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ST 32 - 152

VISUAL ALIGNMENT OF RADIO RECEIVERS

R-390/URR AND R-390A/URR

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VISUAL ALINEMENT OF RADIO RECEIVERS R–390/URR AND R–390A/URR

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CHAPTER 1

INTRODUCTION

1–1 PURPOSE. The purpose of this special text is to acquaint radio repairmen with the visual methods of alining the IF and RF stages of communications receivers. Specific consideration is given to the method which uses an RF sweep generator and oscilloscope.

1–2 SCOPE. This text contains information concerning crystal filter circuits, development of response curves, synchronization of response curves, alinement of IF employing a crystal filter, and alinement of the IF and RF stages of Radio Receiver R–390/URR. Each segment of information is treated in a separate chapter. The first four chapters contain information of general application, whereas the fifth chapter describes the specific alinement procedures for the R–390/URR and R–390A/URR.

1–3 METHODS OF VISUAL ALINEMENT. Visual alinement may be performed by the use of an output meter and an RF signal generator or by the use of an oscilloscope and an RF sweep generator. Although most technical manuals on specific receivers outline the procedure of the first method, use of the latter is decidedly better because the complete response of the tuned circuits is viewed simultaneously on the oscilloscope. Consequently, accurate alinement of broad bandwidth circuits and crystal filter circuits can be achieved with comparative ease within a short period of time.

CHAPTER 2

CRYSTAL FILTER CIRCUITS

2-1 GENERAL. The ability of a receiver to attenuate undesired adjacent channel signals is termed skirt selectivity. The filter circuit to be described achieves high attenuation of undesired signals outside the narrow bandpass by use of a crystal that has a fundamental frequency which corresponds to the central frequency of the desired bandpass. An undesirable characteristic (parallel-resonant frequency) of the crystal can be eliminated by use of a phasing or neutralizing capacitor. Some receivers provide the operator with a front panel control which changes the capacitance of the phasing capacitor to make use of the undesirable characteristic to reject a narrow band of frequencies within the bandpass of the crystal filter.

2-2 CRYSTAL THEORY. The equivalent electrical circuit of a piezoelectric crystal is shown in figure 2-1.

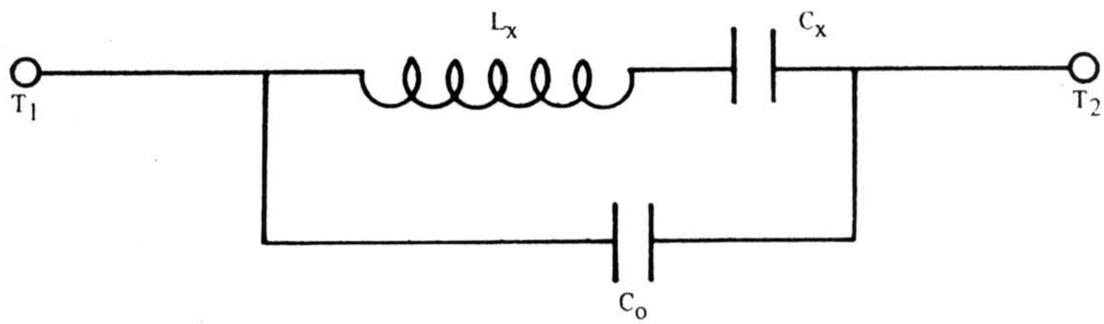


Figure 2-1

L_x and C_x represent the characteristics of the crystal and are functions of the cut of the crystal. C_o represents the capacitance of the crystal holder. T_1 and T_2 represent terminal points in the receiver. The circuit is resonant at two frequencies: the series resonant frequency and the parallel-resonant frequency. In figure 2-2, these frequencies are graphically represented by plotting the reactance of the equivalent circuit for all the frequencies between zero and infinity. The series-resonant frequency is at point f_r the midpoint of the reactance curve going from high capacitive reactance (-) to high inductive reactance (+). The parallel-resonant frequency is at point f_a the midpoint of the reactance curve going from high inductive reactance to high capacitive reactance. For most crystals the two resonant frequencies occur within a few hundred Hertz (Hz) of each other.

2-3 FUNCTIONS OF A CRYSTAL FILTER CIRCUIT. Using the circuit shown in figure 2-3 as a typical crystal filter circuit, a description of the effects such a circuit has on a signal will be presented.

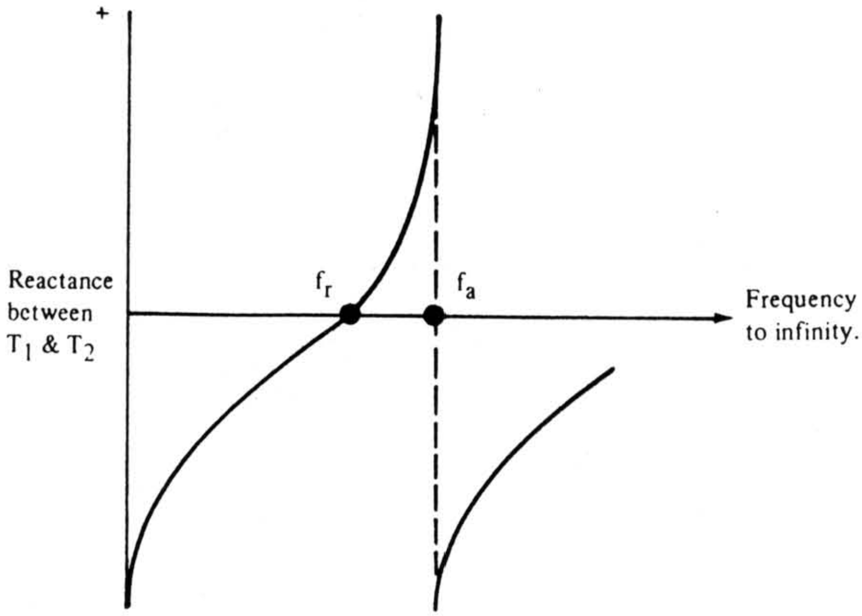


Figure 2–2

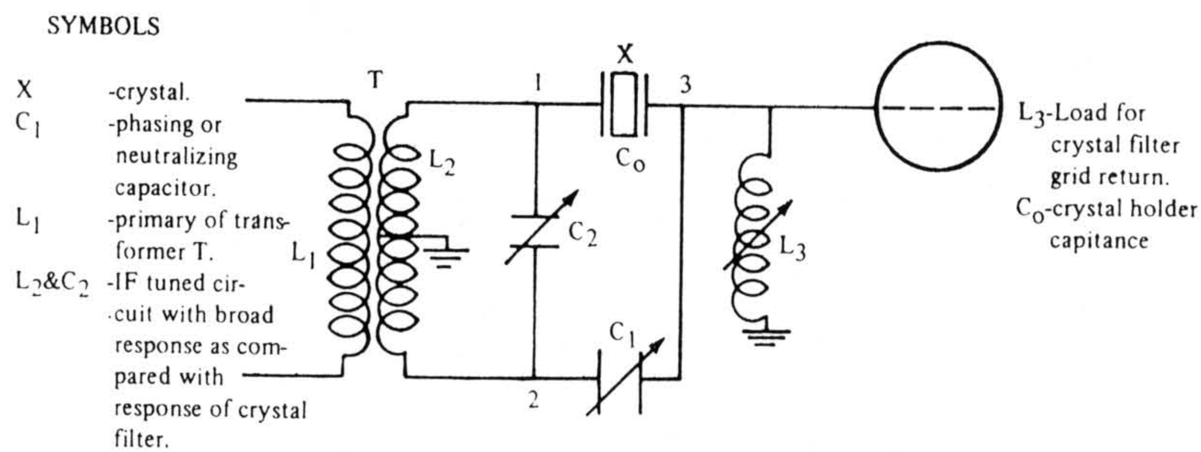


Figure 2–3

A signal is passed through transformer T at a frequency that corresponds to the series–resonant frequency of crystal X. The signal level present at 1 is equal in strength with that present at 2, but it is opposite in polarity (180^{o} out of phase). At the series–resonant frequency, the reactance of X is zero. Consequently, the strength of the signal coupled through X to 3 is approximately equal to that present at 1. C_1 is used to eliminate or employ a particular characteristic of the crystal. In this case, the characteristic is the parallel–resonant frequency and it is to be eliminated. This is done by adjusting C_1 to a value equal to C_o. When this condition is established, the signal passed by C_o is cancelled by the signal passed by C_1 since these two signals are 180^{o} out of phase. Cancelling takes place in L_3. Since the signal passed by C_o is cancelled, the parallel–resonant frequency of the crystal is eliminated, and the response of the filter circuit does not have a rejection notch. A graph of the reactance curve is shown in figure 2–4.

