OPERATION AND SERVICE MANUAL

VIDEO RECORDING MONITOR

MODEL PA-303

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VIDEO RECORDING MONITOR

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INTRODUCTION AND DESCRIPTION

Video recording, the transcription of televised material onto motion picture film from a cathode ray tube, is an essential medium for network television under many and varied operational conditions, among which are:

1. Where relay facilities are insufficient or non-existent.

2. Where the "take" of a rehearsal will dictate changes to be made in a live show.

3. Where the recording of any information which can be transmitted via television is required for data, study or distribution.

Current practice is to record on motion picture film at the standard rate of 24 frames/sec. by using a high fidelity monitor in conjunction with a 16mm or 35mm camera.

The recording camera is driven by a synchronous motor operating from the local power line so that the film exposure rate is synchronized to the local power line frequency. The television picture rate is necessarily synchronized to the power line frequency at the point of origin. With a mechanical shutter a frequency difference between power lines may cause recording difficulties in distant program pickup. Because of this, a new recording system using an electronic shutter timed by electronic counting circuits has been incorporated in the GPL Video Recording Monitor to provide independence of the synchronizing frequency at the point of program origin. Thus, the Video Recording Monitor can be used with cameras of either shutter type.

The GPL Video Recording Monitor requires a standard white positive composite signal. The circuit design also permits the monitor to accept separated sync and video.

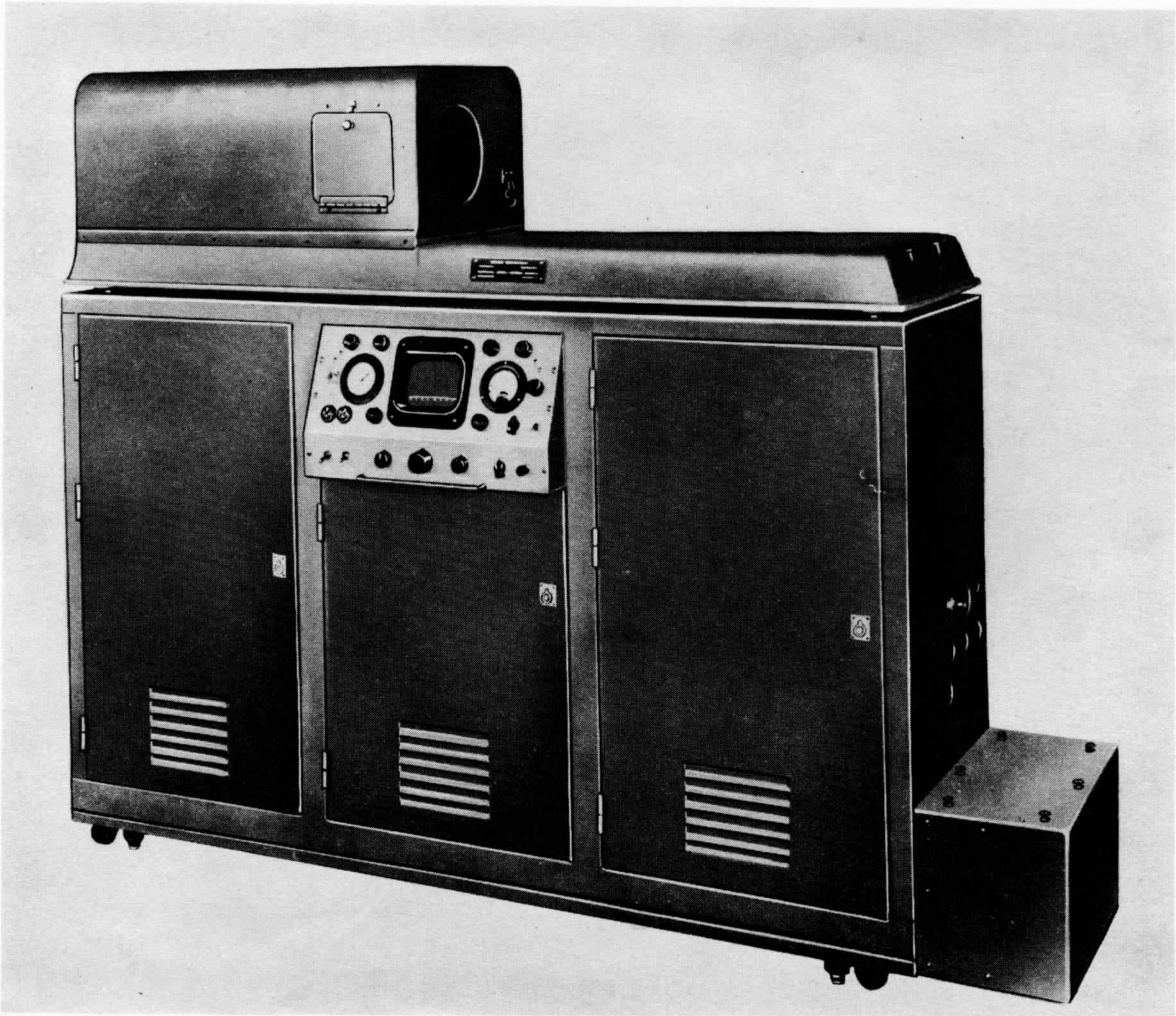
A cathode ray tube operating at 25 KV with magnetic deflection is utilized in the image display unit.

Each original film resolves the scanning lines except in regions of maximum density. A power law amplifier is included to provide the correct grey scale rendition.

Facilities are provided for making either a positive or negative film.

Excellent stability of interlace has been provided, and vibration, which may cause loss of photographic interlace or betray the location of the picture splice, has been reduced to the point where no evidence of vibration effects can be found by close inspection of a recorded picture, projected on a 6 X 8 foot screen.

The information in this manual is presented to better acquaint the operating and maintenance personnel with the GPL Video Recorder and also to facilitate obtaining optimum results.



Video Recording Monitor, Model PA-303

SECTION I

INSTALLATION

1. INSTALLATION REQUIREMENTS

a. Location.-The video recorder (see figure 1-1) must be installed on a solid floor in a location exempt from the vibration caused by railroad trains, subways, trucks or other massive equipment.

b. Space.-The video recorder is 1'10" wide and 6' long. Two and one-half feet of space are needed at the front to operate the unit and two feet in the rear to service it. The room which will contain the recorder should be, therefore, at least 6-1/2 X 8-1/2 feet in size.

c. Ventilation.-The installation location should be properly ventilated to maintain the room temperature at a value which is comfortable for the operators.

d. Power.-A 60-cycle 115-volt a.c. source capable of furnishing two amperes of current for the video recorder is required. The power input preferably should be provided from a branch circuit separate from any other usage. Although the equipment is designed to absorb ±10% variations in line voltage without affecting its performance, voltage regulation should be the best possible.

2. VIBRATION ABSORPTION CHECK AND ASSEMBLY OF EQUIPMENT

Check the top base to see that it is floating properly in its shock mounts. At no time should any object be jammed beneath the base to defeat its vibration-absorption action. Check the vertical deflection chassis (second unit from the top, right section, as viewed from the rear) which is shock-mounted on small rubber grommets. The unit should not be secured too tightly if it is to absorb vibration.

3. CATHODE RAY TUBE INSTALLATION

a. Remove the Allen-head screw which secures the VIDEO switch knob to the shaft protruding through the hood. Note the position of the knob and take it off. Remove the sixteen screws from the base of the hood. Guiding the switch shaft out of the hole in the hood, lift off the hood.

b. Remove the four screws which secure the screen to the base and lift off the screen.

c. Remove the four Allen-head screws which secure the tube-face casting to the base, and life off the casting.

d. If necessary, loosen the screws which secure the sponge-rubber clamps to the casting. Position the face of the cathode ray tube in the casting, and tighten the screws to press the clamps against the tube.

e. Insert the neck of the tube into the deflection yoke and focus coil, and position the face casting over its aligning pins. Install the four Allen-head screws in the casting base.

f. Install the socket on the end of the cathode ray tube and the high voltage lead on the tapered surface using Dow Corning grease (DC-4) for arc-over protection.

