VISUAL TEST MONITOR

TYPE TM-5-A

AND

ML-7352532

INTRODUCTION

The General Electric Monitor, Type TM-5-A, is a specially designed and constructed visual monitor containing two cathode ray tubes for the simultaneous display of the picture and waveform of any video signal. The monitor provides an immediate and constant check on the content of the video signal which is absolutely necessary for proper control adjustments and alignment. There are four monitor models, 4TM5A1, 4TM5A3, 4TM5A4, and ML-7352532.

Model 4TM5A3 is used in all the Camera Control Consoles. Model 4TM5A1 is used in the Line Monitor Console. These two monitors differ in that Model 4TM5A1 has additional annunciator type lights located in a row at the top of the monitor panel to indicate the camera channel being broadcast.

Models 4TM5A4 and ML-7352532 are Calibrating type monitors which are used in the Master Monitor Console, the Cue Monitor Console, the Master Control Console and the Transmitter Console. The difference between 4TM5A1 or 4TM5A3 and 4TM5A4 is in the wave form circuits. Model 4TM5A1 or 4TM5A3 display a dual trace at the vertical and horizontal sweep rates. Model 4TM5A4 displays a single trace wave form and includes wave form calibrating and measuring circuits. The picture circuits are the same in both types.

This instruction book covers the monitors with the calibrating type of wave form circuits, namely 4TM5A4 and ML-7352532. For descriptions of the dual trace type monitors, see Instruction Book EBI-3100.

DESCRIPTION

1. GENERAL

The monitor is rectangular in shape and mounted on inclined slides and guides, with steel tapes and counterbalancing springs for safety and

ease of operation. Two release buttons on each side of the front panel unlock the monitor from the closed position. The unit consists of a waveform monitor chassis and controls on the left side, a picture monitor chassis and controls on the right and two high voltage power supplies mounted in the rear. These supply high-voltage potentials to the two cathode-ray tubes. All other operating power comes from associated rack equipment. Both high-voltage power supplies are interlocked by a switch located behind the top center of each monitor front panel. Metal shields around the power supplies and suitable protection of other parts prevent accidental contact with high voltage in the event of interlock failure when the monitor is extended. Operating controls for adjusting the picture raster and waveform deflections are on the front panel. The cathode-ray tubes are aluminum backed. Each tube is faced against a rubber mask and a shatterproof window.

CAUTION

Be extremely careful when handling these tubes, as they implode with violence when broken. Be sure to wear safety glasses and gloves.

2. ELECTRICAL

A. Picture Monitor

The picture monitor consists of the following circuits:

(1) Video Amplifier

The video amplifier consists of three 6AC7's, two 6AG7's and one 6SL7 in cascade with shunt compensation circuits for a five-megacycle bandwidth and d-c insertion (V1606) for low-frequency response correction, as well as an automatic means of controlling the background level. R1672 (BACKGROUND) is the front panel control for setting the background level. R1609 (CONTRAST) is the panel control which achieves contrast by varying the video gain. Coils L1601, L1602, and L1603 are for high-frequency compensation. The output is a black negative signal to the control grid of the picture cathode-ray tube, V1638.

If, for any reason, the amplifier is out of alignment, adjust coils L1601, L1602, and L1603 for a 5-megacycle flat bandwidth, using standard video amplifier alignment procedure.

(2) Picture Monitor Vertical Sweeps

A sawtooth vertical deflection current is developed in the vertical deflection chain in the following manner. V1607 amplifies a positive vertical sync pulse which triggers V1608, a 6SN7 multivibrator. The output of V1608 controls the sawtooth generating circuit consisting of V1609, the first part of V1610, R1715, and C1630B. The first part of V1610

is a constant current tube charging C1630B at a steady rate to provide the sawtooth. V1609 conducts only during the trigger from the multivibrator, discharging C1630B. R1715 develops a pulse voltage during the discharge which is necessary for a fast flyback. The second half of V1610 is cathode coupled to the output stages. In the cathode of V1610 is a resistor-condenser network which superimposes a parabola shape on the sawtooth to compensate for the non-linearity resulting from the leakage reactance in the output transformer. V1611 is a voltage amplifier driving V1612, the power output stage.

