VERICOLOR TELEVISION

STUDIO EQUIPMENT

INSTRUCTION MANUAL

MANUFACTURED BY: REMINGTON RAND, INC.

LICENSED BY: COLUMBIA BROADCASTING SYSTEM, INC.

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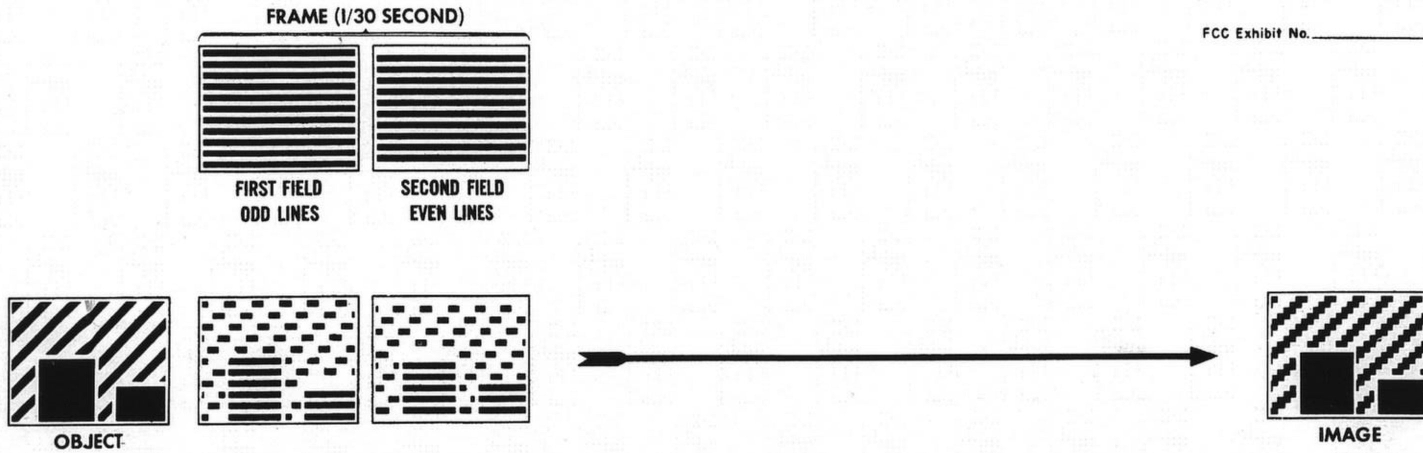
FCC DOCKET NO. 8736 ET AL.

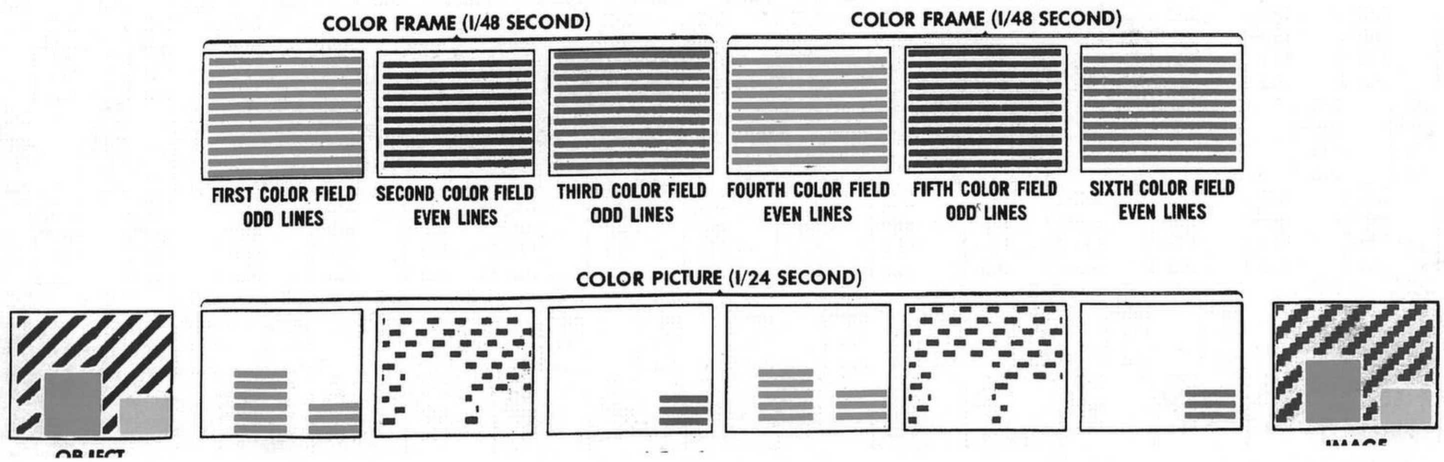
CBS Identification No. ______

FCC Exhibit No. ______

BLACK AND WHITE TELEVISION SCANNING



CBS COLOR TELEVISION SCANNING



INTRODUCTION OF COLOR INTO TELEVISION

Much of the significance of color in television is striking, even to the casual observer. Aside from the most obvious effect, namely, that color introduces a sense of reality and a lifelike quality into the picture, comparison of a color television picture with the corresponding black-and-white image makes it apparent that not only are small objects more perceptible, but outlines in general seem to be more clearly defined. As has been experienced with other media, color in television also seems to introduce a certain perception of depth. This is due, in part, to the increased ability of color to reproduce the contrasts and shadows as well as highlights and reflections in different hues, while the degree of color saturation which is a function of distance, strongly enhances the three dimensional quality.

It has been found that three pure primary colors will reproduce the many thousands of color shades and tints visible to the human eye. The three primary colors required are RED, BLUE and GREEN. To obtain a certain color, we can combine the three primary colors in definite proportions. Yellow may be derived from an additive mixture of red and green, which can become orange by adding more red than green to the mixture. A purple shade would result from an additive mixture of red and blue, and so on for many different shades. Because this result is determined by the additive mixture of these colors, the term "Additive" is applied to this method of color reproduction. In color photography, the complimentary colors Blue-Green, Magenta (red-blue), and Yellow (red-green) are used in a "Subtractive" process.

In the VERICOLOR system, a small drum containing red, blue and green color filters, is interposed between the lens of the Camera and the Photo-cathode of the camera pick-up tube, in such manner that any picture that is picked up must pass through one of these color filters. At the Color Receiver, a disk having red, blue and green filters is interposed between the cathode ray viewing tube screen (kinescope) and the observer. If the color drum in the camera is now oriented so that all of the picture being televised by the VERICOLOR camera passes, say through a red filter, then only the red color information in the picture will be seen by the camera tube, and the resulting video signal generated by the camera tube, amplified in the Camera and Control amplifiers and passed on to the receiver for viewing on the kinescope, will appear in its true red color to the observer, if the disk's red filter is in front of the kinescope screen. This is also true if the camera picture is picked up through a blue filter and the resulting picture is viewed at the receiver through a blue filter. All picture information that is blue, or has components of blue, willbe reproduced at the receiver. Again this is true if a green filter is used both at the camera and receiver, all green information contained in thecamera subject matter will be reproduced at the receiver, in green.

If both the Camera drum and Receiver disk are now turned, in synchronization with each other, and in color phase (i.e. each color at the camera and reciever used at the same time), the picture as taken by the camera and reproduced at the receiver will be a sequential series of red, blue and green pictures. If they are turned rapidly enough, the observer at the receiver, in viewing the resulting picture, does not see three separate images, but merely one, formed by combining all three in his minds' eye. Image follows image in swift succession, and due to the retentivity of the human eye, all three colors integrate and blend back into their original hues, shades and tints. In the

VERICOLOR system, the color filters change at the rate of every 1/144th second, in synchronization with the field scanning of the television system, Thus every 1/48th second, the picture is sequentially scanned in all three colors on the even-odd-even lines, and in the next 1/48th second it is again scanned in all three colors on the odd-even-odd lines. Thus every 1/24th second every picture line has been scanned in red, blue and green. This is shown diagrammatically in Fig. 1-E. Since the picture scanning process is identical to that used in monochrome television, a comparison is shown, in Fig. 1-E.

Since it is presumed that VERICOLOR equipment will be operated under the responsibility of a technically qualified television engineer or technician, this instruction book will deal only with the installation, operation and maintenance of VERICOLOR equipment. To those interested in furthering their technical knowledge of color television, there are several books available, both at the layman and engineering levels.

MAINTENANCE PERSONNEL

The maintenance of this VERICOLOR equipment shall be under the responsibility of a technically qualified engineer or technician. Lacking an employee of this qualification, it is advisable to contact an outside firm having this type personnel. Employees of local television stations, who are engaged in television camera equipment maintenance as their regular work, are excellent men to have contact with. The Chief Engineer of a local television station will often help you to contact such a person.

OPERATION OF EQUIPMENT PERSONNEL

The operating of the equipment (front panel controls), can be entrusted to persons not skilled, provided that they receive specialized training in the operation of VERICOLOR Camera equipment, and leave the maintenance (and maintenance adjustments) strictly to the Engineer in charge of the equipment. It usually takes a minimum of three full days, under the skilled guidance of a qualified television engineer, to train a person to operate this equipment in such a manner that a smooth program, both video and audio wise, will result. It is not difficult for an inexperienced operator to completely ruin the expensive Image Orthicon camera tube, within a very few minutes of improper operation. It is preferable to train the operating personnel right at the VERICOLOR installation, and under the conditions which the equipment will work.

W A R N I N G

THE VOLTAGES EMPLOYED IN THIS EQUIPMENT ARE SUFFICIENTLY HIGH TO ENDANGER HUMAN LIFE AND EVERY REASONABLE PRECAUTION HAS BEEN OBSERVED IN DESIGN TO SAFEGUARD THE OPERATING PERSONNEL. THE POWER SHOULD BE REMOVED COMPLETELY BEFORE CHANGING TUBES OR MAKING INTERNAL ADJUSTMENTS.

FIRST AID IN CASE OF ELECTRIC SHOCK

1. PROTECT YOURSELF with dry insulating material
2. BREAK THE CIRCUIT by opening the power switch or by pulling the victum free of the live conductor.

   DON'T TOUCH VICTIM WITH YOUR BARE HANDS UNTIL THE CIRCUIT IS BROKEN

3. LAY PATIENT ON STOMACH, one arm extended, the other arm bent at elbow. Turn face outward resting on hand or forearm.
4. REMOVE FALSE TEETH, TOBACCO OR GUM from patient's mouth.
5. KNEEL STRADDLING PATIENT'S THIGHS.
6. PLACE PALMS OF YOUR HANDS ON PATIENT'S BACK with little fingers just touching lowest ribs.
7. WITH ARMS STRAIGHT, SWING FORWARD gradually bringing the weight of your body to bear upon the patient.
8. SWING BACKWARD IMMEDIATELY to relieve the pressure.
9. AFTER TWO SECONDS, SWING FORWARD AGAIN. Repeat twelve to fifteen times per minute.
10. WHILE ARTIFICIAL RESPIRATION IS CONTINUED, HAVE SOMEONE ELSE:
    (a) Loosen patient's clothing
    (b) Send for doctor.
    (c) Keep patient warm.
11. IF PATIENT STOPS BREATHING, CONTINUE ARTIFICIAL RESPIRATION. Four hours or more may be required.
12. DO NOT GIVE LIQUIDS UNTIL PATIENT IS CONSCIOUS.

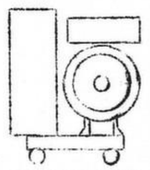
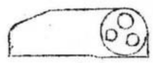
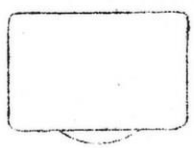
EQUIPMENT	DESCRIPTION	WEIGHT	SIZE	HEAT DISSAPATION
	POWER SUPPLY	335 LBS.	25" X 26" X $22\frac{1}{2}$"	≈ 1 KW
	CAMERA	41.5 LBS.	23" X $7\frac{1}{4}$" X $6\frac{1}{4}$"	≈50 W
	CAMERA CONTROL CONSOLE	156 LBS.	$28\frac{1}{4}$" X 20" X 19"	≈ 750 W

TABLE NO. 1

MECHANICAL SPECIFICATIONS

TECHNICAL SUMMARY

Output Signals

Picture Video response......................Uniform to 10 mcs ± 0.5 db
Uniform to 12 mcs - 3.0 db

Picture output level................1.5 volts max. across 75 ohm load
(with 30% Sync) 1.0 volts max. across 50 ohm load
(volts are peak to peak)

Program Audio response....................150 c.p.s. to 10 kc ± 3.0 db

Program Audio level...............- 18.0 db max. across 500 ohm load

Intercom Audio response.....................150 c.p.s. to 6 kc ± 3 db

Intercom Audio level...............- 14.0 db max. across 125 ohm load

Input Signals

Camera No. 2 input level (for mixing .... 1.0 volt, peak to peak across 75 ohm input, black negative, no Sync

External Sync Signals required for dual or multi-camera operation......	Signal	Peak to Peak Volts Level	Polarity
	HORIZ. DRIVE	4	minus
	VERT. DRIVE	4	"
	COLOR DRIVE	4	"
	COMP. BLANK'G.	4	"
	COMP. SYNC.	4	"

Horizontal Scanning frequency.........................29,160 c.p.s.

Vertical Scanning frequency.................144 c.p.s. interlaced 2:1

Complete color picture repetition rate....................24 c.p.s.

Color sequence......................................Red-blue-green

Lens Coverage The area, and the horizontal angle covered by the standard lens supplied with the equipment, is as follows:

	82MM	135MM	9"
Horizontal angle (Vert. angle = .75 horiz. angle)	21.°	12.2°	5.8°
Lens to subject = 4 feet HORIZ.=	17.5"	10.25"	4.8"
(average for oper. room use) VERT.=	13."	7.7"	3.6"
Multiply the LENS-TO-SUBJECT distance by the following factor, to give horizontal coverage.	.365	.214	.1
System Image magnification (size of object on screen vs. true object size)	.57	1.0	2.0

TYPE NO.	CAMERA CONTROL CONSOLE Camera Control Unit	Sync Unit	Scan Unit	CAMERA	POWER SUPPLY
1X2			3		
3RP1 CRT			1		
5R4GY					6
5W4	1				
5820 (Image Orthicon)				1	
6AK5	5	2		2	
6AL5	1 *	7	1		
6AQ5	3		2	1	
6AU5	1		5		
6AK6	1				
6AU6	3				
6AS6	1				
6AS7	2		2		5
6J6	4				
6S4			1		
6SL7					1
7RP4 CRT			1		
12AT7	3	16	3	1	
12AU7	5	8	2		
12AX7		1			
VR-75	2				
VR-150					2
Totals	32	34	21	5	14

* CHANGED TO 6AG5

TABLE NO. 2

Vacuum tube complement of the Vericolor Equipment

ELECTRICAL CHARACTERISTICS

TOTAL POWER INPUT

A.C. Power Input = 60 cps three phase 4 wire "Y"

WORKING LIMIT UNDER FULL LOAD	VOLTAGE BETWEEN PHASES	PHASE #1 CURRENT	PHASE #2 CURRENT	PHASE #3 CURRENT	POWER .84pf
Lowest =	190	8.5	2.7	2.7	1400
NORMAL =	208	9.6	3.0	3.0	1660
Highest* =	240	11.0	4.4	4.4	2350

* A supply voltage exceeding 230 volts is not recommended because of shortened vacuum tube life. The above table shows the range over which the Vericolor

equipment will work satisfactorily, with only minor adjustments to the gain and brightness front panel controls.

Basic Vericolor Camera Equipment Supplied

Vericolor Stock No.	Quantity	Description
	1	Camera
	1	82 mm Wollensak lens F 3.2
	1	135 mm Wollensak lens F 4.5
	1	9" Dallmeyer telephoto lens F 4.5
	1	Camera Control Monitor
	1	Camera Control External Power Supply
	2	Brush type BL-2 program microphones complete with 35' of cable & modified connecters.
	2	Inter-com Head-sets, type Western Elec. #52AW, complete with 6' of cable & connecters.
		The following Cables, with Connecters:
	25'	Camera Cable, 32 conductor, camera to console.
	25'	Power and Signal Cable, 24 conductor, console to wall receptacle.
	6'	Power Supply output Cable, 8 conductor, from Power supply to wall receptacle.
	6'	Power Supply input Cable, 4 conductor, from external AC supply box or receptacle to Power Supply.
		The following Wall receptacle plates, supplied with receptacle connecters.
	1	24 conductor receptacle, mounted on two gang cover plate, for wall mounting.
	1.	12 conductor receptacle, mounted on two gang cover plate, for wall mounting.
	1.	4 conductor receptacle, mounted on single gang cover plate for 4 X 4 box, for wall mount'g.

VERICOLOR TELEVISION

I. This manual is intended to describe the operation, circuit theory and maintenance of the Remington Rand-C.B.S. Vericolor Television system in sufficient detail for properly trained personnel.

II. The Vericolor Television system was designed and manufactured for industrial and medical application. The equipment and accesories necessary for producing a composite color television signal at either a fixed or mobile location, is shown in the block diagram of fig. 1.

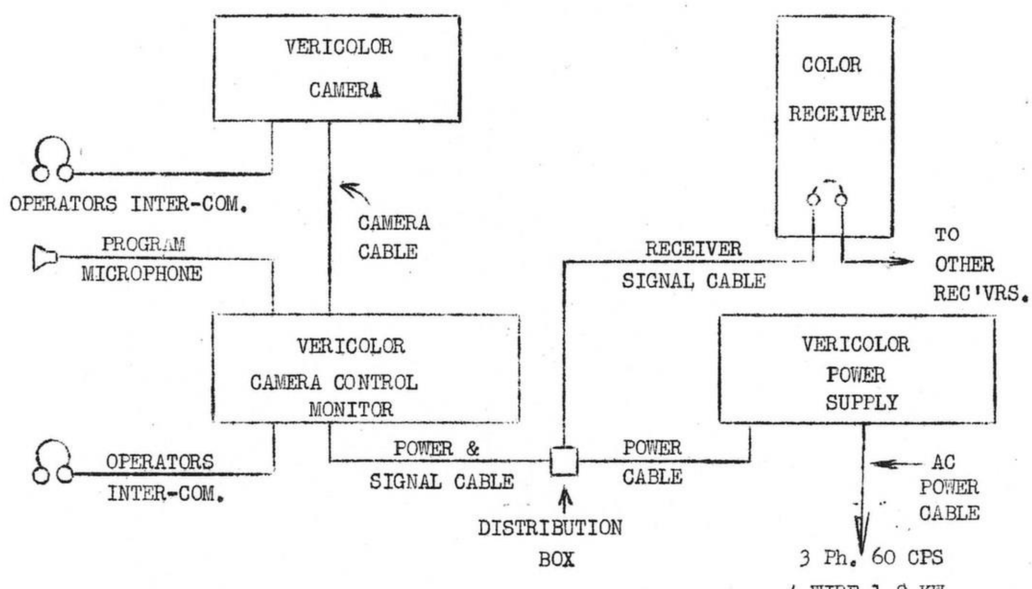


FIG. 1

Block diagram of Single Vericolor camera chain.

FIG. 2 VERICOLOR CAMERA ON TRIPOD AND DOLLY

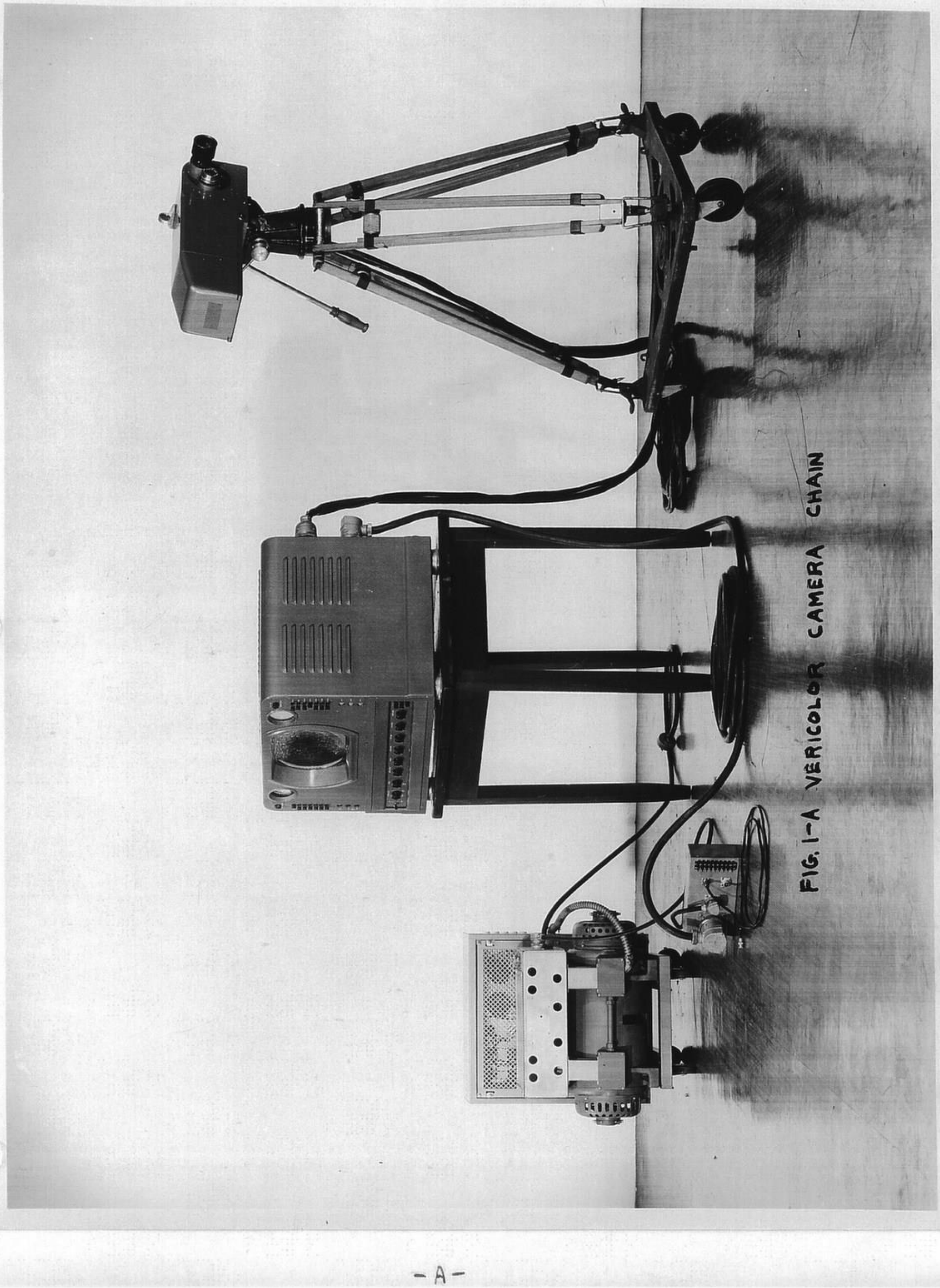


FIG. 1-A VERICOLOR CAMERA CHAIN

FIG. 1-B CAMERA CONTROL MONITOR

INSTALLATION OF EQUIPMENT

CONNECTING UNITS

Set camera tripod on dolly, as shown in fig. 2, or use chain between legs of tripod to prevent tripod legs from spreading.

Adjust tripod legs for desired height, and tighten adjusting knurled ring nuts.

Set pin in middle hole and tighten pan-tilt head friction adjustments.

Pull camera cable connector up through middle of tripod and pan-tilt head, and plug into base of camera.

Set camera on pan-tilt head, using two guide pins on pan-tilt head as guide. Screw in the captive screws into tapped opening in base of camera.

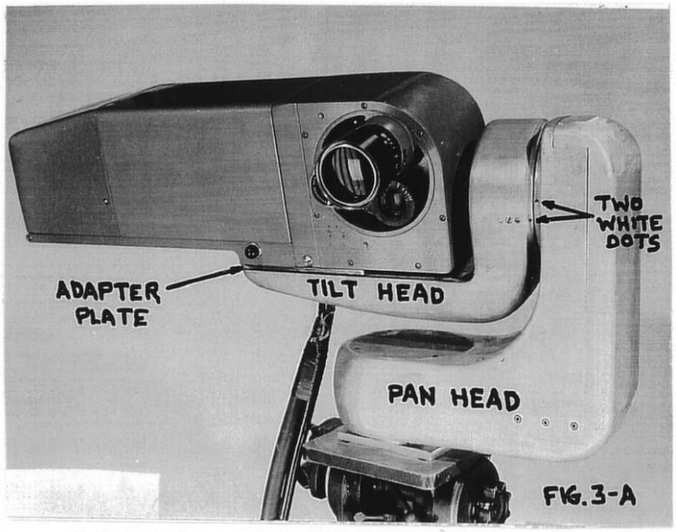
Place Camera Control Monitor on convenient table and connect other end of "camera cable" into appropriate receptacle, back end of chassis.

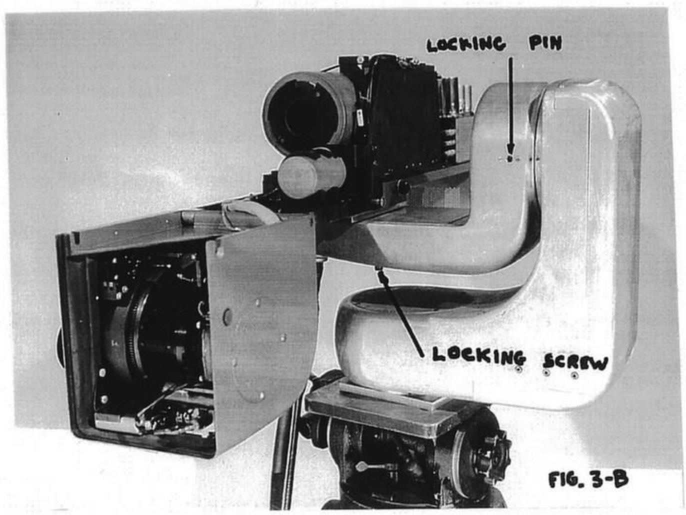
Connect "Power and Signal Cable" into appropriate receptacle, back end of Camera Control Monitor chassis, and connect other end to "Power and Signal Distribution Box".

Connect "Power Cable" to "Power and Signal Distribution Box" and "Power Supply Unit".

The ON-OFF-REMOTE switch, located on the Motor Generator Control panel, should be in the "OFF" position; until ready for test. Connect Power Cable to Power Supply and to a 3 phase 4 wire 208 volt power source.

If unit is being used for the first time, remove end cover of 48 cycle motor generator, and snap power switch to ON and then OFF. Note direction of armature rotation to see if it corresponds to arrow marking on motor generator. If not, reverse two phase


TWO WHITE DOTS
ADAPTER PLATE
TILT HEAD
PAN HEAD
FIG. 3-A


LOCKING PIN
LOCKING SCREW
FIG. 3-B

connections and check again. Every time this Power Unit is connected to a different ac power supply, this check should be made, before the camera equipment is put into operation.

Throw ON-OFF-REMOTE power switch to the "REMOTE" position, and the camera equipment is now ready to be turned on and controlled from the camera Control Monitor.

REMOTE CONTROLLED PAN-TILT HEAD

The remote controlled pan-tilt head, shown in fig. 3a, is useful for those camera locations where camera space is a limitation, such as in an operating room, or where the camera location is in a hazardous location, such as in a Jet flame testing lab.

The remote control pan-tilt head can be mounted directly onto a tripod pan-tilt head, as shown in fig. 3a, or onto a "V" type bracket that may be attached to a wall or ceiling, and it also may be attached to a special pipe coupling to overhead tracks that are used for hospital operating room lights. Special Operating Room lights (now being manufactured by the WILMOT-CASTLE Company) have been designed to accomodate the camera and Remote Control unit, within the light housing.

Installation of Camera on Remote Control Unit

Locate Camera Tilting Head and Panning Head so that the two white dots on the side of each are adjacent. Screw in locking pin. With the camera cable removed, the camera is placed on the

Camera Tilting Head in the position shown in fig. 3a so that it slips over the two Locating Pins. Unscrew camera Locking Screw and fasten camera to Adaptor Plate with four #¼ - 20 X 3/8 long filister head machine screws provided for this purpose, by rotating camera and inserting each screw in turn from the bottom. Rotating the camera clockwise approximately 120° to the third indexing position the cable connector can now be inserted into the camera. Rotate the camera back to the operating position as shown in fig. 3a and fasten camera Locking Screw. Unscrew Locking Pin. The camera is now ready for use.

Servicing of Camera on Remote Control Unit

For service maintenance or adjustments on camera when it is mounted on the remote control unit, orient tilting head and panning head so that the white dots on the side of each are adjacent, such as shown in fig. 3b. Screw in Locking Pin. Unscrew camera Locking Screw and rotate camera clockwise approximately 90° to the second indexing position where an audible click will be heard when it hits the right position. Screw in camera Locking Screw to lock this position. The camera can now be opened for adjustments or servicing. This is shown in fig. 3b.

MULTI-CAMERA OPERATION

When three or more cameras are to be used in a system there are advantages, both economical and program-wise, to using one "Synchronizing Signal Generator" to provide triggering, blanking and Sync. pulses to all camera chains.

In using an external Sync. Generator, Isolation Amplifiers are necessary for each signal to each camera chain. The additional wire cabling is shown in the block diagram of fig. 4.

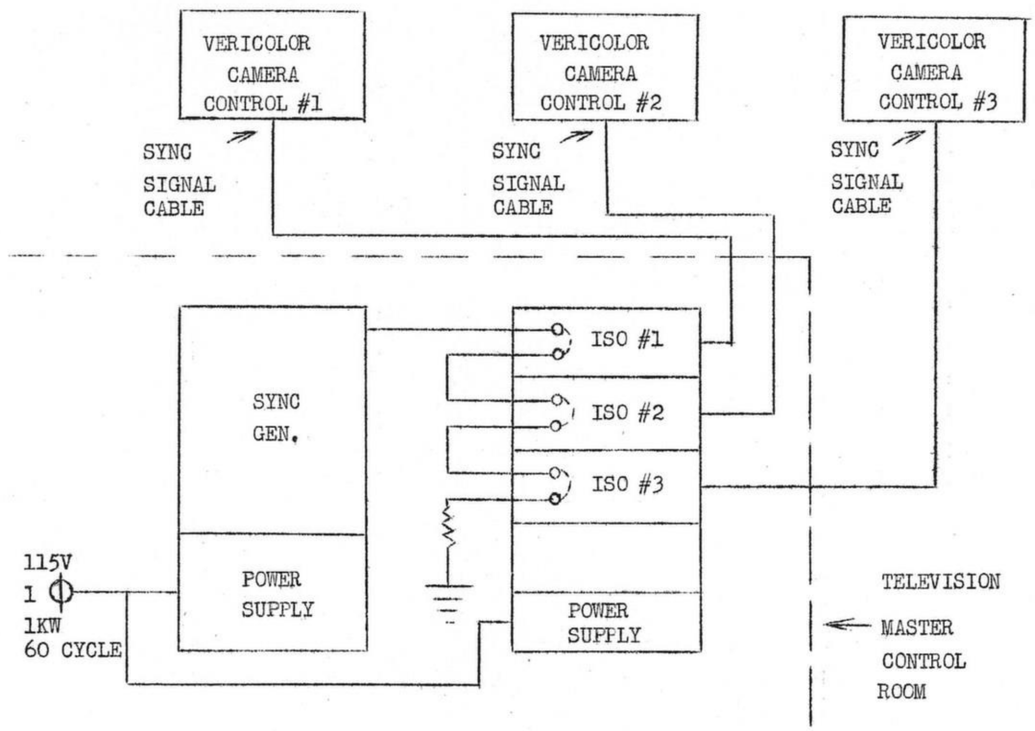


FIG. 4

Block diagram of External Sync. Signal feed to three camera chains.

For Industrial Color TV equipment that may be moved from room to room for successive camera pick-ups, it is not too practical to feed External Sync. Signals in a "Series" fashion, as done between camera chains in a television studio (i.e. one isolation amplifier feeds three camera chains) because of the interference to other camera chains on the same Sync. line.

External Sync. Signal required to operate the Vericolor equipment, is given in the "Technical Summary"

TWO CAMERA CHAIN

Two cameras may be worked together in such fashion that the signal provided to the receivers will be from either camera, the fading from one camera picture to the other camera picture being done by the camera control operator. This makes for smooth programing of local and remote camera pick-up points. This can not be done however, unless one of the Camera Control units has been modified to supply Sync. Drive signals to the other Camera Control, or an external Sync. Signal Generator is used to supply Sync. Signals to both Camera Controls, as shown in fig. 5.

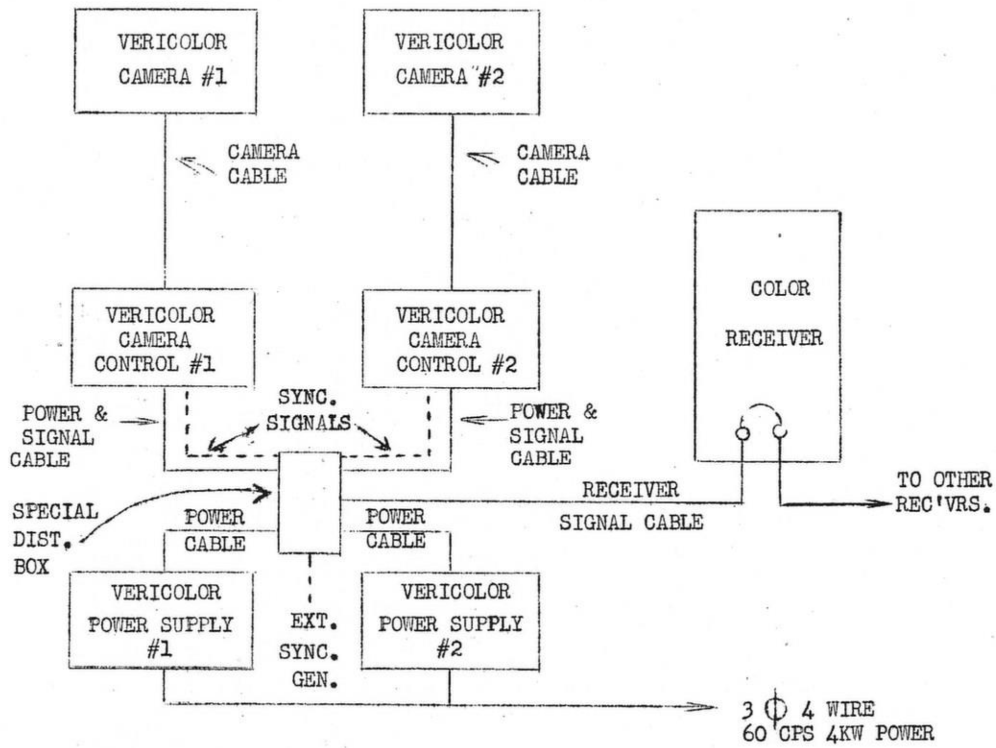


FIG. 5

Block diagram of two Vericolor Camera chain hook-up.

NOTE ON MULTI-CAMERA CHAIN INSTALLATIONS

It may be said in general, that planning a large television installation requires as much thought as planning a television station, and requires the services of an engineer having this experience. There are many problems associated with this type installation, such as location of Television Master Control, proper inter-floor duct wiring, proper light illumination for camera pick-up and air conditioning necessary. Remington Rand can provide this service when the requirements are known.

INSTALLATION AND PRELIMINARY OPERATION OF CAMERA & CONSOLE

7" Kinescope tube installation

Remove kinescope shield from the face plate in the following manner:

a - loosen two knurled screws which fasten the shield to the face plate.

b - lift shield out of the channel which supports it on the underside.

Place kinescope tube inside of shield so that the high voltage pin is centered in the circular cut-out that existes in the shield.

Replace entire assembly (shield and tube) by setting the lower lip of the shield into the channel provided and refasten the two knurled screws.

Plug socket on to base of kinoscope.

Plug high voltage cap into high voltage pin of the kinescope.

Image Orthicon tube installation

Open the front end of the camera by unscrewing the two large screws near the pilot lights, and twist the whole front assembly up and out.

Open the back end of the camera by pressing in the two side catch-release buttons and at the same time twist rear cover upwards and out.

With the left hand steadying the camera, twist the Image Orthicon tube mask in a clockwise direction and pull it out.

Insert the tube, with the white marker near the rear socket facing upward, and the white marker on the face of the tube pointing downward. As an aid in locating the white marker near the base of the tube, a pilot hole is provided in the sprayed bakelite tubing at the rear of the yoke.

Insert tube into coil assembly, and then with the left hand supporting the base of the tube, and the right hand supporting the front of the tube, gently move tube around until the large shoulder pins slip into the shoulder socket. Extreme care should be taken at this point, as forcing the tube into position may damage the shoulder pins beyond repair.

Clean face of Image Orthicon tube with good grade of lens tissue. Insert tube mask in front of tube, by first locating the large pin slot on the mask and then matching same to the large pin. Turn counter clockwise until mask clicks into position. Make sure no finger marks remain on face of tube.

<u>Preliminary adjustments</u>

Make certain all interconnecting plugs are aligned properly and screwed in tightly.