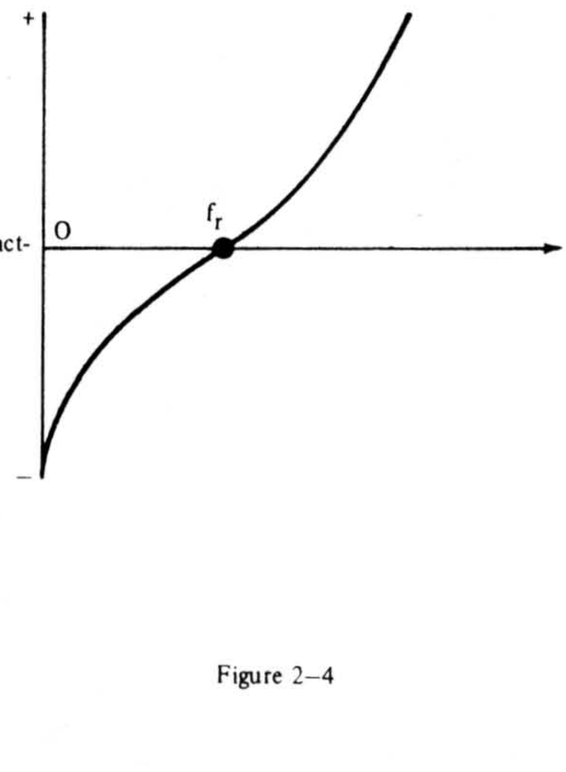


Figure 2–4

The method used and the manner in which C_1 is adjusted will depend on the receiver. In receivers where the parallel–resonant frequency of the crystal is to be eliminated, C_1 is adjusted by the repairman as part of the IF alinement procedure. In receivers where the parallel–resonant frequency of the crystal is to be controlled, C_1 is adjusted by the operator by means of a control on the front panel of the receiver. In this case, the value of C_1 is adjusted either slightly higher or slightly lower than C_o allowing the operator to control the parallel–resonant frequency of the filter and hence the position of the rejection notch within the bandpass. Regardless, the tuned circuit consisting of the first IF transformer (L_2) and its tuning capacitor (C_2) should be adjusted so that the circuit's response peaks at the series–resonant frequency of the crystal. Likewise, all of the other IF tuned circuits must be alined to the series–resonant frequency of the crystal. A complete treatment of this procedure is found in chapter 5.

CHAPTER 3

DEVELOPMENT OF RESPONSE CURVES

3–1 GENERAL. Superimposed curves on the oscilloscope screen permit simultaneous viewing of the complete response of the tuned circuits. Response curves are produced by passing a signal that is generated by the RF sweep generator through the receiver to the oscilloscope. Each function of the procedure is closely related to the other regardless of which piece of equipment is producing it. In order to develop the desired response curves, the equipment must be connected as shown in figure 3–1.

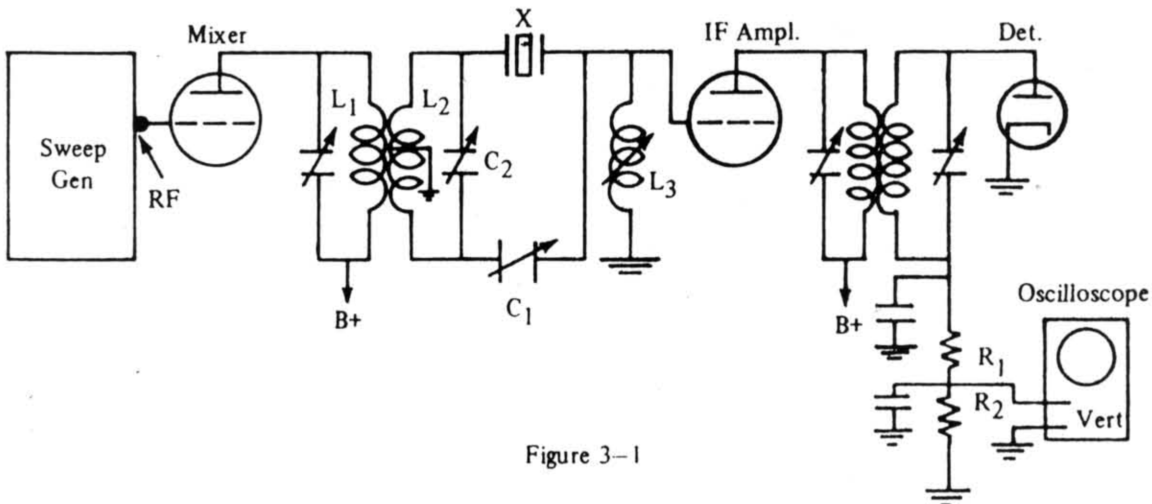


Figure 3–1

With the equipment connected in this manner, the controls of the sweep generator and oscilloscope are set to produce the following:

a. *Sweep Generator.* RF sweep output voltage that has a deviation of ±10 kilohertz (kHz) at a center frequency of 455 kHz and a rate of deviation of 60 Hz.

b. *Oscilloscope.* Maximum vertical sensitivity (ac or dc), internal horizontal sweep frequency of 60 Hz, and horizontal gain sufficient for a trace almost the full width of the screen.

Although the equipment functions as a single unit, each piece of equipment and its operation will be discussed as an independent unit for ease of presentation.

3–2 RF SWEEP GENERATOR. When the sweep generator is set to produce the results described above, the output voltage is constant in amplitude but changing in frequency from 445 kHz to 465 kHz (fig. 3–2). Since the IF tuned circuits are resonant to 455 kHz, maximum response is at this frequency (maximum IF voltage is coupled to the detector). The response of the IF drops off either side of 455 kHz until no IF voltage is coupled to the detector at 450 or 460 kHz. The detector rectifies the IF voltage and provides a negative dc voltage across R_2 (fig. 3–2) that changes in amplitude according to the response of the IF as the frequency changes. Maximum negative voltage occurs across R_2 at 455 kHz. Since one cycle of sweep (one–sixtieth of a second) is from 445 to 465 kHz and from 465 to 445 kHz, application of the negative voltage to the oscilloscope will develop response curves on the oscilloscope screen.

