1848
ICONOSCOPE

For use in portable television cameras

Heater	Coated Unipotential Cathode	
Voltage	6.3	a-c or d-c volts
Current	0.6	amp.
Deflection		Magnetic
Type of Pickup		Direct
Direct Interelectrode Capacitance:		
Signal Plate to Collector & Anode No.2 (with external shielding)	10 approx.	μμf
Control Grid to All Other Electrodes	12 max.	μμf
Dimensions		See *Outline Drawing*
Caps (two)		Small Metal
Base		Dwarf Metal Shell Octal 8-Pin

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

High-Voltage Electrode (Anode No.2) & Collector Voltage	1200 max.■	volts
Accelerating Electrode (Grid No.2) Voltage	1200 max.■	volts
Focusing Electrode (Anode No.1) Voltage	400 max.■	volts
Control Electrode (Grid No.1) Voltage	Never Positive	
Grid No.1 Volt. for Current Cut-Off	-50 approx.	volts
Anode No.2 & Collector Current *	0.5 max.■	μamp.
Ambient Temperature	40 max.	°C
Typical Operation:		
Heater Voltage °	6.3	volts
Anode No.2 & Collector Voltage	1000	volts
Grid No.2 Voltage	1000	volts
Anode No.1 Voltage ●	300 approx.	volts
Grid No.1 Voltage ▲ #	-40 approx.	volts
Anode No.2 & Collector Current *	0.1 approx.	μamp.

■ Design maximum for 117-volt line.
* When this current is measured, the mosaic should not be illuminated.
° The cathode should be connected to one side or, preferably, to the mid-tap of the heater winding.
▲ Should be adjusted and set at largest negative value which will provide sufficient video output.
\# Maximum d-c resistance in the grid circuit should not exceed 1 megohm.
● Should be adjusted and set at value giving best focus.

NOTE: Signal plate-to-collector impedance is a function of bias light, image brilliance, and beam current, and is in the order of a few megohms for normal operation. Normal beam current is in the order of 0.25 microampere.

The signal-plate resistive load should be approximately one-tenth of the signal plate-to-collector impedance if constant signal output without phase shift is required in all frequencies of the picture signal.

A practical design value of signal-plate load impedance is in the order of 0.1 to 0.5 megohm. With low values of load resistance, gain and signal output-to-noise ratio are low. With high values, gain and signal output-to-noise ratio are increased. In either case, the low video frequencies are over-emphasized and must be equalized by a video stage having low low-frequency gain.

Signal output current varies with beam current, illumination level, and bias lighting, but is in the order of 0.15 microampere peak to peak. Good operation can be obtained with a highlight illumination level on the mosaic in the order of 7 foot-candles.

The spectral sensitivity of the 1848 is adjusted for outdoor pickup.

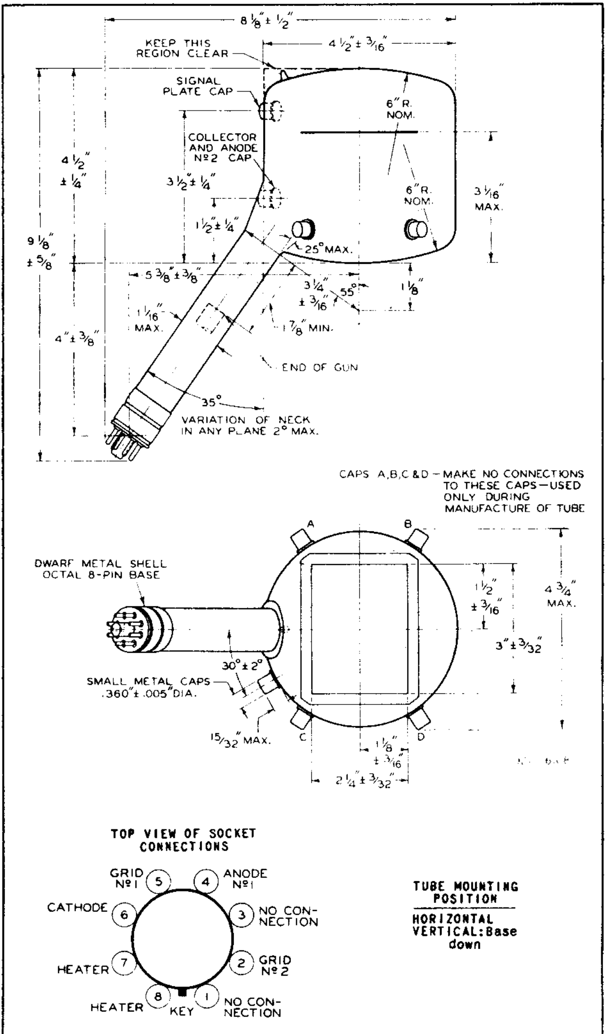
The d-c resistance in the signal-plate circuit should be limited to one megohm.

RCA RADIOTRON DIVISION
RCA MANUFACTURING COMPANY, INC.

1848

1848

ICONOSCOPE



TUBE MOUNTING POSITION

HORIZONTAL
VERTICAL: Base down

April 15, 1940 — 92C-6108

1850-A

ICONOSCOPE

FOR PICKUP FROM MOTION-PICTURE FILM OR SLIDES

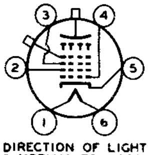
DATA

General:

Heater, for Unipotential Cathode:			
Voltage	6.3 ± 10%	ac or dc volts	
Current	0.6	amp	
Direct Interelectrode Capacitances (Approx.):			
Grid No.1 to All Other Electrodes	6.5	$\mu\mu$f	
Signal Electrode to Grid No.4[o]	10	$\mu\mu$f	
Mosaic, Photosensitive:			
Response		See Curve	
Useful Size of Rectangular Image (4 x 3 Aspect Ratio)		5.75" max. diagonal	←
Focusing Method		Electrostatic	
Deflection Method		Magnetic	
Deflection Angle (Approx.)		55°	←
Max. Width of Mounted Tube		8-1/8"	
Height of Mounted Tube		10-3/16" ± 3/4"	
Depth of Mounted Tube		12-13/16" ± 3/4"	
Mounting Position		Mosaic in vertical plane	
Minimum Deflecting-Coil Inside Diameter		1-1/2"	←
Maximum Deflecting-Coil Length		2-1/4"	←
Caps (Two)		Medium (JETEC No.C1-5)	
Base		Long Medium-Shell Small 6-Pin	

BOTTOM VIEW

Pin 1 - Heater
Pin 2 - Grid No.2
Pin 3 - Grid No.3
Pin 4 - Grid No.1
Pin 5 - Cathode
Pin 6 - Heater



DIRECTION OF LIGHT IS NORMAL TO MOSAIC

Caps { See Outline Drawing
S_J - Signal Electrode
G_4 - Grid No.4 (Collector)

Maximum Ratings, ***Absolute Values:***

AVERAGE MOSAIC ILLUMINATION[●]	50 max.	ft-c	←
OPERATING TEMPERATURE OF BULB AT LARGE END OF TUBE	40 max.	°C	←
SIGNAL-ELECTRODE VOLTAGE	1200 max.	volts	
GRID-No.4 (COLLECTOR) VOLTAGE	1200 max.	volts	
GRID-No.3 VOLTAGE	450 max.	volts	
GRID-No.2 VOLTAGE	1200 max.	volts	
GRID-No.1 VOLTAGE:			
Negative bias value	125 max.	volts	
Positive bias value	0 max.	volts	
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	125 max.	volts	
Heater positive with respect to cathode	10 max.	volts	
GRID-No.4 CURRENT	0.5 max.	μamp	

[o] With external shield.
[●] Averaged over any interval of 1 sec. max.

← Indicates a change.

TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

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Typical Operation and Characteristics:

Signal-Electrode Voltage	1000	volts
Grid-No.4 Voltage.	1000	volts
Grid-No.3 Voltage (Beam Focus)— 24% to 36% of Grid-No.4 Voltage. . . .	240 to 360	volts
Grid-No.2 Voltage.	1000	volts
→ Max. Grid-No.1 Voltage for Pattern Cutoff— 7% of Grid-No.4 Voltage . . .	-70	volts
→ Grid-No.4 Current (With no illumination on mosaic)*. . .	0.1 to 0.2	μamp
External Load Resistance	0.1	megohm
→ Illumination on Mosaic:		
Steady Highlight Value for Slides. . .	4 to 6	ft-c
Average Pulsed Highlight Value for Motion-Picture Film.	10 to 20	ft-c
→ Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.). .	100	
→ Minimum Peak-to-Peak Blanking Voltage. .	20	volts
→ Deflecting-Coil Current (Approx.):**		
Horizontal (Peak to peak).	600	ma
Vertical (Peak to peak).	140	ma

Maximum Circuit Values:

Grid-No.1-Circuit Resistance	1.0 max.	megohm

* Allowance should be made for leakage currents.

** For RCA Deflecting Yoke No.201D76.

→ Indicates a change.

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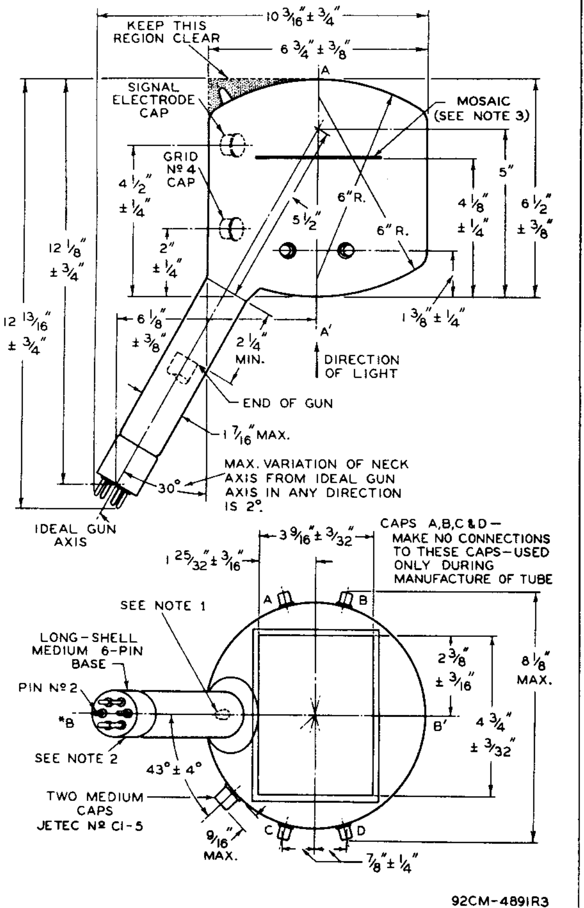
ICONOSCOPE



* BB' IS THE PLANE THROUGH THE BULB AXIS AA' AND THE IDEAL GUN AXIS.

← Indicates a change.

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NOTE 1: VARIATION OF TIP CENTER FROM PLANE BB' IS 1/2".

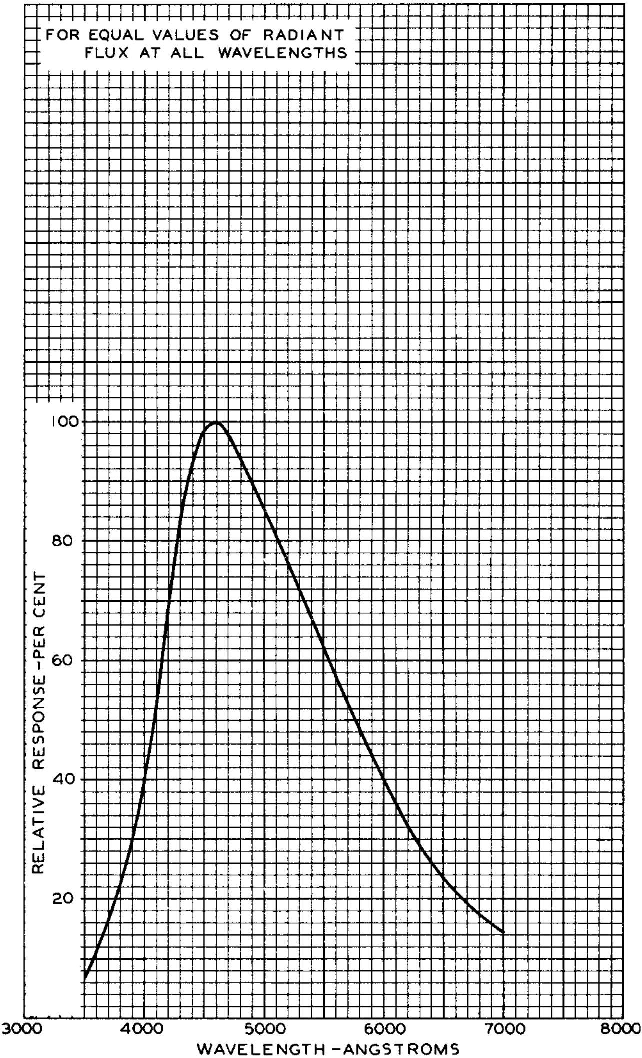
NOTE 2: MAXIMUM ROTATION OF LINE THROUGH PINS 2 AND 5 ABOUT IDEAL GUN AXIS IS ± 10°, MEASURED FROM PLANE BB'.

NOTE 3: DEVIATION OF PLANE OF MOSAIC FROM PLANE PERPENDICULAR TO THE BULB AXIS AA' IS 2.5° MAX. ROTATION OF MOSAIC ABOUT THE BULB AXIS AA' WITH RESPECT TO A LINE OF INTERSECTION FORMED BY MOSAIC PLANE AND PLANE BB' IS 2.5° MAX.

RCA

1850-A

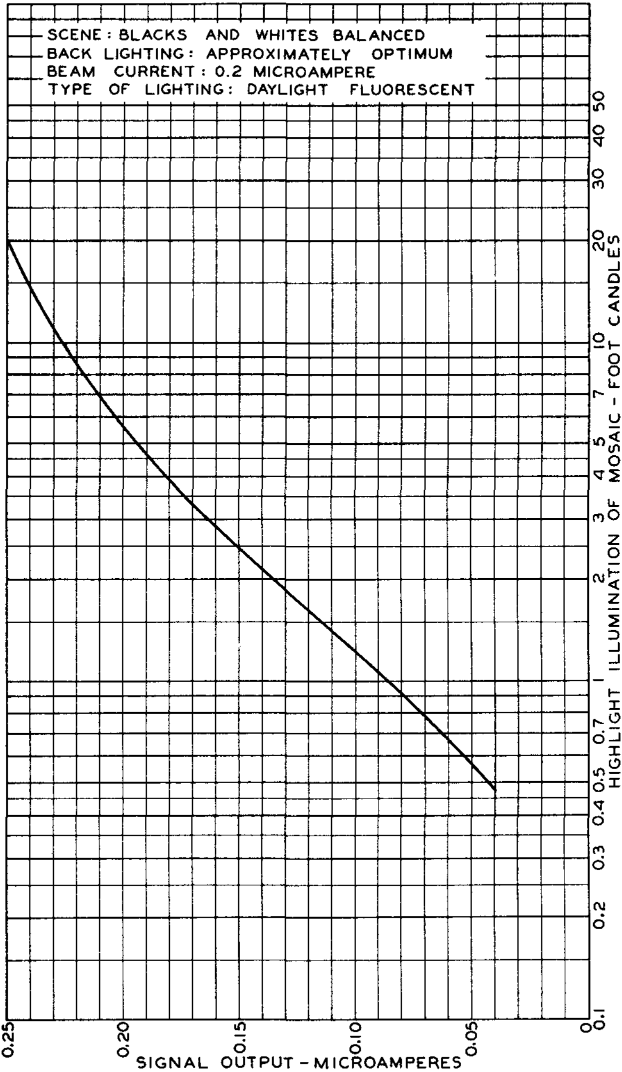
SPECTRAL SENSITIVITY CHARACTERISTIC



RCA

1850-A

TYPICAL SIGNAL-OUTPUT CHARACTERISTIC



JAN. 2, 1951 TUBE DEPARTMENT 92CM-6581R1

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

5527

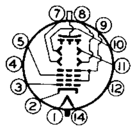
5527
ICONOSCOPE

ELECTROSTATIC FOCUS ELECTROSTATIC DEFLECTION

General:

Heater, for Unipotential Cathode:		
Voltage	6.3 ± 10% . . .	ac or dc volts
Current	0.6	amp
Direct Interelectrode Capacitances (Approx.):▲		
Grid No.1 to All Other Electrodes	7.5 . .	μμf
Signal Electrode to All Other Electrodes and External Shield	5 . .	μμf
Focusing Method		Electrostatic
Deflection Method		Electrostatic
Image Size (4 x 3 aspect ratio)		1.4" Diagonal
Overall Length.		9" ± 1/4"
Seated Length		8-1/4" ± 1/4"
Maximum Diameter.		2-1/4"
Mounting Position		Any
Cap		Recessed Small Cavity
Base		Medium-Shell Diheptal 12-Pin
Basing Designation for BOTTOM VIEW		14L

Pin 1 - Heater
Pin 2 - Cathode
Pin 3 - Grid No.1
Pin 4 - Internal Connection - Do Not Use
Pin 5 - Grid No.3
Pin 7 - Deflecting Electrode DJ_3
Pin 8 - Deflecting Electrode DJ_4



DIRECTION OF LIGHT: INTO END OF BULB

Pin 9 - Anode No.2, Grid No.4
Pin 10 - Deflecting Electrode DJ_2
Pin 11 - Deflecting Electrode DJ_1
Pin 12 - Internal Connection- Do Not Use
Pin 14 - Heater
Cap - Signal Electrode

Maximum Ratings, *Design-Center Values*:

SIGNAL-ELECTRODE VOLTAGE.	900 max.	. . . volts
GRID-No.4 & GRID-No.2 VOLTAGE . . .	900 max.	. . . volts
GRID-No.3 VOLTAGE	450 max.	. . . volts
GRID-No.1 VOLTAGE:		
Negative bias value	100 max.	. . . volts
Positive bias value	0 max.	. . . volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode . . .	125 max.	. . . volts
Heater positive with respect to cathode . . .	10 max.	. . . volts
AMBIENT TEMPERATURE	40 max.	. . . °C
MOSAIC ILLUMINATION	50 max.	foot-candles

▲ With external shield.

APRIL 15, 1947 TENTATIVE DATA

TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

5527

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ICONOSCOPE

Typical Operation:

Signal-Electrode Voltage	800	. . . .	volts
Grid-No.4 & Grid-No.2 Voltage . . .	800	. . . .	volts
Grid-No.3 Voltage for Focus . . .	125 to 250	. . .	volts
Grid-No.1 Voltage	Adjust for best picture		
Max. Grid-No.1 Voltage for Picture Cutoff . .	−75	. . . .	volts
Max. Deflecting Voltages (Peak-to-Peak)*:			
DJ_1 & DJ_2 (Vertical)	120	. . . .	volts
DJ_3 & DJ_4 (Horizontal)	100	. . . .	volts
Min. Peak-to-Peak Blanking Voltage	30	. . . .	volts
Signal-Output Current (Approx.) . .	0.025	. . . .	µamp
Output Resistor (Approx.)	1.0	. . . .	megohm

Maximum Circuit Values:

Grid-No.1-Circuit Resistance . . .	1.0 max.	. . .	megohm
Resistance in any Deflecting-Electrode Circuit□ . .	5.0 max.	. . .	megohms

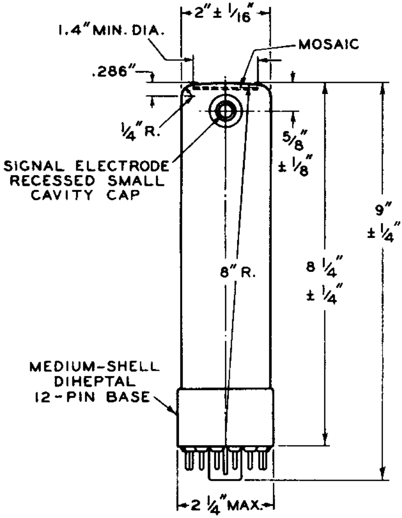
* To scan picture of 1.4" diagonal (4 x 3 aspect ratio).

□ It is recommended that the deflecting-electrode-circuit resistances be approximately equal.

The SPECTRAL SENSITIVITY CHARACTERISTIC curve for the 5527 is the same as that shown for Type 1850-A.

RCA

5527
ICONOSCOPE



℄ OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

THE PLANE THROUGH THE TUBE AXIS AND BASE-PLUG KEY MAY VARY FROM THE PLANE THROUGH THE TUBE AXIS AND SIGNAL ELECTRODE TERMINAL BY AN ANGULAR TOLERANCE (MEASURED ABOUT THE TUBE AXIS) OF 20°. SIGNAL ELECTRODE TERMINAL IS ON SAME SIDE AS BASE-PLUG KEY.

DJ1 AND DJ2 ARE NEARER THE MOSAIC; DJ3 AND DJ4 ARE NEARER THE BASE. WITH DJ1 POSITIVE WITH RESPECT TO DJ2, THE SPOT IS DEFLECTED TOWARD PIN 5. WITH DJ3 POSITIVE WITH RESPECT TO DJ4, THE SPOT IS DEFLECTED TOWARD PINS 1 AND 2. WITH DJ1 AND DJ2 USED FOR VERTICAL DEFLECTION, THE VERTICAL AXIS OF THE SCANNED AREA OF THE MOSAIC IS PARALLEL TO VERTICAL PLANE THROUGH PINS 5 AND 12 WITHIN ±15°. THE ANGLE BETWEEN THE SCANNING DIRECTION PRODUCED BY DJ3 AND DJ4 AND THE SCANNING DIRECTION PRODUCED BY DJ1 AND DJ2 IS 90° ± 3°.

92CS-6803

RCA

5826

IMAGE ORTHICON

Magnetic Focus	**For Studio Pickup**	**3"-Diameter Bulb**
Magnetic Deflection	**Exceptional Sensitivity**	**15-1/4" Length**

TENTATIVE DATA

RCA-5826 is a television camera tube recommended for studio use and other applications where the lighting can be controlled. It has exceptional sensitivity combined with a spectral response approaching that of the eye, and good stability over the range of light levels usually encountered with artificial illumination. Commercially acceptable pictures can be obtained with incident light levels greater than about 35 foot-candles.

The photocathode utilized in the 5826 is characterized by a spectral response having high blue sensitivity, high green sensitivity, good red sensitivity, and practically no infrared sensitivity. This latter characteristic of the response prevents any color-masking by infrared, and thus permits portrayal of colors in nearly their true tonal gradation.

Because of its spectral characteristics and exceptional sensitivity, the 5826 can be substituted to advantage for the type 5655. Requiring a minimum light level only 0.15 of that required by the 5655, the 5826 makes it possible to reduce substantially the amount of illumination as well as air conditioning needed in the studio. Furthermore, the 5826 permits considerably improved gray-scale rendition of color while retaining the same good signal-to-noise ratio of the 5655.

The relatively small size of the 5826 lends itself to use in comparatively light-weight, portable television cameras, and facilitates the use of a telephoto lens with such cameras.

For general outdoor pickup use, RCA-5820 is recommended.

PRINCIPLES OF OPERATION

The 5826 has three sections--an image section, a scanning section, and a multiplier section, as shown in Fig. 1.

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 the 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 2 volts with respect to target-voltage cutoff. 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. Because of the thinness of the glass, the charges set up a similar 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,

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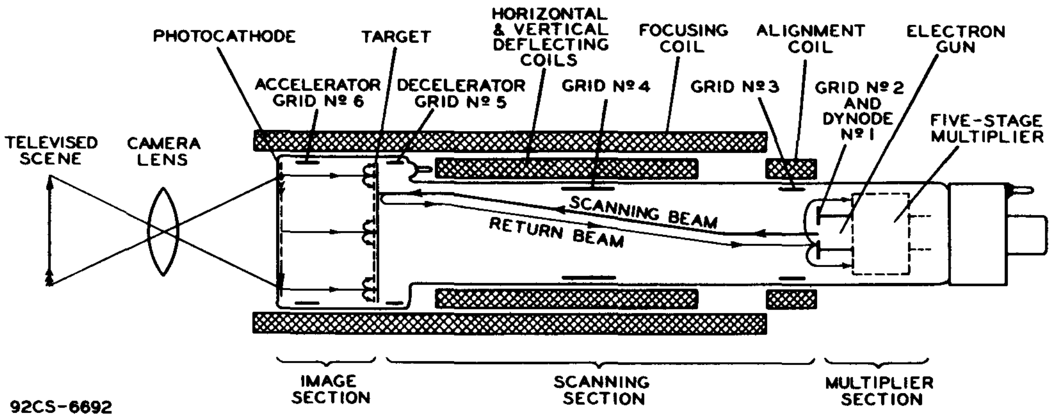


Fig. 1 - Schematic Arrangement of Type 5826.