During the following adjustments, the camera lens should be capped and the camera BEAM and TARGET knobs on the camera control left in their most counter-clock WISE position, and the "IMO HORIZ. SIZE" and "IMO VERT. SIZE" controls left in their maximum clockwise position.

Turn the power on by slightly rotating the "BEAM" control knob until a switch click is heard. Leave this control in this position.

Turn S-1 on the Power Supply Unit to read "AC INPUT", and then turn S-2 until the AC voltage as read on the meter reads between 115 and 120 volts.

About two minutes after the power has been turned on, relay S-1 will close, supplying plate supply power to the regulator tubes. S-1 should now be turned to read "E OUTPUT" and R30 adjusted with a screw driver until the voltage on the meter reads + 280 volts.

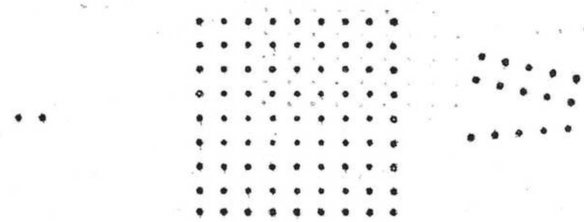
S-1 should now be turned to "I TOTAL", and an approximate reading of 5 X 200 ma = 1 amp should be read from the face of the meter, if everything is working normally. The individual condition of each regulator tube can be checked by turning S-1 to those indicated positions.

At the camera control console, left side, the push button switch SW-1 should be used to check + 280 volts, + 150 volts, - 150 volts and 48 cycle line voltage output of the M.G. set, which should read between 115 and 120 volts, on the meter directly above the push-button switch.

The IMO FOCUS CURRENT should now be checked by pushing in the appropriate push-button, and the current read directly on the meter. adjustment can be made by rotating R-186 control, which is a SCREW driver control located adjacent to V30 (under kinescope shield) on the main chassis.

With the Monitor Selector switch button (Front panel under scope tube) pushed in at the "PRE-AMP" position, turn the "MONITOR BRIGHTNESS" control clockwise until a raster appears on the face of the kinescope, and adjust "MONITOR FOCUS" for sharp lines.

If Monitor raster appears to blink in and out, or slip vertically, the Step Counter circuits in the Sync Generator chassis, are probably not counting properly and should be adjusted. This can be quickly checked with the Monitor Selector switch buttons marked 5 X 3 and 9 X 9, and observing the oscilloscope pattern, and comparing with Fig. 6 below.



2 X (c) | 9 X 9 (b) | 5 X 3 (a)

FIG. 6

If counters are out of adjustment, proceed as follows:

a) Turn "SYNC LOCK" switch on front panel OFF (Counterclockwise)

b) Slide Console cover off, so that inside controls are acessible. Counter Controls, marked 3:1, 5:1, 9:1 and 2:1 are mounted on the top of the Sync Generator chassis, facing left.

c) With Monitor Selector switch button marked 5 X 3 pushed in, adjust controls marked 3:1 and 5:1 until 3 dots are obtained vertically and 5 dots are obtained horizontally, on the scope as shown in Fig. 6a.

d) With Monitor Selector switch button marked 9 X 9 pushed in, adjust controls marked 9:1 and 9:1 until 9 dots are obtained vertically and 9 dots horizontally, on the scope as shown in Fig. 6b.

With the SYNC LOCK switch off, turn MONITOR COLOR PHASE knob clockwise to turn on Monitor Color disk. Looking at the raster through the color disk, the disk filter shape should appear steady or very slowly drifting. If the filter disk appears to be drifting pass the raster at a rate greater than once every two seconds, it is advisable to adjust the Master Oscillator closer to 58, 320 c.p.s. This can be done quite easily by turning the tuning slug adjustment on the Master Oscillator (L-1) coil until the disk filter appears steady. This adjustment is near the middle of the Sync chassis, on the same side as the tubes, a small screw driver is required.

Turning the SYNC LOCK switch on (clockwise) should result in a steady raster and color disk speed.

If Monitor Raster lines appear scrambled or jagged, the 2:1 counter may be out of adjustment. Usually this condition is accompanied by a high pitch audible tone. By pressing in Monitor Selector button marked 2X and adjusting 2:1 counter control on Sync Chassis so that scope pattern will look like Fig. 6-c, this condition will be remedied.

Adjust the aspect ratio of the raster by using the "MON VERT. SIZE" controls found on the right side of the unit, after the console cover has been slipped off. The "MON HOR. SIZE" control is a tuning slug adjustment, and will require a few turns in either direction before a difference in size is noticed.

If the raster size is adjusted so that top, bottom and sides are just visible within the mask opening, the proper aspect ratio will be obtained, and at the same time much service information can be had by observing the edges of the raster when making camera scanning and Sync. Generator adjustments.

Punch in Monitor Selector switch button marked "COLOR MIXER", and then adjust "BRIGHTNESS" control until the pedestal height (see fig. 7) is approximately one-quarter of an inch high on oscilloscope screen (wave form monitor).

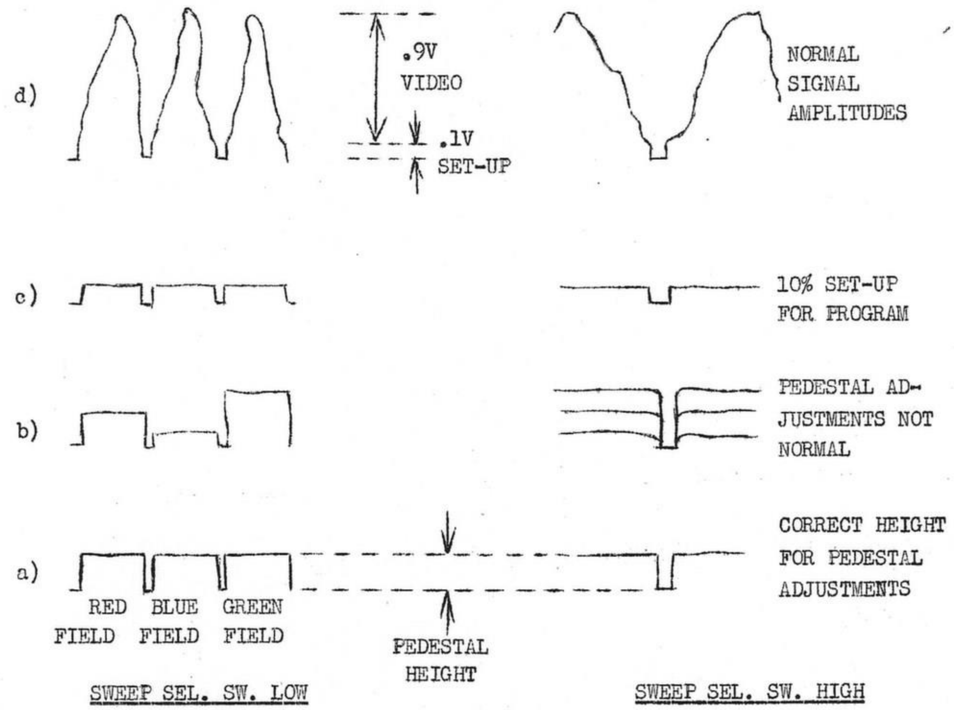


FIG. 7

Wave form monitor signal for color mixer position.

If pedestal heights for the red, blue and green fields are not even, as shown in fig. 7b, adjustment of the RED, BLUE and GREEN

BRIGHTNESS controls will make either field equal to the other. (When all fields are equal, the raster on the kinescope will be white when viewed through the rotating color disk). As will be noticed, there will be an amplitude interaction between the main BRIGHTNESS control, and the individual red, blue and green brightness controls. It is advisable to keep the individual brightness controls set near their center position, and use the main BRIGHTNESS control for the final 10% set-up level, as shown in fig. 7c.

With normal 10% BRIGHTNESS or what is sometimes called "PEDESTAL" set-up, the MONITOR BRIGHTNESS control can be adjusted until the "BLANKED" edges of the raster just "black out".

Rotate the following controls to an approximate 12 o'clock position.

TARGET	ORTH FOCUS
IMAGE FOCUS	MULTI FOCUS
VIDEO GAIN	RED, BLUE AND GREEN GAIN

Rotate the BEAM control slowly clockwise until a signal appears. The signal should be a number of white spots and crater-like appearing spots, that will swirl or blink as the ORTH FOCUS control is turned slightly.

After a minimum 30 minute warm-up period, uncap the lens and set the iris of the lens in use at about f 5.6 a picture signal should now appear on the kinescope.

Adjust optical focus by pushing the OPTICAL FOCUS lever to either "IN" or "OUT".

Adjust the IMAGE FOCUS control for the best picture focus.

Adjust "ORTH FOCUS" control for best picture resolution and then readjust OPTICAL FOCUS.

Rotate TARGET control counterclockwise until picture gets muddy, then turn clockwise until picture looks clean and clear. Leave the TARGET control at this particular point of just where the picture breaks clean and clear. This is usually the optimum point for a given scene brightness. At the same time the target control is being adjusted, the BEAM control should be varied slightly back and forth, so that the whites of the scene being picked up do not "bloom".

Rotate alignment coil (L-5) in camera by turning gear, and observe picture on Kinescope. The effect of rotating the coil should appear as if a searchlight spot is moving across the picture. Leave the coil at the point where most picture signal appears.

Turn knob on back of pre-amp chassis marked "ALIGNMENT". This again should have the effect of a searchlight moving across the picture. Re-adjust L-5 alignment coil gear again, and leave both adjustments set when the searchlight effect appears to be in the center of the picture.

WARNING It will be noticed that any bright object being televised, will tend to burn in, if the camera is aimed at it for more than one minute. This will be noticed as the camera is panned around to other picture material. The Image Orthicon tube is a very sensitive tube, and as such, can be completely ruined if a bad burn-in is allowed. It is common practice among television cameramen, to either re-aim the camera every 30 seconds or so, or continuously pan slowly back and forth, to avoid burn in. Some tubes are worse than others in this respect. If the image is allowed to burn in badly, it is considered by the manufacturer of the tube to have been mis-used, and therefore not guaranteed. If the burn in is not too severe, it may be removed or minimized by removing the lens and aiming at either the sky, or a very bright light. In this way a very heavy burn-in, obscures the lighter burn-in detail. This process shortens the life of the tube considerably and the necessity for it should by all means be avoided.

Preliminary Color Phasing of System

If the colors in the picture appear out of phase, this can be corrected by following this procedure:

a) Turn VIDEO GAIN counter clockwise to zero.

b) Slightly increase RED BRIGHTNESS control (Clockwise)

c) Turn "MONITOR COLOR PHASE" control until Kinescope raster appears red.

d) Return RED BRIGHTNESS control to normal, thus making raster appear white.

e) Turn up VIDEO GAIN control and observe picture. If still out of phase, turn CAMERA COLOR PHASE control until colors appear normal. If necessary turn control completely off and then on again to slip color drum 180° phase and readjust.

By this procedure, you have 1) Synchronized the color monitor disk in the control monitor to the color mixer gain and brightness controls, and 2) synchronized the camera color drum to both. This means that when the red filter is being used in the camera, the red filter will also be in front of the Kinescope, and the video signal being used will be going through the red channel of the color mixer amplifier.

Further adjustment of lens opening, Target and Beam controls, should result in a fair, but not usuable picture. Up to this point this has been considered as a rough check to see that the system is working and ready for final system alignment. If no signal has appeared yet, check the following list:

(1) Lens cap should be off.

(2) 1500 volt switch on back of camera pre-amp chassis should

be on.

(3) Tubes loose, or not in their socket. The amplifier and tubes can be quickly checked with the MONITOR SELECTOR switch. Punch in PRE-AMP test button and observe Kinescope and Waveform Scope. Camera picture should appear at this point as soft and streaking. If not, open up back of camera and tap the last tube slightly with a pencil. Microphonic bars should appear on the kinescope picture. When this section is working properly, punch in CHANNEL button. The picture should appear quite clean and crisp, with its amplitude regulated by the VIDEO GAIN control. This traces the signal up to the Color Mixer stages. To test Color Mixer stages and Blanking or Pedestal injection, punch in COLOR MIXER button, where the waveforms as given in Fig. 7 should be visible. Punch in button marked LINE OUTPUT, where the composite video plus Sync signal should be visible, similar to that shown in Fig. 10a and 10B below.

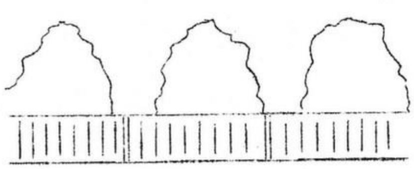


Fig. 10a

SWEEP SEL. SW. LOW

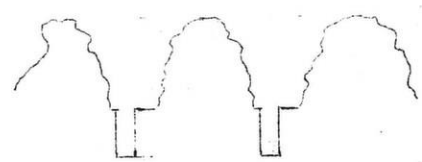


Fig. 10b

SWEEP SEL. SW. HIGH

NORMAL APPEARANCE OF SIGNAL ON WAVEFORM MONITOR FOR "LINE OUTPUT" POSITION

If colors in picture do not look true, particularly if the blacks in the picture appear brownish, it is probable that the

FIG. 8

light source being used for subject illumination has considerable infra-red energy. This is particularly true of ordinary incandescent room lighting. Photographic or regular infra-red corrected television light sources should be used. No. 2 photoflood lamps are excellent for setting up the system for test pattern alignment and short programs.

When a reasonable picture has been obtained in this manner, the system will be ready for "Final System Alignment", where all controls are adjusted for optimum performance.

FINAL SYSTEM ALIGNMENT

(AND OPERATION OF FRONT PANEL CONTROLS)

Final Image Orthicon Tube Alignment

A minimum warm-up period of 30 minutes is recommended, with the lens capped and the HEATER switch (back of pre-amp chassis) is in the ON position. The BEAM control should be in its most counter clockwise position without shutting the equipment off, the HORIZ. SIZE and VERT. SIZE controls should be maximum (clockwise), during the warm-up period.

It is assumed that during the warm-up period, the monitor color disk will be color phased properly and the Brightness pedestals adjusted for proper set-up. Pedestal heights will drift slightly as the equipment warms up to normal operating temperature, and can be re-set near the end of the 30 minute warmup period.

One recommended method of aligning the Image Orthicon (Abbreviated to IMO) tube, is to televise a color test pattern that is evenly illuminated. A photograph of a typical alignment set-up is shown in Fig. 8. The illumination can be checked by sliding a photographic exposure meter flat against the test pattern surface and adjusting the lights until the light reading is reasonably the same over the whole of the test pattern. In the absence of a regular television flood light source, two Photoflood lamps, in reflectors, placed in the position shown in Fig. 9, will give approximately 100 foot candles of even test pattern illumination. If the camera is already mounted in an overhead Hospital operating room light, the test pattern can be laid on the operating room table, and stands used to hold the photoflood lights about four foot higher and four foot away from the test pattern. (If the lights are used too close to the test pattern, hot spots result which, if electrically corrected for in the system with the Multi-focus and shading controls, will give a poor picture when the subject is televised.)

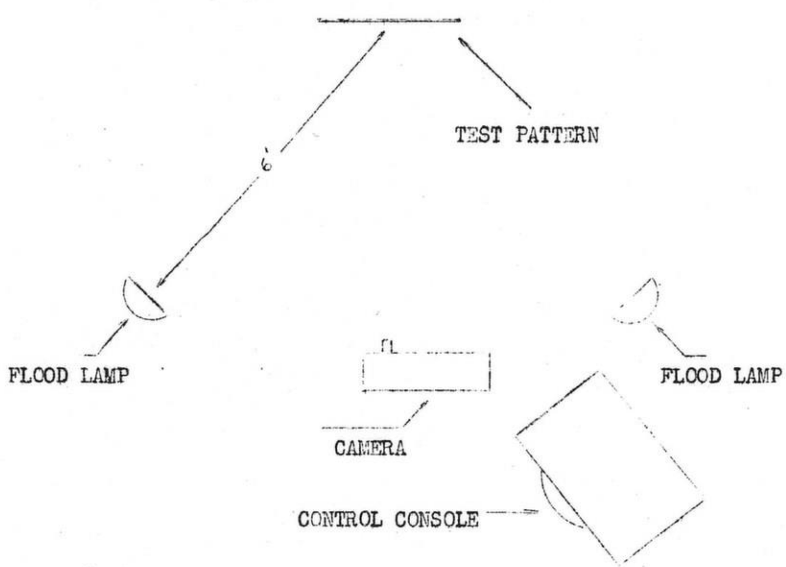


Fig. 9

TYPICAL SET-UP FOR TEST PATTERN ALIGNMENT

Recheck FOCUS CURRENT on meter for correct value of 75 ma. At the end of the warm-up period, uncap the lens and obtain a picture signal as given under Preliminary Adjustments, roughly aligning the IMO tube by adjusting the ALIGNMENT current control and alignment coil position (gear) by centering the "searchlight" effect.

Orthicon Focus

Negatively bias the TARGET (Counterclockwise) until the picture disappears. Increase the BEAM current slightly and focus the white multiplier spots with the ORTH FOCUS Control. When alignment is incorrect, these spots will swirl across the kinescope. While continuously rocking the ORTH FOCUS Control, adjust the alignment coil and ALIGNMENT Current Control until the spots tend to stand still and go in and out of focus, or sort of "blink" at you. Be very fussy about getting these adjustments just right. Adjust TARGET Control again to where picture is obtained, and slowly rotate the ORTH FOCUS counterclockwise until the white multiplier spots just disappear, but good electrical focus of the picture is maintained.

Image Focus

If picture is still a bit fuzzy, turning the IMAGE FOCUS Control one direction or the other will result in a sharper picture.

Imo Vertical and Horizontal Size Controls

It is most important that a new Image Orthicon tube start its useful life with the proper scanning adjustments. During the first twenty hours of an Image Orthicon tube's life, the initial sensitivity of the target surface with regard to secondary electron emmission, is very high. Consequently, if a picture is televised and the target surface is underscanned,

Fig. 11a

IMO overscanned. Test Pattern too far from camera.

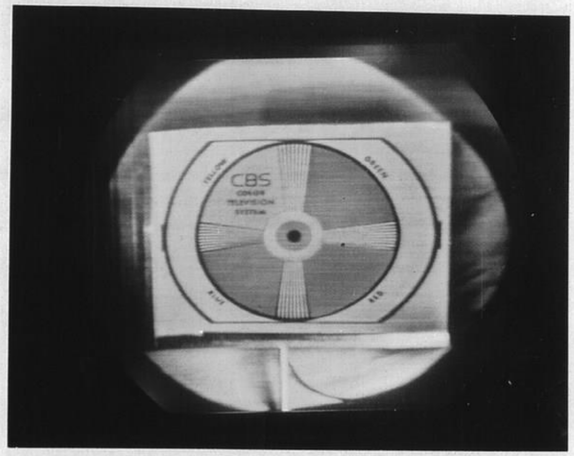


Fig. 11b

IMO overscanned. Outer ring of test pattern just touches inside of circular target mask. Test pattern correct distance from camera.

Fig. 11c

IMO scanning controls adjusted correctly, with the inside circle just touching top and bottom, the outer circle just touching both sides, thus giving correct 3:4 aspect ratio.

that area of the picture that is scanned by the scanning beam is used up at a faster rate, and becomes less sensitive. This results in a burned in mask that prevents the proper use of the tube at any time in the future.

The more surface of the target that is scanned, the (1) better the sensitivity of the tube, thus requiring less picture illumination, and (2) the picture resolutions capabilities of the tube are increased, giving sharper images. If the following procedure is used, the maximum area of the target will be used. For the moment, it is presumed that the scanning raster on the kinescope is of the proper size i.e. top, bottom and sides are just visible within the mask opening, and the raster linearity is proper, as checked in MAINTENANCE.

With the IMO HORIZ. SIZE and IMO VERT. SIZE Controls maximum, the IMO tube beam will overscan the picture on the target, resulting in a circular grey mask around the picture areas. Focus the Camera on the test pattern, and dolly the camera from or toward the test pattern, until the outer circle of the test pattern just touches the inside of the circular grey mask. Make sure that the test pattern is sharply focused optically and electrically (Image Focus and Orth Focus) before leaving camera in this position. The picture should be similar to that shown in Fig. 11b.

By gradually turning the IMO VER. and IMO HORIZ. size controls counterclockwise, the IMO picture should be enlarged until the outer circle of the test pattern just touches the outside of the kinescope raster, both vertically and horizontally. With this adjustment, the inside edge of the circular grey target mask should have just disappeared. The controls should be left in this position, see FIG. 11C.

It is important that both the test pattern and camera be level with each other before the above measurements and adjustments are made. By sighting through the optical eyepiece, pan across the test pattern. If eyepiece appears to be traveling upwards or downwards as the pan is made, re-set the Test pattern. Using a level on Both may be preferable. If the test pattern as viewed on the kinescope still does not appear to set squarely with reference to the raster i.e. the bottom horizontal line of the test pattern should be exactly parallel with the bottom edge of the kinescope raster, the IMO scanning assembly can be turned with respect to the focus assembly, by pushing the handle located in back of the a-lignment gear (coil) adjustment either clockwise or counterclockwise, until the test pattern sets squarely.

Multi Focus and Shading Controls

Proper multiplier focus control setting will give maximum signal with the least shading. With Both HORIZ. and VERT. shading controls in their mid position, adjust the MULTI FOCUS control for the least amount of shading with the maximum amount of signal, by observing both the os-cilliscope and picture. This adjustment can be most easily set by plac-ing a clean white piece of cardboard in front of the test pattern, and turning the SWEEP SELECTOR switch to HIGH.

Observe the trace on the scope closely. If it has some remaining tilt (or shading in the picture monitor) adjust the HORIZ. shading con-trol with Sweep Selector switch turned to HIGH, and then adjust VERT. shading control with switch turned to LOW.

G - 5 Camera Shading Adjustment

With the Test pattern still covered with clean white cardboard, adjust control on back of Camera Pre-amp chassis marked G-5 until all corners of the picture are free of shading. In one extreme position this con-trol will give a type of shading known as a "Port Hole" effect. Re-move white cardboard cover and pan the camera until the bull's eye center of the Test pattern is observed in all four corners of the Kinescope raster. The Vertical and Horizontal resolution will be slightly lower than the resolution as seen when the bulls eye is in the center of the picture. If not, back off slightly on G-5 until corner resolution improves, and compensating the added shading if possible, by re-setting the shading controls. ORTH FOCUS will have to be re-adjusted for each new setting of G-5. It is quite common to compromise between shading and corner resolution. However, if the shading or Port hole effect is very pronounced when reasonable resolution is obtained, slight variations in re-positioning the Mu metal shields which cover the IMO tube assembly will improve shading conditions. This can be accomplished by removing the mid section camera cover, and loosening the dual clamp screws, thus allowing movement of the magnetic shields around the tube. The final choice may require some re-adjustment of Alignment, Beam, Target, and Focus Controls.

HI-PEAKER (Streaking) Control

When focused on the Test pattern, if black or white streaks appear, particularly after the lettering, rotation of the Peaker Control (C-16 shaft extends vertically at the rear of the console adjacent to V6) will correct this condition. Rotation in one direction will cause a trailing black smear. Rotation in the other direction will cause a trailing white smear. Correct adjustment compensates the frequency response so that no smearing appears. If Black and White streaking appears simultaneously, Target is probably too positive (clockwise).

Target, Beam and Iris

Too much Beam current (clockwise) results in a very noisy picture, so therefore adjustments should be aimed at keeping the beam current low.

Too much Target control (clockwise) results in a washed out and color-splotchy picture. The added Beam current re quired to keep the whites from blooming cause the picture to become noisy, and softens the detail.

Although colors are very true in reproduction and good resolution is obtained, too little Target control results in a dark murky picture.

The optimum Target control setting is always a function of the average scene illumination, and is therefore dependant upon the Camera lens Iris control. For a given setting of the target, the beam must be adjusted to just where all the whites are kept from blooming. Any further increase in Beam control setting contributes nothing but added noise signals.

For a given lens opening (iris) the Target control is usually turned clockwise until the picture breaks clean and clear, but no further. As the Target control is turned, the Beam control is also turned but just enough to keep the whites from blooming.

To find the optimum Lens opening and Target control, proceed as follows:

(a) Focus on Test pattern or picture material to be televised, use lens wide open. Adjust Target and Beam for best picture.

(b) Gradually close lens until colors start to fade. Advance Target and Beam setting again for best picture. If colors are not as true or appear murky, open up lens by one stop and readjust Target and Beam controls.

(c) Repeat (b) if a good color picture is obtained. The smaller the lens stop, the better depth of focus field will be obtained. However, if the lens is stopped down too far, resolution will be lost and colors will appear murky.

If a wide range of scene lighting must be accomodated, with no opportunity to change the setting of the Iris control. Adjust the lens opening for the scene having the lowest amount of light (largest lens opening) and carefully readjust Target and Beam controls when panning to the brightest scene. Brightness pedestal will also have to be readjusted under such conditions.

Brightness Controls & Reference White

With the VIDEO GAIN Control set to zero, the Red, Blue and Green brightness pedestals should be adjusted until the kinescope raster shows a good white, a white that looks the same as the white being televised. Since these pedestals tend to very slowly drift at times, particularly the first hour that the equipment is on, it is important to check these pedestals occasionally. Otherwise it might be found that the overall picture suffers from a green, red or bluish haze effect, particularly noticeable on dark scenes.

The preliminary adjustments given on page 15 and shown in Fig. 7 are sufficient if care is taken. If the SWEEP SELECTOR switch is turned to HIGH, the red, blue and green pedestals are superimposed, and if the adjustments are made so that each pedestal falls exactly upon the others, a white of approximately 4000° Kelvin temperature will result. If the oscilloscope trace pattern is thick, it is possible that the pedestals will not superimpose accurately, with the result that the white raster may look pinkish, greenish or bluish. Some operators use a fluorescent desk lamp, fitted with a 3500° K or 4500° K lamp bulb, sitting nearby for their notes and schedule sheets, and use a white piece of paper under the lamp to see what their white raster should look like. This serves as an excellent reference because sometimes one finds that as the program progresses, your idea of white may drift to slightly pink, blue, or green and you adjust the control accordingly. The reference light source will correct this, and also serves equally well for a reference white when the color Mixing Gain Controls are used.

As suggested on page 16, and shown in Fig. 7c, it is adviseable to keep the individual red, blue and green Brightness Controls near their center position, and use the main BRIGHTNESS Control for the usual 10% set-up level. The 10% set-up level is a precautionary level to keep the video signal from dropping down into the Sync-Signal region (in case of poor dc insertion), and causing the receivers to Synchronize badly.

Red, Blue & Green GAIN Controls

By adjusting the Red, Blue and Green GAIN Controls, the picture can be adjusted to give a very true color rendition of the original scene being televised. Generally speaking, the three controls are usually worked between their mid and extreme clockwise postions, and at a point where any white object in the scene appears as the same white on the color monitor picture. With some white in the picture, it will be noticed that the red, blue and green signal amplitudes are almost identical. This can be observed on the oscilloscope with LOW trace sweep (see Fig. 7d). The red video information is first, then blue and then green. With the Monitor switch button marked "Color Mixer" pushed in, the signal amplitudes should be in the order of .75 volts, peak to peak (3/4" vertical deflection on oscilloscope).

It is seldom necessary to turn the color gain control knobs after the initial adjustment for white. There are occasions where it is quite necessary however, such as:

a) When panning from one scene to another scene where a difficult temperature light source is used. For example, when televising a surgical operation where all of the illumination comes from typical operating room (6000° K temperature) lamps, and the camera is then panned over to a medical chart illuminated with a white photo flood (3400° K) lamp, the picture will appear slightly red because of the lower light temperature. Slightly turning the red GAIN Control down, will correct for this.

b) To attenuate certain colors. For example, to minimize the effect of poor facial make-up on close up scenes.

c) To emphasize certain colors to make certain picture details more noticeable. This is particularly useful on Medical Clinic subjects. Also used for artistic effects--moonlight scenes, dark room scenes, etc.

d) For exacting color match to the original scene as closely as possible for technical perfection, such as required for observance of jet flame for combustion adjustments, or color fabric material comparisons , etc.

Video GAIN Control

This control regulates the amount of video signal fed into the console from the Camera, and should always be adjusted to give a value of .75 volt, peak to peak (3/4" vertical deflection on oscilloscope), at the channel amplifier output. If the amplitude of the Video signal varies during the program, because of lighting or density of program material etc, this is the control that should be used to maintain constant video level, so that the gamma amplifier circuit is assured of a constant input, and the "Color Mixer" and "Channel" test points have the required .75 volts peak to peak of video to give a good bright picture on the Color Monitor.

VIDEO LEVEL Control

This control regulates the amplitude of the video signal feeding into the outgoing video signal line. After all other controls are set properly and a good picture is obtained, then the picture signal can be fed to the receivers by turning the control counter-clockwise, until 1" of video deflection (1.0 volt peak to peak) is obtained, riding on top of the Sync. signals already going out. As soon as this control is turned, red pilot lamps in the Camera light up, indicating to the performer and the camera man that the camera picture is now ON-THE-LINE and the picture is being seen at the receiver. The Scopetrace waveform should now look similar to that shown in Fig. 10.

The prime purpose of the VIDEO LEVEL Control, is to allow the Camera Control operator to properly set up his picture adjustments, get into proper color phase etc, and not allow these many adjustments to be seen at the receiver. This control thus allows pre-monitoring of program material to see how it will look before the picture is fed to the receivers, with monitor switch button marked "COLOR MONITOR" being punched in.

The second important use for this control, is to select, if desired, the picture signal from the putput of a second Camera Control Unit, where two cameras are used for program pick-up. Thus the picture from Camera No. 1 or Camera No. 2 can be faded into the one outgoing signal, both signals being visible on your Color Monitor when button marked "LINE OUTPUT" is punched in.

A third use is for monitoring the camera picture signal from another part of the building, their going off thus indicating to you that you can now fade your picture in.

A common Sync Generator is required for two camera operation.

Sync. Level Control

Allows the level of the Sync signal to be varied, independent of the video level. This control is usually adjusted to give .4 volts peak to peak at the live output (.4" vertical scope deflection), and should not be touched once program starts. If touched during program the brightness levels at the receiver will vary.

When the program is fed into another Camera Control unit for mixing (in two camera operation) the Sync Control should be set for zero Sync signal output.

Gamma Control

This control selects the grid operating point of an amplifier tube in such manner that the dark greys or dark color tones are amplified more than lighter tones, thus "Stretching the blacks" to compensate for the natural compression of blacks due to the "grid drive versus light output" characteristic of the kinescope tube. The stretching of the blacks is in addition to some black stretching obtained in the cathode follower impedance of V-32.

All camera adjustments, target, beam, etc. should be done with the Gamma Control at zero. If after the best of adjustments, picture tones look harsh, turning the Gamma Control clockwise will soften the strong shadows. However, depending on picture material, turning the control fully clockwise may make the picture look washed out with no contrast.

Lens Selection and Adjustment

Three lens are supplied with the equipment, and can be selected by punching in the appropriate Lens Selector button. The lens are:

1) 83 mm f3.2 Wollensak Raptar (coated) in special lens mount. Will focus on objects from 2 feet to infinity. The horizontal picture coverage is 21°. The actual horizontal picture area coverage can be computed by multiplying the distance between the lens and subject by .36. For example, if the center of the object being televised is 10 feet from the lens, then .36 X 10 = 3.6 feet total horiz area will be covered, or objects within 1.8 feet either side of the object, will be picked up.

2a) 135 mm f4.5 Wollensak Enlarging Raptar (coated) with special sleeve mounting. This sleeve mounting has one hole drilled so that when the lens is slipped in correctly, a latch pin will fall into the hole, thus locking the lens in place so that focusing from 4 feet to infinity can be accomplished.

2b) MAKE CERTAIN THAT LATCH PIN IS IN HOLE AND TENSION IS TIGHT ON LATCH SPRING BEFORE PLACING CAMERA IN THE OPERATING ROOM LIGHT, TO AVOID SERIOUS ACCIDENT.

2c) The horizontal picture coverage is 12.° The actual horizontal picture area coverage can be computed by multiplying the distance between the lens and subject by .21 For example, if the center of the object being televised is 10 feet from the lens, then .21 X 10 = 2.1 feet, or 1.05 feet on each side of the object will be picked up.

The lens sleeve for the 135 mm lens may have additional holes drilled at ½" interval distances to allow extreme close-ups. It is important to cover the exposed holes with tape to prevent light leakage if the camera is used within the lighted area of the scene being televised. The additional focusing range thus afforded is as follows.

Lens full in	2' - 11"	to	infinity
2nd hole	2' - 1"	to	6' - 6"
3rd hole	1' - 7"	to	3' - 2"
4th hole	1' - 4"	to	2' - 2"

3a) <u>229 mm (9") f4.5</u> Dallmeyer telephoto (coated) with special sleeve mounting. This sleeve mounting has three holes drilled so that when the lens is slipped in correctly, a latch pin will fall into either of the three holes. The outside hole will allow focusing from 3' - 5" to 4' - 8". The middle hole will allow focusing from 4' - 1" to 6' - 11", and the inside hole will allow focusing from 6' - 5" to infinity. A knurled screw ring is supplied on the black tube to fasten the lens securely to the lens mount. Black tube extensions are available to extend the lens thus allowing focusing down to within 18 inches of the subject.

3b) MAKE CERTAIN THAT LATCH PIN IS IN HOLE AND TENSION IS TIGHT ON LATCH SPRING BEFORE PLACING CAMERA IN THE OPERATING ROOM LIGHT, TO AVOID SERIOUS ACCIDENT.

3c) The horizontal picture coverage is 6°. The actual horizontal picture area coverage can be computed by multiplying the distance between the lens and subject by .1 i.e. at a lens distance of 24 inches, the 2.4 inches is the total horizontal coverage, or 1.2 inches on either side of center.

<u>Audio Gain Controls</u>

a) Inter-Com Gain control allows the adjustment of inter-com volume to a comfortable listening level, and its adjustment is dependent upon how many local and remote i ter-com phone sets are connected in. Punch test button marked "Inter-com Audio", talk into headset microphone, and adjust Inter-com Audio Gain Control until test meter needle indication hits about the middle of the scale on peaks. Have microphone about one inch in front of your mouth when setting this level.

b) No. 1 Microphone Gain Contols the level of either the Surgeons microphone or No. 1 program microphone. Any high impedance type microphone having a minimum output of -46 db can be used, to give a + 8 db line output signal. Microphone level should always be adjusted to give a + 8 db level on the outgoing line. This level will be indicated on the test meter by reading the signal peaks at about 300, with test button marked "Program Audio" punched in.

c) No. 2 Microphone Gain controls the level of No. 2 program mecrophone, and is used the same as No. 1 control above.

The surgeons microphone is usually enclosed within two layers of gauze material, and then pinned inside the face mask, slightly to either side. The miniature hearing-aid type earpiece can be inserted over the lobe of either ear. The connector cord is usually brought over the shoulder and safety pinned to the gown at about the middle of the back, in such manner that any slight tug on the connecting line will be felt only on the gown, but heavier pulls will pull the connectors apart, thus freeing the surgeon altogether.

SCREW DRIVER CONTROLS

The following controls can be reached only by sliding the console cover off, and adjusted with a screw driver. Most of these controls should be adjusted only by a qualified technical person.

Camera Control Amplifier Chassis

High Peaker control functions to emphasize the high frequency response of the video amplifier, to compensate for the high frequencies lost in the first video preamp stage. It is adjusted for minimum streaking in the picture. A method of adjusting this control is explained on page 25.

IMO Focus Coil Current control regulates the current flowing through the IMO focus coil, and, with the test button switch marked "IMO FOCUS CURRENT" punched in, adjusted to give 75 ma. This control (R186) is adjacent to V30, underneath the Kinescope shield.

Coarse Beam Control shifts the range of operating bias for the IMO grid, leaving the front panel BEAM control act as a vernier control. If the IMO target cannot be discharged with the front panel Beam control, shift the Coarse Beam control until it can. If no picture appears on a newly installed IMO tube, turn front panel BEAM control to 3/4 full on, and shift coarse control until target just discharges. The coarse control (R148) can be located just to the rear and under the color disk motor.

-150 Volt Regulator Control adjusts the -150 volt supply voltage output. Test button marked "-150" should be punched in, and this control adjusted until meter reads 150 volts. If frequent adjustments have to be made on this control, have tubes V23, V24 and V26 checked. This control (R164) located just to the right and under the color disk motor.

+150 Volt Regulator Control adjusts the +150 volt supply voltage output. Test button marked "+150" should be punched in, and this control adjusted until meter reads 150 volts. If frequent adjustments have to be made on this control, have tubes V24, V25 and V27 checked. This control (R172) is located at the rear top of the chassis adjacent to V24.

Color Monitor & IMO Scan Chassis

Scope Horiz. Centering control should be adjusted to center the scope trace in its mid-horizontal position. This control (R118) is located underneath the chassis, extreme left, top row.

Scope Vertical Centering control should be adjusted to shift the trace about ½" vertically down from true center. This control (R116) is located underneath chassis, second from left, top row.

