SERVICE MANUAL

ZENITH

REG. U. S. PAT. OFF.

TELEVISION RECEIVERS

MODELS	28T925	28T960	28T961	28T962	28T963
CHASSIS	28F20	28F20Z	28F21	28F22	

ZENITH RADIO CORPORATION

6001 DICKENS AVENUE • CHICAGO 39, ILLINOIS

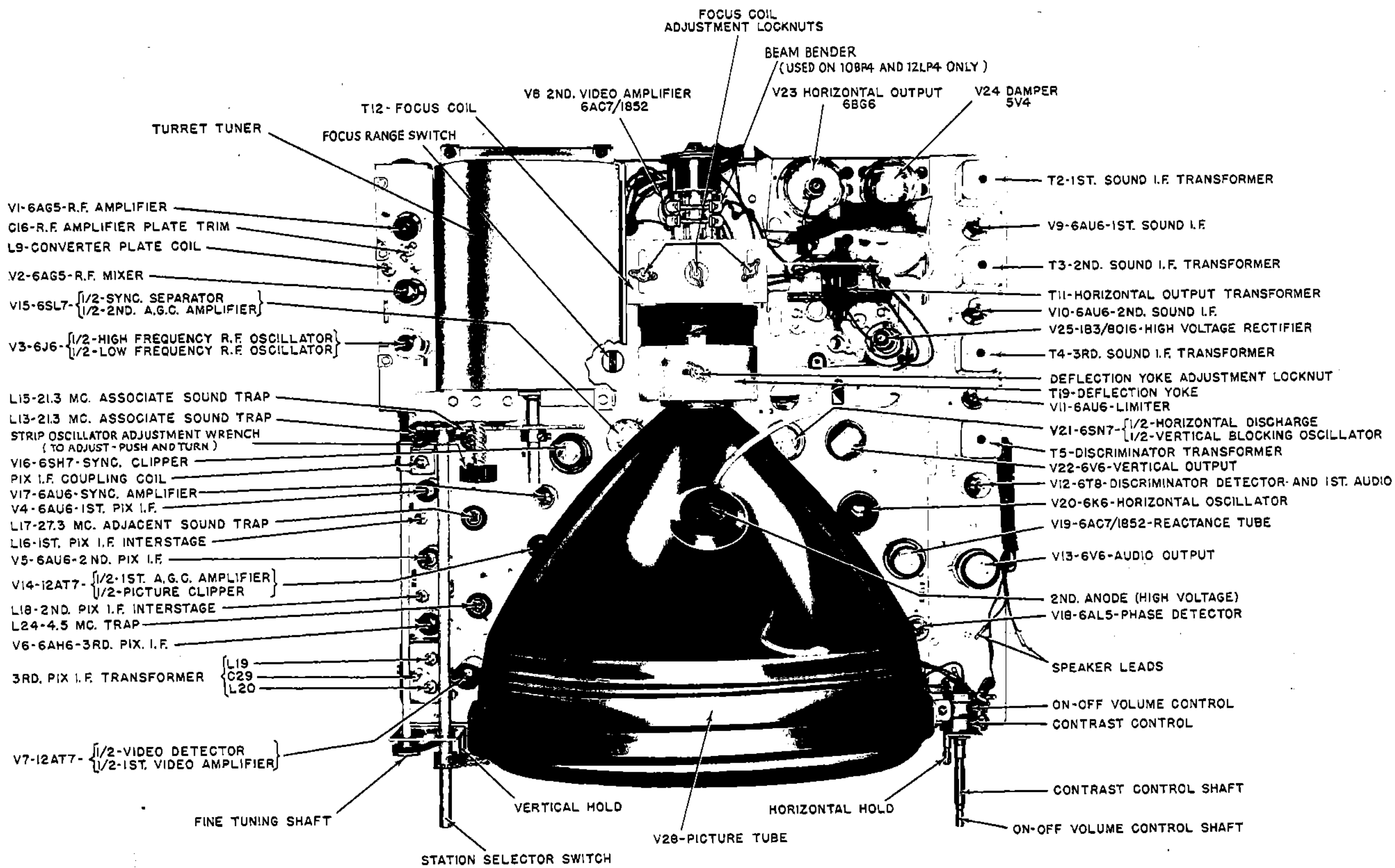


Fig. 1 Top View Zenith Television Receiver.

GENERAL DESCRIPTION

ZENITH TELEVISION RECEIVERS

Zenith 28-tube direct view television receivers have many outstanding features. These include gated automatic gain control, turret tuning with replaceable channel strips and main chassis break down into easily interchangeable sub-chassis. Chassis 28F20, 28F21 and 28F22 are identical electrically. The primary differences are in the size and the method of mounting the picture tube. An "A" screen (10FP4, 10BP4) is used in the 28F21 and 28F22 chassis while a "B" screen (12KP4,12LP4) is used in the 28F20 and 28F20Z chassis. Because the 28F22 chassis is used in table model receivers, a specially shielded power transformer is used in the low voltage power supply to prevent magnetic interaction with the receiver sweep circuits.

Cabinet Model	Chassis Model	Description
28T960E	28F20 28F20Z	Consolette Cabinet - Modern Design Blonde Mahogany Finish. Twenty - Eight (28) tubes including "B" Screen Picture Tube 10-in. P.M. Speaker. Turret Tuning - 12 Channels.
28T962R	28F20 28F20Z	Consolette Cabinet - Period Design Mahogany Finish. Twenty-Eight (28) tubes including "B" Screen Picture Tube 10-in. P.M. Speaker Turret Tuning - 12 Channels
28T961E	28F21	Same as Model 28T960E except "A" Screen Picture Tube.
28T963R	28F21	Same as Model 28T962R except "A" Screen Picture Tube.
28T925E	28F22	Table Cabinet - Modern Design Blonde Mahogany Finish Twenty-Eight (28) tubes including "A" Screen Picture Tube. 5 1/4-in. P.M. Speaker Turret Tuning - 12 Channels
28T925R	28F22	Same as Model 28T925E except Mahogany Finish Cabinet.

Power Consumption-325 Watts

Power Supply-110V 60 Cycles AC

Antenna Impedance Balanced 300 ohms.

Audio Output-Undistorted 3.5 Watts
Maximum 6.5 Watts

CONTROLS AND FUNCTIONS

Fig. 2 indicates the various receiver controls. After the receiver has been properly adjusted, the service man should remove the fine tuning, vertical hold, brightness and horizontal hold control knobs. These knobs have a white dot stamped on their periphery and should be re-inserted with the dot facing upward (See fig. 2). This will aid the customer in determining the proper position of the controls should they be accidently moved out of position.

CHANNEL SELECTOR SWITCH. Switches into operating position the R. F. strip which tunes the particular channel selected.

FINE TUNING CONTROL. Provides a means of varying the frequency of the local oscillator to compensate for any frequency changes which may result from tube and circuit variations. When tuning the receiver, three distinct and closely related sound response positions will be found. Adjust the receiver to the center response.

VERTICAL HOLD CONTROL. Provides a means of changing the R. C. time constant in the grid circuit of the vertical blocking oscillator to synchronize the vertical sweep with the transmitted sync pulses. Improper adjustment of this control will cause the picture to roll in the vertical direction.

FOCUS CONTROL. Regulates the magnitude of DC current flow through the focus coil to effect proper focusing of the electron beam on the screen of the picture tube.

VERTICAL CENTERING CONTROL. Regulates the magnitude and polarity of DC current flow through the vertical deflection coils for proper vertical centering of the raster on the picture tube screen.

HORIZONTAL CENTERING CONTROL. Regulates the magnitude and polarity of DC current flow through the horizontal deflection coils for proper horizontal centering of the raster on the picture tube screen.

VERTICAL HEIGHT CONTROL. Effects the vertical sweep amplitude by regulating the plate voltage to the vertical blocking oscillator. This control is used to adjust the vertical size of the raster.

TUBE COMPLEMENT

Symbol	Tube	Function
V 1	6AG5	R. F. Amplifier
V 2	6AG5	Converter
V 3	6J6	1/2 R. F. Oscillator, (V3A) High Frequency. 1/2 R. F. Oscillator, (V3B) Low Frequency.
V 4	6AU6	1st Picture I. F. Amplifier
V 5	6AU6	2nd Picture I. F. Amplifier
V 6	6AH6	3rd Picture I. F. Amplifier
V 7	12AT7	1/2 Video Detector (V7A) 1/2 Video Amplifier and Noise Clipper (V7B)
V 8	6AC7/1852	2nd Video Amplifier
V 9	6AU6	1st Sound I. F. Amplifier
V 10	6AU6	2nd Sound I. F. Amplifier
V 11	6AU6	Limiter
V 12	6T8	Discriminator - Detector and 1st Audio Amplifier
V 13	6V6GT-G	Audio Output
V 14	12AT7	1/2 1st A. G. C. Amp. (V14A 1/2 Picture Clipper (V14B)
V 15	6SL7GT-G	1/2 Sync Separator (V15A) 1/2 2nd A. G. C. Amp. (V15B
V 16	6SH7	Sync Clipper
V 17	6AU6	Sync Amplifier
V 18	6AL5	Phase Detector
V 19	6AC7/1852	Reactance Tube
V 20	6K6GT-G	Horizontal Oscillator
V 21	6SN7GT-G	1/2 Hor. Discharge (V21A) 1/2 Vert. Block. Osc. (V21B
V 22	6V6GT-G	Vertical Output
V 23	6BG6	Horizontal Output
V 24	5V4	Damper
V 25	1B3GT/8016	High Voltage Rectifier
V 26	5U4	Low Voltage Rectifier
V 27	5U4	Low Voltage Rectifier
V 28	10FP4 or 12KP4	Picture Tube

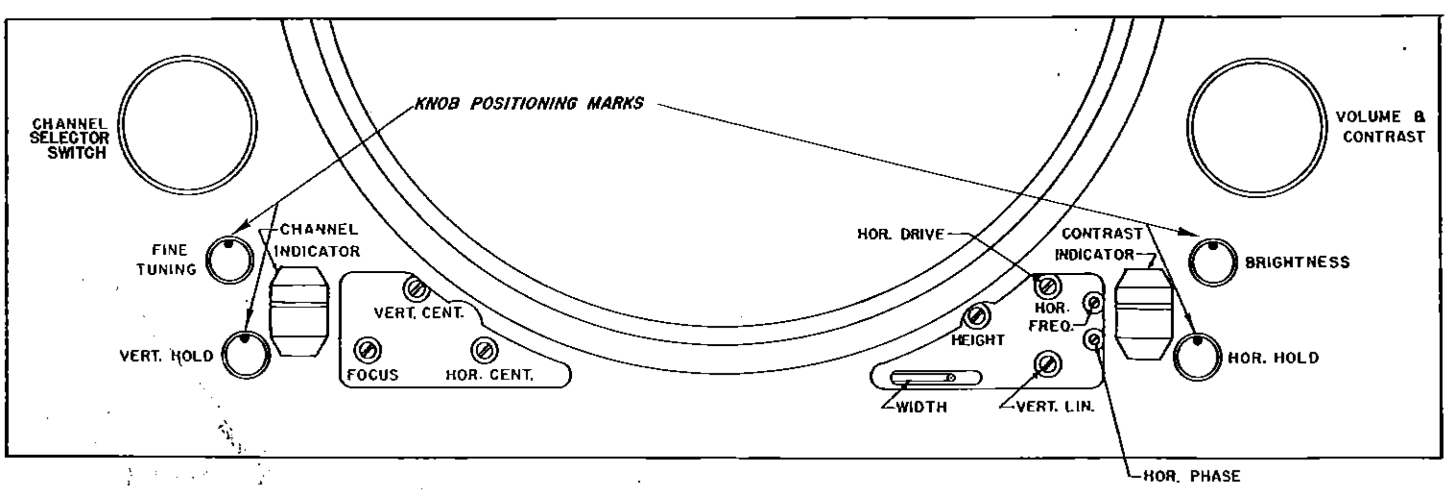


Fig. 2 Front Panel Controls.

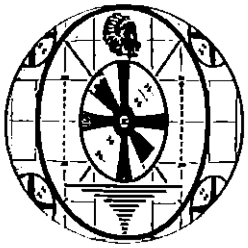


FIG.3 NORMAL PICTURE

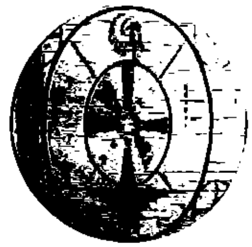


FIG. 4 WEAK SIGNAL

FIG. 5 SOUND IN PICTURE

FIG. 6 CONTRAST CONTROL LOW OR BRIGHTNESS HIGH

FIG. 7 GHOSTS

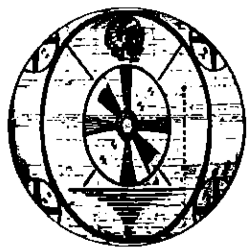


FIG.8 IGNITION INTERFERENCE

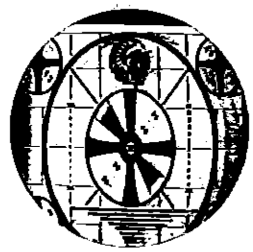


FIG.9 VERTICAL CENTERING CONTROL INCORRECTLY SET

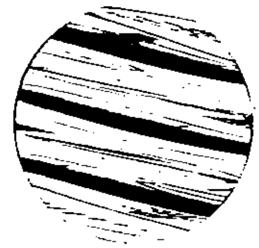


FIG.10 HORIZONTAL HOLD CONTROL INCORRECTLY SET

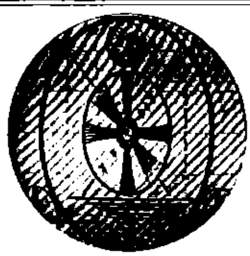


FIG. 11 R.F. INTERFERENCE

FIG.12 DIATHERMY INTERFERENCE

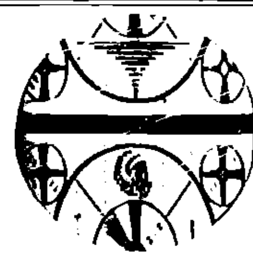


FIG.13 VERTICAL HOLD CONTROL INCORRECTLY SET

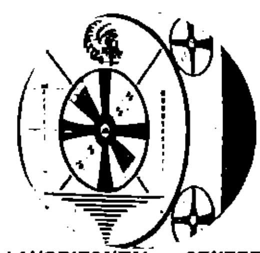


FIG.14 HORIZONTAL CENTERING CONTROL INCORRECTLY SET

CHANNEL	FREQ. BAND MC	PICTURE CARRIER	SOUND CARRIER	RECEIVER LOCAL OSCILLATOR
	54-60	55.25	59.75	81.05
	60-66	61.25	65.75	87.05
	66-72	67.25	71.75	93.05
	76-82	77.25	81.75	103.05
	82-88	83.25	87.75	109.05
	174-180	175.25	179.75	201.05
	180-186	181.25	185.75	207.05
	186-192	187.25	191.75	213.05
	192-198	193.25	197.75	219.05
	198-204	199.25	203.75	225.05
	204-210	205.25	209.75	231.05
	210-216	211.25	215.75	237.05

Fig. 15 Television Channels and Corresponding Receiver Oscillator Frequencies.

CIRCUIT DESCRIPTION

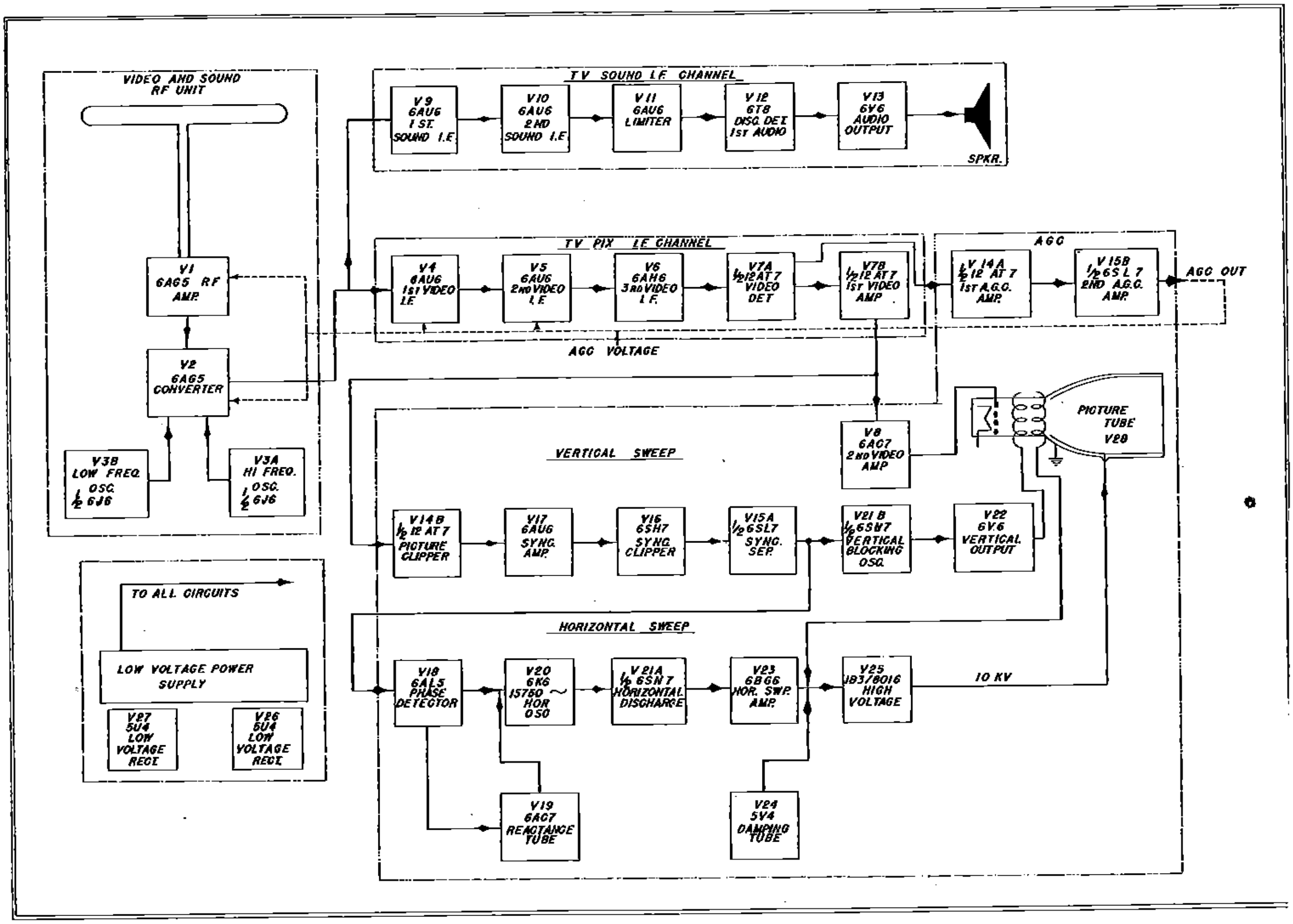


Fig. 16 Block Diagram of Zenith Television Receiver.

THE R. F. SHELF

The three stages of the R. F. shelf consist of a 6AG5 R. F. amplifier V1, 6AG5 converter V2, and a 6J6 R. F. oscillator V3. The 6J6 twin triode tube functions as two separate oscillators. V3A tunes channels 7 to 13 and V3B channels 2 to 6. The oscillator frequency can be changed approximately 1 Mc by the off-set tuning slugs which are attached to the fine tuning shaft. Both the high and the low channel oscillators are pre-set at the factory and adjustment should not be attempted unless a defective part is replaced or the unit has been tampered with. If adjustment becomes necessary, slug L11 trims the low frequency oscillator. The high frequency oscillator trimmer L10 is a slotted disc type control. Adjustment is made by inserting a pointed tool into one of the slots and turning the disc clockwise or counter clockwise (See fig.45). The serviceman is cautioned against making these adjustments unless the oscillator trimmers on the various channel strips cannot be made to resonate at the sound channel frequencies or if the high and low channels cannot be made to fall at the same setting of the fine tuning control.