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 utilizes 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 (R_{30} in Fig.2) changes in the positive direction. Hence, for highlights in the scene, the grid of the first video-amplifier stage swings in the positive direction.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current	0.6	ampere
Direct Interelectrode Capacitance:		
Anode to All Other Electrodes	20	μμf
Photocathode, Semi-transparent:		
Response		See Fig.6
Useful Size of Rectangular Image (4 x 3 aspect ratio)		1.6" max. Diagonal
Orientation of Rectangular Image — Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of face plate and pin No.7 of the shoulder base.		
Focusing Method		Magnetic
Deflection Method		Magnetic
Overall Length		15-1/4" ± 1/4"
Greatest Diameter of Bulb		3" ± 1/16"
Shoulder Base		Keyed Jumbo Annular 7-Pin
End Base		Small-Shell Diheptal 14-Pin
Mounting Position		See Text
Minimum Deflecting-Coil Inside Diameter		2-1/8"
Deflecting-Coil Length		5"
Focusing-Coil Length		10"
Alignment-Coil Length		15/16"
Photocathode Distance Inside End of Focusing Coil		1/2"

Maximum Ratings, *Absolute Values*:

PHOTOCATHODE VOLTAGE	-550 max.	volts
PHOTOCATHODE ILLUMINATION	50 max.	ft-c
OPERATING TEMPERATURE OF ANY PART OF BULB	65 max.	°C
OPERATING TEMPERATURE OF BULB AT LARGE END OF TUBE (TARGET SECTION)	45 min.	°C
TEMPERATURE DIFFERENCE:		
Between target section and any part of bulb hotter than target section	5 max.	°C
GRID-No.6 VOLTAGE	-550 max.	volts

TARGET VOLTAGE:		
Positive value	50 max.	volts
Negative value	50 max.	volts
GRID-No.5 VOLTAGE	150 max.	volts
GRID-No.4 VOLTAGE	300 max.	volts
GRID-No.3 VOLTAGE	400 max.	volts
GRID-No.2 & DYNODE-No.1 VOLTAGE	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
ANODE-SUPPLY VOLTAGE*	1500 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts

Typical Operation and Characteristics:

Photocathode Voltage (Image Focus)	-300 to -500	volts
Grid-No.6 Voltage (Accelerator)—80% of photocathode voltage	-240 to -400	volts
Target Voltage°	0	volts
Grid-No.5 Voltage (Decelerator)°°	0 to 100	volts
Grid-No.4 Voltage (Beam Focus)	160 to 240	volts
Grid-No.3 Voltage#	225 to 330	volts
Grid-No.2 & Dynode-No.1 Voltage	300	volts
Grid-No.1 Voltage (For picture cutoff)	-45 to -115	volts
Dynode-No.2 Voltage	600	volts
Dynode-No.3 Voltage	800	volts
Dynode-No.4 Voltage	1000	volts
Dynode-No.5 Voltage	1200	volts
Anode Voltage	1250	volts
Anode Current	50	μa
Target Temperature Range (See text)	45 to 60	°C
Highlight Illumination on Photocathode for Maximum Signal Output: With 2870°K Tungsten Illumination, Daylight, or White Fluorescent Illumination	0.04	ft-c
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.)	70	
Minimum Peak-to-Peak Blanking Voltage	10	volts
Field Strength at Center of Focusing Coil	75	gausses
Focusing-Coil Current (Approx., for Coil listed below)■	75	ma
Deflecting-Coil Current (Approx., for Assembly listed below):		
Horizontal (Peak to peak)	625	ma
Vertical (Peak to peak)	290	ma
Alignment-Coil Current (Approx., for Coil listed below)	0 to 30	ma

Components:

Deflecting-Coil Assembly (Includes Keyed Jumbo Annular 7-Pin Socket)	RCA Type No. 201D75
Focusing-Coil Assembly	RCA Type No. 202D75
Alignment-Coil Assembly	RCA Type No. 204D75
Hor. Deflection Output Transformer	RCA Type No. 204T1
Ver. Deflection Output Transformer	RCA Type No. 204T2

* Ratio of dynode voltages is shown under Typical Operation.

° Adjustable from -3 to +5 volts with blanking voltage off.

°° Taps at 0, 30, 60, and 90 volts are recommended. Set at voltage giving most uniform resolution and signal output over entire picture area.

Adjust to give the most uniformly shaded picture near maximum signal.

■ Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil.

INSTALLATION

The *end-base* pins of the 5826 fit the diheptal 14-pin socket; the *annular-base* pins fit the keyed jumbo annular 7-pin socket which is part of the deflecting-coil assembly having RCA Type No. 201D75.

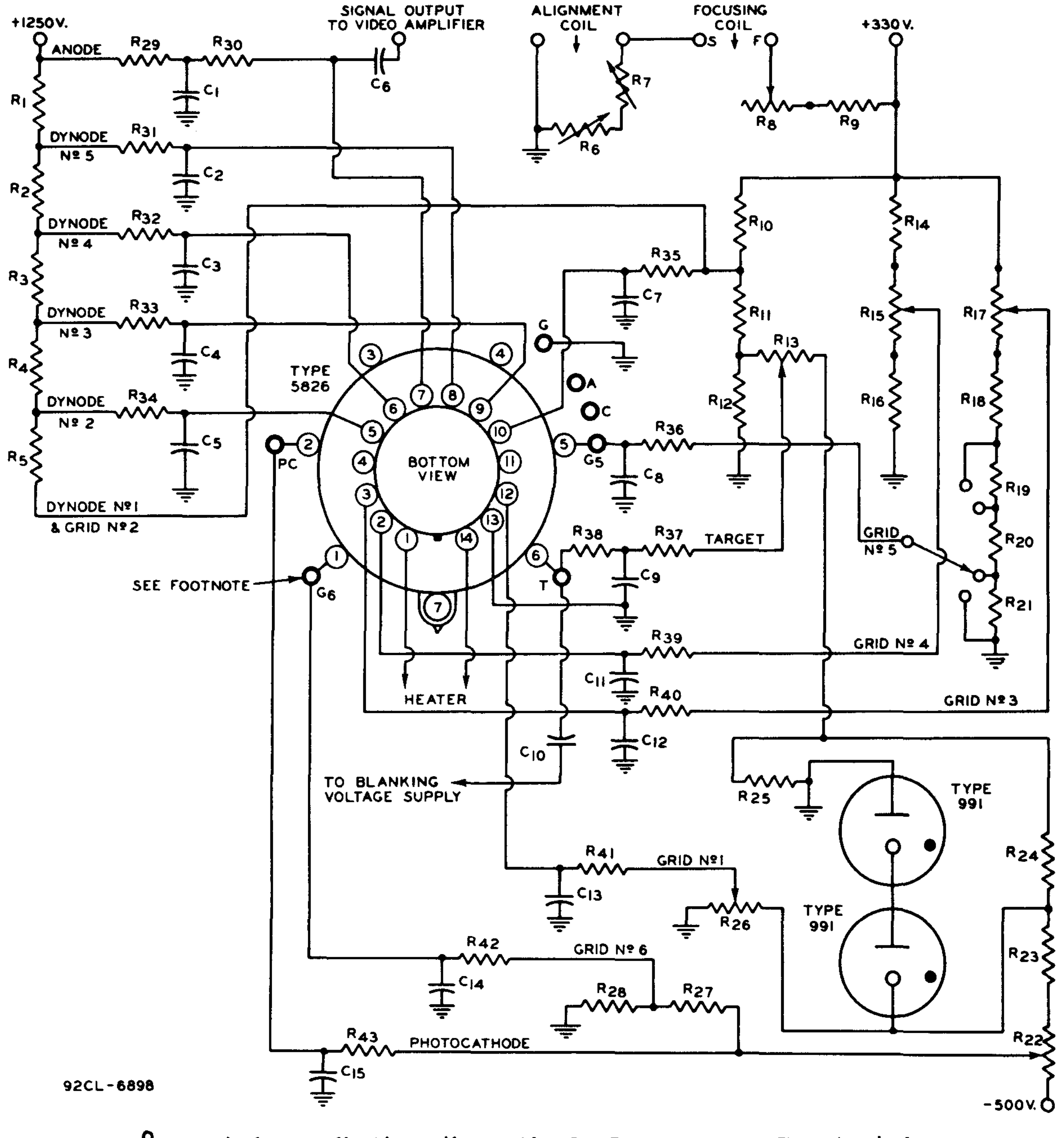
The 5826 has three complementary guides for inserting the tube correctly in the annular socket, i.e., the large pin (No.7) on the annular base, the white radial line on face of bulb, and a white longitudinal line on neck. Designers of equipment should position the annular socket so that pin No.7 of the annular base, and the white radial line when viewed from the face end of the tube, will be at the bottom of the face after the tube has been correctly inserted in the annular socket. The 5826 is installed by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin No.7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the slot in the annular socket, and makes the longitudinal line on the neck visible through the sight hole in the deflecting-coil assembly. The annular-base pins are then pushed into their socket, and the diheptal socket is put on the 14-pin base.

Proper orientation of the annular socket with respect to the horizontal-deflecting field is essential, and is obtained when the plane which is perpendicular to the plane of the annular socket and which passes through the center of the annular socket and the center line between pins 3 and 4 of the annular base is at right angles to the horizontal scanning field. This orientation prevents the damper bars in the target assembly from showing in the picture when the target is normally scanned, and also minimizes beat-pattern effects by placing the sides of the mesh holes at an angle of 45° with respect to the horizontal scanning lines.

The damper bars serve to minimize microphonics and consist of two metal strips between the mesh-screen portion and the glass-disc portion of the target. They are positioned so that, with the orientation described above, they appear parallel to the horizontal scanning lines when the target is over-scanned, but do not show in the picture with normal scanning of the target.

The *operating position* of the 5826 should preferably be such that any loose particles in the neck of the tube will not fall down and strike or become lodged on the target. Therefore, it is recommended that the tube never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with base up makes an angle of less than 20° with the vertical through the center of the base.

The *operating temperature* of any part of the glass bulb should never exceed 65°C, and no part of the bulb at the large end of the tube (target section) should ever fall below 45°C during operation. The temperature of the target is essentially the same as that of the adjacent glass bulb and can, therefore, be determined by measuring the temperature of the glass bulb adjacent to the target. It is recommended that the temperature of the entire bulb be held between



o = Terminals on Deflecting-Coil Assembly, RCA Type No.201D75. These terminals are connected to annular socket within the Assembly as shown, except for those marked G, A, and C. G is connected to yoke shielding. A and C are connected to heater terminals on face of annular socket. Other terminals on the Assembly not shown above are indicated in Figs.3 and 4.

Fig.2 - Voltage Dividers for Type 5826 with Connections for: Alignment Coil, RCA Type No.204D75, and Focusing Coil, RCA Type No.202D75.

45° and $60^{\circ}C$. Operation at too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the tube. Resolution is regained by waiting for the temperature to drop below $65^{\circ}C$. No part of the bulb should run more than 5° hotter than the target section to prevent cesium migration to the target. Such migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 5826 may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

When the equipment design or operating conditions are such that the maximum temperature rating or maximum temperature difference as given under Maximum Ratings will be exceeded, provision should be made to direct a blast of cooling air from the diheptal-base end of the tube along the entire length of the bulb surface, i.e., through the space between the bulb surface and the surrounding deflecting coil and its extension. Any attempt to effect cooling of the tube by circulating even a large amount of air around the focusing coil will do little good, but a small amount of air directly in contact with the bulb surface will effectively drop the bulb temperature. For this purpose, a small blower is satisfactory, but it should be run at low speed to prevent vibration of the 5826 and the associated amplifier equipment. Unless vibration is prevented, distortion of the picture may occur.

Ordinarily, the temperature in a camera equipped with a blower will not exceed $65^{\circ}C$, except in very hot weather or unless the target heater is left on accidentally for a long period.

To keep the operating temperature of the large end of the tube from falling below $45^{\circ}C$, some form of controlled heating should be employed. Ordinarily, adequate heat will be supplied by the focusing coil, deflecting coils, and associated amplifier tubes so that the temperature can be controlled by the amount of cooling air directed along the bulb surface. If, in special cases, a target heater is required, it should fit snugly between the focusing coil and the bulb near the shoulder of the tube. Such a target heater is included in the RCA Deflecting-Coil Assembly.

The *lens system* used with the 5826 should be designed according to basic optical principles and should incorporate an iris to control the amount of light entering the television camera lens. Because of the relatively small face diameter of the 5826, the use of a telephoto lens is facilitated. The lens holder should have all inside surfaces finished in matte black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

A *mask* having a diagonal or diameter of 1.6 inches should always be used on the photocathode to set limits for the maximum size of scan, and to reduce the amount of light reaching unused parts of the photocathode.

For the *high dc voltages* required by the 5826, the use of two pulse supplies for which the plate voltage is provided by a well-regulated, 330-volt, B-supply may be used. Each of these supplies should be actuated by the horizontal driving pulse which is obtained from the synchronizing generator. One of the pulse supplies should be capable of furnishing 1250 volts with an output current of 1 milliampere for the multiplier section; the other pulse supply should be capable of furnishing -500 volts with an output current of 1 milliampere for the image section. In addition to supplying the plate voltage and current for the pulse supplies, the 330-volt

LEGEND FOR FIG. 2

C1 C2: 0.05 µf, 1600 v working voltage
C3: 0.01 µf mica, 1600 v working voltage
C4: 0.001 µf mica, 1000 v working voltage
C5: 0.001 µf mica, 600 v working voltage
C6: 0.03 µf mineral-oil impregnated, 1600 v working voltage
C7 C8 C9 C11 C12 C13 C14: 0.001 µf mica, 400 v working voltage
C10: 1 µf, 400 v working voltage
R1: 47000 ohms, 1/2 watt
R2 R3 R4: 220000 ohms, 1/2 watt
R5: 270000 ohms, 1/2 watt
R6: 100 ohms, 1/2 watt, wire wound
R7: 20 ohms, 1 watt, wire wound
R8: 2500 ohms, 25 watts
R9: 750 ohms, 10 watts
R10: 5100 ohms, 1/2 watt
R11: 51000 ohms, 2 watts
R12: 510 ohms, 1/2 watt
R13: 150000-ohm potentiometer, 1/2 watt
R14: 820000 ohms, 1/2 watt
R15: 100000-ohm potentiometer, 1 watt
R16: 150000 ohms, 1/2 watt
R17: 100000-ohm potentiometer, 1 watt
R18: 56000 ohms, 1/2 watt
R19 R20 R21: 20000 ohms, 1/2 watt
R22: 250000-ohm potentiometer, 1 watt
R23: 180000 ohms, 1/2 watt
R24: 390000 ohms, 1/2 watt
R25: 11000 ohms, 1/2 watt
R26: 500000-ohm potentiometer, 1 watt
R27: 110000 ohms, 1/2 watt
R28: 560000 ohms, 1/2 watt
R29: 47000 ohms, 1/2 watt
R30: 20000 ohms, 1/2 watt
R31 R32: 100000 ohms, 1/2 watt
R33 R34 R36 R37 R39 R40 R41 R42 R43: 200000 ohms, 1/2 watt
R35: 50000 ohms, 1/2 watt
R38: 100000 ohms, 1/2 watt

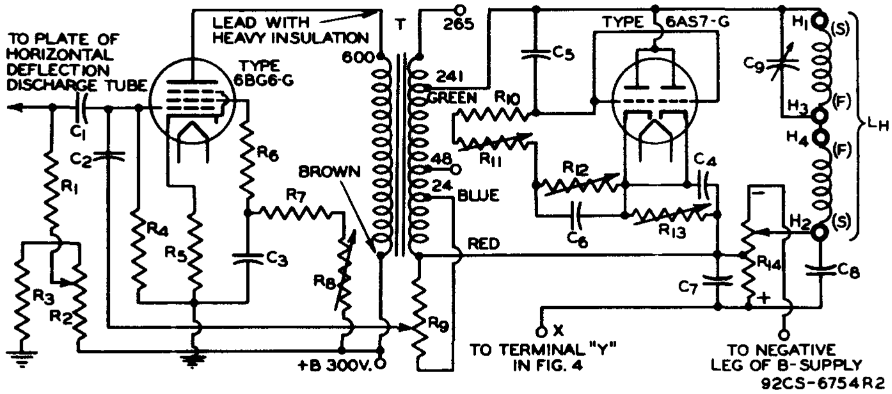
B-supply should also provide an output current of 90 milliamperes for the focusing and alignment coils and for the voltage divider which is used to supply the voltages for the electrodes in the scanning section of the 5826.

Voltage dividers to provide the required operating voltages for the various electrodes of the 5826 are shown in Fig.2. It is to be noted that the blocking capacitor C_6 should be of the mineral-oil impregnated type to minimize capacitor leakage which will introduce disturbing effects into the picture.

In designing a voltage divider for the multiplier stages of the 5826, engineers should recognize that the dc output of individual 5826's of the multiplier as the beam current is increased. This current reversal will also produce a sharp drop in the ac output of the tube. To prevent such current reversal, it is recommended that provision be made to reduce the overall multiplier voltage for tubes with dc outputs at the upper end of the range. A reduction to 1000 volts should be adequate.

A *horizontal deflection circuit* for use with the 5826 is shown in Fig.3; and a *vertical deflection circuit* in Fig.4.

The *video amplifier* should be designed to cover a range of ac signal voltages corresponding to signal-output current of 3 to 30 microamperes in the load resistor (R_{30} in Fig.2).



C1: 0.01 µf	R5: 100 ohms, 2 watts
C2: 150 µµf	R6: 100 ohms
C3 C4: 4 µf	R7: 3000 ohms, 2 watts
C5: 30 µµf	R8: 10000 ohms, 2 watts. Value should be such that screen input of the 6BG6-G will not be exceeded.
C6: 0.02 µf	R9: Peaking Amplitude and Linearity Control, 5000 ohms
C7 C8: 100 µf	R10: 50000 ohms, 1 watt
C9: Balancing Capacitor, 10 to 40 µµf	R11: Linearity Control, 250000 ohms
LH: Horizontal Deflecting Coils: Terminals H1, H2, H3, and H4 on Deflecting-Coil Assembly, RCA Type No.201D75. LH has inductance of 5.5 mh and dc resistance of 19 ohms.	R12: Linearity Control, 100000 ohms
R1: 1 megohm	R13: Linearity Control, 500 ohms, 5 watts
R2: Sawtooth Amplitude and Linearity Control, 250000 ohms	R14: Centering Control, 10 ohms tapped at 5 ohms
R3 R4: 250000 ohms	T: Horizontal Deflection Output Transformer, RCA Type No.204T1. DC resistance of used portion of secondary is 3.4 ohms.

Fig.3 - Horizontal Deflection Circuit for Type 5826.

may have a range of 10 to 1. This range, therefore, must be considered in the choice of bleeder-resistor values. If the values are too high, the distribution of voltages applied to the dynodes will be upset by a 5826 with a dc output at the upper end of the range. As a result, there will be an abrupt drop in the ac output of the tube as the beam current is increased. When this drop occurs before the beam is at its optimum value, the ratio of signal to noise will be lessened.

Even with satisfactory bleeder-resistor values, it is possible to overload the tube itself. For 5826's having high dc outputs, a current reversal can occur at the 5th dynode stage

APPLICATION

Resolution of better than 500 lines at the center of the picture can be produced by the 5826 when the photocathode highlight illumination from an RMA Standard Test Chart is above the knee of the curve in Fig.5. This value of resolution is that obtained after optimum adjustments have been made to minimize the prominence of beat patterns and dynode spots.

A beat pattern is caused by the beating of the scanning lines against the lines of the target mesh. As a result, a moiré pattern, sometimes called a "swirl", appears in large-area highlights of the picture. Besides defocusing of the beam by adjustment of the beam-focus control (grid No.4), a slight change in the vertical or horizontal size controls of the camera may be helpful in reducing the beat-pattern effect.

A dynode spot is caused by a slight blemish on a dynode surface and appears as a white spot chiefly in the dark areas of the picture. Little defocusing of the beam is required to minimize the effect of dynode spots when the scene is brightly illuminated, but in dark scenes, the effect of dynode spots is a limiting item on resolution.

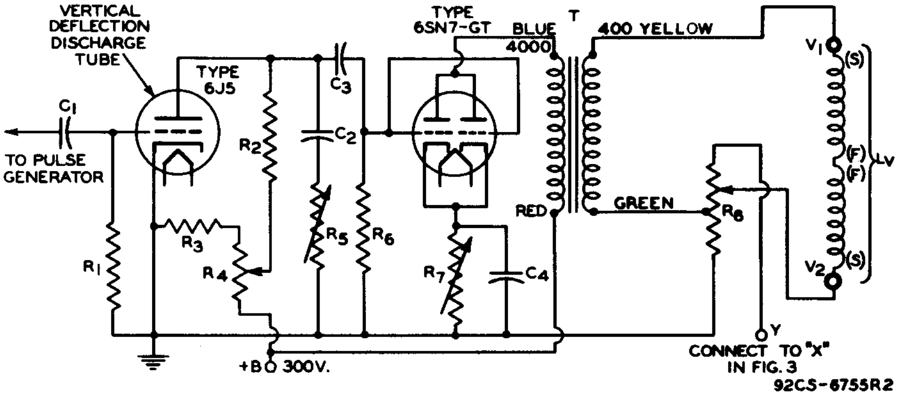
To utilize the resolution capability of the 5826 in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles. The maximum resolution obtainable is limited by the mesh-screen portion of the target.

Even with a wide-band amplifier, the resolution may be limited by "cross talk" caused by the scanning fields. Unless prevented by proper shielding from extending into the image section, these fields will cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

Proper shielding will be provided by a shield which employs seven separate layers of silicon-steel strips (0.007" thick and 1/2" wide) applied to the outside of the focusing coil as follows: First, wrap a single insulating layer of 0.005" thick motor paper around the focusing coil; then, wrap two turns, one above the other of the silicon-steel strip repeating the operation to fill the entire focusing-coil length but allowing 1/64" between each successive 2-turn section, to insure electrical insulation. Second, wrap a second insulating layer of motor paper and repeat the silicon-steel strip operation but space the 2-turn sections so that each is directly over a 1/64" insulating space of the previous layer. Operations 1 and 2 are repeated to provide 7 layers of shielding. The entire assembly is completed with a final wrap of motor paper. A convenient method for handling the 2-turn strip sections is to cut the strips just long enough to take care of two turns. Each 2-turn section is, of course, completely independent of any other section.

If equipment space will not accommodate the full seven layers of shielding as described above, fewer layers can be used, but will be less effective in minimizing "cross talk".

The *sequence of adjustments* in operating the 5826 is as follows: After the tube has been inserted in its sockets and the voltages applied as indicated under Typical Operation, allow it to warm up for 1/2 to 1 hour with the camera lens iris closed. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target. Adjust the deflection circuits so that the beam will "overscan" the target, i.e., so that the area of the target scanned is greater than its sensitive area. This procedure during the warming-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than-normal picture on the



C1: 0.1 μf
C2: 0.05 μf
C3: 1 μf
C4: 1000 μf
LV: Vertical Deflecting Coils: Terminals V1 and V2 on Deflecting Coil Assembly, RCA Type No.201D75. LV has inductance of 28.3 mh and dc resistance of 34 ohms.
R1: 1 megohm
R2: 5 megohms
R3: 100000 ohms
R4: Sawtooth Amplitude Control, 250000 ohms
R5: Peaking Amplitude Control, 25000 ohms
R6: 500000 ohms
R7: Linearity Control, 5000 ohms
R8: Centering Control, 10 ohms tapped at 5 ohms
T: Vertical Deflection Output Transformer, RCA Type No.204T2. DC resistance of secondary is 6.9 ohms.