If for any reason the vertical sweeps need adjusting, proceed in the following manner:

a. Put horizontal bars, such as the 2.1-kilocycle bars from the pulse generator, on the video input and adjust the brightness and picture contrast so that both bars and vertical retrace lines are visable.

b. Turn R1651 (VERT PULSE WIDTH) completely clockwise.

c. Adjust R1661 (VERT PARABOLA) so that bars are spaced equally over the bottom three-quarters of the sweep.

d. Adjust R1715 (VERTICAL PULSE AMPLITUDE CONTROL) so that the bars in the top quarter of the sweep have the same spacing as in the lower bars. Correct any tendency to fold or stretch in the top part of the picture with this control.

e. If the vertical amplitude is not sufficient to sweep the entire tube, back off R1651 VERT PULSE WIDTH (turn counterclockwise) and retune R1661 for linearity. Repeat until linearity and amplitude are satisfactory, keeping the vertical pulse width as short (clockwise) as possible to insure a fast retrace.

f. Different deflection yokes and transformers require different amounts of parabola. Sometimes this variation is enough to overdrive V1611 causing a squashing of the vertical sweep which cannot be corrected by varying R1715. In this case change the value of R1714 to vary the bias on V1611 until a satisfactory value is found which will permit R1715 to perform as it should. R1714 is set at the factory and should not have to be readjusted unless a new yoke and transformer are installed.

(3) Picture Monitor Horizontal Sweeps

The horizontal deflection circuit develops the sawtooth waveform needed for horizontal sweep and retrace. In operation, it is similar to the vertical sweep, except that the output utilizes a pair of 6BG6G tubes (V1617 and V1618) in parallel to furnish the power for the horizontal sweep. Linearity is obtained by the feedback network R1704, R1693, C1650, C1654, R1713, and C1649 connected from the output transformer to the plate of V1615.

If for any reason the horizontal sweeps need adjusting, proceed as follows:

a. Put vertical bars from a bar generator on the video input.

b. Turn R1685 (HORIZ PULSE WIDTH) completely clockwise.

c. Adjust R1704 and R1693 (HORIZ LIN 1 and 2) so that bars are spaced equally over the tube.

d. Readjust R1685 (HORIZ PULSE WIDTH) as needed to obtain linearity at the left edge of the picture, keeping the control as far clockwise as possible.

e. Too much feedback, caused by incorrect settings of R1704 and R1693, will cause the system to oscillate or "ring" at the left edge of the picture. The correct setting of these potentiometers is just before oscillation starts.

f. Check the horizontal amplitude to see that it is sufficient; if not, realign the potentiometers until amplitude is sufficient without sacrificing linearity.

g. Better linearity is sometimes obtained by changing the value of R1713, which changes the wave shape of the feedback voltage. Optimum value of this resistor is picked at the factory and should not require changing unless a new yoke is installed.

(4) Vertical and Horizontal Centering Circuits

Both vertical and horizontal centering circuits have controls so that the value of current through the winding of the centering yoke can be varied. Voltage for this operation is taken from the +400 volt supply.

(5) High Voltage Circuits

High voltage for the picture tube elements comes from a voltage doubler using two half-wave rectifiers, V1641 and V1642, located in the rear of the monitor assembly. Divider circuits are connected across the output of this rectifier to obtain the proper voltages for the cathode-ray tube elements from a common source. Exception is taken in the case of the first anode of the picture tube which is supplied from the 400 volt bus. This connection is used to prevent burning of the fluorescent screen during application and removal of power to the monitor.

(6) Cathode Ray Focusing and Deflection Components

Three magnetic units placed around the neck of the 10FP4 cathode ray tube form what is known as the yoke. Looking at them from the front of the tube they consist of the sweep deflection yoke in its shield can, the centering yoke and the focus coil. The focus unit is made up

of a permanent magnet ring and an electromagnetic coil. The current passes through the coil in the direction which makes the permanent and the electromagnetic fields aid each other.

CAUTION

Handle the focus unit carefully. Dropping or hitting the magnet may demagnetize it.

(7) Tube Adjustments

When a picture tube is first installed, a better focused, squarer picture may be obtained by the following method.

CAUTION

If these adjustments are made with power on, do not touch the 8KV lead to the 10FP4.

a. Remove the two 6BG6 tubes and the 6AS7G sweep tubes, (V1617, V1618 and V1612). Make sure that the brightness control is turned down to prevent burning a spot in the tube.

b. Loosen the wing nuts and the two Phillips head screws holding the centering and focus units.

c. Rotate the centering yoke until the spot moves horizontally when the horizontal centering control is turned. Tighten the Phillips screws in their tapped holes. Do not tighten the wing nuts.

d. Set both the horizontal and vertical centering pots to the middle of their range and move the focus assembly until the spot is as close to the center of the tube face as possible. Tighten the wing nuts.

e. Replace sweep tubes and spread the raster to its normal size by adjusting the horizontal and vertical coil amplitude controls.

f. Loosen the two studs holding the deflection coil and rotate it until the raster sides are parallel with the side of the mask. If the sides of the raster are not straight lines, move the deflection coil horizontally or vertically to minimize the curving. A slight adjustment of the focus coil will also help. Tighten the studs.