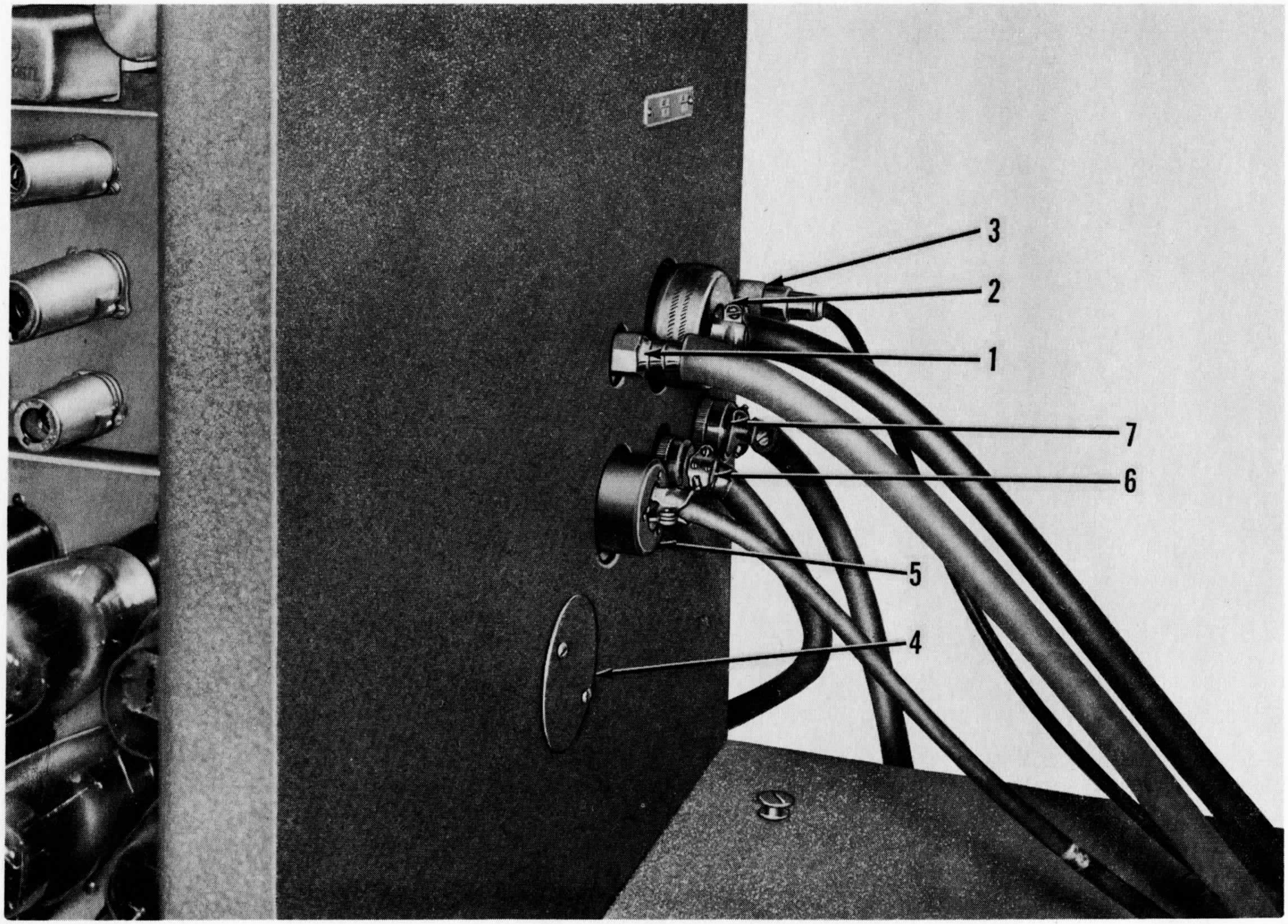


Figure 1-2. External Connections On Right End of Recorder

g. Place the screen in position and install the four screws which secure it to the base.

h. Insert the switch shaft into the hood hole, align the hood screw holes and install the screws.

4. INSTALLATION OF CABLES

a. All external connections are at the right end of the recording monitor console as viewed from the operating side (see figure 1-2).

NOTE

> In preparation for the installation connections, open the rear left door. See PA-302 instruction manual for connections to the GPL 16mm Video Recording Camera.

b. Connect a jumper across terminals 4 and 6 on terminal block E2 of the camera interlock unit if the GPL Rapid Film Processor Model PA-401 is not used.

5. INITIAL OPERATION

a. Prior to applying high voltage to the photographic cathode ray tube, become familiar with the operating controls (see Section I, par. 5) and check the waveform monitor. Use the monitor to determine whether the sweep circuits are functioning properly.

b. Allow a minimum of one-half hour between the time the heater of the cathode ray tube is turned on and the time the anode voltage is applied. This interval is necessary to prevent internal arcing between the anode and other elements of the tube.

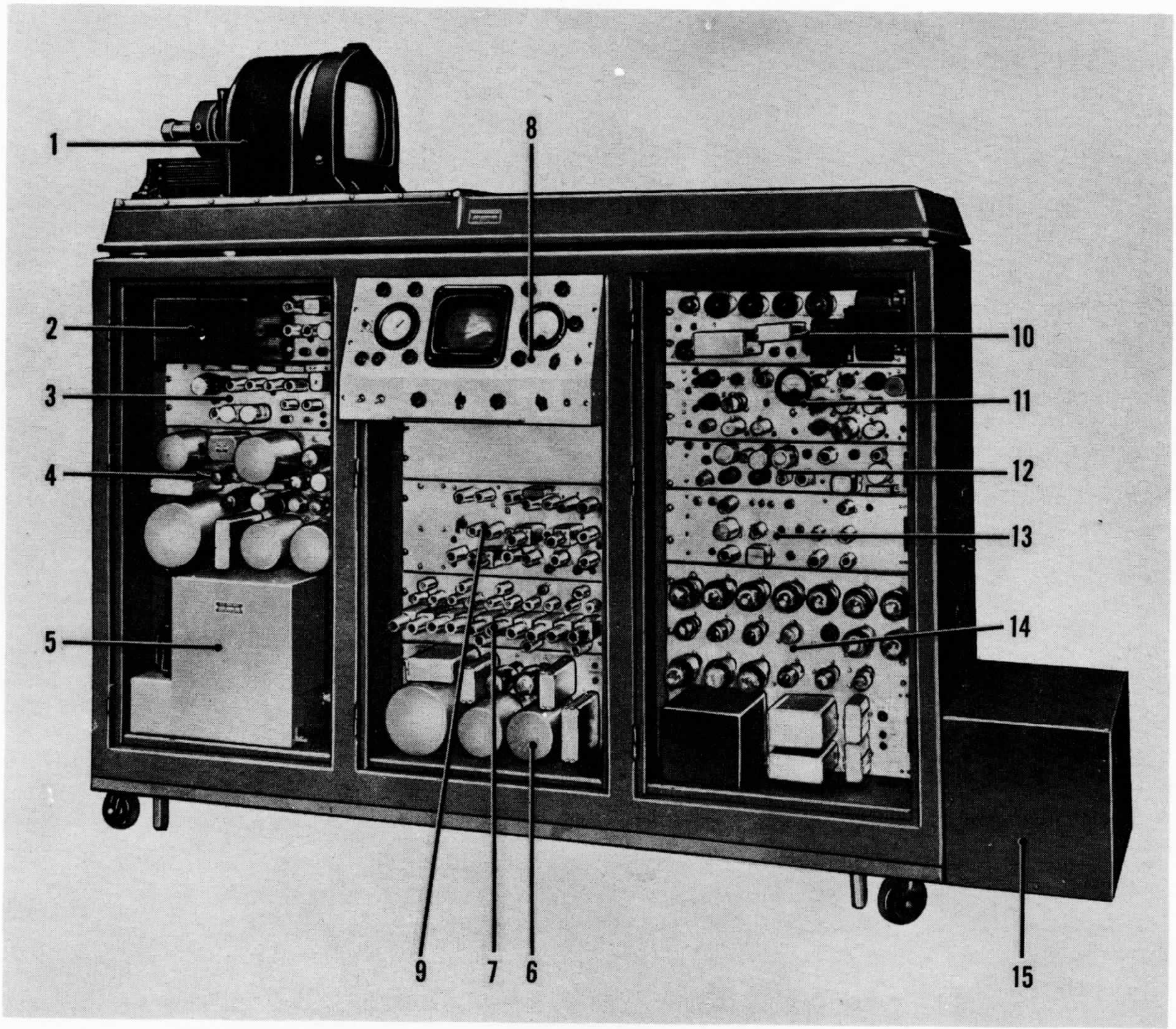


Figure 1-3. **Video Recording Monitor, Sub-Chassis Locations**

Legend for Figure 1-2:

1. Vacuum In
2. A. C. In
3. Video In
4. Sound Galvanometer Input
5. A. C. to Vacuum Pump
6. Processor Interlock
7. Processor Interlock

Legend for Figure 1-3:

1. Image Display Unit
2. Horizontal Deflection Chassis
3. Vertical Deflection Chassis
4. ±150 Volt Power Supply
5. 30 KV High Voltage Supply
6. 450-Volt and 550-Volt Power Supply
7. Pulse Counter Chassis
8. Waveform Monitor and Control Panel
9. Electronic Shutter and Control Chassis
10. Videogam Power Supply
11. Videogam Amplifier
12. Sync Separator Chassis
13. Sync Pulse Generator
14. Low Voltage Power Supply
15. Blower

Legend for Figure 1-4:

1. Meter Selector Switch
2. Calibration Voltage Adjust
3. Video Gain CRT
4. WFM Selector Switch
5. CRT Focus
6. WFM Vertical Gain
7. 25 KV On-Off Switch
8. Power On-Off Switch
9. Anode Voltage On-Off Pilot Lamp
10. Power On-Off Pilot Lamp
11. Vacuum Gauge
12. Input Test Jack for WFM
13. CRT Vertical Hold
14. CRT Horizontal Hold
15. Waveform Monitor CRT
16. Anode Voltage Adjust
17. CRT Bias
18. Test Meter
19. CRT Horizontal Centering
20. WFM Line/Frame Frequency Switch
21. Camera/Standby Switch
22. Beam Current Meter Shunt

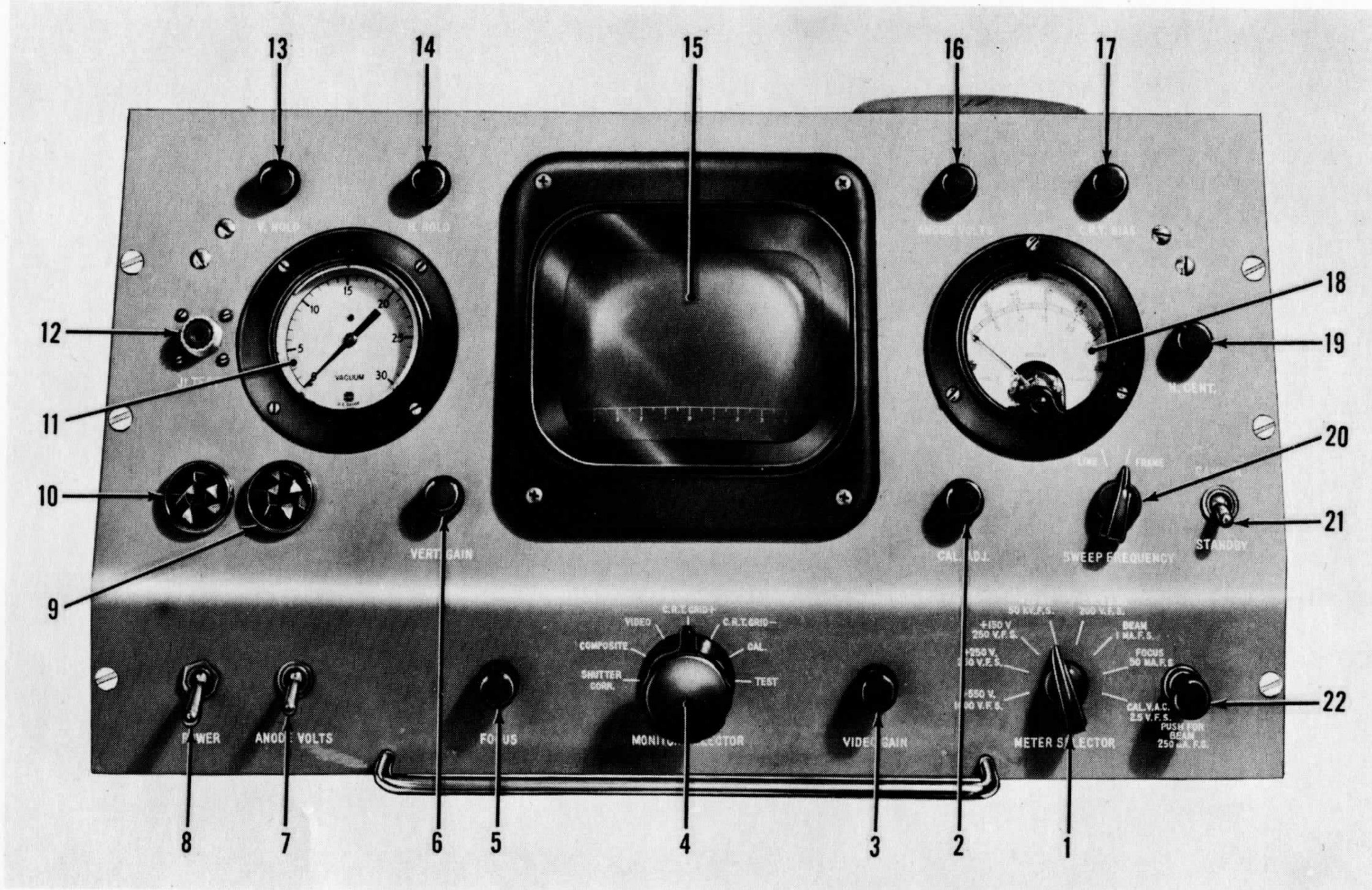


Figure 1-4. **Waveform Monitor and Control Panel**

6. OPERATING CONTROLS AND INDICATORS

a. Waveform Monitor and Control Panel (see figure 1-3, item 8)

(1) "POWER" Switch (see figure 1-4, item 8).-Turns on all power in the equipment except the 25KV anode voltage. A green pilot light indicates that power is on.

(2) "ANODE VOLTS" Switch (see figure 1-4, item 7).-Turns on the 25KV anode voltage for the photographic cathode ray tube. A red pilot light indicates that high voltage is on.

(3) "FOCUS" Knob (see figure 1-4, item 5).-Adjusts the focus of the picture appearing on the face of the photographic cathode ray tube.

(4) "V. HOLD" Knob (see figure 1-4, item 13).-Holds the raster vertically in position.

(5) "H. HOLD" Knob (see figure 1-4, item 14).-Holds the raster horizontally in position.

(6) "H. CENT" Knob (see figure 1-4, item 19).-Centers the raster horizontally on the photographic cathode ray tube monitor face.

(7) "CRT BIAS" Knob (see figure 1-4, item 17).-Controls the brightness of the cathode ray tube picture. Read on the voltmeter when the METER SELECTOR switch is set at "CRT BIAS".

(8) "ANODE VOLTS" Knob (see figure 1-4, item 16).-Adjusts the value of the anode voltage as read on the voltmeter with the METER SELECTOR switch set at 25KV.

(9) "CAMERA-STANDBY" Switch (see figure 1-4, item 21).-In the "CAMERA" position the vacuum pump is turned on and the electronic shutter chassis is gated by the camera through the camera interlock. (Timing control, therefore, must originate in the camera.) In the "STANDBY" position the vacuum pump is inoperative. This position substitutes a dummy 24-cycle pulse for the camera pulse and allows operation of the whole system, with the exception of the camera, for checking purposes.

(10) "VACUUM" Meter (see figure 1-4, item 11).-Indicates the vacuum pressure (at the vacuum regulator) holding the film in the camera gate.

(11) "VOLTMETER-AMMETER" (see figure 1-4, item 18).-Operates in conjunction with the METER SELECTOR switch as internal test and calibration meter. Three scales (0-25, 0-50 and 0-100) appear on the meter.

(12) "METER SELECTOR" Switch (see figure 1-4, item 1).-Any one of eight positions may be selected, seven of which are check positions and one a calibration position. Readings should be accurate to $\pm$5% except for the anode voltage which should be accurate to $\pm$2%. The switch positions are:

(a) "+550V".-A check on the +550 volt power supply. Read on the 0-100 scale with the "100" mark representing 1000.

(b) "+250V".-A check on the +250 volt power supply. Read on the 0-25 scale with the "25" mark representing 250.

(c) "+150V".-A check on the +150 volt power supply. Read on the 0-25 scale with the "25" mark representing 250.

(d) "50 KV"-A check on the 30 KV high voltage supply. Read on the 0-50 scale with the "50" mark representing 50 KV. The anode voltage is adjusted by the ANODE VOLTS control knob.

(e) "CRT BIAS".-Permits a reading of the photographic cathode ray tube bias. Use the 0-100 scale with the "100" mark representing 200 volts (or readings multiplied by 2). The cathode ray tube bias is adjusted by the CRT BIAS control knob.

(f) "BEAM".-Permits measurement of the photographic cathode ray tube beam current. Read on the 0-100 scale with the "100" mark representing 1 milliampere.

(g) "FOCUS".-Permits measurement of the cathode ray tube focus coil current. Read on the 0-50 scale with the "50" mark representing 50 milliamperes.

(h) "CAL. V. A.C.".-Provides a regulated voltage for calibration purposes. The voltage is controlled by the CAL. ADJ. knob and is read on the 0-25 scale with the "25" mark representing 2.5 volts (peak-to-peak). The calibration setting is made with the MONITOR SELECTOR switch in "CAL." position and is used to fix the VERT GAIN control knob and calibrate the monitor tube.

(13) 250uA PUSH BUTTON (see figure 1-4, item 22).-Increases the sensitivity of the meter by a factor of 4 for a beam current reading. Read on the 0-25 scale with the "25" mark representing 250 microamperes.

(14) "CAL. ADJ." Knob (see figure 1-4, item 2).-Controls the calibration voltage read on the meter.

(15) "VERT GAIN" Knob (see figure 1-4, item 6).-Controls the vertical gain of the waveform monitor. The knob is left fixed after the monitor tube is calibrated.