Scope Brightness controls the trace sweep brightness, and should be used in conjunction with the Scope Focus control to achieve a fine and fairly bright scope trace line. Adjustments should be made with Video and Sync information. Varying either of these controls will vary to a certain extent the -400 volt bias to the IMAGE FOCUS Control, which should be checked with signal to see if it is within its focusing range. This control (R91) is located underneath chassis, third from left, top row.

Scope Focus control (R93)-see under Scope Brightness above-- is located underneath chassis, fourth from left, top row.

IMO Vertical Linearity Control (R54) varies the grid operating bias on the Vertical output scanning tube, thus distorting the output waveform to counteract the low frequency distortion of the output transformer. Presuming that the color Monitor kinescope raster is linear, the control can be adjusted, in conjunction with the IMO VERT. SIZE control, to make the test pattern circle round instead of egg shaped,, i.e. both vertical wedges should be the same length. This control is located fifth from the left-top row-underneath chassis. By placing an oscillosope across R50 test points, the current waveform can be observed, and linearity adjustments can be made until the correct straight sawtooth waveform is obtained.

IMO Vertical Centering control (R49) centers the Image Orthicon vertical scanning and should be adjusted when a new IMO tube is installed, so that the Bulls eye of the test pattern falls directly in the center of the target masking (see fig. 11). This control is located third from the right, top row, underneath chassis.

IMO Horizontal Peaking control (R21) compensates for the resistance-inductance ratio of the horizontal scanning coil. To a certain extent, it can be used for linearity correction for the beginning of the horizontal trace period (left side of picture). The action of this control can be best observed by placing an oscilloscope across R30, and adjust the peaking control up to the point of no "overshoot" on the retrace. The scanning current waveform should look like a good straight sawtooth, with no more than 15% flyback time. This control is located second from the right, top row, underneath chassis. When the oscilloscope is used across these test points, the chassis of the oscilloscope will be + 280 volts to ground AND DANGEROUS TO LIFE if due caution is not observed.

IMO Horizontal Centering control (R 29) centers the Image Orthicon horizontal scanning, so that the Bulls eye of the test pattern falls directly in the center of the target masking (see fig. 11) this control is located extreme right, top row, underneath chassis.

IMO Horizontal Linearity control (L-11), is an inductance with an adjustable iron core, used as a part of the filtering circuit of the Booster tube V-9. By varying this inductance, the plate current supplied to the 6AU5 output tubes can be slightly distorted, thus altering the output. The action of this control can best be observed by placing an oscilloscope across R30 test points, and adjusting the control until the sawtooth waveform looks straight. When placing the oscilloscope across these test points, the chassis of the oscilloscope will be + 280 volts to any grounds AND DANGEROUS TO LIFE if due caution is not observed. This coil is located underneath the chassis and below the large output scanning transformer. The adjustable screw is adjacent to V9, and adjusted from the tube side of the chassis.

Monitor Video Gain control (R66), allows a vernier adjustment, within limits, of the video gain for both the Color Monitor and the Scope waveform display. It has been adjusted at the factory so that a 1 volt peak to peak video level at the test point, will produce 1" of vertical deflection, with the scope trace reasonably bright and sharp. This level also will give an excellent contrasty color picture on the color monitor. Adjustment of this control does not affect the outgoing signal, and may be re-set by the operator to give a softer or more contrasty picture on the color monitor, provided the Vertical

Scope trace is recalibrated to show if the outgoing signal exceeds 1.4 volts peak to peak, which should always be the maximum output. This control is located directly in back of the push-button selector switch, underneath the chassis.

Monitor Vertical Size scanning control (R41) changes the plate voltage to the vertical discharge tube V11, regulating the amplitude of the sawtooth discharge voltage, thus controlling the vertical size of the kinescope raster. This control should always be adjusted so that the visible unblanked raster (punch color Mixer test button in and use 10% brightness set-up with no video) just barely touches the top and bottom of the kinescope mask. Adjustment of this control will effect vertical linearity, which can be checked by observing the line structure closely (each raster line should be spaced the same) or by punching in test button marked 9 X 9 and observe the spacing of the counter bars. However, do not adjust size in this test position. This control is located underneath the chassis near the top left hand corner of the hi-voltage cage.

The action of this control can be observed by placing an oscilloscope across R31 (mounted under kinescope cable plug in socket). Adjustment should be such as to make the sawtooth waveform linear on the straight portion, with no more than 6% flyback time. When the oscilloscope is used across these test points, the chassis of the oscilloscope will be + 280 volts to ground AND DANGEROUS TO LIFE if due caution is not observed.

Monitor Vertical Linearity scanning control (R39) regulates the value of screen grid voltage on the vertical output tube (V10). The screen voltage shifts the operating range of the tube from linear to non-linear ranges, thus distorting the output waveform to counteract the low frequency distortion of the output transformer. Adjustment of this control will effect vertical size, therefore both controls should be adjusted together. This control is located underneath the chassis near the left middle of the hi-voltage cage.

Monitor Vertical Centering control (R32) can be used to center the kinescope raster in a vertical direction. Normally, this control is adjusted in conjunction with the vertical size control, until both top and bottom of the unblanked raster trace just barely touches the kinescope tube mask. This control is located underneath the chassis, at the bottom-center.

Monitor Horizontal Centering control (R2) can be used to center the kinescope raster in a horizontal direction. Normally, this control is adjusted in conjunction with the horizontal size control, until both sides of the unblanked raster trace just barely touches the kinescope tube mask. This control is located underneath the chassis, at the bottom and adjacent to the high voltage cage.

Monitor Horizontal Size control (L-2) is a variable iron core inductance, placed across part of the secondary to act as a variable shorting reactance. Because the iron core is mounted on the end of a very fine threaded screw, quite a few turns are necessary before a change in size will be noticed. This control is located through a small hole at the bottom of the high voltage cage, underneath the chassis.

Sync. Generator and Audio Chassis

Scope Horiz. HIGH Sweep adjustment control (R73), is a plate voltage adjustment on a tightly synchronized multivibrator type oscillator.

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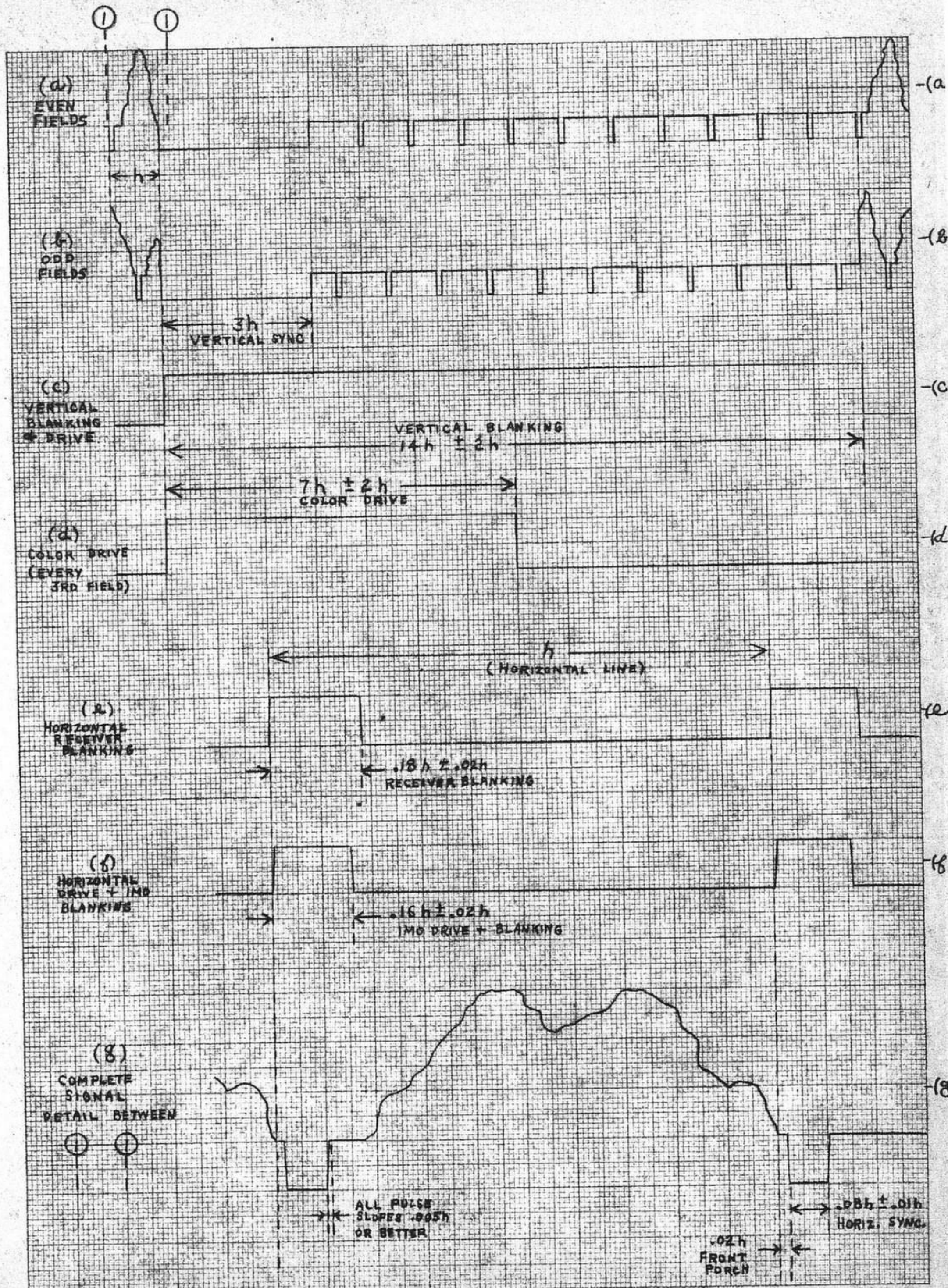

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FIG. 12 INDUSTRIAL COLOR TELEVISION SYNCHRONIZING WAVEFORMS

The range of this control has been fixed at the factory so that from one to three line intervals can be seen on the scope trace. Usually two horizontal line intervals, such as shown in fig. 7, give all the waveform information required. The control is located adjacent to V26, underneath chassis, bottom center.

Vertical Sync Width control (R147) is used to adjust the Vertical Synchronizing Signal pulse width, to exactly 3 lines width (102 microseconds) as shown in fig. 12b. See "PULSE WIDTH MEASUREMENTS" for a method of adjusting this control accurately. This control is located underneath chassis in back of Mic #1 input receptacle.

Vertical Drive & IMO Blanking Width has no adjustable control. The width of this pulse has been adjusted at the factory for a blanking interval of 14 horizontal lines (7% of Vertical Interval) and for present 12AT7 tube replacements available for V4, no trouble should be experienced in keeping within the limits as given in fig. 12c, which is plus or minus 2 horizontal lines. It may be that in later production runs of the type 12AT7 tube used at V4, the vertical pulse as generated by the tube may fall outside the limits given, in which case R-105 grid resistor can be increased or decreased, to bring the pulse width back within limits. Several tubes should be tried however, before this procedure is used. For measuring or making a width adjustment, see "PULSE WIDTH MEASUREMENTS".

Horizontal Drive & IMO Blanking Width has no adjustable control. The width of this pulse has been adjusted at the factory for a blanking interval of .16h plus or minus .02h, h being the time required for one horizontal scan, as shown in fig. 12f. For present 12AT7 tube replacements available for V1, no trouble should be experienced in keeping within the tolerance limits. It may be that in later production runs of the type 12AT7 tube, the Horizontal Drive pulse as generated by the tube may fall outside the limits given, in which case R26 grid resistor can be increased or decreased slightly, to bring the pulse width back within limits. Several tubes should be tried however, and the 2:1 counter control should be in the middle of its fall-out-of-count positions, as this control does effect the width of the pulse slightly. For measuring or making width adjustments, see "PULSE WIDTH MEASUREMENTS".

Horizontal Receiver Blanking control (R-90) is used to adjust the Horizontal Blanking pulse width in the final signal. The pulse width is purposely made wider than other pulses, to cover up and blank out of the final signal any interference from clamping pulses or cross-talk. The front edge of the pulse automatically starts before the front edge of camera blanking arrives, due to camera cable and channel amplifier delay, and lasts, in time, until after the back edge of camera blanking disappears.

Since the return trace time of the kniescope raster is roughly .14h and it is triggered off by the horizontal Sync Pulse which is .02h late, a rough field adjustment of this control can be made by observing the kinescope raster with blanking pedestal as the only signal, and turning the control until about ¼" of the left hand side of the raster "blanks out". For a more precise measurement, see "PULSE WIDTH MEASUREMENTS".

This control is located underneath the chassis-left middle under V13 and V14.

Horizontal Sync. Pulse Width control (R-115) is used to adjust the horizontal Sync pulse width in the final signal. The Sync pulse is purposely delayed in time .02h to form a "front porch", which acts as a guard against the video signal climbing up a poor blanking slope and getting into the Sync. signal region, which it may do if the front edge of the Sync. pulse coincides, in time, with the edge of blanking.

Since the Horizontal Blanking time width is usually always twice the Sync. pulse width, a rough field adjustment (in case of V19 tube replacement) can be made by observing the "LINE VIDEO" signal, Scope sweep switch to HIGH, and adjusting the Sync. Width control until the Sync. pulse is about half the total width of the observed horizontal blanking pedestal, as shown in fig. 12g. For a more precise measurement, see "PULSE WIDTH MEASUREMENTS".

This control is located underneath the chassis-left middle under V14 and V15.

All Counter Controls are located along the top of the chassis, underneath the upper chassis lip. The adjustments of the controls are explained in Preliminary Adjustments on page 14.
The purpose of the 2:1 counter, is to divide the main oscillator frequency fo 58,320 cps by two, to give the horizontal scanning frequency of 29,160 cps. A staircase wave shape can be observed with an oscilloscope across C-15, having two steps, when adjusted properly.

The purpose of the 9:1, 9:1 and 5:1 counters, is to divide the main oscillator frequency of 58,320 cps by 405 (the number of horizontal lines) to give the correct vertical scanning frequency of 144 cps. Staircase waveforms having that number of steps can be observed across C-30, C-47 and C-63 respectively, when properly adjusted.

The purpose of the 3:1 counter, is to divide 144 cps by 3 to give 48 cps (color field frame - see fig. 1-E) to give the correct color gating sequence of the color mixing amplifiers, and to provide an AFC comparison voltage to lock the Sync. Generator Master oscillator frequency. A Staircase wafeform having three steps can be observed with an oscilloscope across C-73, when properly adjusted.

PULSE WIDTH MEASUREMENTS

The slope of all pulses used, has a minimum time-of-rise tolerance of .005h (.17 microsec), which indicates that the time taken by the front or back edge of any slope should not take more than .17 microseconds to rise from .1E to .9E, E being the full amplitude of the pulse. Therefore, a test oscilloscope having a minimum vertical deflection bandwidth of 3 mcs is required, but 5 or 10 mcs is preferred, to pass such waveforms without distortion. Representative precision type oscilloscopes available for this type measurement are: Dumont type 303, RCA type WO-79B, and Tektronix types 511, 513 and 514-D are all reasonably priced instruments, and there are probably others available that will do a good job. The above oscilloscopes have expanded horizontal sweep voltages that will aid in measuring the horizontal pulse widths, and allow the pulse slopes to be seen clearly.

Since all pulses generated in the Sync Generator circuits are clipped in other tube stages before use, it is important that the pulse widths be measured after they have been clipped and injected into the final signal. For example Horizontal Sync and Blanking, Vertical Sync and Blanking, and their slopes, should be measured in the composite signal as it exists on the output Video line of the Camera Control. The test oscilloscope can be clipped across R10 in the console (with 75 ohm loading) or across the Video line at any of the reciever positions. Blanking with no video signal, plus Sync, should be the only signal present for this measurement.

IMO Horizontal and Vertical target Blanking should be measured at the output of the camera pre-amp blanking amplifier. The co-axial lead going to "TARGET" should be disconnected. Since this disconnectsapproximately 55 mmfd. of capacity loading on this stage, it is important that additional capacity be shunted across the oscilloscope leads, so that the capacity of the oscilloscope plus the additional shunt capacity, equals 55 mmfd., when placed across this output.

Color Drive can be measured across the cathode resistor R-154 of V30 in the Sync Generator Chassis.

<u>Vertical Pulse Width Measurements</u>

Place the oscilloscope test leads across the proper termination, as per above instructions, and adjust vertical amplitude of scope signal to no more than $1\frac{1}{2}$ inches deflection. Use a 1 mmfd. condenser (or two leads twisted together for about one inch) in series with a line <u>from</u> the Horizontal Sync output resistor R-127 (cathode resistor of V-29 in Sync Generator), to the hot oscilloscope test lead. This will produce additional spikes on top of the waveform being observed, which can be used as time marker pips. Because of the 2:1 interlace, these pips will appear as half line internal markers. For example, when measuring the width of the Vertical

Sync Pulse, six half line intervals should be counted for the correct pulse width. 28 half line intervals should be counted for the correct pulse width of Vertical Blanking.

An oscilloscope with an expanded and triggered time base is essential for this type measurement.

Horizontal Pulse Width Measurements

Place the oscilloscope test leads across the proper termination, as per previous instructions, and adjust vertical amplitude of Scope signal to no more than $1\frac{1}{2}$ inches deflection. Using an expanded sweep, the width of each horizontal pulse can be measured directly on the Dumont and Tektronix oscilloscipes mentioned. If the oscilloscope used does not have a calibrated time scale marker or sweep, the following method, less accurate but good, can be used, provided that the horizontal sweep of the oscilloscope is linear.

Adjust speed of oscilloscope horizontal time base until two line pulse periods appear (as shown in fig. 7). This will put the pulse to be measured in the center of the Scope trace, the second pulse partially hidden by the retrace on the scope. Slowly expand horizontal sweep trace until one line trace period is two inches in length. If observed pulse starts to move to the left or right as the sweep is expanded, stop, as this indicates sweep distortion. With the celluloid graph tube face scale (or ruler) measure off the total width of one line, and adjust the horizontal blanking time to 18% of this width, as accurately as possible. This procedure will give the proper blanking pulse width to within 2%, which is within the tolerance given. This Blanking pulse width can now be used as a standard width on an expanded time scale, to represent

.18 h, and the width of the other pulses adjusted with relation to it. For example, the horizontal Sync pulse is almost half the width of the receiver horizontal blanking, and the IMO horizontal blanking just slightly less than the receiver horizontal Blanking (see fig. 12 e, f and g).

External Power Supply Unit Controls

On-Off-Remote switch (SW-1 in schematic dwg. B-S-1217) is located on top panel of M-G Control box. The purpose of this switch is to allow preliminary testing such as required for proper direction armature turning, or servicing of the supply as a unit by itself and not necessarily with the console connected to it. In the ON position, all power supplies will have power. In the OFF postion ac power will not be supplied and the supplies will not function. In this position, the power switch in the console will not function. In the REMOTE position, power can be applied only by turning the power switch to ON, in the console.

Line Voltage Top Switch (SW-2 in schematic dwg. D-S-1210) See page 13 under "preliminary adjustments" for proper operation. Located within Regulated supply cabinet, on front panel.

Voltage & Current Meter Switch (SW-1 in schematic dwg. D-S-1210) See page 13 under "Preliminary Adjustments" for proper operation. Located within Regulated Supply Cabinet, on front panel under meter.

D.C. Voltage Output screw driver control (R-29 in schematic dwg. D-S-1210) regulates the dc output voltage of the Regulated supply, and should always be adjusted to read + 280 volts at the console. Because of the voltage drop in the power line from the console to the Regulated power supply, the dc meter in the Regulated Supply Cabinet should read higher by a few volts. This reading can be marked on the front panel with a grease pencil, for future reference in case of servicing.

Camera Controls

Alignment Current Control (R-23 in schematic dwg. D-S-1209) is a mid-topped control connected in such manner that the direction of current flow in the alignment coil can be reversed. The proper operation of this control is explained under "Preliminary Adjustments" page 17, and under Orthicon Focus on page 22. The control is located on the back panel of the pre-amp chassis. Calibration figures are engraved on the knob to provide a quick future reference point for the particular IMO tube being used.
Alignment Coil Adjustment is a mechanical rotation of the alignment coil. The proper operation of this control is explained under "Preliminary Adjustments" page 17, and under Orthicon Focus on page 22. This coil is rotated by turning the small 3/4" gear located over the coil. Indexing numbers may be found under a small arrow, for future reference for the particular IMO tube being used.
G-5 Control (R-22) is located on the back panel of the Camera pre-amp. chassis, and is principally used to minimize corner shading. The proper method of using this control is explained under G-5 Camera Shading Adjustment pages 24 and 25.

IMO Tube Orientation Adjustment Lever is used to turn the IMO scanning coil so that a true horizontal line being televised will appear exactly parallel to any receiver raster line. The adjustment of this lever is given on page 23 and 24. The lever is located right behind the alignment coil gear adjustment.

High Voltage Switch (SW-1) has been provided so that the 1450 volt multiplier high voltage supply can be turned off for servicing adjustments and when changing IMO tubes. This switch disconnects the screen grid supply voltage to the 3 KC high voltage oscillator, thus stopping oscillation. The switch is located on the back plate of the camera pre-amp chassis.

IMO Heater ON-OFF Switch (S-2) located on the back panel of the camera pre-amp chassis, should always be left at the "ON" position, unless the picture becomes noisy with poor resolution, in which case turn switch to "OFF". This may indicate that the thermostat automatic cut-off switch S-3 is not operating properly, and the image section of the IMO tube is becoming too hot. The ambient temperature inside the camera case will ordinarily not exceed the room or outside temperature by more than 35° F. after several hours use.

IMO Thermostat Heater Switch (S-3) is mounted close to the image end of the scanning coil assembly (over the focusing motor. This switch has been adjusted at the factory to cut off the image heater current when the temperature in the vicinity of the image section of the IMO tube exceeds 105°F. It has been found that after the heater coil current has been turned off (usually within the 30 minute warm-up period), the temperature of the bulb surrounding the image section of the tube and the inside ambient temperature of the camera, are within 5°F. of each other. If defective operation of S-3 is suspected, an ordinary engraved stem type thermometer can be laid within the focus coil bracket, with the mercury end of the thermometer pointing over the the thermostat, and the temperature observed when the thermostat cuts out (6 volts ac can be read across thermostat terminals when it cuts out). The ambient temperature inside the camera case will ordinarily not exceed the room or outside temperature by more than 35°F. after four hours use, unless the thermostat remains ON because of cold weather. The ambient temperature inside the camera can rise to 150°F. (65°C.) before the IMO tube picture will be affected. The manufacturer's requirement that the temperature at the image section of the tube not differ by more than 5°C. to that of the filament end of the tube is maintained because of the air circulation caused by the revolving color drum filters.

CIRCUIT THEORY

Image Orthicon tube operation

An excellent description of the operation of image orthicon tubes is given in a pamphlet usually supplied with each new tube. A condensation of this material is as follows:

The type 5280 Image Orthicon tube has three sections - an image section, a scanning section, and a multiplier section, as shown in fig. 13.

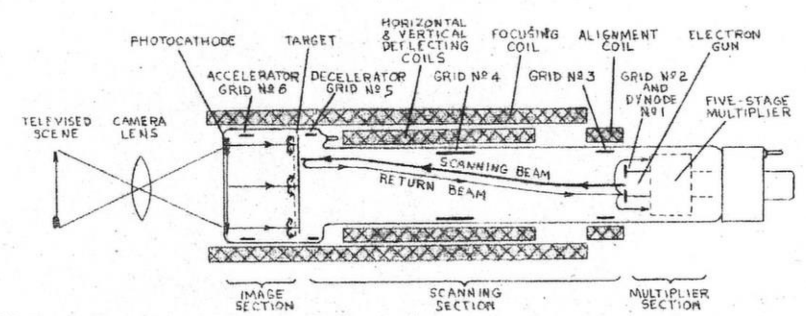


FIG. 13
Schematic arrangement of type 5620 IMO

Image Section

The image section contains a semi-transparent photocathode on the inside of the face plate, a grid to provide an electrostatic accelerating field, and a target which consists of a thin glass disc with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by varying the photocathode voltage.

Light from the scene being televised is picked up by an optical lens system and focused on the photocathode which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. The streams of electrons are focused on the target by magnetic and accelerating fields.

On striking the target, the electrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen which is held at a definite potential of about one volt. Therefore, the potential of the glass disc is limited for all values of light and stable operation is achieved. Emission of the secondaries leaves on the photocathode side of the glass a pattern of positive charges which corresponds with the pattern of light from the scene being televised. The charges set up a corresponding potential pattern on the opposite or scanned side of the glass.

Scanning Section

The opposite side of the glass is scanned by a low-velocity electron beam produced by the electron gun in the scanning section. This gun contains a thermionic cathode, a control grid (grid No. 1), and an accelerating grid (grid No. 2). The beam is focused at the target by the magnetic field of an external focusing coil and the electrostatic field of grid No.4.

Grid No. 5 serves to adjust the shape of the decelerating field between grid No. 4 and the target in order to obtain uniform landing of electrons over the entire target area. The electrons stop their forward motion at the surface of the glass and are turned back and focused into a five-stage signal multiplier, except when they approach the positively charged portions of the pattern on the glass. When this condition occurs, they are deposited from the scanning beam in quantities sufficient to neutralize the potential pattern on the glass. Such deposition leaves the glass with a negative charge on the scanned side and a positive charge on the photocathode side. These charges will neutralize each other by conductivity through the glass in less than the time of one frame.

Alignment of the beam from the gun is accomplished by a transverse magnetic field produced by an external coil located at the gun end of the focusing coil.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

The electrons turned back at the target form the return beam which has been amplitude modulated by absorption of electrons at the target in accord with the charge pattern whose more positive areas correspond to the highlights of the televised scene.

Multiplier Section

The return beam is directed to the first dynode of a five-stage electrostatically focused multiplier. This utilized the phenomenon of secondary emission to amplify signals composed of electron beams. The electrons in the beam impinging on the first dynode surface produce many other electrons, the number depending on the energy of the impinging electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons. Grid No. 3 facilitates a more complete collection by dynode No. 2 of the secondaries from dynode No. 1. The multiplying process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode No. 5 are collected by the anode and constitute the current utilized in the output circuit.

The multiplier section amplifies the modulated beam about 500 times. The multiplication so obtained increases the signal-to-noise ratio of the tube and also permits the use of an amplifier with fewer stages. The gain of the multiplier is sufficiently high so that the limiting noise in the use of the tube is the random noise of the electron beam multiplied by the multiplier stages. This noise is larger than the input noise of the video amplifier.

It can be seen that when the beam moves from a less positive portion on the target to a more positive portion, the signal output voltage across the load resistor changes in the positive direction. Hence, highlights in the scene produce an output signal voltage of positive polarity across the load resistor. As a result, the grid of the first video-amplifier stage swings in the positive direction for white.

A blanking signal is supplied to the target from the plate circuit of V3b, to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting scans. Unless this is done, the return trace lines will appear in the received picture, as black lines. The blanking output signal from the plate of V3b is a series of negative voltage pulses, having a minimum peak to peak amplitude of 10 volts. It is important that the voltage between pulses be constant to prevent fluctuation of the target voltage during the scan period. During the blanking pulse period, the full beam current without video signal modulation is returned to the multiplier, and provides a reference potential which corresponds to a no signal or "Black" level.

Camera Video Amplifier

The IMO multiplier video signal current flows through R20, a 24K load resistance. With a total circuit capacity of approximately 45 mmfd across this load resistance, the total load impedance presented to 12 mc. multiplier current components is in the order of 300 ohms, thus giving a high frequency attenuation of 80:1. This video signal is then amplified by two conventional 12 mc video stages V-1 and V-2, and thenfed into 50 ohm camera co-ax cable via a cathode follower tube V-3a. This signal can be observed on the color monitor and Scope by pressing in test button marked "Pre-amp". The picture should lack resolution and appear streaked because of the lack of high frequencies. The amplitude of the low frequency components should be approximately .2 to .3 volts (.2 to .3" vertical scope deflection) with normal picture illumination.

Multiplier High Voltage Supply

This circuit is a typical "Reversed feed-back oscillator" with grid stabilization. It can also be thought of as a "Hartley" type oscillator. The 6AQ5 tube grid is self excited by a 100 turn coil inductively coupled to the 600 turn plate coil. The near sine wave voltage existing across the plate coil is also inductively coupled to a 6:1 step-up coil and then full-wave rectified by the selenium rectifier SR-1, through a voltage doubling circuit. Resistor R-24 is used to limit the peak current through the selenium rectifiers to a safe value. Since the high resistance load is steady, the voltage output from R-30 should be a steady 1450 volts dc, with less than 0.8 volts, peak to peak, measured at terminal No. 8 on the IMO tube socket (Dynode #5). If parts are replaced in the small high voltage box, be sure transformer leads and the transformer itself, with its shielding, is replaced exactly as removed. Otherwise some interference in the picture taking the form of horizontal bars may be visible. The oscillation frequency is approximately 3 KC. If this is audibly heard, the transformer laminations are probably loose and vibrating at that frequency. The screen grid voltage can be varied by means of R29, if voltages lower than 1450 volts dc is desired. Voltages higher than 1650 volts should never be used, otherwise the guarantee on the IMO tube will no longer be in effect.

IMO Target Blanking

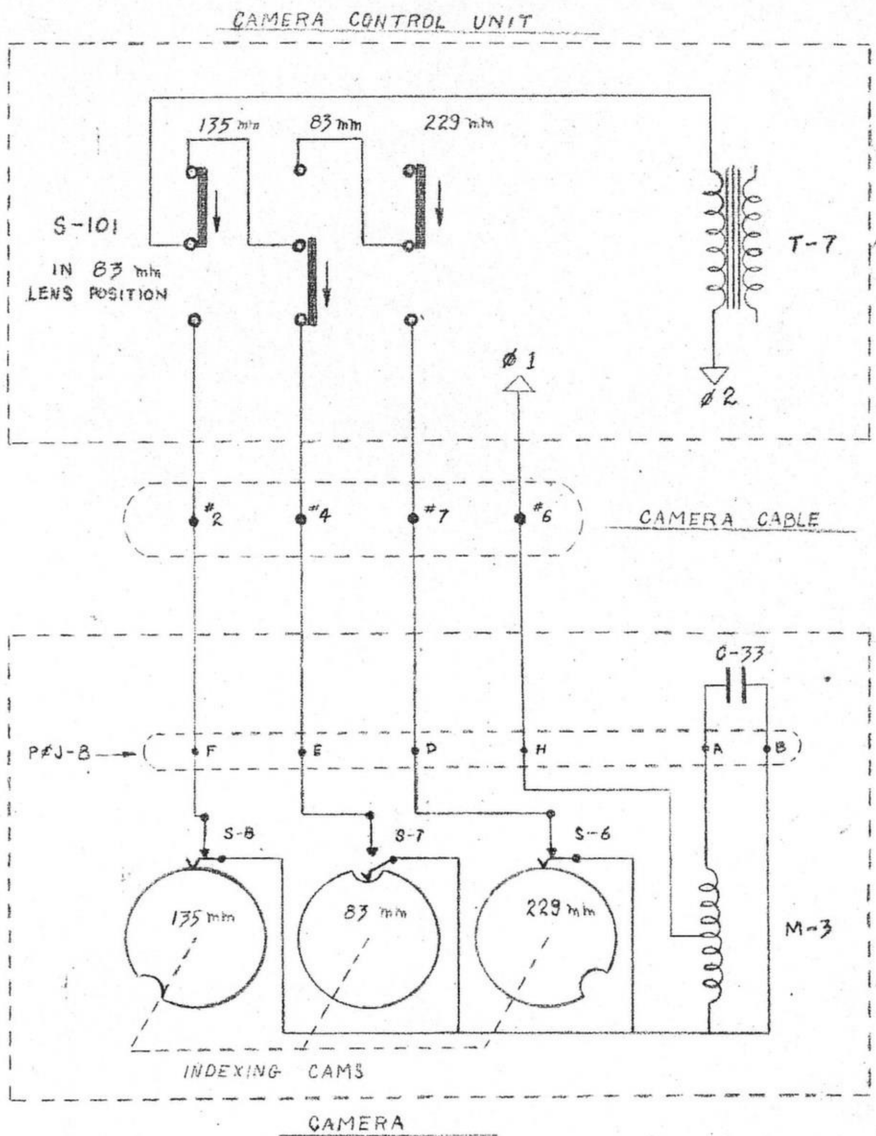
A minimum of 10 volts peak to peak, is required to blank the target properly during the fly-back period. This is supplied by an amplifier tube V3-b. Cathode peaking is used to improve the slope rise time, at the target. Occasionally an IMO tube is found to require more target blanking (which is evidenced by streaks through the picture when white objects appear at the extreme right or left edge of the picture). Increasing R-19 to 150 ohms should minimize this condition. Looking at the "channel" output, no signal movement should occur during the horizontal blanking interval.

G-6 ("S" distortion correction)

The dc voltage on tube element G-6 has been pre-set at the factory to have a value that corresponds to 80% of the voltage existing on the Photo Cathode. On some IMO tubes "S" distortion may be apparent with this voltage, and resistor R41 may be increased to minimize this type distortion. When any change in voltage is made to this element, the IMAGE FOCUS control will have to be reset. "S" distortion shows up when any horizontal lines in the picture curve like the letter S on its side i.e. . This is particularly noticeable when panning the camera from side to side.

Lens Turret Switching Circuit

A simplified sketch showing the complete electrical system of lens selection, is shown in drawing A-9812. The turret revolves in a counter clockwise direction for all lens changes. The push-button switches in the camera control unit serve to connect power to the correct cam switch on the lens turret. If that particular cam switch is closed, then power is connected through to the motor, and the motor turns the turret until the cam switch arm drops into a detent, thus opening the cam switch and stopping the turret at the correct lens position. If the lens turret should try to over-ride because of momentum, the cam switch will again close and the turret will again start turning. To avoid this, a spring



REVISIONS				MATERIAL:	COLUMBIA BROADCASTING SYSTEM INC. 485 MADISON AVE., NEW YORK ENGINEERING RESEARCH & DEVELOPMENT
NO.	DESCRIPTION	REV. BY	C'K'D BY	FINISH:	TITLE: Lens Turret Switching Ckt.
				NO. REQD.:	
				TOLERANCES DECIMALS ±.003 FRACTIONS ±1/64 ANGLES ±1/2° UNLESS OTHERWISE SPECIFIED	FIRST USED ON S.ME-9
					DES. / C'K'D.
					DWN. W.J.B 9/20/51 / AP'D.
				SCALE:	DWG. A- 9812 / NEXT ASS'Y

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loaded arm is also made to fall into a detent when the lens position is correct. The timing of these two detent arms is such that the cam switch arm disconnects power to the motor a fraction of a second before the spring loaded arm drops into its detent. If the pressure applied by this arm is not sufficient to stop the turret when the lens position is reached, adjustment of the spring tension can be made with an off-set screw driver. The screw and spring adjustment is located directly behind the color filter drum.

It some times happens that when the lens turret is forced out of position manually, which may happen when changing lens, the cam switch will close and the turret will again turn until that particular lens position is reached again. By lightly pushing one of the "out" lens push buttons, all three push buttons will be out (disconnected) the lens turret will remain stationary.

Optical Focusing Motor

A small condenser motor is used for moving the tube back and forth, instead of the lens, for optical focusing of the image onto the IMO photo cathode. A double position switch is provided on the front panel of the Camera Control Unit, to supply power to either field of the motor for reversing its direction. Limit switches are provided on top of the focus coil assembly, to limit the travel of the tube assembly. Correct adjustment of these limit switches are (a) the power should disconnect when the tube assembly is within 1/8th inch of the pre-amp chassis on its travel to the rear (b) the power should disconnect when the front face of the tube assembly is just even with the back edge of the motor gear housing.

Color Drum Drive Motor

This is a condenser type motor, and is supplied with 48 cycle power, the phase of which is controlled by a special tapped variac in the camera control unit. The electrical phase shift is in the order of 120 degrees of 1/48 cps, or 1/144th second, the period of one vertical scan. However, the motor is a 1440 RPM four pole motor which makes the effective phase shift good for ½ of a vertical field, which is sufficient for effective phasing of the color drum with relation to the scanning. Proper phase adjustment occurs when the bars of the drum, separating adjacent color filters, coincide with the locus of the scanning beam in the camera tube. If the color drum is taken off of its motor shaft for any reason, a mark should be made on its shaft collar so that it can be replaced back on the shaft in its original position. Otherwise, the electrical phase shifting may not carry it through the proper phasing range.

Channel Video Amplifier (V5 to V10 inc. dwg. D-S-1206)

The camera video signal terminates in the VIDEO GAIN control potentiometer of 100 ohms, paralleled with 240 ohms to make a cable terminating impedance of 70 ohms. The signal amplitude selected by the Video Gain control is amplified by V5 and then coupled through C-15 to a resistance-capacity network R-193, R-58 and C-16, for low frequency attenuation. This approximate 80:1 loss in low frequencies is to compensate for the 80:1 loss in high frequencies at the IMO tube output, thus making the frequency response of the system flat up to this point. C-16 is adjustable to compensate for the slightly different output capacities of different IMO tubes, and the control is known as a "High Peaker" adjustment (see page 25 for adjustment instructions).