THE TURRET TUNER

The turret tuner provides a superior method of obtaining positive contact between the various channel strips and the R. F. shelf. The stationary contacts are a part of the R. F. shelf. Guides are provided which properly position the strip contacts prior to their entry into the stationary assembly. The design allows easy replacement of channel strips. When a strip is replaced it should be mechanically aligned with the adjacent strip. If several strips are replaced, the strip positioning guide (See fig. 46), should be adjusted so that it comes in contact with a properly centered strip. This will serve as a guide for any other strip which may be installed. After adjustment, the strip positioning guide must be backed out so that it does not interfere with strip movement.

THE SOUND I. F. CHANNEL

The local oscillator beats against the incoming R. F. signal an produces a sound intermediate frequency of 21.3 megacycles. Thi signal is coupled through a 21.3 Mc series resonant trap L15, int the sound I. F. amplifier. The small inductance between lugs 2 an 5 of T2 offers a common coupling between the series trap and th sound input coil. The series resonant trap has a very low impe dance at the 21.3 Mc frequency, but offers a high impedance to th picture I. F. It thereby serves a dual purpose in that it passes t sound and rejects the picture I. F. The sound I. F. is amplified b the 6AU6 first sound I. F. amplifier V9 and the 6AU6 second sour I. F. amplifier V10. The output from the third I. F. transformer coupled to the grid of the limiter tube V11 where amplitude varia tions and noise are removed by driving the tube into plate curre saturation so that the input to the discriminator is free from amp litude variations and noise. The discriminator converts the fre quency changes into audio, the audio being removed from the fu discriminator load, amplified by the 6V6 power amplifier and re produced by the speaker.

Because the television sound channel is frequency modulated, the intermediate frequency amplifier must be aligned with a FM signal generator to obtain proper band pass with gain.

THE PICTURE I. F.

The picture I. F. sub-chassis consists of a 6AU6 1st picture I. F., 6AU6 2nd picture I. F., 6AH6 3rd picture I. F. and a 12AT7 video detector, 1st video amplifier and noise clipper. Fig. 17 indicates the method of coupling the converter to the 1st picture I. F. It

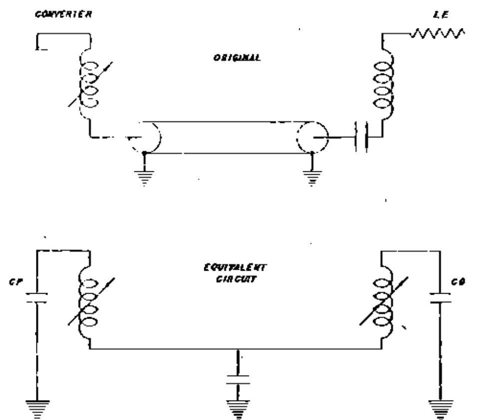


Fig. 17 Converter Coupling into the Picture I. F. Channel.

can be seen that the cable capacity is common to the converter plate and 1st I. F. grid by virtue of the inherent inter-electrode and stray capacities.

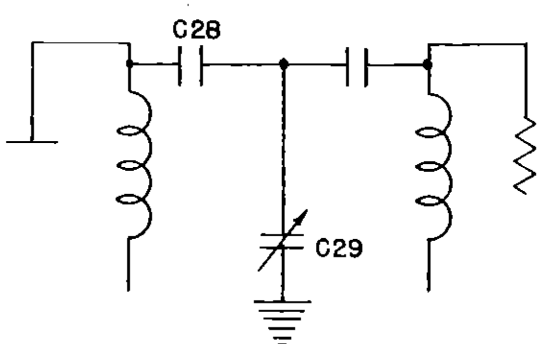


Fig. 18 3rd I. F. Transformer Coupling.

The degree of coupling between the primary and secondary of the 3rd picture I. F. transformer depends on the setting of C29. It can be seen that the I. F. voltage at the plate of V6 is divided across C28 and C29 and the I. F. voltage applied to the grid of the video detector depends on the reactance ratio of the two capacitors. An increase in the capacity of C29 lowers the applied voltage to the grid. While a decrease in capacity increases this voltage.

The 4.5 Mc difference between picture and sound I. F.'s may produce an undesirable voltage into the video amplifier creating a condition where sound could appear in the picture. The 4.5 Mc trap in the cathode circuit of the 1st video amplifier eliminates this possibility.

GATED A.G.C.

The purpose of the automatic gain control is to feed back a negative voltage to the grids of the R. F. and I. F. amplifier tubes to automatically control their gain. Strong signals do not overload the receiver because they develop considerable feedback voltage and reduce the sensitivity of the receiver. Weak signals feed very little voltage to the grids and the sensitivity of the R. F. and I. F. stages is at maximum.

With ordinary A.V.C. circuits, as used in broadcast receivers, the average of the rectified signal voltage is taken from the detector and fed back to the R. F. - I. F. grids. With a television receiver it is impossible to use the average signal because the amplitude is constantly changing with picture content. The components in the video signal which have a relatively constant amplitude are the sync pulses. These are maintained at a level approximately 20 to 25% above the blanking and video level (See fig. 19). Because the amplitude of the sync pulses is relatively constant, they are used to control the gain of a television receiver.

Ordinary methods of A.G.C. have certain disadvantages which have been overcome by using the gated system. If the automatic gain control is not gated, it remains open to noise impulses which can have an amplitude as great, and in some cases, greater than the sync pulses. The average voltage developed by the noise pulses creates a false A.G.C. voltage where the noise rather than the signal can be the controlling factor.

The superior A.G.C. circuit in this receiver consists of a cathode follower V14A, and a cathode coupled grounded grid amplifier V15B, which obtains its plate voltage (15.75 Kc sine wave) from the horizontal oscillator. The sync pulses which are applied to the grid of V14A are negative with respect to its cathode. As the sync pulse amplitude increases, with an increase in signal input, the grid is driven more negative resulting in less plate current flow and consequently less voltage drop across the cathode resistor R40. Since the bias of V15B is developed across this resistor, the reduction of the voltage drop causes V15B to conduct more current which in turn leads to the development of additional negative feedback voltage for application to the R.F. and I. F. grids. The application of the 15.75 Kc sine wave voltage to the plate of V15B, allows the tube to conduct during the positive half cycles. This is an "open gate" condition and exists at any time that the combined sine wave and sync pulse amplitude makes the plate of V15B positive with respect to its cathode. During this conduction period (open gate period) A.G.C. voltage is developed across C53. The brief period of time that the gate is open is slightly longer than the 5 microseconds duration of the horizontal pulse. However, during the comparatively long interval of time between pulses, the gate is closed and noise pulses can have no effect on the A.G.C.

The primary advantage of the gated A.G.C. system is its relative immunity to noise. Another advantage is the fact that short time constants are used which enable the A.G.C. to follow much faster changes in amplitude such as those developed by airplane reflections. The long time constants in conventional A.G.C. systems cannot follow such rapid changes in amplitude and undesirable effects such as picture "breathing" result.

THE SYNC SEPARATOR

The purpose of the sync separator circuit, which consists of V14B picture clipper, V17 sync amplifier, V16 sync clipper and V15A sync separator, is to remove the picture element from the 60 cycle vertical and 15.75 Kc horizontal sync pulses. The pulses must be free from noise and picture before they are applied to the integrating and differentiating circuits. Since the sync pulses are 20 to 25 per cent higher in amplitude than the blanking-video signal (See fig. 19), the tubes are sufficiently biased so that the lower

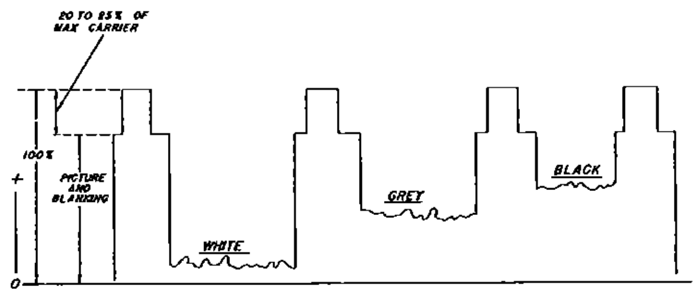


Fig. 19 The Composite Video Signal.

amplitude picture signal cannot produce a plate current change and consequently does not appear in the output. The higher amplitude sync pulses, however, overcome the bias, produce a change in the plate current and appear in the output. The picture clipper V14B removes the greatest portion of picture signal from the sync pulses. The sync amplifier V17 amplifies and inverts the output from the picture clipper. Some picture and noise is still present in the output, the noise being removed by the 47 MMF high cut capacitor (C61) from plate to cathode of V17. The low frequency boost circuit, which consists of the 10,000 ohm resistor R53 and the .1 MFD capacitor C58 in the plate circuit, raises the plate impedance at the vertical sync frequency in order to clip the vertical sync pulses at a more noise-free level. The input of the sync clipper V16, contains a relatively small amount of picture component. A combination of fixed and self bias causes complete re-

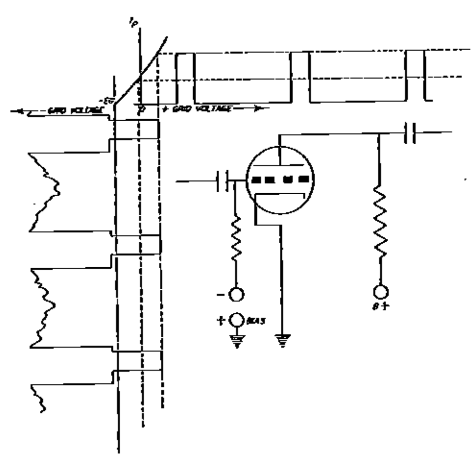


Fig. 20 Stripping Sync Pulses from Picture and Blanking Component.

jection of the picture signal which remains and only the sync pulses appear in the output. The polarity of the output voltage is negative. Because of the reversal through the sync separator tube V15A, the required positive pulses appear at the plate for triggering the blocking oscillator. The horizontal sync input is fed into the phase detector through the 150MMF capacitor (C77) and the vertical input to the integrating circuit through the 10,000 ohm resistor R53.

THE VERTICAL SWEEP

The purpose of the vertical sweep is to gradually move the electron beam from the top to the bottom of the picture tube as it is swept from left to right by the horizontal sweep. It requires approximately 15,500 microseconds for the beam to move from the top of the picture tube to the bottom and approximately 1,166 microseconds to again return to the top for the next field. This period of time is the retrace and is blanked out. The frequency of the vertical sweep is 60 cycles. Because the 15.75 Kc horizontal triggering must never stop, even during the vertical retrace, the vertical pulses are serrated so that they continue triggering the horizontal oscillator. Since the horizontal sweep continues, the beam does not go directly from the bottom of the picture tube to the top during the retrace. It is zig-zagged back to the top by action of the horizontal sweep. The retrace can be observed by reducing the contrast and advancing the brilliance control. Six equalizing pulses precede and follow the serrated vertical pulse to stabilize the circuits before and after the vertical sync pulse.

Both the horizontal and vertical pulses enter the integrating and filter network which consist of three 8,200 ohm resistors R5 and three .0047 MFD capacitors C65. Because of the long time constant in the integrating circuit, the short duration horizontal sync and vertical equalizing pulses have very little effect on developing a charge across the integrating capacitors (See fig. 23). The slight charge that does develop leaks off during the interval of time between pulses and for all practical purposes, has no effect. The serrated vertical pulse, on the other hand, has a time duration of approximately 190 microseconds and very little time interval between pulses. Each pulse charges the integrating capacitor to a higher potential until the voltage becomes high enough, and properly shaped, to trigger the blocking oscillator.

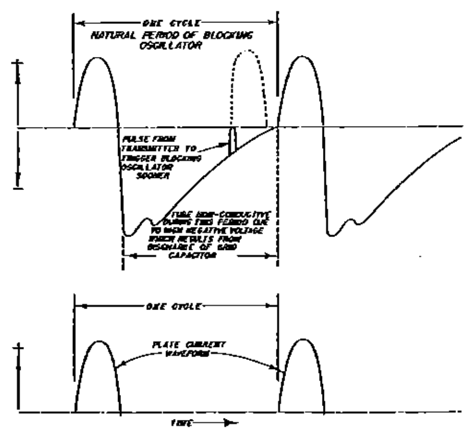


Fig. 21 Grid Voltage and Plate Current Wave Forms of Blocking Oscillator.

The blocking oscillator V21B is designed so that its natural frequency corresponds to the approximate vertical frequency of 60 cycles. Its frequency of oscillation is determined by the RC time constant of the .01 MFD capacitor C66 and the resistance in the grid circuit which consists of the VERTICAL HOLD CONTROL R60 and the 1 megohm resistor R59. The VERTICAL HOLD CONTROL is adjusted to fire the blocking oscillator earlier than at its natural frequency, the time being determined by the vertical sync pulses from the transmitter. The circuits must be arranged so that the oscillator is triggered solely by the vertical synchronizing pulses and not from any other source such as noise, etc. When

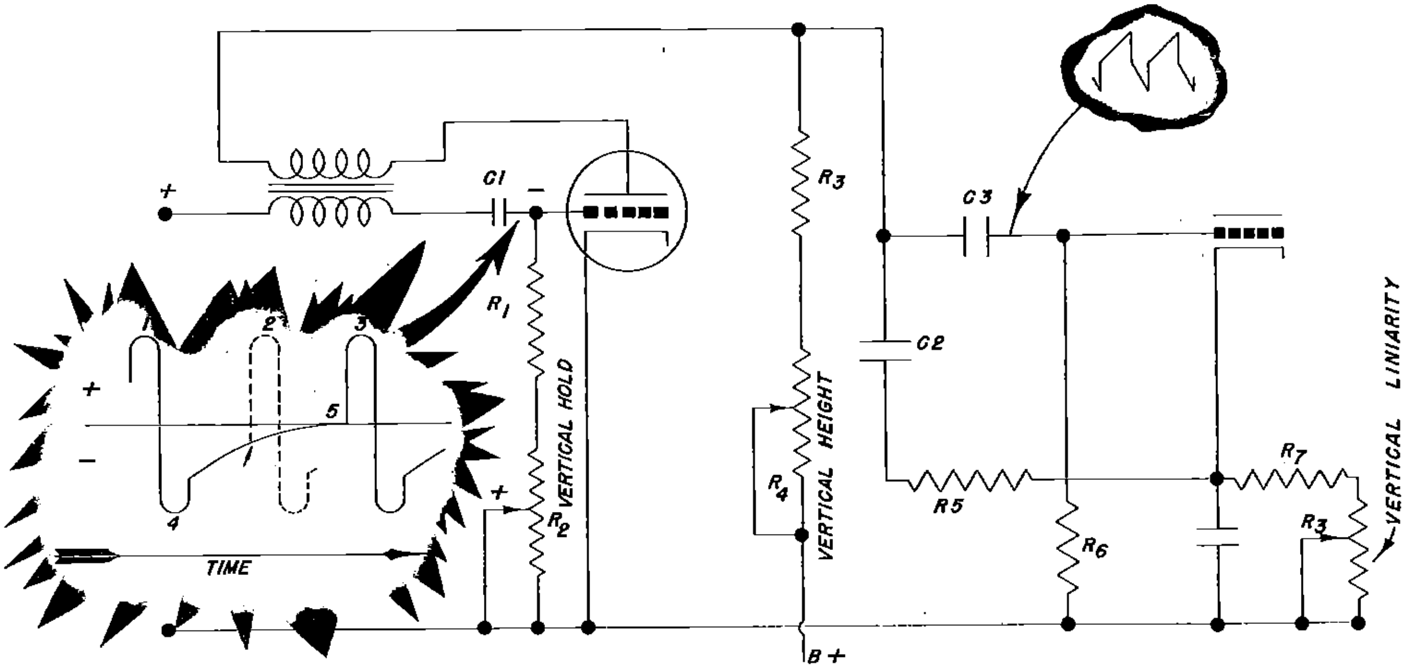


Fig. 22 Development of the Sweep Voltage by the Blocking Oscillator.

the positive sync pulse from the integrating and filter circuits appears at the grid of the blocking oscillator, the tube conducts heavily and its plate voltage is induced into the grid by transformer action through T7. This makes the grid more positive and causes grid current flow which develops a bias voltage across the grid resistor, charging the .01 MFD capacitor to the value of the bias voltage. When the bias voltage becomes sufficiently high, plate current cut-off occurs. The charge on the .01 capacitor gradually diminishes but because of the Rc time constant the tube remains cut-off until the next positive pulse starts conduction and the next cycle.

The vertical saw-tooth voltage is developed across the .047 MFD vertical charge discharge capacitor C60. When plate current cut-off occurs, there is no appreciable voltage drop across the plate load resistor, which consists of the VERTICAL SIZE CONTROL R62 and 470,000 ohm series resistor R59. Because there is no voltage drop the capacitor charges to nearly full plate potential in approximately 15,500 microseconds. This is the sweep portion of the saw-tooth voltage. When the vertical sync pulse causes the blocking oscillator to conduct again, the capacitor discharges through the internal resistance of V21B. This is the retrace and occurs in approximately 1,166 microseconds. The 8,200 ohm resistor R47, in series with the charge discharge capacitor, shapes the voltage so that it will have a combination of saw-tooth and pulse which is necessary to produce a saw-tooth current through the deflection coils (See fig.25). The 6V6GT-G vertical amplifier develops the relatively high current for deflecting the beam.

The 5,000 ohm VERTICAL LINEARITY CONTROL R67, shifts the operating point of the tube so that the sweep is amplified along that portion of the plate current curve which results in a linear output.

Because the impedance of the vertical deflection coils is high at the 15.75 Kc horizontal frequency, two 560 ohm damping resistors R38, are shunted with the windings to prevent interaction between the two sweep voltages.

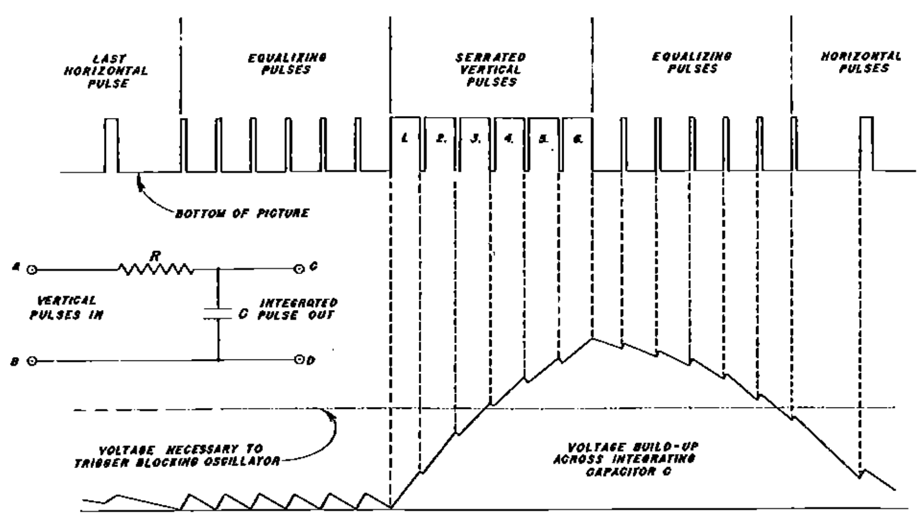


Fig. 23 The Effect of Vertical Synchronizing Pulses on the Integrating Capacitor.

THE HORIZONTAL SWEEP

The purpose of the combined horizontal sweep circuits is to develop a saw-tooth current through the horizontal deflection coils which produces a magnetic field that moves the electron beam horizontally across the picture tube. The horizontal synchronizing pulses from the transmitter must solely control the sweep. Noise pulses must be discriminated against so they are unable to produce triggering, and cause erratic operation and instability. The saw-tooth voltage originates in the plate circuit of the 6SN7GT horizontal discharge tube V21A. The horizontal discharge tube could be triggered by noise as well as sync pulses. This very undesirable factor is overcome by designing the sweep so that the frequency and not the amplitude of the transmitted sync pulses control it. The frequency control circuit consists of a 6K6GT 15.75 Kc horizontal oscillator V20, a 6AL5 phase detector V18 and a 6AC7 reactance tube V19. The reactance tube, which is in parallel with the 15.75 Kc horizontal oscillator resonant circuit, acts as a shunt reactance and affects the frequency of oscillation. The amount of shunt reactance depends on the mutual conductance of the tube, which in turn, is dependent on the grid voltage. A change of .5 volts on the oscillator grid produces a corresponding frequency change of approximately 100 cycles. Normally the reactance tube is biased at -2.4 volts. Study of the circuit indicates that this bias is in series with the DC output from the phase detector V18, and that the phase detector output voltage affects the reactance tube grid voltage.

