terminal block E-2. The output potentials from each section of secondary windings 5-6-7 and 8-9-10 of T-3 may thus be set at 6.0, 6.3 or 6.6 volts, either to compensate for loss in the output cables or to provide selection of the best operating level. The outputs are routed from terminal block E-3 to the distributing power cable in the cabinet. Voltmeter M-1 indicates the output voltage from winding 9-10.

*(b)* Transformer T-3 also provides an output voltage selecting circuit for the bias supply transformer, T-4. Taps on E-2 which connect to T-3 are arranged so that the input to T-4 may be changed in 11-volt steps, while other taps on E-2 which connect to T-4 make it possible to change the input in five-volt steps. A strap on E-2 interconnects the taps at leads "C" and "D".

(5) THE BIAS AND PLATE SUPPLY RECTIFIER CIRCUITS.
*(See figure 7-50.)*

*(a)* In the bias supply rectifier circuit, T-5 supplies heater current to type 2050 tubes V-1 and V-2, each of which is connected as a gas diode. The secondary winding of T-4 provides anode current, while L-4 and C-2 form a tuned-choke filter for the rectified output of the tubes. The rectifier output circuit is controlled by contacts in time-delay unit, K-1. C-3 is the final element in the filter. M-3 indicates the output bias voltage which is applied through E-1 to the multiplex equipment units.

*(b)* In the plate supply rectifier circuit, another winding of T-5 supplies filament current to type 3B28 tubes V-3 and V-4, each of which is a half wave gas rectifier. The secondary winding of plate supply transformer T-6 provides anode current, while L-5 and C-4 form a tuned-choke filter for the rectified output of the tubes. C-5 and C-6, connected in parallel, are the final elements in the filter. M-2 indicates the output plate supply voltage which is applied through E-1 to the multiplex equipment units.

*(c)* The input to T-6 is controlled by S-3, the plate control switch, and also by contacts in time-delay relay unit, K-1. The input circuit is fused by F-5, which is rated at two amperes, and paralleled by indicator alarm fuses F-3 and F-4, each rated at 0.5 ampere. An overload which will cause F-5 to blow will also cause F-3 and F-4 to blow. The springs on F-3 and F-4 will then close their respective external circuits to indicator lamp I-3, type NE51, and alarm buzzer I-4.

(6) THE TIME-DELAY RELAY CIRCUITS.
*(See figure 2-73.)*

When filament supply switch S-2 is closed, it applies power through rectifier heater transformer T-5 to the filaments of V-1 to V-4, and also to a heater transformer in time-delay relay unit K-1. The secondary of this transformer provides heating current to a bimetallic element. As the element heats, it bends; and after a time interval of 30 to 40 seconds it closes the contacts shown closest to the element in the diagram. This closes the output circuit for V-1 and V-2. At the end of about another ten seconds, contacts 1 and 3 close, completing the primary circuit for plate supply transformer T-6, provided plate supply switch S-3 is also closed. The appearance of the 230 volt d-c plate supply potential causes the relay coil in K-1 to be energized through R-1. This locks up the relay. Closure of contacts 4 and 5 then opens the bimetallic heater primary circuit at the contact normal to contact 5. K-1 remains locked up until the power is shut off at S-3, S-2, or S-1, or fails. Subsequent reclosing of the input circuits will restart the time-delay cycle.

*b.* OSCILLOSCOPE OS-11/FGC-5
*(Figures 7-51 and 7-62 or 7-63)*

(1) GENERAL DESCRIPTION OF CIRCUITS.
*(See figure 2-74)*

*(a)* The general circuits comprising the Oscilloscope unit are the vertical and horizontal deflection amplifier channels for the cathode ray tube, the linear time base oscillator, the converter oscillator calibration channel, the sweep synchronizing circuits, and the rectifiers for supplying plate and bias potentials.

*(b)* The vertical and horizontal amplifier channels are quite similar. Each consists of an input attenuating network and ATTENUATOR selection switch, an input amplifier tube with an active and a stabilizing section, an impedance transforming and decoupling tube, and an output amplifier tube. The output amplifier tube provides push-pull output signals to the appropriate deflecting plates in the cathode ray display tube. A GAIN control in each channel permits various degrees of signal amplification. Other controls marked V POS and H POS set the vertical and horizontal quiescent positions of the indicator tube beam trace. The vertical amplifier input signal is selected by the monitor switch in the Control-Monitor unit of the Telegraph Group with which the Oscilloscope is associated. These signals are applied to the Oscilloscope through a coaxial cable.

*(c)* A FUNCTION control switch operable to six positions is provided. In the first four positions of this switch, the output of the linear time base oscillator is applied to the horizontal amplifier channel, bypassing the attenuator switch. In the last two positions of the function switch, the horizontal channel input circuit is extended through the attenuator switch to a pin jack on the panel. External signals may then be picked up through the latter jack. Other functions of the switch will be described later.

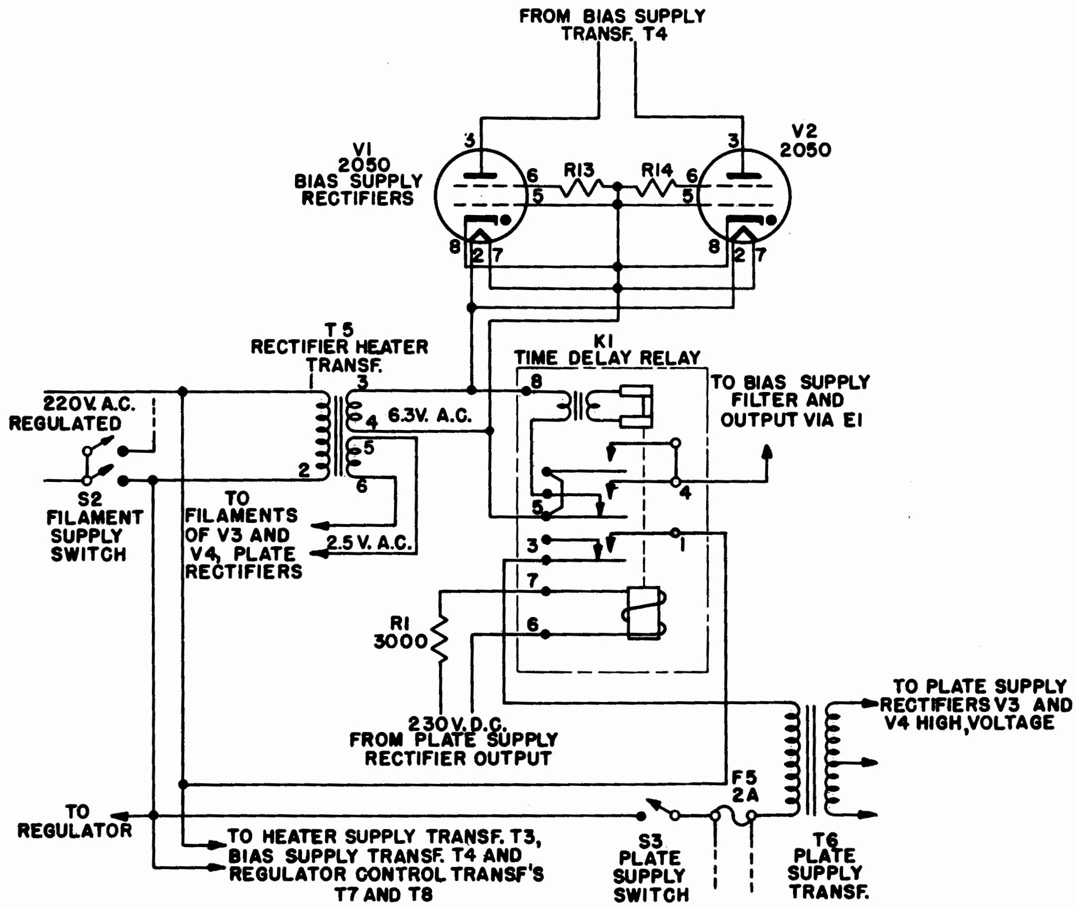


*Figure 2–73. Power Supply PP–484/FGC–5, Schematic Diagram of Time-Delay Circuits*

*(d)* The linear time base oscillator circuit consists of a blanking amplifier, a pulse amplifier, and an impedance transforming tube. These three tubes form a regenerative loop circuit which may be operated in two different manners, periodic or aperiodic. By means of a SWEEP control switch, the selection of either type of oscillation is made possible. In the periodic or REPETITIVE sweep condition, the circuit is a cathode-coupled multivibrator with two unstable operating conditions; one of very short duration, and the other of a variable controlled duration. During the short period, a timing capacitor is discharged through the blanking amplifier tube. During the extended period, the capacitor is recharged through a variable resistance network. By means of a sweep RANGE switch, various capacitance values may be selected to provide four ranges of operation between five cycles and 50 kilocycles per second. A potentiometer in the resistance network permits precise FREQUENCY control.