(8) Focus Adjustment

Two 10 watt resistors R1897 and R1898 are included in the picture monitor focus circuit. One or both may be disconnected in test in order to adjust the focus control in the center range. If a new focus coil is installed, a new combination of these resistors may be necessary for proper focus centering, otherwise they should not be touched.

B. Waveform Monitor

The waveform monitor is located in the left-hand section of the visual test monitor. It includes a video amplifier circuit in the bottom part of the chassis, a horizontal sweep circuit along the rear, a synchronizing separator at the top of the chassis, and a calibrating pulse generator and mixer in the center. It operates from two regulated inputs: 300 volts, 190 ma and 350 to 400 volts, 240 ma. In addition, -105 volts is used for bias. 6.3 volts from the transformers in the rear of the monitor supplies the filament power. The waveform circuits operate a 5CP1A cathode-ray tube which has 4-kv accelerating voltage, arranged for 2 kv above and below ground.

(1) Video Amplifier

The video amplifier consists of seven stages having shunt compensation for high frequencies and adjustable time-constant compensation for low frequencies. The amplifier is essentially flat to 3 mc, and drops slowly at higher frequencies. It produces negligible phase shift on a 60-cycle square wave. The input level is 0.2 to 0.5 volt peak-to-peak. Vertical deflection up to four inches is permissible.

The first stage consists of two 6SJ7's (V4781 and V4782), each having 1,800-ohm unbypassed cathode resistors and a common plate impedance. They act as mixers to combine the incoming video signal with a calibration pulse. The video feeds into V4781, and the pulses into V4782. With small signals and high degeneration, there is negligible amplitude distortion.

The second stage, V4701, drives a low-impedance gain control, R4712. The compensation for loss of low frequencies in the coupling circuit is adjustable by R4706.

V4705 is a phase inverter, which feeds the two 807's in push-pull. V4706 inserts d-c on the grids of the 807's by rectifying on the sync peaks of the signal. The discharge time constants of these circuits are long, permitting low-frequency distortion and hum which occurs on the incoming signal to be seen on the scope. A switch, S4751, on the front panel is available to disengage the d-c insertion circuits.

The screen supply for the 807's is a VR150 tube, V4710, which acts as a series regulator. V4783 supplies screen voltage for the mixer tubes. Another VR150 tube, V4709, regulates screen voltage for the next three stages.

(2) Horizontal Sweeps

Either of two horizontal sweep speeds can be selected by panel switch S4901. For vertical waveforms, there is a 30-cps sweep showing two fields, and for horizontal waveforms there is a 7.875-kcs sweep showing two lines. The driving pulses come from the vertical and horizontal picture sweep multivibrators and are selected by the switch, S4901. An Eccles-Jordan frequency-halving circuit, V4901, develops the

actual sweep frequencies. Half of V4902 serves as a discharge tube for developing sawtooth voltages across C4915 and C4914. The double triode 6SN7-GT (V4903) is a cathode-coupled inverter having push-pull output from its two plates.

(3) Synchronizing Separator

When the SYNC SWITCH, S4851, is set to PIC or WF, V4851 and V4855 amplify and deliver a sync-positive video signal to V4852, which is a 6AC7 clipper with low-screen voltage for reducing its cut-off bias. The clipper removes the video, leaving only synchronizing signals. V4853 clips the peaks of the sync pulses on its grid and then separates the vertical and horizontal pulses. The vertical pulses are developed by integration across the condenser, C4874 and C4875, and again across C4876 on one grid of the output cathode coupler, V4854. The horizontal pulses are taken from the plate circuit of V4853 by differentiation through C4879 into the other grid of V4854. The cathode output of V4854 feeds to the picture monitor chassis after the vertical pulses have been integrated a third time across C4867, to synchronize the picture sweep multivibrators.

A 10 K potentiometer, R5062, labelled SYNC SEPARATOR ADJUST is installed as variable cathode degeneration for one stage of the sync separator. Its function is to allow the monitor to synchronize on composite signals of widely different amplitudes and sync percentages. Once set up correctly, it should not need readjustment during operation.

To adjust initially, apply a composite monoscope or studio camera signal of the input level expected in operation, but with a lower than normal sync percentage, approximately 15 percent sync. With the monitor operating, turn R5062 clockwise until the monitor sweeps refuse to synchronize. Turn it counterclockwise until the sweeps again refuse to synchronize. Set the control in the middle of this range. Check the setting by going from black signals to white signals and over the range of sync percentages expected.

