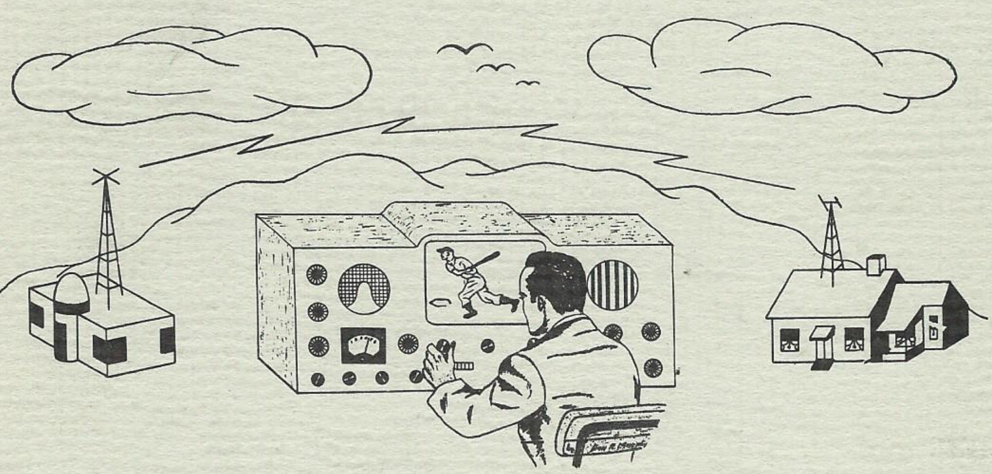
TELEVISION RADIO ELECTRONICS



UNITED TELEVISION LABORATORIES

INCORPORATED

LOUISVILLE, KENTUCKY

ASSIGNMENT 98

THE MONOSCOPE CAMERA CHAIN

ASSIGNMENT 98

THE MONOSCOPE CAMERA CHAIN

A monoscope camera chain is used to generate a standard television test signal. The monoscope camera is not a television camera, in the normal sense of the word, since it contains no lenses and cannot be used to pickup lighted scenes. Instead, this camera chain generates a standard test pattern signal. Figure 1 shows the test pattern generated by a monoscope camera when using one particular type of monoscope tube. It is also possible to obtain special monoscope tubes with any desired pattern, for example, it is possible to get a test pattern with the call letters of a particular station on it. The pattern produced by the monoscope camera is determined entirely by the monoscope tube employed.

When a standard television pattern is desired the monoscope camera excells the normal television cameras employing the Iconoscope or Image Orthicon tube in a number of respects. In the first place a constant image is formed by the monoscope, since the transmitted image is contained within the monoscope tube itself. In other cameras the image changes from time to time depending upon the lighting conditions and the scene televised, whereas in the monoscope a particular scene is available and since no light is necessary for the reproduction of the scene, it will always remain the same. This permits a person using the monoscope signal to become familiar with this test pattern and thereby make accurate comparison of the operation of various types of television equipment.

Another advantage gained through the use of the monoscope camera for obtaining a standard signal is the fact that no external lighting or optical lens arrangements are required. This makes the operation of the camera quite simple. Another advantage of the monoscope camera is that this tube is many times more sensitive than the normal television pick-up tubes, thereby permitting a definite amplitude of output signal from the camera chain with fewer stages of amplification. This simplifies the circuit arrangement.

Monoscope cameras are used for several purposes. In many television broadcasting stations a special monoscope tube is employed which generates a test pattern containing the station call letters. This monoscope camera is then used to generate the signal transmitted during the time that the television station is transmitting a test pattern.

Monoscope cameras are also used very widely in television broadcast stations to provide a standard signal to check the linearity, definition, etc., of the other camera equipment. For example, if the monoscope camera is generating the standard signal with near perfect linearity the circuits of the various monitors can be adjusted to obtain correct linearity. Then the signal from the other cameras can be viewed on the monitor and the necessary linearity adjustments made on these cameras to obtain a correctly proportional scene. If no monoscope camera is used it is rather difficult to determine what should be used in the setup as the standard signal, since all of the cameras and monitors have linearity controls.

Monoscope cameras are used in other places besides television broadcasting stations. For example, practically all large television manufacturers employ monoscope cameras for generating the test signals at their production plants. This test signal may then be used in the final phases of receiver adjustments and final checking. A separate synchronizing generator must, of course, be used in these cases.

Block Diagram of Monoscope Camera Chain

The block diagram of the UTL monoscope camera chain is shown in Figure 2. As indicated in this figure, the video signal is generated in the monoscope tube. The deflection circuit and the high-voltage circuit used with the monoscope tube are similar to magnetic deflection circuits which have been considered in previous camera equipment. The output signal from the monoscope is coupled to the main video amplifier where it is amplified and combined with the blanking signal. The video and blanking output signals from the main video amplifier are then fed to the distribution amplifier which provides several outputs for various viewing monitors. A viewing monitor is located adjacent to the monoscope and a common high-voltage power supply is used for the monoscope tube and the picture tube in the viewing monitor. A standard synchronizing generator is used with this camera chain and supplies the synchronizing signals and blanking signals required for correct operation of the circuits.

The circuits employed in this monoscope camera are typical of those employed in other monoscope cameras, and if the operation of this circuit is well understood no difficulty will be encountered in understanding the operation of other monoscope camera chains. The monoscope camera chain explained in this assignment is used constantly at our laboratory for checking the operation of television receivers.

The Monoscope Tube

Before taking up the circuits associated with the monoscope camera, it will be of value to explain the working principles of the monoscope tube. A photograph of the monoscope tube is shown in Figure 3. Although this tube does not resemble the Iconoscope in appearance, it is very similar in internal construction with the exception of the signal generating plate. In place of the mosaic of the Iconoscope, the monoscope uses a signal generating plate consisting of a thin sheet of aluminum upon which has been printed the scene to be televised. The nature of this scene is shown in Figure 1.

The scene to be reproduced is printed on the aluminum plate by means of ordinary printer's ink. In the heating process that accompanies the manufacturing of the tube the ink is reduced to pure carbon. Thus as the electron beam scans the surface of the signal plate, there must be some difference in carbon and aluminum if a signal is to be generated. The fact is that secondary electrons are emitted as the electron beam scans the surface of the signal plate and, furthermore, the secondary emission ratios for carbon and aluminum are different. The secondary emission ratio of aluminum is approximately 7:1 and that for carbon 3:1. This means that for every incident electron bombarding the signal plate, 7 secondary electrons will be released when scanning the aluminum surface and, similarly, when scanning the carbon surface 3 secondary electrons are released for each incident electron.

It would be of value at this time to go back and review the operation of the Iconoscope in connection with the generation of a signal, since the operation of a monoscope is identical to that of the Iconoscope with the exception of the method in which secondary emission is made proportional to the scene to be televised. For example, in the Iconoscope the secondary emission ratio as the scanning beam passes a black area on the mosiac is different from that of highly illuminated areas. In the case of the monoscope the same condition is set up by means of the difference in secondary emission ratios of aluminum and carbon. Thus, it will not be necessary to go into a detailed explanation of the monoscope camera tube if it is accepted that the operation depends upon differences in secondary emission over various portions of the scanned surface. The electrons produced by secondary emission are collected by the grounded inner coating of the monoscope tube and provides the signal current.

The electron gun employed in the monoscope tube is quite similar to the electron gun in the Iconoscope and should require no detailed explanation. Since illumination of the target is not required, the electron gun in the monoscope is mounted perpendicular to the surface of the signal plate as may be noted by observing Figure 3. It will be recalled that in the Iconoscope such construction was not possible since an electron gun so arranged would obstruct the light image.

To obtain a better picture of the internal construction of the monoscope refer to Figure 4. Inspection of this diagram will show that the components within the monoscope are very similar to the Iconoscope. In this respect the element connected to pin 2 is the accelerating anode, the element marked (G_4) the high-voltage anode, the element connected to pin 3 the focus anode, the element connected to pin 4 the control grid, and the element connected to pin 5 the cathode. The intensity is controlled by R_7 which varies the bias voltage applied between the control grid and cathode. Electrostatic focusing is employed and the correct focus voltage is obtained by focusing adjustment R_{11}.

The output signal from the monoscope is developed across R15 and applied to the input of the cathode follower V_3. From the output of the cathode follower the signal is fed to a video amplifier located a distance of several feet from the monoscope output terminal. This necessitates the use of the cathode follower in order to match the impedance of the transmission line. The high-frequency response of the circuit shown in Figure 4 is rather poor. This condition arises from the high value of input resistance R_{15} of the cathode follower. This resistor is shunted by the output capacity of the monoscope tube plus the input capacity of V_3; an arrangement which, as explained previously, has the effect of reducing the high-frequency response. However, the use of the large value of resistance has an advantage with respect to signal-to-noise ratio and is therefore employed. It will be recalled that a similar arrangement is employed in the Iconoscope camera circuit. Also as in the Iconoscope camera chain, a "high-peaker" circuit is employed in the video amplifier which produces uniform frequency response and time delay when the over-all video amplifier characteristic is considered.

The schematic diagram of Figure 4 also includes the blanking amplifier stage consisting of V_2 and the associated components. This stage functions as an ordinary amplifier with some degeneration present. The blanking pulses are developed in the synchronizing generator and are applied to J_1, the blanking input. At the input of V_2 the blanking pulses are negative and therefore will be positive going in the plate circuit of V_2. This means that the blanking pulses must be applied to the cathode circuit, rather than the grid circuit, if blanking of the return trace of the monoscope is to take place. Unless this return trace is blanked, it will be found that good pattern reproduction from the monoscope is impossible.