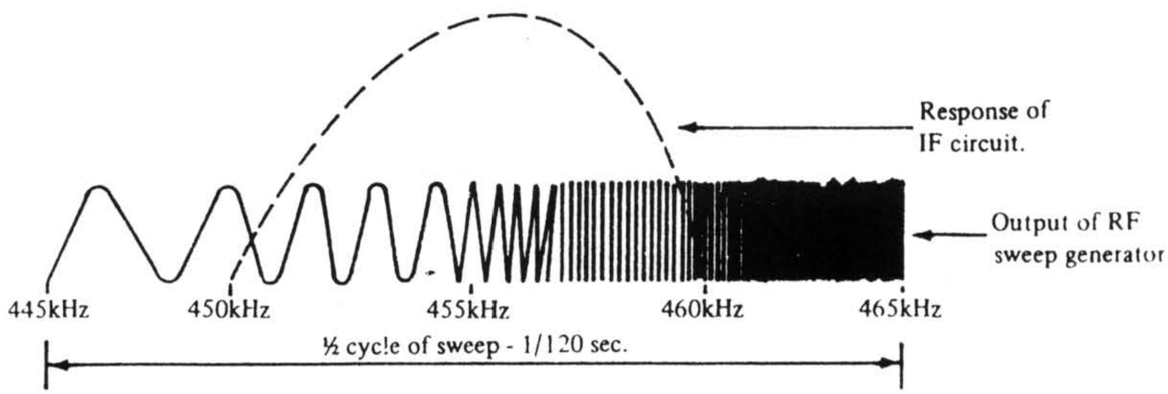


Figure 3–2

3–3 OSCILLOSCOPE. Application of unidirectional dc voltage across R_2 to the vertical input of the oscilloscope with the internal horizontal sweep, synchronized at 60 Hz produces two complete response curves on the oscilloscope screen. The two curves are identical, but are produced by different portions of the sweep–frequency cycle. The first curve, appearing on the left, is developed during the first half cycle (455 to 465 kHz), whereas the second curve is developed during the second halfcycle (465 to 445 kHz). A graphic example of this curve development is shown in figure 3–3. When the horizontal sweep frequency is doubled to 120 Hz (synchronized with the RF sweep), the two response curves will appear over one another as shown in figure 3–4. A horizontal sweep of 120 Hz is used for alining communications receiver IF because the symmetry of the response curve is checked against the low frequency skirt. If the response curve is not symmetrical, it is because the IF are not peaked to the series–resonant frequency of the crystal, or because the crystal filter capacitor is not adjusted to the balanced position. In either case, a rejection notch will appear within the response of the crystal filter causing the entire response of the receiver IF to appear unsymmetrical. Use of a 120 Hz sweep during alinement allows the signal generator to be tuned so that the IF response is in the center of the RF sweep. Tuning the signal generator off frequency will cause the two curves to separate as shown in figure 3–5. In this figure, the RF sweep generator frequency control is adjusted to produce a sweep that ranges from 440 to 460 kHz and back again instead of the normal 445 to 465 kHz range. This places the IF response off the center of the RF sweep and separates the response curve on the screen (inset, fig. 3–5). As the frequency adjustment control is increased in value, the response curves will move together and separate again in the opposite direction. Adjustment of the frequency control through the bandpass will cause the response curves to cross over one another.