If either V4851 or V4855 is changed, it may be necessary to readjust this control.

(4) Calibration Circuits

There are four positions on the calibration selector switch These have the functions outlined below:

VID This position permits only video in the vertical deflection amplifier.

SINE Sine position substitutes for the video at the input of the amplifier, a 60-cps sine calibration wave taken from the power line and calibrated to read directly on the scale of the calibration Helipot, R4811, in peak-to-peak volts.

WHT Here the incoming video is mixed with a white extending pulse which occurs during the vertical blanking interval at 60 cps. The amplitude can be adjusted by R4811. This pulse creates a marker by pushing a block of serrations in the white direction from sync peaks.

BLK Selecting BLK, will mix a black extending pulse with the incoming video, in the Visual Text Monitor, ML-735253201, which is used in the Transmitter Console, TC-13-A. This occurs during every other vertical blanking interval and is triggered from the zero r-f reference pulse appearing in the demodulated output of an RCA WM13-A Converter, or other type of keyed r-f demodulator. The amplitude of this pulse is also adjusted by R4811. This position has no function in Monitor Model 4TM5A4.

The absolute amplitudes of these pulses are not directly indicated, but their relative amplitudes can be read on the scale of R4811 with considerable precision. The pulses are generated by the "stop-and-go" multivibrator, V4785. When producing a white pulse, the multivibrator is triggered through half of V4784 by the picture monitor vertical sweep. When producing a black extending pulse, which is used only in ML-735253201 at Transmitter Monitor, the multivibrator, V4785, is triggered through V4784 by the zero r-f level. In order to get the 30-cycle zero r-f signal from the video output of the WM13-A, the signal with white positive is fed to clipper V4784, which cuts off all video and synchronizing pulses and then triggers the multivibrator with the remaining zero r-f pulse. Thus the black calibration pulse starts right after the beginning of the zero r-f signal. With either type of trigger, the output of the "stop-and-go" multivibrator is connected to the second grid of V4784, which develops calibrating pulses of opposite polarity on its plate and cathode. The proper polarity is selected by S4781 for each switch position. Monitor Model 4TM5A4 does not require the BLK pulse and so the amplifier tube V4786 is omitted.

INSTALLATION

The unit is shipped mounted in a console. It has been thoroughly tested and inspected. All interconnection wiring is terminated at the master terminal boards located behind the access door of the console.

CAUTION

Do not extend the monitor from the console without first securing the console to the floor.

1. CONTROL CONSOLE CATHODE-RAY TUBES. Both top and bottom tubes can be installed with the monitor in place, fully extended. With the installation of the cathode-ray tubes, the unit is ready for adjustments and use.

CAUTION

When unpacking, handling, and installing the cathode-ray tubes, wear gloves and a face mask. These tubes can implode with sufficient violence to cause severe cuts and lacerations.

A. The safety-glass ring masks of sponge rubber and the tube shields are shipped in position in the monitor. To install the large cathode-ray tube, remove the shield and supporting yoke by loosening the four Phillips-head screws in the yoke assembly.

B. Remove the tube from its container, and place it face down on the table.

C. Clean the tube face and both sides of the safety glass window. This should be done regularly as dust will cut down the contrast ratio considerably.

D. Slide the shield and the yoke over the neck of the tube as far as it will go, making sure that the anode lines up with the opening in the side of the shield. The anode connection is the electrical connection on the side of the tube.

E. Loosen two screws attaching upper front interlock and slip interlock out of position. Remove the top front tubes in the monitor. Otherwise, they will interfere with locating the tube in place. Hold the tube in the right hand by the neck, allowing the yoke assembly to rest against the bulb proper, and slide the fingers of the free hand between the shield and the tube. If the tube is kept in a horizontal position, it can be lowered easily into its cradle. Note that some adjustment of the focus and deflection system may be necessary to square the raster properly.

F.* With the tube assembly properly positioned (the tube should be full forward against the face mask), secure the screws that fasten the yoke assembly to the yoke carrier and the shield screw. Notice that the bracket screw holes are elongated to permit some adjustment of the tube to proper position.

G. Make all necessary electrical connections (including socket and anode), and replace tubes removed to facilitate installation.

H. The smaller cathode-ray tube is installed from beneath the monitor in a similar manner.

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*See Special Adjustments in MAINTENANCE section.

OPERATION

By following the steps listed below, the monitor can be adjusted for operation. Once properly set up, it requires little attention. The waveform and picture controls are listed separately to simplify the procedure. Do not twist or turn controls until power has been applied, since each monitor has been factory adjusted with all controls being left in their proper position. These may have been disturbed in shipping, however. If the following procedure does not set up a proper raster, refer to the section on MAINTENANCE.