Monoscope Power Supply

The schematic diagram of the power supply for the monoscope is shown in Figure 5. Transformer T_1 supplies the high voltage which is rectified in a half-wave circuit by the 2X2 tube V_1. Capacitors C_1 and C_2 together with resistors R_1, R_2, R_3, and R_4 function as a pi-type filter to produce the d-c output. The output of this power supply connects to the point marked (from the regulated high-voltage supply) in Figure 4. This power supply also feeds high voltage to a viewing monitor which shows the pattern produced by the monoscope camera. Regulation of the high-voltage d-c output is accomplished by connecting a number of VR tubes in series. The resistors R_1, R_2, R_3, and R_4 also serve as the series resistance for the regulator tubes.

A point of confusion that is likely to arise in comparing Figure 4 and Figure 5 comes about in showing voltage divider components in both drawings. For example, R_7, R_8, R_9, R_{10}, R_{11}, R_{12}, R_{13}, and R_{14} of Figure 4 are the same components as are shown for the same numbers in Figure 5. This was done to make it possible for the Associate to analyze the circuit more readily.

It will be noted in Figure 4 that the cathode of the monoscope tube is connected to the heater. Consequently the heater is at a negative potential of approximately 1200 volts. For this reason, a special transformer T_2 must be provided in the power supply for supplying the filament voltage for this tube. This transformer must be insulated sufficiently to withstand a potential difference of at least 1200 volts between the primary and secondary winding and between the secondary winding and core.

Monoscope Deflection Circuit

Scanning of the signal plate in the monoscope is accomplished by means of magnetic deflection. The horizontal and vertical deflecting coils forming the deflection yoke are mounted around the neck of the tube in an arrangement quite similar to that employed in magnetic deflection arrangements for the Iconoscope or magnetic picture tubes. A schematic diagram of the deflection circuits for the monoscope camera is shown in Figure 6. Inspection of the schematic diagram will show that transformer T_2 is the vertical output transformer coupling the vertical scanning signal to the vertical deflection coil and transformer T_4 performs a similar operation in the horizontal circuit.

Vertical and horizontal synchronizing pulses are fed to independent inputs (J_1 and J_2) as shown in Figure 6. This arrangement eliminates the need of the sync separation circuit which would be required if the two sync signals were combined before application to the deflection circuits. Stages V_1 and V_4 of Figure 6 function as buffer stages and are used to prevent the blocking oscillators from feeding signals back into the synchronizing generator.

In the plate circuits of V_1 and V_4 the synchronizing pulses are present and from here fed to the blocking oscillators where they are used for synchronizing purposes. For example, the output of V_1 is developed across R_7 which is part of the grid circuit of the vertical blocking oscillator. Thus the synchronizing pulses are injected into the grid circuit of the blocking oscillator. Tube V_2 is a dual purpose triode with one section employed as a blocking oscillator and the other section as the discharge tube, or saw-tooth generator. As indicated in the figure, the grid of the blocking oscillator section of V_2 is directly connected to the grid of the section of V_2 functioning as a saw-tooth generator. Since a high-negative bias is present on the blocking oscillator section when this tube is not conducting, it follows that the same value of bias will be applied to the saw-tooth generator section. This holds the saw-tooth generator section at below cutoff and allows a saw-tooth voltage to be developed across C_6. When the blocking oscillator fires, capacitor C_6 discharges since the bias on the saw-tooth generator section of V_2 drops to a low value permitting plate current to flow.

As explained in previous assignments, when magnetic deflection is employed, it is necessary to have a saw-tooth waveform of current pass through the deflection coils. To obtain the saw-tooth of current a trapezoidal waveform of voltage is required. The rectangular component of the waveform is used to produce a linear saw-tooth of current through the inductive component of the deflecting coils and the saw-tooth causes a linear saw-tooth of current to flow through the resistive component of the deflection coils. In the vertical discharge tube circuit of Figure 6 the resistor R_{11} connected with the saw-tooth generating capacitor C_6 causes the trapezoidal waveform to be developed across the combination.

The output of the saw-tooth generator is developed across R_{12} and provides excitation voltage for the vertical output stage V_3. This stage should require no explanation since it is of conventional construction. By adjusting R_{15} in the cathode circuit the desired vertical linearity is obtained.

The horizontal blocking oscillator and horizontal saw-tooth generator are identical to the similar circuits of the vertical circuit, except for the size of the components, and should, therefore require no further explanation. One minor point of difference will be noted in the saw-tooth generator circuit. The resistor connected in series with the saw-tooth generating capacitor for the purpose of producing the rectangular component of the output waveform is variable in this circuit, whereas in the vertical circuit it is a fixed resistor. In the horizontal circuit, it was found necessary to vary the rectangular component with respect to the amplitude of the saw-tooth component of the waveform applied to the input of the horizontal output stage in order to obtain proper linearity.

The amplitude of the horizontal sweep voltage is changed by changing the screen voltage applied to the horizontal output tube V_6. The control which varies the screen voltage is R_{33} of Figure 6 and is labelled "Horizontal Drive". The horizontal sweep signal is coupled from the horizontal output to the horizontal deflection coil by transformer T_4. A damping circuit must be employed to eliminate the undesired effects of oscillation which will occur at this point and the triode damping circuit employing the 6AS7 tube V_7 is used. The operation of the triode damper has been explained previously and this explanation should be referred to at this time as a review. There is one thing in this circuit which is rather unusual; that is the fact that three horizontal linearity controls R_{35}, R_{36}, and R_{37} are employed. As mentioned at the first of the assignment the monoscope camera is designed to produce a standard test signal and, to obtain as near perfect linearity over the entire scene as possible, the three horizontal linearity controls are incorporated in the damper circuit. Each of these controls affects the over-all horizontal linearity to some extent, but affects the horizontal linearity at certain portions of the trace to a greater extent.

The Main Video Amplifier

Although the output of the monoscope tube is considerably greater than that of the Iconoscope, nevertheless, a considerable amount of video amplification is required. This is the purpose of the video amplifier shown in the schematic diagram of Figure 7. Before going into the video amplifier circuits, it will be of interest to consider the heater power applied to V_1 and V_2. These tubes are supplied with d-c power through the bridge rectifier circuit shown in Figure 7. Copper oxide rectifiers are employed and filtering of the rectified voltage is provided by C_{32}.

It is necessary to use a d-c heater supply on the first two amplifiers in order to eliminate amplification of hum from the 60 cycle power line. The remaining stages of amplification did not require d-c heater power since the over-all amplification of the 60 cycle power line frequency beginning in a later stage is not sufficient to override signal level.

The cathode follower V_3 in Figure 4 is used to feed the video output signal from the monoscope to the input of V_1 of Figure 7 by means of a length of transmission line. It should be observed that the resistor R_1 of the input circuit of V_1 has a value of only 47 ohms. This low value of resistance is necessary to properly terminate the transmission line connecting the cathode follower to the first video amplifier. It may occur to the Associate that the low value of resistance R_1 will place too low a bias on the cathode follower since R_1 is effectively in parallel with R_{17} of Figure 4. The cathode follower operates at a low enough screen and plate voltage, however, so that the reduced bias will not cause excessive power dissipation with the tube.

Inspection of the plate circuits of the video amplifier stages in Figure 7 should show that shunt peaking is employed. Thus with reference to the first stage, L_1 is the peaking coil and R_3 is the plate load resistor. Components such as C_4 and R_4 associated with the plate circuit of the first video amplifier are decoupling networks and are used to stablize the video amplifier. Other components used for stabilization are the 100 ohm resistors, such as resistor R_7, between the first and second video amplifiers. More stable performance is obtained if these resistors are used.

The problem of amplifier stability is much more difficult with an amplifier, such as shown in Figure 7, where six stages of amplification are provided than in a circuit where two or three stages of video amplification are employed, as for example, in television receivers. Some of the factors that must be considered in designing a multiple stage video amplifier are as follows:

1. The distance from the plate of one tube to the grid of the next tube must be kept at a minimum. This is done to avoid unnecessary radiation.
2. Mount the coupling capacitor and plate load resistor of each stage in such a manner that stray capacity will be minimum. This is done, of course, to reduce the shunt capacity of the video amplifier.
3. The peaking coils of each stage should be mounted in a shield can with the location of each coil as near the plate terminal of the associated tube as possible. Unless this is done magnetic coupling between peaking coils can cause oscillation to take place.
4. The screen grid bypass capacitor should be mounted as near to the screen grid of the respective tubes as possible. Furthermore, the leads extending from these capacitors should be placed as close to the chassis as possible. This is also done to prevent undesired coupling between stages.
5. A plate decoupling network is usually required for each video amplifier stage. This decoupling network should be physically located near the particular tube with which it is associated.
6. In some cases it is necessary to bypass the "high" side of each heater lead with a capacitor placed as close as possible to the heater terminal of the tube it effects. This precaution is taken to prevent coupling of energy from one video stage to another by way of the heater circuits.

7. Small values of resistance should be placed in series with the grid input signal of the various stages, as for example, R_7 of Figure 7. This inserts a bias in the grid circuit which must be overcome before oscillation can occur.

The preceding outline should suggest some of the difficulties of building a multiple stage video amplifier in comparison to one where only a few stages of amplification are employed.

The next factor to consider in Figure 7 is the coupling network consisting of R_{12}, C_8, and R_{13}. This network is the high-peaking network, or as it is sometimes called, an R-C peaking network. The function of this high peaker is the same as the high peaker considered in the Iconoscope camera circuit. Its purpose is to attenuate low frequencies and permit the higher frequency components to pass with little or no attenuation. This condition of operation is brought about largely by the capacitor C_8 shunting R_{12}.