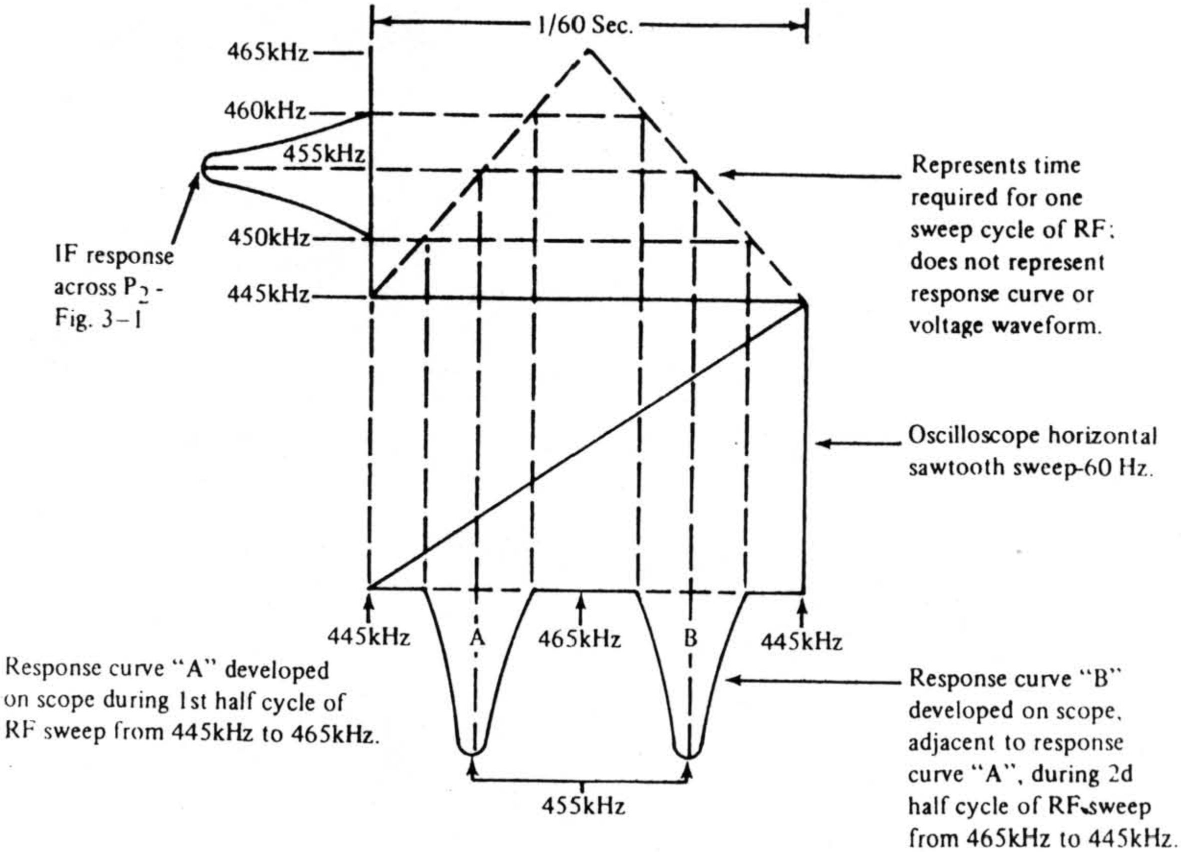


Figure 3–3

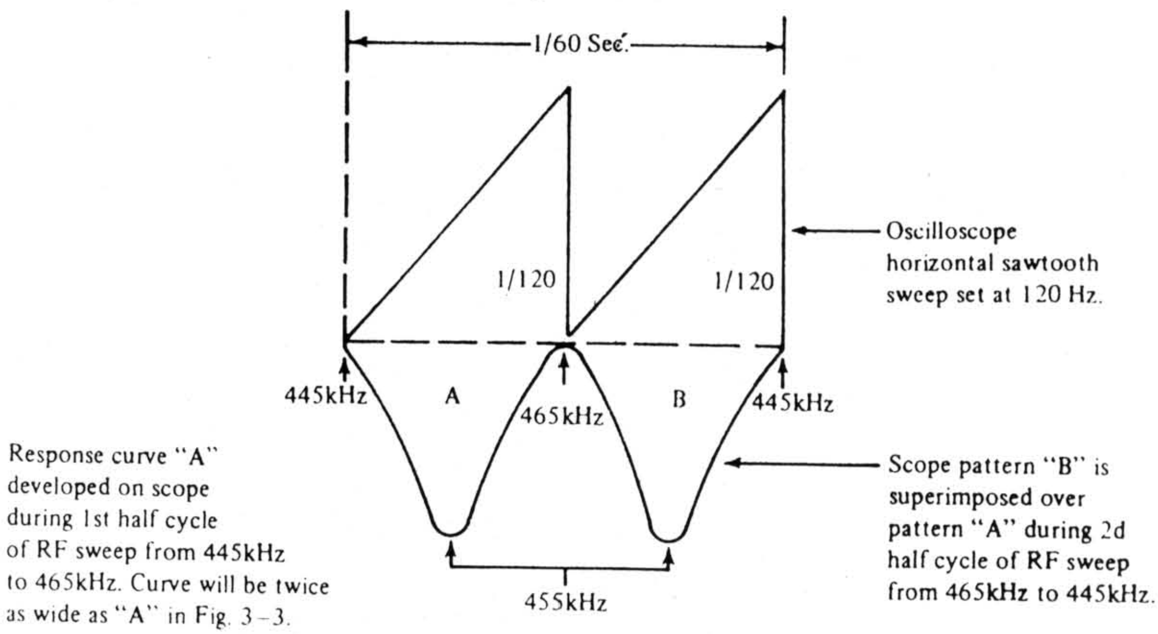


Figure 3–4

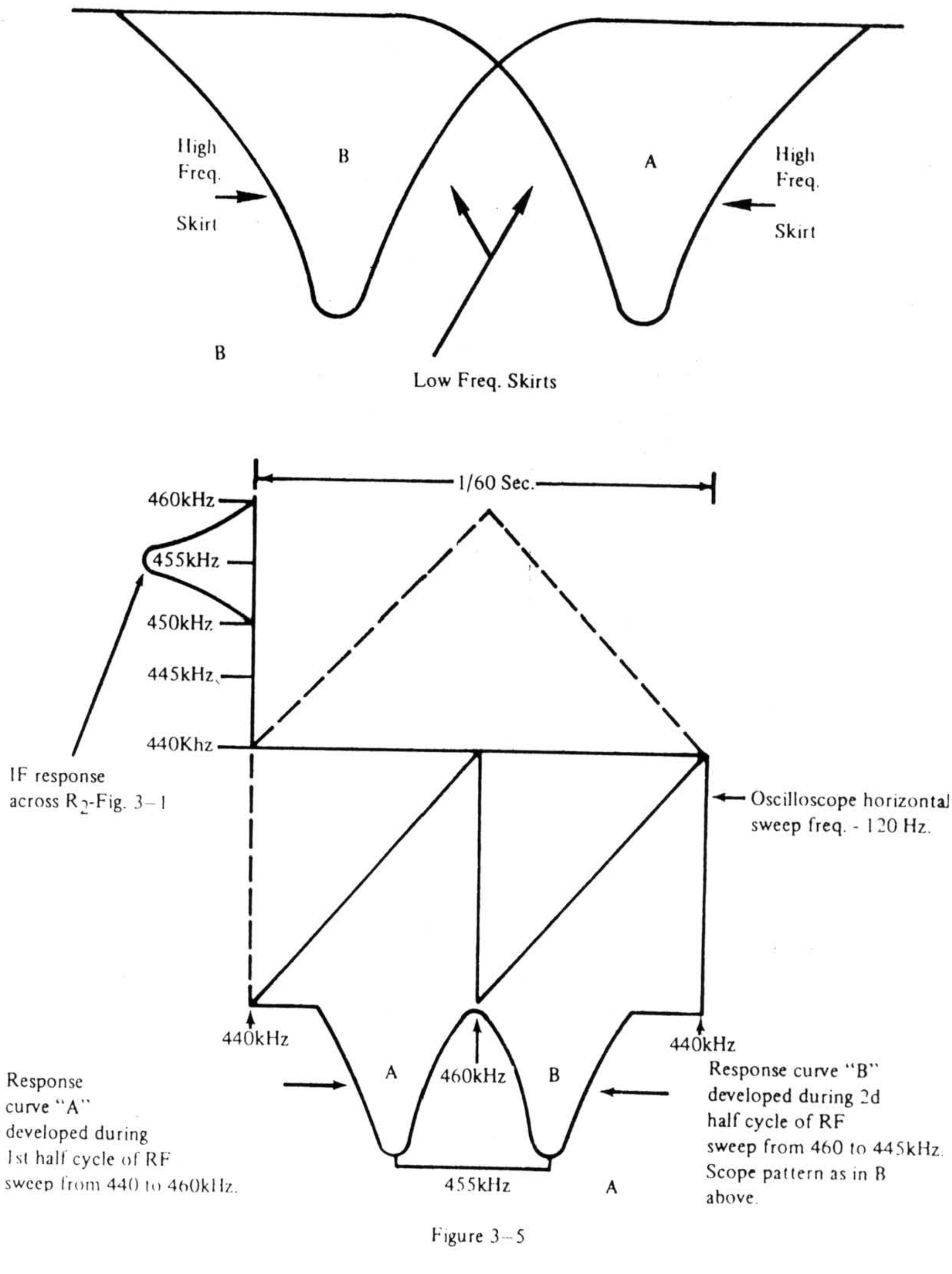

High
Freq.
Skirt
B
A
High
Freq.
Skirt
B
Low Freq. Skirts
1/60 Sec.
460kHz
455kHz
450kHz
445kHz
440Khz
IF response
across R_2-Fig. 3-1
Oscilloscope horizontal
sweep freq. - 120 Hz.
440kHz
460kHz
440kHz
A
B
Response
curve "A"
developed during
1st half cycle of RF
sweep from 440 to 460kHz.
Response curve "B"
developed during 2d
half cycle of RF
sweep from 460 to 445kHz.
Scope pattern as in B
above.
455kHz
A

Figure 3-5

CHAPTER 4

SYNCHRONIZATION OF RESPONSE CURVES

4–1 GENERAL. Synchronization of response curves is essential in the oscilloscope visual alinement method. Proper synchronization always presents a problem in any pattern analysis, but the problem can be minimized considerably by a clear understanding of synchronization.

4–2 REQUIREMENTS. Synchronization voltage. These requirements are as follows:

a. The RF sweep output of the sweep generator depends on the line voltage and is sweeping at a 60 Hz rate. In order to produce a response curve on the oscilloscope while the sweep generator is sweeping from 445 to 465 kHz and another during the generator's sweep from 465 to 445 kHz, the oscilloscope horizontal sweep oscillator must oscillate at 120 Hz. Therefore, the synchronizing voltage must be at a frequency twice the internal sweep frequency of the RF sweep generator or 120 Hz.

b. The 120 Hz synchronized voltage also must be developed from the line voltage because line frequency is subject to drift. This insures that the synchronized voltage frequency is always exactly twice the internal sweep frequency of the generator. Hence, the 120 Hz synchronized voltage is developed from the same voltage source that is used for the sweep in the RF sweep generator.

c. The receiver circuits and vertical amplifiers of the oscilloscope shift the phase of the 60 Hz sweep of the generator from that of the line voltage. Thus, a means of shifting the phase of the 120 Hz synchronized voltage must be provided.

4–3 OSCILLOSCOPE SYNCHRONIZATION CAPABILITIES. Most oscilloscopes are equipped with 60 Hz line synchronization and internal synchronization. These provisions are adequate for most applications but not for the visual alinement of receivers, since they affect the accuracy of the alinement. Visual alinement requires 120 Hz synchronized voltage; furthermore, the internal synchronized voltage is not suitable because it is taken from the cathodes of the vertical deflection amplifiers and is of the same frequency as the voltage passing through the amplifiers. If the 60 Hz line voltage were used to synchronize the oscilloscope horizontal sweep oscillator at 120 Hz, only every other cycle would receive a synchronization pulse. This would cause the oscillator to drift during the cycle between the synchronization pulse, and the response curves would appear as those shown in figure 4–1. In this case, the signal generator would have to be adjusted off frequency in order to superimpose the two response curves. Consequently, this would result in alinement at the wrong frequency.

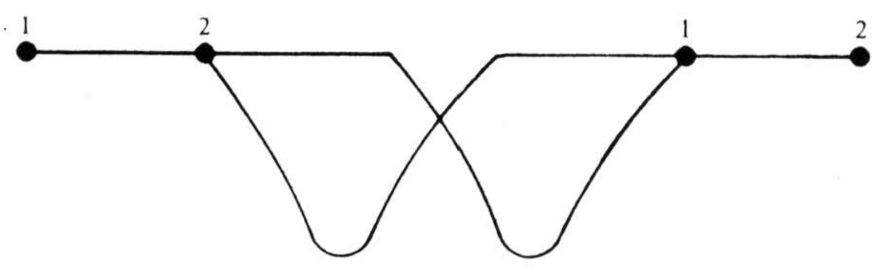


Figure 4–1

4–4 SYNCHRONIZING UNIT. At present, synchronizing units cannot be requisitioned and must be constructed by the repairman. The circuit of such a unit is simple and consists of basic parts available in any repair shop. This circuit (fig. 4–3) provides + 165° phase shift at 120 Hz and +193° or -127° of phase shift at 60 Hz. Figure 4–3 also shows the formulas used to derive the proper values of the components necessary to give the various degrees of phase shift desired.