1. OPERATING ADJUSTMENTS

A. Picture Controls

(1) A few seconds after power has been applied, a raster should appear on the picture screen. Adjust its intensity with the background control so that it is clear.

(2) Adjust the horizontal and vertical speed controls to synchronize the scanning frames with the pulses coming from the pulse generator. When these are properly adjusted, all movement (horizontal and vertical) across the screen will stop. Proper timing provides for good interlace and a resultant cessation of all motion.

(3) Use the focus control to get the best electrical focus.

(4) The vertical and horizontal amplitude controls adjust the screen image for proper size.

(5) The contrast control adjusts the video amplifier gain to determine the range of brightness. If a specific video voltage level is wanted for transmission, it has to be adjusted with the contrast control on that particular camera channel control monitor desk.

B. Waveform Controls

(1) Use the INTENSITY control to adjust the brightness of the trace.

(2) Adjust the electrical focus with the FOCUS control until the image is sharply defined.

(3) Use both the VERT CENT control and the HORZ CENT control to adjust the position of the trace.

(4) HORZ AMP control adjusts the width of the display.

(5) SWEEP AMP adjusts the size of the sweep.

(6) SYNC SWITCH. S4851 selects any of four types of synchronizing for the visual test monitor: (a) composite picture signal, (b) composite waveform signal, (c) separate super sync, (d) separate external horizontal and vertical sync pulses. This switch is also located on other monitors, but instead of (b) composite waveform signal, it is OFF. Synchronizing is usually done from the composite picture signal, unless for some reason that signal is inferior to the signal on the waveform scope. The signal from the WM-13A demodulator cannot be used for synchronizing if the r-f zero keyer is turned on. This causes the sync pulses to disappear during the keying pulse, and the sweeps to run free for that period. The third or fourth positions are useful if there is a local pulse generator to supply those signals. When switching from composite or super sync to external separate sync, the horizontal centering will have to be adjusted, because the sweeps are triggered on the leading edge of the horizontal sync pulses for composite or super sync and on the leading edge of the pedestal for external sync. The raster must be shifted to the left by the equivalent width of the front porch.

(7) SWEEP SPEED SWITCH. S4901 permits selection of a waveform monitor sweep frequency of either half-horizontal or half-vertical scanning frequencies. Viewed on the scope, the former (about 7.8 kilocycles) exhibits two sets of line traces side-by-side, with a trace of the horizontal sync pulse in the center. The latter (30 cycles) shows two sets of field traces separated in the center by a trace of the vertical pulse.

(8) CALIB SWITCH. The calib switch is a four-position switch, S4781, for selecting the following inputs to the waveform amplifier:

a. Video only.

b. 60-cycle sine wave calibration only (substituted for the video), which is adjustable by means of the CALIBRATION PULSE AMPL control up to 3 volts peak-to-peak. Its actual amplitude is given by the scale reading on the control within the percent deviation of the line voltage from 120 volts rms. Three hundred on the scale equals 3 volts peak-to-peak.

c. White-extending 60-cycle pulse timed to fall within the vertical blanking interval and mixed with the video signal to avoid errors due to differences between the average value of the video and the calibration pulse. The absolute amplitude of the pulse is not calibrated, but relative heights are given accurately by the scale readings on the CALIBRATION PULSE AMPL control.

d. Black-extending 30-cycle pulses triggered from the zero r-f pulses in the output of the WM-13A Demodulator. These pulses, like the white-extending pulses, can be adjusted in amplitude and their relative heights accurately determined by the scale readings on the CALIBRATION PULSE AMPL control.

(9) DC INSERTION. The d-c insertion is a two-position ON-OFF switch, S4701. D-c insertion should be ON when a television picture signal is connected to the amplifier. This causes the sync peaks to remain at the same position on the scope, independent of variations in the average value of the signal.

(10) CALIBRATION PULSE AMPLITUDE. This is a three-turn Helipot, R4811, with 0.1 percent linearity of resistance as against rotation. It adjusts the level of the calibration pulses fed into the amplifier. It can be set for direct reading by adjusting it to a scale reading of 200 and setting the CALIBRATION REFERENCE control so that the pulse in the waveform display tube matches the maximum peak-to-peak excursion of the signal. The ratio of the reading on the scale of the calibration control for any other setting gives a direct ratio of the height of the calibrated pulse when matching any other part of the signal to the established peak-to-peak reference level. When the pulse is then set to match any other part of the signal, the ratio of the new scale reading to 200 represents the true voltage ratio of the part of the signal to its peak-to-peak value. Thus the scale markings become direct reading. The minimum resistance from the rim of the potentiometer to ground may not quite be zero. To correct for this, the minimum scale reading may be set up proportionally usually about three small divisions.