At the lower video frequencies C_8 has a very high reactance and its effect upon the circuit operation may be neglected. Thus the input voltage appearing across R_{13} depends upon the ratio of resistance of R_{13} and R_{12}. At the higher frequencies the reactance of C_8 becomes quite low and the voltage developed across R_{13} increases correspondingly. Thus if the frequencies applied to the input of the first video amplifier stage were uniform in amplitude, the response characteristics of the amplifier would show a falling off at the low frequencies. However, it was mentioned in connection with the monoscope tube that the shunt capacity of the monoscope causes the higher frequencies to be attenuated. Thus the over-all response of the video amplifier can be made uniform by adjusting the capacity of C_8.

A factor of even more importance in connection with the network between V_2 and V_3 of Figure 7 is its phase compensating properties. The effect of phase distortion is much more noticeable to the observer than the effect of poor frequency response and therefore the phase characteristics of a video amplifier are of greater importance. The reason for this can be understood by considering the effects of phase distortion and nonuniform frequency response. Phase distortion causes an apparent smearing of the reproduced scene. This condition arises from the streaking produced by phase distortion. In the case of nonuniform frequency response the definition of the picture is affected. This condition compares to trying to read a newspaper at a distance too far away from the viewer. In such a case no annoying effect would be produced upon the observer since he would not be able to read the paper at this distance. However, in the case of phase distortion a comparative condition would be to cause the print to smear on the paper being read. In this case the observer would be in viewing distance so that he could distinguish the words of the paper and the smeared effect would make reading of the material very annoying.

By adjusting the capacity of C_8 the phase error produced by the shunt capacity of the monoscope can be counteracted.

The combined blanking signal, consisting of the vertical and horizontal signals, is applied to the input of the circuit of Figure 7 at jack J_3 and developed across R_{45}. At this point the blanking signals have negative going polarity. Stage V_8 amplifies the blanking signal and serves to invert the polarity of the signal. In addition this stage provides additional isolation between the blanking generator and the video amplifier stages. The blanking amplitude control R_{46} is used to control the magnitude of the blanking pulses applied to the grid circuit of the mixer stage V_9. Inspection of Figure 7 will show that stages V_9 and V_3 have common plate loads, (R_{16} and L_3). This arrangement is employed to mix the blanking signals from V_9 with the picture information from V_3. Thus it should be evident that the input signal to V_4 contains both the picture information and the blanking signals.

In order to control the amplification of the video amplifier the bias applied to V_4 and V_5 is made variable by changing the setting of R_{26}. The individual bypass capacitors shown are necessary since a minimum bias is developed across R_{23} and R_{30}; consequently, these resistors could not be bypassed by a single capacitor.

The output of the final video amplifier stage V_6 is coupled to the input of the cathode follower V_7. This cathode follower is of conventional construction and is used to feed the output of the video amplifier to the distribution amplifier. With only the components shown in Figure 7, it should be evident that the cathode follower stage V_7 could not function since its cathode circuit is open. The remaining portion of the cathode circuit is found on the distribution amplifier chassis. This is done in order to properly terminate the transmission line running between the main video amplifier and the distribution amplifier. The 200 ohm resistor R_{42} of Figure 7 is used to provide the correct bias for the cathode follower. Without this resistor the bias applied to the cathode follower stage would be of too low a value and excessive d-c plate current would result. It will probably occur to the Associate that a considerable signal voltage will be wasted since R_{42} does not have a bypass capacitor across it. This is true, but since sufficient signal level was obtained without the bypass capacitor none was provided. However, in the event it would become necessary to increase the level of the output signal from the cathode follower, then R_{42} would have to be bypassed with a capacitor of sufficient size.

The Distribution Amplifier

A block diagram of the distribution amplifier is shown in Figure 8. The purpose of this amplifier is to distribute the signal to the various devices. The circuits which are normally fed by the distribution amplifier will be determined largely by the type of installation with which the monoscope camera is being used. Almost without exception, one of the outputs of the distribution amplifier is used to feed a viewing monitor. Such a circuit will be taken up in this assignment. Other outputs would normally be used to feed other devices, as for example, in a broadcast station using the monoscope camera to generate the test pattern, one of the outputs is fed to the transmitter modulator circuit. In the particular installation at UTL one of the outputs from the distribution amplifier is used to modulate a small r-f amplifier, which is in turn, used to distribute television signals to various test outlets in the laboratory.

With reference to Figure 8, video and blanking signals are fed from the input Jack J_1 to stages V_1 and V_6 of the distribution amplifier. These amplifiers are used to increase the amplitude of the video and blanking signals for application to the cathode follower stages. Inspection of the block diagram shows that V_1 feeds cathode follower stages V_2 and V_3. Since only the video and blanking signals are fed to these circuits, only video and blanking signals are present at the output jacks J_3 and J_4. This arrangement was provided so that, if desired, synchronizing signals may be added in some later stage such as, for example, in the modulator of a transmitter. Two outputs are also provided which contain the composite signal, (J_5 and J_6). By composite signal is meant the video picture information, the vertical and horizontal blanking signals, and the synchronizing signals. The synchronizing signals used here contain the horizontal sync pulses, the equalizing pulses, and the serrated vertical sync blocks since the horizontal and vertical synchronizing signals have been combined. It has been explained previously that in cases where the horizontal and vertical synchronizing signals are confined to individual channels then equalizing pulses and serrated vertical synchronizing pulses are not necessary.

The composite synchronizing signal is fed from the synchronizing generator to jack J_2 of the distribution amplifier for the monoscope. These signals are then applied to the input circuit of tube V_4 which acts as a sync amplifier or buffer. The buffer stage is used primarily to provide isolation between the distribution amplifier and the source of the synchronizing signals in order to avoid any reaction between these components. It also serves to invert the polarity of the synchronizing signals so they will be correct when combined with the blanking and picture information.

The mixer stage V_5 has its plate circuit common with the plate circuit of V_6 and thereby combines synchronizing signals with the picture information and blanking signals. Thus at the output terminals of the cathode follower stages V_7 and V_8 the composite signal is available.

Schematic Diagram of the Distribution Amplifier

The schematic diagram of the distribution amplifier is shown in Figure 9. With the aid of this drawing the termination of the cathode follower shown in Figure 7 may be seen. The terminating resistor is R_1 of Figure 9. In connection with the cathode follower located on the monoscope tube chassis the grid resistor and terminating resistor of the following video amplifier are one and the same. To be more explicit, resistor R_1 of Figure 7 serves as grid return resistor for the video amplifier V_1 and also the cathode follower terminating resistor for V_3 of Figure 4. It should not be difficult to visualize that the grid of V_1 of Figure 7 is made positive with respect to ground. The value of this voltage, however, is rather low and the cathode bias voltage developed across R_5 is sufficiently great to make the grid of V_1 negative with respect to its cathode by the required amount. In the case of the input to stages V_1 and V_6 of Figure 9, however, a different condition exists. The reason for this arises from the plate current value of V_7, the cathode follower, located in the circuit diagram of Figure 7. The current drawn by this tube is considerably greater than the cathode follower covered previously. Thus if R_1 were connected directly to the input of V_1 and V_6 the grid circuits of these tubes would have a bias which would be too low. Therefore, it is necessary to provide the isolation network C_1 and R_2 shown in Figure 9.

Small resistors are connected in series with the grid circuits of the various stages in the distribution amplifier to prevent the possibility of oscillation in the same way as explained in connection with the main video amplifier. Inspection of the circuit diagram of Figure 9 shows that V_1 feeds two cathode follower stages whose inputs are connected in parallel. The resistors R_{12} and R_{14} in the cathode circuits of the cathode follower stages are used to develop bias voltage. With the circuits as shown in the schematic diagram of Figure 9 no current would flow through the cathode followers. Thus to place the followers in operation, it is necessary to terminate each one in the proper value of resistance. The value of this resistance depends upon the characteristic impedance of the transmission line which is used to feed the output of the cathode follower tube to remote points and will usually be 47 or 50 ohms.

The video and blanking signals from jack J_1 are also fed to the input of V_6. Inspection of the circuit diagram of Figure 9 shows the plate circuits of V_5 and V_6 as having a common plate load impedance. This impedance consists of R_{22} and the shunt peaking coil L_2. Through this arrangement signals from V_5 which form the composite sync signal are combined with the signal from V_6, which is the video and blanking signal, producing in this common plate circuit the composite video signal.

The composite video signal from the output of V_5 and V_6 is fed to the cathode follower stages V_7 and V_8 which are identical in construction to the ones already explained. Thus at the output jacks J_5 and J_6 a composite video signal is available.

The over-all frequency response of the monoscope camera chain is such that frequencies as high as 7 mc will be amplified satisfactorily. This frequency is, of course, in excess of the highest video frequency transmitted in the standard television system. However, it is desirable to have the response characteristics of a monoscope camera chain in excess of the value which is used in the ordinary systems, since the monoscope signal is often used as the standard signal for testing the other systems. The wide frequency response of the amplifiers is obtained by using peaking circuits in conjunction with very low values of load resistance. If the value of the plate load resistors used in these amplifiers are compared with those found in video amplifiers in other television equipment which has been covered, for example in the video amplifiers in television receivers, it will be found that these load resistors are much smaller. This provides improved frequency response, although more stages are required to secure the same degree of amplification.

All of the circuits in the monoscope camera chain with the exception of the monitor have been discussed. At this time, it might be well for the Associate to review the circuits covered this far before proceeding with the monitoring circuits. While reviewing the over-all picture of the monoscope circuits, it should be evident that the monoscope camera is rather simple in comparison with the circuits which have already been explained.