4–5 PEAKING THE IF. The exact series–resonant frequency of the crystal does not have to be known in order to peak the IF to it. All that is necessary is to connect and adjust the equipment as described above, switch the crystal into the circuit by means of the bandwidth control, and adjust the RF sweep generator frequency adjustment control so that the two response curves are superimposed. When the peaks of the response curves are superimposed, the phasing capacitor is adjusted to determine if the peaks of the response curves will separate or break in the opposite directions as shown in figure 4–2. If the peaks break in opposite directions, the series resonant frequency of the crystal is in the center of the RF sweep. At the completion of this operation, the coil of the crystal filter is adjusted for maximum response and the curves are superimposed by adjusting the phasing capacitor. Readjustment of the sweep generator frequency control may be necessary to insure that the response curves are superimposed. Now that the series–resonant frequency of the crystal is in the center of the RF sweep, the bandwidth control is switched to the sharpest noncrystal position and the IF tuned circuits are adjusted for maximum response with the curves superimposed. Repetition of this procedure may be necessary to obtain maximum response. Alinement is checked by switching the bandwidth control from the crystal position to the sharpest noncrystal position to determine if the curves remain superimposed. An important point to be remembered is that the RF sweep generator frequency adjustment control is adjusted to superimpose the curves only when the crystal is in the circuit, that is when the series–resonant frequency is at the center of the sweep.

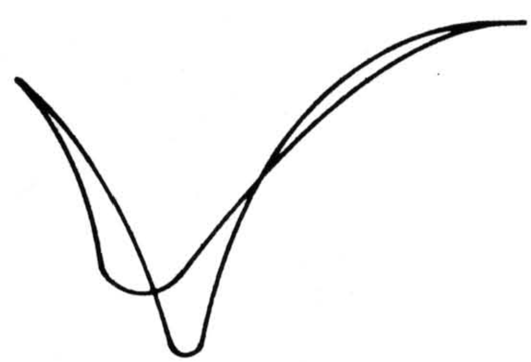
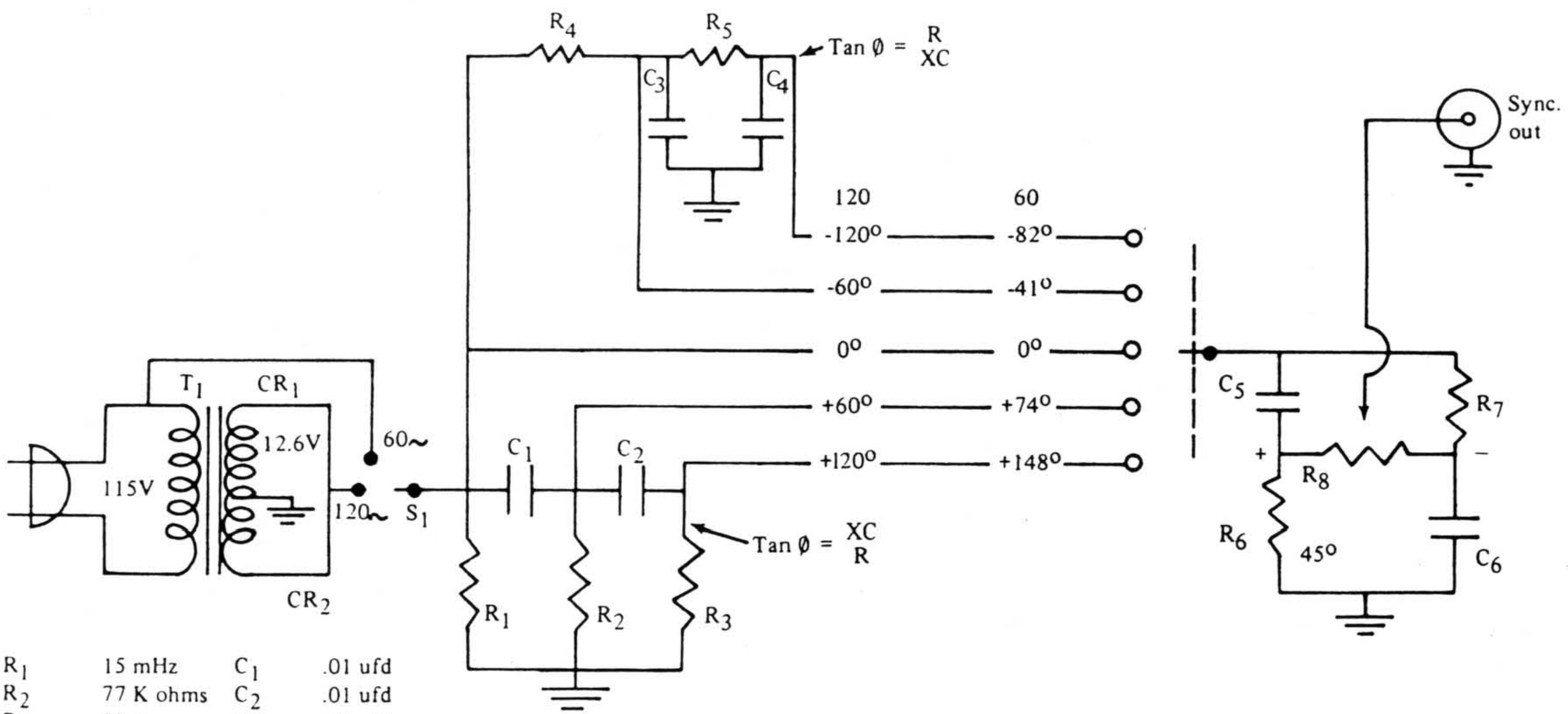


Figure 4–2



SYNC SUPPLY PHASE SHIFTER

R_1	15 mHz	C_1	.01 ufd
R_2	77 K ohms	C_2	.01 ufd
R_3	77 K	C_3	.01 ufd
R_4	230 K	C_4	.01 ufd
R_5	230 K	C_5	.01 ufd
R_6	130 K	C_6	.01 ufd
R_7	130 K	T_1	115V:12.6V ct
R_8	550 K	S_1	SPDT switch
		S_2	5 or 6 pos wafer switch (if six position - one position used for OFF)
		CR_1	XTAL DIODE
		CR_2	XTAL DIODE 1N 34 or equivalent

Figure 4–3

4–6 RESPONSE ANALYSIS. If, when the phasing capacitor is adjusted, the peaks of the curves do not break in opposite directions but only change in amplitude (fig. 4–4), the IF tuned circuits are misalined. When the phasing capacitor is adjusted, the symmetry of the response curves changes because a rejection notch appears in the response of the crystal filter circuit. This adjustment does not affect the position of the center frequency of the RF sweep in relation to the series–resonant frequency of the crystal after adjustments of the RF sweep have superimposed the curves. The series–resonant frequency should be the same as the center frequency of the RF sweep, but as the alinement progresses the series–resonant frequency will appear at the peaks. The reason for the separation and change of amplitude of the response curves shown in figure 4–2 is illustrated in figure 4–5. In this case, the capacitance of the phasing capacitor is adjusted to a value less than the capacitance of the crystal holder. Due to the asymmetrical response curve, caused by the rejection notch (parallel–resonant frequency), time T_1 is less than time T_2. Peak *a* is lower than peak *b* because the RF voltage does not have sufficient time to build up to the actual amplitude of the response peak. Time T_1 is relatively short because of the steep curve. As the RF voltage builds up to peak *b*, the time T_2 is greater. Therefore, the amplitude of the peak is higher and more closely approaches the actual amplitude of the peak response. The rejection notch in response curve *a* is more pronounced than in response curve *b* because of the stored energy effects in a highly resonant circuit under conditions of changing frequency. In order to perform visual alinement, the tuned IF circuits must be alined approximately to the crystal frequency. This is done by setting the signal generator controls for a 455 kHz, 400 Hz amplitude modulated signal and adjusting all of the IF tuned circuits for maximum audio output in the headphones.