*(e)* In the aperiodic or TRIGGERED sweep condition, the circuit becomes a univibrator with the pulse amplifier tube biased so that the circuit comes to rest after each cycle of operation. A positive triggering impulse must be inverted and amplified by a synchronizing amplifier circuit, and then applied to the sweep circuit to start each operating cycle. A SYNC gain control provides means for adjusting the synchronizing signal amplitude. In the quiescent condition, the indicator tube beam is in a position to begin sweeping the instant that the triggering impulse is applied.

*(f)* The synchronizing amplifier is also operative when repetitive sweep is used. A periodic negative input impulse or signal transient applied to the amplifier then causes the multivibrator to recycle provided the signal is applied near the end of the natural sweeping period. A positive synchronizing signal transient or smooth wave will delay the recycling. In either event, synchronization with the external signal will be accomplished. Synchronizing signals are obtained from four sources: first, the normal signal applied by one section of the vertical output amplifier to the display tube (—); second, the inverted signal applied by the other section of the vertical output amplifier to the display tube (+); third, power line frequency potential obtained from the heater winding on the power transformer (LINE); and fourth, an ex-

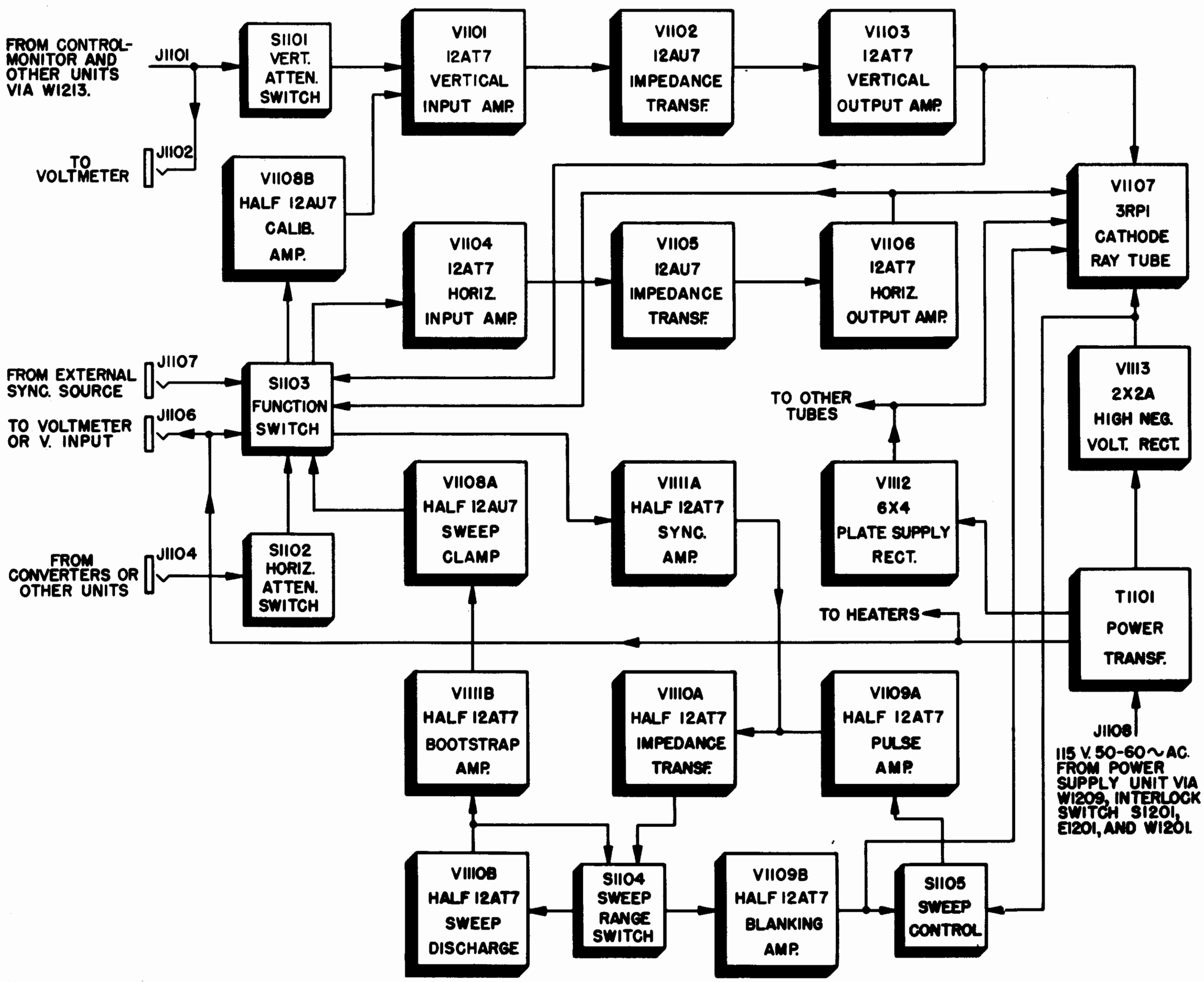


***Figure 2-74. Oscilloscope OS-11/FGC-5, Functional Block Diagram***

ternally applied signal received through a separate pin jack (EXT).

*(g)* When the time-base oscillator starts a sweep cycle, another timing capacitor begins charging through a second variable resistance network. The charging rate is held constant through use of a feedback "bootstrap" amplifier which linearizes the sweep. At the end of the cycle, the timing capacitors are discharged through a sweep discharge tube in preparation for the next sweep period. The sweep range switch also selects various capacitance values for this circuit. A potentiometer, which is mechanically coupled to the FREQUENCY control in the sweep timing network, provides the appropriate charging resistance for the sweep frequency used. The output of the bootstrap amplifier is passed by a clamping tube to the input of the horizontal amplifier channel. Clamping causes the sweep wave to always start at the same potential, so that the cathode ray tube beam always starts moving from the same position at the left side of the tube face, regardless of sweep frequency, aperiodic timing, or the amplitude of sweep. Sweep is always from left to right, and the beam return trace is blanked out.

*(h)* In the fifth position of the FUNCTION switch (H AMP), separate potential waves may be applied to the horizontal and vertical signal input amplifiers, to thereby obtain lissajou figures. Such patterns are useful, for example, in testing the step-down ratios of the frequency divider stages in the Signal Distributor Drive units.

*(i)* In the sixth position of the FUNCTION switch (CAL), the input signal to the horizontal input amplifier is also applied to a calibration amplifier circuit. The circuit amplifies the input signal, shifts its phase, and then applies it to the stabilizing section of

the vertical input amplifier tube. Any sine wave signal applied to the horizontal input circuit will then produce an elliptical pattern on the face of the display tube. Normally, this input signal is obtained from a continuously running oscillator in one of the Converter units. The frequency of this signal is not precisely known, but must be adjusted to exactly 45 or 56.25 cycles for optimum operation at 60 or 75 w.p.m., respectively. If the calibrating frequency of 450 or 562.5 cycles obtained from the crystal controlled oscillator-frequency divider circuits in the Drive unit is then applied to the normal vertical input amplifier circuit, the elliptical pattern will show the higher frequency superimposed upon it. This pattern will contain exactly ten small positive impulses and will be stationary only if the frequency to be calibrated is exactly correct. If the Converter oscillator is slow, the pattern will rotate counterclockwise; if it is fast, the rotation will be clockwise; and if it is very far from the correct frequency, more or less than ten impulses will be seen. The oscillator frequency control in the Converter unit must be adjusted to bring about the stationary pattern.

*(j)* The power supply circuits include a positive plate supply rectifier with filter and a high voltage negative supply rectifier with filter. Various potentiometers in a negative potential divider network permit control of the cathode ray tube BEAM intensity and FOCUS, and set the threshold sensitivity of the triggered sweep circuit. A POWER control switch and pilot lamp are provided in the panel of the unit.

(2) THE VERTICAL AND HORIZONTAL AMPLIFIER CIRCUITS.