(16) "FRAME-LINE" Switch (see figure 1-4, item 20).-Permits synchronization at line (15, 750 lines/sec.) or frame (30 frames/sec.) rate for any of the MONITOR SELECTOR positions.

(17) "MONITOR SELECTOR" Switch (see figure 1-4, item 4).-Any one of seven positions may be selected for waveform checking:

(a) "SHUTTER CORR."-Permits checking of the compensating voltage waveform.

(b) "COMPOSITE".-Permits examination of the video input signal.

(c) "VIDEO".-Permits examination of the video signal at the output of the videogam amplifier, before it reaches the VIDEO GAIN control knob.

(d) "CRT GRID +".-Permits checking of the signal delivered to the grid of the photographic monitor cathode ray tube by the video amplifier in film recording (positive polarity).

(e) "CRT GRID-".-Same as (d). (negative polarity.)

(f) "CAL".-Permits adjustment of the calibrating voltage.

(g) "TEST".-Permits examination of the waveforms at various points of the equipment. A test probe is inserted into the J1 TEST jack and connected to various chassis test jacks or to any desired point of the apparatus (by prod). When a voltage value is more than 10 volts peak-to-peak, an attenuator (with high frequency compensation) should be connected into the test line.

(18) "VIDEO GAIN" Knob (see figure 1-4, item 3).-Controls the photographic monitor cathode ray tube grid swing. The video swing is monitored with the MONITOR SELECTOR Switch in the CRT GRID+ or CRT GRID- position.

(19) "VACUUM PRESSURE" Control.-A screw-knob and adjustment on the vacuum regulator permits bleeding and control of the vacuum pressure when necessary. It is located in the upper right-hand corner of the Videogam Power Supply compartment (figure 1-3, item 10).

(20) PHOTOGRAPHIC MONITOR.-The VIDEO SIGNAL switch permits direct-positive or negative film recording in the "Pos." and "Neg." positions, respectively.

7. CONSOLE CHASSIS ADJUSTMENTS. Most of the chassis in the console contain screwdriver or control knob adjustments (indicated on the associated schematic diagram with direction of increase). These adjustments are set prior to shipment and need not be changed except in case of radical departure from normal operation.

a. Horizontal Deflection Chassis (see figure 1-3, item 2)

(1) "HOLD" Screwdriver Adjustment.-Provides synchronism of the blocking oscillator with the incoming horizontal synchronization pulse through the adjustment of potentiometer R5.

(2) "DRIVE" and "BIAS" Knobs.-These controls adjust the magnitude of the synchronized sawtooth voltage through the use of potentiometers R7 and R17 respectively. The controls are set in conjunction with the linearity control (R36) until optimum linearity of the picture is obtained as shown by either a bar or a test pattern.

NOTE

Occasionally better linearity may be obtained by disconnecting the plate of one-half of one of the 6AS7G tubes in the damping circuit.

b. Vertical Deflection Chassis (see figure 1-3, item 3)

(1) "HOLD" Screwdriver Adjustment.-Provides synchronism of the blocking oscillator with the incoming vertical synchronizing pulse. The frequency of the blocking oscillator is controlled by variation of the grid time constant through the adjustment of potentiometer R5.

(2) "LINEAR" Screwdriver Adjustment.-A 1000-ohm linearity control (R27) which permits obtaining optimum linearity of sweep.

(3) "AMPL." Knob.-Controls the vertical size of the raster on the photographic monitor tube.

c. +150 Volt Power Supply (see figure 1-3, item 4)

(1) "+150V" Screwdriver Adjustment.-Permits adjustment of the voltage output through potentiometer R8 so that +150 may be set accurately. The range of the control is from 120 to 175 volts.

d. 30 KV Regulated High Voltage Power Supply.-None

e. High Voltage Condenser Assembly.-None

f. Waveform Monitor and Control Panel Unit (see figure 1-3, item 8)

(1) "FOCUS" Screwdriver Adjustment.-A coarse control of the focus of the photographic monitor picture through potentiometer R105.

(2) "ASTIG. CORR." Screwdriver Adjustment.-Permits correction of any distortion in the waveform monitor through potentiometer R37.

(3) "FRAME LOCK" Screwdriver Adjustment.-Controls sweep frequency of the waveform monitor blocking oscillator at frame rate. Waveform locked to frame frequency through potentiometer R66.

(4) "LINE LOCK" Screwdriver Adjustment.-Control of sweep frequency of waveform monitor blocking oscillator at line rate. Waveform locked to line frequency through potentiometer R67.

(5) "SYNC" Screwdriver Adjustment.-Permits synchronization of the waveform monitor sweeps with the input signal through potentiometer R94.

(6) "HOR. GAIN" Screwdriver Adjustment.-Control over the waveform monitor horizontal amplitude of the input signal through potentiometer R56.

(7) "EXT. SYNCH-NORMAL" Switch.-Permits employment of external synchronization if desired. (Internal synchronization is normally used.)

(8) "H. CENT."-Coarse adjustment of horizontal centering.

(9) "V. CENT."-Coarse adjustment of vertical centering.

(10) "INT".-Controls intensity of trace on face of CRT.

g. Electronic Shutter Unit (see figure 1-3, item 9)

(1) "LINE PULSE HOLD" Screwdriver Adjustment.-This adjustment (potentiometer R17) permits positioning of the shutter bars. Observing the photographic monitor tube face, 24-cycle synchronized operation can be established.

(2) "EXT. CAM" Switch.-Permits the operator to control the source of triggering signal for the shutter. In the "CAM" position, the camera pulse provides the triggering for the shutter; in the "EXT" position, an externally generated pulse can supply the triggering for non-standard recording.

(3) "AMPL." Screwdriver Adjustment.-Controls the amplitude of the shutter correction pulse through potentiometer R80.

(4) "SHAPE" Screwdriver Adjustment.-Also controls the amplitude of the shutter correction pulse, but primarily changes the slope of the waveform. When the "SHAPE" control (potentiometer R79) is set at maximum clockwise, the waveform will be most parabolic.

(5) "V. WIDTH" Knob.-Controls the width of the vertical superblanking pulse through potentiometer R55.

(6) "H. WIDTH" Knob.-Controls the width of the horizontal superblanking pulse through potentiometer R64.

NOTE

The vertical and horizontal superblank width controls are adjusted so that the picture is surrounded by a white border 1/16 to 1/8 inch wide when operating with a negative polarity video signal.

h. Pulse Counter.-None (see figure 1-3, item 7)

i. +550, +450 Volt Power Supply.-None

j. Sync Separator (see figure 1-3, item 13)

(1) Input Gain Control.-Set for 1 volt at grid of V1.

(2) "SEPARATION LEVEL CONTROL" Knob.-Used to adjust the DC level of clamping during the back porch interval through potentiometer R19.

(3) "SET UP" Knob.-Changes the bias on the video output diode so that the separation level for the video signal can be raised slightly above that of the synchronizing signal through potentiometer R47.

NOTE

If the level of the signal through the entire video channel is too high, it may over-ride the clamping pulses being fed into the double diode clamp. As a result the clamp will not function properly during high video signals and streaks will appear in the picture. Conversely, if the signal is too small throughout the system, not only will the output signal be too small but the clamp may lose synchronization, rendering the signal unusable. The range of signals over which the equipment will operate satisfactorily is very large, corresponding approximately to those which produce video output signals varying from 0.2 to 2.0 volts peak-to-peak.

k. +330, +250 Volt Power Supply (see figure 1-3, item 14)

(1) R16 and R28 are screwdriver adjustments controlling the +330 and +250 volt outputs.

l. Sync Pulse Generator (see figure 1-3, item 13)

(1) See Section III since this requires the use of an oscilloscope.

SECTION II

OPERATION

1. INITIAL AND PERIODIC SET UP OF THE VIDEO RECORDER

a. General.-Upon installation of the video recorder and at periodic intervals, it will be necessary to determine certain optimum operating levels for best results in film recording. The determination of the necessary settings involves considerable testing, but once established, the settings are used continually. Aging of components, the cathode ray tube in particular, will cause the optimum settings of the controls to change slowly with time. Therefore the controls must be checked periodically by film results to ascertain what readjustments, if any, should be made.

The establishment of the optimum operating levels for the video recorder assumes that the photographic processing for the film recording has been standardized to eliminate all variable factors. The operating levels can, therefore, be determined by fixing the several remaining variables for best picture.

Another consideration is that of whether single (direct positive) or double (negative and positive) film technique is to be employed in the film recording. The technique applied will indicate the optimum film density range.

b. Picture Variables.-The black and white levels in the film recording need to be set for best results. These levels depend upon the iris setting of the camera lens and upon the amount of light reaching the film.

The iris setting of the camera lens is a compromise between available light and depth of field. In general, operating conditions will require all available light to insure obtaining the optimum film density. This necessitates operating the lens at its widest opening (f/1.6). With this setting, however, the depth of field of the lens is so shallow that focus is lacking over the entire raster area. Optimum results are therefore obtained at a compromise value between f/2 and f/2.4.