The Viewing Monitor

Viewing monitors are used with the monoscope camera for the same reason that monitors are used with other cameras. That is the monitors are used to observe the signal produced by the monoscope camera. In some instances only one viewing monitor will be used, whereas in other instances two or more viewing monitors might be employed. It is customary to have a viewing monitor built in the same rack with the monoscope camera equipment so that the effects of the various adjustments in the camera equipment can be observed while they are being made. It is desirable in many instances to have other viewing monitors at remote points from the monoscope camera for observing the reproduced scene.

The monitor which is often built in the same rack as the monoscope camera normally employs a small picture tube (3 inch screen). This is done for two reasons. In the first place the larger picture tube requires much more space and would therefore make the monoscope camera chain excessively large. Also the amount of high voltage available from the monoscope tube high-voltage supply is sufficient for operation of a smaller diameter tube but is not great enough for operation of larger picture tubes. If the three inch picture tube is employed the monitor will normally use electrostatic deflecting means.

The monitor which will be considered in this portion of the assignment is the remote monitor used with the monoscope camera. It is usually advisable to use at least one remote monitor since the larger picture tube used in such a monitor will be able to make use of the full reproduction capabilities of the monoscope system. That is, a scene can be reproduced with definition equal to the 7 mc bandwidth of the camera chain, whereas this high degree of definition cannot be reproduced by the small three inch picture tube.

Essentially the viewing monitor is a receiver with the r-f oscillator and i-f sections removed. This is possible since the video, blanking, and synchronizing signals can be fed to the video amplifier and the sweep circuits by means of cables. Furthermore, if the synchronizing signals are kept in separate channels, sync separator circuits are not a necessary part of the viewing monitor.

A schematic diagram of the circuits for the viewing monitor is shown in Figure 10. Since the circuits of this monitor are arranged so that synchronizing signals are kept in separate channels, the video input terminal J_5 contains only the picture information and the blanking pulses from J_3 or J_4 of the distribution amplifier shown in Figure 9. The resistor R_{21} at the input to the video amplifier stage is used to terminate the transmission line properly. This resistor is also a part of the cathode circuit of the cathode follower located in the distribution amplifier. To control the magnitude of the video signal at the output of the video amplifier of Figure 10, the potentiometer R_{22} is provided. This control adjusts the level of the signal applied to the first video amplifier stage V_6 and is therefore a Contrast control.

Fixed bias is used for both video amplifier stages (V_6 and V_7) in order to avoid the use of large values of capacitors in the cathode circuits. Where cathode bias is employed in video amplifiers very large values of capacity are required if no phase distortion is to result. The value of this capacitor should be in the neighborhood of 500 to 1000 μfds. Of course the voltage rating of capacitors of this size can be very low but even then the capacitors are large in physical size.

The video amplifier stage V_6 does not employ a peaking coil because the value of plate load resistor R_{24} is only 680 ohms. When such a low value of resistance is employed the peaking coil is not necessary. Where maximum amount of gain per stage is necessary the circuit arrangement for V_6 would not be satisfactory.

The second video amplifier stage employs a 6AG7 pentode. This tube was selected in order to obtain the required signal voltage for application to the input circuit of the picture tube. It should be recalled that the selection of a video amplifier tube where a high output voltage is needed cannot be determined by selecting a tube with high-mutual conductance alone. Instead a tube must be selected with a d-c plate current value at least equal to the peak amplitude of the a-c component of current needed to develop the signal voltage in the plate circuit. This requirement has been explained in an earlier assignment and the subject should be reviewed at this time if necessary.

Combination peaking is employed in the second video amplifier and the output signal is coupled to the grid of the picture tube. A simple d-c restorer consisting of V_8 is used as part of the output circuit of the video amplifier. The operation of such a stage has been explained in detail previously. The brightness of the reproduced scene on the monitor screen may be varied by adjusting potentiometer R_{33}. This control varies the fixed bias voltage applied between the grid and cathode of the picture tube.

The sweep circuits employed in the monitor are of the driven type. This means that no sweep voltage will be developed unless synchronizing signals are available at the input circuit of the saw-tooth generators. This would be an undesirable condition in the case of a television receiver since no raster would be available until a station was tuned in and would lead to difficulty of tuning in the desired station. However, in the case of the fixed monitor where no selection of stations is involved, the circuit arrangement shown in Figure 10 provides satisfactory operation.

The circuit has been constructed so that either positive or negative synchronizing pulses may be used to provide driving signals for the saw-tooth generator. Thus the stages associated with tubes V_{1A} and V_{1B} may be classed as phase inverters. If the sync pulses available are positive going they are of the proper polarity for operation of the saw-tooth generator and may be applied directly to jacks J_2 and J_4. If however, the synchronizing pulses available are of negative polarity they should be applied to jacks J_1 and J_3. In this case tubes V_{1A} and V_{1B} act as phase inverters producing the necessary positive going sync signals for operation of the saw-tooth generators.

Both the vertical and horizontal saw-tooth generators are of the high-vacuum type. Although the saw-tooth generator tubes V_{2A} (the horizontal saw-tooth generator) and V_{2B} (the vertical saw-tooth generator) appear to be operating at zero bias, this is not the case. On the positive excursions of the synchronizing signals grid current flows and places a charge in the grid capacitor which is proportional to the amplitude of the sync pulses. Between sync pulses the voltage present across these capacitors holds the saw-tooth generator tubes at below cutoff bias. This type of bias has been given considerable attention in previous assignments and should require no further coverage at this time. The vertical saw-tooth waveform is developed across C_{10} while the rectangular component is developed across R_{18}. The result is an input waveform to the vertical output stage with trapezoidal shape. The vertical output stage V_5 is of ordinary construction and should require no explanation.

Considering next the horizontal saw-tooth generator V_{2A}, the capacitor C_4 together with the resistance R_7 form the saw-tooth generating network. The resistor R_5 of this circuit causes the final output waveform to take on a trapezoidal shape. If all the resistance of R_5 is removed from the circuit then the input signals to V_3, the horizontal output stage, will be a saw-tooth waveform. As R_5 adds resistance to the circuit a rectangular component will be added to the saw-tooth wave and thereby results in a trapezoidal waveform. By selecting the proper value of R_5 good linearity is obtainable. This may seem to provide a rather simple linearity arrangement when considering the elaborate linearity network of the monoscope camera. In the case of the monoscope camera, it was necessary to go to considerable trouble to obtain exceptionally good linearity since the monoscope is to be used as a standard for setting up linearity for other circuits. In the case of the viewing monitor however, some nonlinearity can be tolerated. The remaining circuits shown in Figure 10 should require no explanation since they are of ordinary construction and have been covered in detail in other assignments.

The Monitor Power Supply

A schematic diagram of the viewing monitor power supply is shown in Figure 11. As may be seen by inspection of this diagram both low-voltage and high-voltage supplies are included. The low-voltage supply provides B supply voltage for the sweep circuits and the video amplifiers. Transformer T_1 supplies the necessary voltages for this circuit and the 5U4 tube is arranged in a full-wave rectifier circuit. Filtering is provided by capacitors C_1, C_2, and C_3 and inductances L_1 and L_2. It will be noted that the B- lead of this power supply is not grounded. This arrangement is used so that the plate current drawn by the tubes in the monitor whose cathodes are grounded will flow through the centering controls. In this manner centering and a fixed bias voltage is made available.

The high-voltage power supply employs a half-wave rectifier circuit. Since this supply is operated from the a-c power line, the ripple frequency in the output of the rectifier will be 60 cps and relatively large values of filter capacitors are required to provide the necessary filtering. Because of these large values of filter capacitors, a great deal of care must be exercised when working on this type of power supply.

Summary

The monoscope camera is a very useful instrument for use in setting up linearity of television equipment and in comparing the operation of various types of television amplifiers, cameras, etc.

As the scanning beam in the monoscope tube passes across the signal plate secondary emission is produced. The amount of secondary emission from the bare aluminum areas and the carbon areas of the plate varies and thus a signal current is developed. As this signal current flows through the load resistor the output signal voltage is developed which must be amplified before it can be used for other purposes. After amplification the video signal is applied to cathode followers for use in whatever circuit it is required. This operation is performed by the distribution amplifier. In most cases various outputs are available which contain the video and blanking signals or the composite signal, so that the monoscope camera can be used with most any type of circuit.

Test Questions

Be sure to number your Answer Sheet Assignment 98.
Place your Name and Associate Number on every Answer Sheet.
Send in your answers for this assignment immediately after you finish them. This will give you the greatest possible benefit from our personal grading service.

1. What is the principle difference between the monoscope tube and the Iconoscope?

2. Why is a cathode follower used to couple the video signal from the monoscope to the video amplifier?

3. Explain the purpose of the high-peaker circuit (R_{12} and C_8) in the main video and blanking amplifier circuit of Figure 7.