*(See figures 2-75 and 7-51)*

*(a)* Since the two amplifier channels are practically identical, a description of one should be sufficient. An explanation of differences will be given when they are encountered. The inputs to the vertical and horizontal amplifier are directed through jacks J-1101 and J-1104 respectively to attenuator switches S-1101 and S-1102. J-1102, which is attached in parallel with J-1101, provides external connection to the vertical channel. It, however, is not generally used because of the danger of crossing up the circuit which is normally applied through J-1101. Such connections should be made through the external jack on the Control-Monitor unit. J-1102 is useful as a voltmeter connecting point for measuring potentials of the various multiplex circuits. Each attenuator switch is adjustable to five positions to provide for signals with either or both a-c or d-c components. In the LOW AC position, a blocking capacitor couples the input to the gain potentiometer for the channel. In the HIGH AC position, an attenuating network of two more capacitors and one resistor is provided. One of these capacitors is variable for control of high frequency compensation. In the OFF position, the amplifier input is grounded. In the HIGH DC and LOW DC positions, the connections are similar to the corresponding a-c positions, except that the blocking capacitor is shorted out. The horizontal amplifier channel input is coupled to the input attenuator only when function switch

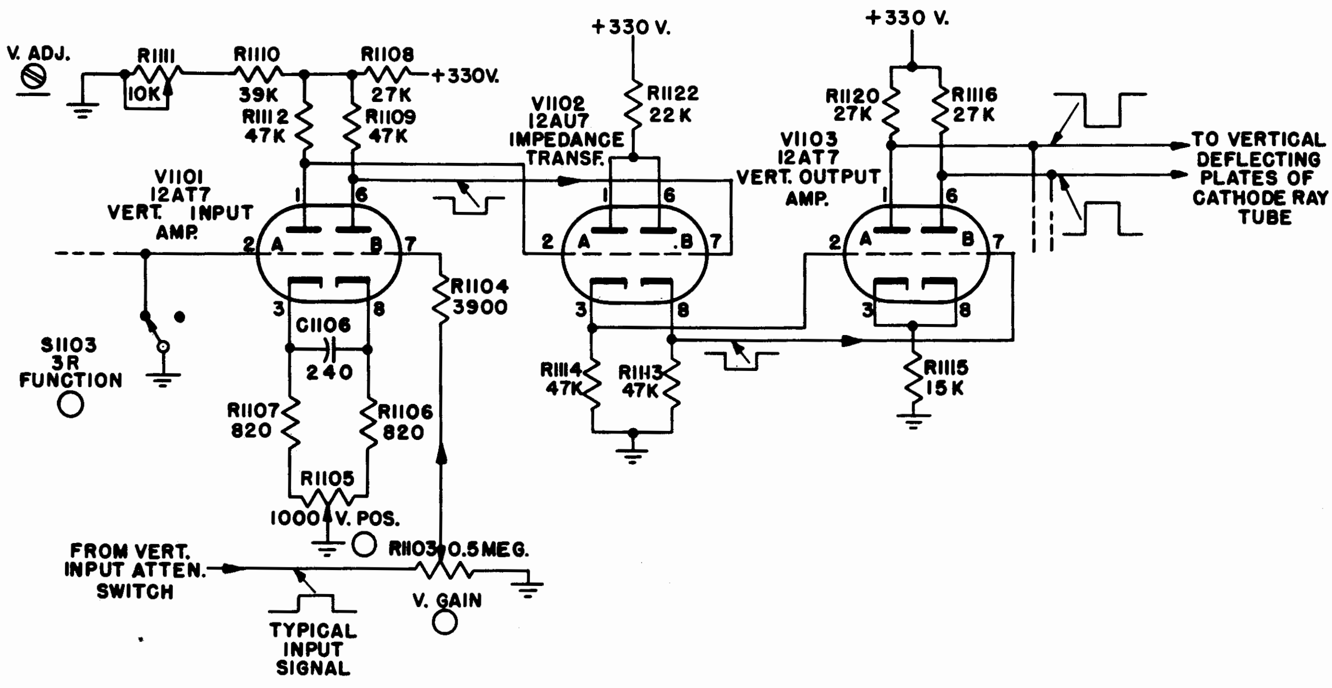


*Figure 2–75. Oscilloscope OS–11/FGC–5, Schematic Diagram of Vertical Amplifier Circuits*

S-1103 is in the horizontal input or calibration input positions. When S-1103 is manipulated to other positions, the channel is connected to the output of the time base oscillator circuit.

*(b)* Considering the vertical channel, figure 2-75, the input signal is applied through gain control R-1103 to input grid 7 of the B section of V-1101, the vertical input amplifier tube, type 12AT7. R-1104 in the grid circuit suppresses possible oscillatory action in this stage. V-1101B operates as a cathode biased amplifier, with cathode circuit resistors R-1105 and R-1106 determining the operating level. R-1105, the vertical position control, varies the operating levels of the two tube sections in opposite directions and produces corresponding changes in the quiescent vertical position of the electron beam in the cathode ray tube. C-1106 provides increased high frequency response in the circuit. The grid of V-1101A is grounded through S-1103, except when the latter is in the calibration position, and therefore, this section is usually inactive with respect to the vertical input signal. However, the presence of V-1101A causes the amplifier to be inherently stable, since plate supply potential variations are neutralized in the output amplifier circuits that are driven by the two sections of V-1101. V-1104, the horizontal input amplifier tube, has its A section grid permanently grounded.

*(c)* The output of V-1101B, developed across R-1109, is coupled directly to the grid of section B of V-1102, type 12AU7, the impedance transformer and isolation stage. The operating bias level for V-1102 is determined by the V-1101 plate supply dividing network which consists of R-1108, R-1110, and R-1111. The last named component is a potentiometer which allows adjustment of the bias level. Both sections of V-1102 operate as cathode followers, V-1102A being a stabilizer for the amplifier channel.

*(d)* The output of V-1102B is applied from load resistor R-1113 directly to the grid of section B of V-1103, type 12AT7, the vertical output amplifier. The latter tube operates as a cathode-coupled phase inverter to provide push-pull output directly to the vertical deflecting plates of the type 3RP1 cathode ray display tube, V-1107.

*(e)* When S-1103 is in the calibration position, the ground will be lifted from grid 2 of V-1101A. A signal may then be applied to the grid. This signal will be amplified in the A sections of V-1101, V-1102 and V-1103 in a manner similar to the action which takes place in the B sections of the same tubes. If separate signals are applied to both amplifying circuits simultaneously, they will be mixed in the output amplifier stage. See paragraph (4), following.

*(f)* The output signals from the two sections of V-1103 are applied through dividing networks to input terminals of S-1103 for use in synchronizing the sweep circuit with "+" or "−" vertical signal transitions. These networks are frequency compensated by very small capacitors.

(3) THE LINEAR TIME BASE OSCILLATOR. *(See figures 2-76, 2-77 and 7-51)*

*(a)* In the periodic or repetitive sweep position, S-1105 connects the grid of the pulse amplifier tube, section A of V-1109, type 12AT7, to a positive potential divider. R-1152, in the dividing network, controls the degree of tube conduction during the sweep period. The output of V-1109A is directly coupled to the grid of an impedance transformer, V-1110A, type 12AT7. The latter is a cathode follower which applies a low potential to the frequency-determining capacitor that is selected by range switch, S-1104. This capacitor, C-1120, C-1121, C-1122, or C-1123 and C-1124 (paralleled) is driven negative at the beginning of each sweep and then charges through R-1160 and R-1161A in a positive direction during the sweep time. The negative potential biases V-1109B and V-1110B beyond cut-off during the sweep period. V-1109B is the blanking amplifier, and V-1110B is the sweep discharge tube. Both tubes have a common cathode coupling circuit with V-1109A through R-1155. Conduction through V-1109A thus also applies some cathode bias to V-1109B and V-1110B.

*(b)* When the timing capacitor is nearly charged, V-1109B and V-1110B begin to conduct, thereby increasing the potential drop in R-1155. This causes V-1109A to cut off slightly and pass a positive potential to V-1110A and the timing capacitor. The grids of V-1109B and V-1110B accordingly are made more positive and the tubes conduct more. The circuit is regenerative and V-1109A is quickly driven beyond cut-off. The large potential drop in R-1155 lasts only as long as the sweep timing capacitor is being discharged through the well positive grids of V-1109B and V-1110B. At the same time, a sweep linearity capacitor, which is in the anode circuit of V-1110B, is also being discharged through that tube, and contributing to the current in R-1155. When this current falls to the point that V-1109A again begins conduction, the regenerative circuit causes a reverse operation by which V-1109B and V-1110B are quickly cut off. V-1109A then fully conducts. The cathode potential of V-1110A falls to normal; and in so doing it drives the timing capacitor in the negative direction, and causes the grids of V-1109B and V-1110B to receive well negative potentials. The capacitor then recharges during the next sweep period.