Because of the fact that this low frequency attenuation circuit is in the camera control unit, another useful purpose of the circuit is to attenuate any low frequency signals and power supply interference that may be picked up because of Camera Cable location, and also reduces the effects of low frequency microphonic disturbances in all amplifier tubes before this circuit.

Video amplifier tubes V6 to V10 are 12 mc wide band compensated amplifiers, to amplify the very low video signal from the "High Peaker" circuit to a 2 volt minimum across all color gain video controls. The type 6AS6 and 6AK6 tubes were used because a separate connection was available to the suppressor grid, which is used for blanking off the video signal when camera lens' are being changed. The 6AK6 tube, being a power amplifier pentode, is used for handling the high video level required for the Gamma circuit, with a minimum of distortion. The type 6AQ5 tube has a desireable Eg-Ip characteristic for Gamma Control, besides having the high plate current required for developing a minimum of two volts across the low impedance color mixer amplifier input. The grid signal is pulse clamped by V15, to assure equal gamma treatment to each of the three color fields.

Lens Blanking Circuit

When any Lens selector button is pressed, thus connecting power to the Lens Turret motor, the current used by the motor passes through the filament secondary winding of transformer T-7. This causes a small 2 volt (48 cycle) rms drop, which is stepped up to about 40 volts rms across the primary of T-7, which signal is then fed to the normally biased off diode circuit of V1-a. This 40 volt signal then causes diode current to flow through V1-a which by rectification causes a negative bias voltage of 12 volts dc minimum to build up across R3. C-1 has been selected in value (.1 mfd) to give adequate RF grounding to the suppressor grids, and at the same time give an approximate quarter of a second decay of the blanking bias to zero, thus allowing the video signal to fade back in that period of time after the lens turret has stopped, instead of abruptly popping back in.

<u>Color Mixing Amplifier and Blanking Injection</u> (V11-V12-V13-V14-V16-V17-V18 & V32)

The video signal output of V10 appears across three individual gain control potentiometers. The mid arm of each gain control pot. goes to a separate amplifier tube. Each of the three amplifier tubes V16-V17-V18 are sequentially gated on for 1/144th second and turned off for 2/144th seconds, by control voltages on the suppressor grids supplied from the color ring circuit (described later). The timing of the ring circuit is such that when the image is being televised through the red filter in the camera, amplifier tube V11 is gated on and amplifier tubes V12 & V13 are gated (biased) off. This allows the red video signal to be amplifeid <u>only</u> by tube V11, and the amplitude of this red signal can be controlled by the RED GAIN potentiometer R-84. As the color drum in the camera continues to turn, the image will be next televised through a blue filter. When this happens tube V11 will be gated off and tube V12 gated on (V13 is still off). This allows the blue signal to be amplified <u>only</u> by tube V12, and the amplitude of this blue signal can be controlled by the BLUE GAIN potentiometer R-86. This action is repeated for the green filter i.e. tube V13 is gated on and tube V11 and V12 off. The amplitude of each color signal can therefore be controlled for color mixing purposes (see page 28), and then combined in the common plate circuit of the three amplifier tubes into one signal again.

Because each of the color mixer amplifier tubes are entirely biased off and on in sequential fashion, the difference in plate current flowing in the plate circuit during the switching time abruptly changes, causing a positive transient voltage to appear in the plate circuit. Since the color switching is timed to occur during the vertical blanking period, this transient does not appear in the picture, but it must be removed from the signal for good blanking action. Since it is required that Kinescope Blanking also be injected into the video signal to remove

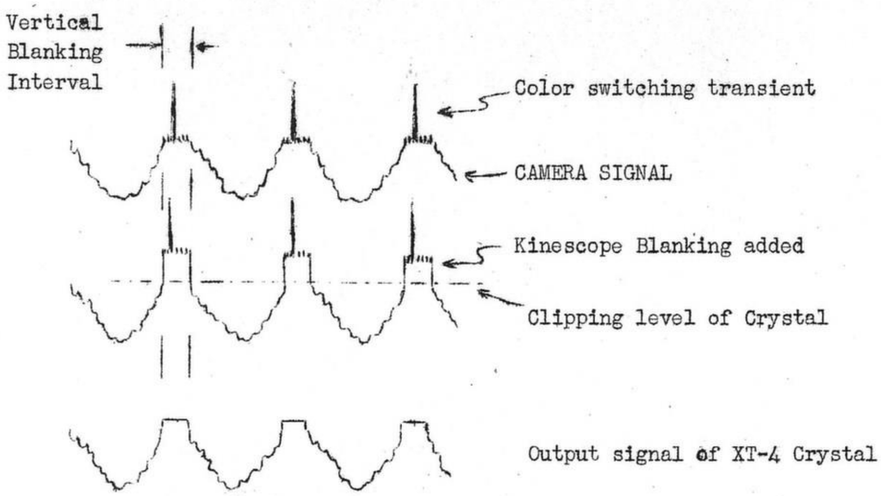


FIG. 14

KINESCOPE BLANKING INJECTION WAVEFORMS

the camera shading signals, the Blanking can be added at this point to also remove the color switching transients. This is accomplished by adding the blanking signal to the mixed color signal, via tube V14, in such polarity and amplitude that the transient and shading signals will be well above the clipping range of XT-4 crystal clipper. This is shown in fig. 14.

Kinescope Blanking (Pedestal) level must bear the same relationship to the rest of the video signal as the original "Black" dc level from the IMO tube, particularly for each color signal, and should maintain that relationship regardless of signal amplitude variations. To insure this action, the grid signal of each color amplifier tube is pulse clamped, via tubes V16-V17 & V18.

A cathode follower tube (V32) is used as a low impedence constant dc voltage source to the crystal clipper. The difference between the dc voltage across the crystal clipper XT-4 determines the clipping or "pedestal" level. By varying the grid voltage on the cathode follower, the cathode supply voltage will follow, thus varying the pedestal level.

An RC filter, R-229 and C-12, is used in the grid circuit of V-32, to assure a good clean dc supply voltage from the cathode to the crystal.

<u>Color Gating Pulse Generator (Ring Circuit)</u> (V19-V22 inc.)

It is important that the Red, Blue and Green color mixer gain controls retain their color identity, and thus provide a color timing reference for the rest of the system to phase to. This is accomplished by using the 48 cycle pulse from the last divider-counter circuit in the Sync. Generator, and agreeing that this pulse, hereafter referred to as the "Color Drive Pulse", should always just preceed the red picture, in timing, during the vertical blanking interval (shown in fig. 12d). Therefore, only the color drive pulse is used to trigger off the gating pulse that allows the red amplifier to function. With reference to fig. 15, this is accomplished as follows:

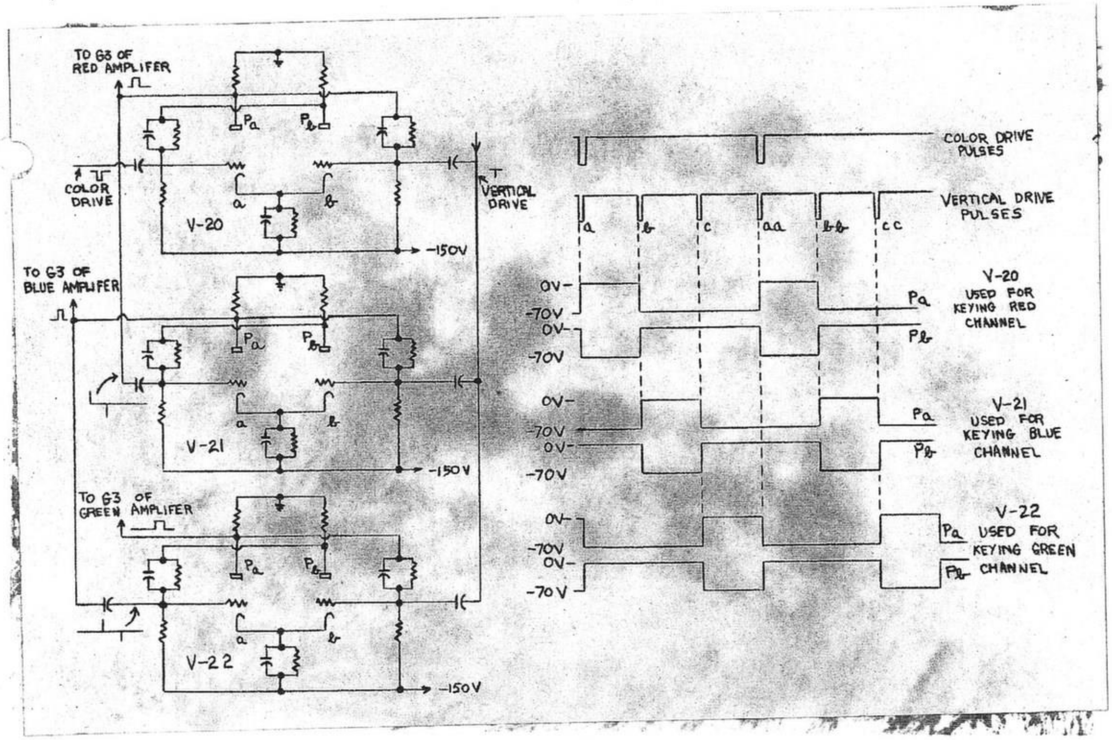


FIG. 15

Color Gate Circuit with Signal Waveforms

Tube V19 is used to provied negative color drive and negative vertical drive triggering pips to tubes V20-V21-V22, typical flip-flop circuits. Since V20b-V21b-V22b are being triggered with negative vertical drive pips at all times, these tubes will remain off (no plate current) until the correct triggering sequence starts, which may be explained as follows:

(a) Color Drive turns V20a off, thus turning V20b on.

(b) The next vertical drive pulse turns V20b off again, which automatically turns V20a on. The rectangular wave thus generated at the plate of V20a is used to gate the red amplifier tube on and off, and at the end of the red period, the back slope is differentiated via C-50 to a negative triggering pip that turns V21a off and V21b on. V21b also has a vertical drive trigger voltage on its grid but this has no effect because the large positive rectangular voltage pulse fed from the plate of V21a as it is being turned off, keeps the grid near zero bias.

(c) The next vertical drive pulse turns V21b off again, which automatically turns V21a on. The rectangular wave thus generated at the plate of V21a is used to gate the blue amplifier tube on and off, and at the end of the blue period, the back slope is differentiated via C-56 to a negative triggering pip that turns V22a off and V22b on.

(aa) The next vertical drive pulse turns V22b off again, which automatically turns V22a on again. The rectangular wave thus generated at the plate of V22a is used to gate the green amplifier tube on and off. Since the Color Drive pulse occured at the same time as this third Vertical Drive pulse, V20a is turned off, thus turning V20b on, and the red amplifier tube is again being used.

(a), (b), (c) and (aa) refer to the time intervals on the waveforms shown in Fig. 15.

<u>Pulse Clamp Circuits</u> (V14a to V18 inclusive. dwg. D-S-1206)

The primary use of a dc restorer, or pulsed clamper, is to charge the grid of a tube to given dc level during the blanking periods in the picture, regardless of changes in video signal amplitudes and consequent changes in the ac coupling axis. The circuit used connects the grid of each color amplifier tube and the gamma tube to a fixed reference potential for a short time at the beginning of each horizontal scanning interval, and releases the grid thereafter for the remaining duration of the horizontal line scanning period, so that the grid can follow the variations of the video signal potentials. This circuit can be thought of as a keyed bridge, in simplified form as shown in fig. 16.

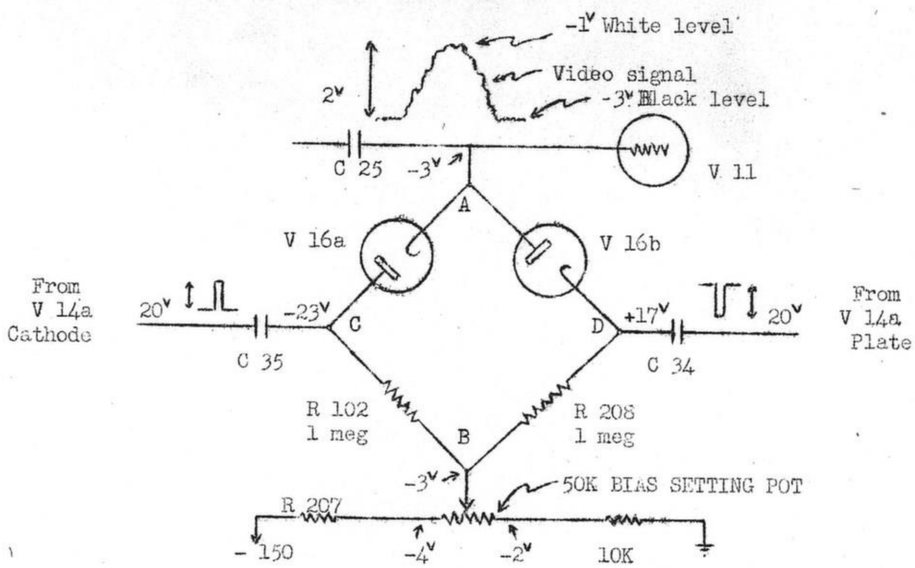


FIG.16 Simplified Clamp Circuit

Referring to fig. 16, the two diodes and resistors R-208 and R-102 can be thought of as a simple bridge circuit. Horizontal Sync pulses (here in after called "Clamp" pulses for this circuit) of equal and opposite polarity are supplied from V14, to diodes V16a and V16b (triodes are connected as diodes). If points "A" and "B" were grounded, the circuits could be redrawn to look like two peak rectifier circuits with point "C" charging to - 20 volts and point "D" charging to + 20 volts, neglecting duty cycle coupling axis. If point "A" is now lifted from ground, the diodes will continue to work as before with the diode current of one diode supplied through the other, and presuming the impedance of each diode is idnetical, zero volts will still exist at point "A". Once points "C" and "D" are charged to peak voltage, diode conduction will only occur on the very peaks of the clamping pulses due to the slow discharge current of C35-R102 and C34-R208. When the diodes cease conducting, the positive charge at "D" and the negative charge at "C" biases the diodes open, thus leaving point "A" at zero volts. With a video signal now coupled through C-25, during the horizontal blanking period the clamping pulses will cause both diodes to conduct, charging the plate of C-25 and the grid of V-11 to zero volts, thus removing any charge that may be there from signal, hum or microphonics. After the clamp pulse interval, the diodes cease to conduct, leaving point "A" at zero volts for that level of signal corresponding to "Black", and all video signal variations will be positive in polarity with respect to it.

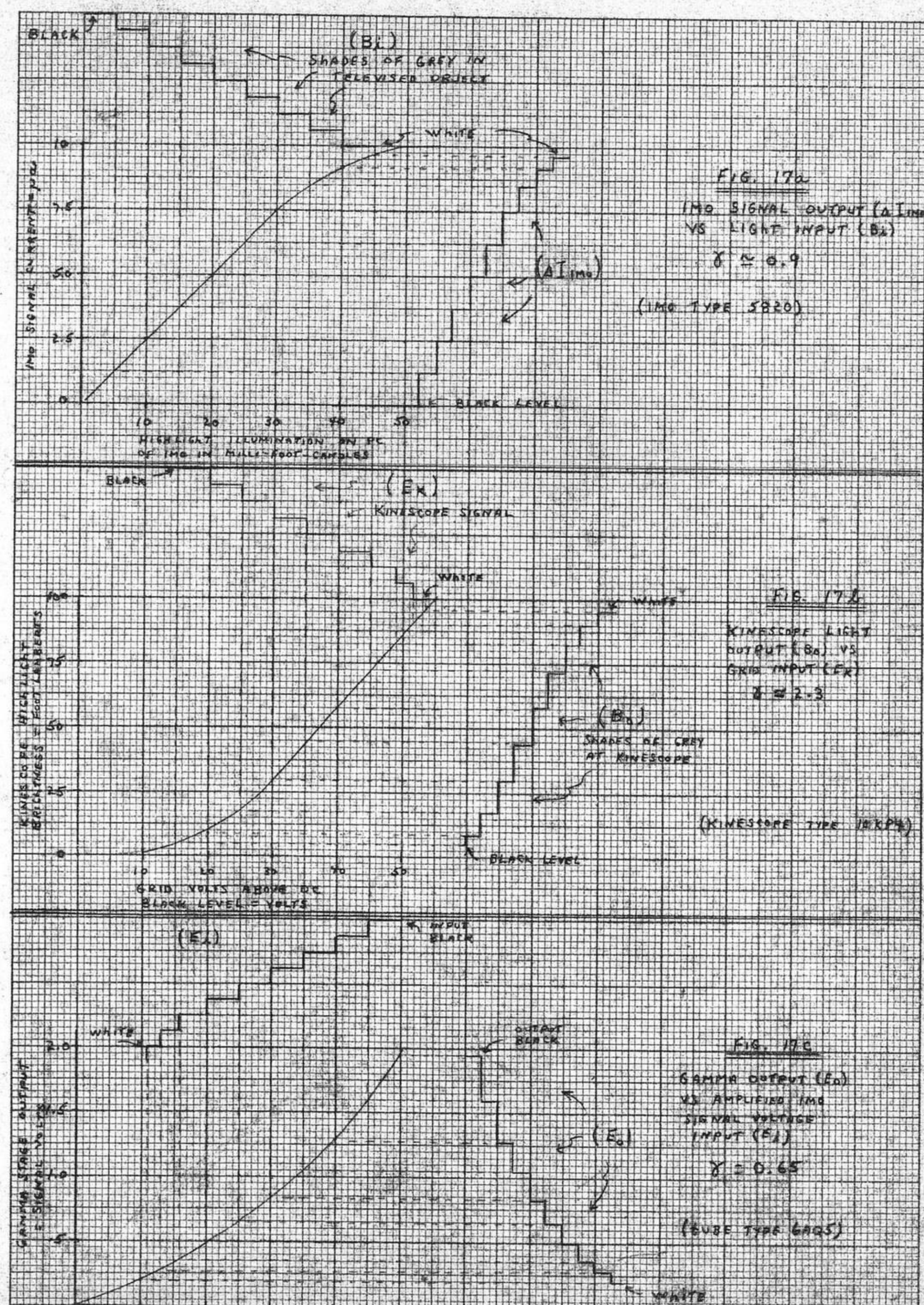
Since a negative bias is required to avoid grid current and operate the color mixer amplifier tubes properly, point "B" can be returned to a negative bias source as shown in fig. 16. The - 3 volts at point "B" adds both to point "C" and "D", thus making point "C" ≅ - 23 volts and point "D" ≅ + 17 volts. When the diodes conduct on clamp pulses, there is still a potential difference of 40 volts across both diodes but one side is unbalanced by - 6 volts with respect to the other side, which when divided in half for the midpoint between the diodes leave - 3 volts as the charge left on C25. - 3 volts will now always correspond to "Black" level and all video signal variations will be in a positive direction with reference to it. When televising picture material having very bright spots of white, such as reflection of lights from metal or instruments, peak white will be more than 3 volts positive with respect to black level, and cause V11 grid current which will neutralize the clamp bias action, and cause streaks to follow that portion of the picture. The remedy is to use a lower signal input into the color mixer, or use more gamma correction which has the effect of compressing the white portion of the signal.

Gamma Correction Circuit (V10 dwg. D-S-1206)

"Gamma" is a photographic term that is used to describe the relation between the logarithim of the exposure and the density of the film or print emulsion. It has been borrowed for television use to describe the relationship between the logarithim of the ratio between values of brightness in portions of the televised object in the studio and the logarithim of the ratio between the values of brightness. at the receiver.

The Image Orthicon tube used in the Vericolor camera, delivers a signal current that is directly proportional to the shades of grey or color saturation in the televised subject, except for peak whites where some unobjectionable compression takes place, as shown in fig. 17a.

With the exception of the Gamma amplifier, all video amplifiers in the Vericolor chain are designed to amplify the camera signal voltages with a minimum of distortion and if the signal output of the IMO is amplified and applied directly to the kinescope grid, the resulting output ($B_{\odot}$) as shown in fig. 17b will result. It will be noticed on this curve that the relationship between the grid signal voltage and light output is not linear, with the result that the lower black steps are compressed. This tends to make the reproduced picture very contrasty with the effect that skin blemishes are emphasized in a color which is primarily red.


BLACK
(Bi)
SHADES OF GREY IN TELEVISED OBJECT
WHITE
IMO SIGNAL CURRENT — μA
10
7.5
5.0
2.5
0
(Δ I IMO)
BLACK LEVEL
10 20 30 40 50
HIGHLIGHT ILLUMINATION ON PC OF IMO IN MILLI-FOOT-CANDLES
FIG. 17a
IMO SIGNAL OUTPUT (Δ I IMO) VS LIGHT INPUT (Bi)
$\gamma \approx 0.9$
(IMO TYPE 5820)
BLACK
(Ek)
KINESCOPE SIGNAL
WHITE
KINESCOPE HIGHLIGHT BRIGHTNESS = FOOT LAMBERTS
100
75
50
25
0
(Bo)
SHADES OF GREY AT KINESCOPE
BLACK LEVEL
10 20 30 40 50
GRID VOLTS ABOVE DC BLACK LEVEL = VOLTS
FIG. 17b
KINESCOPE LIGHT OUTPUT (Bo) VS GRID INPUT (Ek)
$\gamma \approx 2.3$
(KINESCOPE TYPE 10KP4)
(Ei)
INPUT BLACK
WHITE
OUTPUT BLACK
GAMMA STAGE OUTPUT = SIGNAL VOLTS
2.0
1.5
1.0
.5
(Eo)
WHITE
-20 -18 -16 -14 -12 -10
SIGNAL VOLTS INPUT
FIG. 17c
GAMMA OUTPUT (Eo) VS AMPLIFIED IMO SIGNAL VOLTAGE INPUT (Ei)
$\gamma \approx 0.65$
(TUBE TYPE 6AQ5)

For medical television purposes this contrasty effect may be desirable, but most of the time a linear brightness transfer is required. Therefore an amplifier is inserted in series with the video signal amplifier, to pre-distort the video signal so that when it is applied to the kinescope grid, the values of brightness in the reproduced picture will closely approximate the corresponding values of brightness in the televised object. As can be seen from the curve in fig. 17c, a type 6AQ5 tube is used to particularly stretch the darker shades of grey to compensate for the compression of blacks due to the kinescope. The Gamma Control potentiometer (R95) varies the clamping grid bias on this tube between the limits of good linearity (Gamma = 1) to slightly more distortion than that shown in fig. 17c (Gamma = .6). For good average medical clinic pick-up material, it would be run approximately under the conditions shown under fig. 17c.

Because each red, blue and green field should be pre-distorted in similar fashion so that the intermediate shades of grey add correctly to reproduce delicate color hues, the bias is pulse clamped, thus referencing the black level for each scanning line (see page 64,65 & 66 for clamper theory).

<u>Line Video and Sync. Mixer</u> (V1-V2-V3-V4, dwg. D-S-1206)

Video Signals from the color Mixer Circuit are amplified in tube V4 and appear across the tapped attenuator switch SW104. Cathode peaking condenser C-8 is used for high frequency compensation of the attenuator switch load, so that the frequency response of this circuit extends beyond 10 mc's.

The double section tapped attenuator switch SW-104, is connected in such manner that the sliding selector tap of the first section can either select all or part of the internal video, or the video from another console. The second section of the switch simultaneously applies 6.3 volts of 48 cycle filament to the "ON-AIR" lights of either console and camera #1 or console and camera #2. This warns everyone concerned which camera picture is being fed out over the line.

It is essential that the two camera control units are either run from an external Sync. Generator, or that the Sync. Generator of #2 unit be controlled from #1 unit, when using this tapped attenuator switch for a smooth fade from one signal to the other. Otherwise the sync signals added to the signal on the output line will not be in proper phase with the video signal from camera #2.

Sync. Signal Addition

The selected video signal is fed to the control grid of V3 where it is amplified and then applied to the grid of V2 output tube via C-5. High frequency compensation is by normal series-shunt inductance type, with some assistance from cathode peaking condenser C-9. The video signal is paralleled with the Sync. signals from V-1, and the combination fed into the outgoing line. This method of adding sync allows the video output tube to swing over a greater plate current swing for video only, thus giving a greater video amplitude on the outgoing line than would be possible if it had to amplify both video and sync.

Sync. Signal amplitude is controlled by varying the cut-off grid bias to V-1, thus allowing all or none of the sync signals fed to the grid, to appear in the plate circuit.

Scope and PC High Voltage Supply Circuit (V31 dwg. D-S-1206)

This circuit is a typical "Reversed feed-back oscillator" with grid stabilization. It can also be thought of as a "Hartley" type oscillator. The 6AQ5 tube (V-31) grid is self excited by a 100 turn coil inductively coupled (T5) to the 600 turn plate coil. The near sine wave voltage existing across this plate coil is also inductively coupled to a 6:1 step-up coil and then full-wave rectified by the selenium rectifiers SR-1 and SR-2 through a voltage doubling circuit. Resistor R179 is used to limit the peak current through the selenium rectifiers to a safe value. This circuit is identical to the IMO multiplier high voltage supply except for the polarity of output, minus being used with plus at ground potential.

This supply is used for two purposes (1) to supply -1150 volts to the 3" oscilloscope tube for trace and (2) the -205 to -505 volt range required for the Image Focus Control. Since the oscilloscope uses most of the current from this supply, it will be found that varying the brightness of focus of the scope trace, will slightly shift the Image Focus control range.

IMO Focusing Current Circuit (V30 dwg. D-S-1206)

A type 6AU5 Beam pentode is used for a constant current source for the IMO focusing and alignment coil. Heavy cathode degeneration and regulated screen voltage to this tube assures constant plate current regardless of plate voltage variations due to alignment adjustments. The plate current can be adjusted between 65 and 80 ma by varying the cathode bias rheostat R186.

+ 150 Volt Regulated Supply Circuit (V24b-V25-V27-V29, dwg. D-S-1206)

This is a convential "Series" type of voltage output supply, where type 6AS7G tubes (V24b and V25) are in series with the load current to the +280 volt supply, through the monitor focus coil. A portion of the +150 volt 6AS7G cathode output is fed to a voltage amplifier tube type 6AK5 (V27). Thus voltage variations on the +150 volt supply are amplified and fed to the grid of the 6AS7G. Since this grid voltage is out of phase with the original cathode voltage variation, the 6AS7G tube will act with cathode follower action and cancel out the variation. Another way of looking at this circuit action is to regard the 6AS7G tube as a variable resistance, its resistance depending upon its grid bias. If the cathode output voltage drops slightly, this variation is amplified by V27 and applied to the grid as a positive boost (less negative) which decreases the internal resistance of the tube and lowering the plate voltage drop across itself, which increases the voltage across the load, thus canceling the output drop. V29 is used as a high cathode voltage reference for V27, so that a larger percentage of the voltage variations appearing across the output will be fed into the control grid of V27. (If, for example, the cathode of V27 was worked at ground potential, R172 would have to be at ground potential or slightly negative so that V27 will work properly as an amplifier. By so doing the dc voltage variations appearing across the output would be divided down in the order of 75:1 which more than equals the gain of V27, and no degeneration of the output voltage would occur.)

<u>— 150 Volt Regulated Supply Circuit</u> (V23-V24a-V26-V28 dwg. D-S-1206)

This circuit is a conventional "Series" type of regulated output. The ac voltage from T-4 is full wave rectified by V23, and filtered by C-61 and CH-1 CL filter. A type 6AS7G tube is used as the series impedance to the load, its impedance varying proportionately with the voltage drop across the load (see paragraphs under +150 Regulated Supply, for theory) thus maintaining the —150 voltage across the load constant. Tube V28 maintains a high cathode voltage reference level for amplifier tube V26.

SYNC. GENERATOR CHASSIS CIRCUITRY

General Description

The simplified Industrial Sync. signals required for operation of this equipment has minimized the number of tubes and chassis space required. The generous use of stable and well known circuits however, has increased the number of tubes slightly, but it was felt that such action was preferable to using complex and trick circuiting that always seem to be on the edge of triggering and falling out on power line surges. The common use of only one "biased off" type of multivibrator circuit is used throughout the entire Sync. Generator, which simplifies trouble shooting considerably.

For convenience in description, the circuits are divided as follows:

(1) Master oscillator

(2) Master oscillator frequency control

(3) "Biased off" type of Multivibrator - theory of operation

(4) Count down circuits

(5) Generation of DRIVE signals

(6) Generation of IMO BLANKING signals

(7) Generation of RECEIVER BLANKING signals

(8) Generation of RECEIVER SYNCHRONIZING signals

(9) Oscilloscope WFM SWEEP signals (Wave Form Monitor)

The use of the Block diagram dwg. B-S-1212 and reference to fig. 12 on page 40-B will help in following the pulse timing sequence.

The prime purpose of a Synchronizing signal Generator is to generate and establish the relative phasing or time relationship of pulses at three different frequencies: 48 cps, 144 cps and 29,160 cps. The pulses are properly timed with respect to each other by deriving them by count down methods from a common Master oscillator, the frequency of which is controlled by automatic comparison with the 48 cycle frequency of the Motor-Generator power unit, which in turn is synchronous to the 60 cycle power line.

Master Oscillator Circuit (V17-V12 dwg. D-S-1208)

The Master oscillator V17 is a typical "colpitts" circuit, with a free running frequency determined by inductance L1, capacitors C36-C37, and the impedance presented by the plate circuit of Reactance tube V12 (with zero bias on the control grid of V12). The oscillator frequency is 58,320 cps.

A sample of the 58,320 cps sine wave is fed via C-34 to the grid of V-16b, which self biases (toes up) the grid so that only the very peaks of the sine wave appear in the plate circuit (class "C" self bias operation). The negative polarity fractional sine wave is then fed via C-21 to the grid of V-16a, which is driven considerably beyond cut-off by the large signal amplitude, which in turn produces a pulse in the plate circuit having fast time of rise slopes with short duty cycle. This pulse is now called a "triggering" pulse because of its further functions.

Master Oscillator Automatic Frequency Control Circuit (V12-V13-V14 dwg. D-S-12C

The control grid of the reactance tube V-12 is fed a bias voltage that is developed from a comparison bridge of four diodes. 48 cycle filament supply voltage is fed to one corner of the bridge through the cathode of V13a and plate of V14a respectively. The 48 cycle positive pulse from the last counter circuit is applied to the mid-section of the bridge via transformer T-4, and time constant resistor R-82 and condenser C-48. The other corner,called the output corner, of the bridge, is connected to filter resistors R83-R84 and filter capacitors C49-C50-C51.

When a 48 cycle pulse from the last counter occurs, the polarity of the pulse across the secondary is such that all diodes conduct, making possible a transfer of current in either direction between the input and output corners of the bridge. The diode plate current also charges up capacitor C-48 so that during the interval between 48 cycle pulses, the charge keeps the diodes open, or non-conducting.

The Master Oscillator frequency is adjusted to 58,320 cps when the voltage on the reactance tube is zero. If the frequency is exactly 58,320 cps, the 48 cps sinusoid voltage applied to the inside corner of the bridge will be passing through zero when the 48 cps pulse from the last counter causes the diodes to conduct. No current will pass through the bridge circuit because there is zero voltage at that instant at both the inside and outside corners of the bridge.

The cause of frequency drift in the oscillator circuit is usually the warming up of the oscillator tube and resistive components, with the temperature coefficient of the capacitor causing a change principally with the tank capacitors C36-C36. Therefore the tank circuit should not be adjusted until the unit has operated for at least a half hour.

If the constants of the tank circuit are such as to cause the resonant frequency to be low, electronic correction takes place in the following manner: The delay of the counter pulses will be such that the 48 cps sine wave voltage applied to the inside corner of the bridge will be slightly negative just before it goes through its zero point, when the 48 cps counter pulse occurs causing both diodes to conduct. The inside corner of the bridge being slightly negative at that instant will cause additional electron current to flow from cathode to plate of V13a, through T-4 and then from the cathode to plate of V14b, thus charging C49 negatively. This pulse type charge is filtered to dc by the filter network and then fed to the grid of the reactance tube V12. This negative bias reduces the Gm of the reactance tube, which in turn decreases the virtual inductance shunted across the oscillator tank circuit, with a result that the total oscillatory circuit remains at 58, 320 cps resonance.

A similar action takes place when the resonant frequency of the tank circuit is higher than 58,320 cps. The 48 cps counter pulse occurs when the 48 cps sinusoid has passed through zero and in the positive half of its cycle. The positive plate voltage on diode V14a will cause electron current to flow through that diode, which in trun causes the plate of V13b to go positive which causes electron flow in that diode, which in turn charges capacitor C49 positive. After filtering, this positive grid voltage increases the Gm of the reactance tube, which increases the virtual inductance shunting the oscillator tank circuit, thus keeping the total oscillatory circuit tuned properly to 58,320 cps.

A high impedance voltmeter connected to the output arm of the bridge (across C49) will therefore indicate whether the resonance of the tank circuit it too low (negative bias) or too high (positive bias).

A portion of the oscillator voltage existing across the oscillator tank capacitors C36-C37, is applied to the grid of the reactance tube V12 via a small coupling condenser C31. The input capacity of V12, in parallel with R 56-R57 causes delay to this signal so that the plate current signal variations in this tube are delayed with respect to the tank condenser voltage fed back. Since the voltage across a tank circuit leads the tank inductance current by 90°, the plate current variations of the reactance tube are almost in phase with the oscillator inductance tank current, hence the term "virtual inductance" is used.

"Biased off" Multivibrator Circuit Theory

This circuit is often referred to as a "one shot" multivibrator because it takes one trigger pip to start it going, and it stops itself after a given fixed interval determined by an RC grid time constant. There is no direct connection between the output and input, thus giving good signal isolation, and normal variations of tube characteristics or resistance-capacity charges do not effect its working reliability. Basically, the circuit is as shown in fig. 18:

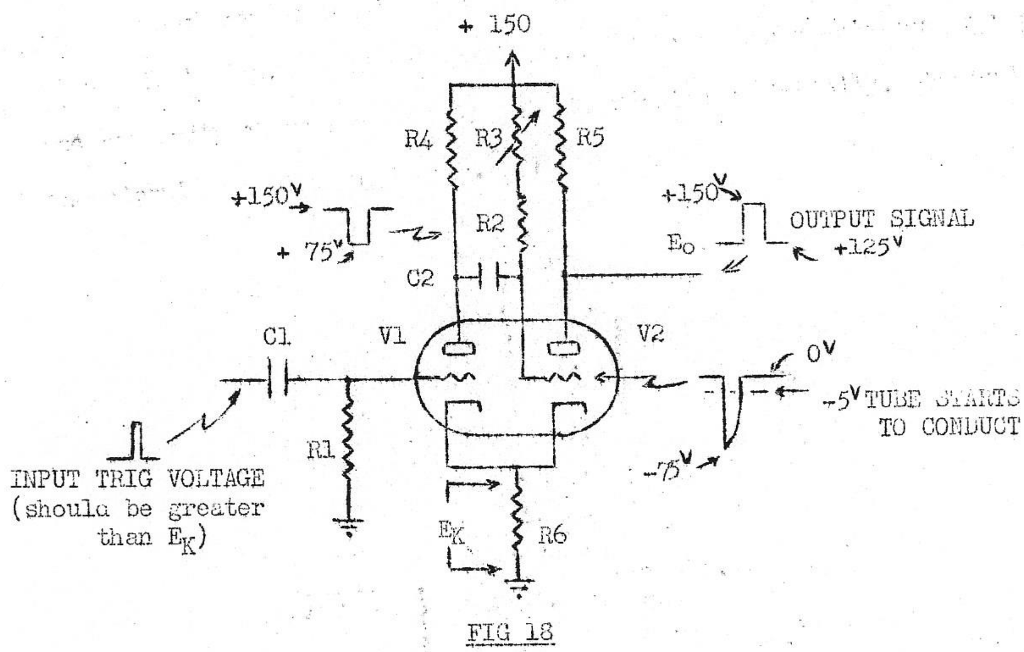


FIG 18

BIASED OFF TYPE OF MULTIVIBRATOR

With no input trigger signal, the constants are selected as follows: With the grid of V2 going to a position voltage source through high value resistors R3 R2, there will always be a negligible voltage drop from the grid to cathode of this tube, so therefore it can be said that tube V2 is running at zero bias, regardless of the low cathode resistance R6 used. Therefore the plate voltage drop across R5 will be maximum. If cathode Resistance R6 is now selected in values so that the plate current of V2 will cause a voltage drop across it that will bias off tube V1, then the steady state condition in which the tube circuit can be checked is(1) plate current is flowing only in V2 indicated by a low plate voltage and (2) no plate current is flowing in V1, indicated by no drop across R4.

If a positive trigger pulse is now fed into the grid of V1, sufficient in amplitude to cause tube V1 to start conducting, the lowering plate voltage of V1 coupled into the grid of V2 via C2 starts biasing V2 off. This of course decreases the cathode bias to V1 and causes a further increase of its plate current which in turn lowers the plate voltage of V1 more, which coupled into the grid of V2 via C2 cuts V2 off altogether. At this particular instant, the plate voltage at V2 is equal to the supply voltage because of no plate current drop across R5. In the process, the grid plate of C2 accumulates a heavy negative charge that slowly leaks off via resistors R2-R3. When this charge has leaked off to the extent that V2 again starts conducting, the added cathode bias voltage again starts to bias V1 off again, which increases the plate voltage of V1, which in turn through C2 causes the grid of V2 to go positive faster, which in turn causes V2 to conduct more plate current,etc. until V2 is fully conducting and V1 is again biased off. The plate voltage at V2 has again dropped to a low value because of the IR drop across R5. The plate voltage of V2 during cut-off is the desired output signal. It can be seen that the cut-off time of V2 can be varied by varying the total resistance in its grid circuit (by R3) so that the negative grid charge leaks off faster or slower. This in turn determines the width of the pulse appearing on the plate of V2.