(11) CALIBRATION REFERENCE. Potentiometer, R4812, is used to adjust the CALIBRATION PULSE AMPL control to some convenient scale reading (200 or 100) to represent 100 percent of peak-to-peak amplitude. There is a dial locking device to prevent accidental changes of its settings.

(12) ADDITIONAL SWITCHES. (The following two switches are mounted only on Monitor ML-735253231 in the Transmitter Console, Type TC-13-A, and are not required for Monitor Model 4TM5A4.

a. R-F Keyer. S4991 turns the zero keyer on or off. (The zero keyer is built into the Waveform Demodulator, Type WM-13A.) The r-f keyer is usually connected in series with the corresponding switch in the Demodulator Power Supply, MI-8262. The latter switch should be placed in the "OFF" position (closed) to permit control at the console.

b. Crystal Detector. The crystal detector turns the wide-band crystal detector on or off. It is built into the WM-13A Demodulator. S4992 is also wired in series with the corresponding switch in the Power Supply, MI-8262, and it should be left in the TEST position to permit control at the console. This detector is intended for exhibiting through the WM-13A, the detected envelope of the transmitter response, to a video sweep signal fed through the monitor.

MAINTENANCE

1. PREVENTIVE

Regular inspection of capacitors, tube sockets, resistors and tubes for noisy or intermittent operation is recommended. Check transformers for abnormal temperature rise.

Keep the unit clean. Use an air hose to remove dust. The high-voltage bushings in the high-voltage supply must be kept clean. Keep the safety glass window clean.

The unit requires no special mechanical maintenance beyond the normal care given studio furniture. Should the monitor become difficult to pull out, use a little cup grease and oil on the slide rollers to get smoother and easier operation. Also, oil spring tapes by shooting oil directly into the spring housing.

On either side of the monitor are two latches operated by buttons actuated from the front of the monitor. Each latch can be adjusted by loosening the associated screws, retightening them when the latch is properly positioned.

To remove the monitor from the cabinet, extend it fully, being careful to unhook the two spring tapes so that they do not wedge and break. Remove the two #10-32 screws on the underside that pull the slide carriage forward with it and disconnect the cable; the monitor then lifts out.

2. CORRECTIVE

A. Monitor Chassis Alignment

If the front panel of the monitor fails to seat properly, realign it as follows:

(1) Re-adjust the position of the ball bearing roller guides on both sides of the top of the monitor and relocate them so that the front panel is properly centered in the opening.

(2) Readjust front panel screws. Clearance for a 1/16-inch adjustment has been provided in the monitor chassis.

(3) If steps 1 and 2 are not sufficient, readjust the runners by first removing the pin screws and then the runner screws. New holes for the pin screws will have to be drilled and tapped after the runners have been relocated.

B. Amplifier Gain

The gain of the picture and waveform video amplifiers is adjusted by means of the contrast and vertical deflection controls on the front panel. The maximum gain of the amplifiers can be measured as follows:

(1) If available, apply a picture signal to the monitor input. Otherwise use a sine wave, preferably of an audio frequency, obtainable from a signal generator and applied to the video input terminal of the monitor. The peak-to-peak amplitude of the signal should not exceed 0.1 volt.

(2) Turn the contrast and vertical deflection controls to maximum clockwise position.

(3) Measure input and output voltage levels using a vacuum tube voltmeter or an oscilloscope with calibrating means. If a voltmeter is used, an oscilloscope should also be used to make sure that excessive distortion does not affect the readings.

C. Waveform Monitor Gain

The approximate gains of the various stages are given below as an aid to isolating a tube or circuit that may be causing trouble.

Tube	Stage Gain	Gain Through Stage
4781	0.5	0.5
4701	2	1.0
4702	4	4.0
4703	4	16.0
4704	5	80.0
4705	0.75	60.0
4707 & 4708	10 (1 tube to ground)	600

D. Picture Monitor Gain

The over-all picture monitor gain as measured to V1638 pin 2 should be about 400. The approximate gains of the various stages are:

Tube	Stage Gain	Gain Through State
V1601	1.25	1.25
V1602	8	10
V1603	4	40
V1604	10	400
V1605	1	400

E. Picture Amplifier High-Frequency Response.

The high-frequency response of the video amplifier in the picture monitor can be checked by use of either a video sweep oscillator and oscilloscope, or a sine wave oscillator and vacuum tube voltmeter.