*(c)* As just noted, V-1110B discharges the sweep linearity capacitor before each sweep. Range switch S-1104 selects the appropriate capacitor from among C-1125 and C-1126 (paralleled), C-1127,

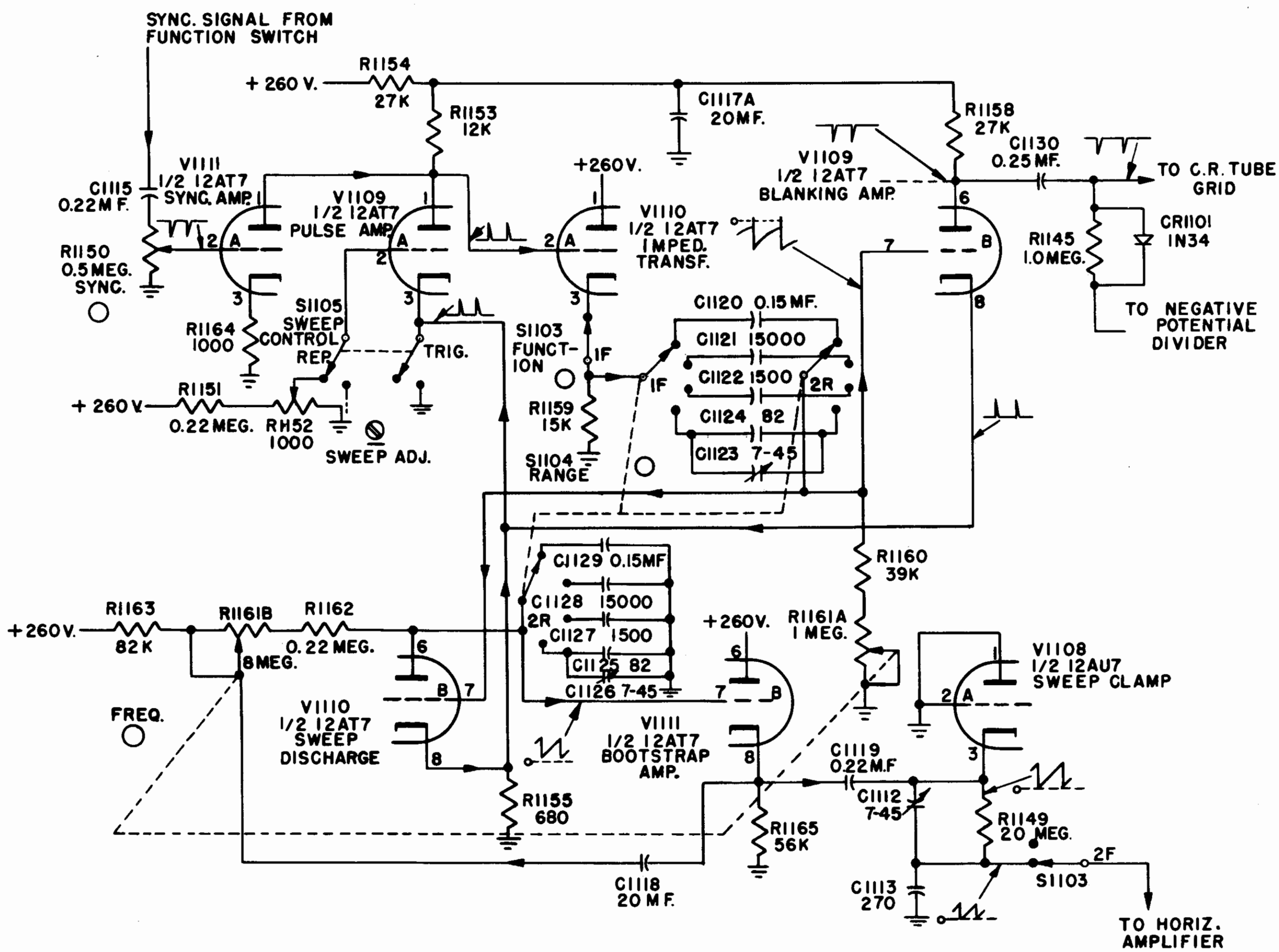


*Figure 2–76. Oscilloscope OS–11/FGC–5,*
***Schematic Diagram of Horizontal Linear Time Base Oscillator, Repetitive Sweep***

C-1128, or C-1129. The other terminal of each capacitor is grounded. During the sweep period, the selected capacitor charges through R-1162, R-1163, and R-1161B from positive battery. The instantaneous charging potential is applied to the grid of the bootstrap amplifier V-1111B, type 12AT7. This triode is a cathode follower with load resistor R-1165. Its cathode potential is fed back through C-1118 to R-1161B, and provides a nearly constant potential drop in R-1161B and R-1162 during the sweep time. The resultant constant charging rate for the linearity capacitor gives a linear sweep to the cathode ray tube beam. The output of V-1111B is applied through a network composed of C-1119, C-1112, R-1149, and C-1113 to the input gain control of V-1104. C-1112 provides adjustment of the linearity. The sweep clamp tube, section A of V-1108, type 12AU7, provides stabilization of the output d-c level. It is connected as a diode with the anode grounded. During the sweep, it presents a high impedance to the output circuit; but during the sweep return, it discharges C-1119 if the potential of the latter overshoots ground level. This causes the sweep to always start off from a fixed potential position.

(*d*) If a synchronizing signal is applied from S-1103 through C-1115 and R-1150 to the grid of the synchronizing amplifier V-1111A, the sweep timing may be controlled. V-1111A is connected as a normal cathode biased amplifier with its anode connected to R-1153, the load resistor for V-1109A. A periodic negative input transient or impulse will tend to cut off V-1111A and cause the common anode potential to rise. A positive potential transient will then be fed through V-1110A and the timing capacitor to the grids of V-1109B and V-1110B and cause the latter to begin conduction if the sweep period is almost ended. This will trigger the sweep oscillator into a new cycle. A positive input signal will extend the natural sweep period and delay the natural relaxation of the circuit.