4. How is the blanking signal mixed with the video signal in the main video and blanking amplifier circuit?

5. What is the purpose of the 100 ohm resistors in the grid circuit of all the video amplifiers in this camera chain?

6. Explain why R_{11} is connected in series with C_6 in the circuit of Figure 6.

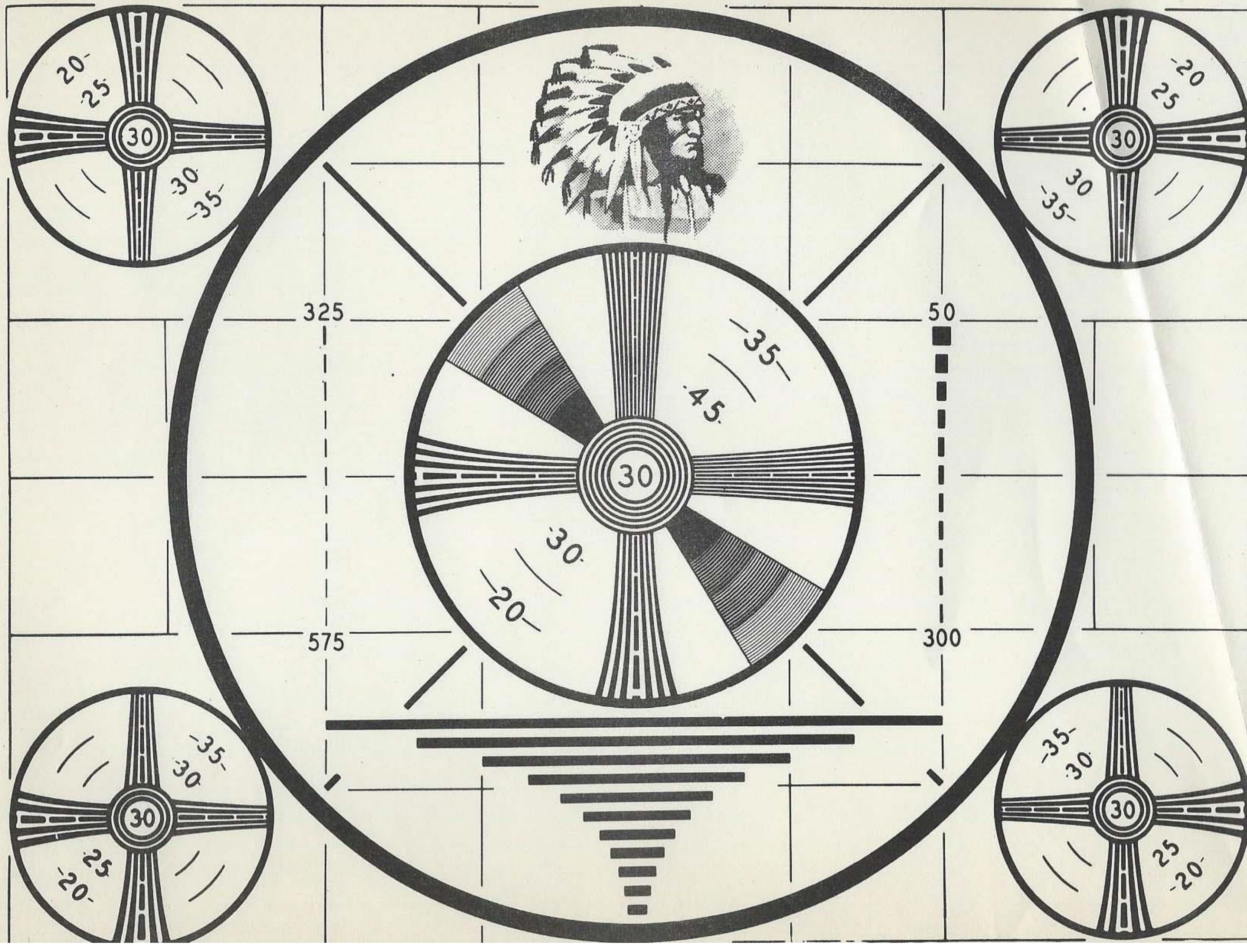
7. What is the function of R_{15} and C_{12} in the circuit of Figure 7?