Count Down Circuits (V1 to V10 inc. dwg. D-S-1208)

Since all five counter circuits perform in a similar manner, the operation of only one will be described. The 9:1 counter V2-V7, which divides the Master oscillator frequency by 9 will be used as the example.

The 58,320 cps trigger pulse output of V16 if fed to a dual cathode follower stage V11, which acts as a buffer to the two low impedance outputs. The positive trigger voltage from V11a is fed through a small capacitor C-18, causing diode V7a to conduct. The diode electron current thus charges C-29 to a positive voltage and deposits the electrons on the diode condenser plate side of C18 during the pulse time. When the pulse returns to zero, the electrons deposited on C18 leak back to ground via diode current of V7b, but due to the positive bias charge of C29, diode V7a is non-conducting and the charge on C29 remains. The next positive triggering pip repeats this action i.e. more electrons are taken from C-29 through diode V7a and deposited on the diode side of C18. When the trigger pulse returns to zero, the electrons deposited on C18 again leak back to ground via diode current of V7b, but due to the additional positive bias charge of C29, diode V7a is non-conducting and the charge on C29 remains. This action repeats for the remainder of nine trigger pulses, and as each trigger pulse takes more and more electrons from C29, the positive charges on this condenser build up in stair case fashion, until the positive voltage on the grid of V2b exceeds the cathode bias due to V2a. If the cathode bias has been adjusted properly by R53, the ninth trigger pulse will exceed the cut-off bias and tube V2b will conduct, thus generated a short positive pulse on the plate of V2a (see "biased off" Multivibrator theory for pulse generation of V2). Therefore, of nine pulses input, one pulse is generated on the output, and this pulse is in turn counted down 9:1 in the next counter circuit, and in a similar manner.

In this fashion, the 58,320 cps trigger pulse is counted down to a 48 cps pulse, which is used in part for comparison to the 48 cps sine wave in the comparison bridge for A.F.C. control of the Master oscillator, as previously described. The output of the 5:1 counter is 144 cps, and therefore used for Vertical drive purposes, with its pulse width fixed by R105-C61 to equal the width required for vertical blanking purposes. The 58,320 cps trigger pulse is also counted dwon 2:1 by tubes V1-V6, to deliver the required 29,160 Horizontal Drive pulse required. Two cathode follower tubes are used at V11 to isolate both counter chains, and make provision for external synchronizing purposes.

Condensers C15-C30-C47-C63 and C73 are used to furnish a sample of the stair case charging waveform of the diode charge condenser it is in series with, the charge actually dividing up 10:1 between the charge and sample capacitors.

<u>Generation of DRIVE Signals</u> (dwg. D-S-1208)

Color drive is the output pulse of the 3:1 counter tube V5, with the width of the pulse regulated by C71-R129, to the width shown in fig. 12d. The pulse width tolerances are wide, and required within the limits shown only for color mixer use.

Vertical Drive is the output pulse of the 5:1 counter tube V4, with the width of the pulse regulated by C61-R105, to the width shown in fig. 12c. The pulse width tolerances are wide, and required within the limits shown becuase of required Vertical blanking intervals for both IMO and Receiver Blanking functions. This pulse is also used for triggering the Vertical Sync pulse multivibrator, and vertical scan circuits.

Horizontal Drive is the output pulse of the 2:1 counter tube V1, with the width of the pulse regulated by C12-R26, to the width shown in fig. 12f. It is used for IMO target blanking and drive to the IMO horizontal scan circuit.

IMO Target Blanking Mixer Circuit (V30b-V21b-V22-V26a dwg. D-S-1208)

The Horizontal Drive pulse is cathode coupled via V21b to the grid of V22b. The Vertical Drive pulse is cathode coupled via V30b to the grid of V22a. Both Drive pulses are positive and high enough in amplitude (42v) to cause both grids to clamp, which biases off both plate currents during the interval between pulses. The addition of both pulses in the plate circuit, in a negative direction, results in a large negative (68v) signal which is then fed to the grid of V26a, where only the top positive 6 volts of the signal is used for plate current control. The positive pulse mixed blanking is then coupled into a 75 ohm transmission line in the Camera Cable via C26, the camera end of the line being terminated.

Generation of RECEIVER BLANKING Signal (V21a-V18-V23-V30b dwg. D-S-1208)

Horizontal Drive pulses form the cathode output of V21b, are differential by C52-R85-R86, and the positive front edge is thus used to trigger off the Horizontal Blanking pulse generator tube V18 (see "Biased off" MV theory for V18 action). The output pulse width is regulated by an adjustable rheostat R90 so that the blanking, as observed after it has been mixed with video, will fall within the limits as given in fig. e. (also see page 44 for method of pulse measurements).

The Horizontal Blanking pulse output of V18 is fed into the grid of V23a for mixing with Vertical Blanking. The grid circuit of V23a uses a crystal as a short circuit across R92, to reduce power supply interference during the interval between pulses, the negative portion of the pulse duty cycle causing the XT-4 diode to conduct.

The Vertical Drive pulse output from the cathode output of V30 is fed to the grid of V23b. The high amplitude of the positive Vertical Drive (42 volts) causes the grid of V23b to dc clamp, which biases off the plate current of V23b during the interval between pulses. The addition of both Vertical and Horizontal Blanking pulses in the plate circuit, in a negative polarity direction, results in a large (18^V) signal which is then fed to the grid of V28a, where only the top positive 6 volts of the signal is used for plate current control. The plate output of V28a is further amplified by V28 and then plate coupled to the grid of the Blanking mixer tube in the Color Mixer Amplifier. The plate decoupling filter C66 has purposely been made small, so that low frequency pre-emphasis will distort the vertical blanking to a positive slope (upward tilt) so that when fed into the Vertical shading Control Circuit, the slope could be over, under or just exactly corrected for, to give vertical shading to the picture material.

It will be noticed that the Blanking mixer tube V23 plate circuit is connected to the plate supply through a common load resistance of the IMO

Blanking Mixer tube V22. This is to correct for the time delay of the Blanking pulse generator V18 in firing, by mixing the horizontal IMO Blanking pulse in with the Reciever Blanking, thus extending the front edge of Receiver blanking by an amount equal to the delay time.

Generation of RECEIVER SYNCHRONIZING Signals (V21a-V19-V24-V29-V20-V25-V30 dwg. D-S-1208)

Horizontal Drive from the cathode follower V21a is differentiated by C64-R110-R111, and fed to the grid of V19 Horizontal Sync. pulse generator. The grid firing of V19 is delayed by C87-R111 so that a "front porch" interval, as shown in fig. 12g, is allowed for. The Horizontal Sync. pulse is generated in the plate circuit of V19 (see "biased-off" MV theory) and then fed into grid V24a Sync. Mixer tube. A portion of this voltage is also fed to the cathode follower output tube V29b, which in turn feeds the pulse to the Monitor horizontal scan circuit, so that the timing of the horizontal scanning of the interval Color Monitor will be the same as the Receivers off-the-line.

Vertical Drive from the Cathode follower V30b, is differentiated by C82 and R152, so that only the positive front edge of the pulse would be effective in triggering the Vertical Sync. pulse generator V25 (see "Biased-off" MV theory for V25 action). The Vertical Sync. output pulse width is regulated by R147, an adjustable screw driver control (see page 45 for vertical pulse measurement procedure), to the width as shown in fig. 12g. The vertical Sync. pulse is coupled to a cathode follower V20b, the output of the cathode follower then feeding the Sync. Mixer tube V24. The addition of both Vertical and Horizontal Sync. signals in the plate circuit, in a negative polarity direction, results in a large (35^V) signal which is then fed to the grid of V29a. The grid circuit of V29a is of low impedance with a crystal diode to prevent biasing from grid current. This allows the grid of V29a to swing from zero bias to way beyond cut-off with only the top 6 volt portion of the signal being used for plate current control. The clipped top portion thus appears across a low plate of V29a as positive polarity pulses and is then fed to the grid of the Sync. Mixer tube in the Line Video output circuit. The low plate load R125 is to preserve the fast time-of-rise slopes required of Sync. pulses, as given in fig. 12g.

The Vertical Sync. pulse is also fed from the cathode follower V20b to the Vertical Scanning circuit of the Internal Color Monitor, so that the timing will be the same as the Receivers on-the-line that use this same signal after it has been mixed.

WFM Scope SWEEP Signals (V26b-V27 dwg. D-S-1208)

The Color Drive pulse is used from cathode follower V30a output, to drive the grid of V26b with a high positive pulse, dc grid current clamping occurs, thus biasing the grid of V26b to the near peak value of the color drive pulse (45^v) or approximately -40 volts during the interval between pulses. This allows the plate voltage to build up across C24-C87 via condenser discharge through R48. When the next color pulse occurs, the positive voltage on the grid of V26b causes a heavy plate current that stores up (charges) on C24-C87. During the interval between pulses this charge again leaks off through R48 and since the time constant is long because of the high resistance R48, the discharge current is constant, thus causing a linear sawtooth voltage to appear across the output. This sawtooth voltage is further amplified in the scope amplifier for horizontal deflection. Since the color drive pulse is also used for firing the red gating pulse generator, the three video fields as seen with this 48 cps sweep on the Scope will always be in Red-blue-green sequence.

The Horizontal Drive pulse is used to tightly synchronize a free running multivibrator V27 through a small coupling capacitor C41. The free running MV is similar to the "Biased-off" multivibrator, with the exception that the first section is also at zero bias, thus allowing both plate circuits to alternately bias off the other grid. R73 is used for frequency adjustment and C43 is used for building up a sawtooth waveform, that is further amplified in the Scope horizontal deflection amplifier. The frequency is usually adjusted to show two horizontal line periods on the Scope trace.

Using External Synchronizing Signals

External Drive Signals are used only to trigger the internal Drive pulse generators. The external Drive signals themselves are not used. There are three good reasons for this action:

(1) Effects from 60 cycle hum pick-up on the external lines are minimized.

(2) The most important reason, all Drive pulse widths are fixed by the internal Drive pulse generators, and won't change when the switch is made.

(3) Avoids the changing of circuitry to provide amplifiers for the many outputs required for Drive Signals.

The external Reciever Sync. and Blanking signals are used, and added to the video signal at the appropriate circuit.

When the EXT-INT. Sync. switch SW-3 is turned from INT. to EXT., +150 volts dc is applied to all solenoid relays SW 110a to e inclusive, with the following circuit action results:

External Horizontal Drive is amplified in V15b to a positive high amplitude pulse, which when fed into diode V6 causes the diode current of V6a to completely charge C14 to a high positive polarity voltage (no counting charges take place) with the consequence that Horizontal Drive pulse generator V1 is immediately triggered, and generates the Horizontal Drive pulse that is used as normally.

External Vertical Drive is amplified in V20a to a positive high amplitude pulse, which when fed into diode V9 causes the diode current of V9a to completely charge C62 to a high positive polarity voltage (no stair case counting charges take place) with the consequence that Vertical Drive pulse generator V4 is immediately triggered, and generates the Vertical Drive pulse that is used as normally.

External Color Drive pulse is amplified in V15a to a positive high amplitude pulse, which when fed into diode V10 causes the diode current of V10a to completely charge C72 to a high positive polarity voltage (no step counting takes place) with the consequence that Color Drive pulse generator V5 is immediately triggered, and generates the Color Drive pulse that is used as normally.

Note: All external Drive input can be made as high impedance bridging inputs by removing the 75 ohm terminations, and returning the drive signals back to J104 via a co-ax cable. This is especially useful when two camera chains are being used side by side or in the same room, and have to share the one source of External Drive signals. This is also true for the external Blanking signal. If the video from camera console #2 is fed back into camera console #1, the external Sync. can be added to both video output signals. Four additional co-ax cables running between J104 socket connectors on both camera consoles are required for this type operation.

Program Audio Circuits (V33-V34 dwg. D-S-1208)

Program Audio amplifiers are usually considered as a separate piece of equipment and not supplied as part of camera equipment. Because the Vericolor industrial equipment is not intended for broadcast studio use, it was felt that in the interest of compactness and one control panel for everything, the two extra tubes and miniature transformer required for such service would be welcome.

Two separate high impedance microphone inputs are provided with connectors J106 & J107, with a parallel extension connector J105 in common with J106. The two inputs feed two front panel PGM AUDIO GAIN controls, which control the signal level of each to a mixer-amplifier tube V33. The mixed plate output is then further amplified by V34a and output tube V34b, with output transformer T-3 providing a 500 ohm "balanced to ground" output.

Frequency response should be as shown in fig. 19. It will be noticed that increasing C9 or C11, or both, will increase the response of the low frequencies in case it is required for phono music from a turn table. The lack of low frequency response (below speech frequencies) is intended to reduce any 48 cps or 144 cps interference from the adjacent Sync Generator pulse circuits. The amplifier has an overall gain of over 500, with an output overload point of 18 db. 8db on peaks (O. V11) is the level normally used on program lines to the audio amplifiers in the receivers.

Inter-Communication Amplifier Circuits

Because a good many of the inter-com phone sets are located at remote Vericolor reciever positions, it was felt that the usual "Repeater Coil" type of inter-com was not adequate, with the usual fault of dropping low in volume as more head sets are connected in parallel. Since long distances are usually involved between camera equipment and receivers, an amplifier with balanced input and output connections, has been built into the Vericolor Camera Console.

W.E. telephone Headsets are used by camera and console operators, with excitation current for the carbon mikes supplied by the cathode current ~~for the carbon mikes supplied by the cathode current~~ of V31a. One half of the input transformer T-1 primary is used for the mike input of the local camera and console operating personnel, and one half of the input transformer is used for mike outputs of the receivers. Each Receiver, when turned on, supplies its own mike current. The output of transformer T-1 feeds a front panel gain control, where the amplitude of the signal is selected and fed into two stages of amplification V32a and V32b. Resistors and condensors of both amplifier stages have been selected to favor voice frequencies, as shown in fig. 19. The output transformer feeds two separate secondary winding outputs. One balanced 250 ohm output is used for feeding all headsets and telephone recievers at the color receiver locations, the other output is terminated with 220 ohm resistor via SW109, until someone at a reciever location wishes to talk to the surgeon. When the small button located on the phone at the receiver is pressed in, a wire connection from the grid of V31b is shorted to ground thus removing grid cut-off bias, causing plate current of V31b to energize the solenoid of SW-109 which throws switch output to lines going to surgeons earpiece. Instructions for setting levels are given on page 33 and 34.

Meter Test Switch (SW-1 dwg. D-S-1208)

The circuitry is arranged in such manner that if two switch buttons are pressed in at the same time, no shorting between test point occur.

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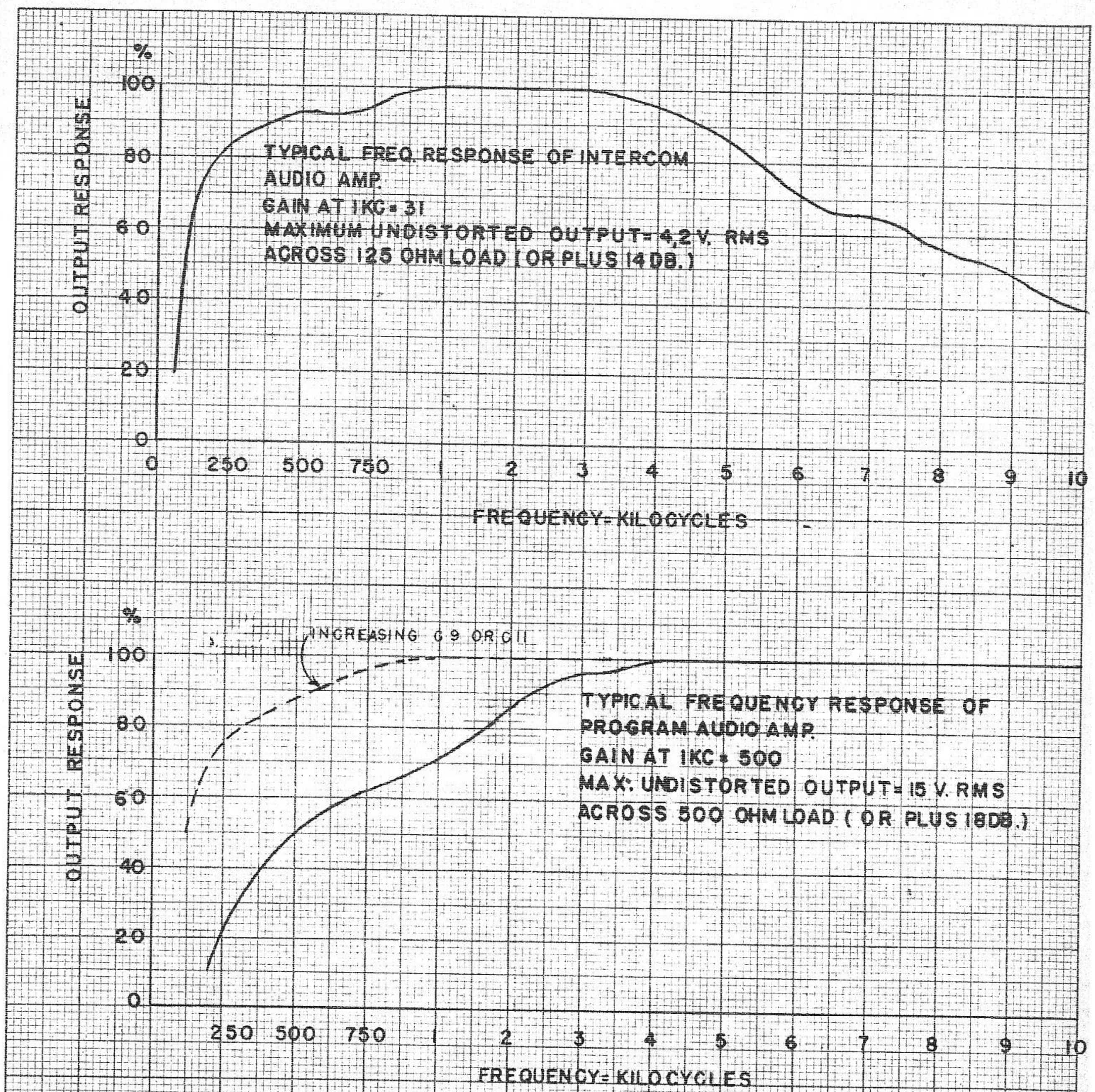


VERICOLOR PROGRAM & INTER-COM AUDIO RESPONSE CURVES

FORM 1127

K & E CO., N.Y.

FIG. 19

R-157 meter shunt resistor is tailor made to suit the meter used, and if the meter is replaced with another type, the internal impedance of the meter will affect the accuracy of the focus current reading. This can be checked, with a good grade 100 ma meter in series, for accuracy, and changing the wire turns of R157 until meters match.

Optical Focus Switch Circuit (dwg. D-S-1208)

The switch is wired in such manner that the optical focus motor rotation can be reversed depending upon the "up" or "down" position of the switch. V35 and V36 are pilot lamp indicators, that indicate when motor current is being used, thus indicating to the operator when the focus power has been shut off when the focus coil carriage in the camera has reached the limit of its travel. The 15 ohm shunt resistors limit the pilot lamp current to a safe value and also provide emergency continuity in case of pilot lamp burn out. C85, C86 and R158 constitute a switch transient suppressor. If picture flashes occur when throwing the switch toggle up or down, C85 and C86 may be increased in value.

COLOR MONITOR & SCAN CHASSIS CIRCUITRY

Color Monitor Video Amplifier Circuit (V13-V14-V15-V16 dwg. D-S-1207)

Amplifier input selector switch SW-107 is used to select any one of seven test points throughout the control unit, and feeds the selected test signal into the high impedance grid input of V13a. The plate circuit of V31a, including Gain Control, is frequency compensated by cathode peaking capacitor C34. The level of signal selected by the Gain Control R66 is further amplified by conventional wide band 10 mc amplifier V13b-V14-V15 and dc re-insertion is accomplished with one half of V16 for the kinescope grid.

Waveform Monitor Circuit (V18-V19-V20 dwg. D-S-1207)

The switching circuit and video amplifier tubes of the Color Monitor is used as a pre-amplifier for the Vertical output tube V18, a portion of the signal being taken from cathode resistor R76 of the last video tube. Push-Pull output is obtained by feeding signal from the plate output of V18a to the grid of V18b, a conventional phase splitting circuit giving equal outputs from cathode and plate. The frequency response is adequate for this type of scope presentation, being in the order of 3 db down at 3 mcs.

Horizontal sweep scanning speeds of either 1/48th second or 1/14,580th second, in sawtooth waveform as generated in the Sync Generator chassis, can be selected by SW-108, with high enough amplitude to drive the horizontal push-pull output stage V20 directly.

Centering of the trace in either direction is accomplished by biasing the condenser coupled cathode output to a positive voltage that can be either above or below the plate voltage drop of the plate output side.

Color Monitor Vertical Scanning Circuit (V10-V11a dwg. D-S-1207)

A high amplitude (40 volts min.) Vertical Drive pulse is used to drive the grid of the Vertical discharge tube V11a. Rheostat R41 in the plate circuit controls the positive voltage available and therefore serves as an amplitude control for the sawtooth output of V11a. The output of V11a is coupled to the grid of the Vertical output amplifier tube V10. Vertical Linearity control R39 regulates the value of screen-grid voltage on the output tube, thus shifting the operating range of the tube from linear to non-linear ranges, thus distorting the output waveform to counter-act the low frequency distortion of the output transformer. The output of V10 is coupled to the vertical deflection coil by transformer T-2, and centering is obtained by using the voltage drop across tapped potentiometer R32 to cause plus or minus current flow through the vertical deflection coils. Resistor R-31 is provided so that the scanning waveshape can be observed with an oscilloscope, as described on pages 39 and 40.

<u>Color Monitor Horizontal Scanning and High Voltage Circuit</u> (V1-V2-V4-V5-V6-V7a-V25 dwg. D-S-1207)

A horizontal drive pulse having a minimum amplitude of 30 volts, peak to peak, is used to drive the grid of the horizontal discharge tube V7a. The sawtooth output of V7a is coupled to the grids of the paralleled power output tubes V5 and V6. The output of the power amplifier tubes V5 and V6 is coupled to the horizontal deflection coils and to damper tube V1 through transformer T-1. Centering current of the proper polarity and amount is fed into the horizontal deflection coils by R2, which is connected in series with part of B+ power supply circuit.

The <u>Damper tube V-1</u> performs two functions (1) to dampen out transient oscillations due to shock excitation of the reactive output circuit and (2) to convert the damping energy into additional dc voltage "Boost" supply. The circuit functions as follows:

At the end of the trace scanning period, the sawtooth voltage as fed to the output tubes goes negative, considerably beyond plate current cut-off. The magnetic fields across the output transformer T-1 and scanning coils L-1 collapse rapidly, and in doing so cause a very high voltage surge across the transformer.

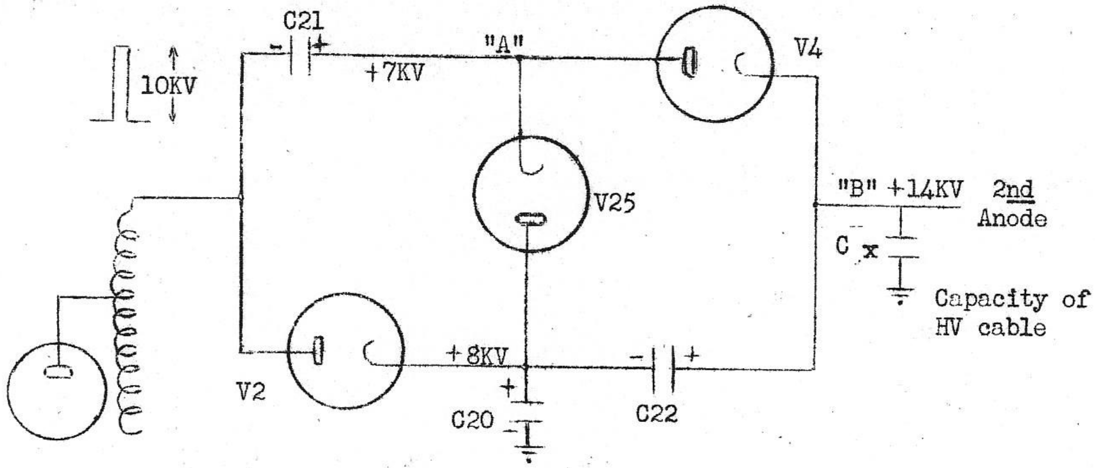
As designed, the output transformer and circuit has a resonant period approximately equal to twice the desired retrace time of 5.5 microseconds, or 11 microseconds. Ths sharp cutting off of the plate current in the primary of T-1 shocks this resonant circuit into oscillation. During the first half cycle of this shock oscillation (5.5 microseconds) the very high surge voltage across the output of T-1 is negative, so the damper tube will be non-conducting. At the instant the oscillation current reaches its maximum negative amplitude and starts to decay, the voltage across the output reverses and becomes positive (second half cycle), and tube V-1 conducts. At this particular instant, active line trace begins again, and the energy being returned from the now negative collapsing field induces current flow in the yoke with the damper tube regulating the current flow to a constant value. Thus during the first part of the scanning period, the damper tube V-1 supplies current derived from the energy in the magnetic field, the tubes electron flow, from cathode to plate, being taken from C49,L3 and C48, thus charging both condensers more positive which "boosts" the B supply voltage to the output tubes. If linearity control is desired during this part of the sweep, C49 and L3 can be changed to distort the electron flow of V-1. The values as shown are for best linearity conditions as adjusted at the factory.

During this first part of the scanning period, the output tubes V5 and V6 are biased very negative by the high amplitude grid excitation, therefore all of the scanning current is supplied by the "damper-booster" tube V-1. However, during the latter part of the scanning period when the stored magnetic energy is just about dissipated, grid excitation is such that the output tubes V5 and V6 start supplying plate current again, with the "damper-booster" tube V-1 supplying practically no current.

Resistor R-1 is provided so that the yoke scanning current waveshape can be observed with an oscilloscope.

High voltage of approximately 14,000 volts for the kinescope second anode, is supplied by a "Flyback" type of supply using tubes V2-V4-V25 in a "doubler" service. V25 is used to replace the conventional resistor used in doubler service, to give less series voltage drop and better voltage regulation.

Fig. 20



Simplified H.V. Supply Circuit

During the horizontal flyback or retrace period, the sudden collapse of magnetic energy, as mentioned before, generates a very high voltage surge across the output transformer, negative in polarity across the secondary, positive in polarity across the primary. The extension of many more turns on the primary above the plate connection makes this complete winding act as an auto-transformer, thus stepping up the positive pulse surge voltage to approximately 10KV. With reference to either the schematic drawing or the simplified sketch as given in fig.20, when the first positive pulse occurs, electron flow of V2 will charge C-20 up to approximately 8KV. After the first positive pulse leaves and during the interval between pulses, diode V2 is non-conducting therefore the positive charge on C-20 causes point "A" to also charge to 7KV via diode V25, which in turn causes diode V4 to change the output capacity to 6KV. The inside plate of C-21 is therefore 7KV with respect to ground. The next horizontal pulse is coupled through C21, thus adding a high positive pulse to the 7KV already there, making a total of 17KV during pulse time. This causes V4 electron current to charge up the output capacity CX to 14KV volts, allowing for voltage drop across V4 internal impedance. The function of V2 after this is to keep C-20 charged to 8KV which in turn keeps point "A" at 7KV so that when the 10KV pulse is added to point "A" the total will charge up point "B" to 14KV. C-22 in series with C-20, plus the parallel capacity of the co-ax cable provide sufficient filtering at that frequency.

A variable iron core inductance is placed across part of the secondary to act as a variable shorting reactance. The more inductance that it is adjusted to, the less loading effect on T-1, therefore more scanning current available.

<u>IMO Vertical Scanning Circuit</u> (V11b-V12 dwg. D-S-1207)

A high amplitude Vertical Drive pulse (40 volts min) is used to drive the grid of the vertical discharge tube V11b. Rheostat R200 (front panel control dwg. D-S-1206) in the plate circuit controls the positive plate voltage available and therefore serves as an amplitude control for the sawtooth output of V11b. The output of V11b is coupled to the grid of the vertical output tube V-12. Rheostat R54 in the cathode circuit serves as the linearity control by varying the grid operating bias on the output tube, to compensate for the input sawtooth non-linearity or low frequency distortion of the output transformer. The output tube V12 is coupled to the vertical deflection coils by transformer T-4, and centering current of either polarity is obtained by using the voltage drop across R49. A resistor, R50, is provided so that the yoke scanning current waveshape can be observed with an oscilloscope, as described on page 37.

<u>IMO Horizontal Scanning Circuit</u> (V3-V7b-V8-V9 dwg. D-S-1207)

A horizontal drive pulse having a minimum amplitude of 30 volts, peak to peak, is used to drive the grid of the horizontal discharge tube V7b. The sawtooth output of V7b is coupled to the grids of the paralleled power output tubes V3 and V8. A variable resistance R21 provides "peaking" of the generated sawtooth waveform, which gives a modest amount of linearity control of the yoke scanning current via damper tube V9 action. The output of the power amplifier tubes V3 and V8 is coupled to the horizontal deflection coils and damper tube V9 through transformer T-3. Centering current of the proper amount and polarity is supplied by utilizing the voltage drop across R29. Resistor R199 (see dwg. D-S-1206) in the cathode circuit of V3 and V8 controls the bias and degeneration of this stage, thus controlling the output. It is labeled "IMO WIDTH" control on the front panel.

The damper tube V9 action in suppressing transient oscillations and supplying a boosted voltage to the output tubes, is identical to that as described for V1 under the "Color Horizontal Scanning and High voltage Circuit" and will not be repeated here except for the difference that this output circuit uses two output secondaries, one is used for the actual scanning current, with a turns ratio to match the transmission line to the camera, and one secondary with a higher turns ratio to provide better magnetic coupling and higher voltage for "boosting" purposes. Because of tight magnetic coupling the two windings can practically be considered as one, as far as damper tube action is concerned.

EXTERNAL POWER SUPPLY UNIT CIRCUITRY

48 Cycle Motor Generator Circuit (Dwg. B-S-1217)

It is advantageous and required by the Underwriters, that the prime 60 cycle power supply with a common ground not be allowed to enter a hazardous location (NFPA 5-1 and NFPA 5-5). Locations in which hazardous c concentration of inflammable gases or vapors exist continuously, intermittently, or periodically, under normal operating conditions, is termed by the NBFU*1947 Electric Code (P 187) as a "hazardous location". NFPA** 2-2 terms hospital operating rooms, delivery rooms, pre-operative and anesthesia rooms as "hazardous areas, with the hazardous location to be considered as extending from floor level to five feet above the floor.

Instead of using a large Power isolation transformer for the Vericolor equipment, it was advantageous to use a frequency changer which in itself provided the necessary power supply isolation with no common ground, and generate a frequency that is common to the color system, which could be either 144 cycles (vertical scanning rate) or 48 cycles (color frame frequency). In this way the color disk and drum motors would not require gears or belting for the 1440 RPM speed required, and any electrical or magnetic interference from the power source would be synchronous and thus cause the least amount of interference. The 48 or 144 cycle supply, since it is synchronous to the 60 cycle supply in the building, also supplies a steady locking voltage for the Sync Generator to synchronize to. Thus any receivers on the same 60 cycle power supply can use synchronous motors to

*Nat'l. Board of Fire Underwriters
** Nat'l. Fire Protective Assoc.

drive their color disk.

Power may be applied to the motor generator at the box control panel by throwing SW-1 to the "ON" position or it may be applied remotely by throwing SW-1 located on the "Beam Control" at the control console to the "ON" position. This action supplies power to the solenoid of SW-2 and time delay relay SW-3. SW-2 closes and applies power to the motor generator, which should reach almost full running speed within five seconds. After 30 seconds relay switch SW-2 closes and applies power to the Regulated dc Supply chassis (SK-D-S-1210) and to the Selenium rectifier T-1 which supplies a pulsating dc voltage (95 volts at 1.2 amps) to the motor generator field coils, bringing the motor generator into synchronous speed (the dc is not used for field excitation for output power as might be supposed, but merely for synchronizing the motor to the 60 cycle line).

The reason for the 30 second time delay switch, is to allow the 48 cycle (or 144 cycle) power to warm up all tube filaments and the -150 volt bias supply, before the main dc plate power is applied from the regulated supply. The time delay is not critical and may be adjusted from 30 seconds minimum to 90 seconds maximum. Any time power is interrupted or turned off, the time delay of Sw-2 automatically recycles to its starting position. This is to avoid the possibility of applying dc plate voltage without negative bias, and particularly the application of dc power to the motor generator field winding before it is up to near its normal running speed, as otherwise the Motor generator will labor heavily or not start at all.

All input and output circuits have test points provided for easy testing with normal test meter prods, and each test point has an engraving on the terminal board to show what test point it is. Needless to say that the control box with its cover off and all test lugs exposed is dangerous to life. Watch out particularly for dangling test leads and keep cover on for the safety of untrained personnel.

One motor generator set, with its control box, is required for each camera chain. The following data concerns the input and output voltages and currents for the 48 cycle motor generator set, when it is operated at the lowest and highest power line voltages that the equipment will work satisfactorily at, and its normal operating drain.

A.C. Power Input = 60 cps three phase 4 wire "Y"

WORKING LIMIT UNDER FULL LOAD	VOLTAGE BETWEEN PHASES	AVERAGE PHASE CURRENT	POWER .75pf
Lowest =	190 volts	2.65 amps	660 watts
NORMAL =	208 "	3.0 "	810 "
Highest =	240 "	4.4 "	1370 "

A.C. Power Output = 48 cps three phase 3 wire delta

WITH MOTOR INPUT VOLTAGE AT	GENERATOR OUTPUT VOLTAGE	GENERATOR LOAD CURRENT	@ 90% POWER FACTOR
190 volts	106 volts	1.9 amps	350 watts
208 "	118 "	2.1 "	430 "
240 "	132 "	3.1 "	710 "

The loading of each generator output phase is well balanced, and is within 10% of the values as given in the above table.

+280 Volt Regulated Power Supply (Dwg. D-S-1210)

This power supply provides a source of regulated dc voltage for one camera chain. A multi-tapped primary on the power transformer allows the input voltage supply to be from 100 volts to 130 volts the tapped switch being set to the point where the ac voltage input as read on M-1 reads between 115 and 120 volts. At this switch position the power supply will require 6.5 amps from the line.

The power supply delivers 1.0 ampere of direct current at any voltage between +270 and +290 volts, with less than 30 millivolts, peak to peak, of 120 cycle ripple voltage across output. The voltage output is maintained constant over a load change of 400 ma and through input voltage variations of plus or minus 5 volts on any given tap of S-2.

Rectification of the high voltage output of T-1 is accomplished by three tubes in parallel in each branch of the full wave circuit (V1 to V6 inc.). The dc output of the rectifier tubes is filtered by a conventional LC filter, with four 4 henry chokes in parallel. The 1000 volt lt 15 mfd oil condensers used will take any dc surges, thus not requiring thermal delay switch RS-1 as an absolute necessity, as these type switches have been known to give trouble. However, if RS-1 is not used, it would be advisable to wire in a one watt neon bulb (with no internal resistance) between the grid and cahtode leads of any one of the output tubes (V7 to V11 inclusive), which avoids a temporary high positive voltage between grid and cathode.

The voltage regulating circuit consists of five controlled tubes V7 to V11 inclusive, all similar elements connected in parallel but with parasitic suppressor resistors for rf isolation (i.e. R-11. R-13, etc.). These tubes act as variable resistors, their internal resistance being controlled by the bias on their grids. The bias on the controlled tubes is regulated by the voltage applied to them by the dc amplifier tube V-12. The operation of the circuit is as follows:

(a) consider the action of the dc amplifier tube V12 when for example the dc output voltage should be reduced for an instant. Since any dc variations will be coupled through gas regulator tube V13, almost all of the dc variation will appear across cathode resistor R33 (rapid ac variations would be coupled to R33 by C-4) thus lowering the cathode voltage to V12b. This in effect decreases the negative bias on V12b causing more plate current, which in turn lowers the plate voltage on V12b. Since the grid of V12a is directly coupled to V12b plate, this causes additional negative bias to V12a decreasing its plate current. The decreased plate current of V12a causes less voltage drop across R-21, which results in less negative bias to the controlled output tubes V7 to V11 inclusive. This decreases their plate-to-cathode resistance, thus causing less voltage drop between the plate and cathode thus increasing the cathode to ground voltage. The circuits would function in the reverse manner if the dc output voltage should try to increase. V14 is used as a constant voltage reference level for V12a, keeping the cathode voltage constant regardless of control grid variations (the characteristics of gas tube regulators are such that the voltage across the tube remains practically constant irrespective of current variations through the tube), and for supplying a fixed dc reference level across R-30, the slider of R30 governing the dc reference voltage to V12b.