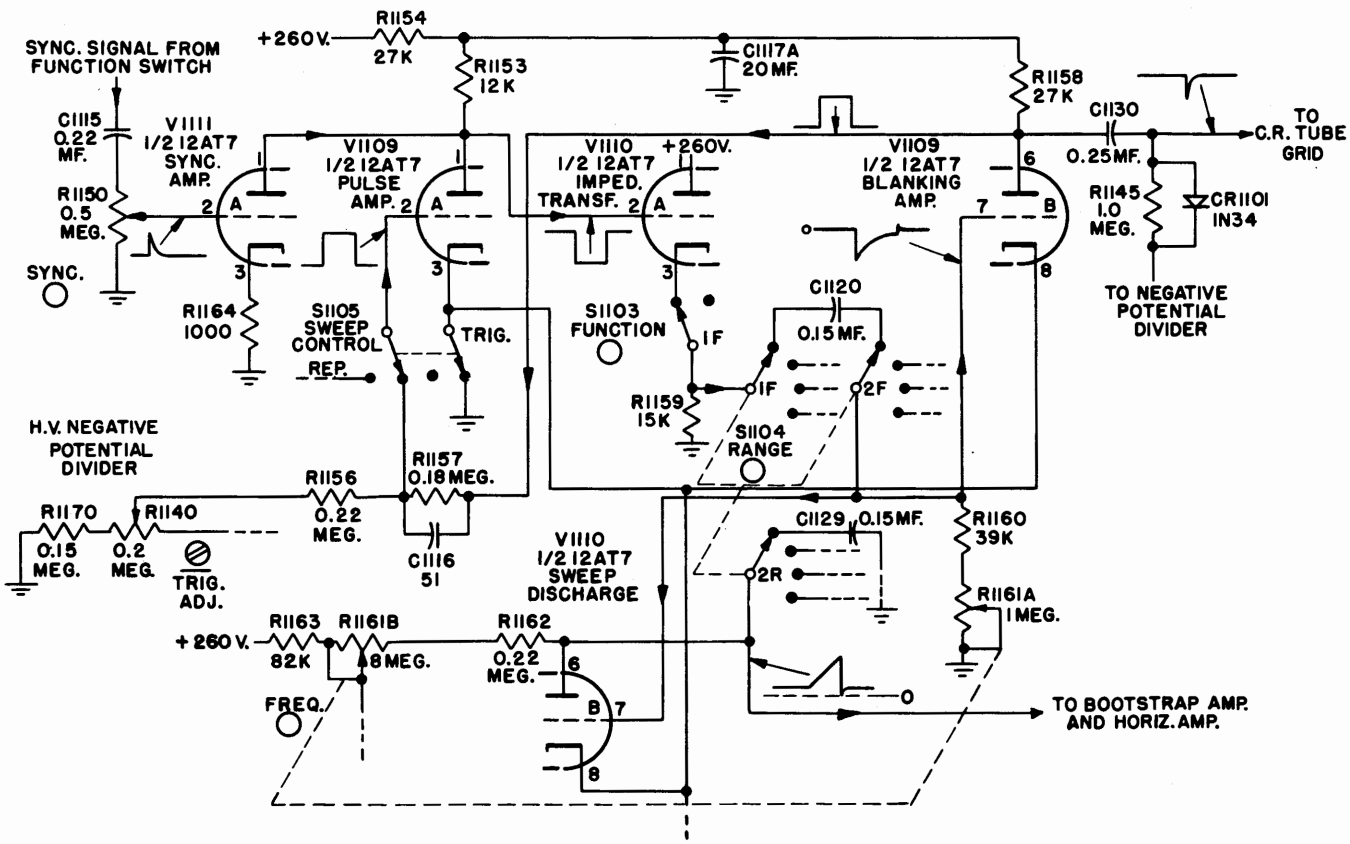


***Figure 2–77. Oscilloscope OS–11/FGC–5, Schematic Diagram of Horizontal Linear Time Base Oscillator, Triggered Sweep***

(*e*) When S-1105 is manipulated to the triggered sweep position, cathode coupling resistor R-1155 is shorted out, while grid 2 of V-1109A receives negative bias through R-1156 from the triggering level adjusting potentiometer, R-1140, in the negative potential divider circuit. Grid 2 connects through R-1157 and C-1116 to the anode of V-1109B. This connection provides the regenerative circuit since R-1155 is now inactive. In the idle circuit condition, V-1109A will be cut off, V-1110A will have a high positive cathode potential, and V-1109B and V-1110B will be conducting. Both the timing and linearity capacitors will be discharged and the cathode ray beam will be restricted to vertical movement at the left side of the indicator tube. A positive synchronizing signal impulse applied to grid 2 of V-1111A will cause the latter tube to conduct more through R-1153. The grid 2 potential of V-1110A will fall and cause a negative potential transient to be applied by the timing capacitor to the grids of V-1109B and V-1110B. As V-1109B cuts off, its anode potential rises and passes a positive potential excursion through R-1157 and C-1116 to grid 2 of V-1109A. If this impulse overcomes the negative grid bias, V-1109A will conduct and cause the grid potential of V-1110A to fall even more. Once the circuit is excited, it will function until V1109A is fully conducting and until V-1109B and V1110B are driven well beyond cut-off, even though the triggering impulse is removed. The timing and linearity capacitors then begin to charge through their respective networks with the latter capacitor producing a linear sweep. At the end of the sweep period, V-1109B begins conducting and passes a negative potential back to the grid of V-1109A. The regenerative circuit then operates in reverse to cut off V-1109A while V-1109B and V-1110B are made fully conducting. The timing and linearity capacitors are discharged through the tubes. The display tube beam then returns to its starting position in preparation for another cycle. The clamp tube operation is most effective at this time, especially with randomly timed synchronizing impulses triggering the circuit.

(*f*) Each time that V-1109B conducts during the sweep return period in either repetitive or triggered sweep operation, a negative impulse is passed through C-1130 to the control grid of V-1107. This causes the indicator tube beam return trace to be blanked out. When V-1109B cuts off, the positive impulse applied through C-1130 is bypassed through CR-1101, thus preventing brightening or blooming of the trace.

(4) THE CALIBRATION CIRCUIT.
*(See figure 2-78)*

With S-1103 in the CALIBRATE position and S-1102 in either of the two HIGH positions, the Converter oscillator signal may be connected to J-1104. This signal will be applied through R-1124 to the horizontal amplifier channel in the normal manner, and consequently will produce a horizontal-beam motion in V-1107. The same input signal is amplified and inverted in the calibration amplifier tube, V-1108B, and applied through phase shift network C-1109 and R-1171 to grid 2 of V-1101A. The A section of V-1101, which was previously inactive with respect to vertical input signals, now functions as a normal amplifier and drives the vertical amplifier channel. The calibrating frequency is applied in the normal manner through J-1101 and R-1103 to grid 7 of V-1101B. As a consequence, a low frequency elliptical pattern is produced, with the calibrating frequency superimposed upon it along the vertical axis. R-1102 and C-1135, used in the anode circuit of V-1108B, are of the proper values to filter out power supply or other spurious low frequencies which might interfere with the signal that is being calibrated.

(5) POWER CIRCUITS.
*(See figure 7-51 and 7-62 or 7-63)*

Operating power is obtained from the common power supply at connector J-1108. The 115 volt a-c input is separately switched in the Power unit and controlled by safety interlock switch S-1201 on the

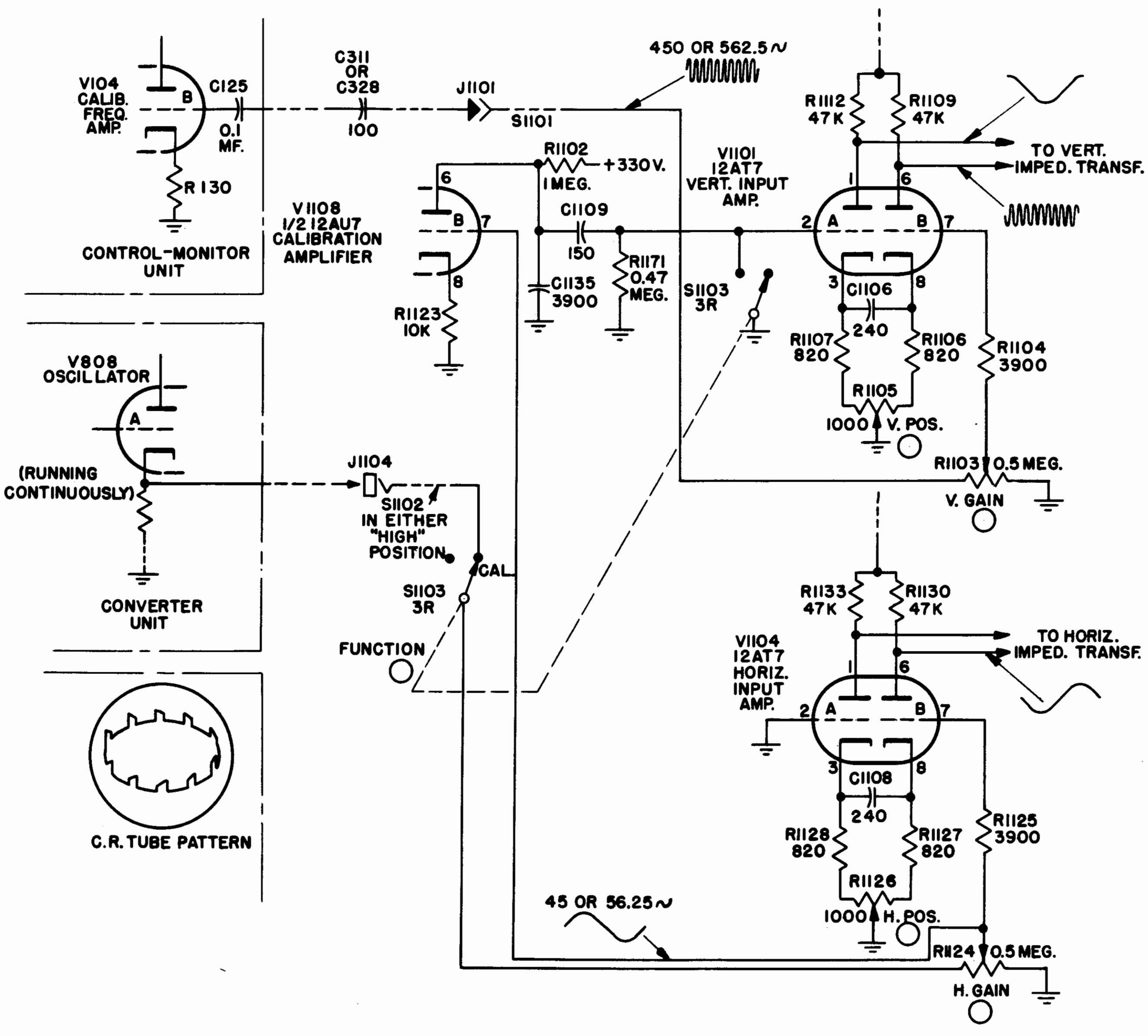


*Figure 2-78. Oscilloscope OS-11/FGC-5, Schematic Diagram of Calibration Amplifier Circuits*