(1) Connect the indicating device or detector to the output of the amplifier. V1605 pin 5 can be used for the picture monitor. Care should be taken to prevent adding more than about 5 microfarads to the output-circuit capacity. A series capacitor of about 5 mmfd can be used to feed the indicating device, thus providing a capacity divider of constant ratio over the desired frequency range.

(2) Connect the oscillator input through a capacitor of 0.01 to 0.1 microfarad to the various grids, starting near the output and working back towards the input, adjusting the compensating coils for each stage to give response at 5.0 mc equal to that at 0.5 mc. Adjust the following listed coils while the partner tube and pin is connected.

Connect Input to		Adjust
Picture Monitor		
V1604	Pin 4	L 1603
V1603	Pin 4	L 1602
V1602	Pin 4	L 1601

The input level should be adjusted from stage to stage in order to keep the output at a suitable level.

If any trouble is encountered in adjusting the response, check tubes and values of plate load resistors.

F. Picture Amplifier Low-Frequency Response.

The low-frequency response of the amplifier can be checked by means of a 60-cycle pulse or a picture signal.

(1) Apply the pulse or other test signal to the input of the monitor.

(2) Observe the tilt of the wave at the grids of the various stages by means of oscilloscope. Considerable tilt is allowable, since the d-c insertion diodes at the end of the amplifiers will correct it when operating on a picture signal containing both horizontal and vertical blanking. If very excessive tilt occurs, check tubes, grid resistors, coupling capacitors and bypass capacitors for proper value.

(3) Connect the output of the amplifier to be tested directly to the plates of an oscilloscope. If a picture signal is now applied to the input, the blanking or black line should be flat. If the amplifier tilt is not excessive but the output is still tilted, check the d-c insertion tube, V1606, and the associated resistors and capacitors.

G. Deflection Linearity

The picture monitor linearity may be checked and adjusted as directed under the Electrical Description section.

H. Alignment of Waveform Monitor Video Amplifier.

There are two common methods of adjusting the high-frequency response.

(1) Connect a video sweep generator to the amplifier input TB4701-3, and observe the sweep waveform at successive points through the amplifier with a wide-range oscilloscope or with a suitable detector and an ordinary oscilloscope.

(2) Connect a video signal generator to the input, and observe the signal amplitude at various points with a vacuum tube voltmeter or a wide-range oscilloscope.

To adjust the low-frequency compensation of the amplifier, connect to the input a square wave generator having approximately 1/4 volt peak-to-peak signal at 50-100 cps. Observe the signal at various points in the amplifier with a scope having good low-frequency response. Set the calibration switch to VID, position 4. Connect the scope to the cathode of X4701 (temporarily disconnecting the jumper around R4703) or to the grid of X4701. Adjust R4787 for optimum flatness of the pulse and R4705 for the squarest leading edge. Do not check the signal on the cathode of V4702, since there is normally low-frequency distortion at this point. Looking at the cathode of V4703, adjust R4706 for the flatest pulse. Looking successively on the cathodes of V4704 and V4705, adjust potentiometer pairs R4732, R4736 and R4745, R4749 for the best shaped square wave. Looking at the output of the amplifier on the cathode-ray tube, V1637, readjust R4706 for optimum squareness of the wave.

To adjust high-frequency response, first be sure that low-frequency compensation has been adjusted. See previous paragraph. Set the calibration selector switch to VID, position 4, which grounds the grid of the calibration pulse mixer. With an input level of approximately 1/4 volt peak-to-peak, observe the signal on the cathode of X4701 (remove the lead jumper shorting R4703 for video amplifier tests. After alignment, reconnect the jumper from cathode to ground for normal gain from this stage) or the high side of R4712 and adjust compensating coil, L4701, to give a flat response of 3 mc. Connect scope successively to cathodes X4703, X4704, and X4705, and similarly adjust compensating coils L4701, L4702, and L4703. Look at the cathode of the stage following the coil. Take care that there are no peaks in the frequency characteristics. It should never rise above the middle range signal amplitude (about 0.5 mc). The adjustment of the final plate compensating coils, L4705 and L4706 should be done by observing the signal on the w-f tube with a suitable sync signal fed into the horizontal sweep. Short each plate to ground with a capacitor while adjusting the other coil.

I. Trouble Shooting Charts

The following trouble charts will aid the operator in maintaining the unit at its maximum efficiency.