The amount of light reaching the film is determined by the bias level and by the video signal swing on the grid of the cathode ray tube. To determine the best set of values necessitates a series of test film strips using various cathode ray tube grid swings. For single film recording the operating levels should be established to result in a density range on the positive of approximately 0.2 to 2.0; for double film recording the operating levels should be established to result in a density range on the negative of approximately 0.3 to 1.3. While the latter range is small, it will be transformed to a very large range of densities when the positive is printed on the standard high gamma print stock.

In conducting tests with standard television signals, the operator should check to see that a black signal is present in the test picture. Many television signals have considerable setup which will remove any true black from the signal being recorded. When such is the case, the setup control on the sync separator chassis should be adjusted so that the blackest blacks in the signal on the grid of the cathode ray tube just reach the blanking level.

NOTE

> The cathode ray tube bias is read on the control panel meter. The relative video swing is monitored by the waveform monitor in terms of the voltage derived from the special monitor output of the video amplifier which drives the grid of the cathode ray tube. Whenever the cathode follower output tube in the video amplifier is changed, therefore, the system will have to be recalibrated.

The videogam amplifier is the only other variable influencing the picture. After the black and white end points have been established, an additional set of test film strips must be run with different settings of the videogam amplifier to determine the best operating values. The settings will always be at some power value less than 1, regardless whether single or double film recording is applied.

2. TEST STRIP METHOD OF SETTING UP THE VIDEO RECORDER

In order to check focus and picture position when setting up the recorder, and for routine daily checks which do not require accurate photographic processing, the test strip method is recommended.

The equipment is run in a normal manner for ten or fifteen seconds and then shut off. With the room lights off, using only a red safelight, the take-up magazine is opened and 2 or 3 feet of exposed film is removed by breaking the film.

This test strip may be developed, fixed and washed in small open tanks or beakers and then dried in front of an electric fan. For quick processing, the following chemicals are suggested:

Developer: Eastman Kodak D-8 stock solution, 1-3 minutes at 68°F.

Fixer: Eastman Kodak F-7, about 30 seconds at room temperature.

The lights may be turned on after the film clears and the test strip then examined with a microscope of 20-40 power.

3. NORMAL OPERATION OF THE VIDEO RECORDER

a. Chassis Adjustments.-All necessary chassis adjustments in the video recorder are made at the time of manufacture and also when the equipment is installed. These settings are not normally touched again. The settings of the recording factors are determined initially but must be changed periodically. Other adjustments are called for in normal operation of the video recorder which may be performed at the beginning of the operating day and several times during the day at periods when recordings are not being made.

b. Operating Checks.-To operate the equipment and perform these adjustments, proceed as follows:

(1) Check that the CRT "ANODE VOLTS" switch on the control panel is "OFF" and that the "CAMERA-STANDBY" switch is in the "STANDBY" position. Turn on the main "POWER" switch at the lower left of the panel, thereby applying all power to the equipment except the 25 KV anode voltage. Allow

the equipment to warm up for at least fifteen minutes.

(2) After several minutes of the warm-up period, set the meter selector switch on "CAL. V. A.C." and adjust the "CAL. ADJ." control so that a 2 volt peak-to-peak voltage is obtained on the meter. Then set the "VERT. GAIN" control (waveform monitor vertical amplifier) so that the necessary vertical deflection is obtained on the waveform monitor with the MONITOR SELECTOR in the "CAL." position.

(3) Set the MONITOR SELECTOR at the "COMPOSITE" position and check the input waveform on the waveform monitor. The composite video signal should be 1 to 2 volts peak-to-peak in amplitude. Check that there are no peculiar overshoots in the waveform and that high frequency response is not lacking. The latter is indicated by a slow roll off on the edges of the sync and blanking pulses. Also check the sync-to-video amplitude.

(4a) Set the MONITOR SELECTOR at the "VIDEO" position, and check the operation of the sync separator and videogam amplifier. The sync separation level and setup controls on the sync separator chassis should have been previously adjusted for an output signal with the separation exactly at the blanking level and with the setup removed. If necessary, the sync pulse generator may now be adjusted since it is receiving the proper input signal.

(4b) Using "Test" position ascertain that the sweep deflection chassis are operating.

(5) Adjust the "V. HOLD" and "H. HOLD" controls to properly lock the sweep circuits.

NOTE

Proper adjustment of the sync generator chassis and the HOLD controls may not always be indicated by proper synchronism of the sweeps on the picture tube due to the fact that the HOLD controls on the sweep chassis may not be properly adjusted. The "TEST" position of the MONITOR SELECTOR is useful for determining when the sync pulses sent out of the sync pulse generator are properly locked. Faulty synchronism of the sweeps may then be isolated to the sync pulse generator or the deflection circuit itself.

(6) Set the MONITOR SELECTOR on "SHUTTER CORR.". Check the operation of the electronic shutter. A parabolic wave should appear on the waveform monitor.

(7) Set the MONITOR SELECTOR on the "CRT+" and "CRT-" positions. Check the operation of the video amplifier.

(8) Using the METER SELECTOR switch and the meter, check the equipment for proper operating voltages. The 150-volt bias supply cannot be measured by the meter, but it can be checked superficially by noting whether the three voltage regulator tubes in the chassis are properly ionized.

(9) After the necessary warm-up period (with CRT bias at maximum), turn on the high voltage by the "ANODE VOLTS" switch. Use the meter and the "METER SELECTOR" and "ANODE VOLTS" controls to keep the high voltage below 26 KV during the hald-hour warm-up.

(10) After several minutes of warm up, set the "ANODE VOLTS" control so that the meter reads 25 KV. Adjust the "CRT BIAS" control so that a raster of medium brilliance is obtained for optical observation.

(11) Adjust the focus control for optimum focus. Initially this adjustment is made visually, and the focus control set so that optimum focus is obtained in a circle about 4" in diameter about the center of the cathode ray tube as observed by a microscope. When focus is established in this manner, the focus current is slightly more than is necessary for focus in the center of the raster.

NOTE

During the first 15 or 20 minutes of warm-up, the output of the high voltage supply may rise approximately 5%. The high voltage and the focus current values normally will not be steady until the half-hour warm-up is completed.

(12) Adjust the "H. CENT." control to center the raster horizontally.

(13) Turn up the VIDEO GAIN control so that a picture or test pattern appears on the face of the cathode ray tube. Reset all previous adjustments (brightness, focus, centering, etc.) to obtain the best picture in the correct position.

(14) The cathode ray tube picture should contain two splices (two bars, half a picture height apart). The bars represent the beginning and the end of the "ON" time of the cathode ray tube as operated by the electronic shutter.

If the two proper picture splices are not observed, proper frequency control must be set up in the electronic shutter by adjusting the "LINE PULSE HOLD".

(15) Check the shutter compensation waveform to see that it is of proper shape and amplitude. Use the MONITOR SELECTOR "SHUTTER CORR." position and the waveform monitor. Check the operation of the compensating circuit by turning off the video signal and increasing the cathode ray tube bias until the raster is low in intensity. The increase in intensity near the end of the exposure (just above the two splice bars) can then be observed.

(16) Pictures taken by the camera may indicate improper vertical centering. It may be necessary to reposition the focus coil using the mechanical adjusting screws associated with it to correct this defect. In conducting this test, first set the linearity controls on the deflection chassis at their optimum position. Using a test pattern signal, boundaries will be more easily established. The boundaries should be set so that the film receives all the information in the original picture; that is, so that the top and bottom of the picture are not cut off. A small amount of bare film will be left on the sides of the picture due to the fact that the aspect ratio of the television picture (4 by 3) is slightly different from the aspect ratio of the camera aperture (4.2 by 3).

(17) Turn the CAMERA-STANDBY switch to the "CAMERA" position, thereby starting the vacuum pump (when applicable).

NOTE

The picture will disappear from the face of the cathode ray tube in the "CAMERA" position until the camera is in operation. Check the vacuum pressure on the control panel gauge. The value should be between 22 and 26 inches.

(18) Open the camera doors and check the functioning of the camera.