drawer assembly. This input power is filtered, fused and further controlled by switch S-1106. Transformer T-1101 supplies the various potentials required for tube heaters and rectifiers. Pilot light I-1101 is connected to the heater circuit and lights whenever the power switch is turned on. V-1112, type 6X4, is a full-wave rectifier for the plate supply potential, while V-1113 type 2X2A, is a half-wave rectifier for the negative high voltage supply. Dropping resistor R-1166 and filter capacitor C-1117B provide +260 plate voltage from the filtered +330 volt output. A positive potential divider consisting of R-1172 and R-1139 is used to control the second anode potential of V-1107. The negative potential divider network consists of beam intensity control R-1144, R-1142, beam focusing control R-1141, aperiodic trigger circuit control R-1140 and R-1170.

(*c*) Contact gaps should be .006 inch to .012 inch for the MAKE contacts in the unoperated position. The gap for the BREAK contacts should be .010 inch to .020 inch in the operated position. These gaps may be set by bending the springs with pliers or spring bender, and should be rechecked after the proper time delay periods have been obtained.

**Note**

Sometimes if too much spring tension is applied while adjusting the contact gaps, the second time delay may be too long even after adjusting the armature air gap. To remedy this, decrease tension on all springs by bending downward.

*m*. OSCILLOSCOPE OS-11/FGC-5 ADJUSTMENTS.

(1) AMPLIFIER ADJUSTMENT.

The procedure for alignment of the horizontal and vertical amplifier channels is as follows:

| *Control* | *Position* |
|---|---|
| POWER Switch | Toggle down (off) |
| V. and H. POS. | Straight up |
| BEAM and FOCUS | 75% Clockwise |
| V. and H. ATT. | OFF (straight up) |
| V. and H. GAIN | Minimum (extreme CCW) |
| FREQ. | Minimum (extreme CCW) |
| RANGE | 500-5K |
| SYNC. | Minimum (extreme CCW) |
| FUNCTION | H. AMP. |
| SWEEP | REP. |

(*a*) By means of a clip lead, short terminals 2 & 7 of socket XV-1103. With the controls in the aforementioned position, 115 V. 60 cycle line power is applied when the switch is moved to the POWER ON position. Now adjust the V. ADJ, control, R-1111, located on the rear of the chassis, such that the voltage on terminals 1 & 6 of XV-1103 is between 225 and 230 volts. De-energize the unit, remove the clip lead and re-energize the unit. Note that the spot swings off the screen in both directions (up and down) by means of the V. POS. control. It is to be noted that the spot will move upward when the control is rotated clockwise. The three stage vertical amplifier channel has now been properly aligned.

(*b*) Remove power, and short-circuit terminals 2 and 7 of socket XV-1106. Apply power and adjust the H. ADJ. control, R-1132, located on the rear of the chassis, such that the voltage on terminals 1 and 6 of XV-1106 is between 225 and 230 volts. Cut off the power, remove the jumper and reapply power. Note that the spot swings off the screen in both directions (left and right) by means of the H. POS. control. It is to be noted that the spot will move to the right when the control is rotated clockwise. The three stage horizontal amplifier channel has now been aligned.

(*c*) Adjust the SEC. ANODE ADJ, R-1139, such that the voltage on terminal 2 (center-arm) of this control, located on the rear of the chassis, is between 225 and 230 V.

(*d*) The spot should now be approximately in the center of the screen with the V. and H. POS. controls pointed straight up. Any wide variance may be due to magnetization of the tube shield assembly which can be eliminated by the application of a strong AC electromagnetic field. If the spot is far from center and demagnetizing the tube shield has no effect, replace any tube in the amplifier circuits, which when removed, causes the spot to return to center. Repeat the amplifier adjustments if a tube is replaced.

(2) ATTENUATOR ADJUSTMENT.

(*a*) If any component associated with the vertical attenuator, V ATT circuit is changed, the following procedure is to be followed. Apply the square wave signal from terminal 5 of XV-106 in either Signal Distributor Drive unit to the vertical input of the Oscilloscope by means of a test lead. With power applied to the Oscilloscope, switch the V ATT switch to the AC HIGH position and the FUNCTION switch to the INT. + position. Set the various controls for two cycles of the square wave. Adjust C-1102, located behind the front panel on the V ATT switch, for the most square wave form. The adjustment is correct when the vertical transition lines between the upper and lower levels of the square wave are of minimum intensity.

(*b*) The adjustment procedure for the horizontal attenuator H ATT is practically the same as described in paragraph (a) above. Apply the square wave signal from terminal 5 of XV-106 in the Signal Distributor Drive unit to the horizontal input of the Oscilloscope by means of a test lead. Turn the H ATT switch to the AC HIGH position, and the FUNCTION switch to the H AMP position. Apply power to the Oscilloscope. Supply a sawtooth wave form from the junction of C-1113 and C-1112 in the Oscilloscope of the companion Group to the vertical input of the Oscilloscope under test, by using a test lead. Capacitors C-1113 and C-1112 are located on the FUNCTION switch behind the front panel. Set the frequency controls on the supplementary Oscilloscope to obtain two cycles of the signal waveform and adjust C-1114, located on the front panel H ATT switch, for the most square wave form. Note that the horizontal transition lines between the right and left hand limits of the square wave are of minimum intensity.

(3) LOCAL BATTERY OUTPUT CONTROL.

Measure the potential between ground and pin eight of XV-317 or XV-318 with a voltmeter and adjust the control for +115 volts as read on the voltmeter.

(4) KEYER OUTPUT CONTROLS.

The "+" and "−" KEYER OUTPUT controls are adjusted for +90 volts output from the keyer tube V-312, cathodes. Connect a voltmeter to the vertical input jack of the Oscilloscope and turn the MONITOR switch on the Control-Monitor panel to position six. Transmit a-c reversals on the local system and adjust the "+" control for +45 volts. Repeat the adjustment for the "−" control with the MONITOR switch in position seven.

(5) SIGNAL PIP BALANCE CONTROL.

Attach the Oscilloscope lead to the junction of C-324 and a shielded lead on terminal board TB-304. The SIGNAL PIP BALANCE control should then be adjusted so that all of the input impulses have approximately the same height as judged by eye. The adjustment has control over alternate pips, the others being fixed in amplitude.

*k.* POWER SUPPLY PP-484/FGC-5 ADJUSTMENTS.

(1) LINE VOLTAGE TAPS.

*(a)* Connect the white flexible lead to the tap on E-2 which most nearly corresponds to the supply voltage (105–250 volts).

(2) FILAMENT AND BIAS TAP ADJUSTMENT.

*(a)* With the PLATE potentiometer set for a plate voltage of approximately 225 volts, the filament voltage is set to 6.3 volts by proper positioning of the flexible slate wire on E-2. The bias voltage is set to approximately 115 volts by positioning the flexible green wire on E-2. The taps marked 6.0/6.3/6.6 cause a five per cent change in the bias voltage, while those marked 1/2/3 cause a two per cent change in the bias voltage.

*(b)* The filament and bias taps are set at the factory for 6.3 and 115 volts respectively, and no further tap adjustment should be needed unless some component is replaced.

(3) PLATE CONTROL ADJUSTMENT (FRONT PANEL).

*(a)* The potentiometer labeled PLATE, controls the regulated a-c voltage. Thus, a change in the potentiometer setting causes a corresponding change in the filament, bias and plate supply voltages. The PLATE control adjustment is normally correct when the bias voltage is exactly 115 volts. The plate voltage will then be between 225 and 228 volts, and the filament voltage will be 6.3 volts if the tap adjustments are correct.