8. List at least three uses for a monoscope camera.

9. Explain the purpose of V_{1A} and V_{1B} in the circuit of Figure 10.

10. Why is blanking applied to the monoscope tube?

MONOSCOPE TEST PATTERN



BLOCK DIAGRAM OF MONOSCOPE CAMERA CHAIN

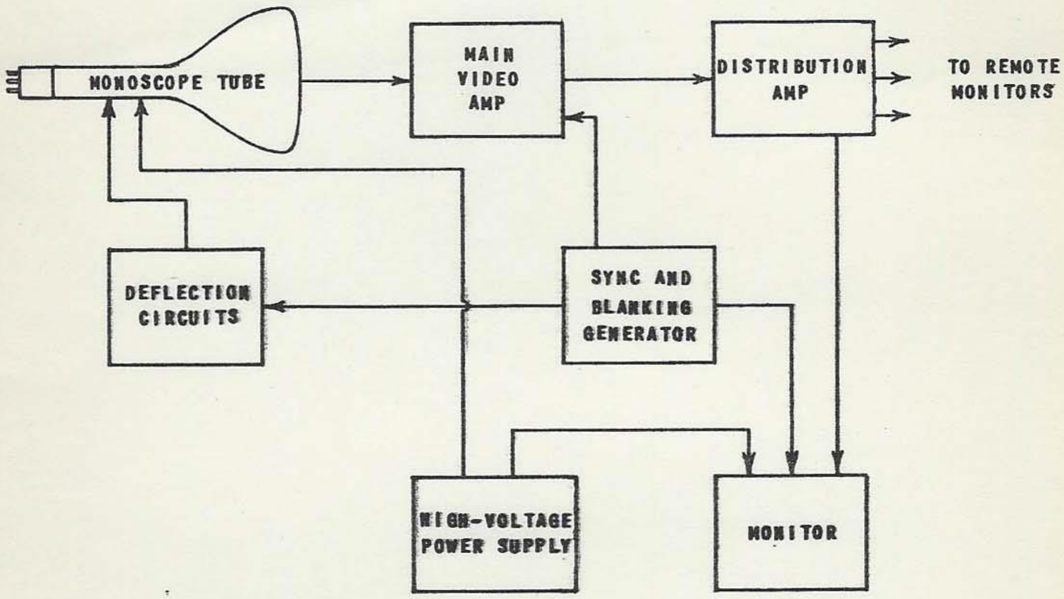


FIGURE 2

MONOSCOPE TUBE

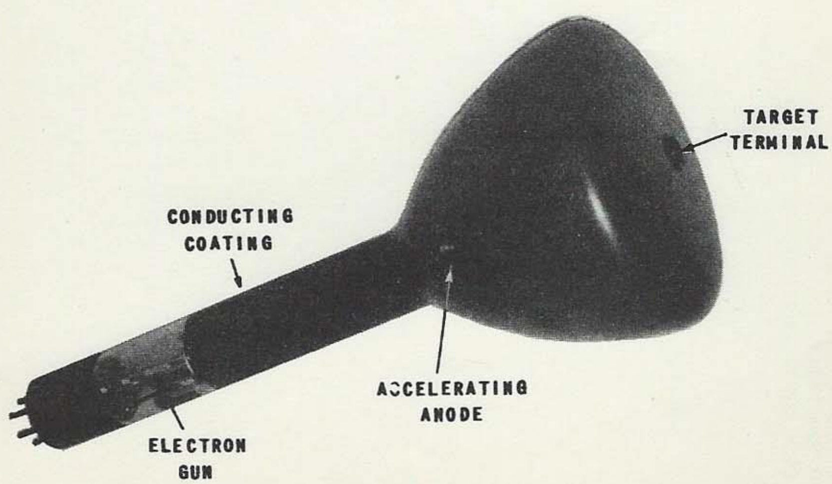