Fig.4 - Vertical Deflection Circuit for Type 5826.

monitor. Then open the iris partially and focus the scene to be televised on the photocathode. Next, adjust the grid-No. I voltage until a picture or noise appears on the monitor screen. If there is no picture, rotate the alignment coil and adjust the current through it until the maximum picture response is obtained. An occasional

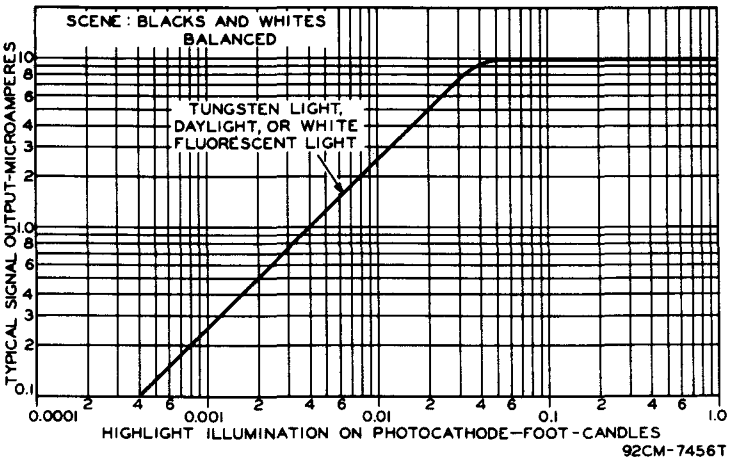


Fig.5 - Typical Signal Output of Type 5826.

tube may require very little or no current through the alignment coil. Correct alignment is obtained when the picture does not rotate as the beam-focus control (grid No.4) is varied. Proper alignment may also be checked even more critically than by the above procedure by observing on the monitor any "dynode spots" resulting from small imperfections in the dynode surfaces. The spots appear as small white areas of various shapes, and can best be observed with no light on the photocathode. With proper alignment, the dynode spots do not rotate when the beam-focus control (grid No.4) is varied, but simply go in and out of focus. During alignment of the beam, and during operation of the tube, always keep the beam current as low as possible to give the best picture quality. Adjust the beam-current control to give only enough beam current to hold down the highlights. Next, adjust grid-No. I voltage and the target voltage for the best picture. Then, bring the picture into focus by varying the voltage on grid No.4 and on the photocathode. Next, vary the voltage on grid No.3 to give the most uniformly shaded picture at approximately maximum signal. Final adjustment is made by varying the voltages on grids No.5 and No.6. In general, these need little adjustment and are varied only after completing the other adjustments. When camera is used for rehearsal, the scanning may be restored nearly to normal size. Complete restoration should be made just prior to air-time.

Full-size scanning of the target should always be used during on-the-air operation. Full-size scanning can be assured by first adjusting the deflection circuits to overscan the target sufficiently to cause the corners of the target to be visible in the picture, and then reducing the scanning until the corners just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. Full-size scanning will also reduce the prominence of a beat pattern (see *Resolution*). As indicated previously, overscanning the target produces a smaller-than-normal picture on the monitor.

Underscanning the target, i.e., scanning an area of the target less than its sensitive area, should never be permitted. Underscanning produces a larger-than normal picture on the monitor. If the target is underscanned for any length of time, a permanent change of target cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

The *target voltage* will depend on the type of scene to be televised and should be adjusted simultaneously with the beam-current control to obtain the best signal-to-noise ratio and gray-scale reproduction. If the scene has a large range of illumination, the target should be operated at about 1.5 to 2 volts above cutoff so that highlights will not bloom. For scenes with a lower range of illumination, the target can be operated at or a little over 2 volts above cutoff with resultant gain in signal-to-noise ratio, and improved detail in the shadows.

A *blanking signal* should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking periods, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance.

Shading may be required even with optimum adjustment of voltage on grid No.3 in order to obtain a uniformly shaded picture. A shading signal having a sawtooth shape, a frequency equal to the horizontal scanning frequency, and an amplitude about twice that of the useful video signal, is recommended. Provision should be made for controlling the amplitude of the shading signal and for reversing its polarity. The signal may be introduced into the video channel after the pre-amplifier in the camera but ahead of the master gain control. With this arrangement, changing the gain-control setting does not change the ratio of the shading-signal amplitude to the video-signal amplitude.

The *illumination* on the photocathode is related to the scene illumination by the formula

$$I_s = \frac{4f^2\ I_{pc}\ (m+1)^2}{TR}$$

where

I_s = scene illumination in foot-candles

f = f-number of lens

I_{pc} = photocathode illumination in foot-candles

m = linear magnification from scene to target

T = total transmission of lens

R = reflectance of principal subject in scene.

Except for very close shots, the linear magnification (m) from scene to target may be neglected.

For example, assume that the lens is f:3.5 having a transmission (T) of 75%, that the photocathode illumination is 0.06 foot-candle, and that the scene to be televised is composed largely of whites and blacks (such as a test chart) where the reflectance (R) may be in the order of 50%. Then,

$$I_s = \frac{4 \times 3.5^2 \times 0.06}{0.75 \times 0.50} = 8 \text{ foot-candles}$$

For average scenes where the principal subject has a reflectance of 5 to 10%, the incident illumination should have a value of 30 to 40 foot-candles.

It is good practice before attempting to transmit a particular scene to check its incident illumination with an illuminating-measuring device, such as an exposure meter. It is recommended that the average incident light level be greater than approximately 30 foot-candles for a good picture.

Typical signal output of the 5826 as a function of the highlight illumination on the photocathode under conditions where the televised scene has balanced blacks and whites for each of three types of illumination, is shown by the curve in Fig.5.

For the most natural appearance of televised subjects or scenes, it is recommended that the 5826 be operated so that the highlights on the photocathode bring the signal output slightly over the knee of the signal-output curve for the particular type of illumination utilized. Operation further along on the horizontal part of the curve will give pictures in which the subject has an over-emphasized outline. The position of the knee will shift for individual tubes. The knee may occur at values of highlight illumination on the photocathode ranging from about 0.03 to 0.05 foot-candle.

The *spectral response* of the 5826 is not subject to appreciable variation from tube to tube. The spectral response of the 5826 without correcting filter is shown by curve A in Fig.6. Curve B in this same figure, shows the spectral response when a Wratten No.6 filter is used with the 5826. This curve very closely approaches that of the eye shown by the dotted curve C. Use of the filter, which can be obtained with lens-adapter ring at photographic-supply stores, results in a loss of sensitivity by about 2 to 1.

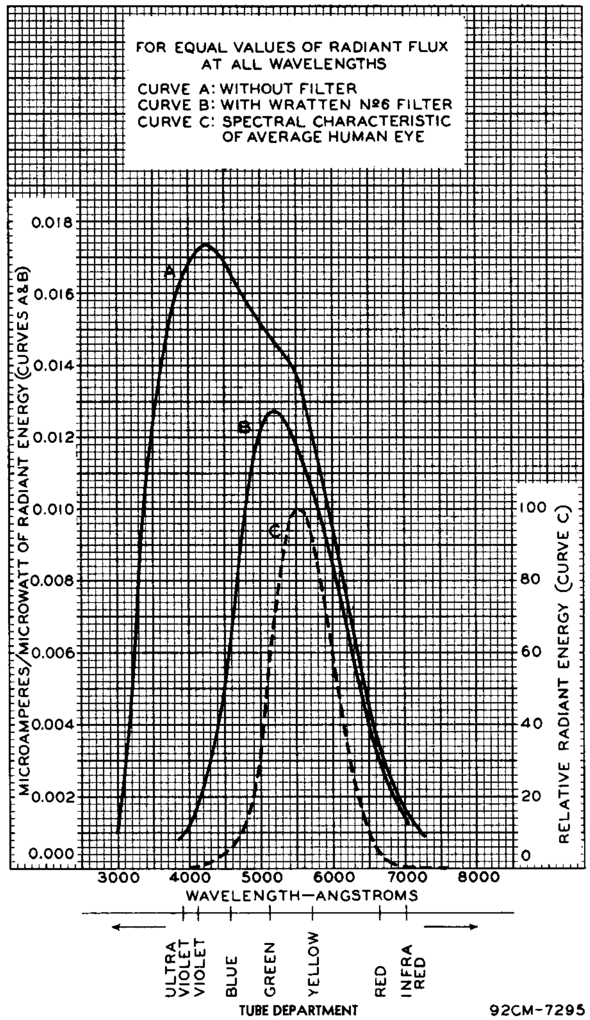


Fig.6 - Spectral Sensitivity Characteristic of Type 5826 With and Without Filter.

Retention of a scene by the 5826, sometimes called a "sticking picture", may be experienced if the 5826 is allowed to remain focused on a stationary bright scene for several minutes, or if it is focused on a bright scene before reaching operating temperature in the range from 45° to 60°C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears.

A retained image can generally be removed by focusing the 5826 on a clear white screen, and allowing the 5826 to operate for several hours with an illumination of about 1 foot-candle on the photocathode. This value is equivalent to 50 to 100 foot-candles on the screen with an f:2.8 lens.

To avoid retention of a scene, it is recommended that the 5826 always be allowed to warm up in the camera for 1/2 to 1 hour with the lens iris closed, and that the 5826 never be allowed to remain focused on a stationary bright scene for more than a few minutes. Never use more illumination than is necessary. If a target heater is used, the warm-up time can be reduced to approximately 10 or 15 minutes.

Failure of scanning even for a few minutes when light is incident on the photocathode may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

To avoid damaging the 5826 during scanning failure, provision should be made to prevent automatically the scanning beam from reaching the target. The scanning beam can be prevented from reaching the target by (1) cutting off the scanning beam, or (2) making the target sufficiently negative. The scanning beam can be cut off by a relay which applies -115 to -125 volts bias to grid No.1. The target can be made sufficiently negative by a relay which applies a bias of at least -10 volts to it. Either relay is actuated by a tube which is controlled by a portion of the scanning pulse voltage developed across either the horizontal or the vertical deflecting coils, or both. It is important to insure that the horizontal scanning pulse and the vertical scanning pulse should each independently actuate the relay in case either one fails.

Rotation in the use of 5826's is recommended. After a 5826 is operated for 200 to 300 hours, it should be given an idle period of three or four weeks during which it generally will recover much of its original resolution and sensitivity.

New 5826's should be placed in service immediately upon receipt. They should be operated for several hours before being set aside as spares.

Spare tubes should be placed in service for several hours at least once a month in order to keep them free from traces of gas which may be liberated within the tube during prolonged storage.

Occasionally, a *white spot* which does not change in size when the beam focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation of the 5826, the 5826 should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

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DOS and DON'TS on Use of RCA-5826

Here are the "dos"--

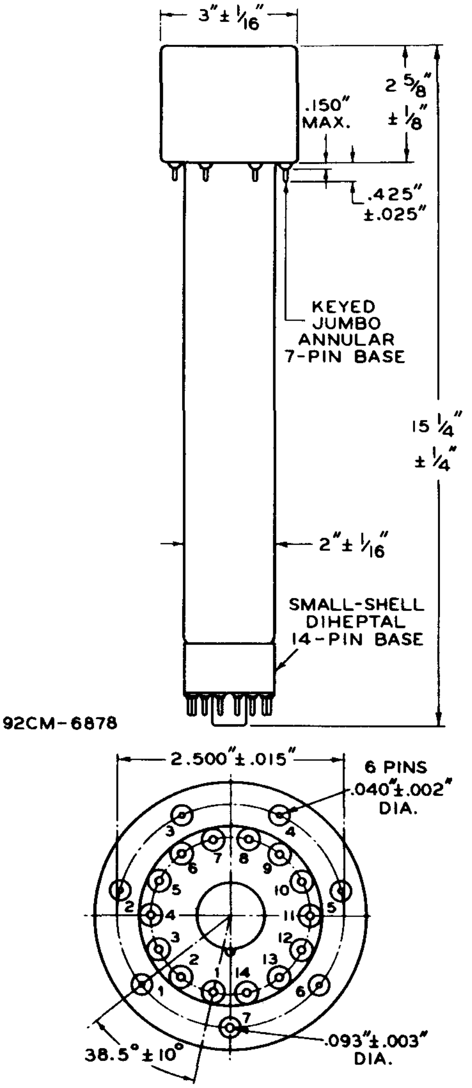
1. Allow the 5826 to warm up prior to operation.
2. Hold temperature of the 5826 within operating range.
3. Make sure alignment coil is properly aligned.
4. Check scene illumination before televising.
5. Select lens stop for best picture.
6. Use lowest beam current and highest target voltage for best signal-to-noise ratio and gray-scale reproduction.
7. Adjust beam-focus control for best usable resolution.
8. Give the 5826 an idle period every 200 hours.
9. Condition spare 5826's by operating several hours once each month.

Here are the "don'ts"--

1. Don't force the 5826 into its shoulder socket.
2. Don't operate the 5826 without scanning.
3. Don't underscan target.
4. Don't focus the 5826 on a stationary bright scene.
5. Don't operate a 5826 having an ion spot.

The significance of each of the above "dos" and "don'ts" in obtaining optimum performance from the 5826 is explained in the preceding pages of this bulletin.

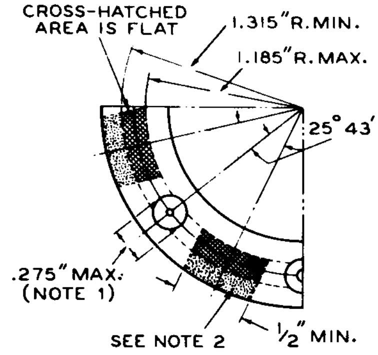
DIMENSIONAL OUTLINE



92CM-6878

ENLARGED BOTTOM VIEW

DETAIL OF BOTTOM VIEW OF KEYED JUMBO ANNULAR BASE



NOTE 1: MEASURED AT DISTANCE OF 1/32" BELOW BOTTOM OF ANNULAR BASE.

NOTE 2: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

KEYED ANNULAR BASE GAUGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAUGE WITH:

a. SIX HOLES HAVING DIAMETER OF 0.065" ± 0.001" AND ONE HOLE HAVING DIAMETER OF 0.150" ± 0.001". ALL HOLES HAVE DEPTH OF 0.265" ± 0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51°26' ± 5' ON CIRCLE DIAMETER OF 2.500" ± 0.001".

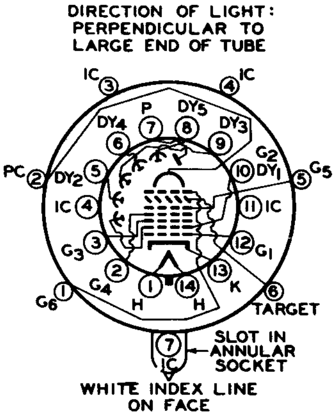
b. SIX STOPS HAVING HEIGHT OF 0.187" ± 0.001", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.

c. RIM EXTENDING OUT A MINIMUM OF 1/8" FROM 2-13/16" DIAMETER AND HAVING HEIGHT OF 0.126" ± 0.001".

d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200" ± 0.001".

Devices and arrangements shown or described herein may use patents of RCA or others. Information contained herein is furnished without responsibility by RCA for its use and without prejudice to RCA's patent rights.

SOCKET CONNECTIONS
Bottom View

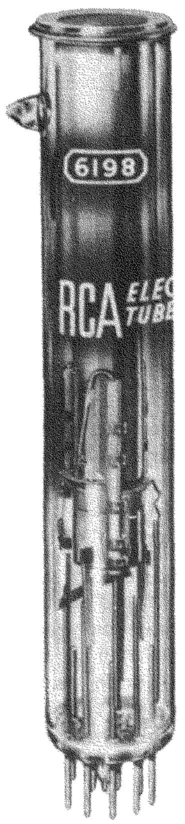


SMALL-SHELL DIHEPTAL 14-PIN BASE

PIN 1: HEATER
PIN 2: GRID No.4
PIN 3: GRID No.3
PIN 4: INTERNAL CONNECTION - DO NOT USE
PIN 5: DYNODE No.2
PIN 6: DYNODE No.4
PIN 7: ANODE
PIN 8: DYNODE No.5
PIN 9: DYNODE No.3
PIN 10: DYNODE No.1, GRID No.2
PIN 11: INTERNAL CONNECTION - DO NOT USE
PIN 12: GRID No.1
PIN 13: CATHODE
PIN 14: HEATER

KEYED JUMBO ANNULAR 7-PIN BASE

PIN 1: GRID No.6
PIN 2: PHOTOCATHODE
PIN 3: INTERNAL CONNECTION - DO NOT USE
PIN 4: INTERNAL CONNECTION - DO NOT USE
PIN 5: GRID No.5
PIN 6: TARGET
PIN 7: INTERNAL CONNECTION - DO NOT USE



6198

VIDICON

Magnetic Focus
Magnetic Deflection

High Sensitivity
400-Line Resolution

TENTATIVE DATA

1"-Diameter Bulb
6-1/4" Length

RCA-6198 is a small, television camera tube intended primarily for use in industrial applications. Its small size and simplicity facilitate the design of the camera and associated equipment in comparison with that needed for larger types of camera tubes. The resolution capability of the 6198 is about 400 lines.

Utilizing a photoconductive layer as its light-sensitive element, the 6198 has a sensitivity which permits televising scenes with 100 to 200 foot-candles of incident illumination on the scene. The photoconductive layer is characterized by a spectral response approaching that of the eye.

The small size of the 6198 lends itself to use in light-weight, compact television cameras. The size and location of the photoconductive layer permit a wide choice of commercially available lenses.

PRINCIPLES OF OPERATION

The structural arrangement of the 6198, shown in Fig. 1, consists of the signal electrode, a transparent conducting film on the inner surface of the faceplate; a light-sensitive element consisting of a thin layer of photoconductive material deposited on the signal electrode; a fine mesh screen (grid No.4) located adjacent to the photoconductive layer; a focusing electrode (grid No.3) connected to grid No.4; and an electron gun for producing a beam of electrons.

Each element of the photoconductive layer is an insulator in the dark but becomes slightly conductive when it is illuminated and acts like a leaky capacitor having one plate at the fixed positive potential of the signal electrode and the other floating. When light from the scene being televised is picked up by an optical lens system and focused on the photoconductive-layer surface next to the faceplate, each illuminated layer element conducts slightly depending on the amount of illumination on the element and thus causes the potential of its opposite surface (on the gun side) to rise in less than the time of one frame toward that of the signal-electrode potential. Hence, there appears on the gun side of the entire layer surface a positive potential pattern, composed of the various element potentials, corresponding to the pattern of light from the scene imaged on the opposite surface of the layer.

The gun side of the photoconductive layer is scanned by a low-velocity electron beam produced by the electron gun. 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 surface of the photoconductive layer by the combined action of the uniform magnetic field of an external coil or permanent magnet and the electrostatic field of grid No.3. Grid No.4 serves to provide a uniform decelerating field between itself and the photoconductive layer so that the electron beam will approach the layer in a direction perpendicular to it--a condition necessary for driving the surface to cathode potential. The beam electrons approach the layer at low velocity because of the low operating potential of the signal electrode.

When the gun side of the photoconductive layer with its positive potential pattern is scanned by the electron beam, electrons are deposited from the beam in sufficient quantities until the surface potential is reduced to that of the cathode, and thereafter are turned back to form a return beam which is not utilized in this tube. Deposition of electrons on the scanned surface of any particular element of the layer causes a change in the difference of potential between the two surfaces of the element. When the two surfaces of the element, which in effect is a charged capacitor, are connected through the external signal-electrode circuit and the scanning beam, a capacitive current is produced and constitutes the video signal. The magnitude

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of the current is proportional to the surface potential of the element being scanned and to the rate of scan. The video-signal current is then used to develop a signal output voltage across a load resistor. The signal polarity is such that for highlights in the scene the grid of the first video-amplifier tube swings in a negative direction.

Alignment of the beam is accomplished by a transverse magnetic field produced by external coils located at the base end of the focusing coil.

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

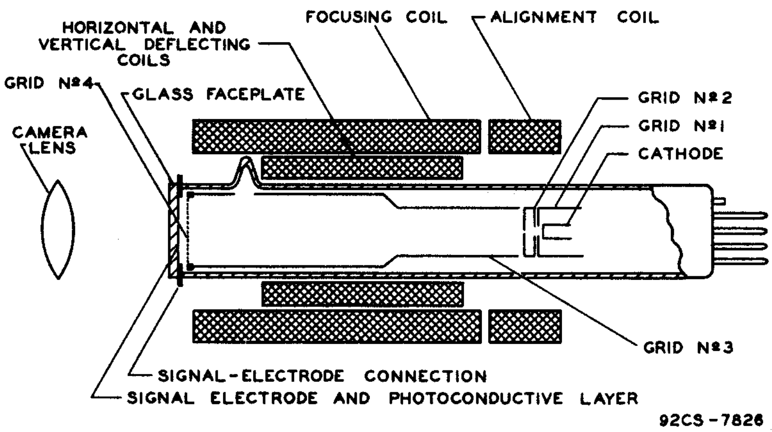


Fig. 1 - Schematic Arrangement of Type 6198.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current.	0.6	ampere
Direct Interelectrode Capacitance:		
Signal Electrode to All Other Electrodes. .	4.5	μμf
Spectral Response.		See Curve
Photoconductive Layer:		
Maximum Useful Diagonal of Rectangular Image (4 x 3 Aspect Ratio) .	0.62	inch

Orientation of Quality Rectangle—Proper orientation is obtained when the horizontal scan is essentially parallel to the plane passing through the tube axis and short index pin.

Focusing Method.	Magnetic
Deflection Method.	Magnetic
Overall Length	6-1/4" ± 1/4"
Greatest Diameter (Excluding Side Tip) .	1.125" ± 0.010"
Maximum Radius (Including Side Tip).	0.805"
Bulb	T-8
Base . . . . Small-Button Ditetrar 8-Pin	(JETEC No. E8-11)
Operating Position	Any

Maximum Ratings, *Absolute Values*:

SIGNAL-ELECTRODE VOLTAGE	125 max.	volts
GRID-No.4 & GRID-No.3 VOLTAGE. . . .	350 max.	volts
GRID-No.2 VOLTAGE.	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value.	125 max.	volts
Positive bias value.	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode. . .	125 max.	volts
Heater positive with respect to cathode. . .	10 max.	volts
FACEPLATE TEMPERATURE.	60 max.	°C

Typical Operation and Characteristics:

For scanned area of 1/2" x 3/8"

Signal-Electrode Voltage for Dark Current of 0.02 μamp . . .	10 to 125	volts
Grid-No.4 (Decelerator) & Grid-No.3 (Beam Focus) Voltage. . . .	200 to 300	volts
Grid-No.2 (Accelerator) Voltage. .	300	volts
Grid-No.1 Voltage (For picture cutoff). .	-45 to -100	volts
Signal-Output Current:*		
Normal Operating Range	0.1 to 0.2	μamp
Minimum, with 0.6 foot-candle of uniform 2870°K tungsten illumination on tube face. . . .	0.02	μamp
Uniform 2870°K Tungsten Illumination on Tube Face to Produce Signal-Output Current of 0.1 to 0.2 μamp.	3 to 10	ft-c
Ratio (Approx.) of Tube-Face Illumination Required to Produce Signal-Output Current of 0.2 μamp to That Required to Produce 0.02 μamp	30	
Minimum Peak-to-Peak Blanking Voltage:		
When applied to grid No.1 . . .	30	volts
When applied to cathode.	10	volts
Field Strength at Center of Focusing Device.	40	gausses
Field Strength of Adjustable Alignment Coil	0 to 4	gausses

* Defined as the component of the signal-electrode current after the dark-current component has been subtracted.

OPERATING CONSIDERATIONS

The *base pins* of the 6198 fit the ditetrar 8-pin connector, such as Cinch No.54A18088, or equivalent.

The *signal-electrode connection* is made by a suitable spring contact bearing against the edge of the metal flange at the face end of the tube. This spring contact may conveniently be provided as part of the focusing-coil design.

Support for the 6198 is provided by a suitable spring-finger suspension at the face end of the tube and by a clamping mechanism near the base end. Orientation of the 6198 in its support should be such that the horizontal scan is essentially parallel to the plane passing through the tube axis and the short index base pin.

The *lens* used with the 6198 may be chosen from a large variety of commercially available camera lenses. It should be a high-quality type incorporating an iris to control the amount of light passing through it. An f:2 lens of the type used for 16-mm movie cameras in satisfactory for many applications. The lens holder should have all inside surfaces finished in matte black to prevent internal reflections from reaching the photoconductive layer, and should provide suitable focusing means. Under almost all conditions, the use of a lens shade is beneficial.

Electrostatic shielding of the signal electrode from external fields is required to prevent interference effects in the picture. Effective shielding is ordinarily provided by grounding a shield on the inside of the faceplate end of the focusing coil; by grounding a shield on the inside of the deflecting yoke; and by grounding the lens mount and its supporting assembly.