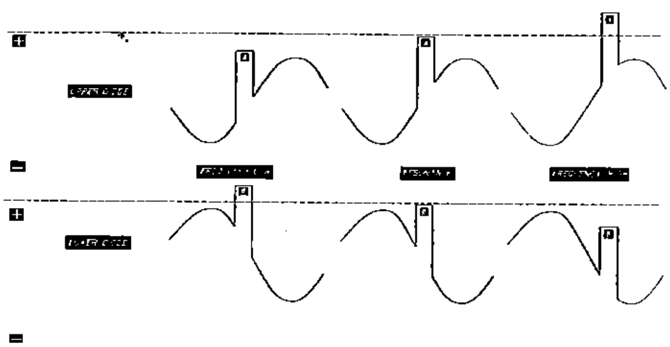


Fig. 24 Voltage at the Plates of the Phase Detector.

The sync pulses from the sync separator V15A are applied through the 75 MMFD capacitor C73 to the center tap of the phase detector winding. Fig. 24 indicates how the sync pulses are super-imposed on the 15.75 Kc sine wave. Although the amplitude of each individual sine wave and sync pulse remains the same, the combined pulse and sine wave amplitude changes with difference in phase. At resonance, the horizontal oscillator is properly phased with the sync pulses and the amplitude at A and B is equal (reference broken line.) Each diode conducts equally and the DC voltages across the two load resistors are the same but opposite in polarity. The resultant voltage across the full load (cathode to cathode) is zero. Since the output is zero, no change in grid voltage occurs and results in no oscillator frequency change. Under "frequency high" condition, the horizontal oscillator frequency is above that of the incoming sync pulses and the plate of the upper diode has a higher combined sine wave sync pulse amplitude than the lower diode. This results in more current flow in the upper diode circuit and a resultant positive difference voltage across the phase detector load. The positive voltage adds to the -2.4 V fixed bias and makes the grid more negative causing the shunt reactance to increase by the amount necessary to lower the frequency of the horizontal oscillator. Under "frequency low" condition, the lower diode conducts more current and the difference voltage is negative. This voltage subtracts from the -2.4 bias and makes the grid of the reactance tube less negative. A reduction in the shunt reactance occurs causing an increase in the frequency to correspond with the incoming sync pulses.

The HORIZONTAL HOLD CONTROL R73, which is connected from the grid of the horizontal oscillator to chassis, has a slight effect on the natural frequency of the oscillator. It is used to adjust the oscillator frequency to approximately that of the sync pulses after which the phase detector and the reactance tube assume control.

The output from the plate of the horizontal oscillator is a flat topped wave which is differentiated for triggering the discharge tube. A saw-tooth voltage is developed by charging and discharging the 600 MMFD capacitor C79. The capacitor charges when the grid of the V21A becomes highly negative, due to the charge accumulated by the grid capacitor C83, and cuts off plate current flow. Since the tube does not draw plate current when cut off, there is no appreciable voltage drop across the 680,000 ohm plate load resistor R20 and the capacitor charges to approximately full plate potential. It is the linear charge of this capacitor that produces the trace portion of the saw-tooth voltage. When the positive half of the pulse appears at the grid, V21A conducts heavily and C79 discharges through it. The charge of the capacitor is

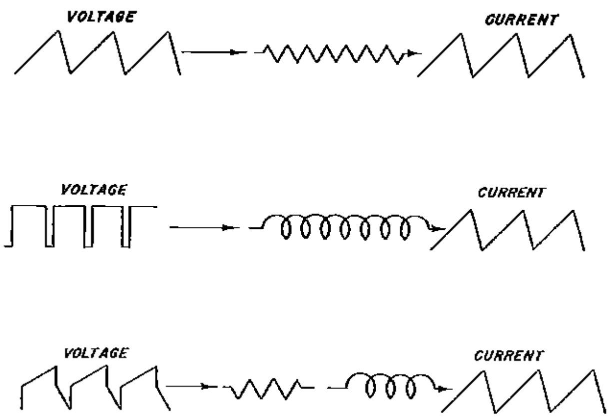


Fig. 25 Voltage Wave Forms Necessary to Produce Saw-Tooth Current Through a Resistance, Inductance and Combination of Resistance and Inductance.

the trace, and the discharge is the retrace. Study of fig. 25 indicates the type of pulses necessary to produce a saw-tooth current through an inductance. The voltage and current through a resistance is in phase and a saw-tooth voltage is necessary to produce a saw-tooth current. Since an inductance has inherent resistance, the voltage wave form must be a combination of saw-tooth and pulse to produce a saw-tooth current through the deflection coils. This wave is formed by the 8,200 ohm resistor R47 which is in series with the charge discharge capacitor C79 and the 25,000 ohm HORIZONTAL DRIVE CONTROL R77.

THE HIGH VOLTAGE POWER SUPPLY

The 10,000 volt DC supply for the second anode of the picture tube is developed by the 6BG6 horizontal sweep amplifier V23, and its associated output transformer and high voltage rectifier. The power supply is the kick back type in which the high voltage is developed during the 7 microsecond retrace of the horizontal sweep when the deflection coil current suddenly collapses. The saw-tooth current which produces the sweep, flows for approximately 53 microseconds. This is the approximate time required to move the beam from the left to the right side of the picture tube. After the sweep reaches the right side of the picture tube, the tube is blanked out and the current suddenly collapses. This sudden collapse of current through the deflection coils generates a 15.75 Kc voltage which is greatly stepped up by auto-transformer action. A low voltage winding supplies filament current for the 1B3GT high voltage rectifier V25, where rectification develops the 10,000 volts DC for the second anode of the picture tube. Because of the high ripple frequency, very little filtering is necessary. The 500 Mmfd 15 Kv capacitor, which is also used to mount the 1B3GT socket, the 470,000 ohm resistor and the capacity formed by the inner and outer coating on the picture tube adequately filter the high voltage.

When servicing the high voltage power supply, extreme care must be exercised to avoid contact with the second anode high potential. A well insulated vacuum tube voltmeter, which has a 10 Kv range, may be used to measure the high potential. Failure in any section of the 15.75 Kc horizontal sweep circuit may cause the supply to be inoperative. If the difficulty is not obvious, circuit tracing should begin at the 6K6 horizontal oscillator, through the 6SN7 horizontal discharge tube and the 6BG6 horizontal amplifier. The 6BG6 plate voltage must be measured at terminal 4 on T 11. Do not measure the voltage at the plate of the tube because the voltage at this point is extremely high due to the inductive build-up through the transformer. The 5V4 damping tube V 24, adds an additional 80 volts to the plate voltage of the 6BG6 horizontal amplifier. Failure of this tube will greatly reduce the high voltage output.

THE DAMPING TUBE

The linear rise of current through the horizontal deflection coils moves the electron beam from the left to the right side of the picture tube in approximately 53 microseconds. The current must then return to its starting value in approximately 7 microseconds to produce the retrace. This sudden collapse of current through an inductance, produces an oscillatory condition (See fig. 26)

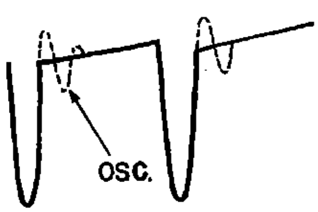


Fig. 26 Oscillation Removed by Damping Tube.

which would destroy the linearity of the sweep and must be removed by the damping tube V24. When the plate of the damping tube becomes more positive than the cathode, conduction occurs which heavily loads the circuit and prevents the undesirable oscillation. As a result of the conduction, a DC potential of approximately 80 volts is developed and stored in the .25 MFD capacitor. This voltage is added to the plate voltage of the 6BG6 horizontal amplifier and raises its potential from 400 to 480 volts for greater output and better performance.

THE VIDEO AMPLIFIER

The output from the video detector ranges in frequency from 30 cycles to approximately 4 Mc. Since the output is very low, it must be amplified by the video amplifier without appreciable loss to the higher video frequencies. The high frequency response of a video amplifier is limited by the impedance which the inter-electrode and stray capacities of tubes and circuits produce. Since the capacitive reactance decreases as the frequency increases, the higher frequencies could be relatively "shorted out" unless the effect of the undesirable capacities is removed. This is accomplished by inserting series and shunt peaking coils L21. L22, L68, L69 and L70, to cancel the effect of the distributed capacities. The peaking coils form a series resonant circuit in which the capacitive reactance is cancelled by the inductive reactance. In addition to the peaking coils, the plate load resistors are of low value so that their impedance at the highest video frequencies is approximately that introduced by the stray capacities. Use of peaking coils and low plate load resistors allows the video amplifier to have a reasonably flat frequency response to 4 Mc.

The 1st video amplifier V7B also acts as a noise clipper. The tube is biased so that noise pulses do not produce a plate current change and, consequently, do not appear in the output. The video signal, which appears at the grid of the 2nd video amplifier V8, has an AC component (See fig. 27). It must be restored to its DC component before being applied to the picture tube grid. DC restoration is made possible by operating the 2nd video amplifier at zero bias, allowing the video signal to produce proportional grid current flow and develop an automatic bias which allows only the DC component to appear at the output (See fig. 27). In order to maintain the DC component, the plate of the 2nd video amplifier is directly coupled to the grid of the picture tube.

The CONTRAST CONTROL R46, in the plate circuit of the 12AT7 1st video amplifier, regulates the magnitude of the signal applied to the grid of the picture tube. The BRIGHTNESS CONTROL R50, regulates the grid bias of the picture tube. The CONTRAST and BRIGHTNESS controls must be varied simultaneously to obtain the greatest contrast between black and white components of the picture.

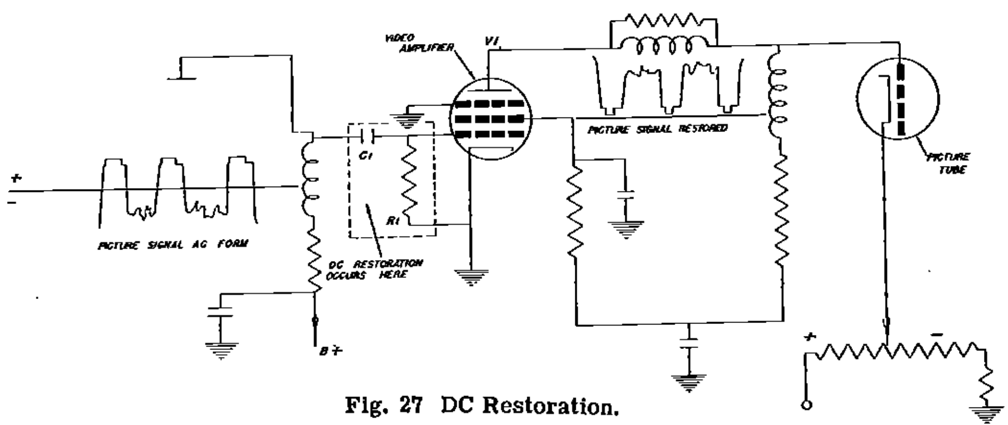


Fig. 27 DC Restoration.

THE BEAM BENDER

The electron gun of a picture tube emits both electrons and ions. The ions are much heavier than the electrons and if allowed to bombard the picture tube fluorescent screen, damage in the form of a burn could occur.

Picture tubes, such as the 10FP4 and 12KP4, are constructed with a metal backing directly behind the fluorescent screen. The high velocity electrons penetrate the backing and strike the fluorescent screen. Low velocity ions cannot penetrate the backing and do not reach the fluorescent screen where damage could occur.

Picture tubes, such as the 10BP4 and 12LP4 do not have a metal backing behind the fluorescent screen and if the ions were allowed to bombard the screen, a brown burn spot would result. To prevent this condition, the electron gun of these tubes is slightly bent so that the ion and electron stream is directed at the neck rather than at the screen of the tube. The beam bender, which is a permanent magnet fitted around the neck of the tube, bends the electrons back into their proper axis so that they strike the screen. The heavier ions are not affected by the magnetic field and do not reach the screen.

The beam bender has an identifying arrow stamped on it. When it is installed, the arrow must point towards the face of the picture tube. To make the adjustment, move and slightly rotate the beam bender along the neck of the tube until the brightest picture appears. It may be necessary to readjust the focus and intensity controls during the adjustment.

THE FOCUS COIL

DC current flow through the focus coil develops a magnetic field which is parallel to the electron beam in the picture tube. As long as the parallel condition exists, the magnetic field remains uncut by the electrons and has little effect. If the electrons diverge from the parallel path, the magnetic field is cut and counters to force them back into their proper axis. An improperly adjusted focus coil causes the electron beam to hit the neck rather than the face of the picture tube, causing the corners of the raster to be shadowed. Adjustment of the focus coil is as follows:

When interchanging picture tubes, it may be necessary to change the position of the focus switch (See fig. 1) to affect proper focusing.

1. Check the vertical and horizontal centering to see that the raster is properly centered.

2. Loosen the focus coil wing nuts (See fig. 1) and turn the coil until the full raster, free from corner shadows, appears on the picture tube.

3. Tighten wing nuts after adjustment.

VERTICAL CENTERING CONTROL

The vertical centering control R68 changes the polarity and magnitude of DC current flow through the vertical deflection coils. Current flow develops a magnetic field which shifts the raster in a vertical plane. Since the 20 ohm centering control is in series with the 400 volt supply, current flow through the various circuits in the receiver produces the necessary voltage drop across it. Because the centering voltage is obtained from the center tap and arm of the control, voltage to the deflection coils can be positive, negative or zero, depending on the position of the arm.

THE HORIZONTAL CENTERING CONTROL

The horizontal centering control R81 regulates the polarity and magnitude of DC current flow through the horizontal deflection coils. The current flow develops a magnetic field which shifts the electron beam for proper horizontal centering of the picture. Two voltages which are in opposition, produce the current flow. Voltage #1 is developed by the damper tube V24 and voltage #2 results from the drop across the 100 ohm centering control. Since the voltages are in opposition, current flow can be reversed by adjusting the centering control so that the difference voltage is either negative or positive.

THE WIDTH CONTROL

The horizontal output voltage appears between terminals 1 and 3 on the output transformer T11. A portion of the secondary winding is shunted by a variable inductance L71 which is the width control. Varying the position of the slug changes the shunt inductance and results in changing the magnitude of sweep voltage across the horizontal deflection coils. As the shunt inductance increases, the output voltage increases and the pattern widens horizontally. When the slug is removed from the coil, the shunt inductance is at minimum and the voltage and pattern width is minimum.

ADJUSTMENTS

A.G.C. ADJUSTMENT

The performance of the A.G.C. circuit is checked or adjusted by applying a known value of voltage into the video detector output jack "S" and observing the corresponding voltage at the A.G.C. output jack "C". To make the adjustment proceed as follows:

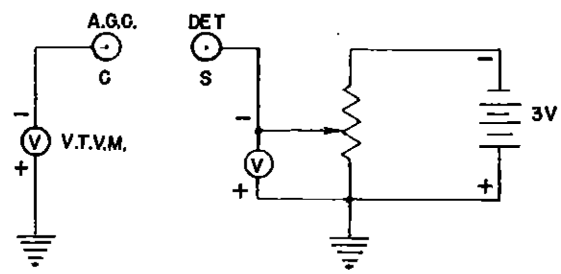


Fig. 28 Connections for A.G.C. Adjustment

1. Turn the station selector switch to an unused (numbered) channel, disconnect the antenna leads and short circuit the antenna terminals.

2. Plug the negative lead of the S-15370 alignment fixture into jack "S" and the positive lead to chassis. The fixture connections remain in this position for the remaining steps.

3. Adjust the fixture control for -1.5V indication at jack "S".

4. Adjust AGC delay control R40 (See fig. 31) for a -3.8V V.T.V.M. indication at jack "C".

5. Readjust fixture voltage at jack "S" to -1V. The corresponding voltage at jack "C" should be -0.5 to -2.

6. Readjust fixture voltage at jack "S" to -2V. The corresponding voltage at jack "C" should be -5 to -7.5V

HORIZONTAL FREQUENCY AND PHASE ADJUSTMENTS

The HORIZONTAL FREQUENCY adjustment L74 (See fig.2) resonates the horizontal oscillator at 15.75 Kc. When properly adjusted, loss of horizontal sync should not occur regardless of the HORIZONTAL HOLD CONTROL setting. To make the adjustment, see that the picture is locked vertically and proceed as follows:

1. Turn the HORIZONTAL HOLD fully counter clockwise.

2. Adjust HORIZONTAL FREQUENCY until the picture "locks" in sync.

3. Turn the HORIZONTAL HOLD fully clockwise and observe that the picture remains "locked". If loss of sync occurs when the selector switch is turned to another channel and returned, a slight readjustment is necessary.

The HORIZONTAL PHASE CONTROL adjusts the phase detector input and affects the position of the picture on the raster. When turning the adjustment screw L73, the picture moves to the left or right side of the raster. Proper adjustment is indicated when the picture is moved farthest to the right. A broad peak is noted at this point.

ALIGNMENT

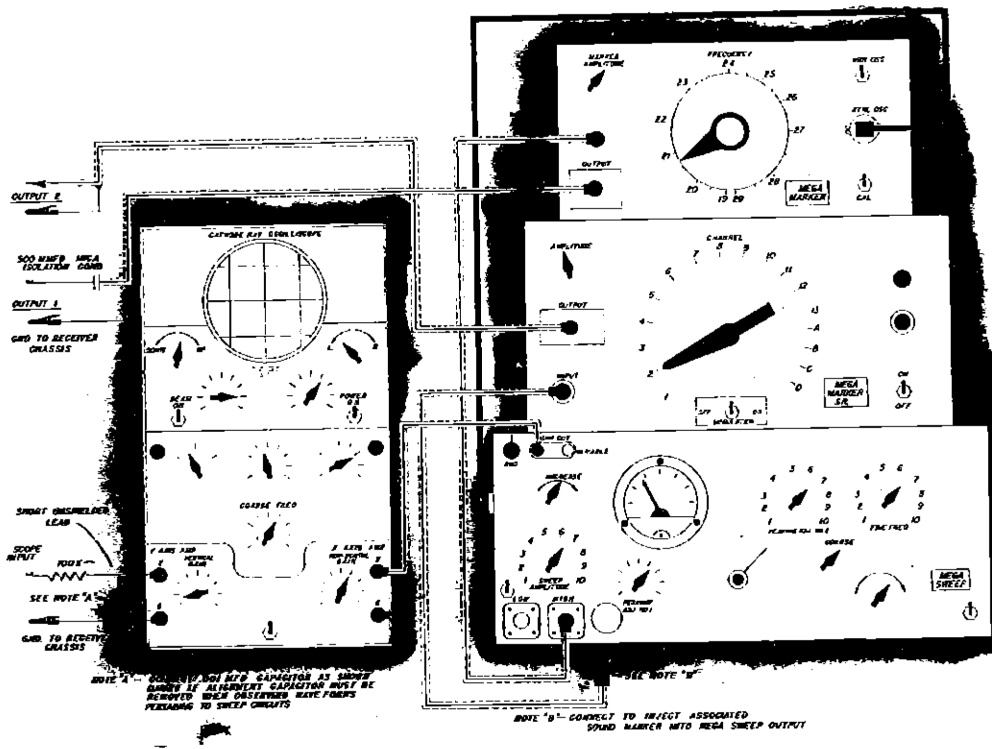


Fig. 29 Test Equipment.

SPECIAL ALIGNMENT FIXTURES

S-15369 BALANCE TRANSFORMER - Used to match the 50 ohm Mega-Sweep unbalanced output to a 300 ohm receiver antenna input. Can also be used for matching a coaxial type antenna transmission line to a 300 ohm receiver input.

S-15370 BIAS TEST FIXTURE - (Plugs into test jacks at rear of receiver chassis), provides an adjustable bias variable from 0 to 3.0 volts for use during alignment and A.G.C. adjustment.

S-15371 CONVERTER COUPLING RING - Made to fit around converter tube for the purpose of injecting an I. F. signal into the grid during alignment.