FIGURE 3

2F21 MONOSCOPE WITH BLANKING CIRCUIT, VIDEO OUTPUT CIRCUIT AND CONTROL CIRCUITS

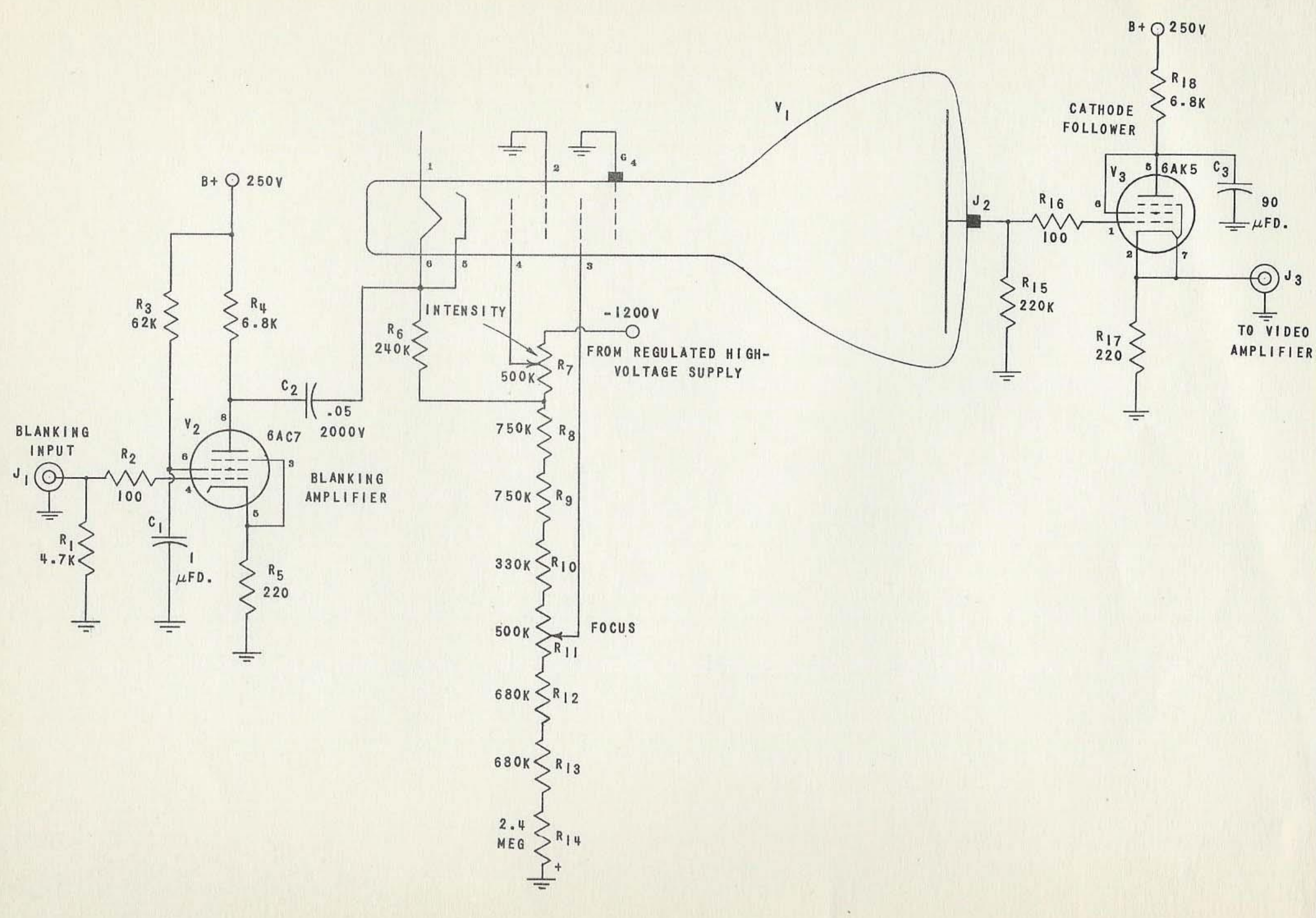


FIGURE 4

2F21 - MONOSCOPE HIGH-VOLTAGE POWER SUPPLY

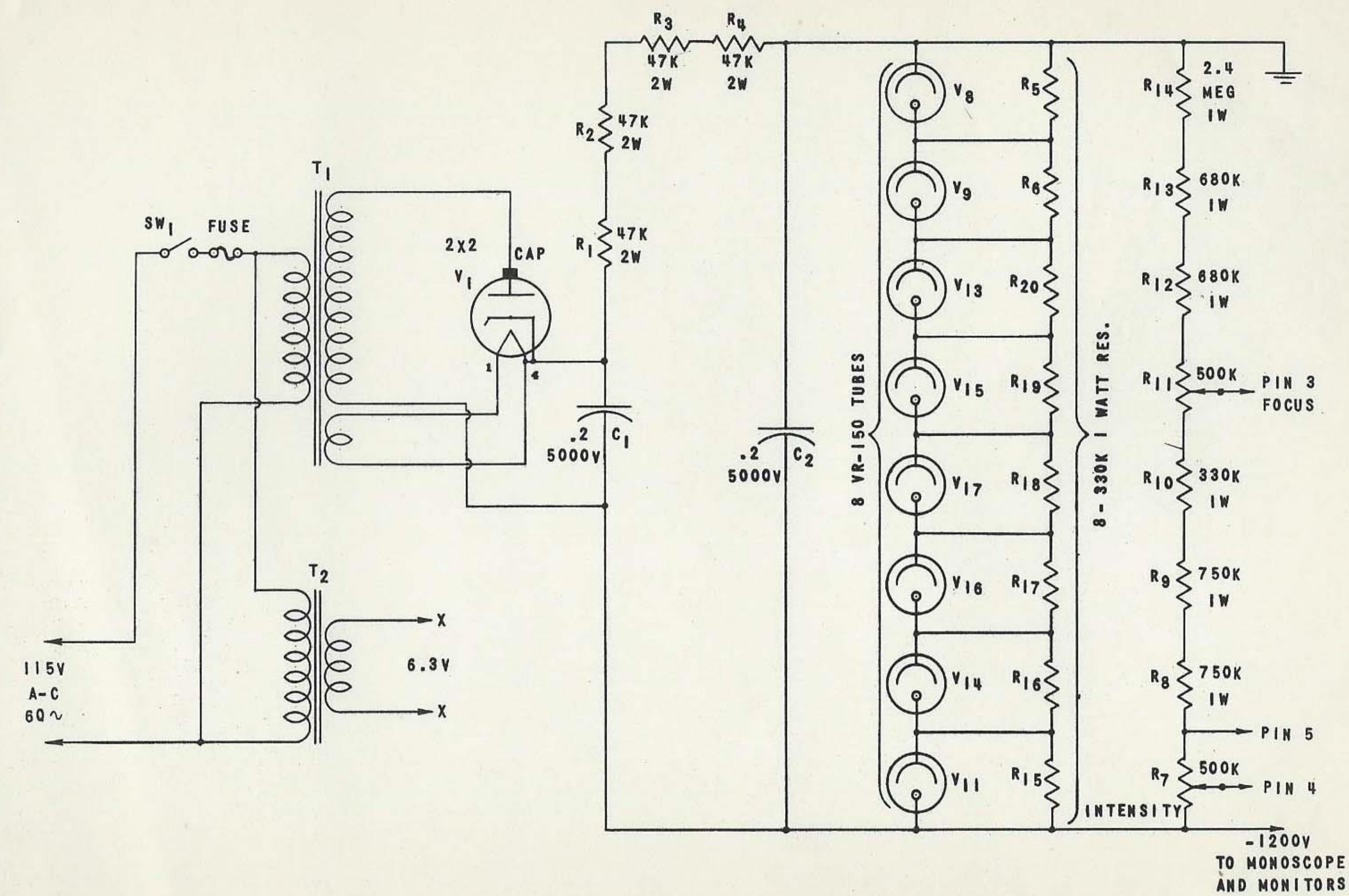


FIGURE 5

MONOSCOPE DEFLECTION CIRCUITS

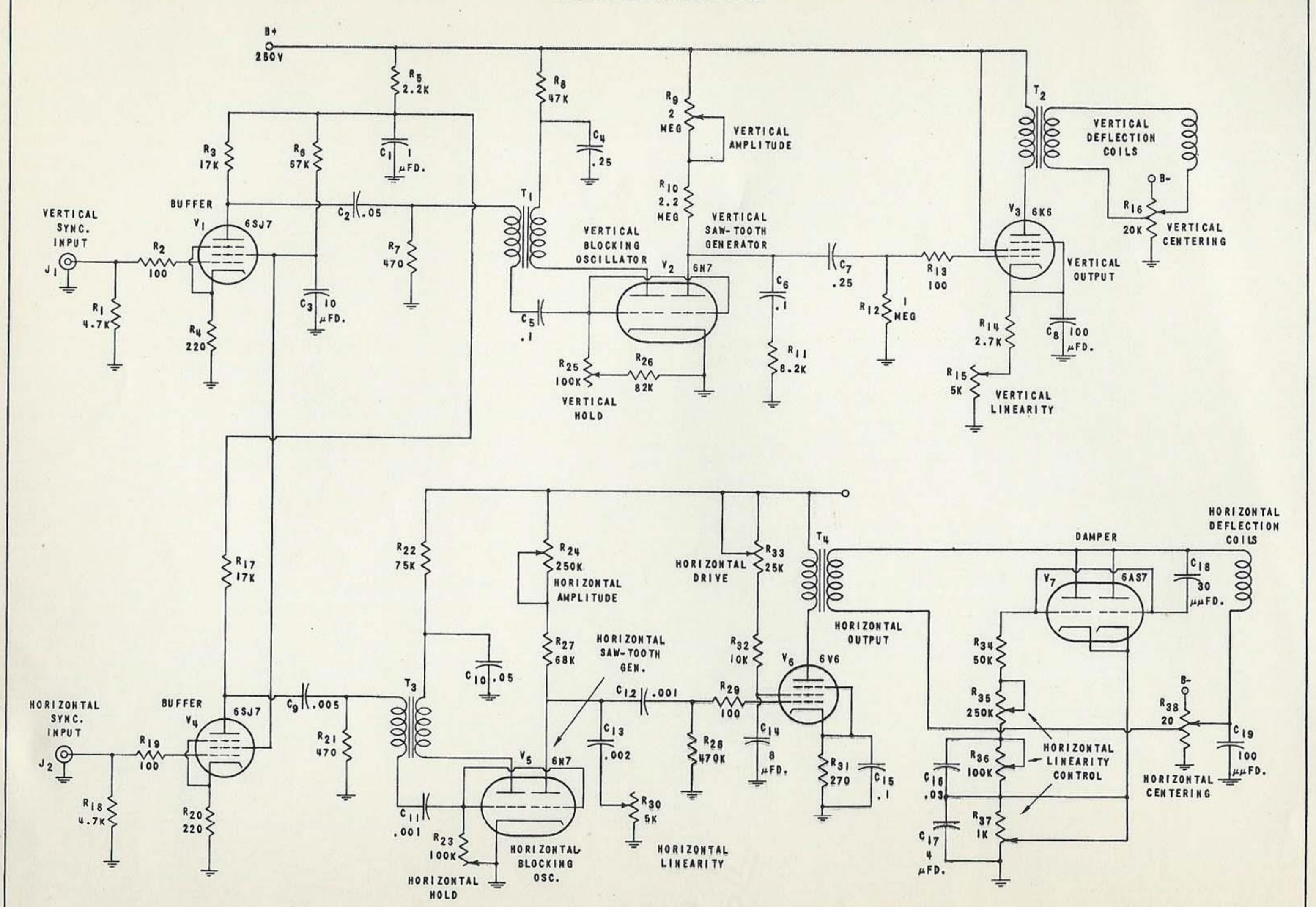
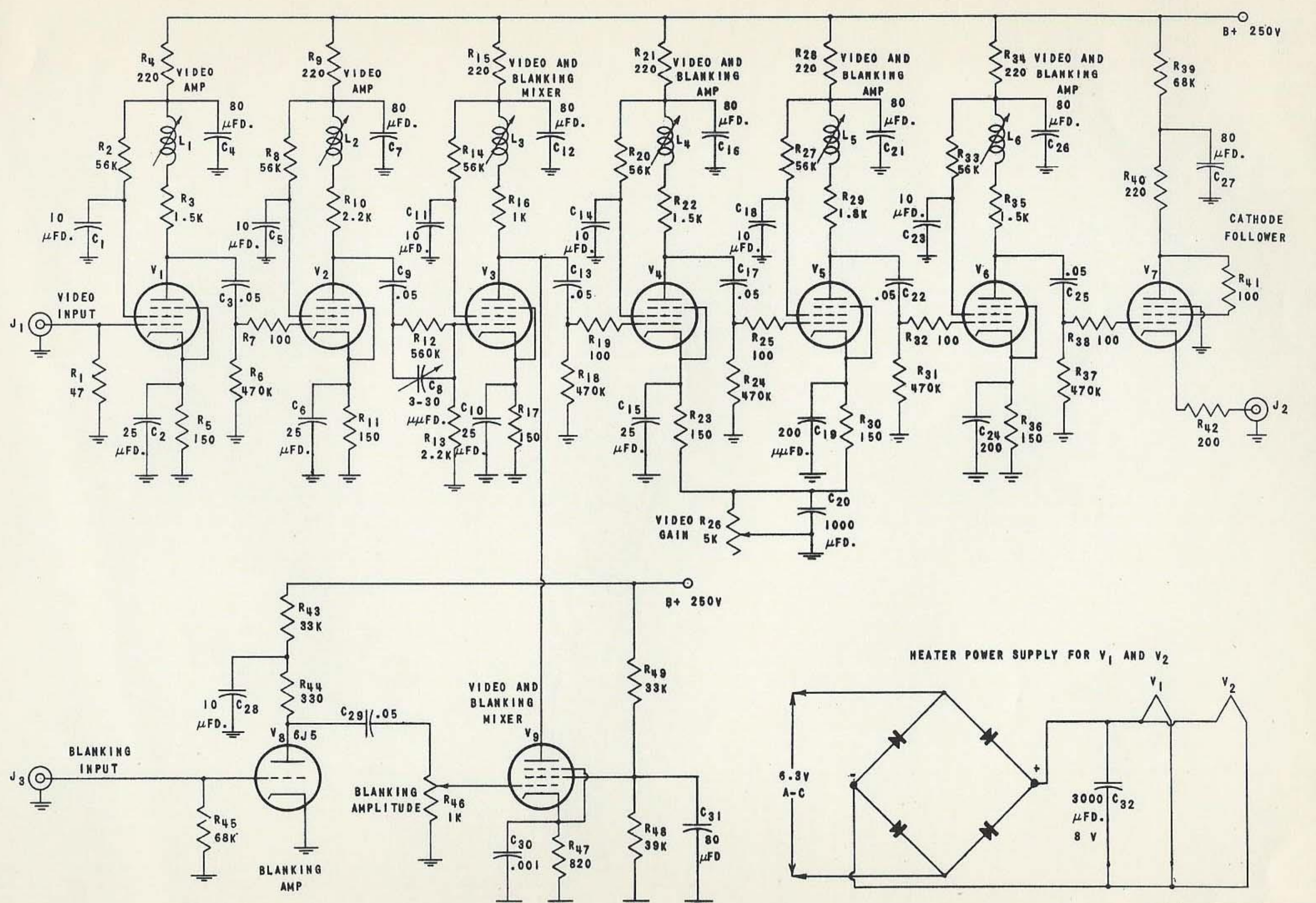