The *temperature* of the faceplate should not exceed 60°C (140°F), either during operation or storage of the 6198. Operation with a faceplate temperature in the range from about 25°C to 35°C (77° to 99°F) is recommended. The signal-output current and the dark current both increase with

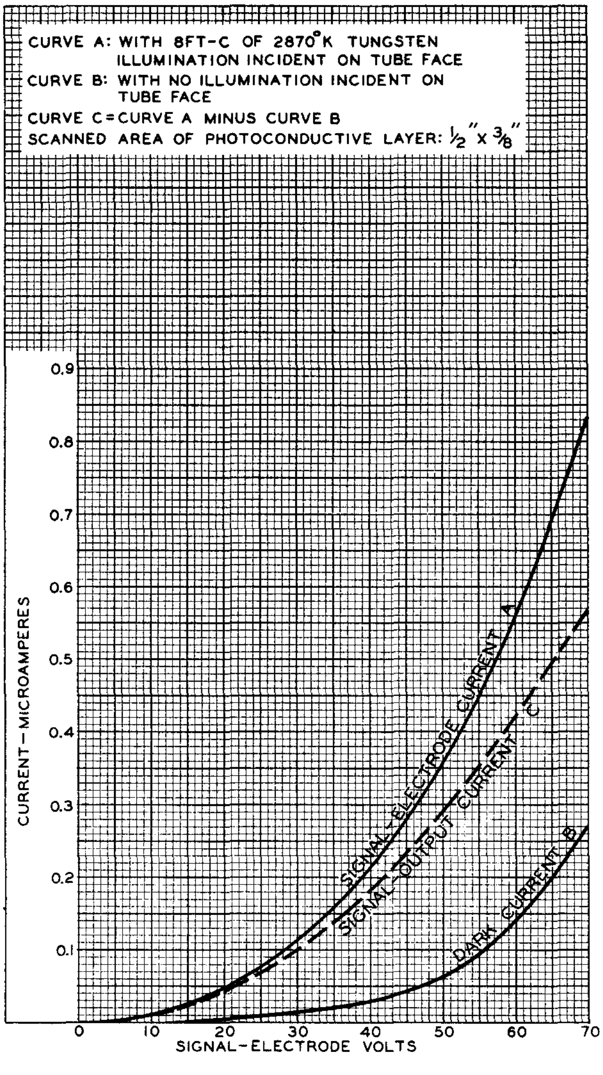


Fig.2 - Typical Characteristics of Type 6198.

increasing faceplate temperature for a given signal-electrode voltage and illumination. Since the dark current increases the more rapidly of the two, it is necessary to reduce the signal-electrode voltage in an effort to restore the signal output-to-dark current ratio. Operation with the faceplate at a temperature of 50° to 60°C causes some sacrifice in performance because the sensitivity at a given signal output-to-dark current ratio or the signal output-to-dark current ratio at a given sensitivity is somewhat lower than at lower temperature. Operation at the higher temperature, however, does not adversely affect the performance of the tube when it is subsequently operated at lower temperature.

The *signal-electrode voltage* should be obtained from a dc source which can provide a voltage adjustable over a range of 10 to 125 volts. As the signal-electrode voltage is increased, the signal-output current (i.e., the component of the signal-electrode current after the dark-current component has been subtracted) and the dark current both increase, as shown in Fig.2. However, a limiting value of signal-electrode voltage is reached beyond which the non-uniformity in the dark-current background of the transmitted picture is no longer tolerable.

For a given signal-electrode voltage, the sensitivity and dark current both tend to change gradually during the life of the tube. By making the signal-electrode voltage supply adjustable, the equipment designer can provide means to compensate for these changes.

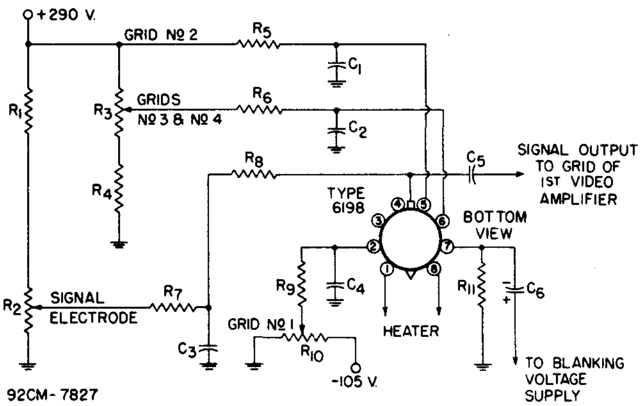
The *focusing-electrode (grid No.3) voltage* may be fixed at a value of about 250 volts when focusing control is obtained by adjusting the current through the focusing coil. The necessary range of current adjustment will depend on the design of the coil, but should be such as to provide a field-strength range of 36 to 44 gausses. When it is desired to use a fixed value of focusing-coil current, or to use a permanent-magnet type of focusing device, capable of providing a fixed strength of 40 gausses at the center of the focusing device, the grid-No.3 voltage should be adjustable over a range from 200 to 300 volts.

The *grid-No.1 voltage* should be adjustable from 0 to -100 volts.

The *dc voltages* required by the 6198 can be provided by the circuit shown in Fig.3.

A *blanking signal* should be supplied to grid No.1 or to the cathode to prevent the electron beam from striking the photoconductive layer during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the reproduced picture. The blanking signal is a series of negative voltage pulses when the blanking signal is applied to grid No.1, or a series of positive voltage pulses when the blanking signal is applied to the cathode.

Beam intensity is controlled by the amount of negative voltage on grid No.1. The beam must have adequate intensity to drive the highlight elements of the photoconductive-layer surface to cathode potential on each scan. When the beam has an intensity sufficient only to drive the lowlight elements to cathode potential, the highlight elements are not returned to cathode potential. As a result, the picture highlights all have the same brightness and show no detail. It is also to be noted with a beam of insufficient intensity that the photoconductive-layer surface, which normally rises in potential by only a small fraction of the signal-electrode potential during each scan, gradually rises in potential to a value approaching nearly the full signal-electrode potential in the highlights. Under this condition, many scans of a beam with inadequate intensity



C1 C4: 0.01 μf, 300 volts (working voltage)
C2: 0.1 μf, 300 volts (working voltage)
C3 C5: 0.1 μf, 200 volts (working voltage)
C6: 4 μf, electrolytic, 300 volts (working voltage)
R1: 120000 ohms, 1/2 watt
R2: 100000-ohm potentiometer, 2 watt
R3: 50000-ohm potentiometer, 2 watt
R4: 70000 ohms, 1/2 watt
R5: 5000 ohms, 1/2 watt
R6: 10000 ohms, 1/2 watt
R7: 200000 ohms, 1/2 watt
R8: 50000 ohms, non-inductive, 1/2 watt
R9: 100000 ohms, 1/2 watt
R10: 500000-ohm potentiometer, 2 watt
R11: 1000 ohms, non-inductive, 1/2 watt

Fig.3 - Typical Voltage Dividers for Supplying DC Electrode Voltages to Type 6198.

are required to drive to cathode potential any element which has changed from a highlight to a lowlight because of movement of the subject. As a result, the highlights tend to "stick". The loss of detail in and sticking of the highlights is referred to as "bloom."

On the other hand, a beam with excessively high intensity should not generally be used because the size of the scanning spot increases with resultant decrease in resolution.

When the 6198 is operated under normal conditions with adequate but not excessive beam intensity, it will be noted that any sudden, large excess of illumination on the televised scene will cause bloom in the televised picture.

The *video amplifier* should be designed to cover a range of ac signal voltages corresponding to signal-output current of 0.02 to 0.2 microampere in the load resistor. A low-noise, video amplifier suitable for use with the 6198 is shown in Fig.4. This amplifier has an 8-Mc bandwidth and incorporates a gain control as well as a frequency- and phase-compensation control.

Resolution of better than 350 lines at the center of the picture can be produced by the 6198. To utilize the resolution capability of the 6198 in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles per second. The maximum resolution obtainable is limited by the size of the scanning-beam spot.

The *illumination* on the photoconductive layer is related to the scene illumination by the formula

$$I_s = \frac{4f^2\ I_{pl}\ (m+1)^2}{TR}$$

where

I_s = scene illumination in foot-candles
f = f-number of lens
I_{pl} = photoconductive-layer illumination in foot-candles
m = linear magnification from scene to photoconductive layer
T = total transmission of lens
R = reflectance of part of scene under consideration.

Except for very close shots, the linear magnification (m) from scene to photoconductive layer may be neglected.

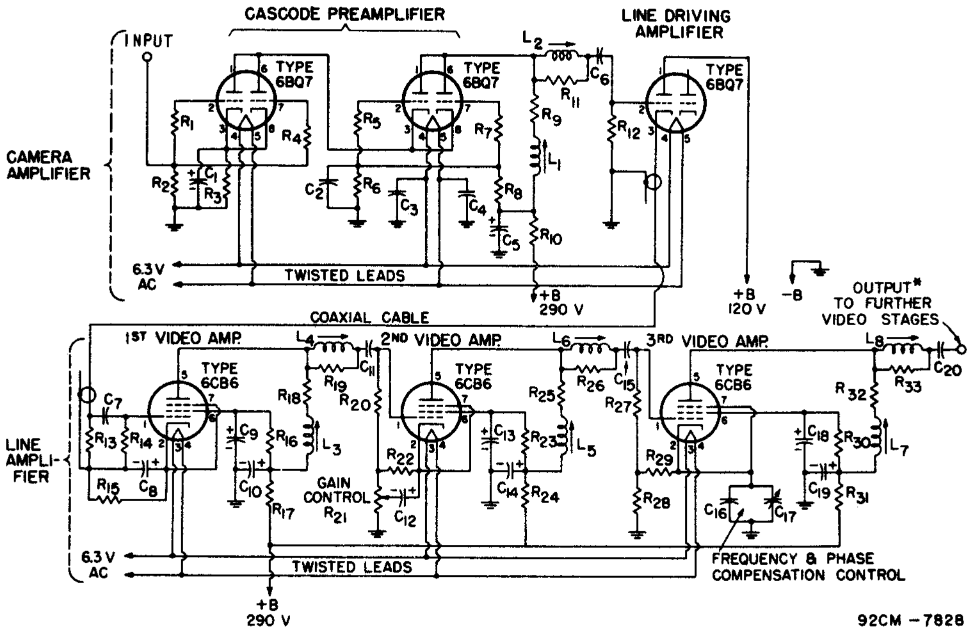
For example, assume that the lens is f:2 having a transmission (T) of 75%, that the photoconductive layer illumination (I_{pl}) is 3 foot-candles, and that the brightest part of the scene under consideration has a reflectance (R) of 50%. Then,

$$I_s = \frac{4 \times 2^2 \times 3}{0.75 \times 0.50} = 128 \text{ foot-candles}$$

It is good practice before attempting to transmit a particular scene to check its incident illumination with an illumination-measuring device, such as an exposure meter.

The *minimum illumination level* which can be used on the photoconductive layer to give a picture depends on a compromise between the ratio of signal-output current to amplifier noise and the ratio of signal-output current to vidicon dark current. Either of these ratios may be a limiting factor depending on the choice of signal-electrode voltage. When the signal-electrode voltage is kept low, the dark current is low. Under this condition, the minimum value of illumination is that which will give a signal-output current larger than the noise of the amplifier. With the usual compensated amplifier, the rms amplifier noise is a fixed amount equivalent to a signal-output current of about 0.002 microampere. The signal-output current can be increased for a given illumination level by raising the signal-electrode voltage as indicated in Fig.2, but it will be noted that the dark current also increases and at a faster rate than the signal-output current. As the signal-electrode voltage is raised, the dark current reaches a

Typical signal output as a function of uniform 2870°K tungsten illumination on the photoconductive layer of the 6198 is shown in Fig.5. It will be noted that if an increase of 10 times in signal-output current is desired, the illumination must be increased by about 30 times.



Coaxial Cable: Amphenol No.21-025 (Army-Navy No.RG-59/U), or equivalent.
C1 C8: 50 μf, electrolytic, 3 volts (working voltage)
C2 C11 C15 C20: 0.1 μf, 300 volts (working voltage)
C3 C4 C7: 0.1 μf, 100 volts (working voltage)
C5 C9 C10 C13 C14 C18 C19: 10 μf, electrolytic, 300 volts (working voltage)
C6: 0.05 μf, 300 volts (working voltage)
C12: 100 μf, electrolytic, 50 volts (working voltage)
C16: 120 $\mu\mu$f, ceramic, 150 volts (working voltage)
C17: 50 - 150 $\mu\mu$f, ceramic, adjustable, 150 volts (working voltage)
L1: 19 μh peaking coil, adjustable core to cover range from 15 to 23 μh
L2 L3 L5 L7: 24 μh peaking coil, adjustable core to cover range from 20 to 30 μh
L4 L6 L8: 5 μh peaking coil, adjustable core to cover range from 4 to 6 μh

All of the following resistors are of the non-inductive type

R1 R4 R5 R7: 100 ohms, 1/2 watt
R2: 250000 ohms, 1/2 watt
R3: 51 ohms, 1/2 watt
R6: 82000 ohms, 1/2 watt
R8: 100000 ohms, 1/2 watt
R9: 2000 ohms, 1 watt
R10: 1000 ohms, 1 watt
R11: 10000 ohms, 1/2 watt
R12 R14 R20 R27: 510000 ohms, 1/2 watt
R13: 75 ohms, 1/2 watt
R15: 120 ohms, 1/2 watt
R16 R30: 3000 ohms 1/2 watt
R17 R24: 10000 ohms, 2 watt
R18 R25 R32: 1500 ohms, 1/2 watt
R19 R26 R33: 6800 ohms, 1/2 watt
R21: 1000-ohm potentiometer, 2 watts
R22: 200 ohms, 1/2 watt
R23: 15000 ohms, 1/2 watt
R28: 7500 ohms, 2 watts
R29: 150 ohms, 1/2 watt
R31: 3000 ohms, 1 watt

* This output circuit is designed to work into a 6CB6 as video amplifier. With gain control (R21) set at minimum and 0.2 microampere signal-current input to camera amplifier, the output voltage is 0.25 volt peak to peak; with gain control set at maximum and with 0.015 microampere signal-current input, the output voltage is 0.25 volt peak to peak.

Fig.4 - Low-noise Video Amplifier for use with Type 6198.

value beyond which the non-uniformity in the dark-current background of the picture becomes intolerable. When this condition occurs, nothing further can be gained by increasing the signal-electrode voltage. It is evident, therefore, that the optimum operating point is a compromise to give the best ratio of signal-output current to both noise and to dark current, and that a useful ratio can be realized only when the level of illumination is adequate to give a value of signal-output current several times larger than either the amplifier noise current or the dark current.

Persistence of the photoconductive layer in the 6198 is given by the curve in Fig.6. This curve shows the decay in signal-output current from an initial value of 0.2 microampere after the illumination is cut off. With adequate illumination on the photoconductive layer, the persistence is sufficiently short to prevent smearing except when the subject moves rapidly across the field of view. With low levels of illumination, the persistence increases somewhat with the result that there is a greater tendency for moving objects to produce smearing. To

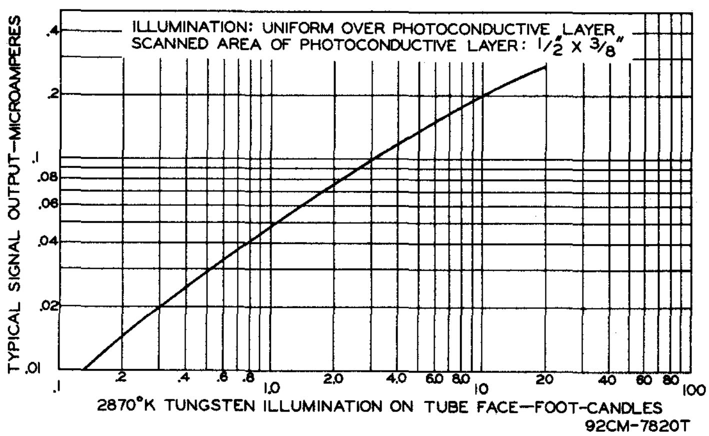


Fig.5 - Typical Signal Output of Type 6198.

minimize smearing, the use of more illumination is recommended.

Signal-output-current buildup when light is applied to the photoconductive layer previously in the dark is as fast as or faster than the rate of decay indicated by the persistence curve in Fig.6.

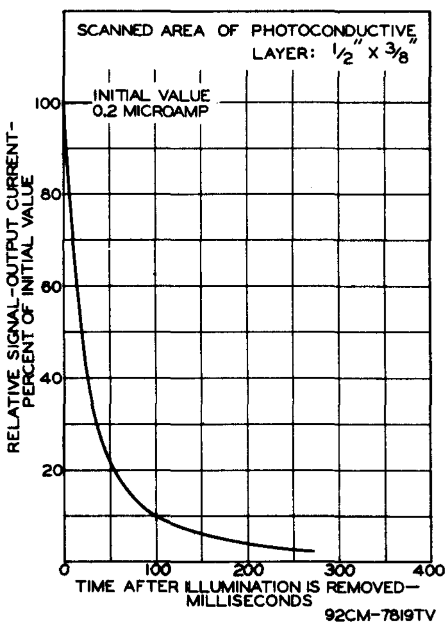


Fig.6 - Persistence Characteristic of Type 6198.

The *spectral response* of the 6198 is shown by curves A and C in Fig.7. Curve A is on the basis of equal values of signal-output current at all wavelengths, whereas curve C is on the basis of equal values of signal-output current with radiant flux from a tungsten source at 2870°K. For comparison purposes, the response of the eye is shown in curve B.

Full-size scanning of the photoconductive layer should always be used. Full size scanning can be assured by first adjusting the deflection circuits to overscan the photoconductive layer sufficiently to cause the edges of the sensitive area to be visible in the corners of the picture, and then reducing the scanning until the edges just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. It is to be noted that overscanning the photoconductive layer produces a smaller-than-normal picture on the monitor.

Underscanning the photoconductive layer, i.e., scanning an area of the layer less than the useful quality area, should never be permitted. Underscanning produces a larger-than-normal picture on the monitor. Because the scanned area may exhibit a permanent change in sensitivity and dark current during operation, an underscanned area showing such change will be visible in the picture when full-size scanning is restored.

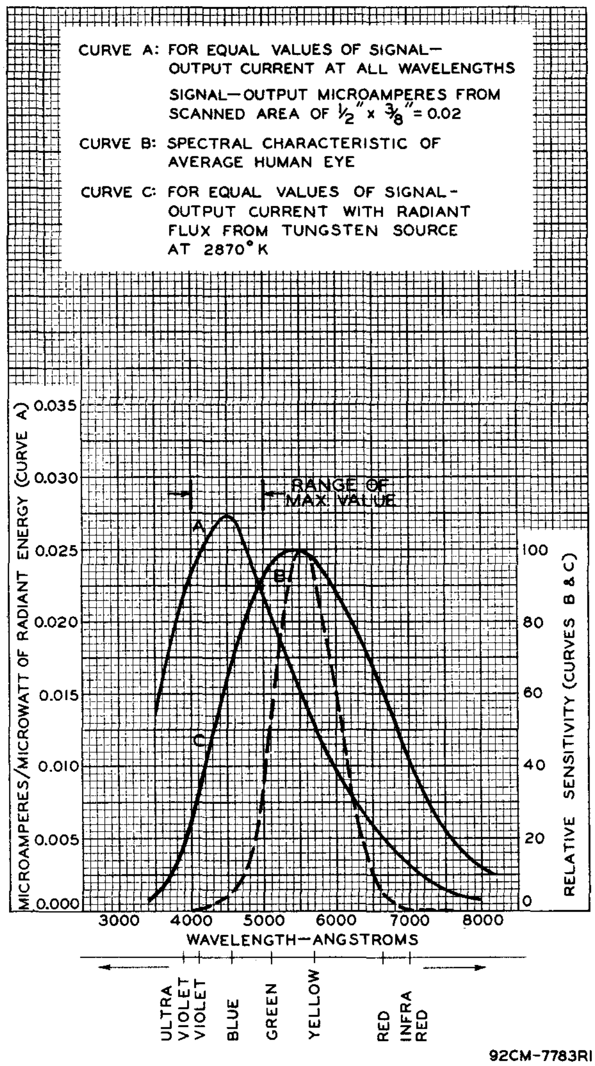


Fig.7 - Spectral Sensitivity Characteristic of Type 6198.

Failure of scanning even for a few minutes may permanently damage the photoconductive layer. The damaged area shows up as a spot or line in the picture during subsequent operation. To avoid damaging the 6198 during scanning failure, it is necessary to prevent the scanning beam from reaching the layer. The scanning beam can conveniently be prevented from reaching the layer by increasing the grid-No.1 voltage to cutoff.

The *sequence of adjustments* in operating the 6198 is as follows: With the grid-No.1 voltage control set for maximum bias (beam cutoff) and with the camera lens iris closed, apply voltages to the tube as indicated under Typical Operation. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the photoconductive layer. Set the signal-electrode voltage at about 25 volts for a first trial. Then open the iris partially and image a scene of adequate intensity on the photoconductive layer. Next, decrease the grid-No.1 voltage until a picture appears on the monitor screen. The lowlights will appear first. Adjust grid-No.1 voltage to bring out a complete picture from the entire scanned area. Then adjust grid-No.3 voltage (or the magnetic-field strength of the focusing coil if fixed grid-No.3 voltage is used) and the optical focus alternately to obtain the best picture. Next, adjust the deflection amplitude and centering to scan the desired area on the photoconductive layer. If the picture is faint (corresponding to an average signal-electrode current of less than 0.05 microampere), even with adequate video amplifier gain, open the lens iris somewhat more and, if necessary, increase the signal-electrode voltage to give a brighter picture. The signal-electrode voltage, however, should not be increased to the extent that it produces an uneven background that is visible on the monitor with the lens capped. Dark current is excess of 0.1 microampere will cause excessive shading. Then, adjust the alignment field so that the center of the picture does not move as the grid-No.3 voltage is varied, and so that the picture has the best shading. Finally, readjust the grid-No.1 voltage for the best resolution in the picture. A signal-electrode current of more than 0.2 microampere is not desirable because resolution is sacrificed.

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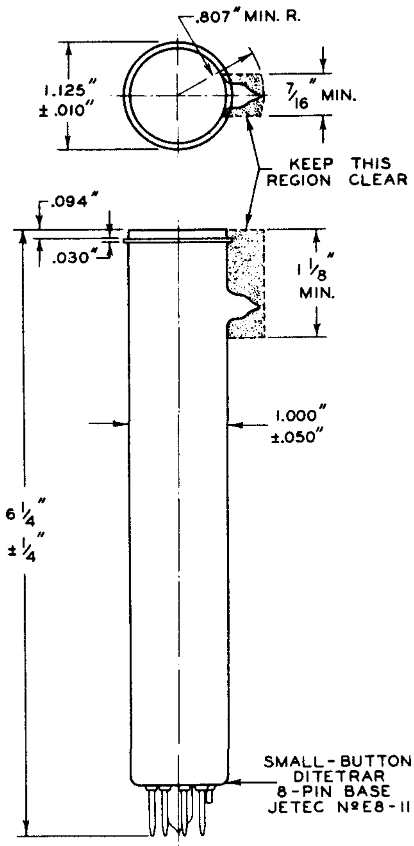
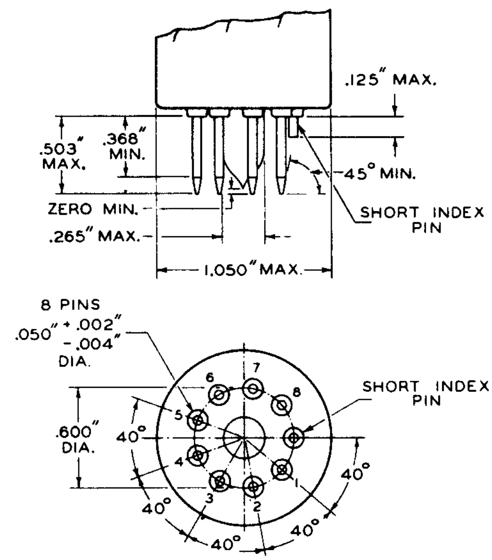
DIMENSIONAL OUTLINE



92CS-7772

BASE DRAWING

SMALL - BUTTON DITETRAR
8-PIN BASE
JETEC Nº E8-11



92CS - 7765

Base-pin positions are held to tolerances such that pins will fit a flat-plate gauge having thickness of 1/4" and 9 holes 0.0700" ± 0.0005" so located on a 0.6000" ± 0.0005" diameter circle that the distance along the chord between any two adjacent hole centers is 0.2052" ± 0.0005". Gauge is provided with center hole having diameter of 0.300" ± 0.001" and same center as the pin circle.

SOCKET CONNECTIONS
Bottom View

PIN 1: HEATER

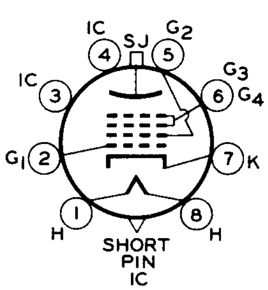
PIN 2: GRID No.1

PIN 3: INTERNAL CONNECTION—DO NOT USE

PIN 4: INTERNAL CONNECTION—DO NOT USE

PIN 5: GRID No.2

PIN 6: GRIDS No.3 and No.4



DIRECTION OF LIGHT:
INTO FACE END OF TUBE

PIN 7: CATHODE

PIN 8: HEATER

FLANGE: SIGNAL ELECTRODE (SJ)

SHORT INDEX PIN: INTERNAL CONNECTION—MAKE NO CONNECTION

6474/1854

IMAGE ORTHICON

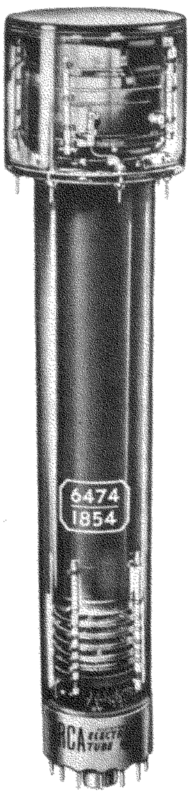
Magnetic Focus
Magnetic Deflection

For Simultaneous Color Pickup
Exceptional Sensitivity

TENTATIVE DATA

3"-Diameter Bulb
15-1/4" Length

RCA-6474/1854 is a television camera tube intended for use in color cameras utilizing the method of simultaneous pickup of the studio or outdoor scene to be televised. This method employs three 6474's--one for each channel--to produce the information necessary for the formation of a color-television image.