S-15372 R. F. ALIGNMENT FIXTURE - Used for the separate alignment of turret tuner R. F. strips.

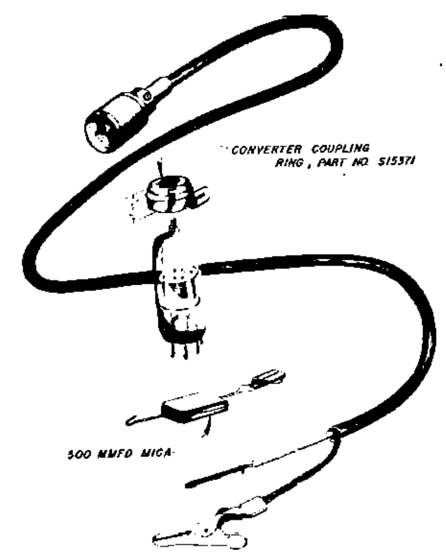


Fig. 30 Connectors.

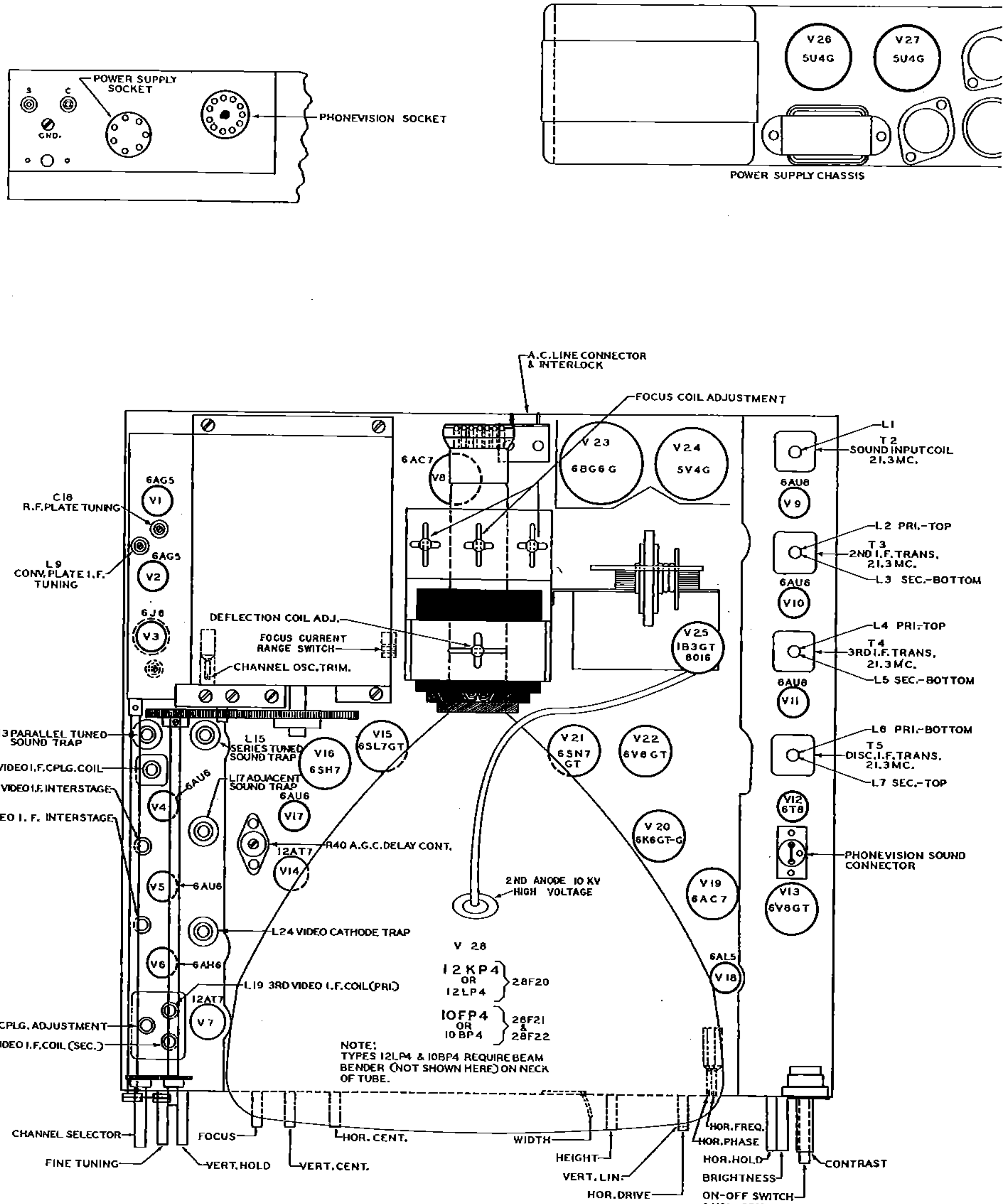


Fig. 31 Tube and Trimmer Layout.

PICTURE I.F. ALIGNMENT

Set up the equipment as indicated in fig. 29. Connect output #1 to point F (picture I.F. strip) and chassis. Connect the negative side of a 1.5 volt bias battery to jack "C" and the positive side to chassis and connect the oscilloscope between jack "S" and chassis. See fig. 37 for bias and scope connections.

If the S15370 alignment fixture is available it should be adjusted as outlined on page 27 under IF-RF alignment.

Adjust the Mega-Sweep for maximum output and turn the coarse frequency adjustment control until pattern is centered on the oscilloscope screen. It is possible to get two modes of operation from the Mega-Sweep. Select the mode which sweeps from low to high frequency. When the proper mode is selected the low frequency portion of the I.F. response curve will appear on the left side of the scope screen. Adjust the vertical gain on the scope and the Mega-Sweep sweep amplitude control, until a sizeable pattern is obtained on the oscilloscope screen (See fig.32). The scope vertical gain is now the reference point and must not be changed for the remaining adjustments. The horizontal gain control must be adjusted so that both ends of the sweep are visible on the scope. After these initial adjustments have been made, proceed as follows:

1. Set the Mega-Marker to 21.6 Mc and adjust L19 and L20 until the two over-coupled response curves are equal in amplitude with the low frequency peak corresponding to the 21.6 Mc marker. To avoid distortion, always use minimum marker amplitude. Set the Mega-Marker to 25.9 Mc and adjust C29 until the high frequency peak corresponds to 25.9 Mc. Check the 21.6 Mc peak and repeat operation if necessary.

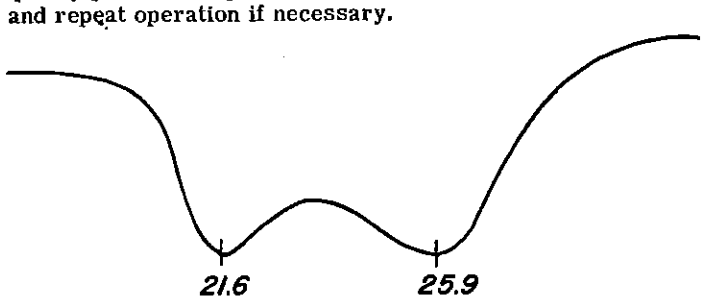


Fig.32 3rd Picture I. F. Response.

2. Connect output #1 between point G and chassis. Reduce the Mega-Sweep gain until the pattern on oscilloscope is the same amplitude as in Step 1. Set the Mega-Marker to 25.3 Mc and adjust L18 until the I. F. peak corresponds to the 25.3 Mc marker.

Fig.33 2nd Picture I. F. Response.

3. Connect output #1 between point H and chassis. Reduce the Mega-Sweep gain as in Step 2. Set the Mega-Marker to 22.2 Mc and adjust L16 until the low frequency peak corresponds to 22.2 Mc. The high frequency peak falls at approximately 25.1 Mc. Set the Mega-Marker to 27.3 Mc and adjust trap, L17 for minimum marker indication. Always use maximum marker amplitude for trap adjustments.

Fig.34 1st Picture I. F. Response.

4. Connect output #1 to the converter coupling ring, Part #S15371 and fit the ring over the 6AG5 converter tube. Because of the low coupling capacity, it will be necessary to increase the Mega-Sweep output in order to obtain a sizeable pattern on the scope. Set the

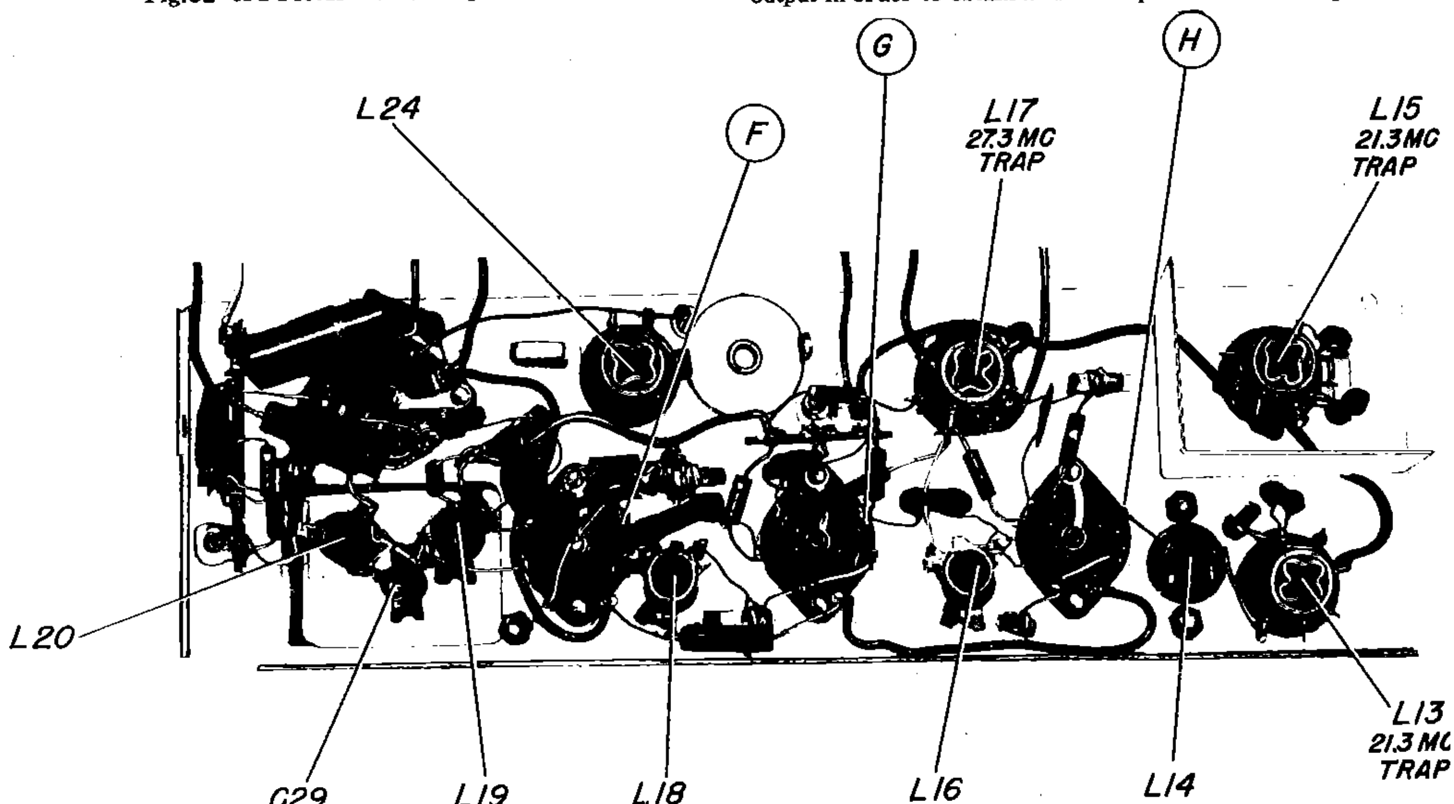


Fig. 35 Picture I. F. Sub-Chassis.

Mega-Marker to 21.3 Mc and adjust traps L13 and L15 for minimum indication on the scope. Adjust L14 and L9 (on RF shelf) alternately until the response curve has a reasonably flat top. Set the Mega-Marker to 25.8 Mc and check the half-way and other points indicated by the over-all response curve.

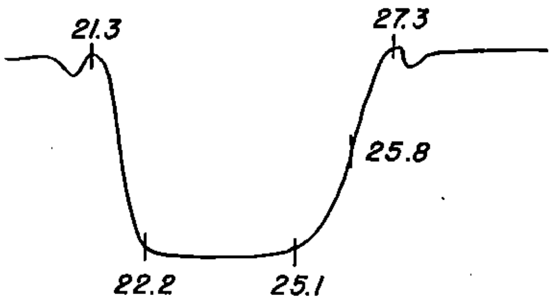


Fig. 36 Over-All Picture I. F. Response.

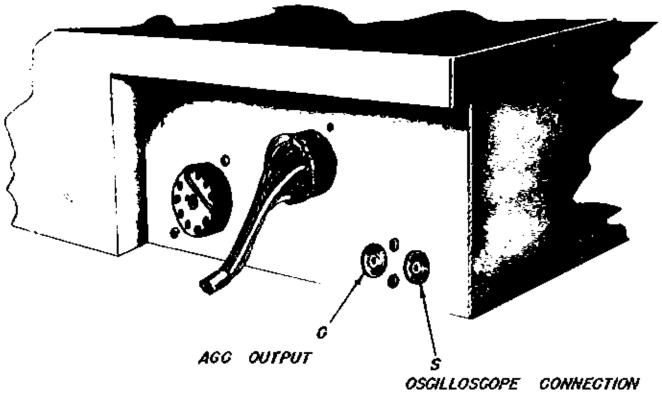


Fig. 37 Test Jacks.

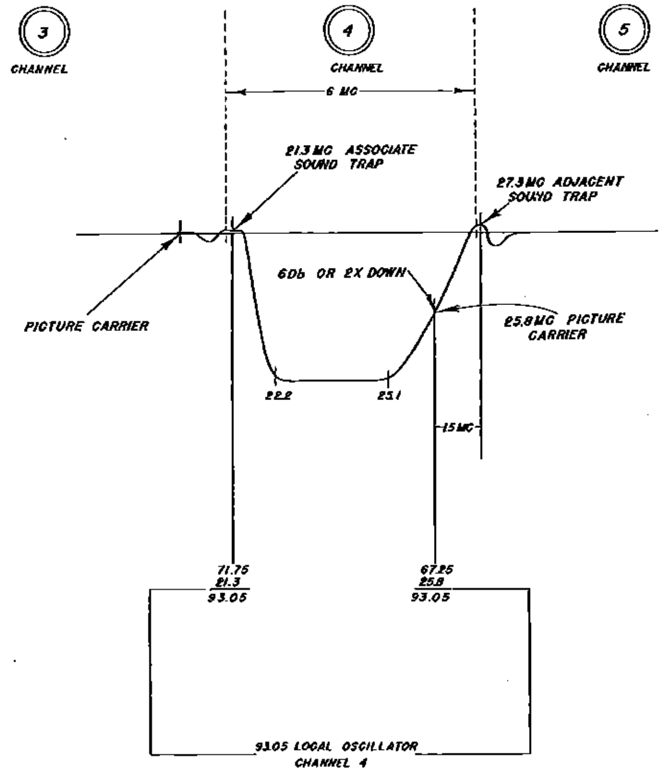


Fig. 38 Converter and I. F. Frequencies.

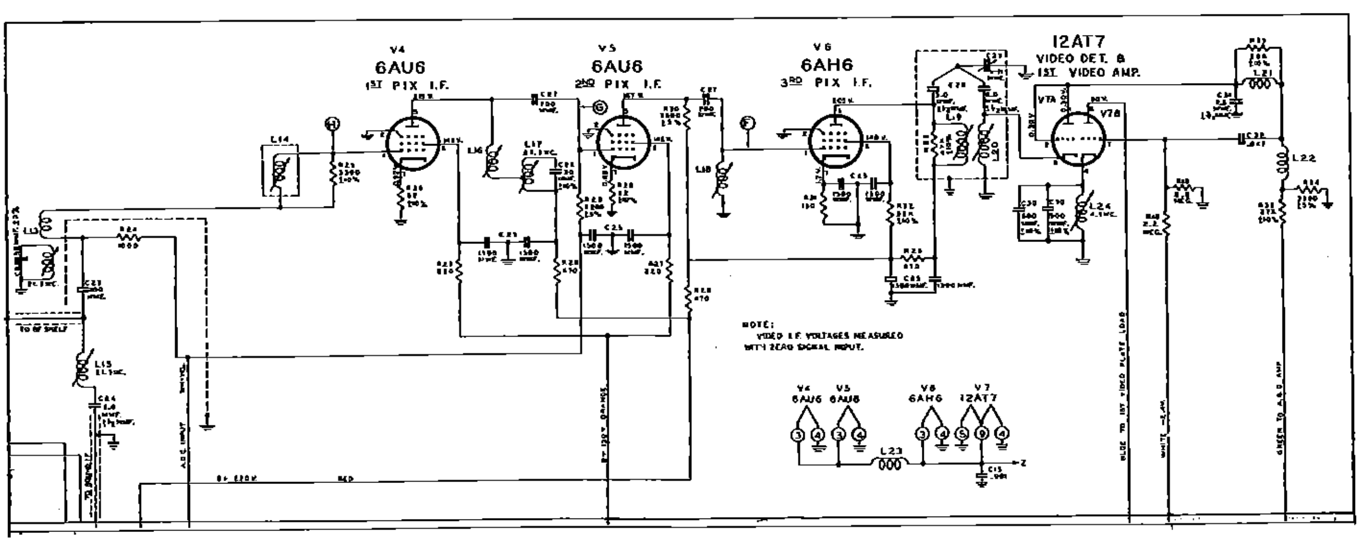


Fig 39 Schematic Diagram Picture I. F. Channel.

SOUND I. F. ALIGNMENT

The 21.3 Mc sound I. F. transformers are of the type indicated in fig.40. A special adjustment wrench, Part No. 68-7 is available for alignment work. Extreme care must be exercised when aligning these transformers to keep the adjustment slugs in the approximate relationship to the coils as in fig. 40. If care is not exercised, it is possible to advance the top slug beyond and the bottom slug above its associated coil. This would result in an incorrect coefficient of coupling, unstable and improper alignment. Always keep the alignment tool in a vertical plane when adjustments are being made. If this is not done the undesirable situation may arise where both slugs are turned simultaneously. To align the sound I. F. channel, set up the equipment as indicated in fig.29 and proceed as follows:

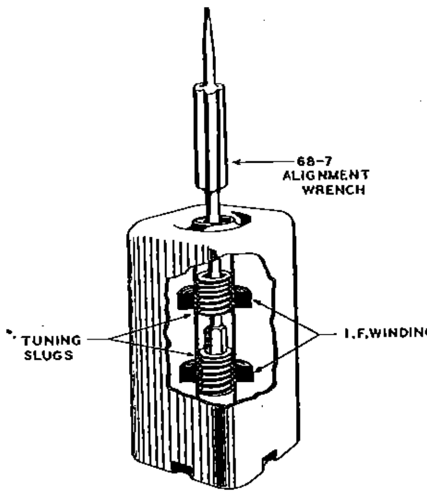


Fig. 40 Sound I. F. Transfomer.

1. Connect the oscilloscope point "A" to chassis (full discriminator load.) Connect output #1 to point "C" and chassis (limiter grid.) Adjust the Mega-Sweep coarse frequency and sweep amplitude controls for a sizeable pattern, (See fig.41) on the scope. Set the Mega-Marker to 21.3 Mc. Always use as little marker amplitude and R. F. input as necessary to obtain a satisfactory indication on the scope. Adjust L6 and L7 to obtain a symmetrical discriminator response curve with the 21.3 Mc marker falling at the center reference line. The peak to peak discriminator width should be approximately 450 Kc.