A small dry rectifier RX-1, used for full rectification of the ac input voltage, supplies a proportionate dc to meter M-1 through meter selector switch S-1. If an ac voltage as read on M-1 falls close to 120 volts, the ac power input voltage will be indicated by the pointer on the switch knob of S-2. R-2 multiplier has been selected to make M-1 read properly by matching the ac voltage as read by a precision type ac voltmeter across the rectifier ac input leads.

R-1 in series with M1 converts M1 to a voltmeter having a full scale reading of 1.5 volts. Switch S-1 in positions 1 to 5 inclusive, places t this 1.5 voltmeter across either of the 5 ohm resistors and measures the plate current drop across the resistor, thus indicating how much plate current is flowing for that particular tube. For example, 200 ma is the average plate current per tube, and 200 ma through 5 ohms will cause 1 volt across the resistor, which causes the meter needle to move up two-thirds to where the 1 volt should be indicated. This is the same reading as indicated for 200 on the voltmeter scale, so the meter will thus indicate directly the number of milliamps current flowing through each tube.

On meter selector switch position 6, the combined total plate current of all controlled tubes V7 to V11 inc., will flow through R4, a one ohm total resistance. Very close to 1 ampere on an average will flow through this one ohm resistance, again causing a two-third scale meter movement. However since this now indicates five times as much current, the scale reading for this position will have to be multiplied by five to give the true total current.

R-3 in series with M-1 converts the meter back to its original purpose of measuring 300 volts dc, and in switch S-1 position #7, the meter measures the regulated dc output voltage, with direct scale reading.

Time Meter (Dwg. D-S-1210)

A time meter is supplied on the regulated supply that reads directly in hours the total time the equipment has been run. It is most useful for clocking the amount of time in hours that different Image Orthicon tubes are used for, such information being required by the manufacturer in case of tube failure. The tube time required is that time when filament and dc voltages are applied to the tube.

MAINTENANCE NOTES

To remove Camera Color drum & motor drive assembly

The color drum and motor drive assembly may be removed **from the** camera as follows:

1. Open the head of the camera, which is hinged at one point, by loosening the two lock screws which are located approximately $2\frac{1}{2}$" from, and slightly below, the tally lights.

2. Unplug the color drum motor power plug which is located in the lower right hand corner of the camera head when it is in the opened position.

3. The color drum motor is mounted on a circular metel disc which is inserted at the rear of the camera head. To remove this assembly, color drum, motor and mounting disc, remove the four screws on the outer periphery of the circular disc and push the whole assembly out towards the rear being careful at all times not to scratch the filter materials on the color drum.

To Remove the Camera Color drum from the motor.

The color drum may be removed from the motor shaft as follows:

1. Loosen the set screw (8-32) by inserting an Allen wrench (1/8" across flats) into the hole provided in the color drum.

2. Slide drum off shaft.

To remove and place a filter segment of the Camera Color drum.

The filter segments of the color drum may be replaced, after the color drum assembly has been removed from the Camera head, as follows:

1. Remove the clamping strip on the side of the filter segment, that is to be replaced by unscrewing the two screws that fasten these strips to the drum ribs.

2. Lift out undesired filter segment, and replace.

3. Don't get fingerprints on filter segments. Use white cotton gloves when working with or replacing camera filters. An extremely mild water-detergent solution may be used for cleaning strips, using a lens cloth or very soft flannel for polishing.

To remove the Kinescope color disc.

1. Remove the $\frac{1}{4}$-20 bolt which clamps the disc housing. This bolt is located in the upper right hand corner of the housing.

2. Remove the lucite cover plate of the disc housing assembly.

3. Remove the six screws from the retaining ring which clamps the disc to the disc hub.

4. Remove the disc.

To remove a filter segment from the kinescope color disc.

A filter segment may be removed from the disc in the following manner:

1. Remove the rivets which hold the filter segments on to the lucite disc.

2. Remove the segment.

Installation of focus coil in monitor

During the course of servicing of the color monitor, it may become necessary to remove the deflection yoke and focus coil from the metal kinescope shield. Care must be taken in replacing the focus coil inside the shield. The coil must be replaced in such a manner, that the gap, which can be identified on the inside of the coil, shall be closest to the screen end of the kinescope tube. This is to insure proper focus within the range of the focus control. Should the coil be reversed, poor focus of the kinescope tube would result.

It shall probably be noticed, that the position of the focus coil, has a definite bearing on the centering of the raster on the picture tube. It also has a definite bearing as to the brightness of the raster. Any sacrifice of picture brightness for the purpose of centering the raster on the picture tube, by means of the focus coil, will result in a poor color picture, subject to low highlight brightness and poor high voltage regulation. It is therefore advisable to adjust the position of the focus coil for maximum raster brightness. Centering of the raster should be accomplished by means of the centering controls. It should be kept in mind that if it becomes necessary to affect a compromise it will be done at the expense of picture quality on the monitor.

January 1952

NOTES ON MULTIPLE CAMERA INSTALLATION

IN HOSPITAL OF VERICOLOR EQUIPMENT

1. Television Master Control Room

In view of the large number of cameras and receivers anticipated one room shall be set aside for the use of terminal equipment, such as switching amplifiers, power supplies, synchronizing signal generators and amplifiers and cross-connecting receptacles. This room is to be known as "Television Master Control" and all camera and receiver lines terminate in this room.

Ventilation was to be provided so that the temperature would not exceed 90 degrees F. maximum. Some facts for the ventilating engineer are (1) for each camera used, associated power equipment in "Television Master Control" will dissipate not over 400 watts; (2) for each receiver (or receiver line) the "station selector amplifier" will dissipate not over 150 watts; and (3) the sync generator and its power supply, plus the sync signal distribution amplifier will dissipate not over 550 watts, in the form of heat.

The sync signal generator and its power supply, plus the sync signal isolating amplifier can be installed in a typical cabinet racks 78" high by 24" wide by 19" deep (similar to Par-Metal Cat. No. P7818). The racks weighs 250 lbs., making a total load of 500 lbs. per 3 sq. ft. floor space (160 lbs. per sq. ft.)

Each special power unit for each camera chain takes up 25" X $22\frac{1}{2}$" of floor space by $26\frac{1}{2}$" high (max. O.D.) and weighs approximately 335 lbs. (86 lbs. per sq. ft.) These units may be mounted directly over each other to conserve floor space, if the floor loading will take it.

Six "Receiver Line Station Selector Amplifiers" plus two regulated power supplies for their operation will fit into a typical cabinet rack (similar to that used for sync signal generator equipment). Rack weight is 250 lbs., equipment weight approximately 300 lbs.

Racks may be mounted alongside each other, but a minimum of $3\frac{1}{2}$ feet should be allowed between the racks and any walls for proper servicing of the equipment.

A block diagram showing the equipment layout for a "Television Master Control Room" is attached and will give the required power and connector facilities.

2. Camera Pickup Locations

A camera pickup location may be defined as any point where connection facilities are already wired in, such as an operating room, laboratories, medical library, autopsy room, X-Ray and radio-graphic suites, specialty clinic rooms and perhaps from the radioactive isotope department. One or two cameras at each location may be involved.

When the term "camera" is used, it is understood that this also includes a "camera control and monitor". It is not good practice, either from an operating viewpoint or a price viewpoint, to build a camera control and monitor unit to control two cameras. However, these units, as they are supplied, can be used for mixing two signals from two cameras into one program output. For example, considering a typical operating room installation, if camera #1 is located within an operating room light and camera #2 is located in a fixed position on the ceiling (or on a portable boom-dolly), the signal from #2 camera control unit can be fed into #1 camera control unit, and the operator at #1 camera control unit can select either signal and feed it out on the program line to the receiver.

When "Television Master Control " is located on a floor other than where the cameras are located, it is advisable to provide a minimum duct space of 2" X 4" for the power leads and an additional 2" X 4" for the audio and video signals. These ducts will handle all inter-floor leads for three complete camera chains. 4 X 4 ducts may be used for six, etc. Normally a 1½" conduit is used between the inter-floor duct and the camera position for video and signal leads, with a 1" conduit between the same points for power leads. It is not advisable to mix the power and signal leads in the same conduit or duct, because of hum pickup in the audio and video leads over a long distance.

If a viewing receiver is desired in the operating rooms (above the five ft. level but tilted) so that its own program or signals from other points can be viewed, its installation should be the same as given under Receivers. The station selector, however, should be installed above the five ft. level or in the "camera control room" where the camera operator can select the program for the surgeon upon his instructions over the intercom. This O.R. receiver will require its own "receiver line station selector amplifier" in "Television Master Control".

Receivers

From one to as many receivers desired can be connected in "series" fashion to a receiver line. The station for selecting programs is shown on the first receiver on the line but it can be mounted at any convenient point. When a program is selected, all receivers on that particular receiver line receive that program. The receivers do not have their own program selectors unless they have their own receiver line and selector amplifier in "Television Master Control". When the program selector unit is operated, the video signal, the program audio, the inter-communicating audio and the Surgeon's communication control leads are switched to the desired pickup point.

Lighting Required for Camera Pickup

It is important that the camera "sees" only what the human eye sees, particularly in color television. The image orthicon tube used in the camera does have a response in the infra-red region and therefore can pickup a signal that the eye does not. This extra signal picked up by the camera will be super-imposed on top of the color signals, thus contaminating the true colors. It is therefore important that any light source that is used for color television does not have an excessive infra-red component (such as 3500 degree K. fluorescents). If the light source does (incandescent lighting of 2800 degree K) it is necessary to either filter the light source with #3962 aklo glass (or its equivalent) or use a polished and optical ground #3962 aklo glass filter with the lens in the camera.

Wilmot Castle, Luminair, or any other infra-red (heat energy) corrected source of operating room light may be used for surgery. Both these lights give excellent color pictures.

For clinical programs, much depends upon the type of program. Actually the type of program is very similar to the type of program picked up in a regular television station studio, and to a certain extent may be treated the same way, if similar results are expected. In general it might be said that it is advisable to have approximately 100 foot candles of flat overall 3500 degree K. lighting over the camera pickup area. This can be obtained from "white" fluorescent lamps provided they are split up evenly on three electrical power supply phases. If 2900 degree K. incandescent lighting must be used, then 200 foot candles are desirable if not infra-red filtered. This allows for approximately 50% attenuation in the aklo #3962 camera lens filter. Half of these foot candle figures will give a good color picture with some loss in focal depth of field. It is desirable but not necessary that incandescent lighting be run off of either two or three phases. Single phase will give a good color picture.

A good overall general type of lighting would be to have 50-100 foot candles of flat light from ceiling fixtures and then support this lighting with portable floor fixtures. It is a good idea not to mix fluorescent with incandescent lighting but to use one or the other exclusively unless the service of a lighting expert is available.

A typical installation woud be a camera pickup area of 10 X 10 feet with 50-100 foot candles of three phase 3500 degree K. fluorescent lighting from ceiling fixtures and two protable floor"pans" of 3 phased fluorescent lighting. The floor pans would be similar to the Century No. 1156 Slimline floods, mounted on a portable dolly stand. 3 phase power connection facilities should be made available either at floor level in class rooms or above the five foot level in operating rooms. Each pan uses 240 watts, 3 phase power.

Another type of installation using incandescent lighting would be to use standard 2900 degree K. lamps for overhead ceiling fixtures to supply 75-150 foot candles of flat lighting, and support this with four portable spotlights similar to the Century Cat. No. 520 6" fresnelites, mounted on a 3 legged castered stand similar to Century Cat. No. 3218. It would be satisfactory to have the ceiling fixtures on one power phase and the portables on another power phase. Provision for these power outlets, however, should be made. The portables draw 500 watts each. Air conditioning should be able to take care of the added heat from these lights.

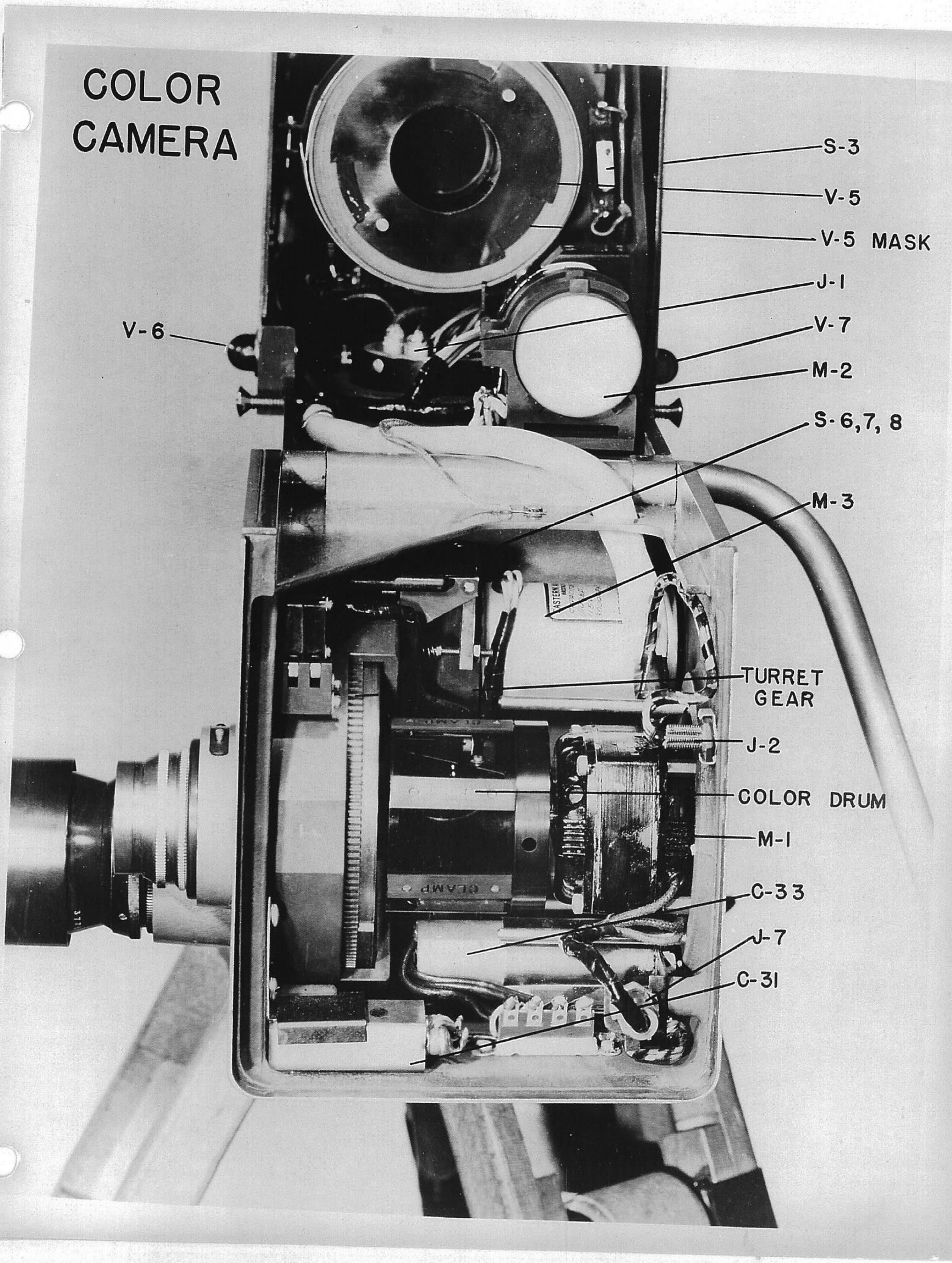
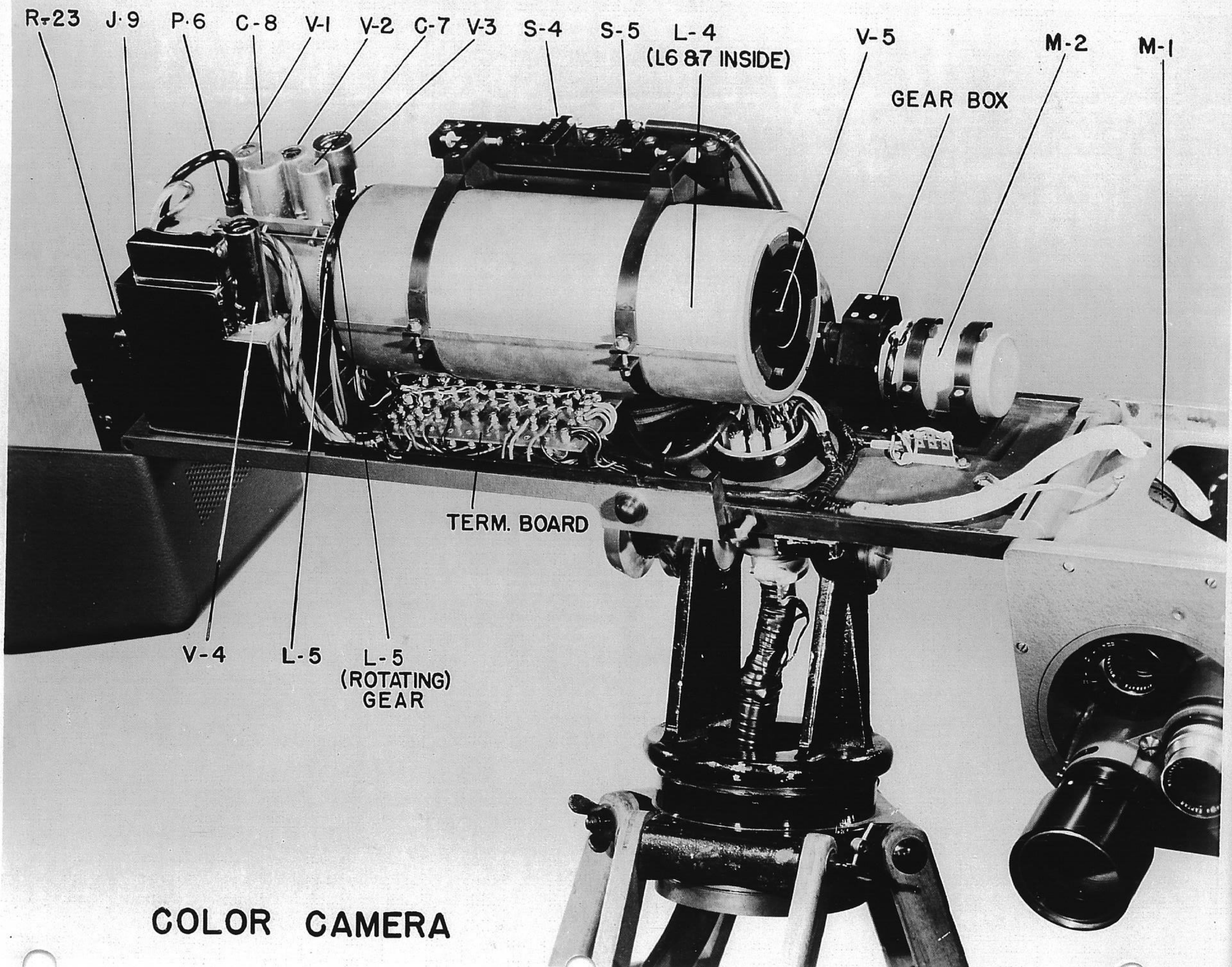