The 6474 has exceptional sensitivity combined with a spectral response approaching that of the eye, and good resolution capability. With a color camera employing a suitably designed optical system and utilizing efficient color filters, commercially acceptable color pictures can be obtained with about 350 foot-candles of incident incandescent illumination on the scene and a lens stop of f:5.6.

The photocathode utilized in the 6474 is characterized by a relatively wide spectral response having high blue sensitivity, high green sensitivity, good red sensitivity, and practically no infrared sensitivity. This spectral characteristic enables the tube to translate colors very accurately when operated in a color camera with appropriate color filters and optical arrangements.

The 6474 is designed to operate on a substantially linear signal-output curve, and is thus capable of producing a picture having natural tone value and accurate detail. Furthermore, the 6474 features a signal-to-noise ratio and contrast range commensurate with the requirements of color reproduction.

The designation 6474/1854, or simply 6474, is the new type number for the image orthicon previously supplied under the type designation 1854.

PRINCIPLES OF OPERATION

The 6474 has three sections--an image section, a scanning section, and a multiplier section, as shown in Fig.1.

Image Section

The image section contains a semitransparent photocathode on the inside of the faceplate, a grid (grid No.6) 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 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 the 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 several volts with respect to target-voltage cutoff. 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. Because of the thinness of the glass, the charges set up a similar 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).

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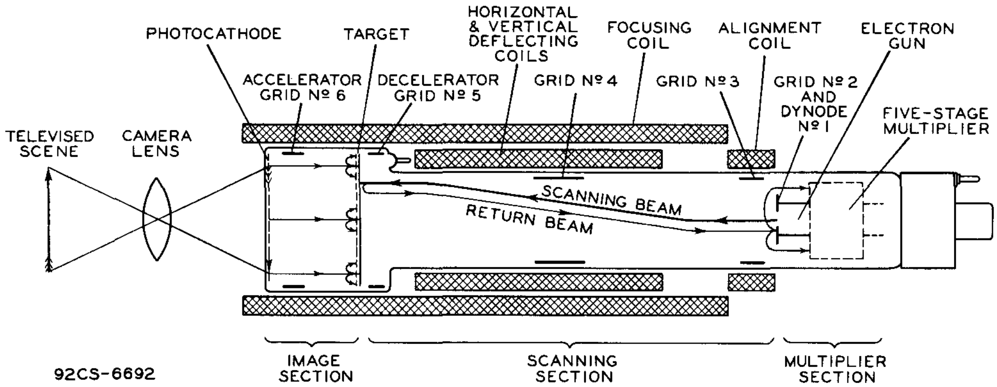


Fig. 1 - Schematic Arrangement of Type 6474.

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 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 utilizes 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. This multiplication permits the use of a video amplifier with fewer stages.

The signal-to-noise ratio of the output signal from the 6474 is high. The gain of the multiplier is such as to raise the output signal sufficiently above the noise level of the video amplifier stages so that they contribute no noise to the final video signal. The signal-to-noise ratio of the video signal, therefore, is determined only by the random variations of the modulated electron beam.

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 (R_{25} in Fig.2) changes in the positive direction. Hence, for highlights in the scene, the grid of the first video-amplifier stage swings in the positive direction.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current.	0.6	ampere
Direct Interelectrode Capacitance:		
Anode to all other electrodes. . . .	20	$\mu\mu$f
Photocathode, Semitransparent:		
Response		See Fig.3
Rectangular Image (4 x 3 aspect ratio):		
Useful size of	1.6" max.	Diagonal
Orientation of . .	Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of faceplate and pin No.7 of the shoulder base.	

Focusing Method	Magnetic
Deflection Method	Magnetic
Overall Length	15-3/16" ± 1/4"
Greatest Diameter of Bulb	3" ± 1/16"
Shoulder Base	Keyed Jumbo Annular 7-Pin
End Base	Small-Shell Diheptal 14-Pin Base (JETEC No. B14-45)
Operating Position	See Text
Weight (Approx.)	1 lb 6 oz
Minimum Deflecting-Coil Inside Diameter	2-3/8"
Deflecting-Coil Length	5"
Focusing-Coil Length	10"
Alignment-Coil Length	15/16"
Photocathode Distance Inside End of Focusing Coil	1/2"

Maximum Ratings, ***Absolute Values*****:**

PHOTOCATHODE:		
Voltage	-550 max.	volts
Illumination	50 max.	ft-c
OPERATING TEMPERATURE:		
Of any part of bulb	50 max.	^{o}C
Of bulb at large end of tube (Target section)	35 min.	^{o}C
TEMPERATURE DIFFERENCE:		
Between target section and any part of bulb hotter than target section	5 max.	^{o}C
GRID-No.6 VOLTAGE	-550 max.	volts
TARGET VOLTAGE:		
Positive value	10 max.	volts
Negative value	10 max.	volts
GRID-No.5 VOLTAGE	150 max.	volts
GRID-No.4 VOLTAGE	300 max.	volts
GRID-No.3 VOLTAGE	400 max.	volts
GRID-No.2 & DYNODE-No.1 VOLTAGE	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
ANODE-SUPPLY VOLTAGE*	1350 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts

Typical Operation and Characteristics:

Photocathode Voltage (Image Focus)	-300 to -500	volts
Grid-No.6 Voltage (Accelerator)--75% of photocathode voltage	-225 to -375	volts
Target Voltage^{o}	0 to 3	volts
Grid-No.5 Voltage (Decelerator)	0 to 125	volts
Grid-No.4 Voltage (Beam Focus)	160 to 220	volts
Grid-No.3 Voltage#	225 to 330	volts
Grid-No.2 & Dynode-No.1 Voltage	300	volts
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	volts
Dynode-No.2 Voltage	600	volts
Dynode-No.3 Voltage	800	volts
Dynode-No.4 Voltage	1000	volts
Dynode-No.5 Voltage	1200	volts
Anode Voltage	1250	volts
Anode Current (DC)	30	μamp
Signal-Output Current (Peak to peak)	3 to 20	μamp
Target Temperature Range (See Text)	35 to 45	^{o}C
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.)	60	
Minimum Peak-to-Peak Blanking Voltage	5	volts
Field Strength at Center of Focusing Coil▲	75	gausses
Field Strength of Alignment Coil (Approx.)	0 to 3	gausses

* Ratio of dynode voltages is shown under *Typical Operation.*

^{o} Adjustable from -3 to +5 volts with blanking voltage off.

\# Adjust to give the most uniformly shaded picture near maximum signal.

▲ Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

INSTALLATION

The *end-base pins* of the 6474 fit the small diheptal 14-contact socket. The *annular-base pins* fit the keyed jumbo annular 7-contact socket which should be rigidly fastened to the deflecting-coil assembly.

The 6474 has two complementary guides for inserting the tube correctly in the annular socket, i.e., the large pin (No.7) on the annular base, and the white radial line on the face of the bulb. The annular socket should be positioned so that the key pin (No.7) of the annular base is in a vertical plane through the common axis of the deflecting-coil assembly and the focusing-coil assembly.

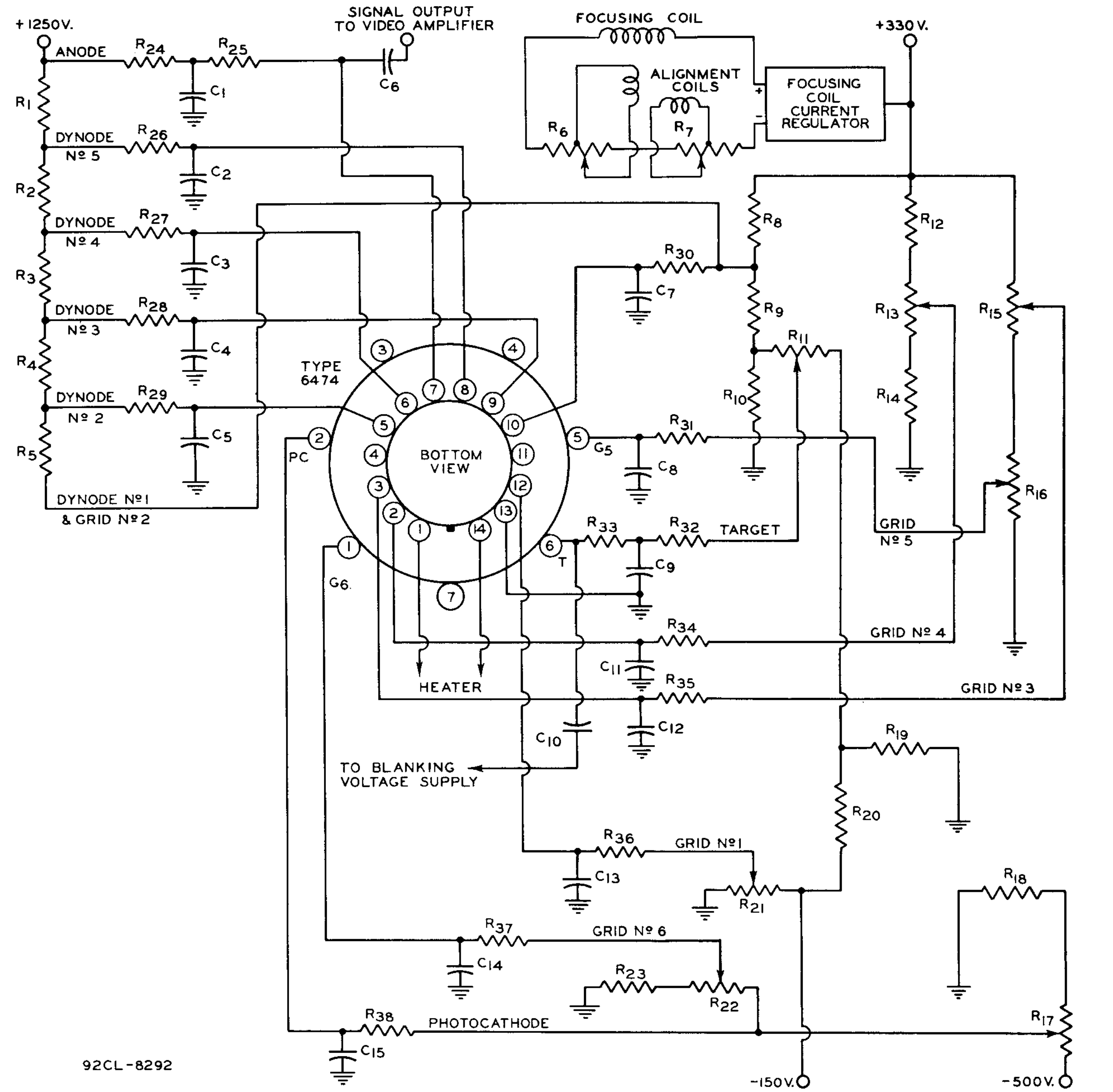
The 6474 is installed by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin No.7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the key-pin hole in the annular socket. The diheptal socket is then put on the 14-pin base.

Proper orientation of the annular socket with respect to the horizontal-deflecting field is essential, and is obtained when the plane which is perpendicular to the plane of the annular socket and which passes through the center of the annular socket and the center line between pins 3 and 4 of the annular base is at right angles to the horizontal scanning field. This orientation minimizes beat-pattern effects by placing the sides of the mesh holes at an angle of 45^{o} with respect to the horizontal scanning lines.

The *operating position* of the 6474 should preferably be such that any loose particles in the neck of the tube will not fall down and strike or become lodged on the target. Therefore, it is recommended that the tube never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with base up makes an angle of less than 20^{o} with the vertical.

A *mask* having a diagonal or diameter of 1.6 inches should always be used on the photocathode to set limits for the maximum size of scan, and to reduce the amount of light reaching unused parts of the photocathode.

The *optical system* used with the 6474 should be designed according to basic optical principles and should incorporate an iris to control the amount of light entering the television camera lens. The entire optical system should have all



C1 C2: 0.05 μf, 1600 v working voltage
C3: 0.01 μf mica, 1600 v working voltage
C4: 0.001 μf mica, 1000 v working voltage
C5: 0.001 μf mica, 600 v working voltage
C6: 0.03 μf mineral-oil impregnated, 1600 v working voltage
C7 C8 C9 C11 C12 C13 C14 C15: 0.001 μf mica, 400 v working voltage
C10: 1 μf, 400 v working voltage
R1: 47000 ohms, 1/2 watt
R2 R3 R4: 220000 ohms, 1/2 watt
R5: 270000 ohms, 1/2 watt
R6 R7: 200-ohm potentiometer, center-tapped, 2 watts
R8: 5100 ohms, 1/2 watt
R9: 51000 ohms, 2 watts
R10: 510 ohms, 1/2 watt
R11: 150000-ohm potentiometer, 1/2 watt
R12: 100000 ohms, 1/2 watt
R13: 75000-ohm potentiometer, 1 watt
R14: 150000 ohms, 1/2 watt
R15: 250000-ohm potentiometer, 1 watt
R16: 150000-ohm potentiometer, 1 watt
R17: 250000-ohm potentiometer, 1 watt
R18: 510000 ohms, 1 watt
R19: 11000 ohms, 1/2 watt
R20: 310000 ohms, 1/2 watt
R21: 500000-ohm potentiometer, 1 watt
R22: 250000 ohms, 1 watt
R23: 560000 ohms, 1/2 watt
R24: 47000 ohms, 1/2 watt
R25: 20000 ohms, 1/2 watt
R26 R27: 100000 ohms, 1/2 watt
R28 R29 R31 R32 R34 R35 R36 R37 R38: 200000 ohms, 1/2 watt
R30: 50000 ohms, 1/2 watt
R33: 100000 ohms, 1/2 watt

Fig. 2 - Voltage-Divider Circuit for Type 6474 with Recommended Arrangement for Connecting the Focusing Coil and Alignment Coils.

inside surfaces finished in mat black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

Proper shielding of the image section can be provided by wrapping around the outside of the focusing coil directly over the center of the deflecting coils a triple layer of Mumetal strip 0.006" thick and 5" wide, or equivalent. Then, wrap another triple layer of Mumetal strip 0.006" thick and 3" wide around the focusing coil directly over the image section of the 6474. Additional shielding is provided by fitting the inside of the focusing coil directly over the image section with a copper cylinder having a length of approximately 2-1/4" and a wall thickness of 1/32". The Mumetal shielding effectively shunts the field-rate deflection field, while the copper cylinder shields the higher frequency line-scanning field from the electron path in the image section. Unless proper shielding is provided, "cross talk" from the deflecting yoke into the image section will result in loss of picture sharpness.

For the *high dc voltages* required by the 6474, the use of two pulse supplies for which the plate voltage is provided by a well-regulated, 330-volt, B-supply may be used. Each of these supplies should be actuated by the horizontal driving pulse which is obtained from the synchronizing generator. One of the pulse supplies should be capable of furnishing 1250 volts with an output current of 1 milliampere for the multiplier section; the other pulse supply should be capable of furnishing -500 volts with an output current of 1 milliampere for the image section. In addition to supplying the plate voltage and current for the pulse supplies, the 330-volt B-supply should also provide an output current of 90 milliamperes for the focusing and alignment coils and for the voltage divider which is used to supply the voltages for the electrodes in the scanning section of the 6474. Provision should be made for regulating the focusing-coil current.

A *voltage divider* to provide the required operating voltages for the various electrodes of the 6474 is shown in Fig.2. It is to be noted that the blocking capacitor C_6 should be of the mineral-oil impregnated type to minimize capacitor leakage which will introduce disturbing effects into the picture.

In designing a voltage divider for the multiplier stages of the 6474, engineers should recognize that the dc output of individual 6474's may have a range of 10 to 1. This range, therefore, must be considered in the choice of bleeder-resistor values. If the values are too high, the distribution of voltages applied to the dynodes will be upset by a 6474 with a dc output at the upper end of the range. As a result, there will be an abrupt drop in the ac output of the tube as the beam current is increased. When this drop occurs before the beam is at its optimum value, the ratio of signal to noise will be lessened, and compression of the signal information will result.

Even with satisfactory bleeder-resistor values, it is possible to overload the tube itself. For 6474's having high dc outputs, a current reversal can occur at the 5th dynode stage of the multiplier as the beam current is increased. This current reversal will also produce a sharp drop in the ac output of the tube. To prevent such current reversal, it is recommended that provision be made to reduce the overall multiplier voltage for tubes with dc outputs at the upper end of the range. A reduction to 1000 volts should be adequate.

A *blanking signal* should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking periods, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance. Excessive amounts of blanking voltage applied to the target will impair resolution, since during retrace the target is out of focus to the continuously flowing photocathode current. A desirable amount of target blanking is 6 volts peak to peak.

Shading may be required even with optimum adjustment of voltage on grid No.3 in order to obtain a uniformly shaded picture. Sawtooth and parabolic waveforms of adjustable amplitude and polarity at both the vertical- and horizontal-scanning frequency should be provided for insertion in the video amplifier to aid in obtaining a flat background. The shading signal should be introduced in the amplifier after clamping is performed, since clamping circuits will remove the vertical-frequency shading component if added previous to the clamp-circuit location.

The *video amplifier* should be designed to cover a range of ac signal voltages corresponding to signal-output current of 3 to 20 microamperes peak to peak in the load resistor (R_{25} in Fig.2). For bandwidth, refer to *Resolution* under OPERATING CONSIDERATIONS.

Failure of scanning even for a few minutes when light is incident on the photocathode may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

To avoid damaging the 6474 during scanning failure, provision should be made to prevent automatically the scanning beam from reaching the target. The scanning beam can be prevented from reaching the target by (1) cutting off the scanning beam, or (2) making the target sufficiently negative. The scanning beam can be cut off by a relay which applies −115 to −125 volts bias to grid No. 1. The target can be made sufficiently negative by a relay which applies a bias of at least −10 volts to it. Either relay is actuated by a tube which is controlled by a portion of the scanning pulse voltage developed across either the horizontal or the vertical deflecting coils, or both. It is important to insure that the horizontal scanning pulse and the vertical scanning pulse should each independently actuate the relay in case either one fails.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data for the 6474 are limiting values above which the serviceability of the 6474 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

New 6474's should be placed in service immediately upon receipt. They should be operated for several hours before being set aside as spares.

Spare 6474's should be placed in service for several hours at least once a month in order to keep them free from traces of gas which may be liberated within the tube during prolonged storage.

Rotation in the use of 6474's is recommended. After a 6474 is operated for 200 to 300 hours, it should be given an idle period of three or four weeks during which it generally will recover much of its original resolution and sensitivity.

Occasionally, a *white spot* which does not change in size when the beam-focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation, the 6474 should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

The *spectral response* of the 6474 is shown in Fig.3 and is not subject to appreciable variation from tube to tube.

The *operating temperature* of any part of the glass bulb should never exceed 50°C, and no part of the bulb at the large end of the tube (target section) should ever fall below 35°C during operation. The temperature of the target is essentially the same as that of the adjacent glass bulb and can, therefore, be determined by measuring the temperature of the glass bulb adjacent to the target. For best results, it is recommended that the temperature of the entire bulb be held between 35° and 45°C. Operation at too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the

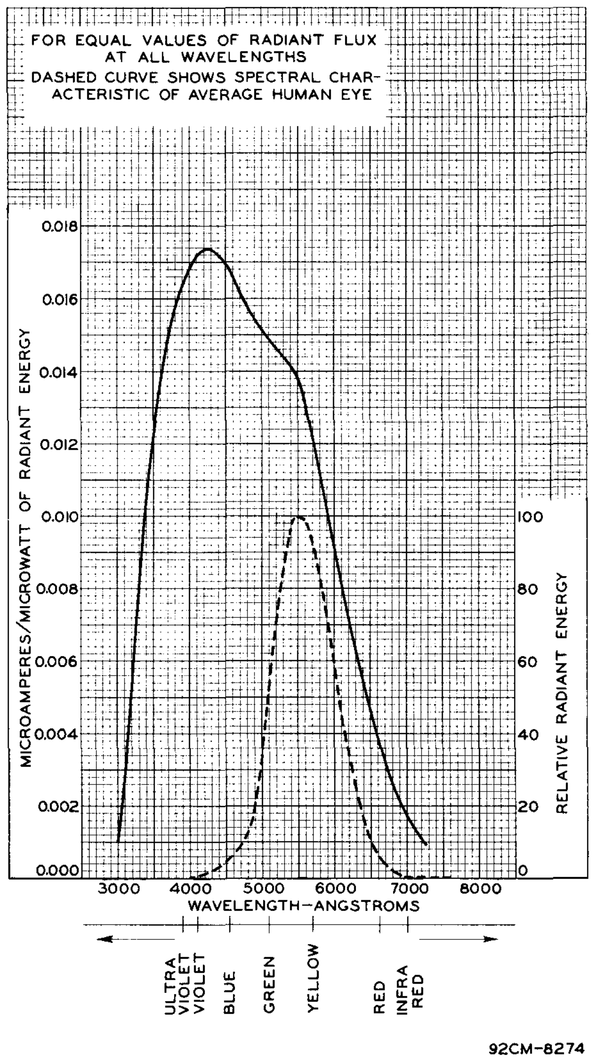


Fig.3 - Spectral Sensitivity Characteristic of Type 6474.

tube. Resolution is regained by waiting for the temperature to drop below 45°C. *No part of the bulb should run more than 5° hotter than the target section to prevent cesium migration to* *the target.* Such migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 6474 may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

When the equipment design or operating conditions are such that the maximum temperature rating or maximum temperature difference as given under *Maximum Ratings* will be exceeded, provision should be made to direct a blast of cooling air from the diheptal-base end of the tube along the entire length of the bulb surface, i.e., through the space between the bulb surface and the surrounding deflecting-coil assembly and its extension. Any attempt to effect cooling of the tube by circulating even a large amount of air around the focusing coil will do little good, but a small amount of air directly in contact with the bulb surface will effectively drop the bulb temperature. For this purpose, a small blower is satisfactory, but it should be run at low speed to prevent vibration of the 6474 and the associated amplifier equipment. Unless vibration is prevented, distortion of the picture may occur.

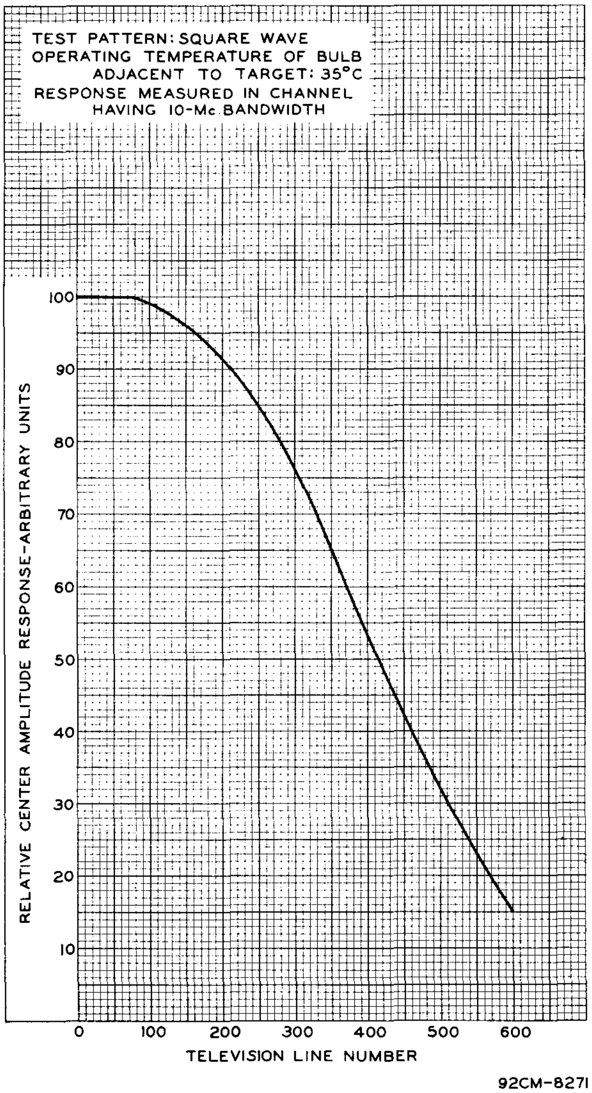


Fig.4 - Amplitude Response Characteristic of Type 6474.