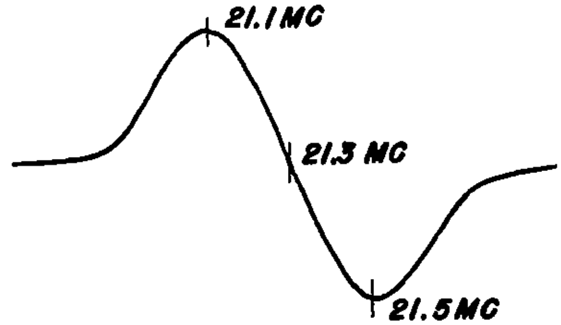


Fig.41 Output From Discriminator

2. Connect the scope to point "B" and chassis (limiter grid.) Connect output #1 to point "D" (grid, 2nd I. F.) to chassis. Adjust L4 and L5 for symmetry and gain with the 21.3 Mc marker falling at the center of the response curve (See fig.42).

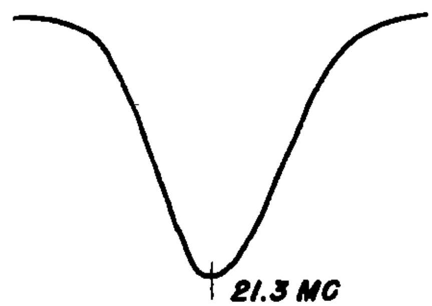


Fig.42 Sound I. F. Response

3. The scope connection remains at point "B". Connect output #1 to point "E" (1st I. F. grid) and chassis and adjust L2 and L3 as in Step 2.

4. The scope connection remains at point "B". Connect output #1 to the S-15371 I. F. coupler ring and place coupler over the converter tube. Advance Mega-Sweep gain and adjust L1 as in Step 2.

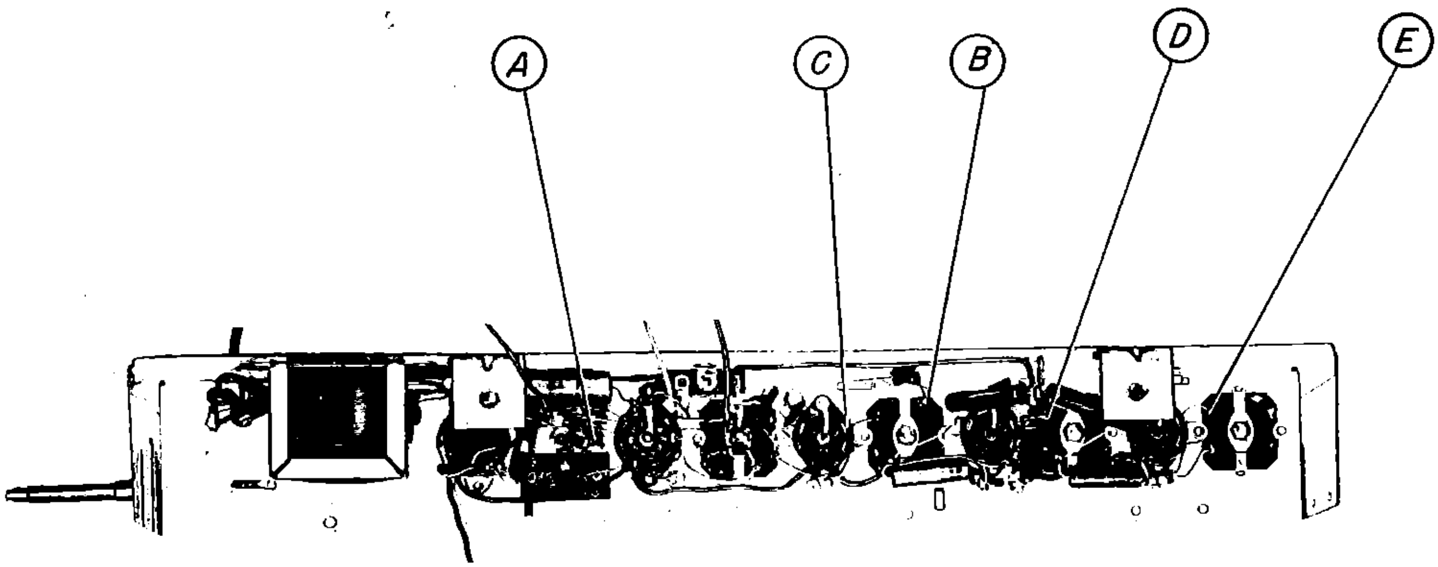
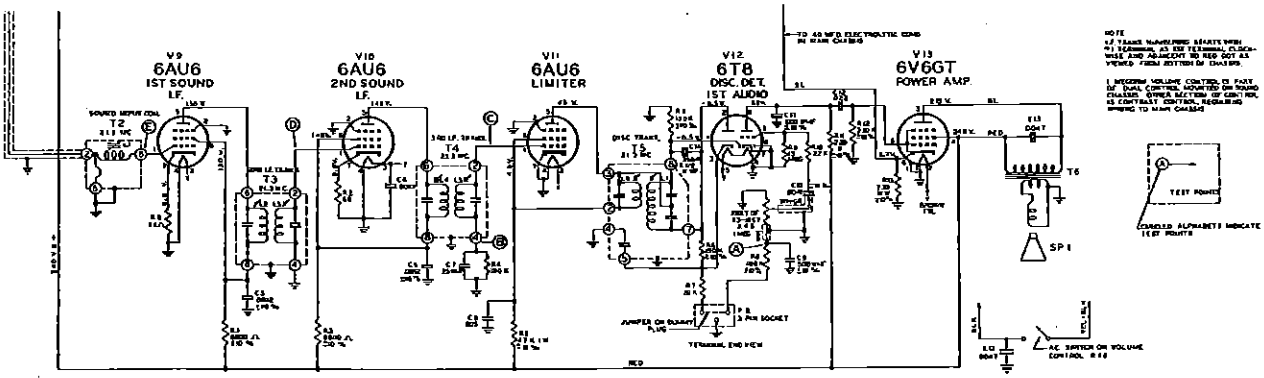


Fig. 43 Sound I. F. Sub-Chassis.

Fig. 44 Sound I. F. Schematic Diagram.



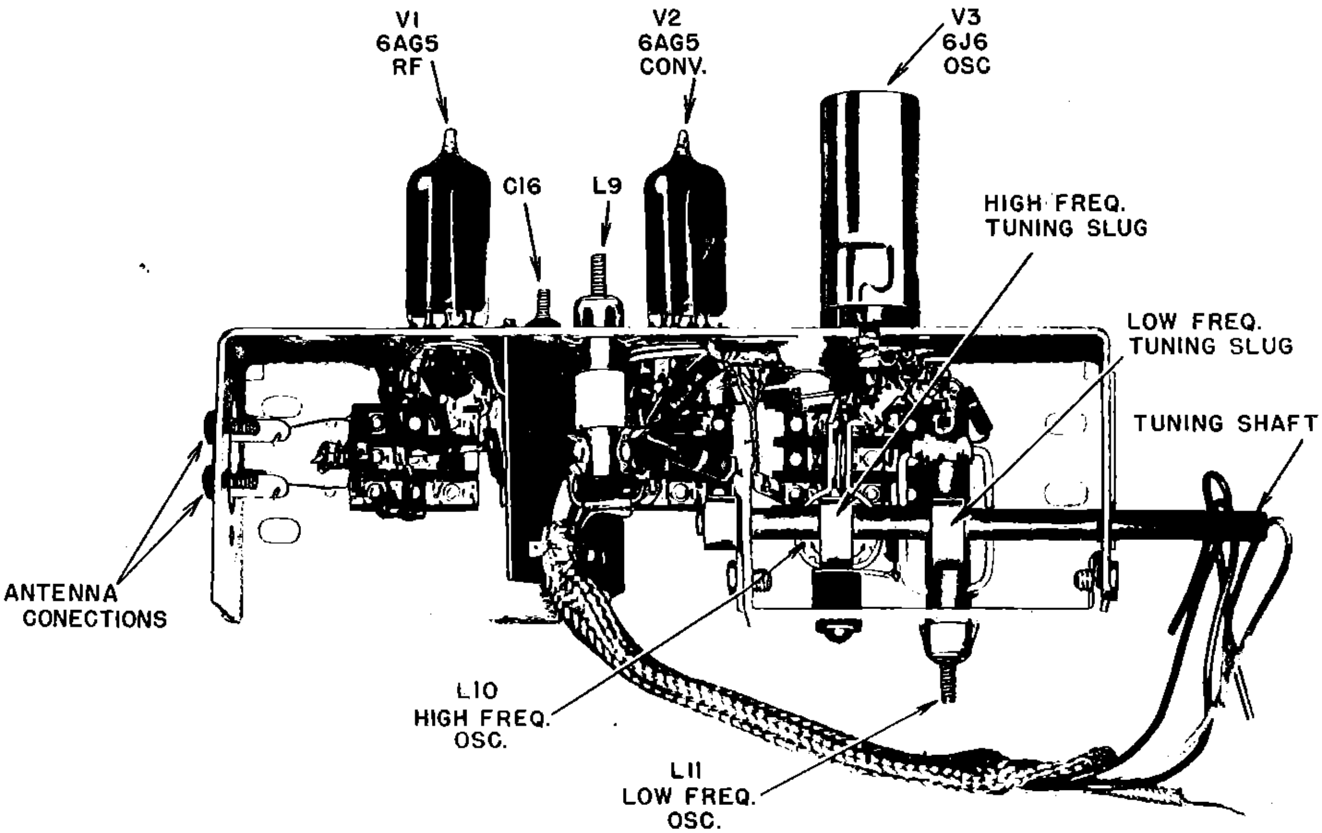


Fig. 45 R. F. Shelf Adjustments.

R. F. OSCILLATOR AND ANTENNA ALIGNMENT

The various oscillator circuits are adjusted by connecting output #2 (See fig. 29) to the antenna terminals of the receiver. A vacuum tube voltmeter is connected across the full discriminator load Point "A" (fig. 43) to chassis. If the chassis is in the cabinet, the meter can be connected to the phonevision connector on the sound chassis or the white lead on the volume control (rear section of dual control). After the equipment is set up, proceed as follows:

1. Set the receiver channel selector switch and the Mega-Marker Sr. to channel 10. Turn the receiver fine tuning control for zero indication on the meter. It will be noted that the meter indicates a positive or negative voltage as the oscillator is tuned through resonance. Proper adjustment is the zero point between the two peaks.

Normally it will be unnecessary to adjust the high frequency oscillator trimmer L10 (See fig. 45). However, if it is impossible to resonate channel 10, with the fine tuning control, a slight adjustment may be necessary. To make this adjustment, turn the receiver fine tuning control until the eccentric tuning slug holding screw faces upward. Insert a pointed tool into one of the adjusting slots and move the disc until resonance is obtained. After channel 10 is adjusted, the position of the fine tuning control must remain unchanged during the remaining adjustments.

2. Set the channel selector and the Mega-Marker Sr. to channel 7. Adjust the strip oscillator trimmer (See fig. 46) for zero indication on the meter. This procedure is followed on channels 8, 9, 11, 12 and 13.

3. Set the channel selector and the Mega-Marker Sr. to channel 4. Adjust the oscillator trimmer for zero indication on the meter as

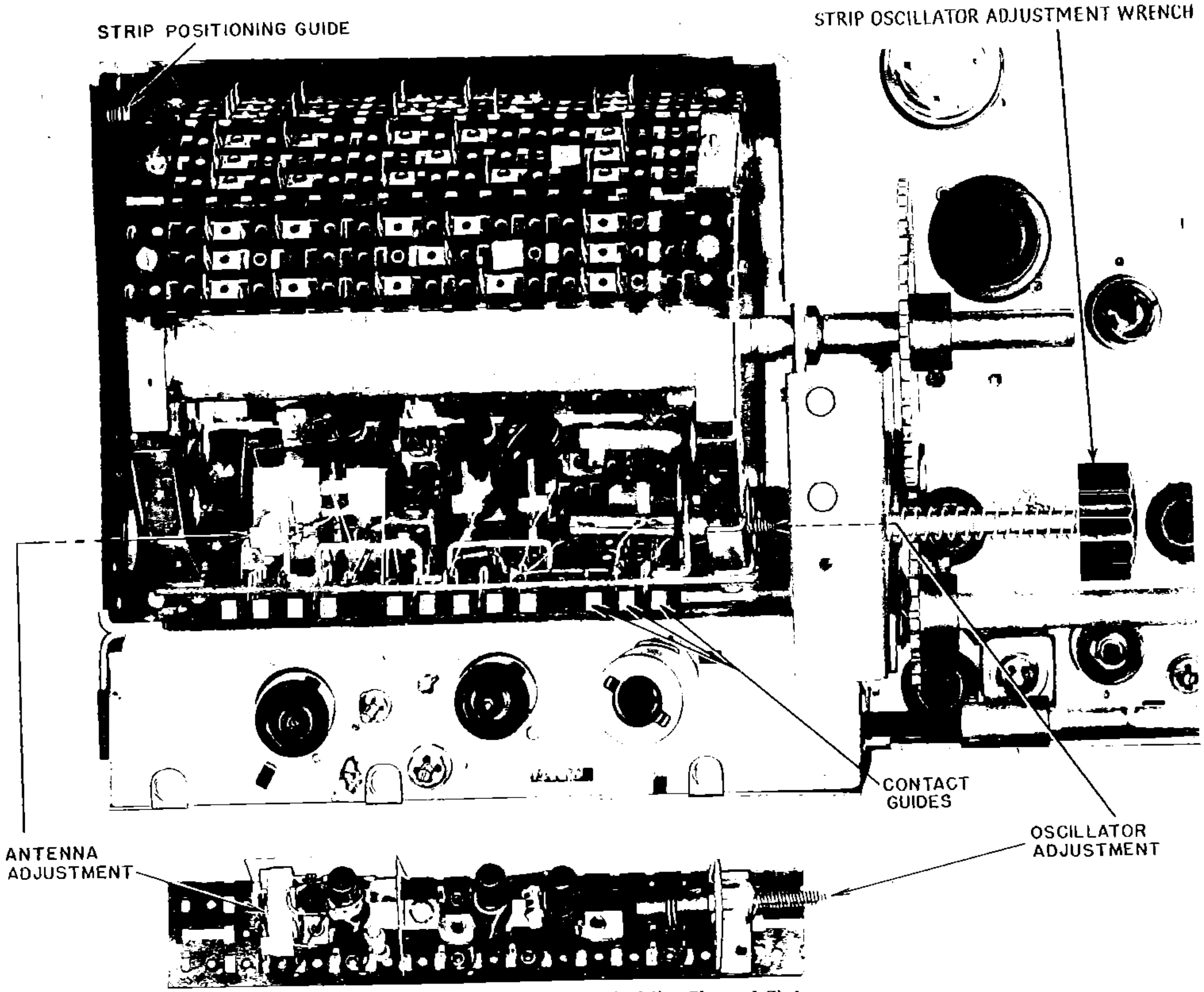


Fig. 46 Adjustment of the Channel Strips.

in Step 2. If resonance does not occur, it may be necessary to re-adjust L11 (the low frequency oscillator trimmer) until resonance is obtained. Channels 2, 3, 5 and 6 are then adjusted. If the above adjustments have been properly made it will be unnecessary to adjust the fine tuning control on any channel.

If the television stations are on the air, the same procedure is followed as outlined above except that the transmitted signal is substituted for the Mega-Marker Sr.

After the oscillator adjustments have been made, proceed to align the antenna trimmer of each channel as follows:

1. Remove the A.G.C. tube V14 and connect the negative side of a 1.5 volt battery to tip jack "C" and the positive side to chassis. If the S-15370 alignment fixture is available, it should be adjusted to 1.5 volts and substituted for the battery.

2. Connect output #1 (See fig.29) through the S-15369 impedance matching transformer to the antenna terminals of the receiver.

3. Connect the scope input from tip jack "S" to chassis and adjust the Mega-Sweep coarse frequency and sweep amplitude controls to obtain a pattern similar to fig.47. Always keep the

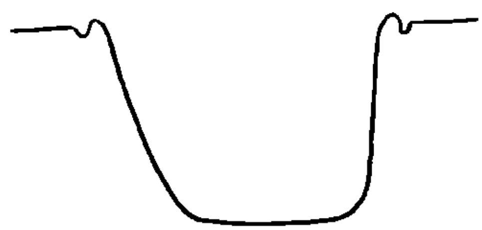


Fig. 47 R. F. Response Curve.

Mega-Sweep output low enough so that the peak to peak voltage, as indicated by the oscilloscope, does not exceed 3 volts. If the oscilloscope is not calibrated, connect a vacuum tube voltmeter to tip jack "S" and chassis. Adjust the Mega-Sweep attenuator for a 1.5 to 2 volt indication on the meter.

4. Adjust the antenna trimmer (fig. 46) for symmetry and gain. This procedure is followed on all channels, the Mega-Sweep coarse frequency control being re-set for each individual channel. If it is impossible to obtain a reasonably flat R. F. characteristic curve on any particular channel, the fault may be in the converter input tuned circuits and replacement of the strip is necessary.

ADJUSTING THE 4.5 Mc TRAP

The high shunt capacity C30 in the 4.5 Mc resonant circuit insures high frequency stability. Adjustment in most cases is unnecessary unless the unit is tampered with or replaced.

If adjustment becomes necessary, an accurate signal generator, crystal calibrated at 4.5 Mc, and an RF VTVM capable or reading frequencies to 5 Mc is required. The procedure is as follows:

1. Connect the 4.5 Mc signal to the grid (Pin 7) of the 12AT7 1st video amplifier V7B.

2. Connect the probe of the VTVM to the grid of the picture tube.

3. Advance the contrast control for approximately 1 volt indication on the meter.

4. Adjust slug L24 for minimum indication on the meter. A pronounced dip will be noted at resonance.

SERVICE HINTS

TROUBLE SHOOTING

Observation of the picture tube during operation of the receiver can often be of value in determining the particular circuit in which the trouble exists. Subsequent procedure will be the measurement of voltages and observation of wave forms. The receiver wave form and voltage measurement chart, fig. 49, lists the correct readings obtained from a normal receiver. Departure from these normal values will lead to the location of defective components.

The A.G.C. circuit is critical to tube changes, and the replacement of the 12AT7 A.G.C. amplifier will necessitate readjustment of the sensitivity control.

The service man is cautioned against interchanging tubes in the R. F. and I. F. stages of the receiver. When these tubes are tested, care should be exercised so that they are re-inserted into their original sockets.

Effects noted when various receiver stages are disabled by removing the tube:

V1 No picture - No sound.
V2 Weak picture - Weak sound.
V3 No picture - No sound.
V4 No picture - Sound OK.
V5 No picture - Sound OK.
V6 No picture - Sound OK.
V7 No picture - Sound OK.
V8 No picture - Sound OK.
V9 No sound - Picture OK.
V10 No sound - Picture OK.
V11 No sound - Picture OK.
V12 No sound - Picture OK.
V13 No sound - Picture OK.
V14 No picture - Weak sound.
V15 Picture cannot be synced horizontally or vertically - Sound OK.
V16 Picture cannot be synced horizontally or vertically - Sound OK.
V17 Picture cannot be synced horizontally or vertically - Sound OK.
V18 Picture cannot be synced horizontally - Sound OK.
V19 Picture cannot be synced horizontally - Sound OK.
V20 No raster - Sound OK.
V21 No raster - Sound OK.
V22 Raster reduced to thin horizontal line - Sound OK.
V23 No raster - Sound OK.
V24 No raster - Sound OK.
V25 No raster - Sound OK.
V26 Undersized picture - Sound OK.
V27 Undersized picture cannot be synced horizontally - Sound OK.

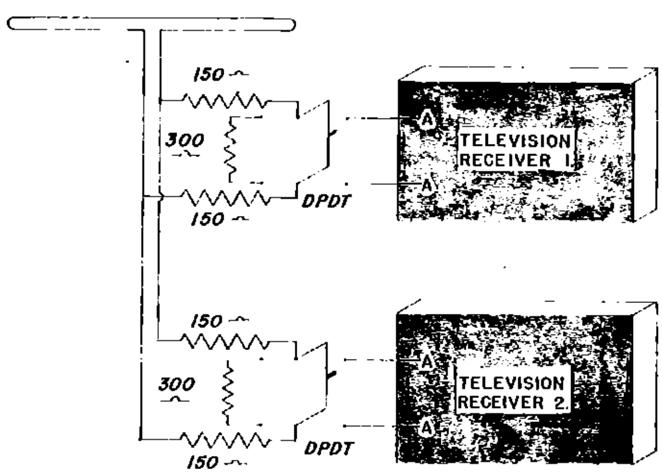


Fig. 48 Connecting Two Television Receivers to a 300 Ohm Transmission Line.