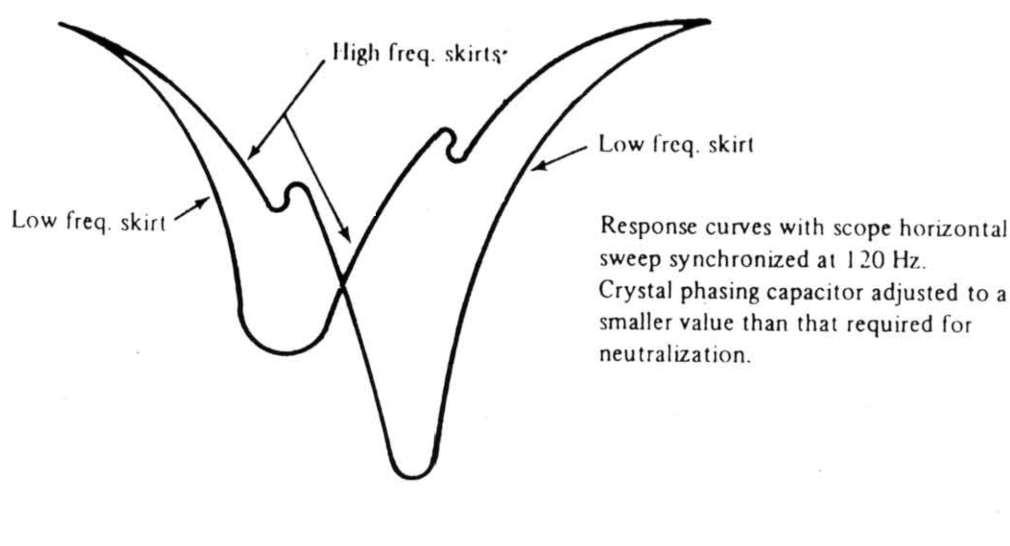


Figure 4–4

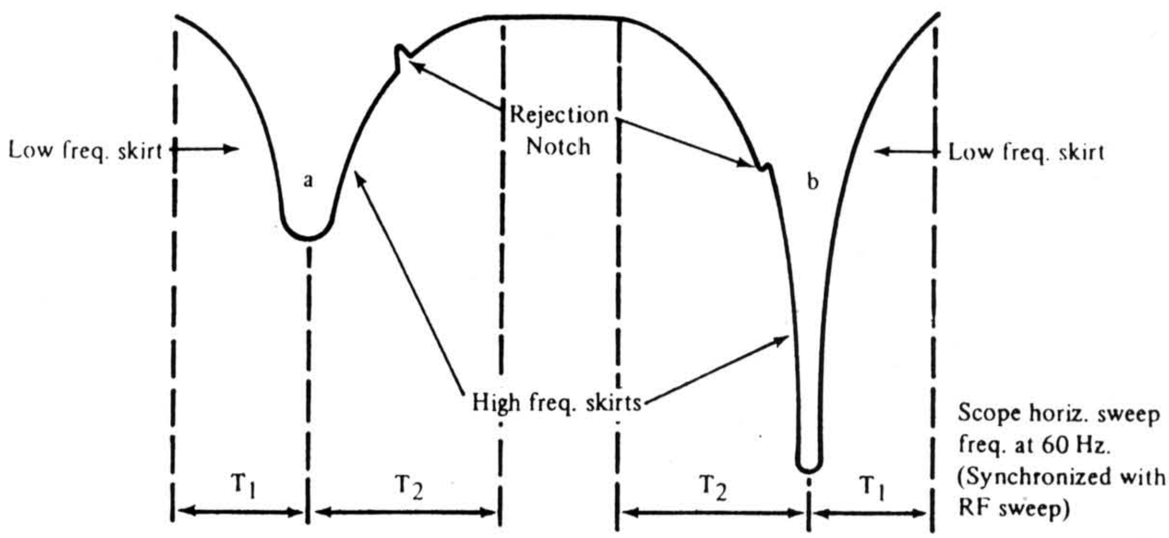

Rejection
Notch
Low freq. skirt
Low freq. skirt
a
b
High freq. skirts
Scope horiz. sweep
freq. at 60 Hz.
(Synchronized with
RF sweep)
T1
T2
T2
T1

Figure 4-5

CHAPTER 5

ALINEMENT OF THE IF AND RF STAGES OF RADIO RECEIVER R-390/URR

5-1 GENERAL. IF employing a crystal filter circuit are alined to the series-resonant frequency of the crystal used in the filter. Technical information concerning the crystal frequency, although accurate, is not exact. Crystal frequencies of identical receivers may vary as much as 200 Hz. Such a variance must be considered when alining IF of communications receivers that make use of a crystal filter to achieve bandwidths in the IF as short as .1 kHz.

5-2 PROCEDURE.

a. Before actual visual alinement can begin on Radio Receiver R-390/URR, certain preparatory adjustments and checks should be performed, such as:

(1) The adjustment of the regulated voltage hum potentiometer.

(2) The synchronization of the tuning shafts.

(3) The alinement of the second crystal oscillator.

(4) The alinement of the first crystal oscillator.

Complete instructions on the above alinements and adjustments will be found in TM 11-5820-357-35.

b. Upon completion of the adjustments and checks, visual alinement may begin by connecting the necessary equipment to the receiver. The RF output of the RF sweep generator is connected to the balanced antenna input of the receiver through a 95-ohm, one-quarter-watt resistor, with a 75-ohm, one-quarter-watt resistor across the generator RF lead as shown in figure 5-1.

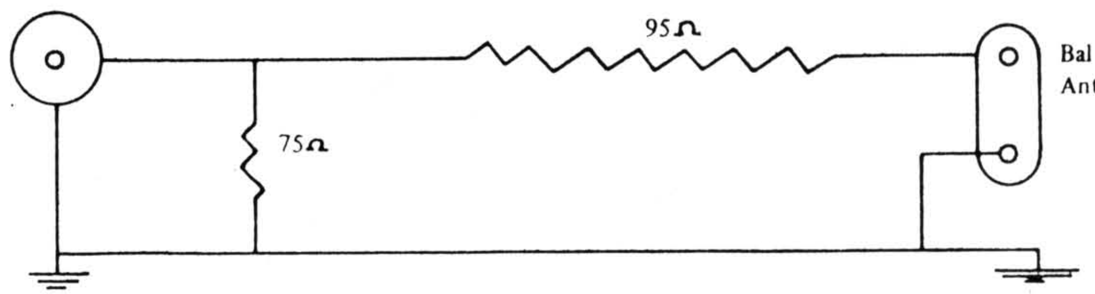


Figure 5-1

c. The vertical input leads of the oscilloscope are connected to the diode–load terminals of the receiver and to ground.

d. The controls of the sweep generator (TS–465 A/U) are set as follows:

(1) Output control at 100.

(2) Output multiplier at 0 to 15 kHz; AF, FM.

(3) FM, AM selector at 1000 kHz, 30 kHz sweep.

(4) Output selector at 60 Hz frequency modulation.

(5) Frequency modulated sweep at approximately 25 kHz, reading the inner scale.

(6) Band selector at D.

(7) Frequency adjustment at 2.9 Megahertz (MHz).

e. The controls of the R–390/URR are set as follows:

(1) MHz change at 01.

(2) Kilohertz change at 900.

(3) Bandwidth at 1 kHz.

(4) BFO at OFF.

(5) Line gain at 0.

(6) Audio response at WIDE.

(7) Function at MGC.

(8) AGC at FAST.

(9) Break–in at OFF.

(10) Limiter at OFF.

(11) RF gain at desired scope level.

(12) Local gain at desired level.

f. The final settings are made on the controls of the oscilloscope.

(1) Horizontal gain to give a desired trace width.

(2) Vertical gain at full sensitivity.

(3) Horizontal sweep synchronized at 120 Hz.

(4) Intensity and focus at a desired level to attain a sharp trace of the oscilloscope pattern.

g. After all the above settings have been completed, the two response curves which appear on the oscilloscope screen are superimposed by adjusting the sweep generator frequency adjustment control.

h. Next, the crystal phasing trimmer in the crystal filter is adjusted to determine if the peaks of the two response curves break in opposite directions (para 14). If the peaks do not break in opposite directions, the 455 kHz IF stage must be adjusted to the approximate crystal frequency by:

(1) Setting the sweep generator output selector at 400 Hz amplitude modulations, and frequency adjustment control at 455 kHz.