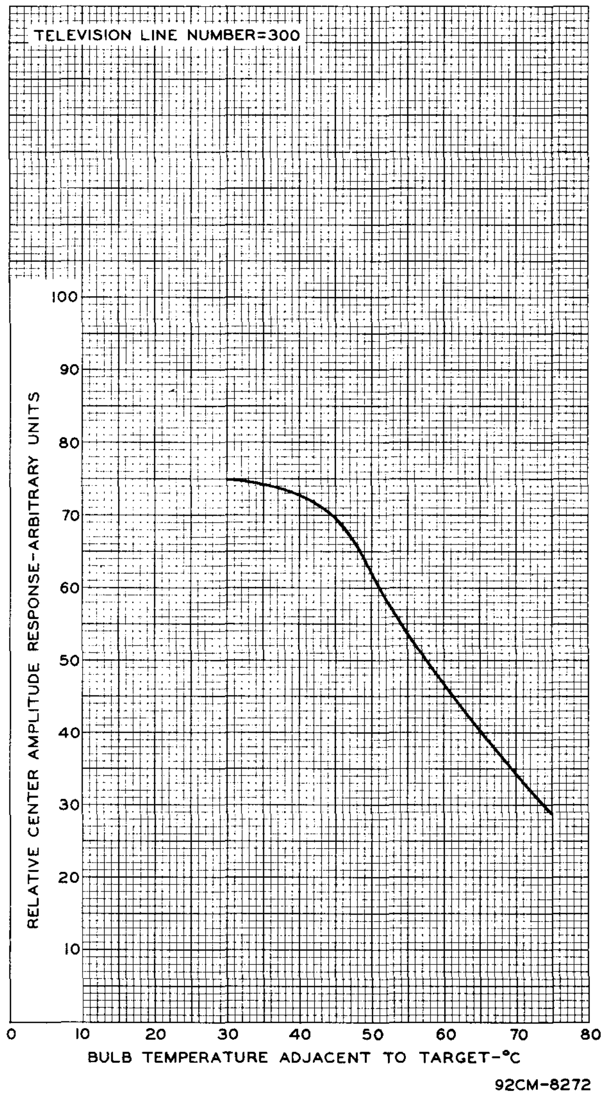


Fig.5 - Temperature Effect on Amplitude Response of Type 6474.

Ordinarily, the temperature in a camera equipped with a blower will not exceed 45°C, except in very hot weather or unless the target heater is left on accidentally for a long period.

To keep the operating temperature of the large end of the tube from falling below 35°C, some form of controlled heating should be employed. Ordinarily, adequate heat will be supplied by the focusing coil, deflecting coils, and associated amplifier tubes so that the temperature can be controlled by the amount of cooling air directed along the bulb surface. If, in special cases, a target heater is required, it should fit between the focusing coil and the bulb near the shoulder of the tube, and be non-inductively wound.

Full-size scanning of the target should always be used during on-the-air operation. Full-size scanning can be assured by first adjusting the deflection circuits to overscan the target sufficiently to cause the corners of the target to be visible in the picture, and then reducing the scanning until the corners just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. Full-size scanning will also reduce the prominence of a beat pattern (see *Resolution*). Note that overscanning the target produces a smaller-than-normal picture on the monitor.

Underscanning the target, i.e., scanning an area of the target less than its sensitive area, should never be permitted. Underscanning produces a larger-than-normal picture on the monitor. If the target is underscanned for any length of time, a permanent change in target cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

Resolution in excess of 500 lines at the center of the picture can be produced by the 6474 when operated for color reproduction. The resolution curve in Fig.4 shows the relative center amplitude response versus television line number for the 6474 when it is operated with the highlights below the knee of the light transfer characteristic (see text below) and at a temperature of 35°C. The values of response plotted on the curve are those obtained after optimum adjustments are made to minimize the prominence of beat patterns and dynode spots.

A beat pattern is caused by the beating of the scanning lines against the lines of the target mesh. As a result, a moiré pattern, sometimes called a "swirl", appears in large-area highlights of the picture. Defocusing of the beam by adjustment of the beam-focus control (grid No.4) may be helpful in reducing the beat-pattern effect. For additional way to minimize beat-pattern effects, refer to *Proper orientation of the annular socket* under INSTALLATION.

A dynode spot is caused by a slight blemish on a dynode surface and appears as a white spot chiefly in the dark areas of the picture. Little defocusing of the beam is required to minimize the effect of dynode spots when the scene is brightly illuminated, but in dark scenes, the effect of dynode spots is a limiting item on resolution.

Loss of resolution with increased bulb temperature adjacent to the target is illustrated in Fig.5. The loss of resolution is caused by the decreasing resistivity of the target glass disc with increasing temperature. As a result, lateral leakage of the image charge occurs.

To utilize the resolution capability of the 6474 in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles. The maximum resolution obtainable is limited by the mesh-screen portion of the target.

Even with a wide-band amplifier, the resolution may be limited in the image section by "cross talk" caused by the scanning fields. Unless prevented by proper shielding from extending into the image section (see *Proper shielding* under INSTALLATION), these fields will cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

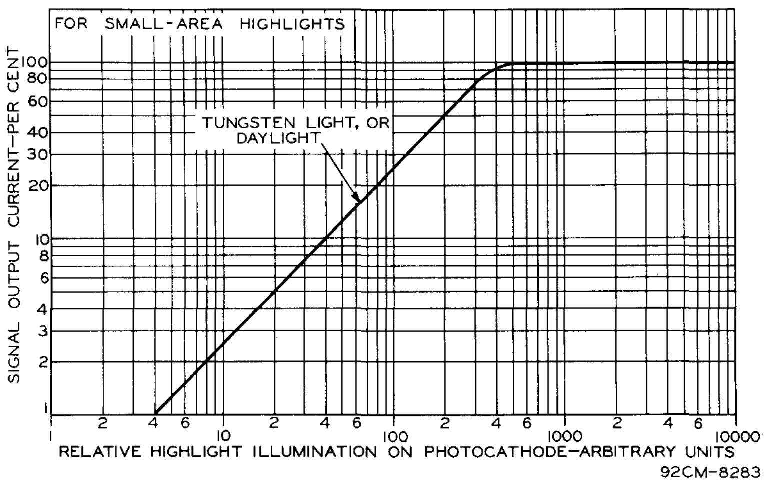


Fig.6 - Basic Light Transfer Characteristic of Type 6474.

The *light transfer characteristics* of the 6474 change for different illumination levels (see Reference 6). The basic light transfer characteristic of the 6474 is shown in Fig.6. This curve is representative only for small-area highlights. The bend or "knee" of the curve is explained by the fact that the charge accumulated by the target can not exceed the charge which raises the voltage of the target to the collector-mesh potential. As a result, when the 6474 is operated with highlights above the knee, not all of the secondary electrons emitted by the target glass disc are collected by the adjacent mesh. Those not collected are randomly distributed over adjacent picture areas. For black-and-white picture transmission, this random distribution is not objectionable if the image orthicon is operated so that the highlights bring the signal output only slightly above the knee. However, for color picture transmission, *any* random distribution represents color dilution or contamination and, therefore, the image orthicon must be operated in such a manner that substantially all of the secondary electrons from the target are collected by the adjacent mesh. Instructions for obtaining this operating condition are given under *Setup Procedure*. Fig.7 shows the light transfer characteristics for the 6474 operated below the knee with two different target voltages. More complete collection and hence a more accurate color picture is reproduced when the target voltage is 4 volts and the signal output is limited to a maximum charge buildup corresponding to the 2-volt initial setup condition as discussed under *Setup Procedure*.

The *setup procedure* for operating the 6474 is as follows: After the tube has been inserted in its sockets and the voltages applied as indicated under *Typical Operation*, allow it to warm up for 1/2 to 1 hour with the camera lens capped. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target. Adjust the deflection circuits so that the beam will "overscan" the target, i.e., so that the area of the target scanned is greater than its sensitive area. This procedure during the warming-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than normal picture on the monitor.

With the lens still capped and the target voltage set at approximately 2 volts negative, adjust the grid-No.1 voltage until noise or a rough-textured picture of dynode No.1 appears on the monitor. Then adjust the alignment-coil current so that the small white dynode spots do not move when the beam-focus control (grid No.4) is varied, but simply go in and out of focus. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and also to prevent excessive noise, and burn of the dynode-No.1 surface.

Next, uncap the lens and open the lens iris partially. Focus the camera on a test pattern. The target voltage is then advanced until a reproduction of the test pattern is just discernable on the monitor. This value of target voltage is known as the "target cutoff voltage". The target voltage should then be raised exactly two volts above the cutoff-voltage value, and the beam-current control adjusted to give just sufficient beam current to discharge the highlights.

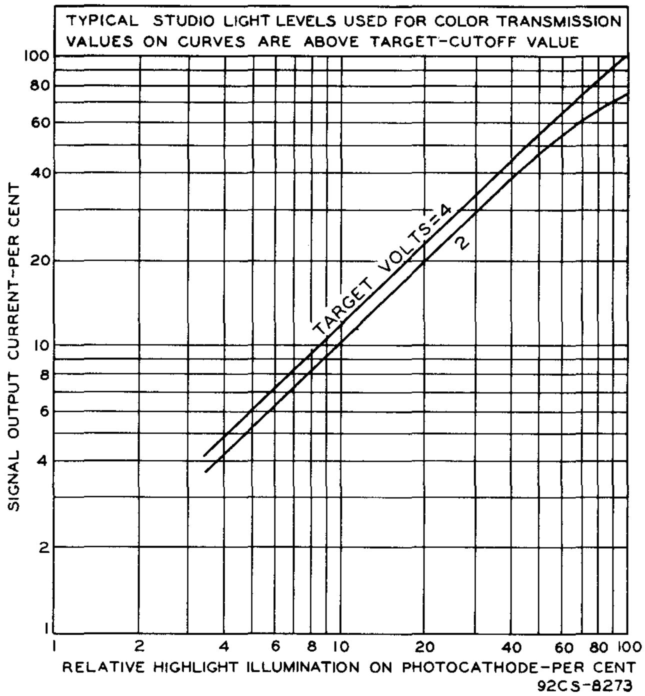


Fig.7 - Light Transfer Characteristics of Type 6474.

Then adjust the lens to produce best optical focus, and the voltage on the photocathode as well as the voltage on grid No.4 to produce the sharpest picture.

At this point, attention should be given to the grid-No.5 and grid-No.3 voltage controls. Grid No.5 is used to control the landing of the beam on the target and consequently the uniformity of signal output. The grid-No.5 voltage control should be adjusted to produce a picture that has most uniform shading from center to edge with the lens iris opened sufficiently to permit operation with the highlights above the knee of the light transfer characteristic. The value of grid-No.5 voltage should be as high as possible consistent with uniform shading. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The grid-No.3 voltage control should be adjusted to produce the maximum signal output.

Now with a test pattern consisting of a straight line centered on the face of the 6474, adjust the voltage on grid No.6 along with the voltage on the photocathode to produce a sharply focused straight line on the monitor. Improper adjustment of the grid-No.6 voltage control will result in the straight-line pattern being reproduced with a slight S-shape.

The above adjustments constitute a rough setup of the 6474. Final adjustments necessary for the 6474 to produce the best possible picture for color or black-and-white transmission are as follows: With the lens capped, realign the beam. Beam alignment is necessary after each change of the grid-No.5 voltage control and sometimes after each adjustment of the grid-No.3 voltage control.

The proper illumination level for color-camera operation should next be determined. Adjust the target voltage accurately to 2 volts above the target-cutoff value. Remove the lens cap and focus the camera on a neutral (black and white) test pattern consisting of progressive tonal steps from black to white. Open the lens iris just to the point where the highest step of the test pattern does not rise as fast as the lower steps when viewed on a video waveform oscilloscope. This operating point assures that the highlights of the scene will not run above the knee of the light transfer characteristic. If the highlights run above the knee of the light transfer characteristic, color dilution or contamination will occur.

Then adjust the grid-No.1 voltage control to just discharge the brightest highlight of the pattern.

Cap the lens and adjust the grid-No.3 voltage control so that the video signal when viewed on a video waveform oscilloscope has the flattest possible trace. This represents the black level of the picture. Unwanted variations in the black level of a color picture are much more evident and objectionable than in a black-and-white picture.

From this point on, the waveform monitor for the camera should be used to determine the lens stop necessary to give the maximum desired highlight signal as determined with the neutral step pattern.

Improved linearity of signal output and color purity can be achieved by next raising the target voltage to approximately 4 volts above the target-cutoff value. This increase assures nearly complete collection of the secondary electrons by the target mesh. In no case should the highlight signal output be greater than the maximum previously determined with the neutral test pattern and controlled by the iris setting. If higher signal output is obtained by increased illumination and beam current, resolution will suffer due to random attraction of the low-velocity scanning beam by the adjacent image charge.

Retention of a scene by the 6474, sometimes called a "sticking picture", may be experienced if the 6474 is allowed to remain focused on a stationary bright scene for several minutes, or it it is focused on a bright scene before reaching operating temperature in the range from 35° to 45°C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears. A retained image can generally be removed by focusing the 6474 on a clear white screen and allowing it to operate for several hours with an illumination of about 1 foot-candle on the photocathode.

To avoid retention of a scene, it is recommended that the 6474 always be allowed to warm up in the camera for 1/2 to 1 hour with the lens iris closed and with a slight amount of beam current. Never allow the 6474 to remain focused on a stationary bright scene for more than a few minutes, and never use more illumination than is necessary.

Further detailed information on use of this image orthicon in a three-tube image orthicon color camera is given in Reference 7.

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   Part III--Electro-Optical Characteristics of Camera Systems", RCA Review, September, 1948;

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7. R. G. Neuhauser, A. A. Rotow, and F. S. Veith, *"Image Orthicons for Color Cameras"*, Proc. of I.R.E., January, 1954.

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DOS and DON'TS
on Use of RCA-6474/1854

Here are the "dos"--

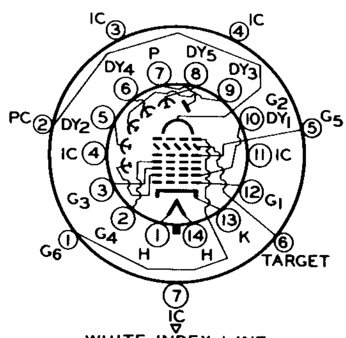
1. Allow the 6474 to warm up prior to operation.
2. Hold temperature of the 6474 within operating range.
3. Make sure alignment coil is properly aligned.
4. Adjust beam-focus control for best usable resolution.
5. Give the 6474 an idle period every 200 hours.
6. Condition spare 6474's by operating several hours once each month.
7. Determine proper operating point with target voltage adjusted to exactly 2 volts above target cutoff.
8. Cap lens during standby operation.

Here are the "don'ts"--

1. Don't force the 6474 into its shoulder socket.
2. Don't operate the 6474 without scanning.
3. Don't underscan target.
4. Don't focus the 6474 on a stationary bright scene.
5. Don't operate a 6474 having an ion spot.

The significance of each of the above "dos" and "don'ts" in obtaining optimum performance from the 6474 is explained in the preceding pages of this bulletin.

SOCKET CONNECTIONS
Bottom View



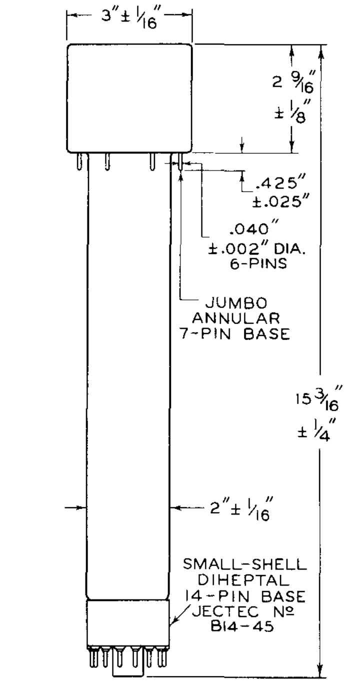
SMALL-SHELL DIHEPTAL 14-PIN BASE

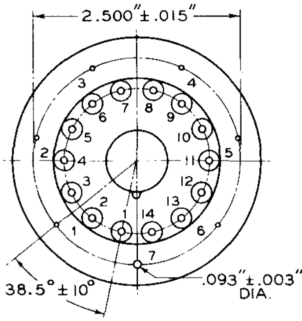
PIN 1: HEATER
PIN 2: GRID No.4
PIN 3: GRID No.3
PIN 4: INTERNAL CONNECTION--DO NOT USE
PIN 5: DYNODE No.2
PIN 6: DYNODE No.4
PIN 7: ANODE
PIN 8: DYNODE No.5
PIN 9: DYNODE No.3
PIN 10: DYNODE No.1, GRID No.2
PIN 11: INTERNAL CONNECTION--DO NOT USE
PIN 12: GRID No.1
PIN 13: CATHODE
PIN 14: HEATER

KEYED JUMBO ANNULAR 7-PIN BASE

PIN 1: GRID No.6
PIN 2: PHOTOCATHODE
PIN 3: INTERNAL CONNECTION--DO NOT USE
PIN 4: INTERNAL CONNECTION--DO NOT USE
PIN 5: GRID No.5
PIN 6: TARGET
PIN 7: INTERNAL CONNECTION--DO NOT USE

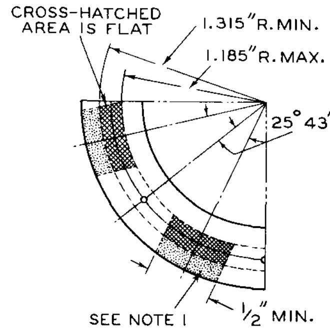
DIMENSIONAL OUTLINE





ENLARGED BOTTOM VIEW

DETAIL OF BOTTOM VIEW
OF JUMBO ANNULAR BASE



NOTE 1: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

ANNULAR BASE GAUGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAUGE WITH:

a. SIX HOLES HAVING DIAMETER OF 0.065" ± 0.001" AND ONE HOLE HAVING DIAMETER OF 0.150" ± 0.001". ALL HOLES HAVE DEPTH OF 0.265" ± 0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51°26' ± 5' ON CIRCLE DIAMETER OF 2.500" ± 0.015".

b. SIX STOPS HAVING HEIGHT OF 0.187" ± 0.001", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.

c. RIM EXTENDING OUT A MINIMUM OF 1/8" FROM 2-13/16" DIAMETER AND HAVING HEIGHT OF 0.126" ± 0.001".

d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200" ± 0.001".

92CM-8293

7037

IMAGE ORTHICON

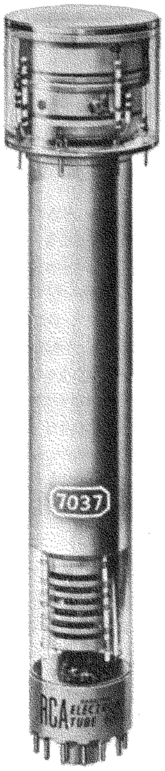
Magnetic Focus
Magnetic Deflection

For Simultaneous Color Pickup
Exceptionally High Sensitivity

3"-Diameter Bulb
15-1/4" Length

TENTATIVE DATA

RCA-7037 is a television camera tube intended for use in color cameras utilizing the method of simultaneous pickup of the studio or outdoor scene to be televised. This method employs three 7037's --one for each channel--to produce the information necessary for the formation of a color-television image.



The 7037 has exceptionally high sensitivity combined with a spectral response approaching that of the eye, and good resolution capability. With a color camera employing a suitably designed optical system and utilizing efficient color filters, commercially acceptable color pictures can be obtained with about 175 foot-candles of incident incandescent illumination on the scene and a lens stop of f:5.6.

The photocathode utilized in the 7037 is an improved type featuring very high sensitivity. Its relatively wide spectral response has high blue sensitivity, high green sensitivity, good red sensitivity, and practically no infrared sensitivity. This spectral characteristic enables the tube to translate colors very accurately when operated in a color camera with appropriate color filters and optical arrangements.

The *spectral response* of the 7037 is shown in Fig. 1 and is not subject to appreciable variation from tube to tube.

Other features of the 7037 include its *"stabilized" target*, its *micro-mesh screen*, and its *super-dynode design*. The "stabilized" target greatly reduces any tendency toward an increase in picture retention throughout the life of the tube and thus contributes to longer service-hours.

The *micro-mesh screen*, which has a fineness of 750 lines per inch, eliminates mesh pattern and moiré effect without defocusing, minimizes beat pattern between color subcarrier frequency and the frequency generated by the beam scanning the mesh-screen pattern, permits operation of the tube with aperture-correction circuit to provide 100 per cent response for 350-line information, and improves picture-detail contrast.

The *super-dynode design* offers freedom from dynode burn, saves adjustment time on dark-shading, reduces color shift in dark areas, provides more uniform picture background with reduced undesirable texture in lowlight areas, and makes it possible to set the decelerator-grid voltage at optimum value for highlight uniformity throughout the useful life of the tube.

The 7037 is designed to operate on a substantially linear signal-output curve, and is thus capable of producing a picture having natural tone value and accurate detail. Furthermore, the 7037 features a signal-to-noise ratio and contrast range commensurate with the requirements of color reproduction.

The 7037 may be used in place of the 6474/1854 in color cameras with the resultant advantage of substantial reduction in illumination on the televised scene. Under most conditions, no change in color filters is required because of the close similarity in the spectral responses of the two types.

PRINCIPLES OF OPERATION

The 7037 has three sections--an image section, a scanning section, and a multiplier section, as shown in Fig. 2.

Image Section

The image section contains a semitransparent photocathode on the inside of the faceplate, a grid (grid No.6) 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.

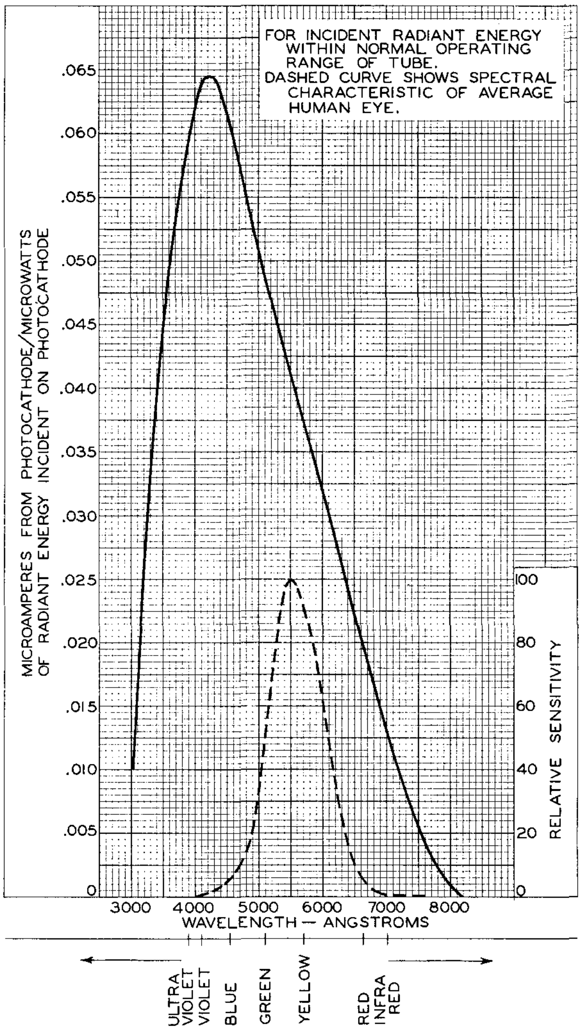


Fig. 1 - Spectral Sensitivity Characteristic of Type 7037.

Light from the scene being televised is picked up by an optical 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 the 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 several volts with respect to target-voltage cutoff. 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. Because of the thinness of the glass, the charges set up a similar 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 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 utilizes 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

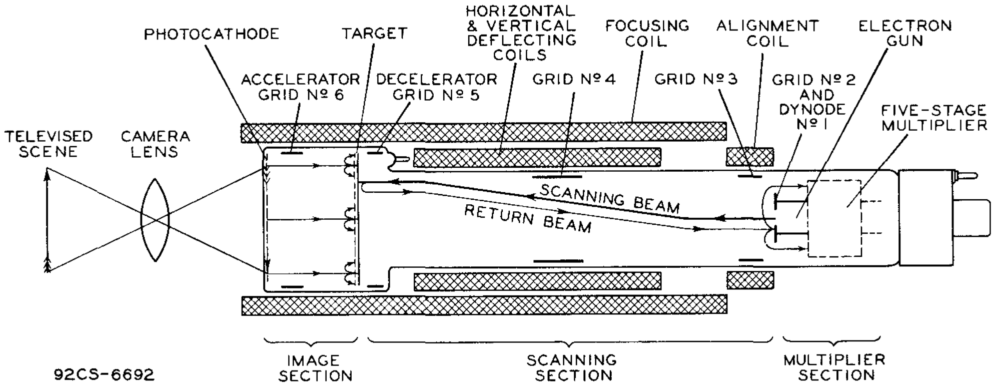


Fig.2 - Schematic Arrangement of Type 7037.

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. This multiplication permits the use of a video amplifier with fewer stages.