SECTION III

THEORY OF OPERATION

1. SENSITOMETRY

When a camera is used to take a picture, the photographer has the specific purpose in mind of obtaining a good reproduction. A subjective approach is an uncertain, inconvenient and often costly way of obtaining this end. In most cases, it is almost impossible to duplicate. The best way is by defining the aim objectively in terms of print quality and obtaining results systematically. A good print, generally specking, is one in which the full scale of the film is utilized from black to white and in which there is detail in the highlight and shadow areas. A good print cannot be made without a good negative; negative film quality is fundamental.

a. Sensitometry is the name applied to the measurement of sensitivity and the study of the technical factors affecting the use of film. In sensitometry the measurements and language are specific and quantitative. While most of the words are familiar enough, many have a special meaning when applied to photography.

b. Exposure (E) is the total quantity of light energy reaching the film at any particular point. It is the product of the illumination (I) as it reaches the film and the time (T) that light is allowed to act on the film. $E = IT$ (where illumination varies with time, Exposure $= \int_0^T I\,dT$. During

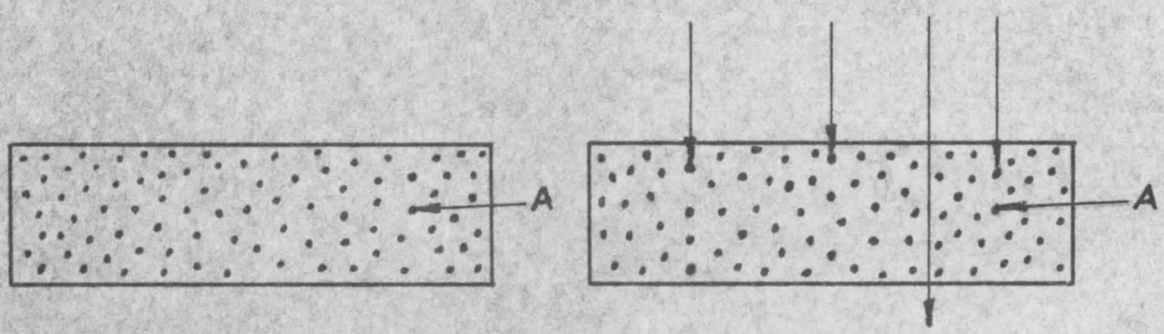


Figure 3-1. Cross Section of Film with Silver Deposit

the time that the film is exposed, many different light inteneities strike the film. This causes various degrees of exposure, all of which go to make up the negative image after development.

c. Illumination (I) is the amount of light which reaches the film. In the case of a direct positive recording, a slightly overexposed film will result in black compression and a slightly underexposed film will result in white compression. Extreme over-or under-exposure will result in an unusable film.

d. Time (T) is fixed at 1/30 second.

e. Density is the result of exposure and becomes a silver deposit on the film after development. On its adequacy and on the inter-relationship of all the deposits on the film depends the ultimate quality of the picture. To conceive the mathematical approach to density:

(1) Consider a cross section of developed film with a silver deposit "A" (See figure 2-1).

(2) Suppose the deposit is just enough to permit half the incident light to pass through.

(3) Since the transmission equals the light passed divided by the light incident, the transmission is one-half or 50%.

(4) The reciprocal is called opacity and is equal to 2.0.

(5) The logarithm of opacity is called density and is equal to 0.3.

Opacity and transmission are both inadequate for most photographic computations since they are arithmetical functions and are not directly related to our visual impressions, which are logarithmic. Therefore, the

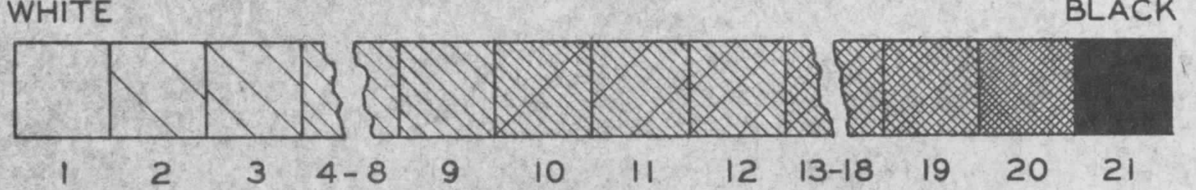


Figure 3-2. Sensitometer Wedge

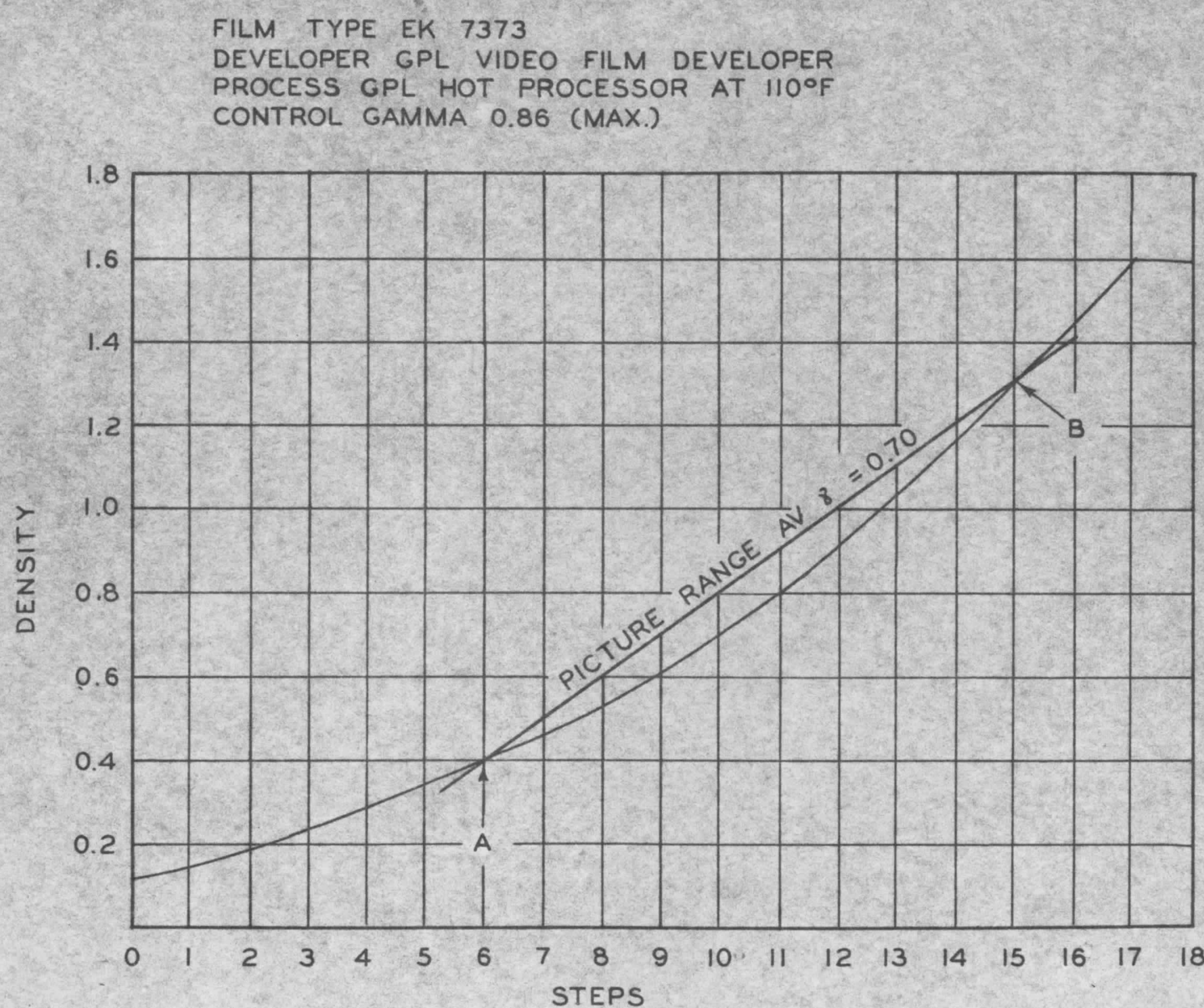


Figure 3-3. Eastman Kodak 7373 H & D Curve

term density is freely used in photographic technical discussions.

f. A sensitometer is any device which produces a series of accurately related exposures. This is required to maintain processing control. A densitometer is required for measuring the densities encountered after exposed film is processed. By comparing and controlling the relationship between exposure and density in film, remarkable uniformity can be maintained on video recordings.

g. The characteristic curve is established on the basis of the above and is plotted on a graph. It indicates the exact relationships between exposure and density. For ease in plotting, since density is a logarithmic expression, exposure is transposed into logarithmic terms and becomes known as "log E".

h. The most common sensitometers consist of a fixed light intensity for a fixed time and a calibrated "wedge" or gray scale as shown in figure 2-2. The film is exposed to the light transmitted through the wedge. If the values of light intensity, time and transmission of the steps in the wedge are known, the curve shown in figure 2-3 can be plotted, using absolute values for log E.

Relative values can be used if the characteristics of the wedge are known, assigning unity values for the light intensity and time. Most wedges in use today are calibrated so that the light transmission of adjacent steps varies by the square root of 2 or log 0.15.

Each film has a unique curve, and since this curve is used to define the characteristics of the film, it is known as the characteristic curve.

The characteristic curve will vary with any appreciable change in the processing constants, such as developer, developing time, or temperature.

Underexposure results in operation at the toe of the characteristic curve. Overexposure will result in operation at the shoulder. The straight line portion, where density increases uniformly with log exposure, is the correct operating range.

Gradient is the slope of a line drawn tangent to the curve at any point. It represents the rate of density growth at that point. Starting from fog level where the gradient is zero, and moving to the right, the tangent reaches its maximum on the straight line portion where it is called gamma.