COLOR
CAMERA
S-3
V-5
V-5 MASK
J-1
V-6
V-7
M-2
S-6,7, 8
M-3
TURRET
GEAR
J-2
COLOR DRUM
M-1
C-33
J-7
C-31
CLAMP
CLAMP

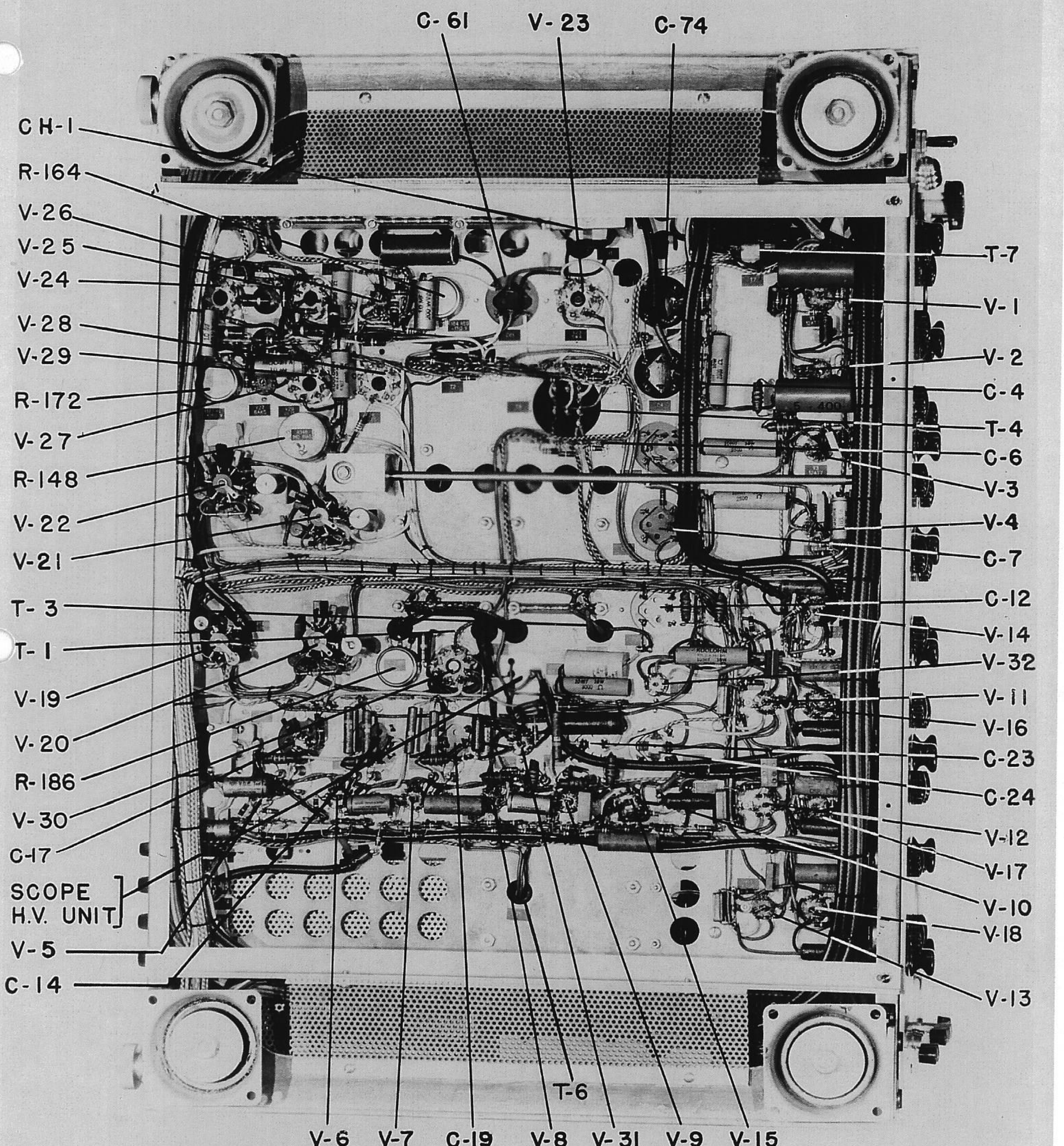
FIG 21



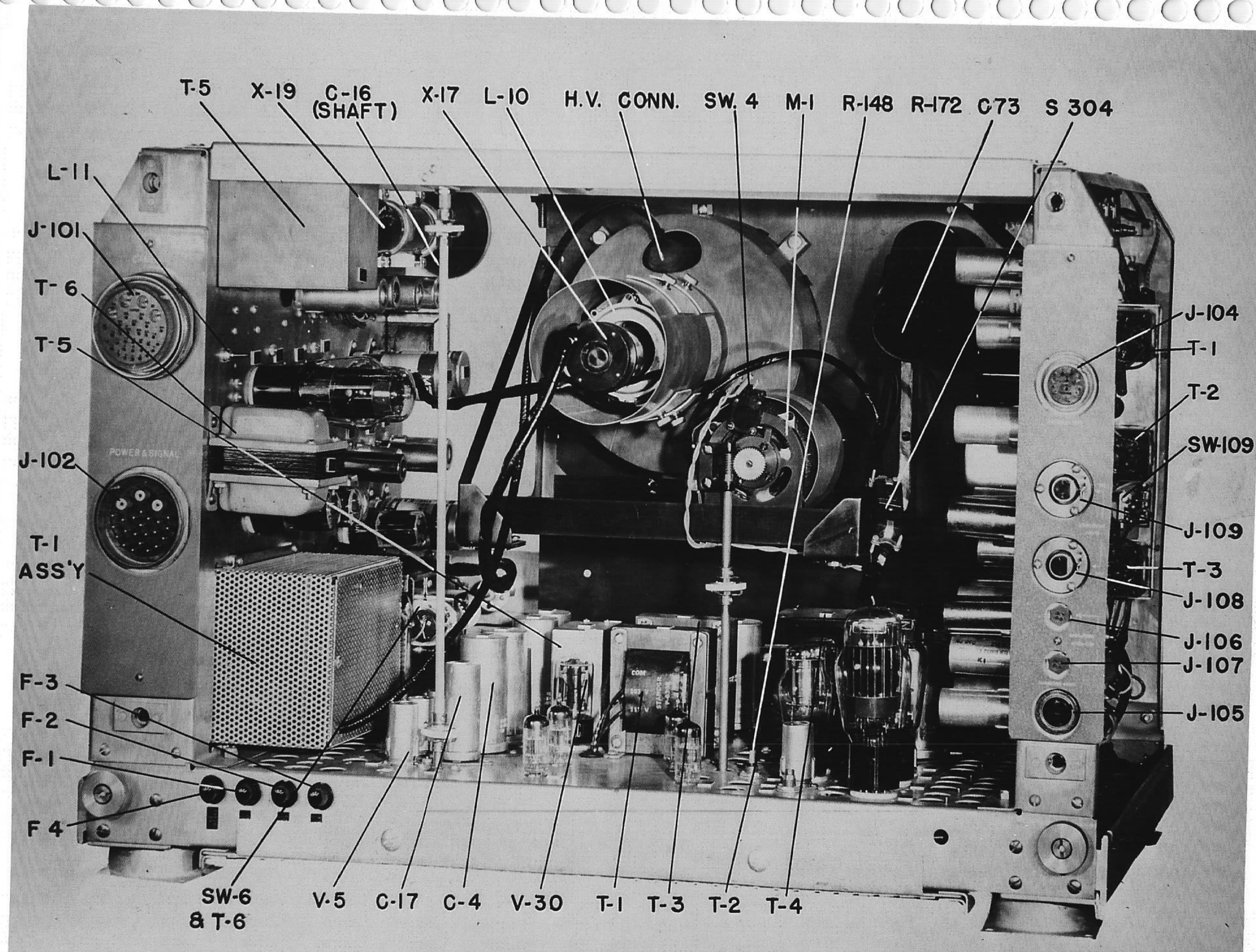
COLOR CAMERA

109 B

FIG 22



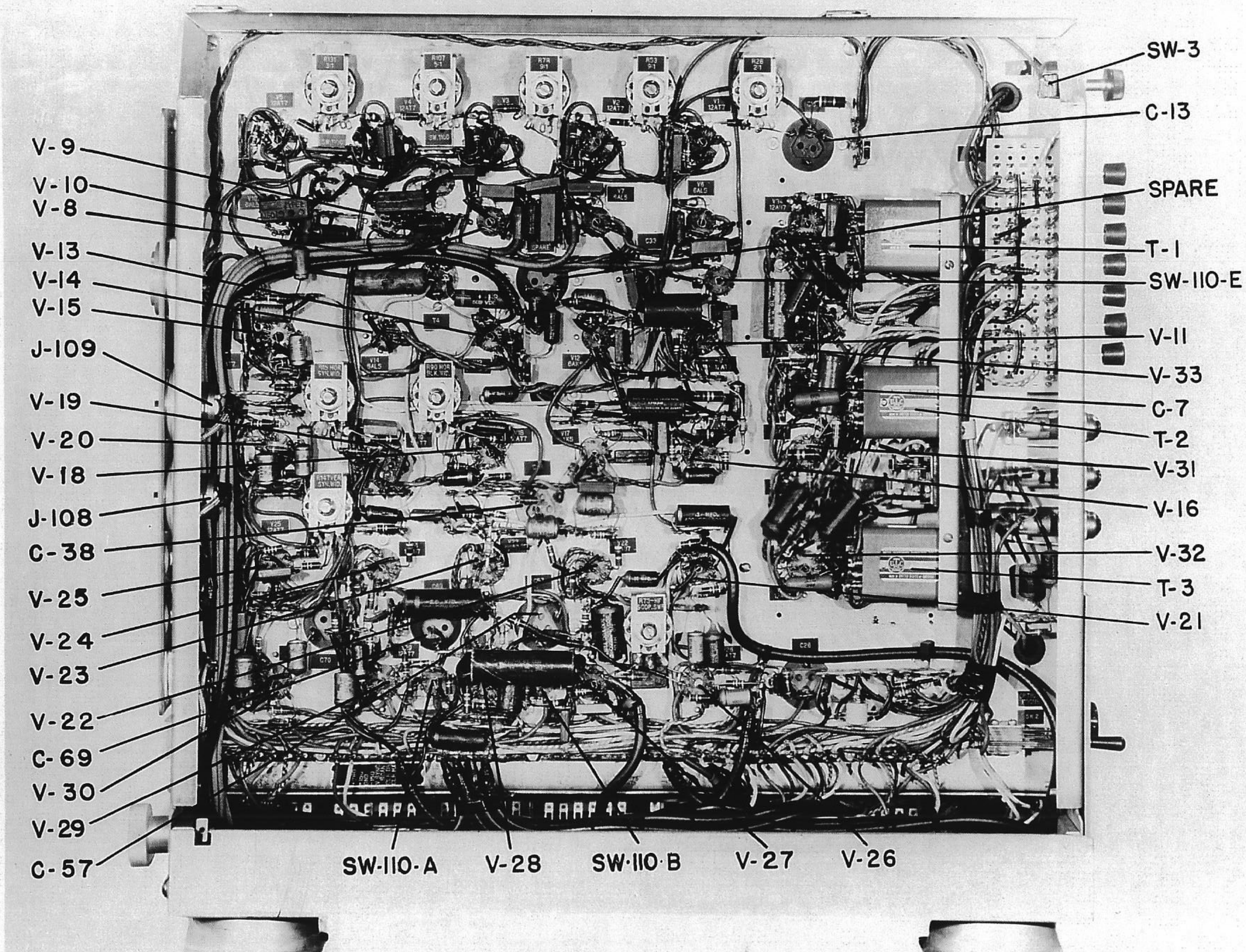
CAMERA CONTROL CHASSIS



CONSOLE — REAR

110 B

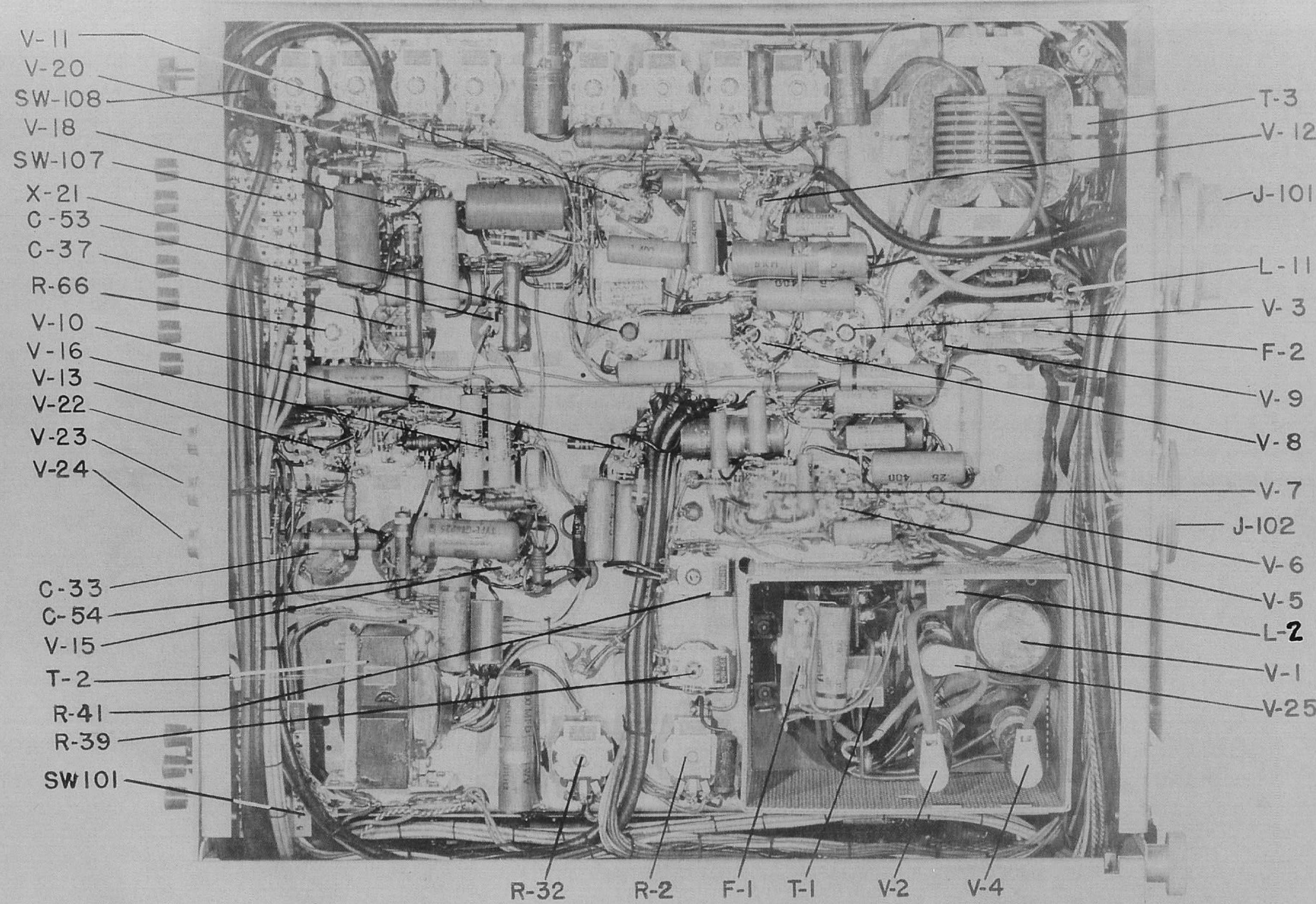
FIG 24



SYNC GENERATOR & AUDIO CHASSIS

111 A

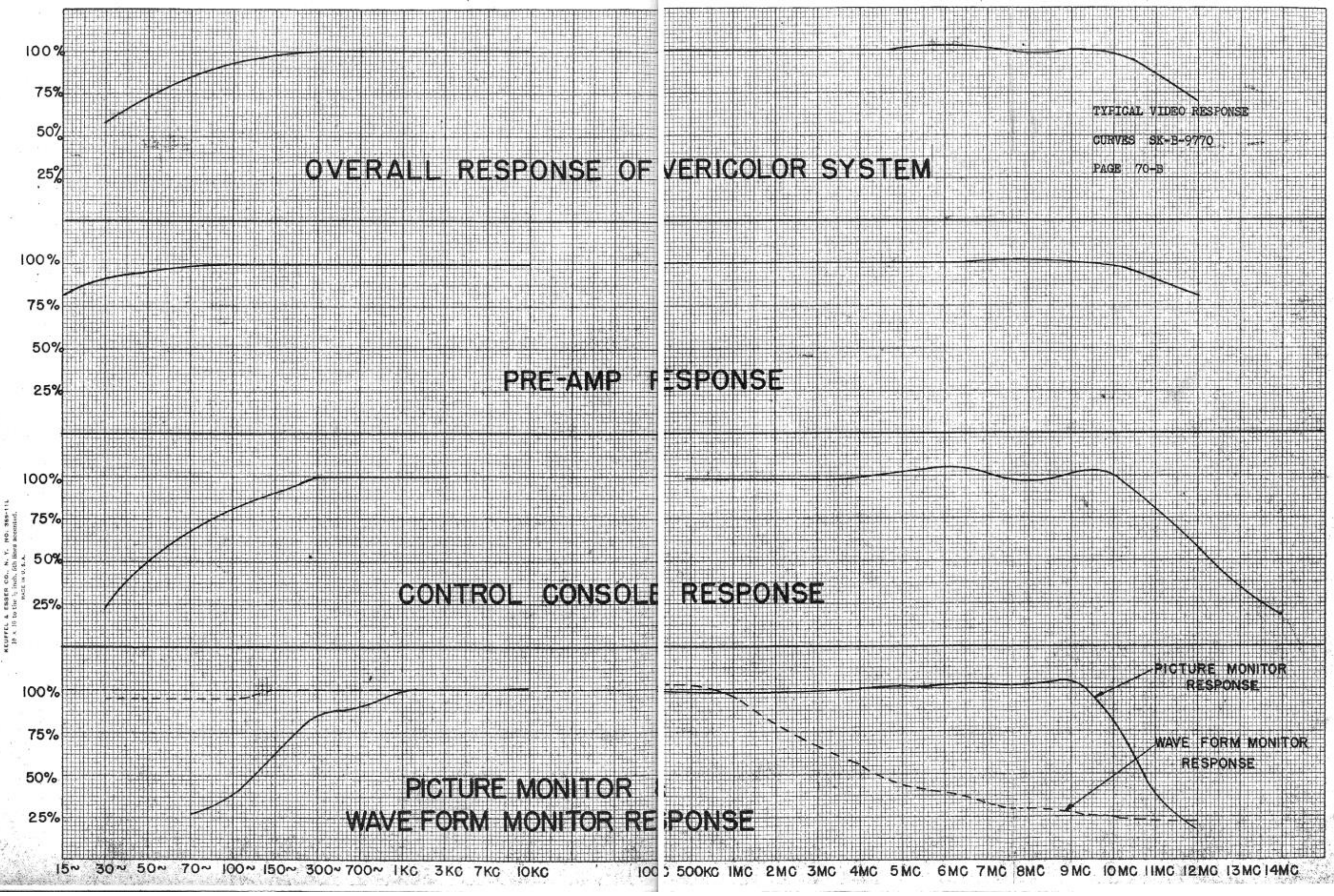
FIG 25



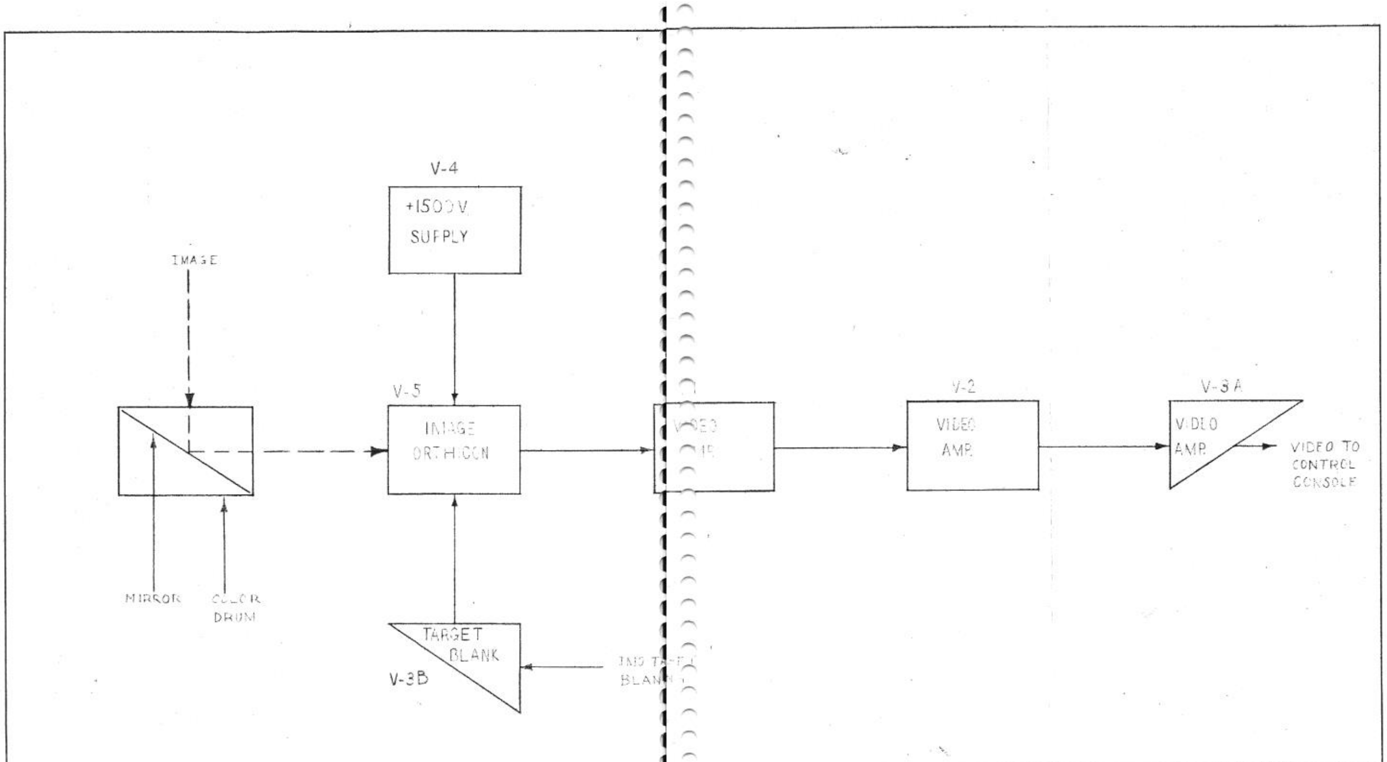
COLOR MONITOR &
IMO SCAN CHASSIS

FIG 26

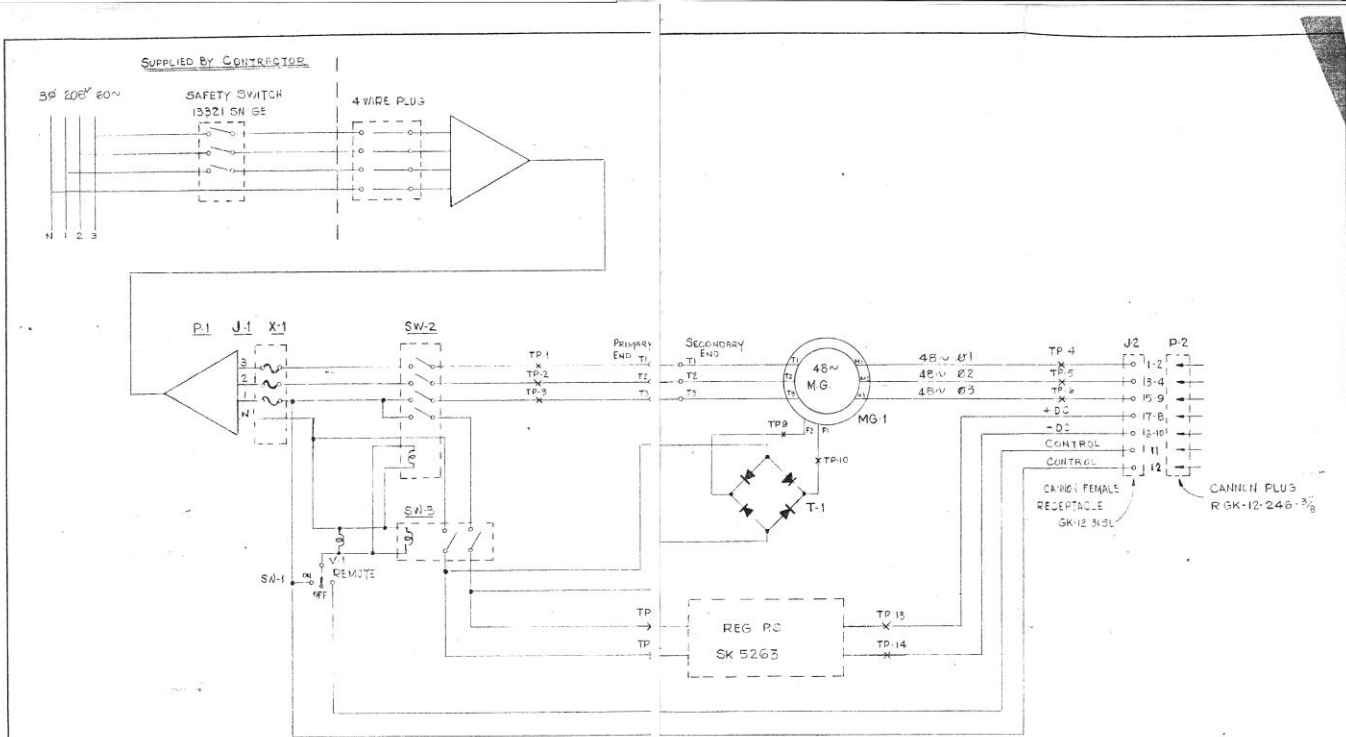
111 B



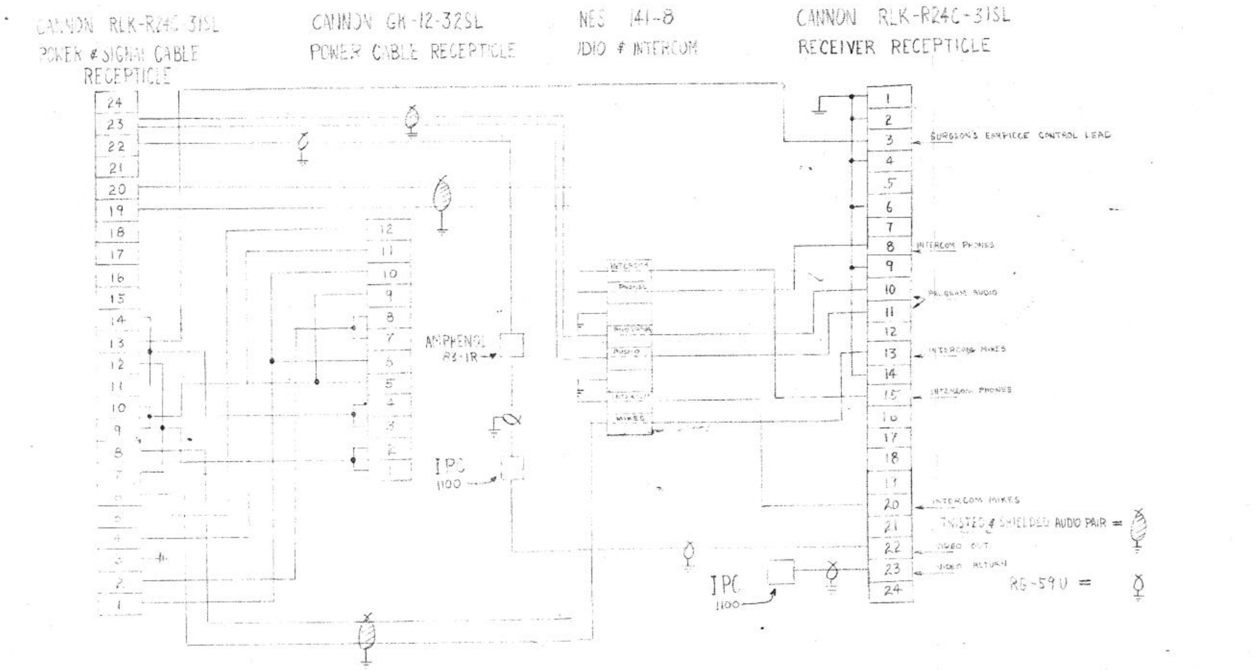
TYPICAL VIDEO RESPONSE
CURVES SK-B-9770
PAGE 70-B
OVERALL RESPONSE OF VERICOLOR SYSTEM
PRE-AMP RESPONSE
CONTROL CONSOLE RESPONSE
PICTURE MONITOR &
WAVE FORM MONITOR RESPONSE
PICTURE MONITOR RESPONSE
WAVE FORM MONITOR RESPONSE
100%
75%
50%
25%
15~ 30~ 50~ 70~ 100~ 150~ 300~ 700~ 1KC 3KC 7KC 10KC
500KC 1MC 2MC 3MC 4MC 5MC 6MC 7MC 8MC 9MC 10MC 11MC 12MC 13MC 14MC



REVISIONS				MATERIAL:	COLUMBIA BROADCASTING SYSTEM INC. 485 MADISON AVE., NEW YORK ENGINEERING RESEARCH & DEVELOPMENT	
NO.	DESCRIPTION	REV. BY	C'K'D BY	FINISH:	TITLE: CAMERA BLOCK DIAGRAM	
				NO. REQD.:	FIRST USED ON SMF-9	
				TOLERANCES DECIMALS ± .003 FRACTIONS ± 1/64 ANGLES ± 1/2° UNLESS OTHERWISE SPECIFIED	DES. J.J.REEVES	C'K'D.
					DWN. W. WEKONY	AP'D.
				SCALE:	DWG. B-S-1214	NEXT ASS'Y



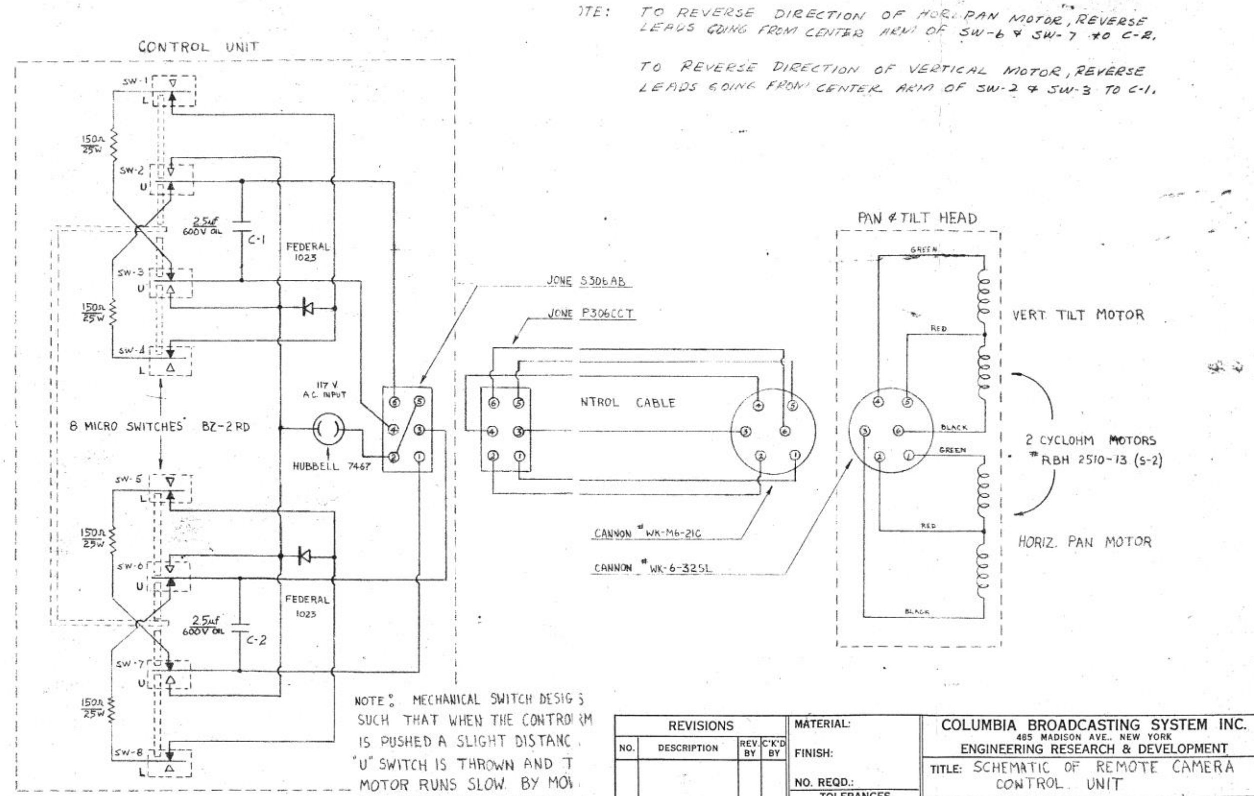
REVISIONS				~~MATERIAL:~~	COLUMBIA BROADCASTING SYSTEM INC. 485 MADISON AVE., NEW YORK ENGINEERING RESEARCH & DEVELOPMENT	
NO.	DESCRIPTION	REV. BY	C'K'D BY	~~FINISH:~~	TITLE: EXTERNAL POWER SUPPLY & CONTROL CIRCUITS	
				~~NO. REQD.:~~	FIRST USED ON SME 9	
				~~TOLERANCES DECIMALS ± .003 FRACTIONS ± 1/64 ANGLES ± 1/2° UNLESS OTHERWISE SPECIFIED~~	DES. J.J.R 6/24/50	C'K'D.
					DWN. JEGLE 9-25-51	AP'D.
				~~SCALE:~~	DWG. B-S-1217	NEXT ASS'Y



REVISIONS				MATERIAL:	COLUMBIA BROADCASTING SYSTEM INC. 485 MADISON AVE., NEW YORK ENGINEERING RESEARCH & DEVELOPMENT	
NO.	DESCRIPTION	REV. BY	C'K'D BY	FINISH:	TITLE: WIRING LAYOUT FOR PORTABLE POWER & SIGNAL DISTRIBUTION BOX	
				NO. REQD.:		
				TOLERANCES DECIMALS ±.003 FRACTIONS ±1/64 ANGLES ±1/2° UNLESS OTHERWISE SPECIFIED	FIRST USED ON SME-9	
					DES. W. J. BALLUS 11/14/51	C'K'D.
					DWN. W. J. BALLUS 11/20/51	AP'D.
				SCALE:	DWG. B- 9814	NEXT ASS'Y

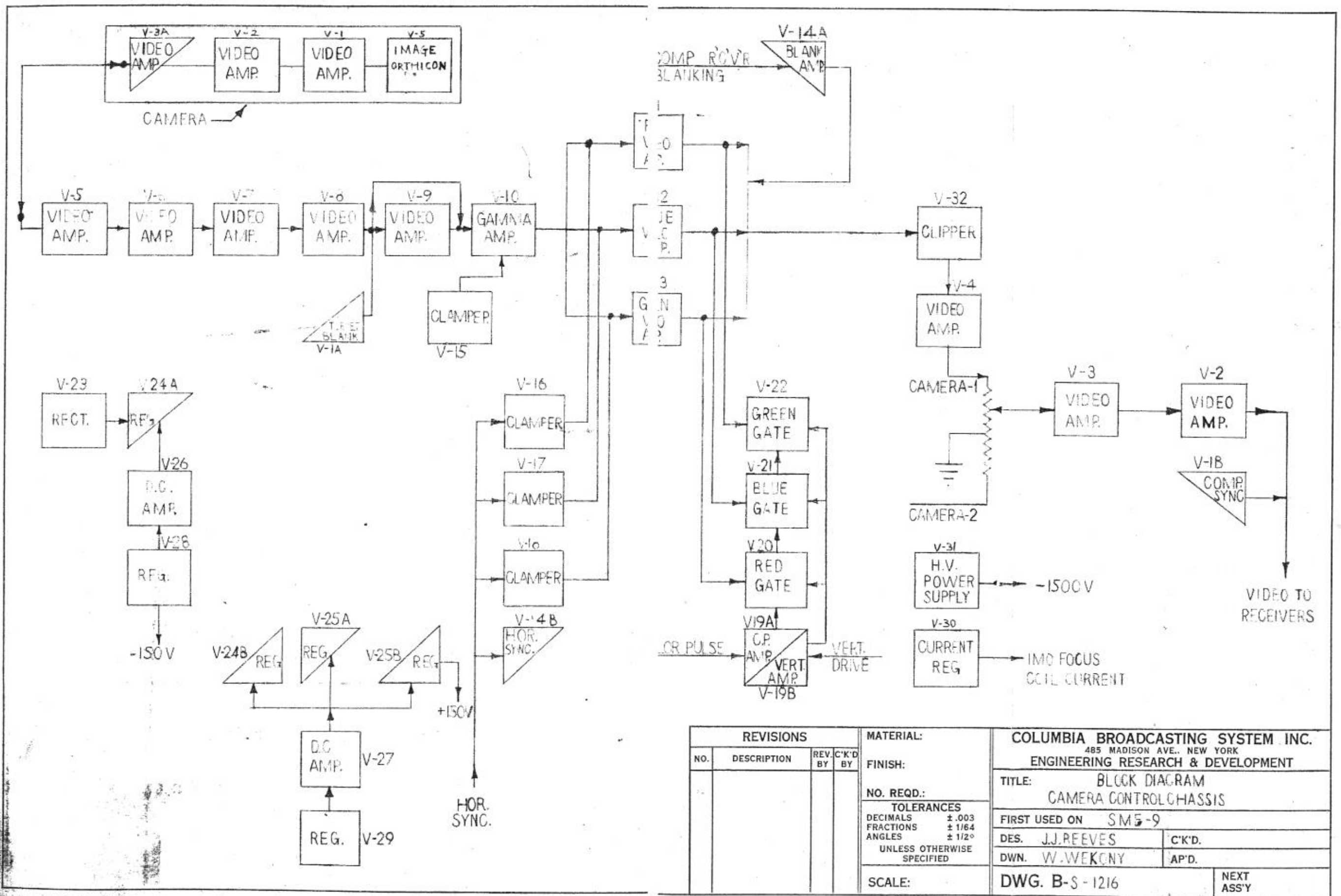
TE: TO REVERSE DIRECTION OF HOR. PAN MOTOR, REVERSE LEADS GOING FROM CENTER ARM OF SW-6 & SW-7 TO C-2.

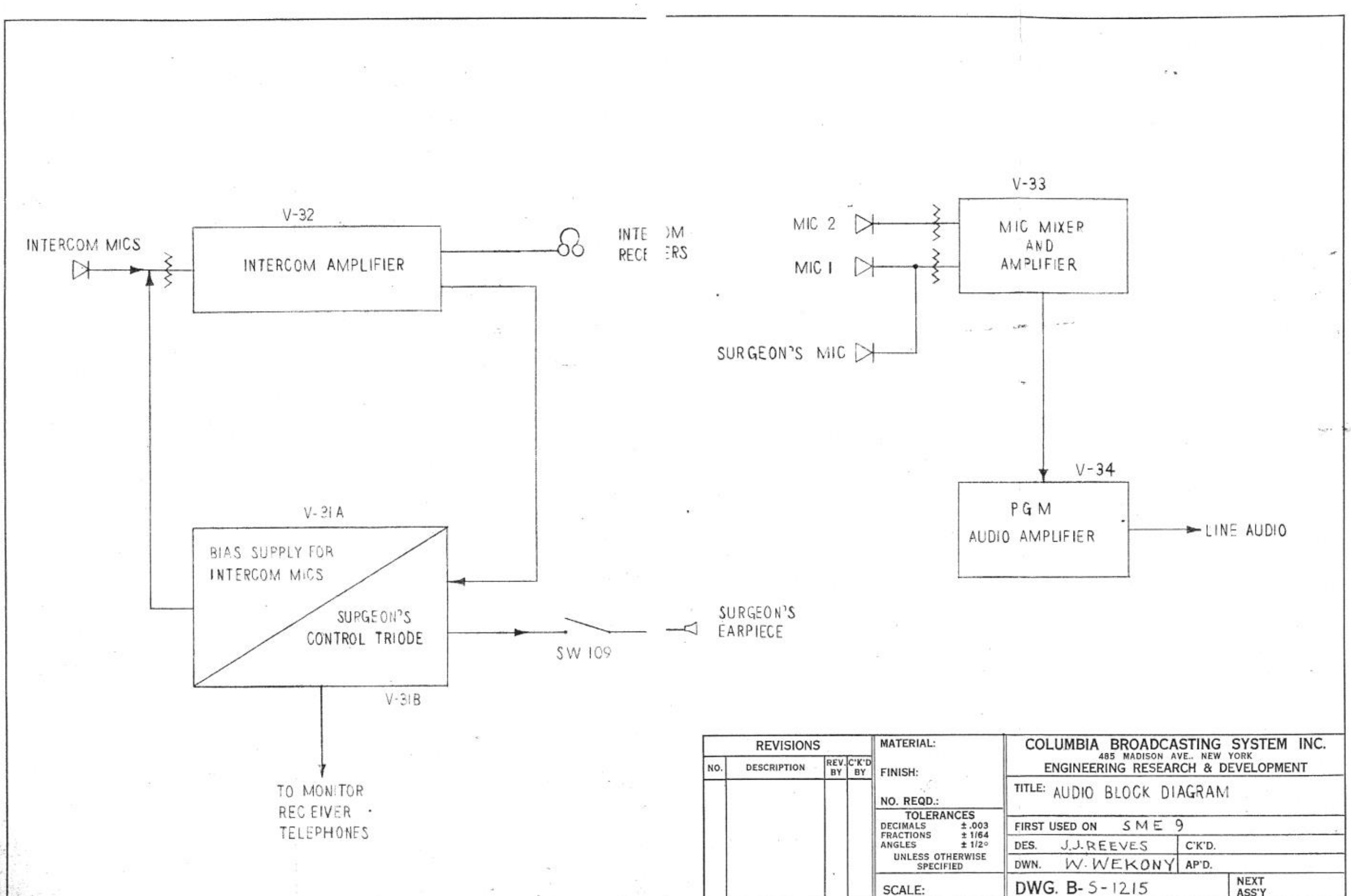
TO REVERSE DIRECTION OF VERTICAL MOTOR, REVERSE LEADS GOING FROM CENTER ARM OF SW-2 & SW-3 TO C-1.

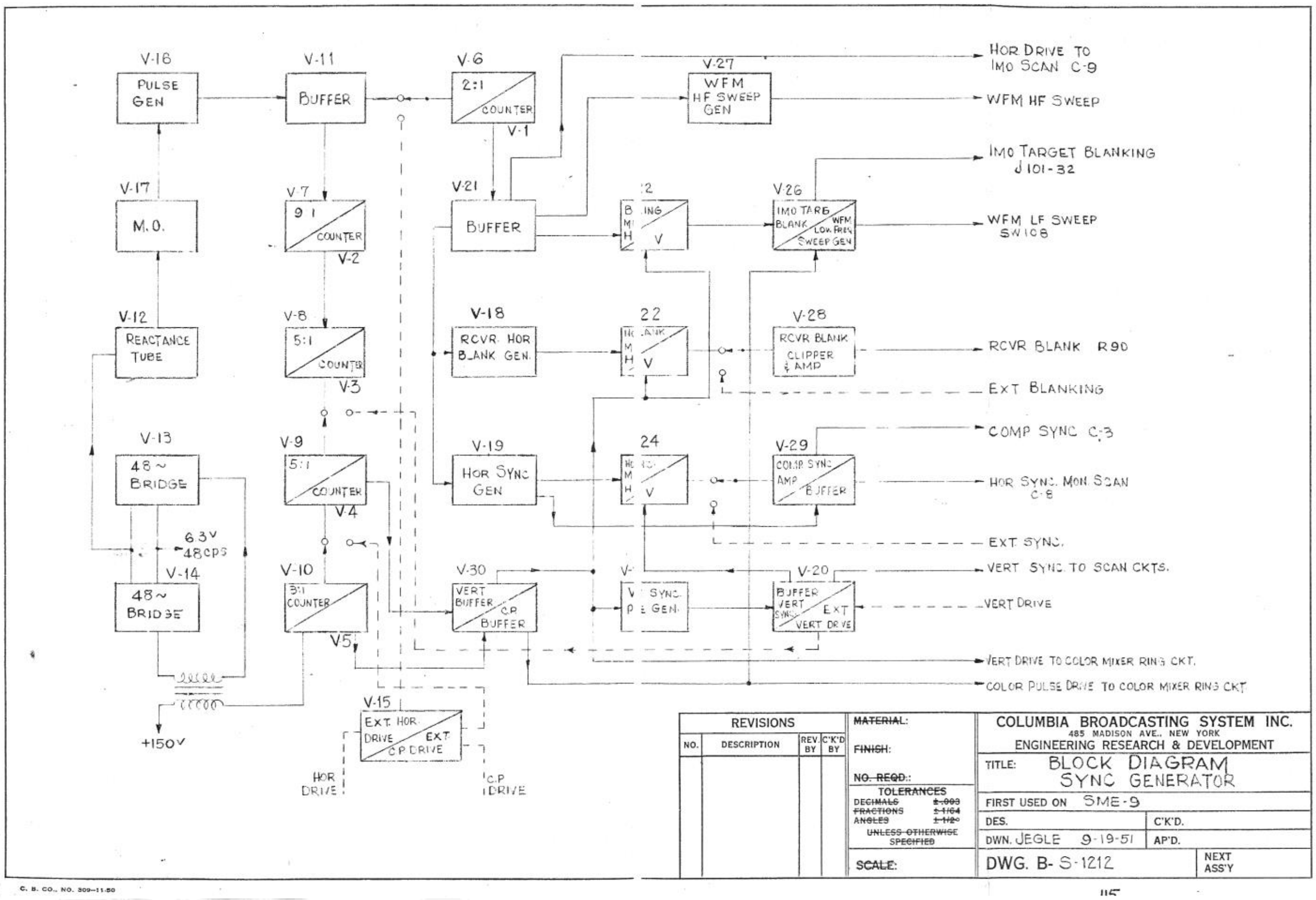


NOTE: MECHANICAL SWITCH DESIG[N]S SUCH THAT WHEN THE CONTRO[L A]RM IS PUSHED A SLIGHT DISTANC[E] "U" SWITCH IS THROWN AND T[HE] MOTOR RUNS SLOW. BY MOV[ING] THE ARM A LITTLE FURTHER "L" SWITCH IS THROWN AND [THE] MOTOR RUNS FASTER

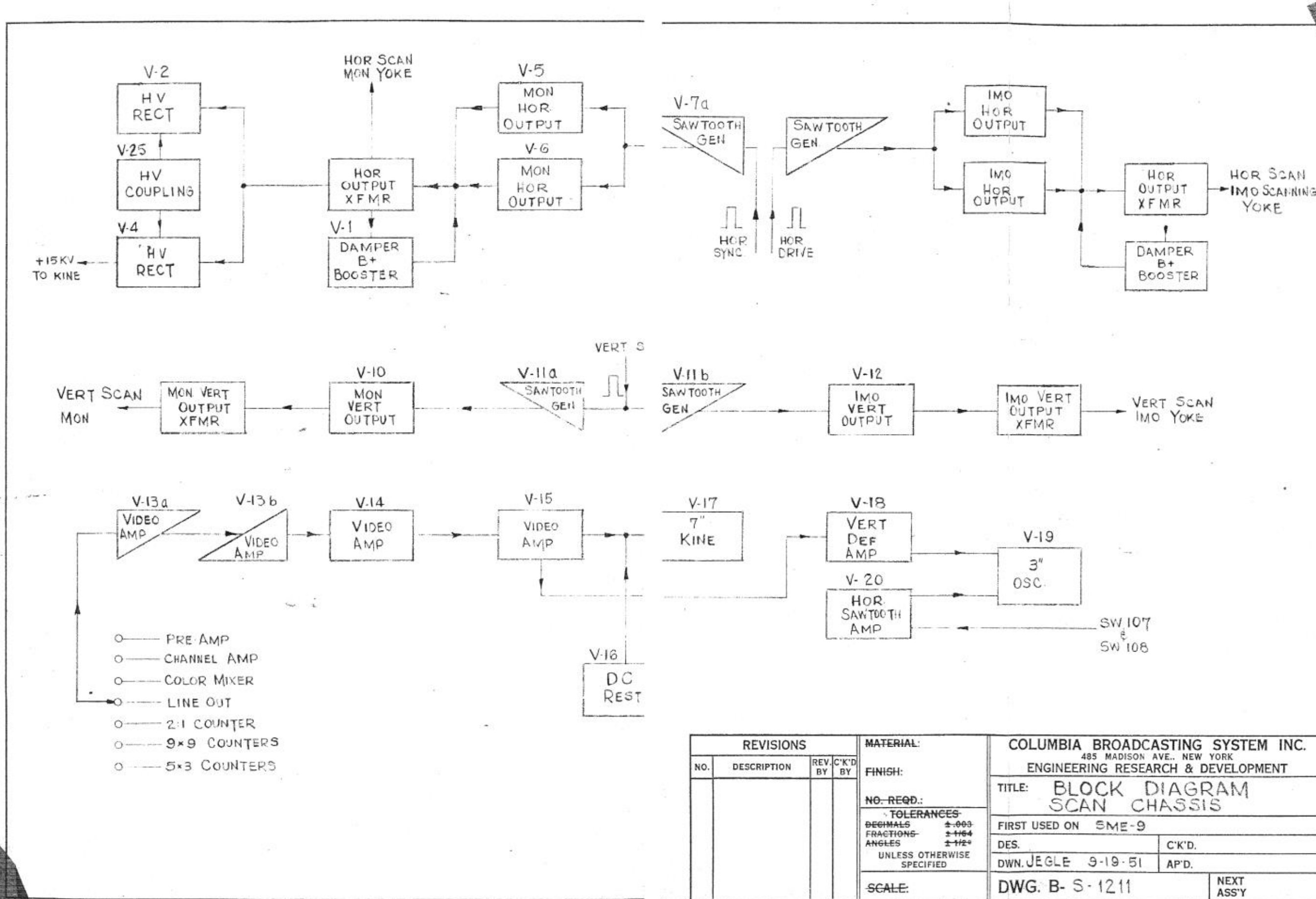
REVISIONS				MATERIAL:	COLUMBIA BROADCASTING SYSTEM INC. 485 MADISON AVE., NEW YORK ENGINEERING RESEARCH & DEVELOPMENT	
NO.	DESCRIPTION	REV. BY	C'K'D BY	FINISH:	TITLE: SCHEMATIC OF REMOTE CAMERA CONTROL UNIT	
				NO. REQD.:		
				TOLERANCES DECIMALS ±.003 FRACTIONS ±1/64 ANGLES ±1/2° UNLESS OTHERWISE SPECIFIED	FIRST USED ON SME-16	
					DES. W.W.C. 12/5/51	C'K'D.
					DWN. WJ.B. 1/24/52	AP'D.
				SCALE:	DWG. B- 9816	NEXT ASS'Y


V-3A VIDEO AMP.
V-2 VIDEO AMP.
V-1 VIDEO AMP.
V-5 IMAGE ORTHICON
CAMERA
COMP. RC'VR BLANKING
V-14A BLANK AMP.
V-5 VIDEO AMP.
VIDEO AMP.
V-7 VIDEO AMP.
V-8 VIDEO AMP.
V-9 VIDEO AMP.
V-10 GAMMA AMP.
V-32 CLIPPER
V-4 VIDEO AMP.
V-1A
CLAMPER V-15
V-23 RECT.
V-24A REG.
V-26 D.C. AMP.
V-28 REG.
-150V
V-16 CLAMPER
V-17 CLAMPER
CLAMPER
V-14B HOR. SYNC.
V-22 GREEN GATE
V-21 BLUE GATE
V-20 RED GATE
V19A C.P. AMP.
VERT. AMP. V-19B
VERT. DRIVE
CAMERA-1
CAMERA-2
V-3 VIDEO AMP.
V-2 VIDEO AMP.
V-1B COMP. SYNC
VIDEO TO RECEIVERS
V-31 H.V. POWER SUPPLY
-1500V
V-30 CURRENT REG.
IMO FOCUS COIL CURRENT
V-24B REG.
V-25A REG.
V-25B REG.
+150V
D.C. AMP. V-27
REG. V-29
HOR. SYNC.
REVISIONS
NO. DESCRIPTION REV. BY C'K'D BY
MATERIAL:
FINISH:
NO. REQD.:
TOLERANCES
DECIMALS ±.003
FRACTIONS ±1/64
ANGLES ±1/2°
UNLESS OTHERWISE SPECIFIED
SCALE:
COLUMBIA BROADCASTING SYSTEM INC.
485 MADISON AVE., NEW YORK
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: BLOCK DIAGRAM CAMERA CONTROL CHASSIS
FIRST USED ON SM5-9
DES. J.J.REEVES C'K'D.
DWN. W.WEKONY AP'D.
DWG. B-S-1216
NEXT ASS'Y

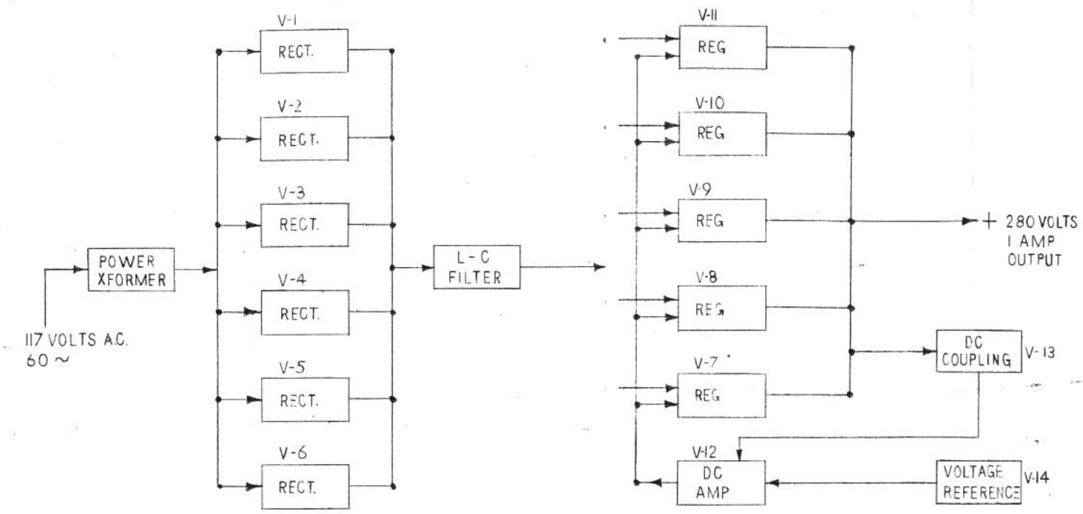

INTERCOM MICS
V-32
INTERCOM AMPLIFIER
V-31A
BIAS SUPPLY FOR INTERCOM MICS
SURGEON'S CONTROL TRIODE
V-31B
TO MONITOR RECEIVER TELEPHONES
SW 109
SURGEON'S EARPIECE
V-33
MIC 2
MIC 1
MIC MIXER AND AMPLIFIER
SURGEON'S MIC
V-34
PGM AUDIO AMPLIFIER
LINE AUDIO
REVISIONS
NO. DESCRIPTION REV. BY C'K'D BY
MATERIAL:
FINISH:
NO. REQD.:
TOLERANCES
DECIMALS ±.003
FRACTIONS ±1/64
ANGLES ±1/2°
UNLESS OTHERWISE SPECIFIED
SCALE:
COLUMBIA BROADCASTING SYSTEM INC.
485 MADISON AVE., NEW YORK
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: AUDIO BLOCK DIAGRAM
FIRST USED ON SME 9
DES. J.J.REEVES C'K'D.
DWN. W.WEKONY AP'D.
DWG. B-S-1215
NEXT ASS'Y