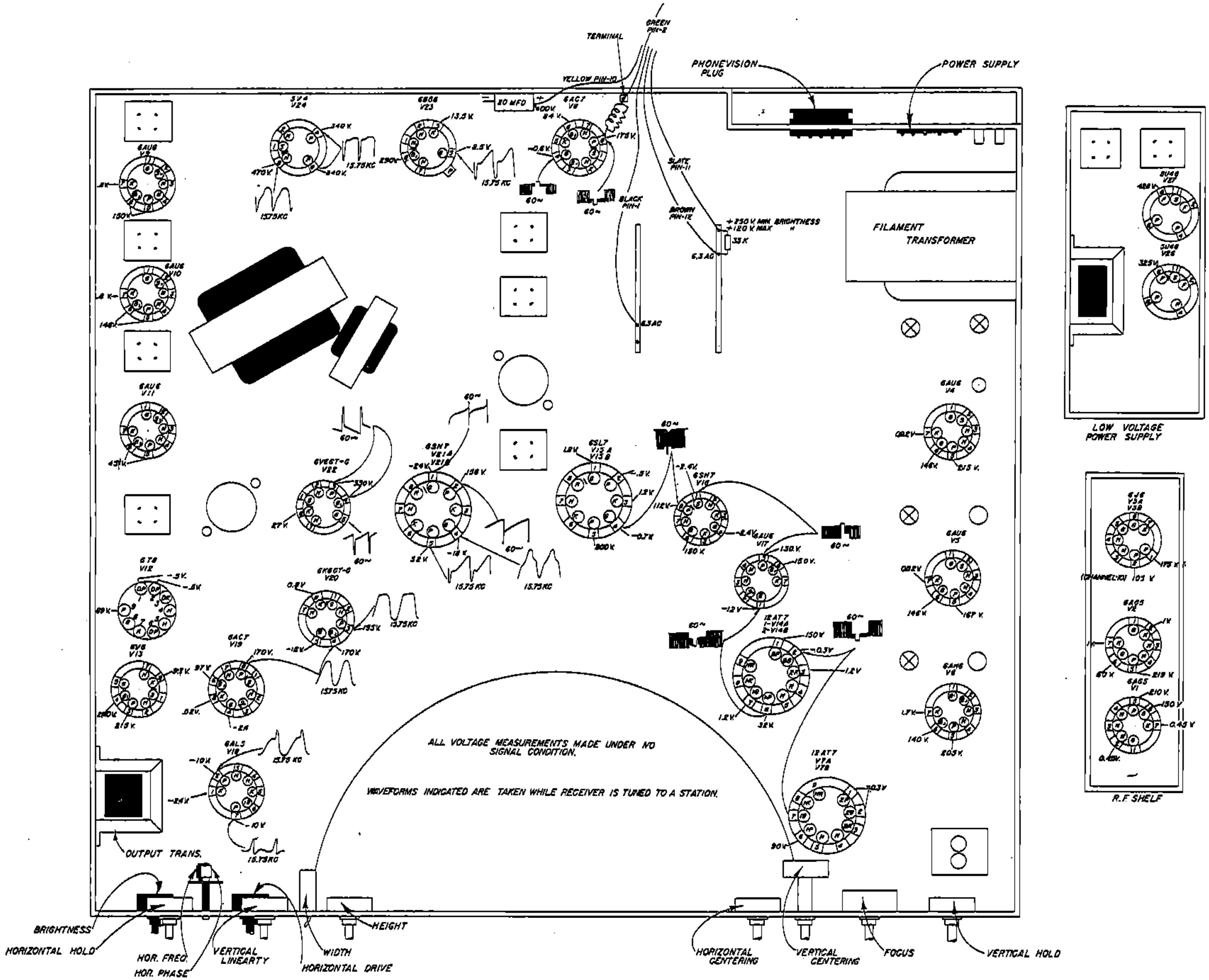


Fig. 49 Wave Forms and Voltage Measurement Chart.

NUMERICAL PARTS LIST
PARTS APPLY TO ALL MODELS EXCEPT WHERE INDICATED

MAIN CHASSIS ASSEMBLY

Ref. No.	Part No.	Description	
	12-1521	Horizontal Size Control Mtg. Bracket	
	12-1537	Horizontal Size Control Support Bracket	
	12-1533	Tube Adaptor Bracket (2 used) Chassis 28F21	
	15-84	Tube Socket Cap (used with 78-806)	
	19-175	Coil Mtg. Clip (used on S-15042)	
	19-176	Coil Mtg. Clip (2 used on S-15041)	
	19-177	Anode Clip (Pix Tube)(used on S-15203)	
	19-178	Capacitor Mtg. Clip (5 used)	
L72	20-255	Filament Choke Coil	
	21-31	Picture Collar	
C62	22-182	250 MMFD (or 22-1666)	500 V.
C77	22-1137	150 MMFD	500 V.
C52	22-1138	500 MMFD	500 V.
C78	22-1573	Dry Electrolytic 40 MFD	450 V.
C61	22-1674	50 MMFD Ceramic (or 22-1532)	500 V.
C73	22-1746	75 MMFD Ceramic (or 22-1256)	500 V.
C32	22-1775	.047 MFD	400 V.
C54	22-1777	.1 MFD	200 V.
C74	22-1778	.047 MFD	200 V.
C64	22-1779	.01 MFD	600 V.
C53	22-1809	.01 MFD	200 V.
C82	22-1831	56 MMFD	1000 V.
C81	22-1832	500 MMFD Special Molded	15000 V.
C79	22-1833	600 MMFD	500 V.
C67, C68, C69	22-1836	Dry Electrolytic 20 MFD - 300 V. X 20 MFD 475 V.X 40 MFD 25 V.	
C48, C49, C50	22-1837	Dry Elec. 10 MFD - 200 V. X 20 MFD 300 V.X 40 MFD 350 V.	
C55, C56, C57	22-1838	Dry Elec. 10 MFD - 200 V. X 100MFD 200 V.X 40 MFD 25 V.	
C51	22-1839	.001 MFD	200 V.
C58	22-1841	.1 MFD	600 V.
C65	22-1842	.0047 MFD	200 V.
C66	22-1843	.01 MFD	600 V.
C60	22-1844	.047 MFD	600 V.
C12	22-1845	.0022 MFD	600 V.
C83	22-1846	.01 MFD	400 V.
C6	22-1847	.0047 MFD	200 V.
C76	22-1849	.0047 MFD	600 V.
C75	22-1850	.015 MFD	200 V.
C80	22-1851	.001 MFD	1000 V.
C59	22-1901	.033 MFD	600 V.
C70	22-1903	Dry Electrolytic 20 MFD	25 V.
C71, C72	22-1904	Dry Electrolytic 500 MFD X 3V. 20 MFD X 25	
	27-112	Channel Indicator Disc.	
	27-113	Contrast Indicator Disc.	
	34-183	Turret Drive Gear (used on S-15025)	
	34-184	Indicator Drive Gear (used on S-15134)	

Ref. No.	Part No.	Description			
	34-185	Indicator Gear (used on S-15346)			
	34-186	Drive Gear (used on S-15347) Chassis 28F20 and 28F22			
	52-518	Low Capacity Shielded Lead			
	44-27	Test Jack			
	54-139	#3/8-32 X 9/16" Hex. Palnut			
	54-189	#8-32 Wing Nut			
	54-267	#6-32 X 5/16" Hex Palnut (2 used)			
	57-1461	Indicator Mtg. Plate (used on S-15367)			
	57-1462	Front Bearing Plate (used on S-15345)			
	58-128	Two Contact A.C. Plug			
	58-173	11 Prong Plug (used on S-15208)			
	61-129	Osc. Cam Drive Pulley (used on S-15205)			
	61-130	Osc. Cam Control Pulley (used on S-15204)			
	61-131	Contrast Indicator Pulley (used on S-15343-44)			
R70	63-947	27K ohm	(Insulated)	10%	2 W.
R58	63-1065	15K ohm	"	10%	1 W.
R74	63-1071	10K ohm	"	10%	1 W.
R63	63-1169	2700 ohm W.W.	"	10%	2.W.
R84	63-1198	10K ohm	"	10%	2 W.
R76	63-1485	33K ohm	"	10%	2 W.
R71	63-1532	2500 ohm	"	10%	5 W.
R75	63-1533	5K ohm	"	20%	3 W.
R83	63-1536	500 ohm	"	10%	3 W.
R72	63-1566	22K ohm	"	10%	2 W.
R78	63-1578	150 ohm	"	20%	2 W.
R49	63-1579	6200 ohm	"	5%	2 W.
R85	63-1581	4.7 ohm W. W.	"	10%	1/2 W.
R82	63-1668	Focus Control			4 W.
R81	63-1669	Horizontal Center Control			
R68	63-1670	Vertical Center Control			
R60	63-1671	Vertical Hold Control			
R73	63-1672	Horizontal Hold Control			
R62	63-1673	Vertical Size Control			
R67	63-1674	Vertical Linearity Control			
R77	63-1675	Horizontal Drive Control			
R79	63-1679	15K ohm W. W.	(Insulated)	20%	20 W.
R50	63-1682	Intensity Control			
R52	63-1684	10K ohm	"	10%	7 W.
R80	63-1689	4500 ohm W.W.	"	10%	10 W.
R40	63-1690	Sensitivity Control			
R23	63-1701	10 ohm	"	10%	1/2 W.
R31	63-1751	150 ohm	"	20%	1/2 W.
R38	63-1775	560 ohm	"	10%	1/2 W.
R44	63-1781	820 ohm	"	5%	1/2 W.
R17	63-1785	1K ohm	"	10%	1/2 W.
R54	63-1807	3300 ohm	"	20%	1/2 W.
R56	63-1810	3900 ohm	"	10%	1/2 W.
R47	63-1824	8200 ohm	"	10%	1/2 W.
R53	63-1827	10K ohm	"	10%	1/2 W.
R7	63-1828	10K ohm	"	20%	1/2 W.

MAIN CHASSIS ASSEMBLY CONT'D

Ref. No.	Part No.	Description			
R39	63-1831	12K ohm	"	10%	1/2 W.
R10	63-1842	22K ohm	"	20%	1/2 W.
R35	63-1845	27K ohm	"	10%	1/2 W.
R32	63-1848	33 K ohm	"	10%	1/2 W.
R45	63-1849	33K ohm	"	20%	1/2 W.
R33	63-1852	39K ohm	"	10%	1/2 W.
R43	63-1856	47K ohm	"	20%	1/2 W.
R42	63-1866	82K ohm	"	10%	1/2 W.
R4	63-1870	100K ohm	"	20%	1/2 W.
R51	63-1873	120K ohm	"	10%	1/2 W.
R11	63-1883	220K ohm	"	10%	1/2 W.
R61	63-1884	220K ohm	"	20%	1/2 W.
R12	63-1891	330K ohm	"	20%	1/2 W.
R57	63-1896	470K ohm	"	5%	1/2 W.
R69	63-1898	470K ohm	"	20%	1/2 W.
R20	63-1905	680K ohm	"	20%	1/2 W.
R55	63-1912	1 Megohm (Also R59 63-1911)	"	20%	1/2 W.
R14	63-1918	1.5 Megohm	"	10%	1/2 W.
R41	63-1919	1.5 Megohm	"	20%	1/2 W.
R18	63-1926	2.2 Megohm	"	20%	1/2 W.
R65	63-1940	4.7 Megohm	"	20%	1/2 W.
	63-1965	150 ohm W. W. (Alt. for 63-1578)	"	20%	2 W.
R66	63-1967	1500 ohm	"	10%	1 W.
	63-1995	150 ohm - Zipohm (Insulated) (Alt. for 63-1578)		20%	3 W.
	69-154	#6-32 X 2 1/4" R.H.M.S. -Steel - N.P.			
	69-265	#8-32 X 2 1/2" R.H.M.S. -Steel - N.P.			
	73-2	#6-32 X 3/16" Headless Set Screw - Cuppoint (2 used)			
	73-21	#8-32 X 3/16" Headless Set Screw - Cuppoint (4 used) Chassis 28F20			
	73-24	#8-32 X 1/4" Hex. Headless Set Screw - Cuppoint (4 used)			
	73-30	#6-32 X 1/4" Hex. Headless Set Screw - Cuppoint (2 used)			
	76-532	Tuning Shaft (Chassis 28F21)			
	76-536	Idler Shaft Chassis 28F20			
	76-537	Tuning Shaft - Chassis 28F20			
	78-706	Socket - Octal Tube			
	78-755	Socket - Octal Tube (8 used)			
	78-788	Socket - Miniature Tube (9 contact)			
	78-791	Socket - 7 contact			
	78-807	Socket - Miniature Tube (2 used)			
	78-826	Socket - 11 contact			
	78-829	Socket - Picture Tube			
	78-834	Socket - Octal Tube (Low-Loss)			
	78-835	Dial Light Socket & Wire			
	80-402	Drive Cord Tension Spring (3 used)			
	80-686	Grounding Spring			
	80-690	Indicator Detent. Spring.			
	83-1567	A.F.C. Terminal Board			
	83-1569	Rubber Strip (C.R.T. Mtg.)			
	83-1573	Insulator Strip (C.R.T. Socket Wire)			
	83-1585	Insulator Strip			
	93-946	Cup Washer			
	93-947	Cup Washer			
	93-952	Bakelite Washer (1/16" X 144 X 3/8")			
	93-953	Indicator Drive Gear Washer			
	93-955	Bakelite Washer (1/16" X 11/64" X 1/2")			
	93-958	Bakelite Washer (used on S-15203)			
	93-965	Rubber Washer (used on S-15203)			

Ref. No.	Part No.	Description
	94-645	Coupling Bushing
	94-653	Focusing Coil Bushing
T9	95-1110	Deflection Yoke
T12	95-1111	Focus Coil
T8	95-1112	Vertical Output Transformer
T7	95-1113	Vertical Blocking Osc. Transformer
T13	95-1116	Filament Transformer
PL-1	97-328	Channel Indicator Stud
	100-36	Dial Light Bulb (2 used)
	112-88	#8-32 Thumb Screw (3 used)
	113-9	#8-32 X 1/4" Hex. Hd. Slotted M.S. (Int. Shakeproof Lockwasher Attached)
	114-39	#8 X 1/4" Hex. Hd. S. T. Screw (18 used)
	114-307	#8-32 X 1 1/4" Hex. Hd. Slotted M.S.
	114-308	#6-32 X 1 1/8" Hex. Hd. Slotted M.S.
	125-72	Rubber Grommet (C.R.T. Mtg.) (2 used)
	149-71	Iron Core (used on S-15126-29)
	149-77	Iron Core & Insert (used on S-15042)
	149-78	Iron Core & Screw (2 used on S-15041)
	188-27	Retaining Ring (3 used) Chassis 28F20
	188-32	" "
	188-75	" "
T11	214-7	Indicator Drive Chain
	S-15015	Horizontal Sweep Transformer Assembly
	S-15020	R. F. Shelf & Turret Tuner Assembly
T10	S-15025	Turret Drive Gear & Bushing Assembly
L71	S-15041	Horizontal Osc. & A.F.C. Transformer Assembly
	S-15042	Horizontal Size Control Assembly
	S-15045	Sound Chassis Assembly
	S-15046	Video I. F. Strip Assembly
	S-15067	Picture Tube Tie Down Strip & Bracket Assembly. Chassis 28F20 and 28F22
	S-15319	Picture Tube Tie Down Strip & Bracket Assembly. Chassis 28F21
	S-15114	Oscillator Coil Assembly(used on S-15041)
	S-15124	A.F.C. Coil Assembly (used on S-15041)
L68	S-15125	1st Video Peaking Coil Assembly
L70	S-15126	2nd Video Shunt Peaking Coil Assembly
L69	S-15127	2nd Video Series Peaking Coil Assembly
L67	S-15128	B Plus Choke Coil Assembly
	S-15132	A. C. Plug & Bracket Assembly
	S-15134	Chain Gear & Washer Assembly
	S-15202	Horizontal Sweep Transformer & Socket Assembly.
	S-15203	Anode Clip & Wire Assembly (used on S-15202)
	S-15204	Osc. Cam Drive Shaft & Pulley Assy.
	S-15205	Osc. Cam Control Extension Shaft & Pulley Assembly.
	S-15206	Osc. Cam Drive Cord & Eyelet Assy.
	S-15207	Picture Tube Socket & Wire Assy.
	S-15208	Phone Vision Dummy Plug & Wire Assy.
	S-15209	Electro-Static & Heat Shield Assy.
	S-15320	Beam Bender unit (used only with 10BP4 or 12LP4)
	S-15343	Pulley Bushing & Disc. Assy.
	S-15344	Pulley & Bushing Assy.
	S-15345	Tuning Shaft Bracket & Plte Assy.
	S-15346	Channel Indicator Disc. & Gear Assy.
	S-15347	Indicator Drive Gear & Bushg. Assy. (2 used) (Chassis 28F20 and 28F22)

MAIN CHASSIS ASSEMBLY CONT'D

Ref. No.	Part No.	Description
	S-15366	Indicator Cord & Eyelet Assy - Chassis 28F20.
	S- 15368	Indicator Cord and Eyelet Assy.
	S-15367	Indicator Plte & Spring Assy.

PICTURE TUBES

12KP4	(12LP4 alternate)	Chassis 28F20
10FP4	(10BP4 alternate)	Chassis 28F21 28F22

TURRET TUNER ASSEMBLY

Ref. No.	Part No.	Description
	19-163	Coil Mounting Clip (36 used)
	56-253	Groove Pin - Type #1 - 3/32" X 1/4" lg.
	57-1428	Bearing Plate
	57-1443	Adjusting Plate
	73-24	#8-32 X 1/4" Hex. Hd. Slotted Set Screw - Cuppoint (2 used on S-15024)
	73-119	Special Set Screw
	80-676	Index Spring
	83-1071	Threaded Insert (36 used)
	93-805	1/32" X 120 X 3/8" Steel Washer (24 used)
	112-730	Adjusting Screw
	113-7	#4-40 X 1/4" B.H.M.S. (Ext. Shakeproof Lockwasher)
	113-8	#6-32 X 1/4" Hex. Hd. Slotted M. S. (Int. Shakeproof Lockwasher)
	113-9	#8-32 X 1/4" Hex. Hd. Slotted M. S. (Int. Shakeproof Lockwasher)
	126-596	Shield
	149-40	Iron Core (36 used)
	149-76	Iron Core & Screw (6 used)
	184-14	Steel Ball - 1/8" Dia. (9 used)
	184-15	Steel Ball - 5/32" dia.
	184-16	Steel Ball - 1/2" dia.
L53	S-15020	R.F. Shelf & Tuner Assy. (Complete)
	S-15021	Turret Tuner Assy (Mechanical)
	S-15022	Turret Tuner Cover Assy.
	S-15023	Idler Gear & Bracket Assy.
	S-15024	Gear & Bushing Assy.
	S-15027	R. F. Shelf Assy. (Complete)
ST2	S-15029	Channel Strip Assy. - No. 2
ST3	S-15030	" " " No. 3
ST4	S-15031	" " " No. 4
ST5	S-15032	" " " No. 5
ST6	S-15033	" " " No. 6
ST7	S-15034	" " " No. 7
ST8	S-15035	" " " No. 8
ST9	S-15036	" " " No. 9
ST10	S-15037	" " " No. 10
ST11	S-15038	" " " No. 11
ST12	S-15039	" " " No. 12
ST13	S-15040	" " " No. 13

R. F. SHELF ASSEMBLY

Ref. No.	Part No.	Description			
	19-166	Coil Mounting Clip			
C17	22-1765	1.2 MMFD	Ceramic		500 V.
C27	22-1668	200 MMFD	"		500 V.
C20	22-1876	47 MMFD	"		500 V.
C15	22-1888	.001 MFD	"		500 V.
C84	22-1895	10 MMFD	"		500 V.
C85	22-1947	100 MMFD	"		500 V.
	52-507	Shielded Lead			
R21	63-943	4700 ohm	(Insulated)	10%	1 W.
R23	63-1701	10 ohm	"	10%	1/2 W.
R15	63-1729	47 ohm	"	10%	1/2 W.
R19	63-1782	820 ohm	"	10%	1/2 W.
R17	63-1785	1 K ohm	"	10%	1/2 W.
R86	63-1792	1500 ohm	"	10%	1/2 W.
R16	63-1841	22 K ohm	"	10%	1/2 W.
R22	63-1855	47 K ohm	"	10%	1/2 W.
R20	63-1905	680 K ohm	"	20%	1/2 W.
R55	63-1912	1 Megohm	"	20%	1/2 W.
R18	63-1926	2.2 Megohm	"	20%	1/2 W.
	76-533	Shaft			
	78-807	Socket - Miniature Tube (2 used)			
	78-828	Socket - Miniature Tube (Ceramic with Shield Base)			
	80-141	Spring - Shaft (Osc. Tuning)			
	80-679	Spring - Shaft Tension			
	83-1560	Master Terminal Strip			
	83-1570	Antenna Terminal Strip			
	93-216	.015 X .255 X 7/16" Steel Washer			
	93-952	Bakelite Washer			
	93-959	Fibre Washer			
	94-647	Oscillator Coil Mtg. Bushing			
	112-732	Calibrating Screw			
	112-742	Trimmer Adjusting Screw (used on S-15211)			
	126-515	Miniature Tube Shield			
	126-597	Shield			
	128-53	Osc. Coil Tuning Cam (3 used)			
	149-62	Iron Core & Screw (used on S-15064)			
	149-74	Iron Core (used on S-15062)			
	149-75	Iron Core & Screw (used on S-15066)			
	188-34	Retaining Ring (used on 76-533)			
	S-15027	R. F. Shelf Assembly (Complete)			
	S-15028	Tuning Washer Assembly			
L10	S-15043	High Frequency Osc. Coil & Capacitor Assy.			
L8	S-15062	Antenna Coil Assy.			
L9	S-15064	Converter Plate Coil Assy.			
L12	S-15065	Filament Choke Coil Assy.			
L11	S-15066	Low Frequency Osc. Coil Assy.			
C16	S-15211	Trimmer Capacitor Assy.			