Tests described in other literature have shown that a wholly acceptable negative is one capable of yielding an excellent print. The minimum exposure must not fall below the point at which the gradient equals .3 of the average gradient.

The average gradient is the mathematical average of the gradient values for all the points on the curve between the points of minimum and maximum exposure. This means that at least part of the subject is located on the toe, with the shadows having moderate contrast and the high lights having more contrast. Additional exposure is permissible but decreased exposure will result in reduced quality in the resulting exposure image. In video recording, additional exposure permits more linear reproduction and maximum resolution.

i. Films should be developed under fixed conditions which control the gamma. These conditions are:

(1) Constant temperature

(2) Fixed time in developer. (For machine processing this means fixed speeds.)

(3) Fixed concentration of developer.

2. ELECTRICAL FACTORS INFLUENCING EXPOSURE

In the preceding section, exposure was defined as the total quantity of light energy reaching the film at any particular point. Since exposure is the product of illumination and time, these terms must be examined to determine their effect on the final print. Although time is considered here as equal to 1/30 second, this is not quite true for either a mechanical or electronic shutter. However, it is a fixed quantity so that it has no effect on this discussion. Illumination is defined as the amount of light which reaches the film in one unit of time. This infers that the amount of light reaching the film can be controlled. In the case of a video recording this is true in two ways:

a. First, the aperture of the lens must be set with the following criteria in mind:

(1) Sufficient depth of field must be available to bring into focus the entire face of the photographic monitor.

(2) A lens has maximum resolution usually one stop from maximum aperture.

(3) Operation of the photographic monitor must be such that the video swing does not cause the image to "bloom" on positive peaks and does not

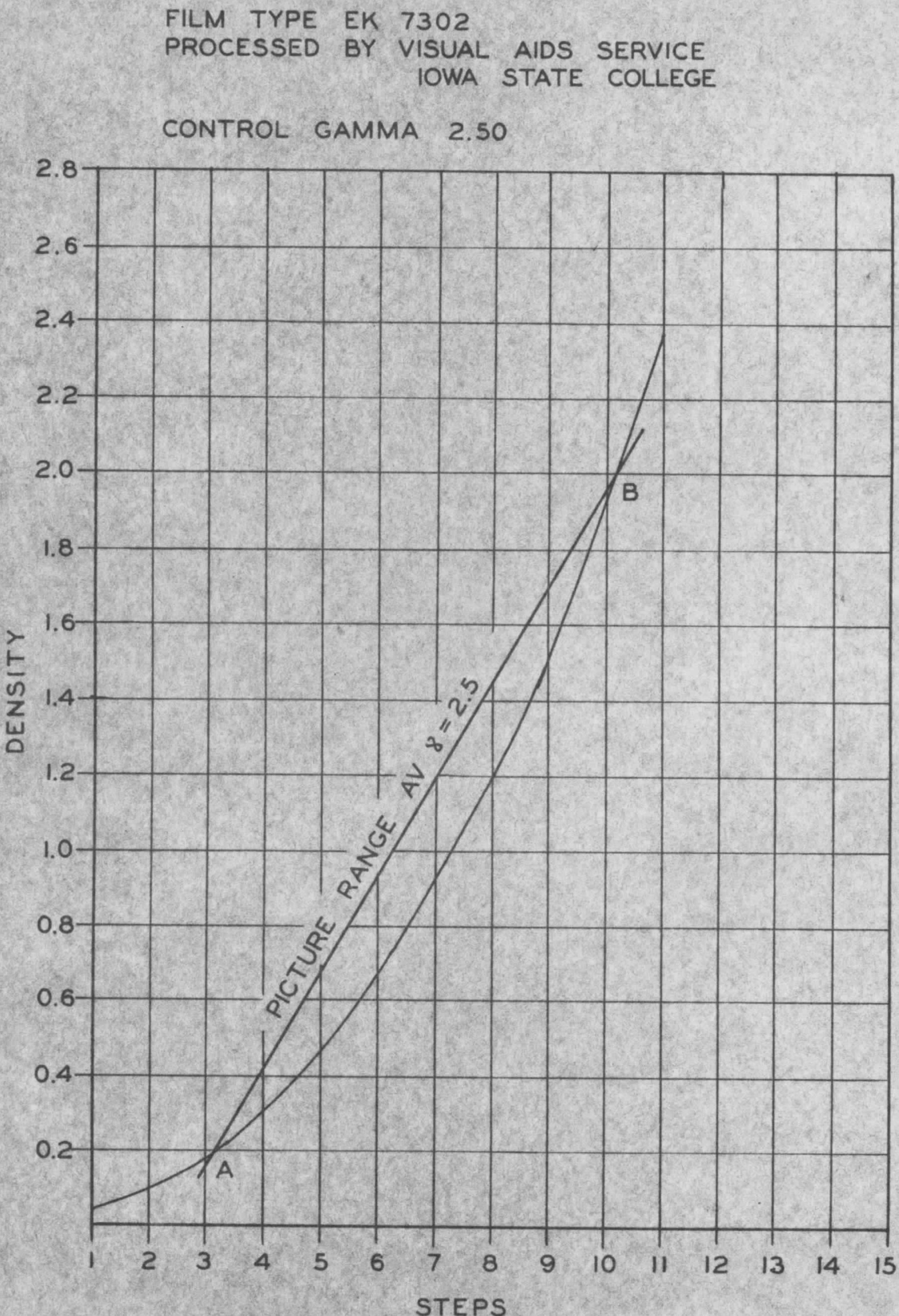


Figure 3-4. Eastman Kodak 7302 H & D Curve

approach cutoff on negative peaks. Present day equipment permits the use of a lens aperture of f/2.0 to f/3.0.

b. Second, the brightness of the photographic monitor must be set correctly. (See Paragraph 3, Exposure Practice). It is very important to monitor the grid bias and each of the following parameters which influence brightness:

(1) The high voltage should be set correctly.

(2) The raster size must be correct.

(3) The focus must be correct.

(4) The video level must be correct. The brightness of the photographic monitor (less video) can be monitored by observing and recording the beam current. External means, utilizing a light meter, or a photocell and microammeter, may also be used.

3. EXPOSURE PRACTICE

A good video recording utilizes the straight line portion of the film characteristic curve from black to white and has detail in the highlight and shadow regions. In order to meet these requirements, the actual video signal used must be of optimum quality.

In the case of a direct positive recording, it is necessary first to obtain the characteristic curve of the positive recording film stock to be used. For the purpose of illustration, such a curve is shown in figure 2-4. Methods for obtaining this curve are covered in a previous section. Point A is the point on the toe which has been determined as the point of minimum exposure for video recording. The density at this point is 0.2 and the transmission is approximately 63%. To expose the film satisfactorily and

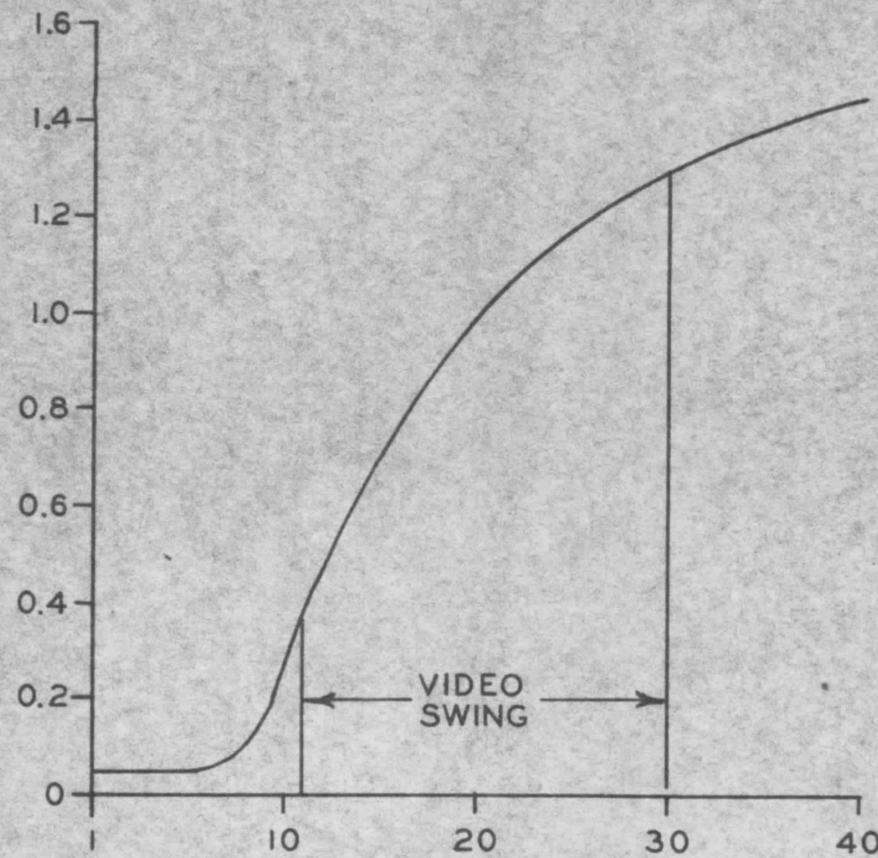


Figure 3-5. Density Versus Grid Voltage

duplicate the contrast ratio of the video signal, a transmission of 2% or less should be used to provide a maximum density of approximately 1.7. However, it is general practice to increase this density to approximately 2.0 or point B.

