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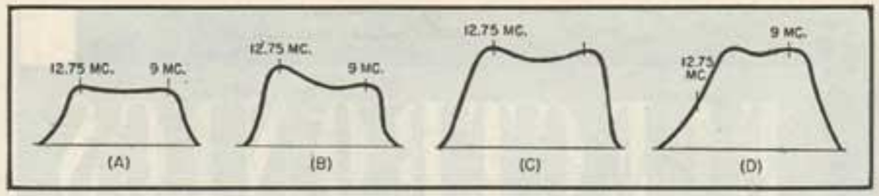

Fig. 4. Curves illustrate i.f. alignment.

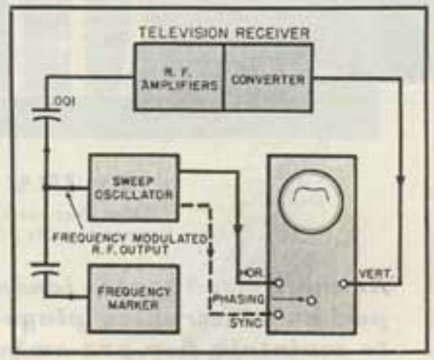

Fig. 5. Alignment diagram for r.f.

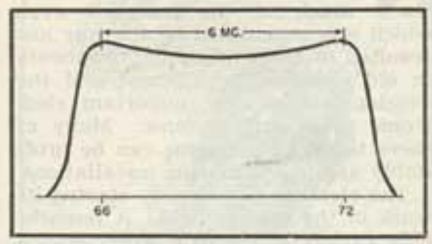

Fig. 6. Alignment r.f. curve (channel four).

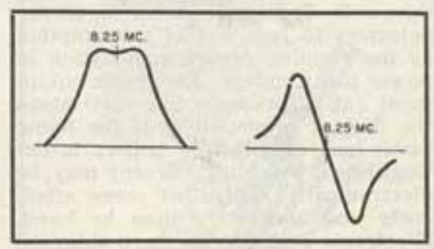

Fig. 7. Sound channel alignment curves.

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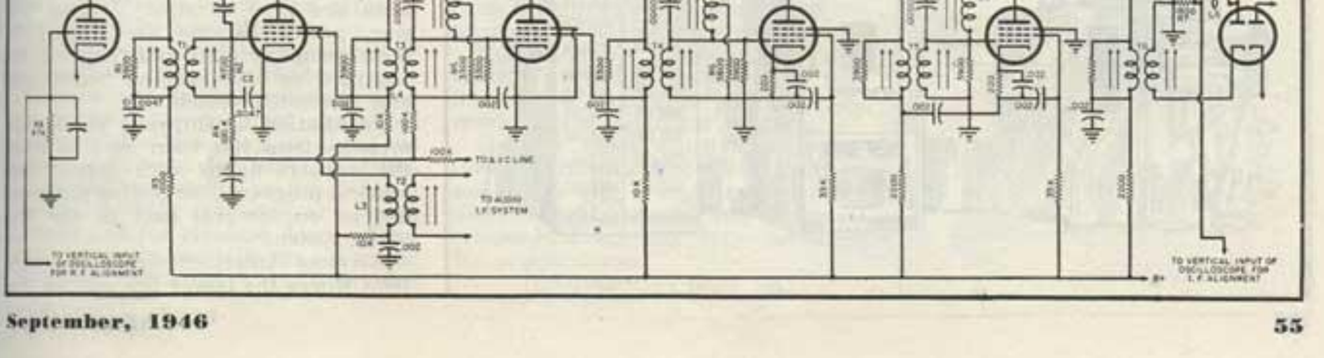
Fig. 8. Diagram showing i.f. system of General Electric Model 90 television receiver. The output of the converter tube contains two signals; the video signal and the sound signal which is four and one-half megacycles lower than the video frequency. Output of sweep oscillator is connected to antenna terminals for r.f. alignment.



Television Alignment

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Fig. 4. If pattern is flat, bright and with a heavy trace on the top, the sweep oscillator output may be overloading the i.f. amplifier. In this case, reduce output of sweep oscillator.

3. Superimpose accurately calibrated 12.75 and 9 mc. marker signals in parallel with the sweep signals. Signal will appear on sweep curve as a wiggle, the center of which is a thin black line. Calibrate these points on the screen of the oscilloscope with a pen or crayon. Hereafter the horizontal controls on the oscilloscope must not be touched. If sweep oscillator has marker points internally supplied this calibration need not be performed.

Connect sweep oscillator to control grid of fourth i.f. amplifier. Adjust iron cores of transformer T_5, Fig. 8, until pattern is similar to curve A of Fig. 4. A relatively flat-top, maximum amplitude, 12.75 mc. marker at one corner and 9 mc. marker at the other insure correct alignment.

5. Connect sweep oscillator to control grid of third i.f. amplifier. Adjust iron cores of transformer T_4 for maximum gain, flatness, and proper centering between markers as illustrated in curve B of Fig. 4. When transferring sweep oscillator from stage to stage, always readjust output to a level which does not overload i.f. amplifier.

6. Connect sweep oscillator to control grid of second i.f. amplifier. Adjust iron cores of transformer T_3 for curve B of Fig. 4.

7. Connect sweep oscillator to control grid of first i.f. amplifier. Adjust iron cores of transformer T_2 for curve C of Fig. 4.

8. Connect sweep oscillator to grid of converter tube. Adjust iron cores of transformer T_1 for curve C of Fig. 4. Since transformer T_1 also passes the audio i.f. signal, check for audio in the sound channel.