SOUND I. F. ASSEMBLY

Ref. No.	Part No.	Description		
	12-1540	Volume Control Mtg. Bracket		
C14	22-1693	3 MMFD	Ceramic	500 V.
C9	22-1703	.0005 MFD	Ceramic	500 V.
C8	22-1706	.005 MFD	Ceramic	450 V. (Disc type)
C13	22-1782	.0047 MFD		600 V.

SOUND I. F. ASSEMBLY CONT'D

Ref. No.	Part No.	Description
C10	22-1811	.0047 MFD 400 V.
C12	22-1813	.022 MFD 600 V.
C6	22-1847	.0047 MFD 200 V.
C5	22-1880	.0012 MFD 600 V.
C11	22-1886	.001 MFD Ceramic 500 V.
C7	22-1887	25 MMFD Ceramic 500 V.
	54-139	#3/8-32 X 9/16" Hex Palnut
	54-267	#6-32 X 5/16" Hex Palnut (Inserted) (4 used)
	58-88	3 Prong Plug
R5	63-1194	47 K ohm (Insulated) 10% 1 W.
R13	63-1227	220 ohm " W. W. 10% 1 W.
R3	63-1571	6800 ohm " 10% 2 W.
R46	63-1667	Dual Control & A.C. Switch (Volume & Contrast)
R2	63-1727	68 ohm (Insulated) 20% 1/2 W.
R7	63-1828	10 K ohm " 20% 1/2 W.
R10	63-1842	22 K ohm " 20% 1/2 W.
R8	63-1869	100 K ohm " 10% 1/2 W.
R4	63-1870	100 K ohm " 20% 1/2 W.
R6	63-1876	150 K ohm " 10% 1/2 W.
R11	63-1883	220 K ohm " 10% 1/2 W.
R12	63-1890	330 K ohm " 10% 1/2 W.
R9	63-1961	15 Megohm " 10% 1/2 W.
	63-1968	6800 ohm W. W. " 10% 2 W. (Alt. for 63-1571)
	63-1997	6800 ohm Zipohm 10% 2 W. (Alt. for 63-1571)
	78-363	Socket - 3 Contact
	78-755	Socket - Octal Tube
	78-788	Socket - Noval Tube
	78-807	Socket - Miniature Tube (3 used)
T6	95-1114	Output Transformer
T3	95-1118	2nd Sound I. F. Transformer
T4	95-1119	3rd Sound I. F. Transformer
T5	95-1120	Discriminator Transformer
T2	95-1121	Sound Input Coil
	114-201	#8 X 5/16" Hex. Hd. Slotted S.T. Screw
	S-15045	Sound Chassis Assy. (Complete)

PICTURE I. F. ASSEMBLY

Ref. No.	Part No.	Description
	19-166	Coil Mtg. Clip (used on S-15051 & S-15052
	19-179	Coil Mtg. Clip (used on S-15049 & S-15054
C27	22-1668	200 MMFD Ceramic 500 V.
C23	22-1669	100 MMFD Ceramic 500 V.
C32	22-1775	.047 MFD 400 V.
C24	22-1869	6 MMFD Ceramic 500 V.
C22	22-1870	52 MMFD Ceramic 500 V.
C26	22-1871	30 MMFD Ceramic 500 V.
C15	22-1888	.001 MFD Ceramic 500 V.
C29	22-1882	Trimmer (used on S-15054)
C31	22-1898	7.5 MMFD Ceramic 500 V.
C25	105-17	Dual Ceramic (2 X 1500 MMFD)
C28	105-18	Dual Ceramic (5 MMFD - 6 MMFD)

Ref. No.	Part No.	Description
C30	27-108	Silver Mica Disc. (2 used)
	54-271	#6-32 X 1/4" Hex Palnut (Inverted) (4 used)
R26	63-1740	82 ohm (Insulated) 10% 1/2 W.
R31	63-1751	150 ohm " 20% 1/2 W.
R27	63-1758	220 ohm " 20% 1/2 W.
R28	63-1772	470 ohm " 20% 1/2 W.
R24	63-1786	1 K ohm " 20% 1/2 W.
R25	63-1806	3300 ohm " 10% 1/2 W.
R34	63-1809	3900 ohm " 5% 1/2 W.
R30	63-1816	5600 ohm " 5% 1/2 W.
R29	63-1818	6200 ohm " 5% 1/2 W.
R35	63-1845	27 K ohm " 10% 1/2 W.
R32	63-1848	33 K ohm " 10% 1/2 W.
R33	63-1852	39 K ohm " 10% 1/2 W.
R22	63-1855	47 K ohm " 10% 1/2 W.
R18	63-1926	2.2 Megohm " 20% 1/2 W.
	64-451	Brass Eyelet (used on 57-1054)
	78-788	Socket - Noval Tube
	78-807	Socket - Miniature Tube (3 used)
	86-182	Capacitor Lug
	94-538	Threaded Insert (used on S-15048-50-53-57)
	125-69	Rubber Grommet (4 used) (Shock Mts. for coils)
	149-39	Iron Core (used on S-15048-50-53-57)
	149-62	Iron Core & Screw (used on S-15049-51-52-54)

PICTURE I. F. ASSEMBLY

Ref. No.	Part No.	Description
	149-71	Iron Core (used on S-15059-60)
	S-15046	Picture I. F. Strip Assy. (Complete)
L13	S-15048	Parallel Tuned Sound Trap Coil Assembly
L14	S-15049	Picture I. F. Coupling Coil Assy.
L15	S-15050	Series Tuned Sound Trap Coil Assy.
L16	S-15051	1st Picture I. F. Interstage Coil Assy.
L18	S-15052	2nd Picture I. F. Interstage Coil Assy.
L17	S-15053	Adjacent Sound Channel Trap Coil Assy.
L20, L19, R22, C28, C29	S-15054	3rd Picture I. F. Transformer Assy.
L24	S-15057	4.5 Meg. Trap Coil Assy.
L21	S-15058	Video Detector Series Coil Assy.(Peaking)
L22	S-15059	Video Detector Shunt Coil Assy.(Peaking)
L23	S-15060	Filament Choke Assy.

POWER SUPPLY

Ref. No.	Part No.	Description
C1	22-1826	Dry Electrolytic 15 MFD - 200 V.
C2	22-1827	Dry Electrolytic 40 MFD - 400 V.
C3		
C4	22-1828	Dry Electrolytic 20 MFD - 475 V. X 100 MFD - 350 V.
	54-42	#10-32 X 5/16" Hex Nut (4 used to mount 95-1115)
P1	58-169	7 Prong Plug (used on S-15009)
R1	63-1580	10 ohm W. W. Insulated 2 W. 5% (or 63-1996)

POWER SUPPLY CONT'D

Ref. No.	Part No.	Description
	78-229	Socket - Electrolytic
	78-274	Socket - Electrolytic
	78-755	Socket - Tube (2 used)
L78	95-1109	Filter Choke (2 used)
T1	95-1115	Power Transformer (28F20, 28F21)
	95-1124	Power Transformer (22F22 ONLY)
	114-43	#10-32 X 3/8" Hex Slotted Washer Hd. M. S. (4 used to mt. 95-1115)
	126-604	Heat Shield
	S-15007	Power Supply Final Assy (Complete) Chassis 28F20, 28F21
W1	S-15375	Power Supply Final Assy.(Complete for 28F22)
	S-15009	Power Supply Cable Assy.

CABINET PARTS

7-11	Bezel 12" Tube
7-12	Bezel 10" Tube
11-106	Line Cord & Plug (9 ft. lg.)
17-105	Bezel Clamp (4 used)
19-180	Control Cover Retaining Clip (3 each used on S-15341-42)
24-446	A.C. Line Cord Plug Cover
24-477	Outer Control Cover (R.H.) Models 28T960G0, 28T961G0, 28T925G0 & 28T925R
24-478	Outer Control Cover (L.H.) Models 28T960G0, 28T961G0, 28T925G0 & 28T925R
24-479	Outer Control Cover (R.H.) (Models 28T925R & 28T925G0
24-480	Outer Control Cover (L.H.) Models 28T925R & 28T925G0
46-752	Vertical & Horizontal Hold Control Knob (4 used) Models 28T960G0, 28T961G0, 28T925G0 & 28T925R
46-761	Channel Selector Knob - Models 28T960G0 28T961G0, 28T925G0 & 28T925R
46-771	Vertical & Horizontal Hold Control Knob (Models 28T925R, 28T925G0, 28T962R & 28T963R
46-762	Contrast Control Knob (Models 28T960G0 28T961G0, 28T925G0 & 28T925R
46-763	Volume Control & "On-Off" Switch Knob Models 28T960G0, 28T961G0, 28T925G0 & 28T925R
46-773	Channel Selector Knob (Models 28T925R, 28T925G0, 28T962R & 28T963R
46-774	Contrast Control Knob (Models 28T925R 28T925G0, 28T962R, & 28T963R
46-775	Volume Control & "On-Off" Knob (Models 28T925R, 28T925G0, 28T962R & 28T963R
58-75	Switch Plug (used on S-15358)

CABINET PARTS

Part No.	Ref. No.	Description
SP1	49-649	10" P.M. Speaker (Models 28T960G0, 28T961G0, 28T962R & 28T963R
SP1	49-654	5 1/2" PM Speaker (Models 28T925G0 28T925R)
	54-30	#8-32 X 5/16" X 7/64" Hex Nut (4 used)
	56-261	#18 GA X 3/8" lg. Brass Escutcheon Pin (2 used)
	57-1463	Name Plate (28T960G0, 28T961G0, 28T925G0 28T925R
	57-1464	Name Plate (28T925R, 28T925G0, 28T962R 28T963R
	70-149	#4 X 1/2" Phillips B. H.W.S.(10 used)
	74-55	Ventilating Screen.
	78-787	Two Contact A.C. Socket
S1	85-445	Dial Light Switch (used on S-15358) (Models 28T960G0, 28T961G0, 28T925G0 28T925R)
S1	85-446	Dial Light Switch (28T925R, 28T925G0, 28T962R and 28T963R)
	93-263	1/32" X 3/16" X1/2" Steel Washer (4 used)
	112-289	#8-32 X 1 3/8" Swedge Hd. M.S.(4 used)
	112-744	Latch Adjusting Screw (2 used)
	112-745	#4-40 X 1/4" Flat Hd. S.T. Screw (8 used)
	114-80	#1/4-20 X 1 3/8" Washer Hd. M.S. (7 used)
	114-313	#8-1/2" Hex Hd. Slotted S.T. Screw (4 used)
	138-32	Speaker Grille Model 28T960G0 & 28T961G0
	138-33	Speaker Grille (Model 28T962R & 28T963R)
	171-9	Indicator Prism (2 used)
	188-102	Clamping Ring
	192-122	Protective Glass 12"
	192-123	Protective Glass 10"
	196-116	Bezel Gasket 12"
	196-117	Bezel Gasket 10"
	196-118	Protective Glass Gasket 12"
	196-119	Protective Glass Gasket 10"
	202-672	Instruction Book - Models 28T960G0, 28T961G0, 28T962R and 28T963R
	202-681	Instruction Book - Model 28T925G0 & 28T925R
	S-15154	Cabinet Back Assy.
	S-15341	Control Cover & Clip Assy. (R.H.)
	S-15342	Control Cover & Clip Assy. (L.H.)
	S-15358	Switch & Wire Assy. Models 28T960G0, 28T961G0, 28T925G0 & 28T925R
	S-15365	Switch & Wire Assy. Models 28T925R 28T925G0, 28T962R & 28T963R
	S-15363	Control Cover & Clip Assy. (R. H.) (28T962R & 28T963R)
	S-15369	Control Cover & Clip Assy. (L.H.) (28T962R & 28T963R)
	70-86	#6 X 5/8" Washer Hd. Wood Screw - Statuary Bronze (11 used)

ZENITH S15370 BIAS TEST FIXTURE

The S15370 Bias Test Fixture is designed to plug into jacks "C" and "S" at the rear of the television chassis to supply an adjustable bias voltage for use during RF-IF alignment and for AGC adjustments.

The VTVM or scope connections are to be made between the SCP-MTR. jack and fixture chassis. IN ORDER TO CONSERVE BATTERY LIFE, ALWAYS TURN THE BIAS CONTROL KNOB TO THE OFF POSITION AFTER USE.

AGC ADJUSTMENT

Before the AGC adjustment is made, turn the Station Selector Switch to one of the numbered channels which is not in use locally, but not to the blank position. Disconnect the antenna leads and short-circuit the antenna terminals of the receiver.

1. Plug the Bias Fixture into jacks "C" and "S" at the rear of the television chassis and set the BAT. Switch to AGC.

2. Set the MTR. Switch to DIODE and adjust the fixture Bias Control Knob for -1.5V at the SCP-MTR. tip jack.

3. Set the MTR. Switch to the AGC position and adjust the AGC Delay Control R40 (on receiver) for -3.8V indication on the VTVM.

4. Set the MTR. Switch to the DIODE position and adjust the Bias Control Knob for -1.V indication on the VTVM. Set the MTR. Switch to the AGC position. The indication on the VTVM should be between -0.5 to -2V.

5. Set the MTR. Switch to the DIODE position and adjust the Bias Control Knob for -2V indication on the VTVM. Set the MTR. Switch to the AGC position. The VTVM indication should be -5. to -7.5V.

It must be remembered that the AGC Delay Control is adjusted under Step 3 only and that Steps 4 and 5 are check points only. If the meter indications under Steps 4 and 5 do not coincide with the values listed, check the 12AT7 AGC amplifier tube and its associated circuits.

IF-RF ALIGNMENT

1. Plug the Bias Fixture into jacks "C" and "S" at the rear of the chassis and set the BAT. Switch to BAND PASS.

2. Set the MTR. Switch to AGC and adjust the Fixture Bias Control for -1.5V VTVM indication at the SCP-MTR. jack.

3. Set MTR. Switch to DIODE and connect the scope to the SCP-MTR. jack.

After the Bias Fixture adjustments have been made, proceed with the alignment as outlined in the Service Manual.

ADJUSTMENT OF ZENITH TELEVISION RECEIVERS ON STANDARD TEST PATTERN

Zenith television receivers are designed and adjusted at the factory to utilize the entire surface of the picture tube fluorescent screen, thereby producing a much larger picture. In accomplishing this, some vertical elongation of the test pattern is effected and this fact must be recognized in making adjustments in the field.

The four controls which affect picture size are, WIDTH, HORIZONTAL DRIVE, VERTICAL LINEARITY AND HEIGHT controls and the following procedure is recommended for their adjustment:

1. Adjust WIDTH and HORIZONTAL DRIVE Controls until picture extends to the edges of the picture tube screen horizontally. Picture must not extend beyond edges. Center pattern with HORIZONTAL CENTERING Control.
2. Adjust HEIGHT and VERTICAL LINEARITY Controls alternately until the pattern extends to the top and bottom edges of the screen and inner and outer circles are equadistant vertically. Adjust VERTICAL CENTERING Control to center picture.

Examples of incorrect adjustment of these controls will produce effects shown in Fig. 2 and 3 and are to be avoided.

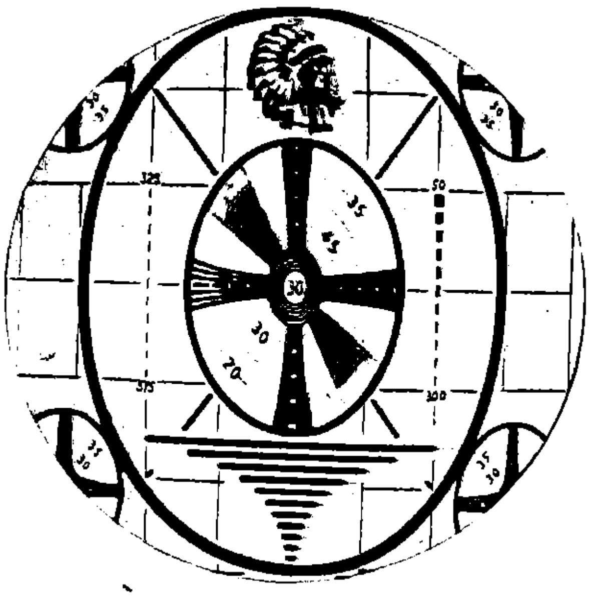


Fig. 1
Receiver correctly adjusted on test pattern.