The signal-to-noise ratio of the output signal from the 7037 is high. The gain of the multiplier is such as to raise the output signal sufficiently above the noise level of the video amplifier stages so that they contribute no noise to the final video signal. The signal-to-noise ratio of the video signal, therefore, is determined only by the random variations of the modulated electron beam.

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 (R25 in Fig.3) changes in the positive direction. Hence, for highlights in the scene, the grid of the first video amplifier stage swings in the positive direction.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current	0.6	ampere
Direct Interelectrode Capacitance:		
Anode to all other electrodes	12	$\mu\mu f$
Photocathode, Semitransparent:		
Response		See Fig.1
Rectangular Image (4 x 3 aspect ratio):		
Useful size of	1.8" max.	Diagonal

Note: The size of the optical image focused on the photocathode should be adjusted so that its maximum diagonal does not exceed the specified value. The corresponding electron image on the target should have a size such that the corners of the rectangle just touch the target ring.

Orientation of . . Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of faceplate and pin No.7 of the shoulder base.

Focusing Method	Magnetic
Deflection Method	Magnetic
Overall Length	15.20" ± 0.25"
Greatest Diameter of Bulb	3.00" ± 0.06"
Shoulder Base	Keyed Jumbo Annular 7-Pin
End Base	Small-Shell Diheptal 14-Pin Base (JETEC No.B14-45)
Operating Position	See Text
Weight (Approx.)	1 lb 6 oz
Minimum Deflecting-Coil Inside Diameter	2-3/8"
Deflecting-Coil Length	5"
Focusing-Coil Length	10"
Alignment-Coil Length	15/16"
Photocathode Distance Inside End of Focusing Coil	1/2"

Maximum Ratings, *Absolute Values:*

PHOTOCATHODE:		
Voltage	-550 max.	volts
Illumination	50 max.	ft-c
OPERATING TEMPERATURE:		
Of any part of bulb	50 max.	°C
Of bulb at large end of tube (Target section)	40 min.	°C
TEMPERATURE DIFFERENCE:		
Between target section and any part of bulb hotter than target section	5 max.	°C
GRID-No.6 VOLTAGE	-550 max.	volts
TARGET VOLTAGE:		
Positive value	10 max.	volts
Negative value	10 max.	volts
GRID-No.5 VOLTAGE	150 max.	volts
GRID-No.4 VOLTAGE	300 max.	volts
GRID-No.3 VOLTAGE	400 max.	volts
GRID-No.2 & DYNODE-No.1 VOLTAGE	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	125 max.	volts
Positive bias value	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
ANODE-SUPPLY VOLTAGE*	1350 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts

Typical Operation and Characteristics Range Values:

Photocathode Voltage (Image Focus)	-400 to -540	volts
Grid-No.6 Voltage (Accelerator)--Approx. 75% of photocathode voltage	-300 to -405	volts
Target-Cutoff Voltage°	-3 to +1	volts
Grid-No.5 Voltage (Decelerator)	0 to 125	volts
Grid-No.4 Voltage (Beam Focus)	140 to 180	volts
Grid-No.3 Voltage#	225 to 330	volts
Grid-No.2 & Dynode-No.1 Voltage	300	volts
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	volts

Dynode-No.2 Voltage.	600	volts
Dynode-No.3 Voltage.	800	volts
Dynode-No.4 Voltage.	1000	volts
Dynode-No.5 Voltage.	1200	volts
Anode Voltage.	1250	volts
Anode Current (DC)	30	μamp
Signal-Output Current (Peak to peak)	3 to 24	μamp
Target Temperature Range (See Text) .	40 to 45	°C
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.).	60	
Minimum Peak-to-Peak Blanking Voltage	5	volts
Field Strength at Center of Focusing Coil▲	75	gausses
Field Strength of Alignment Coil (Approx.)	0 to 3	gausses

* Ratio of dynode voltages is shown under *Typical Operation*.

° Normal setting of target voltage is +2 volts from target cutoff. The target supply voltage should be adjustable from -3 to +5 volts.

\# Adjust to give the most uniformly shaded picture near maximum signal.

▲ Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

INSTALLATION

The *end-base pins* of the 7037 fit the small diheptal 14-contact socket. The *annular-base pins* fit the keyed jumbo annular 7-contact socket which should be rigidly fastened to the deflecting-coil assembly.

The 7037 has two complementary guides for inserting the tube correctly in the annular socket, i.e., the large pin (No.7) on the annular base, and the white radial line on the face of the bulb. The annular socket should be positioned so that the key pin (No.7) of the annular base is in a vertical plane through the common axis of the deflecting-coil assembly and the focusing-coil assembly.

The 7037 is installed by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin No.7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the key-pin hole in the annular socket. The diheptal socket is then put on the 14-pin base.

Proper orientation of the annular socket with respect to the horizontal-deflecting field is essential, and is obtained when the plane which is perpendicular to the plane of the annular socket and which passes through the center of the annular socket and the center line between pins 3 and 4 of the annular base is at right angles to the horizontal scanning field. This orientation minimizes beat-pattern effects by placing the sides of the mesh holes at an angle of 45° with respect to the horizontal scanning lines.

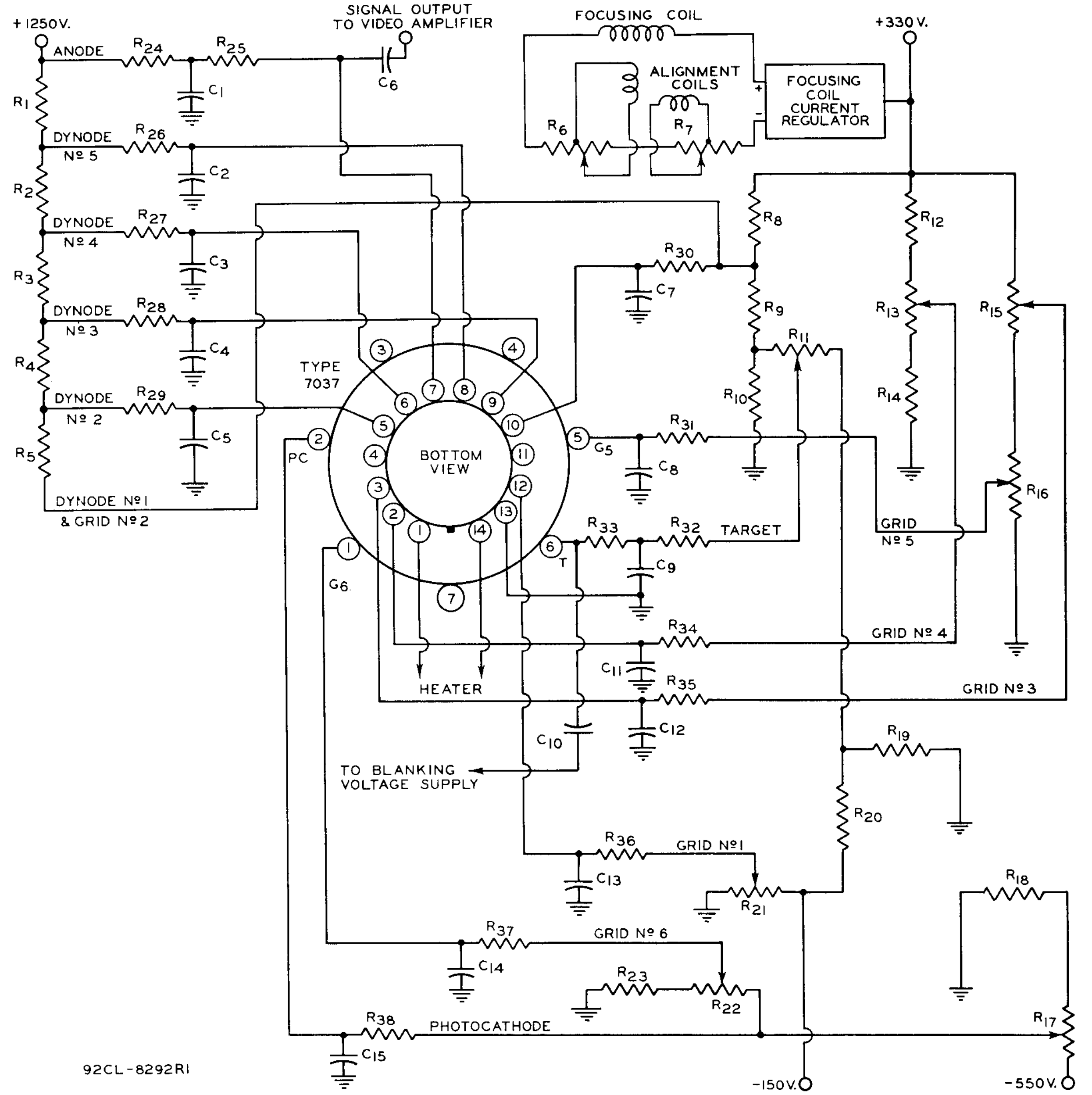
The *operating position* of the 7037 should preferably be such that any loose particles in the neck of the tube will not fall down and strike or become lodged on the target. Therefore, it is recommended that the tube never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with base up makes an angle of less than 20° with the vertical.

A *mask* having a diagonal or diameter of 1.8 inches should always be used on the photocathode to set limits for the maximum size of scan, and to reduce the amount of light reaching unused parts of the photocathode.

The *optical system* used with the 7037 should be designed according to basic optical principles and should incorporate an iris to control the amount of light entering the television camera lens. The entire optical system should have all inside surfaces finished in mat black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

Proper shielding of the image section can be provided by wrapping around the outside of the focusing coil directly over the center of the deflecting coils a triple layer of Mumetal strip 0.006" thick and 5" wide, or equivalent. Then, wrap another triple layer of Mumetal strip 0.006" thick and 3" wide around the focusing coil directly over the image section of the 7037. Additional shielding is provided by fitting the inside of the focusing coil directly over the image section with a copper cylinder having a length of approximately 2-1/4" and a wall thickness of 1/32". The Mumetal shielding effectively shunts the field-rate deflection field, while the copper cylinder shields the higher frequency line-scanning field from the electron path in the image section. Unless proper shielding is provided, "cross talk" from the deflecting yoke into the image section will result in loss of picture sharpness.

For the *high dc voltages* required by the 7037, the use of two pulse supplies for which the plate voltage is provided by a well-regulated B-supply may be used. Each of these supplies should be actuated by the horizontal driving pulse which is obtained from the synchronizing generator. One of the pulse supplies should be capable of furnishing 1250 volts with an output current of 1 milliampere for the multiplier section; the other pulse supply should be capable of furnishing -550 volts with an output current of 1 milliampere for the image section. In addition to supplying the plate voltage and current for the pulse supplies, the B-supply should also provide an output current of approximately 90 milliamperes for the focusing and alignment coils and for the voltage divider which is used to supply the voltages for the electrodes in the scanning section of the 7037. Provision should be made for regulating the focusing-coil current.



C1 C2: 0.05 µf, 1600 v working voltage
C3: 0.01 µf mica, 1600 v working voltage
C4: 0.001 µf mica, 1000 v working voltage
C5: 0.001 µf mica, 600 v working voltage
C6: 0.03 µf, 1600 v working voltage. See text under *voltage divider*.
C7 C8 C9 C11 C12 C13 C14 C15: 0.001 µf mica, 400 v working voltage
C10: 1 µf, 400 v working voltage
R1: 47000 ohms, 1/2 watt
R2 R3 R4: 220000 ohms, 1/2 watt
R5: 270000 ohms, 1/2 watt
R6 R7: 200-ohm potentiometer, center-tapped, 2 watts
R8: 5100 ohms, 1/2 watt
R9: 51000 ohms, 2 watts
R10: 510 ohms, 1/2 watt
R11: 150000-ohm potentiometer, 1/2 watt
R12: 125000 ohms, 1/2 watt
R13: 75000-ohm potentiometer, 1 watt
R14: 125000 ohms, 1/2 watt
R15: 250000-ohm potentiometer, 1 watt
R16: 150000-ohm potentiometer, 1 watt
R17: 250000-ohm potentiometer, 1 watt
R18: 510000 ohms, 1 watt
R19: 11000 ohms, 1/2 watt
R20: 310000 ohms, 1/2 watt
R21: 500000-ohm potentiometer, 1 watt
R22: 250000 ohms, 1 watt
R23: 560000 ohms, 1/2 watt
R24: 47000 ohms, 1/2 watt
R25: 20000 ohms, 1/2 watt
R26 R27: 100000 ohms, 1/2 watt
R28 R29 R31 R32 R34 R35 R36 R37 R38: 200000 ohms, 1/2 watt
R30: 50000 ohms, 1/2 watt
R33: 100000 ohms, 1/2 watt

Fig. 3 - Voltage-Divider Circuit for Type 7037 with Recommended Arrangement for Connecting the Focusing Coil and Alignment Coils.

A *voltage divider* to provide the required operating voltages for the various electrodes of the 7037 is shown in Fig.3. It is to be noted that the blocking capacitor C_6 should be of sufficiently high quality so that its leakage current will not introduce disturbing effects into the picture.

In designing a voltage divider for the multiplier stages of the 7037, engineers should recognize that the dc output of individual 7037's may have a range of 10 to 1. This range, therefore, must be considered in the choice of bleeder-resistor values. If the values are too high, the distribution of voltages applied to the dynodes will be upset by a 7037 with a dc output at the upper end of the range. As a result, there will be an abrupt drop in the ac output of the tube as the beam current is increased. When this drop occurs before the beam is at its optimum value, the ratio of signal to noise will be lessened, and compression of the signal information will result.

Even with satisfactory bleeder-resistor values, it is possible to overload the tube itself. For 7037's having high dc outputs, a current reversal can occur at the 5th dynode stage of the multiplier as the beam current is increased. This current reversal will also produce a sharp drop in the ac output of the tube. To prevent such current reversal, it is recommended that provision be made to reduce the overall multiplier voltage for tubes with dc outputs at the upper end of the range. A reduction to 1000 volts should be adequate.

A *blanking signal* should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking period, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance. Excessive amounts of blanking voltage applied to the target will impair resolution, since during retrace the target is out of focus to the continuously flowing photocathode current. A desirable amount of target blanking is 6 volts peak to peak.

Shading may be required even with optimum adjustment of voltage on grid No.3 in order to obtain a uniformly shaded picture. Sawtooth and parabolic waveforms of adjustable amplitude and polarity at both the vertical- and horizontal-scanning frequency should be provided for insertion in the video amplifier to aid in obtaining a flat background. The shading signal should be introduced in the amplifier after clamping is performed, since clamping circuits will remove the vertical-frequency shading component if added previous to the clamp-circuit location.

The *video amplifier* should be designed to cover a range of ac signal voltages corresponding to signal-output current of 3 to 24 microamperes peak to peak in the load resistor (R_{25} in Fig.3). For bandwidth, refer to *Resolution* under OPERATING CONSIDERATIONS.

Failure of scanning even for a few minutes when light is incident on the photocathode may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

To avoid damaging the 7037 during scanning failure, provision should be made to prevent automatically the scanning beam from reaching the target. The scanning beam can be prevented from reaching the target by (1) cutting off the scanning beam, or (2) making the target sufficiently negative. The scanning beam can be cut off by a relay which applies -115 to -125 volts bias to grid No.1. The target can be made sufficiently negative by a relay which applies a bias of at least -10 volts to it. Either relay is actuated by a tube which is controlled by a portion of the scanning pulse voltage developed across either the horizontal or the vertical deflecting coils, or both. It is important to insure that the horizontal scanning pulse and the vertical scanning pulse should each independently actuate the relay in case either one fails.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data for the 7037 are limiting values above which the serviceability of the 7037 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

New 7037's should be placed in service immediately upon receipt. They should be operated for several hours before being set aside as spares.

Spare 7037's should be placed in service for several hours at least once a month in order to keep them free from traces of gas which may be liberated within the tube during prolonged storage.

Occasionally, a *white spot* which does not change in size when the beam-focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation, the 7037 should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

The *operating temperature* of any part of the glass bulb should never exceed 50°C, and no part of the bulb at the large end of the tube (target section) should ever fall below 40°C during operation. The temperature of the target is essentially the same as that of the adjacent glass bulb and can, therefore, be determined by measuring the temperature of the glass bulb adjacent to the target. For best results, it is recommended that the temperature of the entire bulb be held between 40° and 45°C. Operation at too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the tube. The loss of resolution is caused by the decreasing resistivity of the target glass disc with increasing temperature. As a result, lateral leakage of the image charge occurs. Resolution is regained by waiting for the temperature to drop below 50°C. *No part of the bulb should run more than 5° hotter than the target section to prevent cesium migration to the target.* Such migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 7037 may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

When the equipment design or operating conditions are such that the maximum temperature rating or maximum temperature difference as given under *Maximum Ratings* will be exceeded, provision should be made to direct a blast of cooling air from the diheptal-base end of the tube along the entire length of the bulb surface, i.e., through the space between the bulb surface and the surrounding deflecting-coil assembly and its extension. Any attempt to effect cooling of the tube by circulating even a large amount of air around the focusing coil will do little good, but a small amount of air directly in contact with the bulb surface will effectively drop the bulb temperature. For this purpose, a small blower is satisfactory, but it should be run at low speed to prevent vibration of the 7037 and the associated amplifier equipment. Unless vibration is prevented, distortion of the picture may occur.

Ordinarily, the temperature in a camera equipped with a blower will not exceed 45°C, except in very hot weather or unless the target heater is left on accidentally for a long period.

To keep the operating temperature of the large end of the tube from falling below 45°C, some form of controlled heating should be employed. Ordinarily, adequate heat will be supplied by the focusing coil, deflecting coils, and associated amplifier tubes so that the temperature can be controlled by the amount of cooling air directed along the bulb surface. If, in special cases, a target heater is required, it should fit between the focusing coil and the bulb near the shoulder of the tube, and be non-inductively wound.

Full-size scanning of the target should always be used during on-the-air operation. Full-size scanning can be assured by first adjusting the deflection circuits to overscan the target sufficiently to cause the corners of the target to be visible in the picture, and then reducing the scanning until the corners just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. Note that overscanning the target produces a smaller-than-normal picture on the monitor.

Underscanning the target, i.e., scanning an area of the target less than its sensitive area, should never be permitted. Underscanning produces a larger-than-normal picture on the monitor. If the target is underscanned for any length of time, a permanent change in target-cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

Resolution in excess of 500 lines at the center of the picture can be produced by the 7037 when operated for color reproduction.

To utilize the resolution capability of the 7037 in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles.

Even with a wide-band amplifier, the resolution may be limited in the image section by "cross-talk" caused by the scanning fields. Unless prevented by proper shielding from extending into the image section (see *Proper shielding* under INSTALLATION), these fields will cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

The *dynode aperture* appears as a small white spot near the center of the image of the dynode surface. The white spot is most evident when it falls within dark areas of the scene. Little defocusing of the beam is required to minimize the effect of dynode aperture when the scene is brightly illuminated, but in dark scenes, the effect of dynode aperture is a limiting item on resolution.

The *light transfer characteristics* of the 7037 change for different illumination levels (see Reference 6). The basic light transfer characteristic of the 7037 is shown in Fig. 4. The light values shown are applicable only for white light incident on the photocathode. This curve is representative only for small-area highlights.

The bend or "knee" of the curve is explained by the fact that the charge accumulated by the target can not exceed the charge which raises the voltage of the target to the collector-mesh potential. As a result, when the 7037 is operated with highlights at or above the knee, not all of the secondary electrons emitted by the

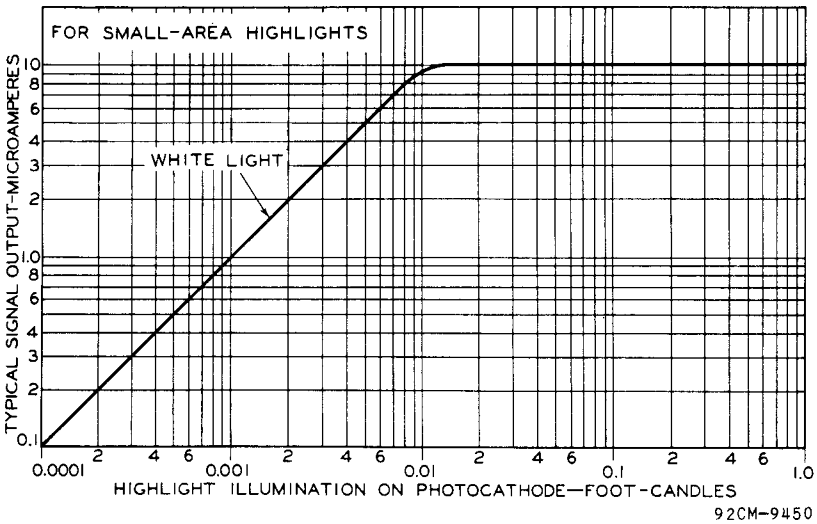


Fig.4 - Basic Light Transfer Characteristic of Type 7037.

target glass disc are collected by the adjacent mesh. Those not collected are randomly distributed over adjacent picture areas. For black-and-white picture transmission, this random distribution is not objectionable if the image orthicon is operated so that the highlights bring the signal output only slightly above the knee. However, for color-picture transmission, any random distribution represents color dilution or contamination and, therefore, the image orthicon must be operated in such a manner that substantially all of the secondary electrons from the target are collected by the adjacent mesh.

In order to operate the 7037 in this manner which makes possible the achievement of a substantially linear transfer characteristic, it is essential that the target voltage be properly adjusted. Fig.5 shows the "knee" portion of the transfer characteristic with the 100%-signal-output level limited by the charge buildup which occurs when the target voltage is adjusted to 2 volts (see *setup procedure*). It also shows how the "knee" is straightened out to give a more accurate color picture when the target voltage is then increased to 4 volts (see *setup procedure*) while retaining the same signal-output level that was established by the 2-volt adjustment.

When the target voltage is adjusted as described above, nearly all of the secondary electrons from the target are collected by the adjacent mesh, the electrons in the scanning beam land more uniformly over the entire target area, and the prominence of after-image is reduced.

Landing of the primary electrons is more uniform because, with almost complete collection of secondary electrons by the mesh, the charge neutralized in each frame by the scanning beam will equal the charge deposited on the target by the photoelectrons. Hence, variation in target-to-mesh spacing and capacitance will not affect the signal output. Furthermore, the relatively large difference between the fixed potential of the mesh and the average potential to which the target is driven by the scanning beam reduces to a negligible value the effect of variations in target potential caused by radial- and tangential-velocity components in the scanning beam.

The prominence of after-image is greatly reduced because the potential developed across the target glass disc due to polarization becomes a much smaller percentage of the mesh potential.

The set-up procedure described below should be followed carefully to obtain optimum performance from the 7037. All three tubes in the color camera should be set up individually in accord with the prescribed procedure.

The *setup procedure* for operating the 7037 is as follows: After the tube has been inserted in its sockets and the voltages applied as indicated under *Typical Operation*, allow it to warm up for 1/2 to 1 hour with the camera lens capped. Uncap the lens momentarily while adjusting the grid-No.1 voltage to give a small amount of beam current. This procedure will prevent the mesh from being electrostatically pulled into contact with the glass disc. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target. Adjust the deflection circuits so that the beam will "overscan" the target, i.e., so that the area of the target scanned is greater than its sensitive area. This procedure during the warming-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than-normal picture on the monitor.

With the lens still capped and the target voltage set at approximately 2 volts negative, adjust the grid-No.1 voltage until noise or a rough-textured picture of dynode No.1 appears on the monitor. Then adjust the alignment-coil current so that the small white dynode spot does not move when the beam-focus control (grid No.4) is varied, but simply goes in and out of focus. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and also to prevent excessive noise.

Next, uncap the lens and open the lens iris partially. Focus the camera on a test pattern. The target voltage is then advanced until a reproduction of the test pattern is just discernable on the monitor. This value of target voltage is known as the "target cutoff voltage". The target voltage should then be raised exactly two volts above the cutoff-voltage value, and the beam-current control adjusted to give just sufficient beam current to discharge the highlights.

Then adjust the lens to produce best optical focus, and the voltage on the photocathode as well as the voltage on grid No.4 to produce the sharpest picture.

At this point, attention should be given to the grid-No.5 and grid-No.3 voltage controls. Grid No.5 is used to control the landing of the beam on the target and consequently the uniformity of signal output. The grid-No.5 voltage control should be adjusted to produce a picture that has most uniform shading from center to edge with the lens iris opened sufficiently to permit operation with the highlights above the knee of the light transfer characteristic. The value of grid-No.5 voltage should be as high as possible consistent with uniform shading. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The grid-No.3 voltage control should be adjusted to produce the maximum signal output.

Now with a test pattern consisting of a straight line centered on the face of the 7037, adjust the voltage on grid No.6 along with the voltage on the photocathode to produce a sharply focused straight line on the monitor. Improper adjustment of the grid-No.6 voltage control will result in the straight-line pattern being reproduced with a slight S-shape.