(4) THERMISTOR CURRENT ADJUSTMENT.

*(a)* The current through the thermistor R-17 is set to 25 a-c rms. milliamperes. Adjustment is provided by the taps on resistors R-2 and R-3 located under the chassis in the rear.

*(b)* This adjustment is made at the factory and should not require readjustment unless the thermistor is replaced.

(5) TIME DELAY RELAY.

*(a)* Adjust screw on tie bar to obtain a time delay of 30 to 40 seconds from the instant of closing the FILAMENT switch until the BIAS supply meter first indicates a voltage. This adjustment should be made with the bimetal strips at room temperature. Refer to Figure 7-41.

*(b)* As the bimetal continues to heat, following the adjustment of paragraph (a), the MAKE spring contacts of the relay should close in an additional 5 to 15 seconds, applying the PLATE battery to the output circuits. If this interval is too long, bend the armature backstop downward to close the gap between armature and pole piece. If the period is too short, bend the stop upward. Bending of the stop may be accomplished by means of long nose or duck bill pliers. For bending the stop upward, a screw driver may be used.

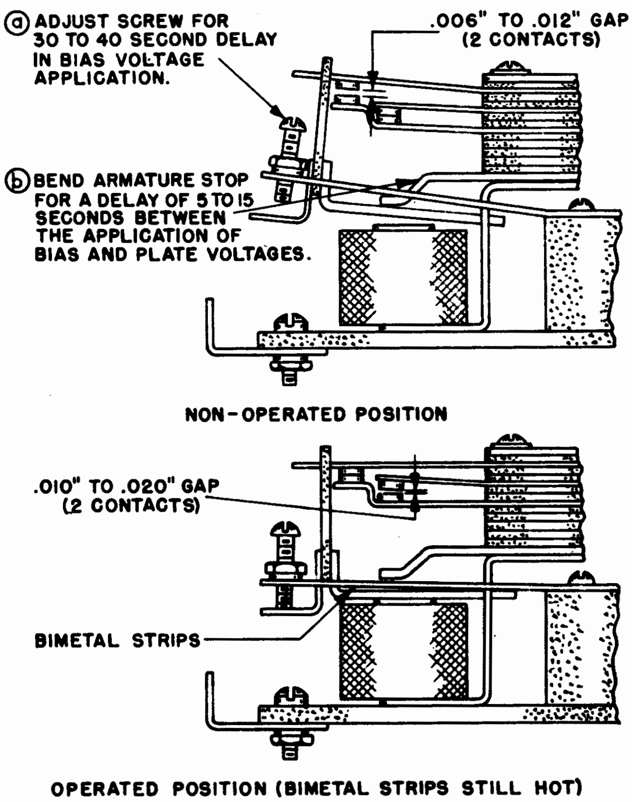


*Figure 7-41. Time Delay Relay*

(3) SWEEP ADJUSTMENT.

*(a)* The linearity of the sweep may be checked and corrected by the following procedure: Connect the vertical input of the Oscilloscope to the junction of the blue-white lead and C-106 on TB-102 in either Signal Distributor Drive unit. Use a test lead isolated at the probe end by a one megohm resistor. Set the RANGE switch to the 500-5K position, the FUNCTION switch in the INT position, and the SWEEP switch in the REP position. Adjust the FREQ control for viewing approximately 10 cycles of the signal with the H GAIN control set for a sweep length of approximately two inches. Adjust C-1112, located on the FUNCTION switch, for optimum linearity.

**Note**

An insulated screwdriver, such as used for alignment of radio receivers is necessary for the proper adjustment of C-1112.

*(b)* Place a jumper from the TEST binding post J-1106 to the SYNC binding post J-1107. Set the FUNCTION switch to EXT the SWEEP switch in the TRIG position, and the SYNC control to minimum (extreme CCW). Now adjust the TRIG ADJ control R-1140, located on the rear of the chassis to just under the threshold point of trigger. This point should be checked for all combinations of the RANGE and FREQ controls. Next, throw the SWEEP switch to REP and with the SYNC control at minimum, adjust the SWEEP ADJ control R-1152, located on the rear of the chassis, such that the length of the trace is approximately the same as for the trigger condition. If any of the sweep timing or linearity capacitors are replaced, a check of the band coverage as referred to the front panel markings can be made with an audio and an R. F. generator. The 5K-50K band is controlled by C-1123 (sweep timing) and C-1126 (sweep linearity). These trimmers, located on the RANGE switch, S-1104, are not critical in adjustment and therefore are set for band overlap and proper linearity.

(4) BEAM POSITIONING CONTROLS.

If manipulation of the "V POS" and "H POS" controls introduces noise causing the trace to become fuzzy, move each control back and forth several times until the trouble disappears.

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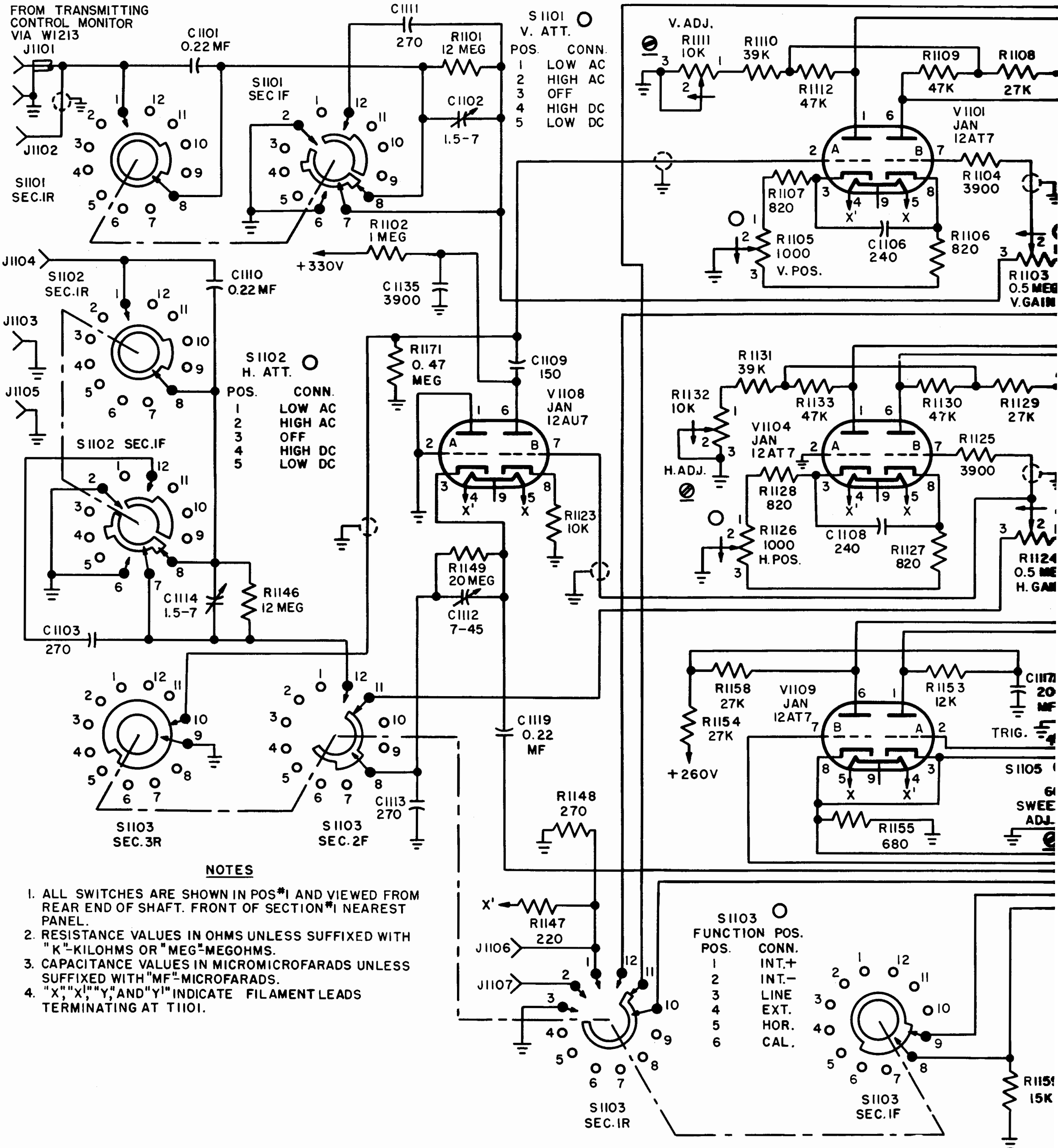


**NOTES**

1. ALL SWITCHES ARE SHOWN IN POS#1 AND VIEWED FROM REAR END OF SHAFT. FRONT OF SECTION#1 NEAREST PANEL.
2. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH "K"-KILOHMS OR "MEG"-MEGOHMS.
3. CAPACITANCE VALUES IN MICROMICROFARADS UNLESS SUFFIXED WITH "MF"-MICROFARADS.
4. "X","X'","Y", AND "Y'" INDICATE FILAMENT LEADS TERMINATING AT T1101.