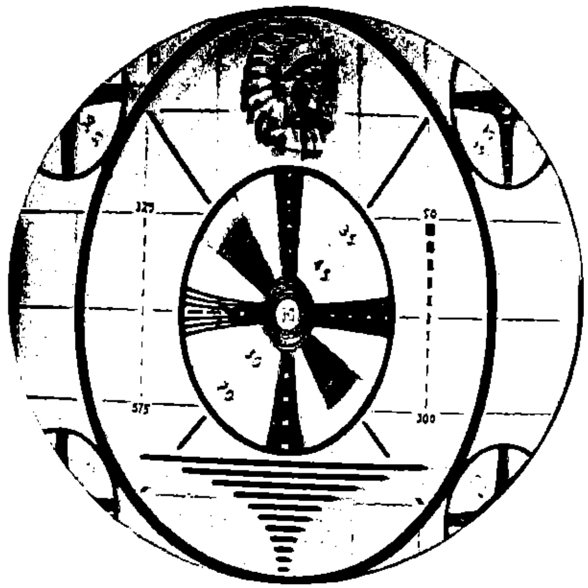
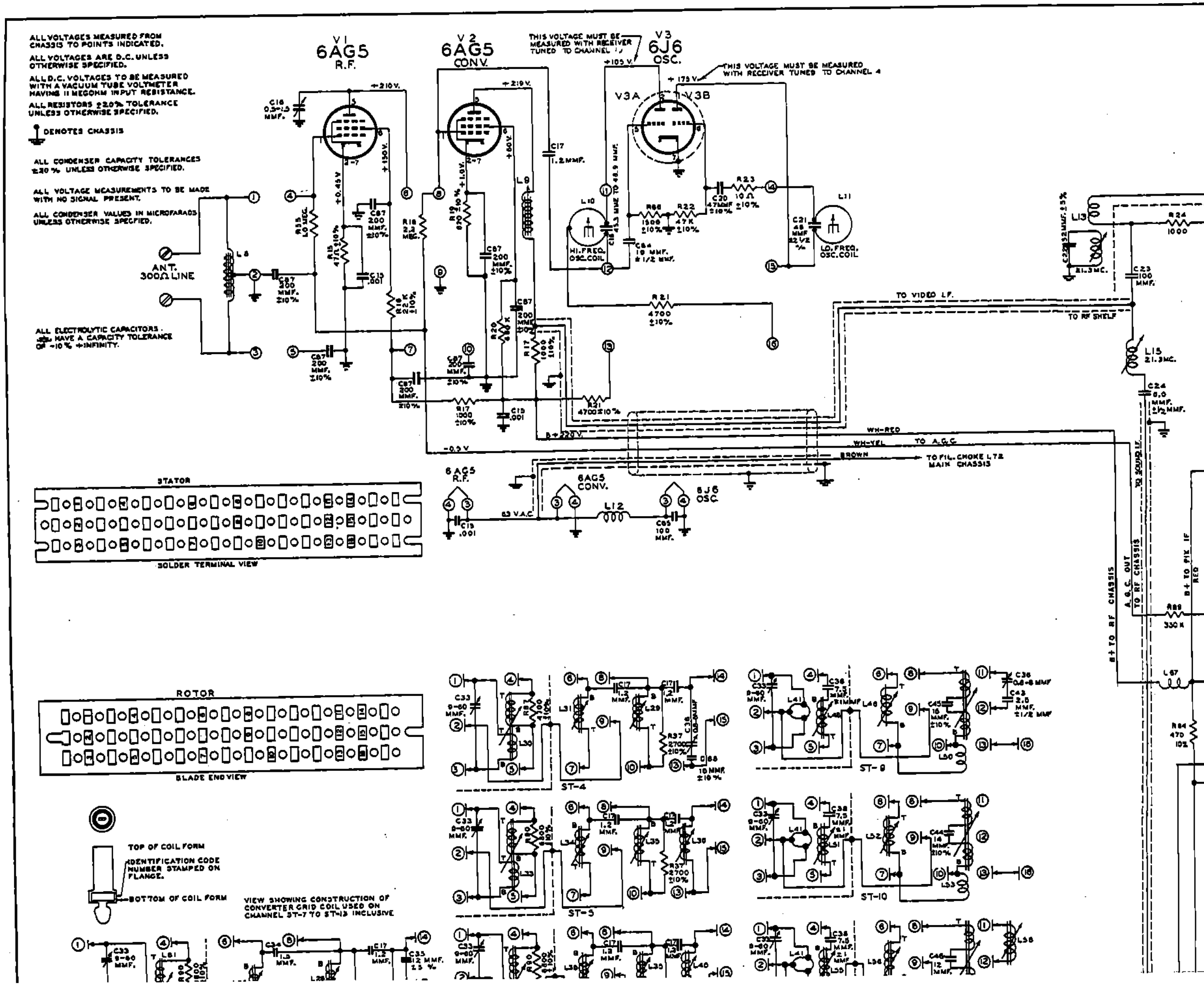


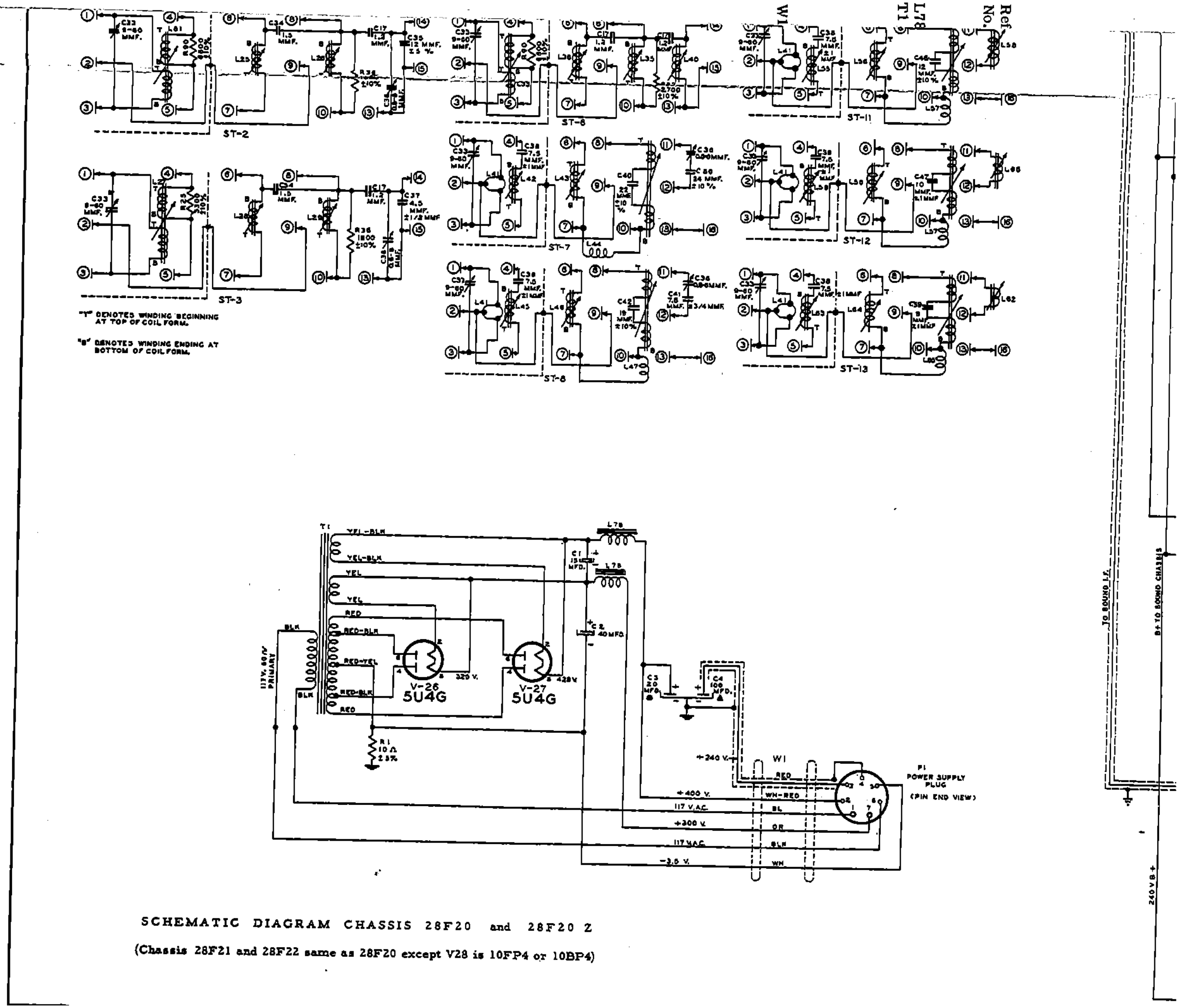
Fig. 2
Improper adjustment of height and vertical linearity controls.

Fig. 3
Improper adjustment of Height and vertical linearity controls.

Fig. 50 Schematic Diagram Zenith Television Receiver.

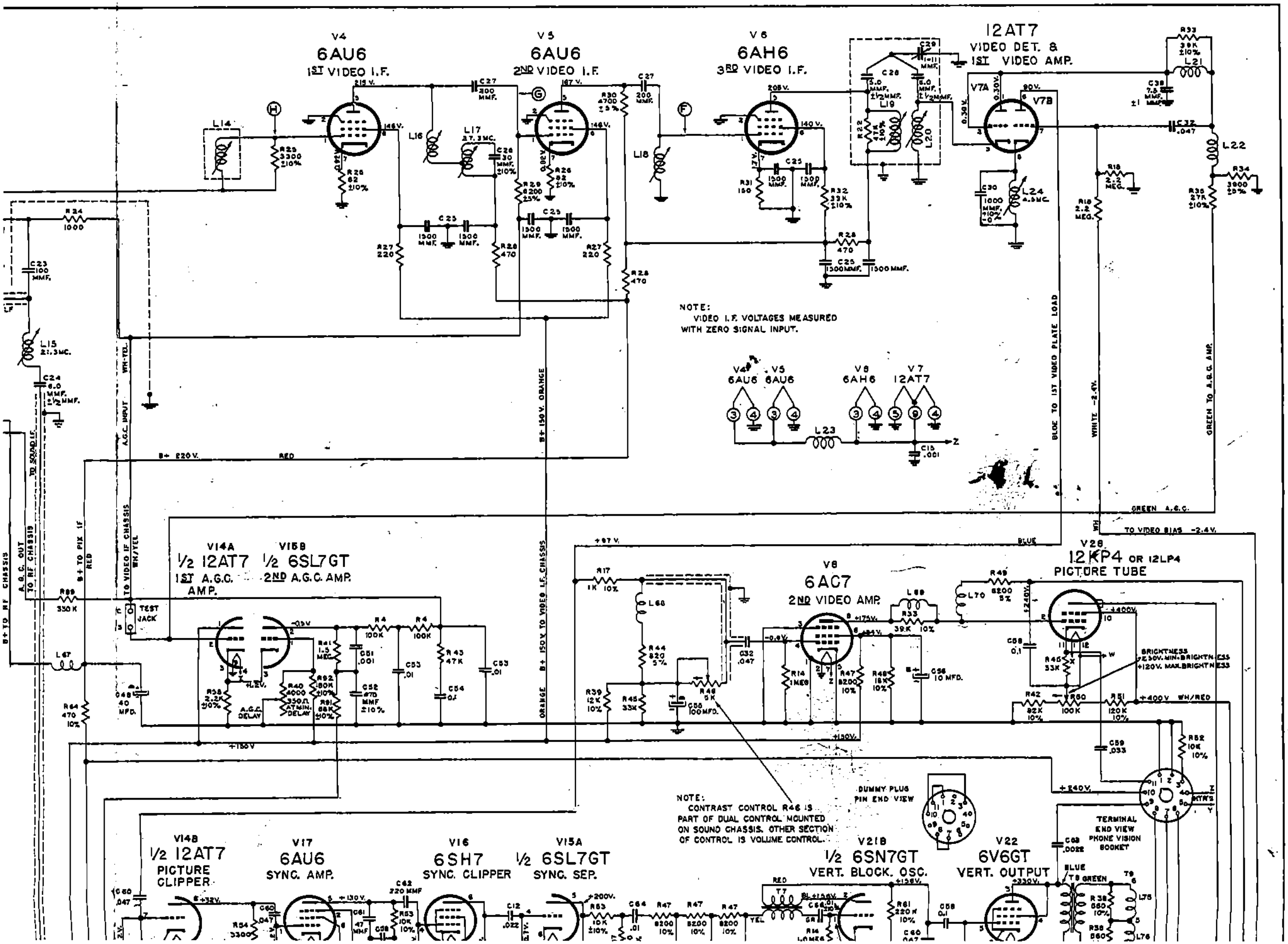


ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.
ALL VOLTAGES ARE D.C. UNLESS OTHERWISE SPECIFIED.
ALL D.C. VOLTAGES TO BE MEASURED WITH A VACUUM TUBE VOLTMETER HAVING 11 MEGOHM INPUT RESISTANCE.
ALL RESISTORS ±20% TOLERANCE UNLESS OTHERWISE SPECIFIED.
DENOTES CHASSIS
ALL CONDENSER CAPACITY TOLERANCES ±20% UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT.
ALL CONDENSER VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
ALL ELECTROLYTIC CAPACITORS HAVE A CAPACITY TOLERANCE OF -10% +INFINITY.
V1 6AG5 R.F.
V2 6AG5 CONV.
V3 6J6 OSC.
THIS VOLTAGE MUST BE MEASURED WITH RECEIVER TUNED TO CHANNEL 7
THIS VOLTAGE MUST BE MEASURED WITH RECEIVER TUNED TO CHANNEL 4
ANT. 300Ω LINE
HI.FREQ. OSC.COIL
LO.FREQ. OSC.COIL
TO VIDEO I.F.
TO RF SHELF
TO A.G.C.
TO FIL. CHOKE L72 MAIN CHASSIS
WH-RED
WH-YEL
BROWN
6AG5 R.F.
6AG5 CONV.
6J6 OSC
STATOR
SOLDER TERMINAL VIEW
ROTOR
BLADE END VIEW
TOP OF COIL FORM
IDENTIFICATION CODE NUMBER STAMPED ON FLANGE.
BOTTOM OF COIL FORM
VIEW SHOWING CONSTRUCTION OF CONVERTER GRID COIL USED ON CHANNEL ST-7 TO ST-13 INCLUSIVE
ST-4
ST-5
ST-9
ST-10
B+ TO RF CHASSIS
A.G.C. OUT
TO RF CHASSIS
TO SOUND I.F.
B+ TO PIX IF
RED

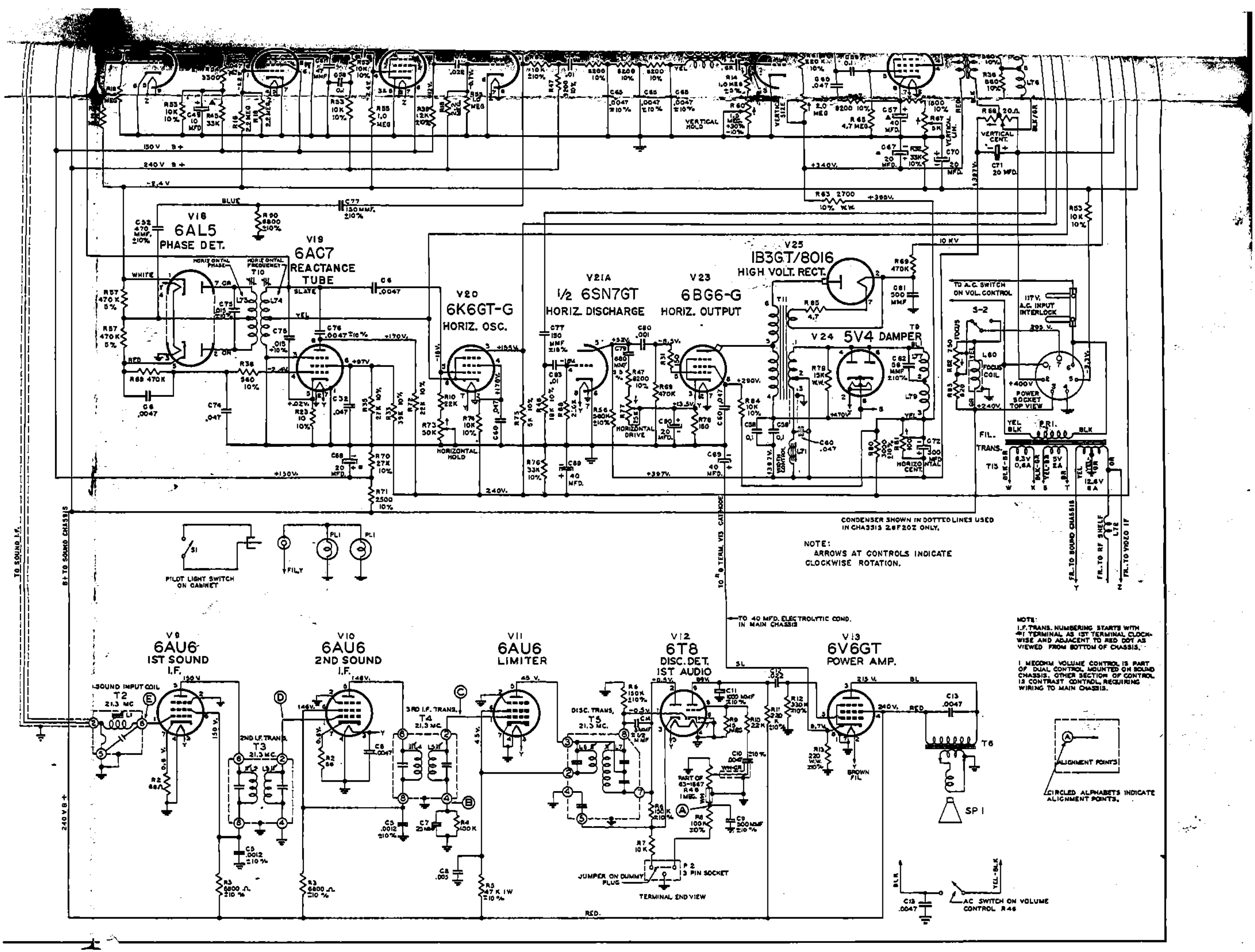


SCHEMATIC DIAGRAM CHASSIS 28F20 and 28F20 Z

(Chassis 28F21 and 28F22 same as 28F20 except V28 is 10FP4 or 10BP4)



V4 6AU6 1ST VIDEO I.F.
V5 6AU6 2ND VIDEO I.F.
V6 6AH6 3RD VIDEO I.F.
12AT7 VIDEO DET. & 1ST VIDEO AMP.
NOTE: VIDEO I.F. VOLTAGES MEASURED WITH ZERO SIGNAL INPUT.
V14A 1/2 12AT7 1ST A.G.C. AMP.
V15B 1/2 6SL7GT 2ND A.G.C. AMP.
V8 6AC7 2ND VIDEO AMP.
V28 12KP4 OR 12LP4 PICTURE TUBE
NOTE: CONTRAST CONTROL R46 IS PART OF DUAL CONTROL MOUNTED ON SOUND CHASSIS. OTHER SECTION OF CONTROL IS VOLUME CONTROL.
DUMMY PLUG PIN END VIEW
TERMINAL END VIEW PHONE VISION SOCKET
V14B 1/2 12AT7 PICTURE CLIPPER
V17 6AU6 SYNC. AMP.
V16 6SH7 SYNC. CLIPPER
V15A 1/2 6SL7GT SYNC. SEP.
V21B 1/2 6SN7GT VERT. BLOCK. OSC.
V22 6V6GT VERT. OUTPUT



V9 6AU6 1ST SOUND I.F.
V10 6AU6 2ND SOUND I.F.
V11 6AU6 LIMITER
V12 6T8 DISC. DET. 1ST AUDIO
V13 6V6GT POWER AMP.
V18 6AL5 PHASE DET.
V19 6AC7 REACTANCE TUBE
V20 6K6GT-G HORIZ. OSC.
V21A 1/2 6SN7GT HORIZ. DISCHARGE
V23 6BG6-G HORIZ. OUTPUT
V24 5V4 DAMPER
V25 1B3GT/8016 HIGH VOLT. RECT.
SOUND INPUT COIL T2 21.3 MC
2ND I.F. TRANS. T3 21.3 MC.
3RD I.F. TRANS. T4 21.3 MC.
DISC. TRANS. T5 21.3 MC.
JUMPER ON DUMMY PLUG
P2 3 PIN SOCKET
TERMINAL END VIEW
PILOT LIGHT SWITCH ON CABINET
AC SWITCH ON VOLUME CONTROL R46
POWER SOCKET TOP VIEW
TO A.C. SWITCH ON VOL. CONTROL
117V. A.C. INPUT INTERLOCK
FIL. TRANS. T15
FIL. TO SOUND CHASSIS
FIL. TO RF SHELF
FIL. TO VIDEO IF
TO SOUND I.F.
B+ TO SOUND CHASSIS
240 V B +
150 V B +
TO 40 MFD. ELECTROLYTIC COND. IN MAIN CHASSIS
CONDENSER SHOWN IN DOTTED LINES USED IN CHASSIS 28F20Z ONLY.
NOTE: ARROWS AT CONTROLS INDICATE CLOCKWISE ROTATION.
NOTE: I.F. TRANS. NUMBERING STARTS WITH #1 TERMINAL AS 1ST TERMINAL CLOCKWISE AND ADJACENT TO RED DOT AS VIEWED FROM BOTTOM OF CHASSIS.
1 MEGOHM VOLUME CONTROL IS PART OF DUAL CONTROL MOUNTED ON SOUND CHASSIS. OTHER SECTION OF CONTROL IS CONTRAST CONTROL REQUIRING WIRING TO MAIN CHASSIS.
ALIGNMENT POINTS
CIRCLED ALPHABETS INDICATE ALIGNMENT POINTS.