(2) Setting the receiver bandwidth control at 2 kHz.

(3) Connecting the generator output to the third mixer control grid.

(4) Adjusting the cores of the transformers of the sixth IF stage through the first IF stage, in this order, for maximum audio output.

i. The maximum response of the crystal is attained by adjusting the slug in the crystal filter and, when maximum response is achieved, the peaks of the superimposed curves on the oscilloscope are brought together by adjusting the trimmer. As mentioned in an earlier chapter, the frequency adjustment control of the sweep generator is adjusted only to superimpose the response curves while the bandwidth control is in the 1 kHz position.

The foregoing series of operations has adjusted the crystal filter circuit to the series–resonant frequency of the crystal and has located this frequency in the center of the sweep (see fig. 3–2).

j. The series–resonant frequency of the crystal is the standard to which the IF stages and RF stages are to be alined. Alinement of these stages follows a procedure similar to that of the crystal filter, but necessitates a frequency change for each stage of alinement.

k. Alinement is started with the 455 kHz IF stage. It is first necessary to set the receiver bandwidth control at 2 kHz and adjust the slugs of the transformers of the sixth IF stage through the first IF and second variable IF, in turn, for maximum response on the oscilloscope with the curves superimposed. From time to time, it will become necessary to adjust the RF gain control to regain the desired response pattern, since successive adjustments of the IF stages will cause the response curves to go off the oscilloscope screen. This corrective adjustment will be made throughout the alinement procedure.

l. At this point, the 455 kHz IF stage can be checked for skirt selectivity and alinement. To check skirt selectivity, switch the receiver bandwidth control to 8 kHz and observe the flatness of the response pattern. The slugs of the second IF transformer are adjusted to give the flattest response pattern. A typical flat response pattern is shown in figure 5–2.

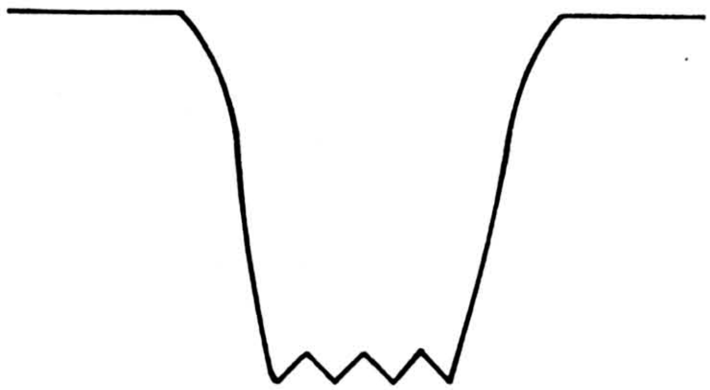


Figure 5–2

Alinement is checked by switching the bandwidth control back and forth from 1 to 2 kHz to determine if the response curves will remain superimposed. If the curves do not remain superimposed, it will become necessary to repeat the complete operation to this point until no further increase in response is achieved and the curves remain superimposed when the bandwidth control is switched from 1 to 2 kHz. At the completion of each alinement stage, the slug and trimmer adjustments of that particular stage are repeated until maximum response is attained.

m. To continue alinement of the second variable IF stage, change the receiver frequency to 1100 kHz, change the bandwidth to 1 kHz, tune the sweep generator to 2100 kHz, and superimpose the resulting two response curves on the oscilloscope screen. When the two response curves are superimposed, the bandwidth is changed to 2 kHz, and the trimmers of the second variable IF are adjusted for maximum response. This adjustment completes the alinement of the 455 kHz IF stage and the second variable IF stage.

n. To aline the first variable IF stage, the receiver must be set at 1500 kHz, the bandwidth must be changed to 1 kHz, the sweep generator set at 2.5 MHz, and the resulting two response curves are superimposed on the oscilloscope screen. Next, the bandwidth must be changed to 2 kHz and then the slugs of the first variable IF are adjusted for maximum response. Before adjusting the trimmers of this stage, the receiver frequency must be set at 7500 kHz, the bandwidth at 1 kHz, the sweep generator at 8.5 MHz, and then the two response curves are superimposed. After changing the receiver bandwidth to 2 kHz, the trimmers of the first variable IF can be adjusted for maximum response. Alinement of the first variable IF stage is completed when the maximum response of the superimposed curves is achieved.

o. The last IF alinement is performed on the automatic gain control (AGC). With the oscilloscope connected to the AGC terminal and ground (fig. 5–3), the function control of the receiver is set at AGC and the core of the automatic gain control IF transformer adjusted for maximum response. The resulting response pattern on the oscilloscope screen at this time will not appear to be the same as those that have been viewed during operations up to this point. A sine–wave like pattern (fig. 5–4) now on the oscilloscope is the normal AGC response pattern and is a result of the time constant in the AGC circuit. When maximum response is attained, the alinement phase of the IF stage is completed.

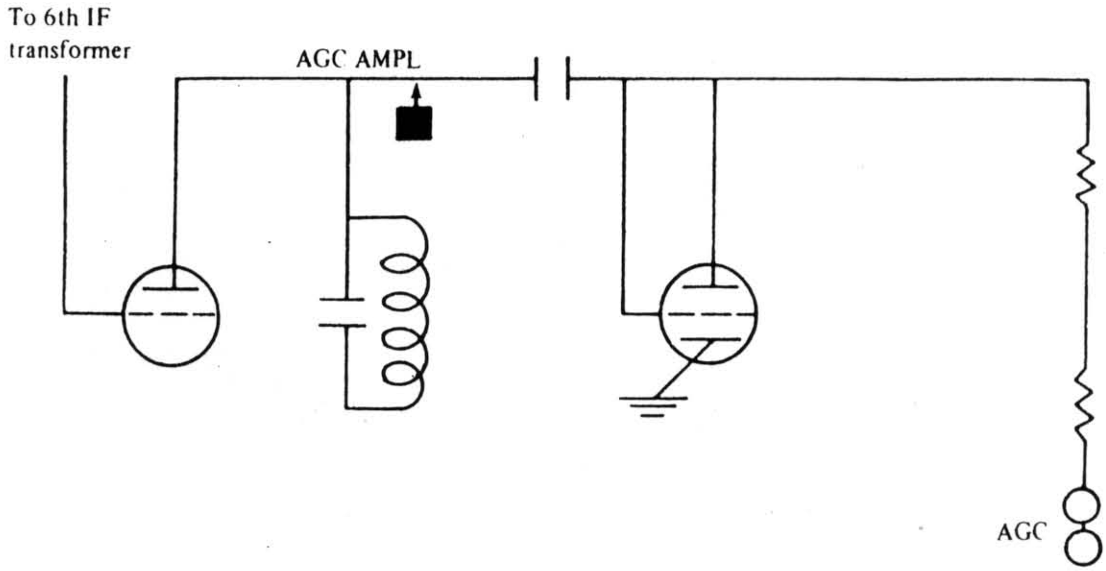


Figure 5–3

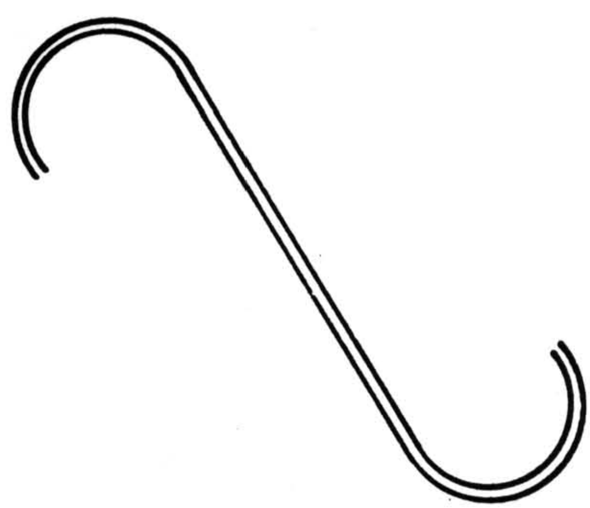


Figure 5–4

p. The RF stages are alined in the same manner that the IF stages were alined. Using the alinement chart, figure 5–5, repairmen will be able to progress from one step to another with ease without the necessity of following a detailed description of each progressing step. Since the alinement procedure is the same for all six RF stages, only the .5 to 1 MHz stage will be described.