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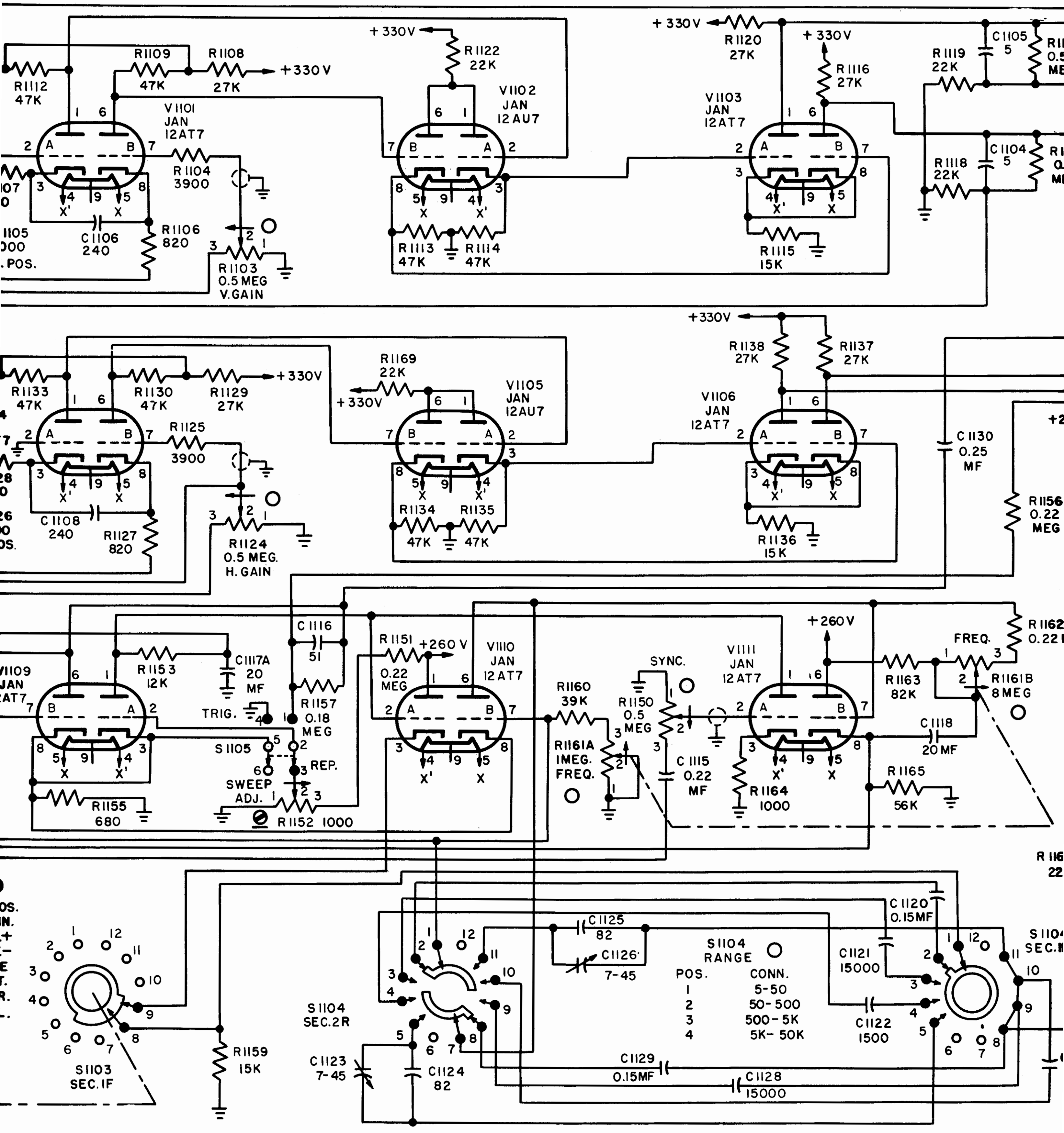

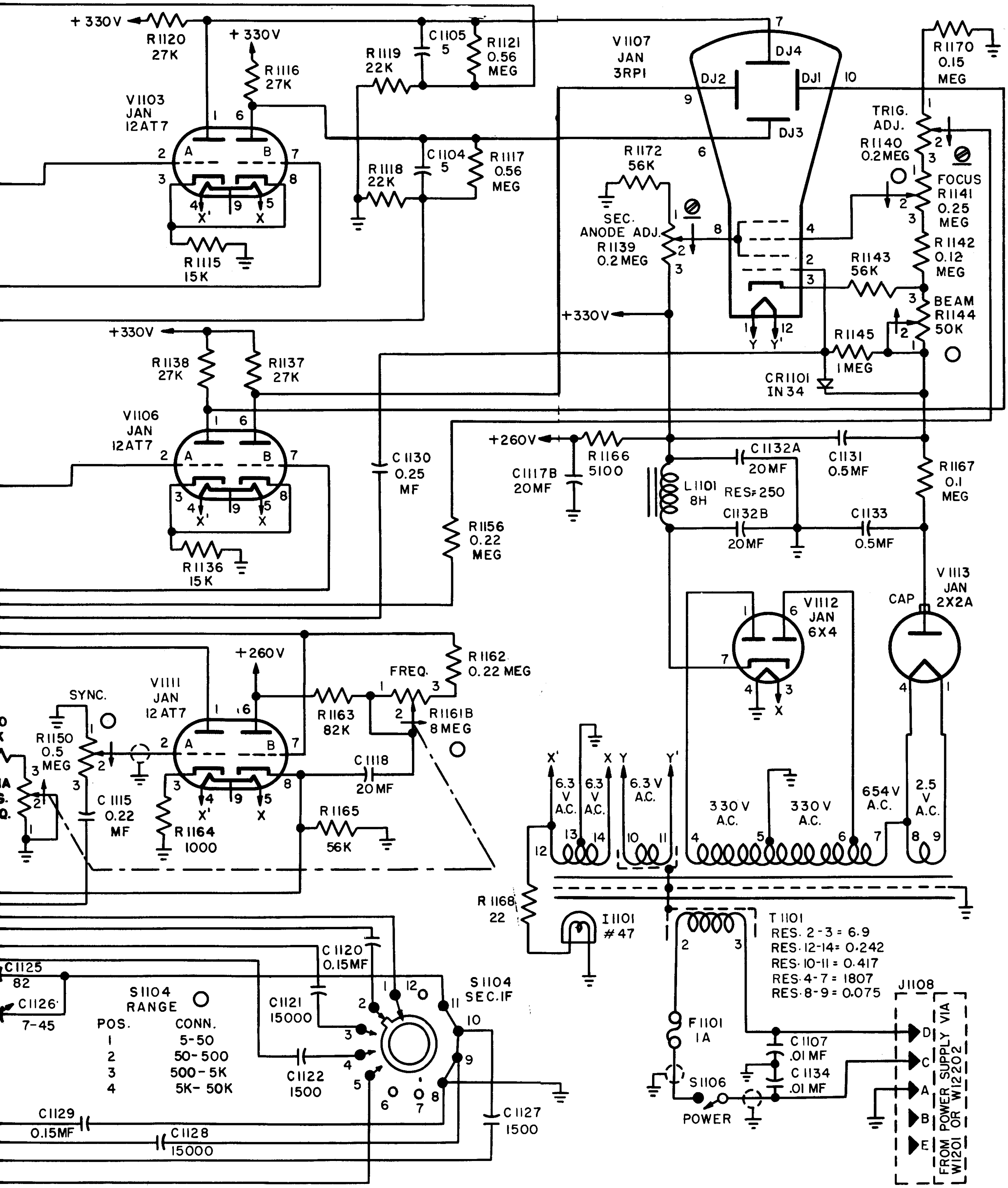


*Figure 7-51. Oscilloscope OS-11/FGC-5, Schematic Diagram*