(1) Picture Monitor

	Symptom	Check
a.	Absence of deflection and video voltages.	Fuse F1601, located in front panel 400 volts.
b.	Absence of picture tube high voltages.	Fuse F1603, 2X2/879 tubes, V1641 and V1642.
c.	Unable to focus picture tube.	Check components and voltages of focus coil circuit against Elementary Diagram.
d.	Unable to extinguish raster on picture tube (no video signals applied).	Check V1606. Check negative voltage on pin 4 of V1606, and rotate R1672 Range should be at least 0-50 volts. Picture tube V1638 may have developed grid cathode leakage and may be improved by removing X1638, grounding all elements except control grid and sparking this element with a high-voltage sparker.
e.	Poor horizontal linearity.	Adjust R1704, R1674, R1685, and R1693.
f.	Poor vertical linearity.	Adjust R1661, R1666, and R1715.
g.	Inadequate centering.	Check R1706 through R1711 and adjustment of focus coil.

h.	Inability to horizontally synchronize within range of control.	Check synchronizing signal at pin 4 of V1613. Check values of R1680, R1684, R1686, R1679, R1678, R1685, C1645, and C1644) Check incoming signal
i.	Inability to synchronize vertically within range of control.	Check synchronizing signal at pin 4 of V1607. Check values of R1644, R1645, R1650, R1651, R1653, R1625 and C1626.) level and percent sync.
j.	Poor resolving power of picture monitor.	Check focus. Check frequency response of picture monitor video chain tubes V1601 through V1606. Check V1638 for poor spot size or shape.
k.	Inadequate picture brilliance.	Check V1638 voltages. Check gain of amplifier chain V1601 through V1606. Check V1638 for low emission or poor screen condition by substitution.
l.	Smear in picture.	If certain that origin is within the monitor, check V1606 as well as the values of C1616 and R1638. Check termination resistors with an ohm meter.
m.	White following black picture components.	Check alignment of stages V1601 to V1605, inclusive.
n.	Hum in picture (represented as single synchronous horizontal bar in picture or 60 cycle curves on the vertical edge of the raster.)	Check regulation of associated power supplies.

(2) Waveform Monitor, Models 4TM5A4 and ML-735253201

a.	No deflection on 5 inch tube.	Check F4701 and F4702.
b.	No anode voltage on 5 inch tube.	Check F1604.
c.	Inadequate vertical deflection with specified input level.	Check stage gain of V4701 thru V4708 and V4781 with a frequency less than 1 megacycle. Replace tubes if gain is low.

d.	Unable to focus 5 inch tube.	Check divider resistors R4954, R4955, and R1837 through R1839.
e.	Intensity of 5 inch tube.	Check above dividers as well as voltage across C4952 when R4952 is rotated. Check V1639 and V1640.
f.	Abnormal centering control.	For horizontal centering check R4930A and B as well as R4928 and R4929. For vertical centering check R4761 as well as R4760, R4762 and R4759.
g.	Incorrect amplitude or speed of horizontal sweep.	Check V4901 and components for half frequency operation. Check V4902 and V4903 and circuits. Check horizontal and vertical sweeps in picture monitor.
h.	No synchronizing from composite source.	Check V4752 through V4756 for video clipping and sync separation. Check contacts of S4851.

(3) Removal of Cathode-Ray Tubes

ALL POWER OFF!!!

a. Five-inch tube

1. Disconnect 2nd anode.
2. Loosen screws with anchor socket bracket.
3. Holding tube with left hand, push socket off tube. Push tube backward slightly; it comes right out.

b. Ten-inch tube

1. Remove top front monitor tubes.
2. Remove plug from yoke to X1619.
3. Remove socket.
4. Remove anode wire.
5. Loosen screws holding sweep-yoke assembly to the frame and shield to the collar.
6. Move tube toward the rear, disengaging it from the front ring; it lifts out.

CAUTION

When handling these tubes, always wear a safety face shield or glasses and gloves. This type of tube has been known to implode with violence.

3. SPECIAL ADJUSTMENTS

A precentering ring, L1613, which consists of a permanent magnet ring mounted on a sleeve is furnished with some monitors to eliminate distortion in the picture tube raster. If included with the monitor the precentering ring will be shipped attached to the deflection yoke. After the picture tube has been properly installed, remove the base socket and slip the ring over the tube base. It can face either direction. Reattach the base socket. There are no electrical connections.

The ring should be located approximately one half to three quarters of an inch behind the focus coil. With the monitor on, alternately rotate the coil and use the centering controls to bring the picture back to the center of the screen. The correct ring position is that which produces the least geometric distortion (opposite sides of equal length and with minimum bowing) yet leaves the centering controls with adequate operating range to center a composite picture. The best ring position is where both centering control and distortion are satisfactory.

Courtesy of George Lemaster