V-16 PULSE GEN
V-11 BUFFER
V-6 2:1 COUNTER V-1
V-27 WFM HF SWEEP GEN
HOR DRIVE TO IMO SCAN C-9
WFM HF SWEEP
IMO TARGET BLANKING J 101-32
V-17 M.O.
V-7 9:1 COUNTER V-2
V-21 BUFFER
V-26 IMO TARG BLANK WFM LOW FREQ SWEEP GEN
WFM LF SWEEP SW 108
V-12 REACTANCE TUBE
V-8 5:1 COUNTER V-3
V-18 RCVR HOR BLANK GEN.
22
V-28 RCVR BLANK CLIPPER & AMP
RCVR BLANK R90
EXT BLANKING
V-13 48~ BRIDGE
V-9 5:1 COUNTER V-4
V-19 HOR SYNC GEN
24
V-29 COMP SYNC AMP BUFFER
COMP SYNC C-3
HOR SYNC MON SCAN C-8
6.3V 48CPS
V-14 48~ BRIDGE
EXT SYNC
V-10 3:1 COUNTER V5
V-30 VERT BUFFER C.P BUFFER
V-20 BUFFER VERT SYNC EXT VERT DRIVE
VERT SYNC TO SCAN CKTS.
VERT DRIVE
VERT DRIVE TO COLOR MIXER RING CKT.
COLOR PULSE DRIVE TO COLOR MIXER RING CKT.
+150V
V-15 EXT. HOR DRIVE EXT C.P DRIVE
HOR DRIVE
C.P DRIVE
REVISIONS
NO. DESCRIPTION REV. BY C'K'D BY
MATERIAL:
FINISH:
NO. REQD.:
TOLERANCES
DECIMALS ±.003
FRACTIONS ±1/64
ANGLES ±1/2°
UNLESS OTHERWISE SPECIFIED
SCALE:
COLUMBIA BROADCASTING SYSTEM INC.
485 MADISON AVE., NEW YORK
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: BLOCK DIAGRAM SYNC GENERATOR
FIRST USED ON SME-9
DES.
C'K'D.
DWN. JEGLE 9-19-51
AP'D.
DWG. B- S-1212
NEXT ASS'Y
C. B. CO., NO. 309-11-50



V-2 HV RECT
V-25 HV COUPLING
V-4 HV RECT
+15KV TO KINE
HOR SCAN MON YOKE
HOR OUTPUT XFMR
V-1 DAMPER B+ BOOSTER
V-5 MON HOR OUTPUT
V-6 MON HOR OUTPUT
V-7a SAWTOOTH GEN
SAWTOOTH GEN
HOR SYNC
HOR DRIVE
IMO HOR OUTPUT
IMO HOR OUTPUT
HOR OUTPUT XFMR
HOR SCAN IMO SCANNING YOKE
DAMPER B+ BOOSTER
VERT SCAN MON
MON VERT OUTPUT XFMR
V-10 MON VERT OUTPUT
V-11a SAWTOOTH GEN
VERT S
V-11b SAWTOOTH GEN
V-12 IMO VERT OUTPUT
IMO VERT OUTPUT XFMR
VERT SCAN IMO YOKE
V-13a VIDEO AMP
V-13b VIDEO AMP
V-14 VIDEO AMP
V-15 VIDEO AMP
V-17 7" KINE
V-18 VERT DEF AMP
V-19 3" OSC.
V-20 HOR SAWTOOTH AMP
SW 107 & SW 108
V-16 DC REST
PRE AMP
CHANNEL AMP
COLOR MIXER
LINE OUT
2:1 COUNTER
9×9 COUNTERS
5×3 COUNTERS
REVISIONS
NO. DESCRIPTION REV. BY C'K'D BY
MATERIAL:
FINISH:
NO. REQD.:
TOLERANCES
DECIMALS ±.003
FRACTIONS ±1/64
ANGLES ±1/2°
UNLESS OTHERWISE SPECIFIED
SCALE:
COLUMBIA BROADCASTING SYSTEM INC.
485 MADISON AVE., NEW YORK
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: BLOCK DIAGRAM SCAN CHASSIS
FIRST USED ON SME-9
DES.
C'K'D.
DWN. JEGLE 9-19-51
AP'D.
DWG. B- S-1211
NEXT ASS'Y
C. B. CO., NO. 309-11-50



REVISIONS			
NO.	DESCRIPTION	REV. BY	C'K'D BY

MATERIAL:

FINISH:

NO. REQD.:

TOLERANCES
DECIMALS ± .003
FRACTIONS ± 1/64
ANGLES ± 1/2°
UNLESS OTHERWISE SPECIFIED

SCALE:

COLUMBIA BROADCASTING SYSTEM INC.
485 MADISON AVE., NEW YORK
ENGINEERING RESEARCH & DEVELOPMENT

TITLE: BLOCK DIAGRAM
REGULATED POWER SUPPLY

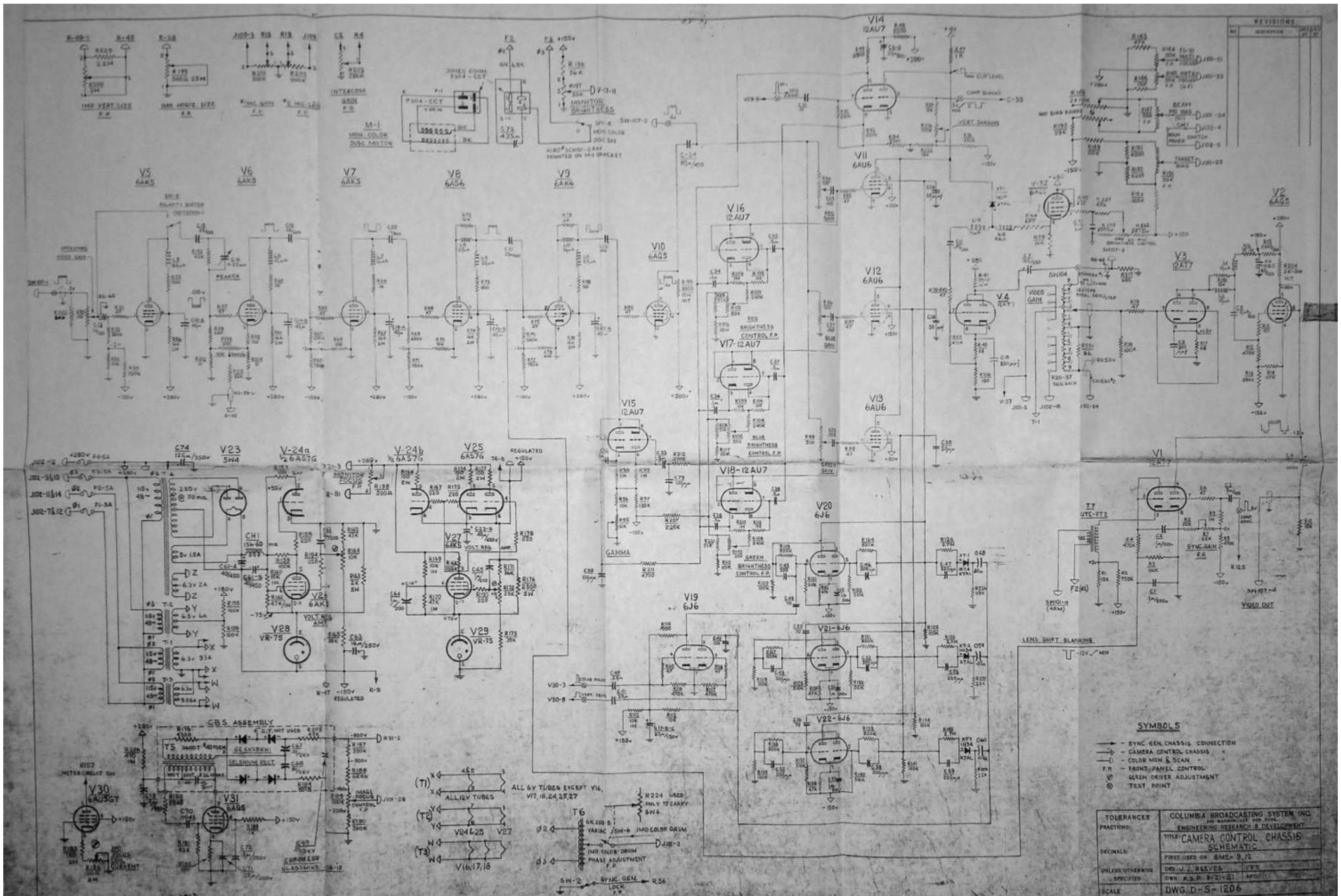
FIRST USED ON SME-9

DES. R. CASTRIGNANO C'K'D.

DWN. W. WEKONY AP'D.

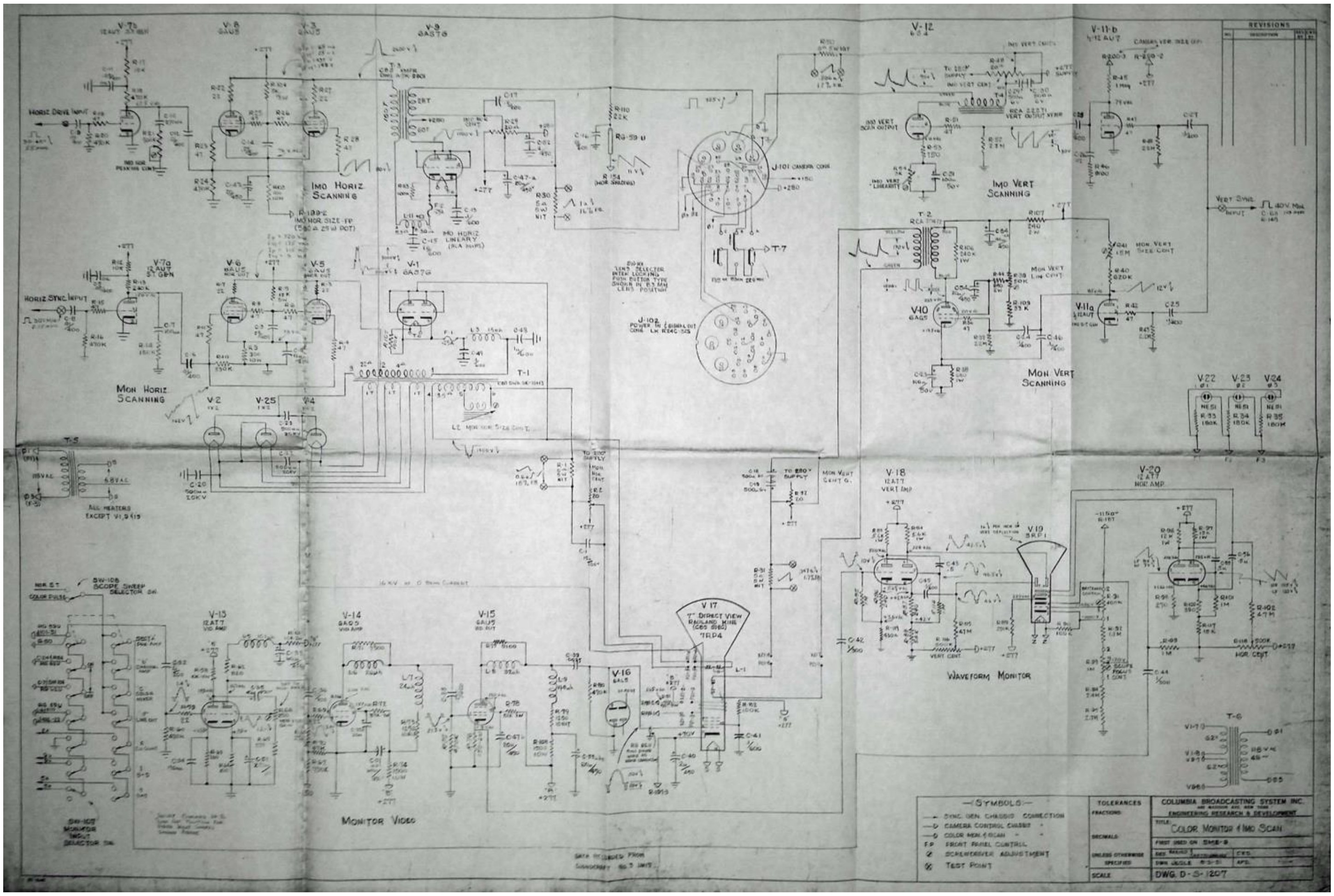
DWG. B-S-1213 NEXT ASS'Y

C. B. CO., NO. 309-11-50

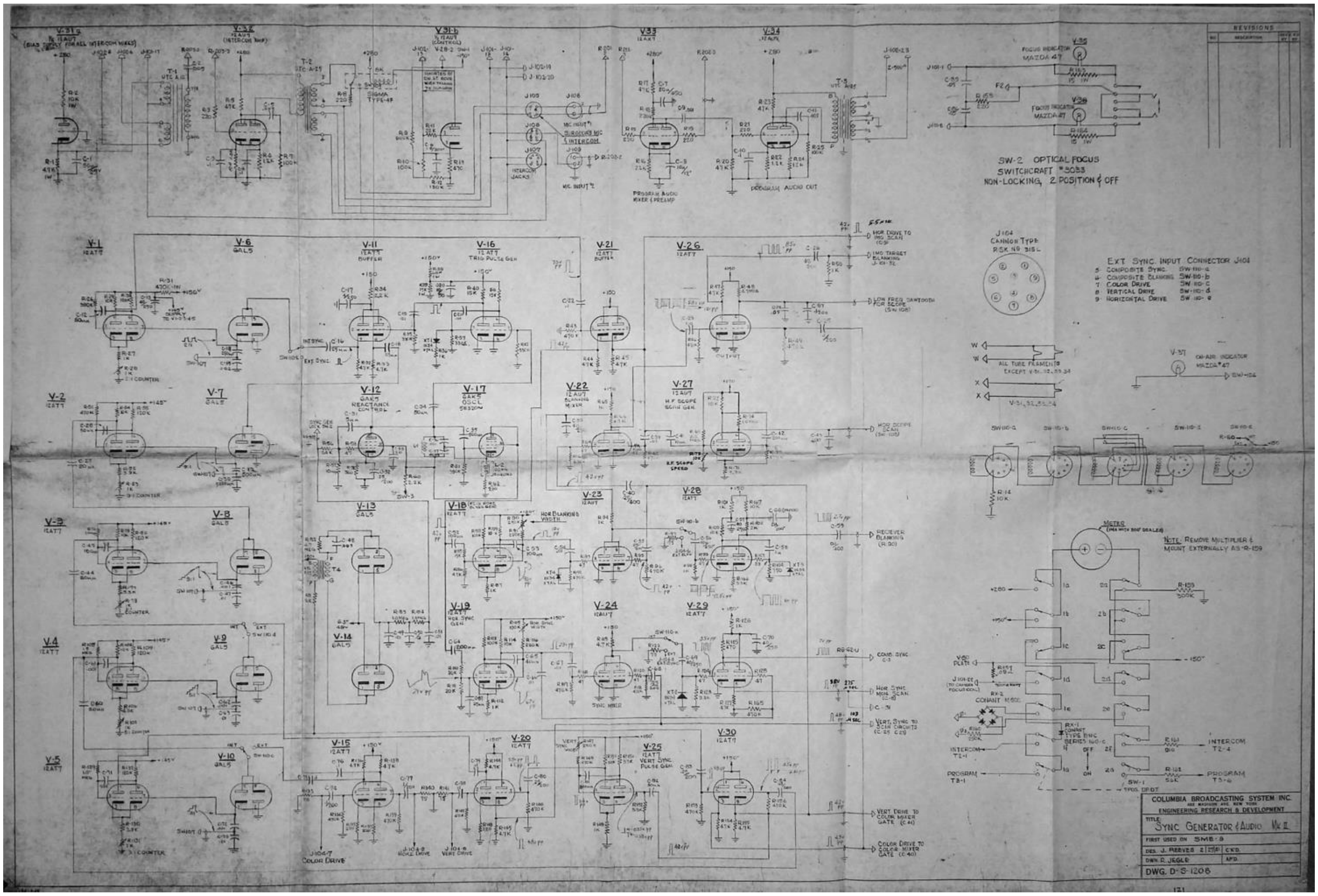


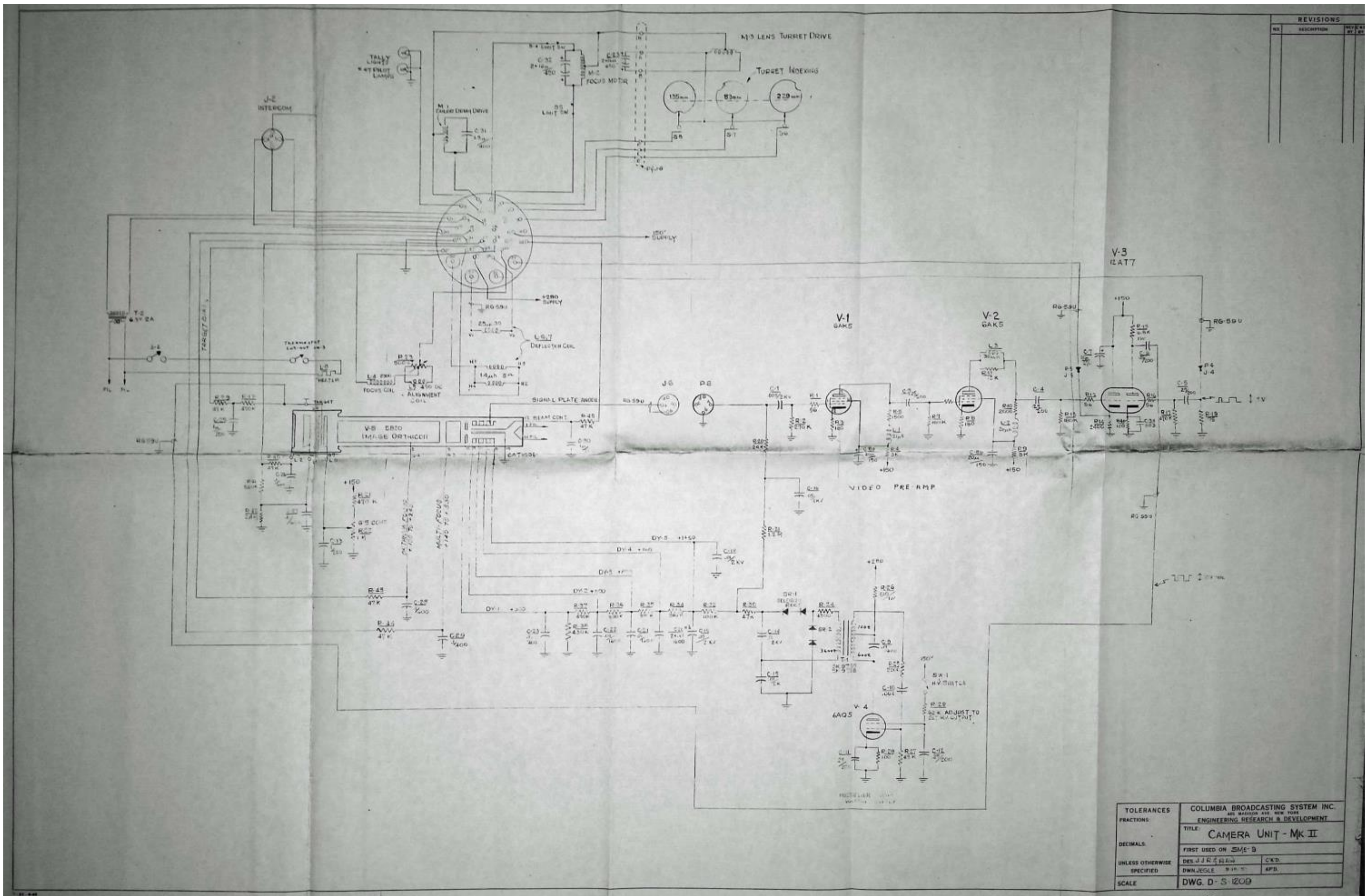
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
V16
V17-12AU7
V18-12AU7
V19
V20
V21-6J6
V22-6J6
V23
V28
V29
V30
V31
GBS ASSEMBLY
GAMMA
LENS SHIFT BLANKING
VIDEO OUT
SYMBOLS
- SYNC GEN. CHASSIS CONNECTION
- CAMERA CONTROL CHASSIS
- COLOR MON. & SCAN
F.P. - FRONT PANEL CONTROL
SCREW DRIVER ADJUSTMENT
TEST POINT
TOLERANCES
FRACTIONS
DECIMALS
UNLESS OTHERWISE SPECIFIED
SCALE
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: CAMERA CONTROL CHASSIS SCHEMATIC
FIRST USED ON SME- 9,12
DRN. J.J. REEVES
CKD.
APD.
DWG. D-S-1206

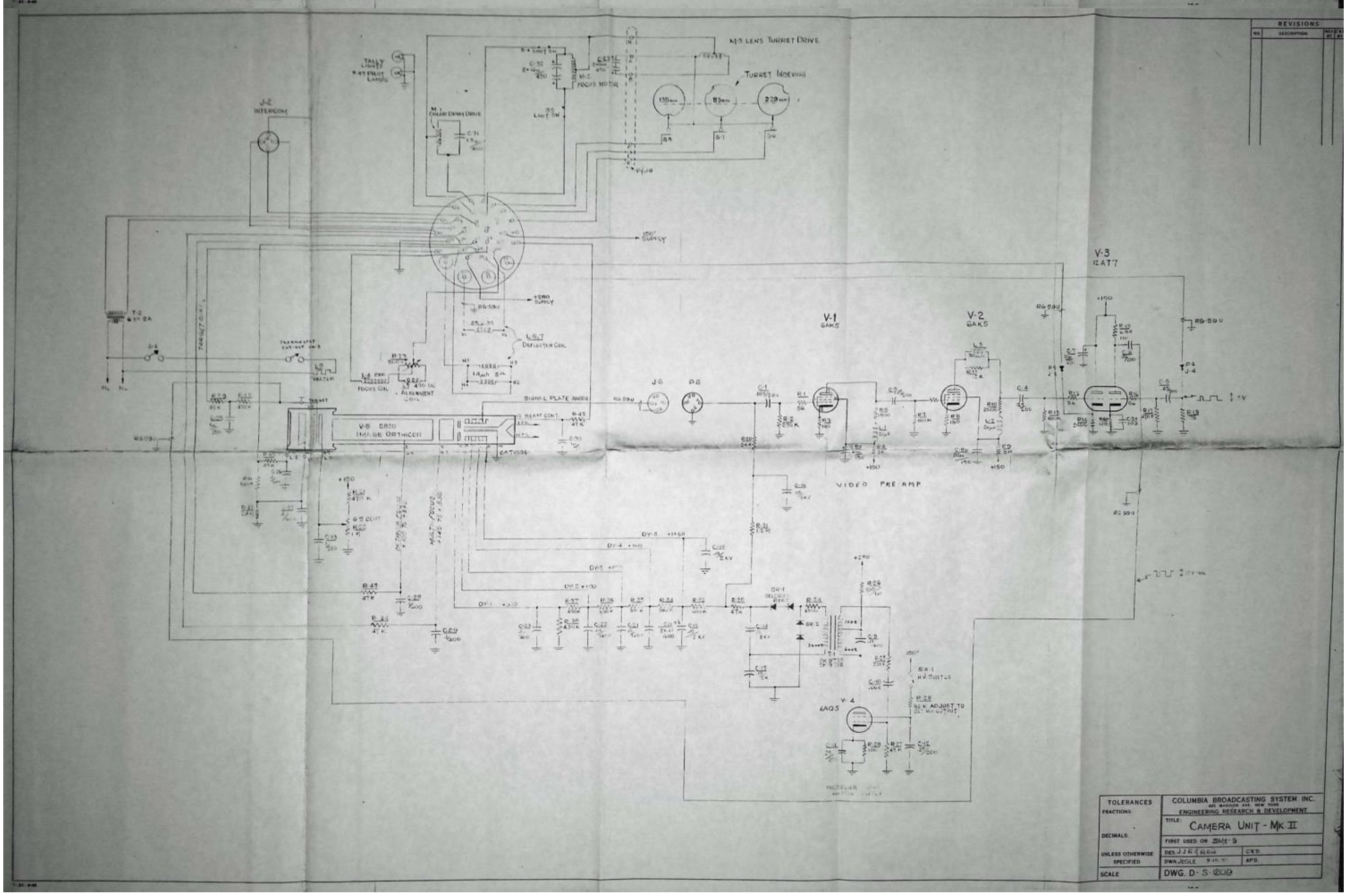
119

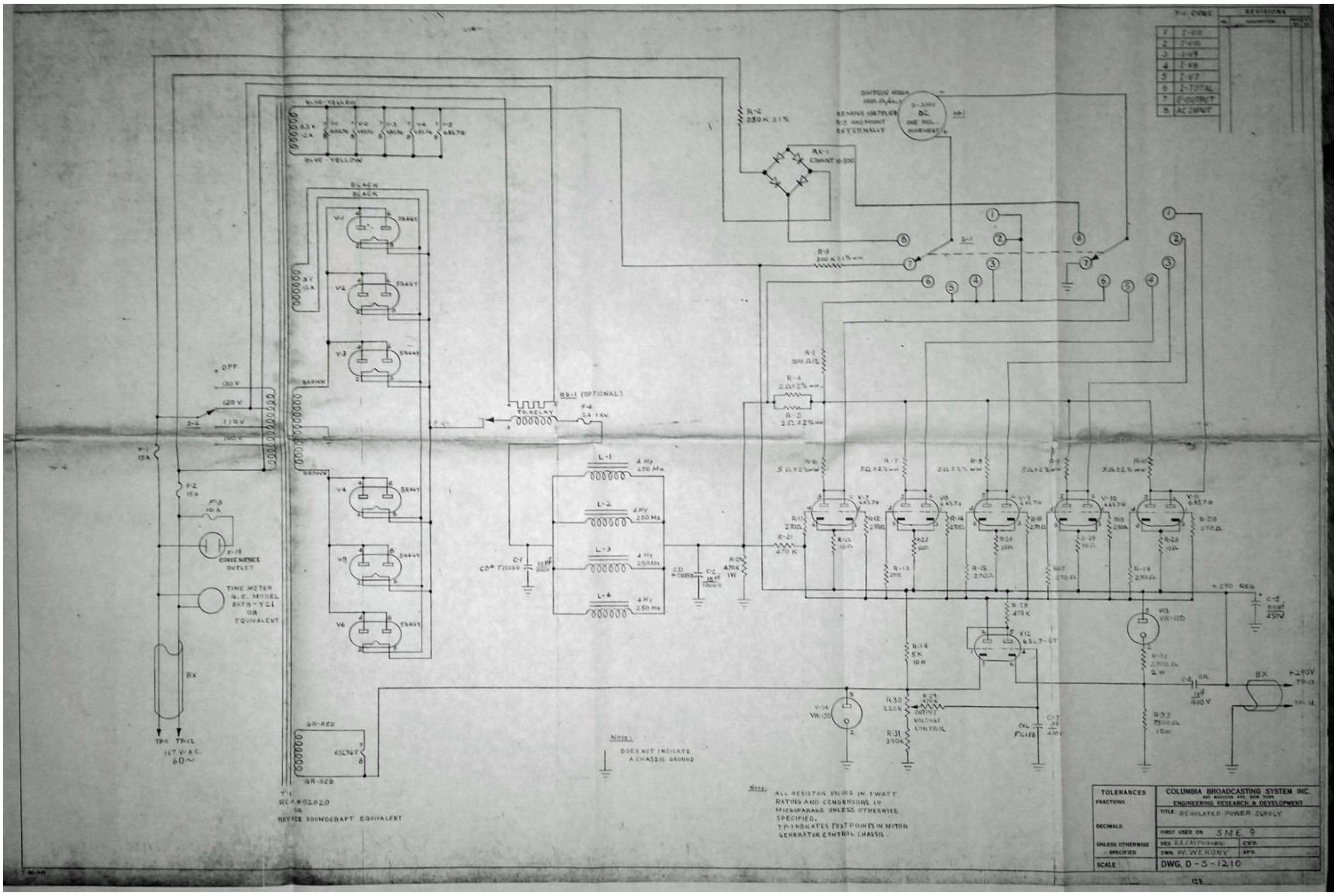


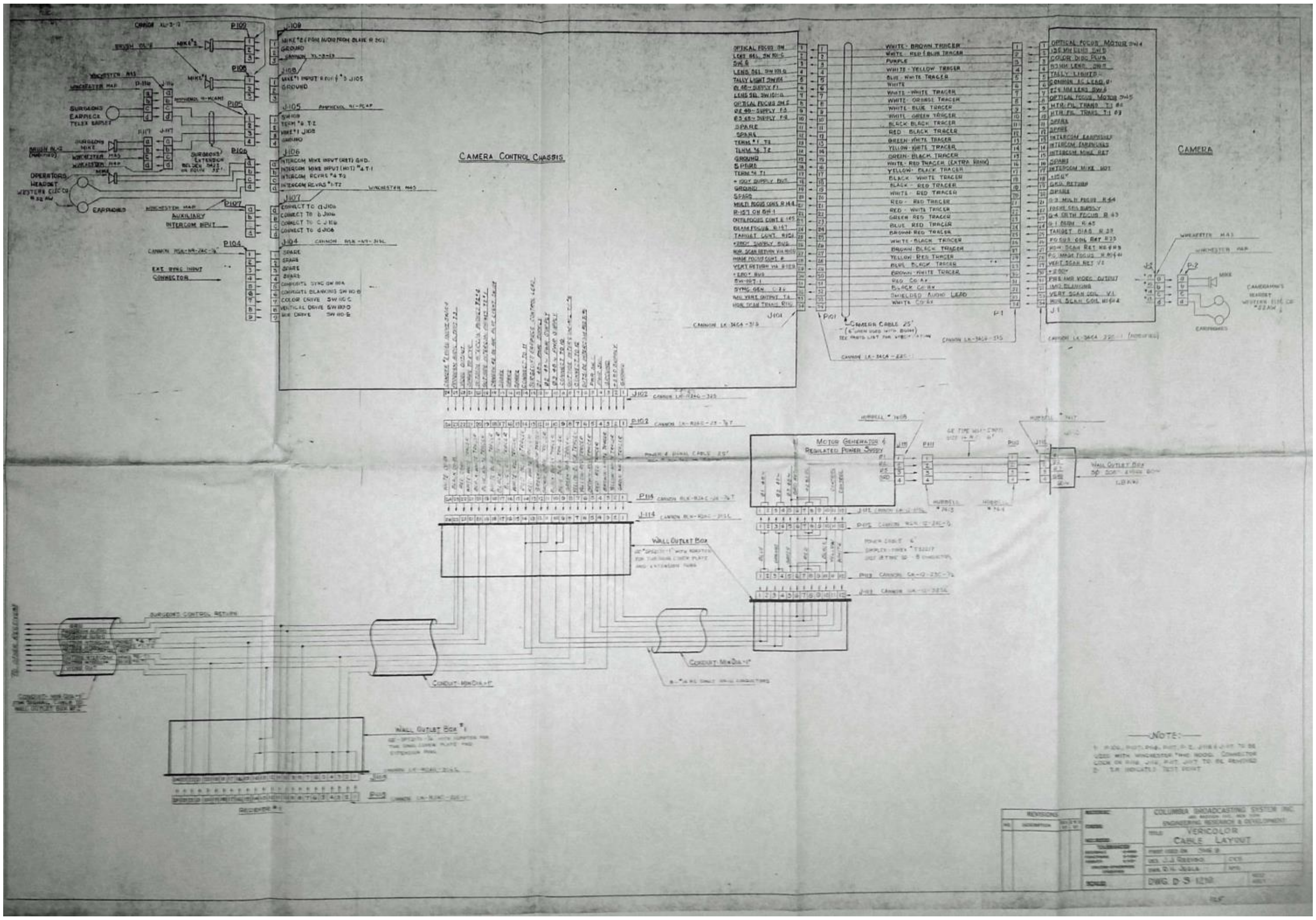
V-7b
V-8
V-3
V-9
V-12
V-11-b
Horiz Drive Input
Imo Horiz Scanning
Imo Vert Scanning
J-101 Camera Conn.
J-102
V-1
T-1
T-2
T-7
Vert Sync Input
Horiz Sync Input
Mon Horiz Scanning
Mon Vert Scanning
V-2
V-25
V-4
V-10
V-11a
V-22
V-23
V-24
T-5
All heaters except V1, 2 & 13
V-18
V-19
V-20
Waveform Monitor
V-13
V-14
V-15
V-16
V 17
Monitor Video
T-6
—SYMBOLS—
SYNC GEN CHASSIS CONNECTION
CAMERA CONTROL CHASSIS
COLOR MON. & SCAN
F.P. FRONT PANEL CONTROL
SCREWDRIVER ADJUSTMENT
TEST POINT
TOLERANCES
FRACTIONS
DECIMALS
UNLESS OTHERWISE SPECIFIED
SCALE
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: COLOR MONITOR & IMO SCAN
FIRST USED ON SMS-9
DWG. D-S-1207


SW-2 OPTICAL FOCUS
SWITCHCRAFT #3033
NON-LOCKING, 2 POSITION & OFF
EXT SYNC INPUT CONNECTOR J104
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE: SYNC GENERATOR & AUDIO MK II
FIRST USED ON SMB-9
DES. J. REEVES
DWN R. JEGLE
CK'D.
AP'D.
DWG. D-S-1208


REVISIONS
M-3 LENS TURRET DRIVE
TURRET INDEXING
J-2
INTERCOM
V-1
6AK5
V-2
6AK5
V-3
12AT7
V-4
6AQ5
V-8 5820
IMAGE ORTHICON
SIGNAL PLATE ANODE
CATHODE
+150
+280 SUPPLY
VIDEO PRE-AMP
FOCUS MOTOR
DEFLECTION COIL
FOCUS COIL
ALIGNMENT COIL
TOLERANCES
FRACTIONS
DECIMALS
UNLESS OTHERWISE SPECIFIED
SCALE
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE
CAMERA UNIT - MK II
DWG. D-S-209


REVISIONS
M-3 LENS TURRET DRIVE
TURRET INDEXING
J-2
INTERCOM
V-1
6AK5
V-2
6AK5
V-3
12AT7
V-4
6AQ5
V-8 5820
IMAGE ORTHICON
SIGNAL PLATE ANODE
CATHODE
+150
+280 SUPPLY
VIDEO PRE-AMP
FOCUS MOTOR
DEFLECTION COIL
FOCUS COIL
ALIGNMENT COIL
TOLERANCES
FRACTIONS
DECIMALS
UNLESS OTHERWISE SPECIFIED
SCALE
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE
CAMERA UNIT - MK II
DWG. D-S-209


NOTE:
DOES NOT INDICATE
A CHASSIS GROUND
NOTE:
ALL RESISTOR VALUES IN 1 WATT
RATING AND CONDENSORS IN
MICROFARADS UNLESS OTHERWISE
SPECIFIED.
TP-INDICATES TEST POINTS IN MOTOR
GENERATOR CONTROL CHASSIS.
TIME METER
G.E. MODEL
8KT8-YG1
OR
EQUIVALENT
CONVENIENCE
OUTLET
117 V-A.C.
60~
OUTPUT
VOLTAGE
CONTROL
RX-1 (OPTIONAL)
REGULATED POWER SUPPLY
TOLERANCES
FRACTIONS
DECIMALS
UNLESS OTHERWISE
SPECIFIED
SCALE
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE REGULATED POWER SUPPLY
FIRST USED ON SNE 9
DWN. W. WEKONY
CKD.
APD.
DWG. D-3-1210
123


CAMERA CONTROL CHASSIS
CAMERA
CAMERA CABLE 25'
MOTOR GENERATOR & REGULATED POWER SUPPLY
WALL OUTLET BOX
WALL OUTLET BOX #1
CONDUIT
NOTE:
REVISIONS
COLUMBIA BROADCASTING SYSTEM INC.
ENGINEERING RESEARCH & DEVELOPMENT
TITLE VERICOLOR
CABLE LAYOUT
DWG. D-S-1210