The electrical parameters which will expose the film over this range must be determined by plotting a curve of density versus grid voltage as shown in figure 2-5 with the exception that a positive film stock must be used, such as EK7302. This curve is made by exposing a strip of film to the photographic monitor at different grid voltages using a defocused raster with zero video gain and processing this strip at the same gamma as that used for obtaining the characteristic curve. Record the beam current of the photographic monitor for future use. From the curve of figure 2-5, select the grid voltage which results in a density of 2.0. Note the corresponding value of beam current so that the display tube can always be set for the same brightness. This establishes the black level of the film. Compute the difference in grid voltage between the densities of 0.2 and 2.0. This will be the grid drive required for the photographic monitor to expose the film correctly. These densities compensate for normal set-up in the video signal. If set-up has been removed, 1.8 should be used as the maximum density.

This entire procedure should be repeated from time to time so that changes which occur in meter readings, aging of the photographic monitor, and so on, can be corrected for.

In the case of a negative recording, repeat the steps described above

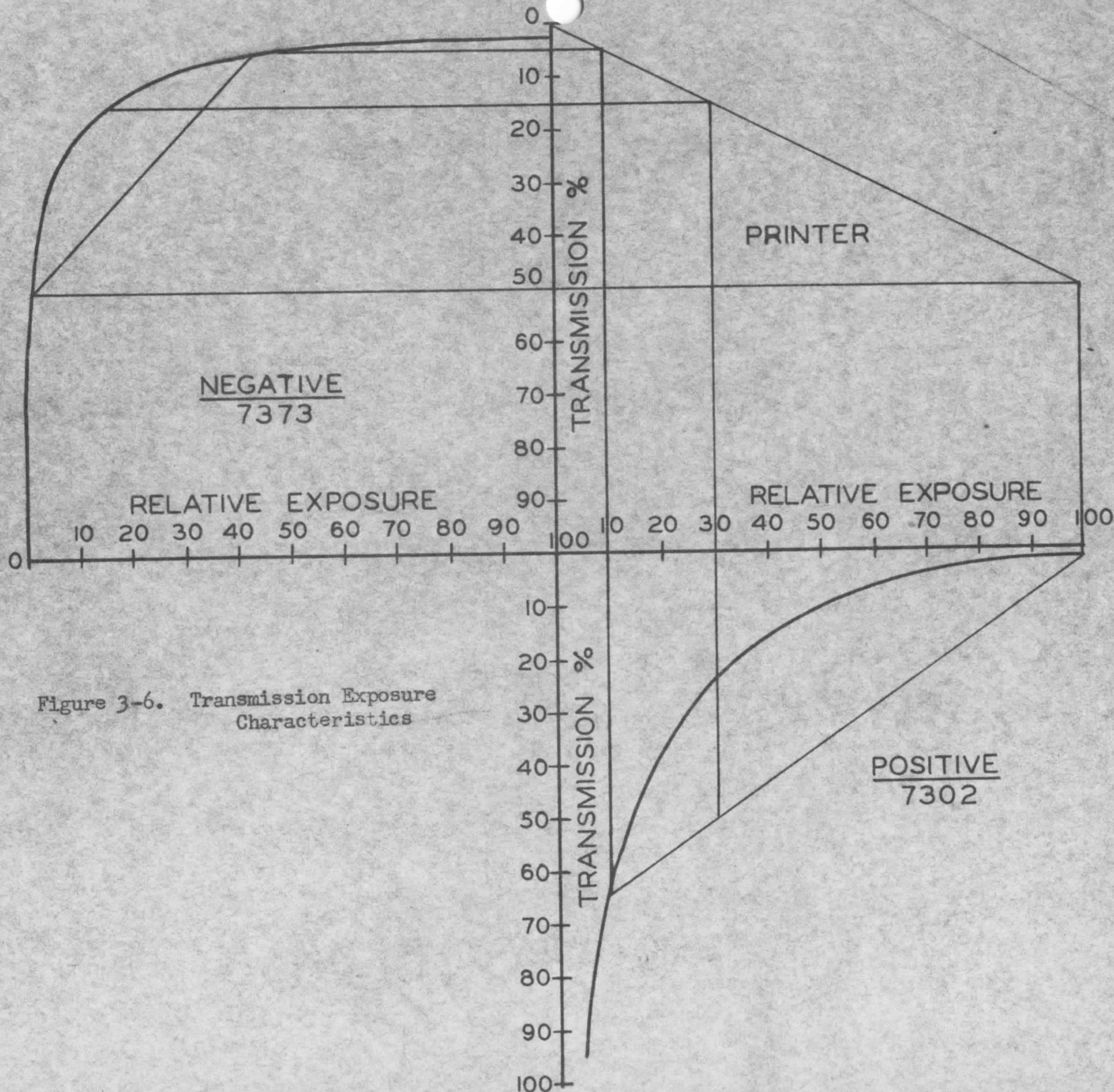


Figure 3-6. Transmission Exposure Characteristics

using a negative recording film stock. First, determine the characteristic curve of the film stock at the selected gamma as shown in figure 2-3.

Point A represents a density of .3 which is considered a good minimum density for obtaining a negative recording. Printing this grey scale on the same stock used in figure 2-4 at several light values should make it possible to match point A of the negative stock to point B of the positive stock. A plot as shown in figure 2-6 will then give point B for the negative stock by geometrical transition from the positive stock back to the negative stock. This will be very close to 1.3.

Note

The slope of the transition line will vary for different printing light values but will always have the same point of origin.

Since points A and B for the negative film stock are known, plot a curve of density versus grid voltage. The black level (.3) and the video drive necessary to reach the white level (1.3) are found as in figure 2-5.

Subsequent prints should be made with the ideal value of printing light found above.

It should be noted that if minor errors are made by the operator or by master control in setting black level or video swing, they can be corrected by changing the printing light. In cases of this nature the negative is "notched" so that reprints will be identical.

Standard procedure by film laboratories is to print facial characteristics on a medium close-up to a density of 0.8 for a man and 0.6 for a woman in the absence of other instructions.

A check sheet for each kine should be made at the time the picture is recorded and then the details rechecked on the print so that data is available for each negative made.

4. FILM STANDARDS

Certain factors must be strictly observed so that all films will reproduce identically. These are the parameters given below in inches for both 16mm and 35mm:

	16mm	35mm
Picture Location	℄ = 0.315 ± .002 from guided edge	℄ = 0.744 ± .002 from guided edge
Picture Height	0.285 ± .002	0.612 ± .004
Picture Width	0.380 ± .002	0.816 ± .004
Sound Track Location	℄ =.058 ± .001 from guided edge	℄ = 0.243 ± .001 from guided edge
Sound Track Width	0.080 ± .001	0.100 ± 0.000 0.008

The aspect ratio for the aperture of a camera is 4.2 x 3 whereas the television aspect ratio is 4 x 3. These have been taken into consideration in the above standards.

5. SYNC SEPARATOR CHASSIS (see Sync Separator schematic diagram)

a. Function.—This chassis provides a clamped 75-ohm video output at standard level and a composite sync signal.

b. Adjustments

(1) COMPOSITE GAIN: The input signal should be reduced to approximately 1 volt peak-to-peak with the COMPOSITE GAIN control R2.

(2) SEPARATION LEVEL: This control (R19) adjusts the DC clamp level of the grid of V4 during the back porch interval.

(3) SET-UP: This control (R49) is to provide for removal of the pedestal so that the output signal has no artificial black components.

c. Theory.—The input signal to the unit is a standard composite television signal of from 0.7 to approximately 3 volts peak-to-peak. The video output signal is the standard 1 to 1-1/2 volt signal across 75 ohms with the white being positive in polarity, the same as the input signal polarity. The synchronizing signal output is white positive. The first two stages, tubes V1 and V2, are ordinary video amplifier stages which drive a cathode follower, V4, in whose grid circuit is a double diode clamp used to restore the DC level to a prescribed potential during the back porch interval. The cathode follower whose back porch signal level has been clamped is then used to drive a double diode separator with all portions of the signal which are positive from a reference point going through a video channel cathode follower, V6, and all signals which are negative from essentially the same point going through the synchronizing output jack. The key clamp is driven by the same synchronizing signal through an amplifier stage (one half of V7) which drives a blocking oscillator pulse-forming tube V8. This pulse, which occurs during the back porch interval and is approximately two microseconds wide, is then applied to the grid of the pulse amplifier stage, (the other half of V7) which is coupled through capacitors C7 and C8 to the input electrodes of the double diode clamp V3.