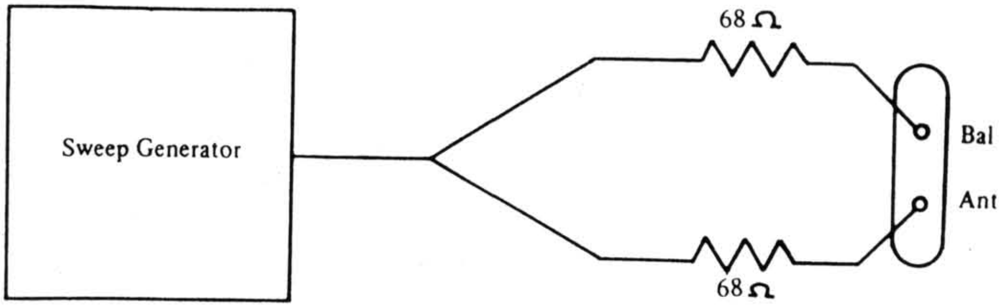


Figure 5-5

q. Alinement of the RF stage begins with the connection of the oscilloscope to the diode-load terminals of the receiver, noting that in this stage of alinement the antenna trimmer control is set at 0, the function control reset at MGC, the receiver set at 600 kHz and the bandwidth control knob at 1 kHz. At this point, the sweep generator is set at 1600 kHz and the two response curves now on the oscilloscope screen are superimposed. Next, the bandwidth is switched to 2 kHz and the slugs of the mixer RF, the second RF, and the antenna transformer are adjusted for maximum response. When maximum response of the curves is attained, the receiver frequency is changed to 900 kHz, the bandwidth is changed to 1900 kHz, and the two response curves are again superimposed. Next the bandwidth is switched to 2 kHz, and the trimmers of the mixer RF and the antenna transformer are adjusted for maximum response. Using the settings shown in figure 5-5, the above procedure is repeated for each set of RF transformers to accomplish the complete RF alinement. Each frequency range includes an antenna transformer that has two trimmer capacitors. It should be noted that only the rear trimmer must be adjusted for peak output response during the alinement of the particular stage. The front trimmers are adjusted after all the RF stages have been alined.

r. Before adjusting the front trimmers, the sweep generator must be connected to the junction of two 68-ohm resistors that are connected in series across the balanced antenna input (fig. 5-6).

Following are the receiver frequency settings used in this operation.

DIAL READING	TRANSFORMER (Front Trimmer)
00 950	T 201
01 900	T 202
03 600	T 203
07 500	T 204
13 500	T 205
31 500	T 206

Set of RF Coils	Megahertz Reading	Kilohertz Reading	Sweep Generator Frequency in kHz	Adjust Slugs	Adjust Trimmers
.5–1 mHz	00	600	1600	Z213 Z207 Z201 T201	Z213 Z207 Z201 T201 (rear trimmer)
	00	900	1900		
1–2 mHz	01	100	2100	Z214 Z208 Z202 T202	Z214 Z208 Z202 T202 (rear trimmer)
	01	900	2900		
2–4 mHz	02	200	3200	Z215 Z209 Z203 T203	Z215 Z209 Z203 T203 (rear trimmer)
	03	800	4800		
4–8 mHz	04	400	5400	Z216 Z210 Z204 T204	Z216 Z210 Z204 T204 (rear trimmer)
	07	600	8600		
8–16 mHz	08	800	9800	Z217 Z211 Z205 T205	Z217 Z211 Z205 T205 (rear trimmer)
	15	200	16200		
16–32 mHz	17	600	18600	Z218 Z212 Z206 T206	Z218 Z212 Z206 T206 (rear trimmer)
	30	400	31400		

Figure 5–6

The receiver is first set at 950 kHz, the bandwidth set at 1 kHz, the sweep generator tuned to 1950 kHz (always 1000 kHz higher than the receiver frequency settings), and the two response curves superimposed. Appearing on the oscilloscope screen will be a fluctuating pattern which is due to noise, because of cancellation of the signal in the antenna transformer. The procedure is continued by switching the bandwidth to 2 kHz and adjusting the front trimmer of the antenna transformer for minimum response. Repetition of the above procedure at the proper frequency setting for each transformer balances the antenna input circuits.

s. The final step of alinement is the calibration of the BFO which is performed with the bandwidth switch in the .1 kHz position and the function switch turned to CAL. The kHz change control is adjusted for maximum response on the carrier level meter at any 100 kHz calibration check point. At this maximum response reading, the BFO switch is set to ON, and the BFO pitch control is adjusted for zero beat in the headphones. Zero beat should occur with the pitch control knob at the zero mark. If the knob is not in the proper position, the knob should be loosened and positioned to zero, then tightened.

t. This final step has completed the visual alinement of Radio Receiver R-390/URR. Four of the most important points to be remembered in conjunction with visual alinement of communications receivers are that:

(1) The series–resonant frequency of the crystal is accurately determined by visual means.

(2) The skirt selectivity is visually determined to be symmetrical.

(3) The crystal frequency is located at the center and peak of the overall IF response.

(4) The IF and RF stages are alined in a manner that can be verified by sight.

5-3 VISUAL ALINEMENT PROCEDURE FOR R–390A/URR.

a. One of the primary differences between the R–390A/URR and the R–390/URR is the IF filter circuit. The 455 kHz IF in the R–390A/URR employ mechanical filters in addition to a crystal filter circuit identical to the one used in the R–390/URR. The basic theory of these filters is somewhat complicated, but a qualitative explanation of the filters is fairly simple (see TM 11–5820–358–35, para 14). Note that these filters are factory set; therefore, no adjustment is required.

b. The IF stages of the R-390A/URR differ slightly from those of the R-390/URR; however, the alinement procedure is very similar. The transformers in the 455 kHz IF are fixed tuned. Normally, they do not require frequent alinement; for this reason, they do not come with a hole in the covers to allow access to the slugs. When it becomes necessary to aline the 455 kHz IF, remove the covers and drill a hole in the center of the top of the can, and replace the covers before alining the coils. These coils require a special non metallic alinement tool with a hexagonal tip. The tool must be inserted through the top core into the bottom core. The bottom core will turn without disturbing the setting of the top core. After adjusting the bottom core, the tool is pulled up and engaged with the slug of the top coil for necessary adjustments.

c. Connect the test equipment to the receivers in the same manner as described for the R 390/URR. Set the controls of the sweep generator as follows:

(1) Output control at 100.

(2) Output multiplier at 0 to 15 kHz; AF, FM.

(3) FM, AM selector at 1000 kHz, 30 kHz sweep.

(4) Output selector at 60 Hz frequency modulation.

(5) Frequency modulated sweep at approximately 25 kHz, reading the inner scale.

(6) Band selector at D.

(7) Frequency adjustment at 2.9 MHz.

Receiver Frequency	*Stages to be Alined*
1900 kHz	455 kHz IF and slugs of 2nd variable IF
1100 kHz	Trimmers of the second variable IF
1250 kHz	Slugs of the first variable IF
7250 kHz	Trimmers of the first variable IF

d. The AGC circuit will be alined in the same manner as described for the R–390/URR.

e. The RF will be alined in the same manner as described for the R–390/URR. Frequencies for alinement will be taken from the chart in TM 11–5820–358–35, para 77, except that the signal generator frequency will in each case be set at 1000 kHz higher than the frequency listed in the chart.

f. The antenna balance trimmers are adjusted in the same manner and at the same frequencies as those for the R–390/URR.