FIGURE 6

MAIN VIDEO AND BLANKING AMPLIFIER



NOTE:
ALL TUBES EXCEPT V_8 ARE 6AC7.

FIGURE 7

BLOCK DIAGRAM OF DISTRIBUTION AMPLIFIER

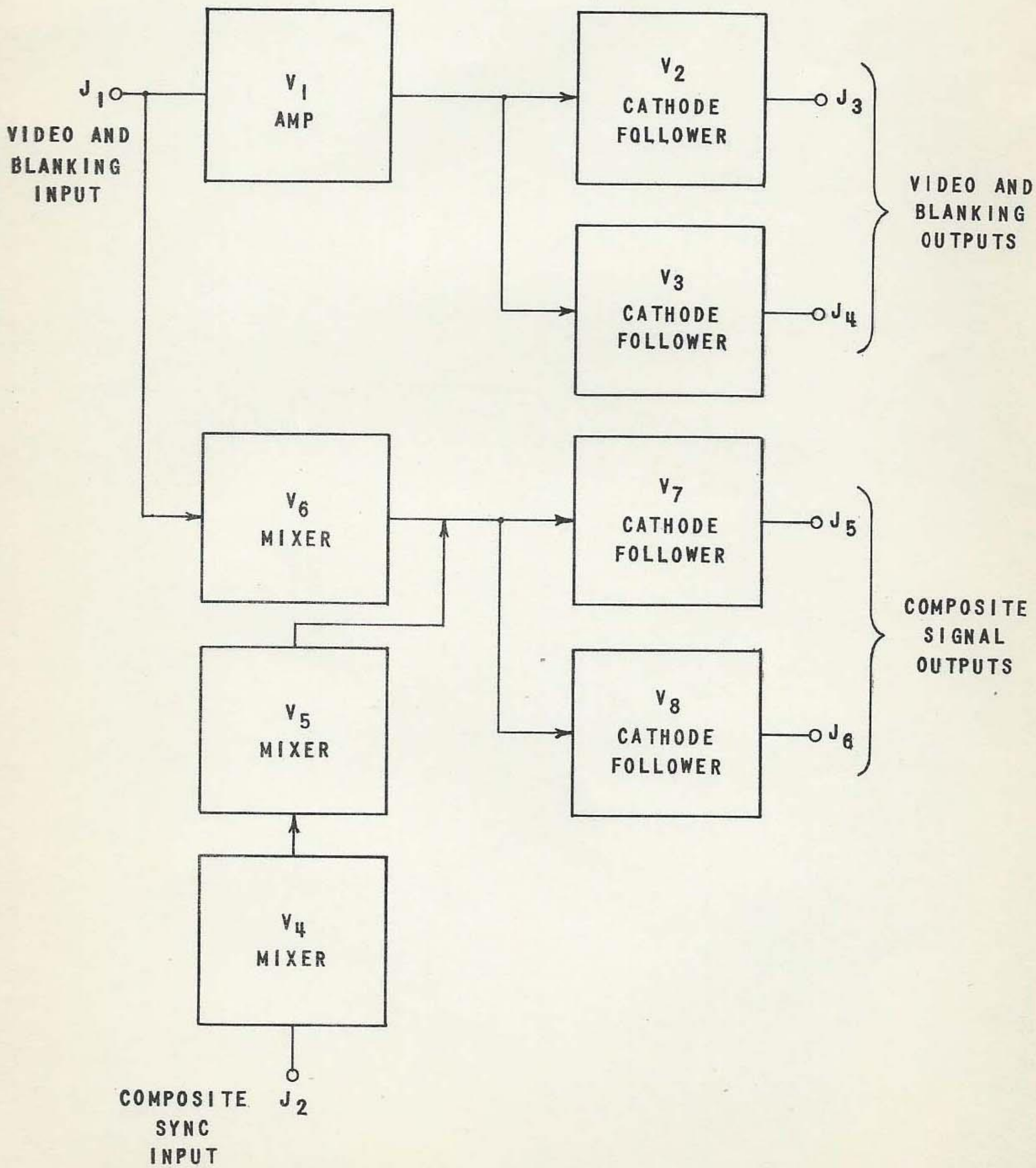


FIGURE 8

DISTRIBUTION AMPLIFIER FOR MONOSCOPE

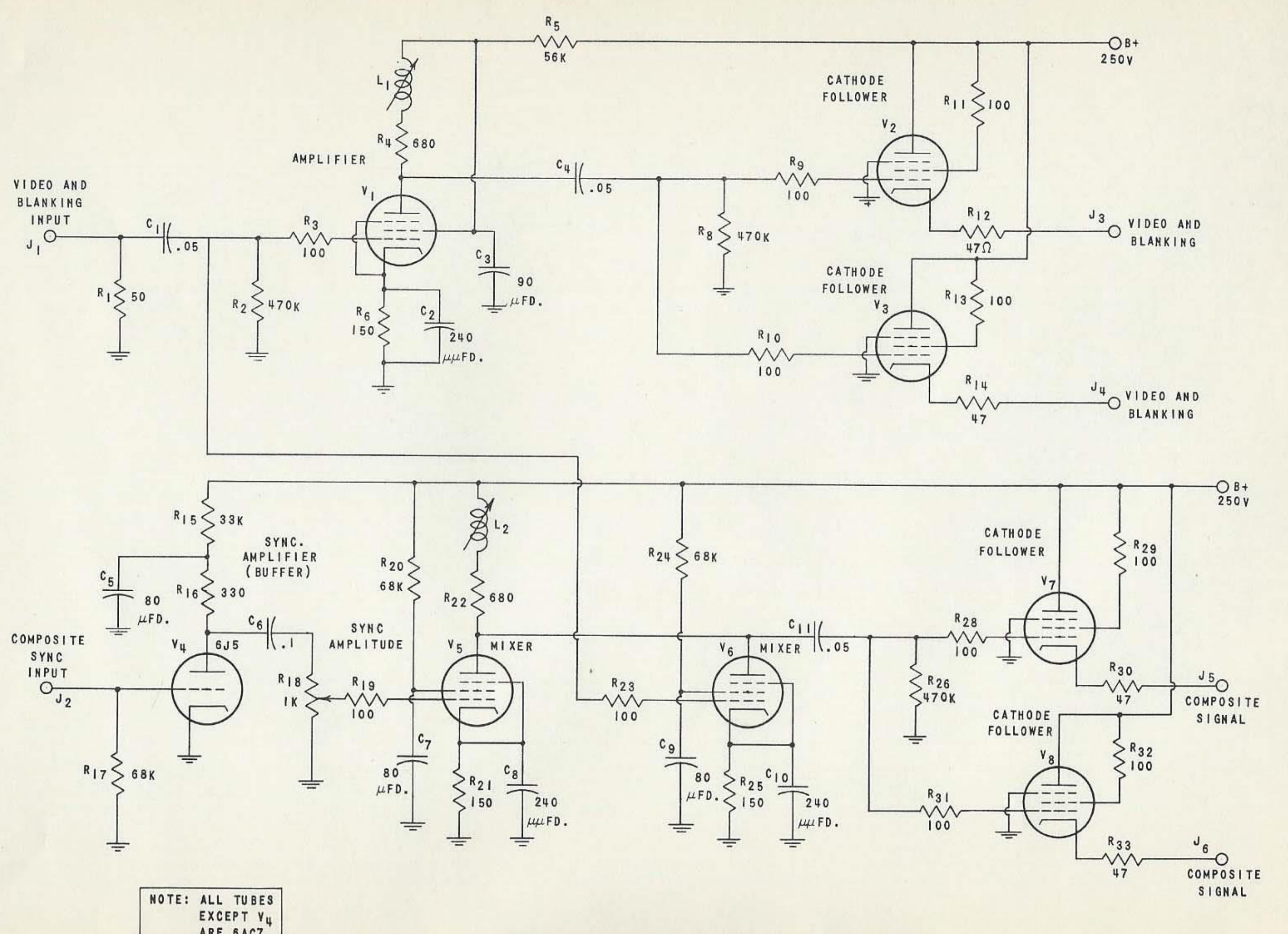


FIGURE 9

MONITOR SWEEP CIRCUITS AND VIDEO AMPLIFIER

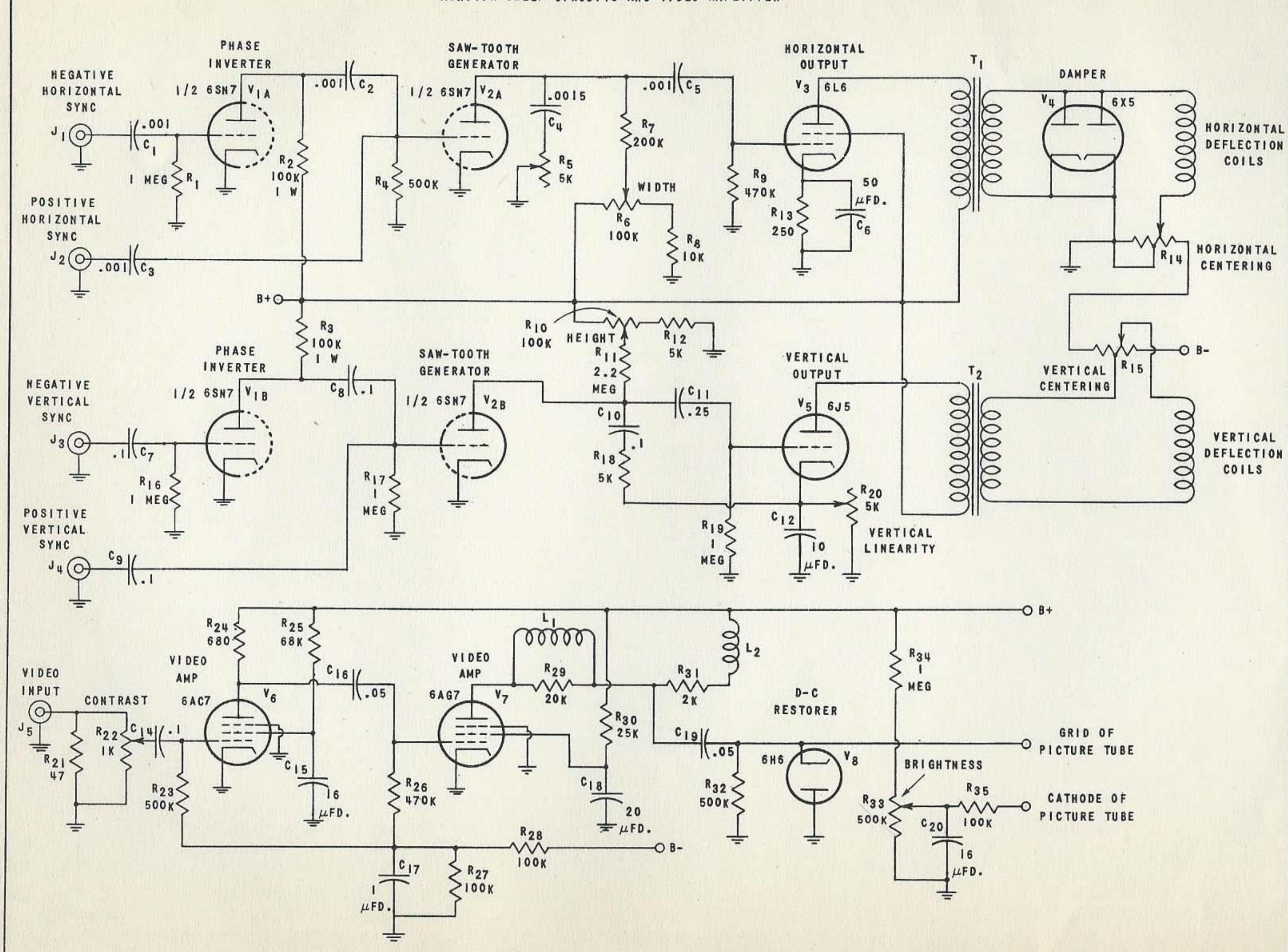


FIGURE 10

MONITOR POWER SUPPLY

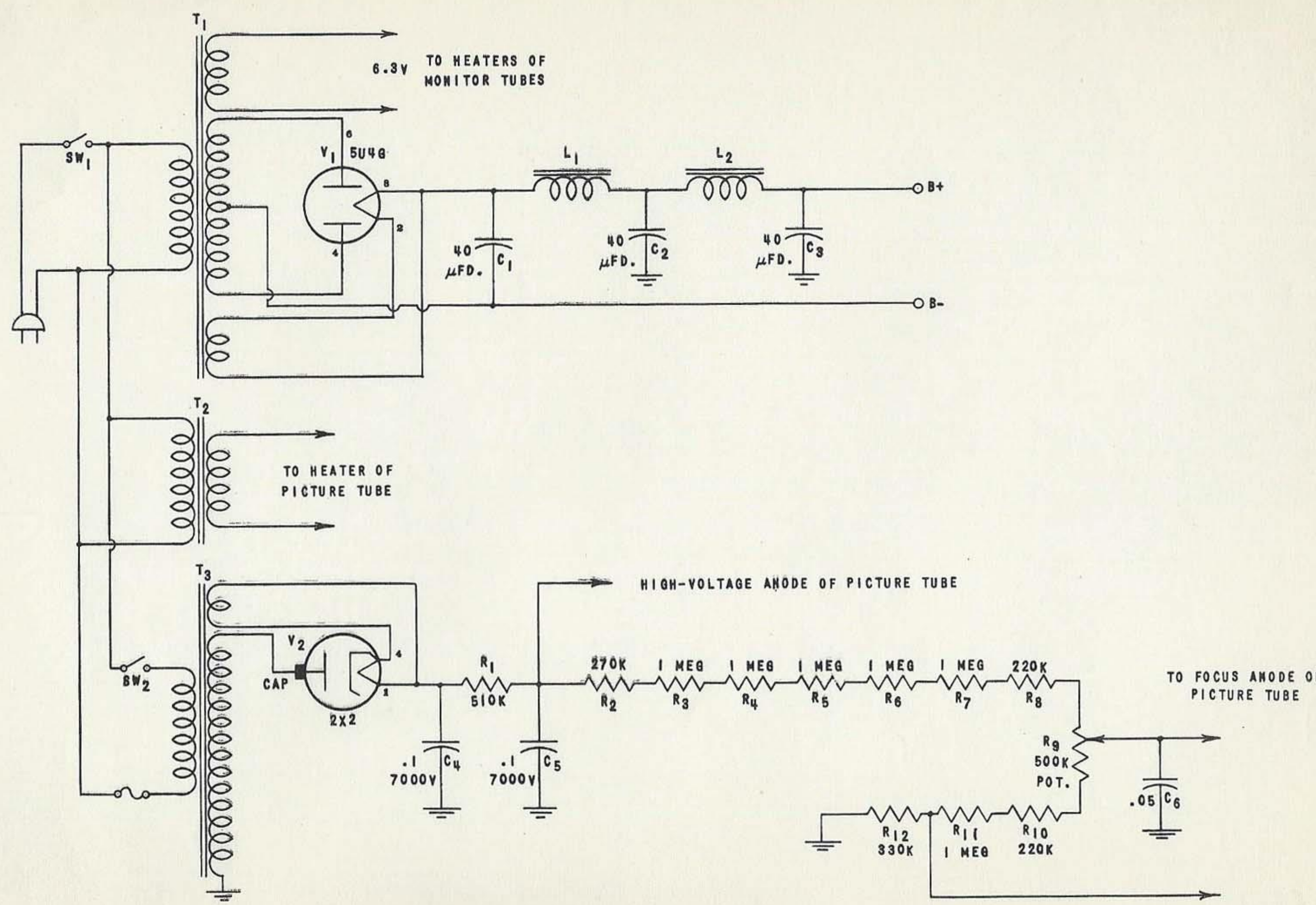


FIGURE 11