The above adjustments constitute a rough setup of the 7037. Final adjustments necessary for the 7037 to produce the best possible picture for color or black-and-white transmission are as follows: With the lens capped, realign the beam. Beam alignment is necessary after each change of the grid-No.5 voltage control and sometimes after each adjustment of the grid-No.3 voltage control.

The proper illumination level for color-camera operation should next be determined. Adjust the target voltage accurately to 2 volts above the target-cutoff value. Remove the lens cap and focus the camera on a neutral (black and white) test pattern consisting of progressive tonal steps from black to white. Open the lens iris just to the point where the highest step of the test pattern does not rise as fast as the lower steps when viewed on a video waveform oscillo-scope. This operating point assures that the highlights of the scene will not run above the knee of the light transfer characteristic. If the highlights run above the knee of the light transfer characteristic, color dilution or contamination will occur.

Then adjust the grid-No.1 voltage control to just discharge the brightest highlight of the pattern.

Cap the lens and adjust the grid-No.3 voltage control so that the video signal when viewed on a video waveform oscilloscope has the flattest possible trace. This represents the black level of the picture. Unwanted variations in the black level of a color picture are much more evident and objectionable than in a black-and-white picture.

From this point on, the waveform monitor for the camera should be used to determine the lens opening necessary to produce the maximum desired highlight signal as determined with the neutral step pattern.

Improved linearity of signal output and color purity can be achieved by next raising the target voltage to approximately 4 volts above the target-cutoff value. A value slightly less then 4 volts will sometimes give the desired results. A value greater than 4 volts is not recommended because any tendency toward microphonics may be enhanced. This increase in the target voltage assures

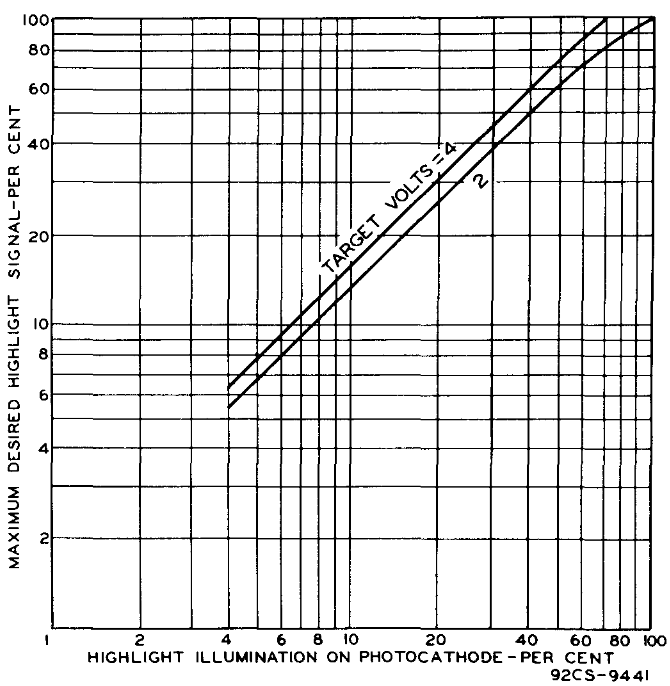


Fig.5 - Light Transfer Characteristics of Type 7037.

nearly complete collection of the secondary electrons by the target mesh. As a result of this increase, the highlights will no longer be fully discharged by the beam as previously adjusted. DO NOT ATTEMPT TO DISCHARGE THE HIGHLIGHTS BY ADJUSTING THE GRID-No.1 VOLTAGE TO INCREASE THE BEAM CURRENT. Instead, the lens iris should be closed until the highlight signal output again reaches the previously determined maximum-signal amplitude as measured on the waveform oscilloscope. In no case should the highlight signal output be greater than the maximum previously determined with the neutral test pattern and controlled by the iris setting. If higher signal output is obtained by increased illumination and beam current, resolution will suffer due to random attraction of the low-velocity scanning beam by the adjacent image charge, and tube life will be shortened.

Retention of a scene by the 7037, sometimes called a "sticking picture", may be observed to a slight degree even initially. However, any initial sticking will decrease during the first few hours of tube operation and then remain at an acceptable low value, or actually decrease, throughout life. Sticking may be aggravated if the 7037 is allowed to remain focused on a stationary bright scene, or if it is focused on a bright scene before reaching operating temperature in the range from 40° to 45°C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears. A retained image can generally be removed by focusing the 7037 on a clear white screen and allowing it to operate for several hours with an illumination of about 1 foot-candle on the photocathode.

To minimize retention of a scene, it is recommended that the 7037 always be allowed to warm up in the camera for 1/2 to 1 hour with the lens iris closed and with a slight amount of beam current. Never allow the 7037 to remain focused on a stationary bright scene, and never use more illumination than is necessary.

Further detailed information on use of the image orthicon in a three-tube image orthicon color camera is given in Reference 7.

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DOS and DON'TS
on Use of RCA-7037

Here are the "dos"--

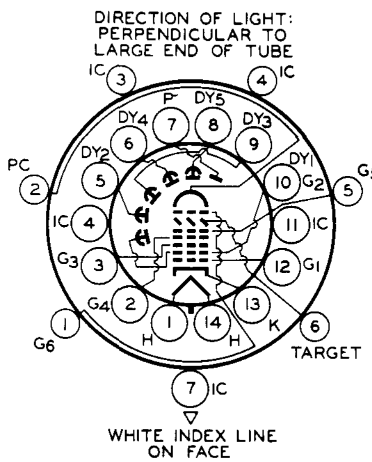
1. Allow the 7037 to warm up prior to operation.
2. Hold temperature of the 7037 within operating range.
3. Make sure alignment coil is properly aligned.
4. Adjust beam-focus control for best usable resolution.
5. Condition spare 7037's by operating several hours once each month.
6. Determine proper operating point with target voltage adjusted to exactly 2 volts above target cutoff.
7. Cap lens during standby operation.

Here are the "don'ts"--

1. Don't force the 7037 into its shoulder socket.
2. Don't operate the 7037 without scanning.
3. Don't underscan target.
4. Don't focus the 7037 on a stationary bright scene.
5. Don't operate a 7037 having an ion spot.
6. Don't use more beam current than necessary to discharge the highlights of the scene.
7. Don't turn off beam while voltages are applied to photocathode, grid No.6, target, dynodes, and anode during warmup or standby operation.

The significance of each of the above "dos" and "don'ts" in obtaining optimum performance from the 7037 is explained in the preceding pages of this bulletin.

SOCKET CONNECTIONS
Bottom View



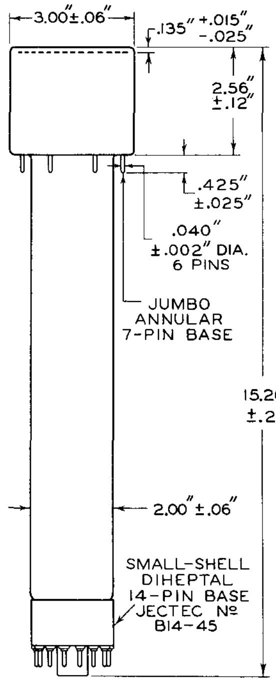
SMALL-SHELL DIHEPTAL 14-PIN BASE

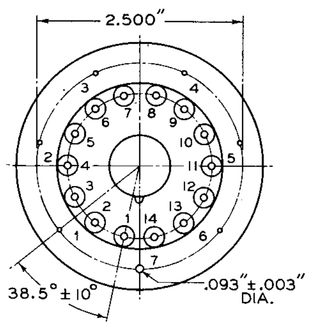
PIN 1: HEATER
PIN 2: GRID No.4
PIN 3: GRID No.3
PIN 4: INTERNAL CONNECTION--DO NOT USE
PIN 5: DYNODE No.2
PIN 6: DYNODE No.4
PIN 7: ANODE.
PIN 8: DYNODE No.5
PIN 9: DYNODE No.3
PIN 10: DYNODE No.1, GRID No.2
PIN 11: INTERNAL CONNECTION--DO NOT USE
PIN 12: GRID No.1
PIN 13: CATHODE
PIN 14: HEATER

KEYED JUMBO ANNULAR 7-PIN BASE

PIN 1: GRID No.6
PIN 2: PHOTOCATHODE
PIN 3: INTERNAL CONNECTION--DO NOT USE
PIN 4: INTERNAL CONNECTION--DO NOT USE
PIN 5: GRID No.5
PIN 6: TARGET
PIN 7: INTERNAL CONNECTION--DO NOT USE

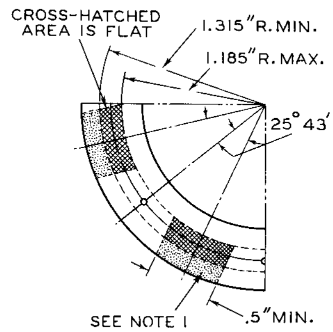
DIMENSIONAL OUTLINE





ENLARGED BOTTOM VIEW

DETAIL OF BOTTOM VIEW OF JUMBO ANNULAR BASE



NOTE 1: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

ANNULAR BASE GAUGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAUGE WITH:

a. SIX HOLES HAVING DIAMETER OF 0.065" ± 0.001" AND ONE HOLE HAVING DIAMETER OF 0.150" ± 0.001". ALL HOLES HAVE DEPTH OF 0.265" ± 0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51°26' ± 5' ON CIRCLE DIAMETER OF 2.500" ± 0.001".

b. SEVEN STOPS HAVING HEIGHT OF 0.187" ± 0.001", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.

c. RIM EXTENDING OUT A MINIMUM OF 0.125" FROM 2.812" DIAMETER AND HAVING HEIGHT OF 0.126" ± 0.001".

d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200" ± 0.001".

92CM-8293R3

7038

VIDICON

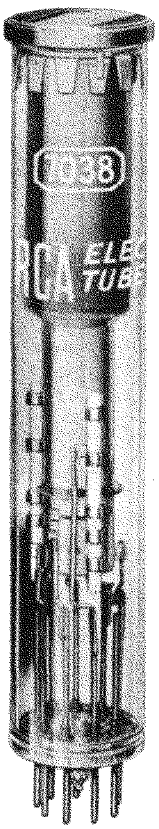
Magnetic Focus
Magnetic Deflection

For Live and Film Pickup
With Color or Black-and-White TV Cameras
600-Line Resolution

TENTATIVE DATA

I"-Diameter Bulb
6.25" Length

RCA-7038 is a small camera tube intended for use in television cameras designed for televising live scenes as well as cameras designed for film pickup. The 7038 is particularly suitable for use in compact color television cameras utilizing the method of simultaneous pickup of the live or film subjects to be televised. This method employs three 7038's--one for each channel--to produce the information necessary for the formation of a color television image. In either color or black-and-white service, the 7038 can provide a picture of high quality for broadcasting or industrial television applications. Its resolution capability is about 600 television lines.



The 7038 utilizes a unique photoconductive surface having uniform thickness which permits constant voltage gradient and uniform dark current across the scanned area. Because of the uniform thickness of its photoconductive surface, the 7038 can produce substantially uniform sensitivity over the entire scanned area. Therefore, the 7038 exhibits a degree of uniformity of characteristics from tube to tube that makes it possible to obtain excellent color uniformity and balance when used in three-vidicon color cameras. While dark current and sensitivity both increase with target voltage, the uniformity of the dark current makes it possible to operate the 7038 at higher values of target voltage and dark current than are permissible with previous types of vidicons. As a result, higher effective sensitivity can be obtained with the 7038.

Featured in the design of the 7038 are nonmagnetic materials in the front end, an extremely flat faceplate free from optical distortion, and an envelope without a side tip. The elimination of magnetic materials from the front end and the use of an optically flat faceplate make it easier to register three pictures when these tubes are used in three-vidicon color cameras. The tipless envelope allows the use of a longer deflecting yoke. The longer yoke offers the advantage of less deflecting power, and a narrower deflecting angle which effectively reduces deflection distortion and improves the center-to-edge focus of the beam. In addition, the tipless structure simplifies the layout of optical arrangements for light splitting in a color camera.

Full advantage of the uniform photoconductive layer of the 7038, particularly in film-pickup applications, may be realized by applying a modulating voltage of suitable waveform to the cathode, grid No.1, and grid No.2 in order to correct for the scanning-beam landing errors introduced by the deflecting and focusing fields.

PRINCIPLES OF OPERATION

The structural arrangement of the 7038, shown in Fig.1, consists of a target composed of a transparent conducting film (the signal electrode) on the inner surface of the faceplate and a thin photoconductive layer deposited on the film; a fine mesh screen (grid No.4) located adjacent to the photoconductive layer; a beam-focusing electrode (grid No.3) connected to grid No.4; and an electron gun for producing a beam of electrons.

Each element of the photoconductive layer is an insulator in the dark but becomes slightly conductive when it is illuminated and acts like a leaky capacitor having one plate at the positive potential of the signal electrode and the other floating. When light from the scene or film being televised is focused on the photoconductive-layer surface next to the face-plate, each illuminated layer element conducts slightly depending on the amount of illumination on the element and thus causes the potential of its opposite surface (on the gun side) to rise in less than the time of one frame toward that of the signal-electrode potential. Hence, there appears on the gun side of the entire layer surface a positive potential pattern, composed of the various element potentials, corresponding to the pattern of light imaged on the layer.

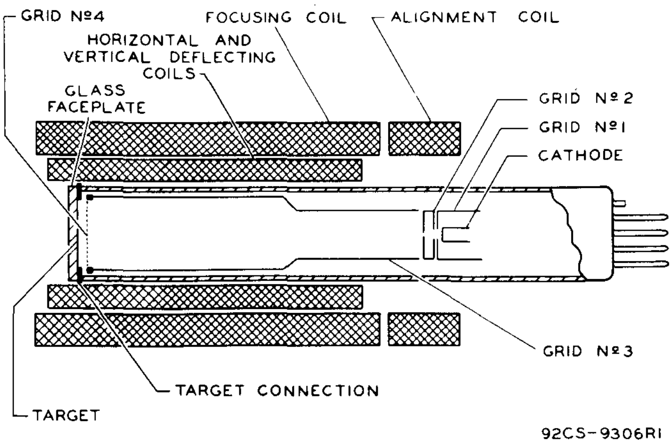


Fig. 1 - Schematic Arrangement of Type 7038.

The gun side of the photoconductive layer is scanned by a low-velocity electron beam produced by the electron gun. 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 surface of the photoconductive layer by the combined action of the uniform magnetic field of an external coil and the electrostatic field of grid No. 3. Grid No. 4 serves to provide a uniform decelerating field between itself and the photoconductive layer so that the electron beam will tend to approach the layer in a direction perpendicular to it--a condition necessary for driving the surface to cathode potential. The beam electrons approach the layer at low velocity because of the low operating potential of the signal electrode.

When the gun side of the photoconductive layer with its positive potential pattern is scanned by the electron beam, electrons are deposited from the beam until the surface potential is reduced to that of the cathode, and thereafter are turned back to form a return beam which is not utilized. Deposition of electrons on the scanned surface of any particular element of the layer causes a change in the difference of potential between the two surfaces of the element. When the two surfaces of the element, which in effect is a charged capacitor, are connected through the external target (signal-electrode) circuit and the scanning beam, a capacitive current is produced and constitutes the video signal. The magnitude of the current is proportional to the surface potential of the element being scanned and to the rate of scan. The video-signal current is then used to develop a signal-output voltage across a load resistor. The signal polarity is such that for highlights in the image, the grid of the first video-amplifier tube swings in a negative direction.

Alignment of the beam is accomplished by a transverse magnetic field produced by external coils located at the base end of the focusing coil.

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

DATA

General:

Heater, for Unipotential Cathode:
- Voltage (AC or DC) . . . . 6.3 ± 10% volts
- Current. . . . . 0.6 amp

Direct Interelectrode Capacitance:•
- Target to all other electrodes . . . . 4.6 μμf

Spectral Response. . . . . See curves in Fig.12

Photoconductive Layer:
- Maximum useful diagonal of rectangular image (4 x 3 aspect ratio). . . . . 0.62 inch
- Orientation of quality rectangle--Proper orientation is obtained when the horizontal scan is essentially parallel to the straight sides of the masked portions of the faceplate. The straight sides are parallel to the plane passing through the tube axis and short index pin. The masking is for orientation only and does not define the proper scanned area of the photoconductive layer.

Focusing Method. . . . . Magnetic
Deflection Method. . . . . Magnetic
Overall Length . . . . 6.25" ± 0.25"
Greatest Diameter. . . . . 1.125" ± 0.010"
Bulb T8
Base . . . . Small-Button Ditetrar 8-Pin (JETEC No.E8-11)
Socket . . . . Cinch No.54A18088, or equivalent
Operating Position . . Approx. horizontal, or faceplate up
Weight (Approx.) . . . . 2 oz

Maximum Ratings, *Absolute Values:*

For scanned area of 1/2" x 3/8"

GRID-No.3 & GRID-No.4 VOLTAGE.	350 max.	volts
GRID-No.2 VOLTAGE	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value.	125 max.	volts
Positive bias value.	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode. . .	125 max.	volts
Heater positive with respect to cathode. . .	10 max.	volts
DARK CURRENT	0.25 max.	μa
PEAK TARGET CURRENT.	0.55 max.	μa
FACEPLATE:		
Illumination	1000 max.	ft-c
Temperature.	60 max.	°C

Typical Operation:

For scanned area of 1/2" x 3/8"
Faceplate temperature of 30° to 35° C

Grid-No.4 (Decelerator) & Grid-No.3 (Beam-Focus Electrode*) Voltage. . . . . . 250□ to 300 volts

Grid-No.2 (Accelerator) Voltage. .	300	volts
Grid-No.1 Voltage for Picture Cutoff●	-45 to -100	volts
Average "Gamma" of Transfer Characteristic for signal-output current between 0.02 μa and 0.2 μa	0.65	
Visual Equivalent Signal-to-Noise Ratio (Approx.)○	300:1	
Minimum Peak-to-Peak Blanking Voltage:		
When applied to grid No.1. . . .	75	volts
When applied to cathode.	20	volts
Field Strength at Center of Focusing Coil (Approx.).	40	gausses
Field Strength of Adjustable Alignment Coil⊕.	0 to 4	gausses

Maximum-Sensitivity Operation for Live-Scene Pickup

Faceplate Illumination (Highlight)	2	ft-c
Max. Target Voltage Required to Produce Dark Current of 0.2 μa in Any Tube**.	110	volts
Target Voltage†.	60 to 100	volts
Dark Current▲.	0.2	μa
Target Current (Highlight)■. . . .	0.4 to 0.5	μa
Signal-Output Current:#		
Peak	0.2 to 0.3	μa
Average.	0.08 to 0.1	μa

Average-Sensitivity Operation for Live-Scene Pickup

Faceplate Illumination (Highlight)	15	ft-c
Max. Target Voltage Required to Produce Dark Current of 0.02 μa in Any Tube**.	60	volts
Target Voltage†.	30 to 50	volts
Dark Current	0.02	μa
Target Current (Highlight)■. . . .	0.3 to 0.4	μa
Signal-Output Current:#		
Peak	0.3 to 0.4	μa
Average.	0.1 to 0.2	μa

Minimum-Lag Operation for Film Pickup

Faceplate Illumination (Highlight)	100	ft-c
Max. Target Voltage Required to Produce Dark Current of 0.004 μa in Any Tube**.	30	volts
Target Voltage†.	15 to 25	volts
Dark Current	0.004	μa
Target Current (Highlight)■	0.3 to 0.4	μa
Signal-Output Current:#		
Peak	0.3 to 0.4	μa
Average.	0.1 to 0.2	μa

♦ This capacitance, which effectively is the output impedance of the 7038, is increased when the tube is mounted in the deflecting-yoke and focusing-coil assembly. The resistive component of the output impedance is in the order of 100 megohms.

* Beam focus is obtained by combined effect of grid-No.3 voltage which should be adjustable over indicated range, and a focusing coil having an average field strength of 40 gausses.

□ Definition, focus uniformity, and picture quality decrease with decreasing grid-No.4 and grid-No.3 voltage. In general, grid No.4 and grid No.3 should be operated above 250 volts.

● With no blanking voltage on grid No.1.

○ Measured with high-gain, low-noise, cascode-input-type amplifier having bandwidth of 5 Mc. Because the noise in such a system is predominately of the high-frequency type, the visual equivalent signal-to-noise ratio is taken as the ratio of highlight video-signal current to rms noise current, multiplied by a factor of 3.

⊕ The alignment coil should be located on the tube so that its center is at a distance of 3-11/16 inches from the face of the tube, and be positioned so that its axis is coincident with the axis of the tube, the deflecting yoke, and the focusing coil.

† Indicated range for each type of service serves only to illustrate the operating target-voltage range normally encountered.

** The target voltage for each 7038 must be adjusted to that value which gives the desired operating dark current.

▲ The deflecting circuits must provide extremely linear scanning for good black-level reproduction. Dark-current signal is proportional to the scanning velocity. Any change in scanning velocity produces a black-level error in direct proportion to the change in scanning velocity.

■ Video amplifiers must be designed properly to handle target currents of this magnitude to avoid amplifier overload or picture distortion.

\# Defined as the component of the target current after the dark-current component has been subtracted.

OPERATING CONSIDERATIONS

The *maximum ratings* shown for the 7038 are limiting values above which its serviceability may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

In the *handling* of the 7038, precautions should be taken to keep the tube in a vertical position with the faceplate up. This procedure will prevent any loose particles in the tube from causing possible damage to the photoconductive layer.

The *base pins* of the 7038 fit the ditetrar 8-pin connector, such as Cinch No.54A18088*, or equivalent.

The *target connection* is made by a suitable spring contact bearing against the edge of the metal ring at the face end of the tube. This spring contact may conveniently be provided as part of the focusing-coil design.

Support for the 7038 is provided by a suitable spring-finger suspension at the face end of the tube and by a clamping mechanism near the base end. Orientation of the 7038 in its support should be such that the horizontal scan is essentially parallel to the straight sides of the masked portions of the faceplate. The straight sides are parallel to the plane passing through the tube axis and short index pin.

The *optical system* associated with the 7038 should be of high quality and provide depth of focus sufficient to focus a sharp image on the photoconductive layer.

The *deflecting yoke* and *focusing coil* should extend 1/4 to 1/2 inch beyond the faceplate of the tube, as shown in Fig. 1. A long yoke, in comparison with a short yoke, not only requires

* Made by Cinch Manufacturing Corporation, 1026 S. Homan Ave., Chicago 24, Illinois.

less deflecting power but also deflects the beam through a narrower angle which effectively gives better center-to-edge focus and reduces geometric distortion of the image. Freedom from such distortion is particularly important

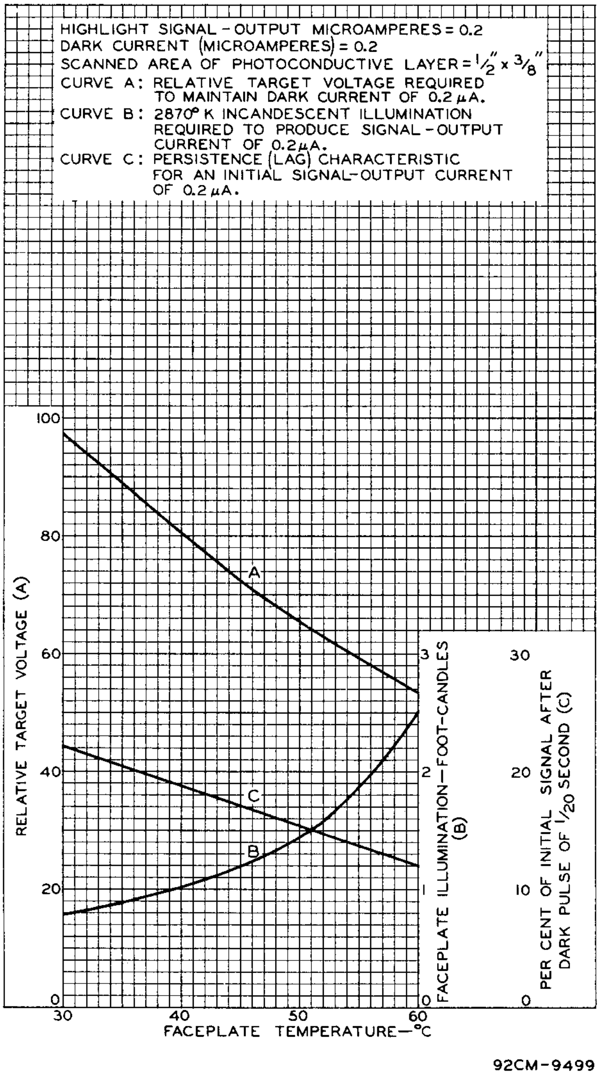


Fig.2 - Typical Characteristics of Type 7038.

in color cameras utilizing the method of simultaneous pickup in which three images must be identical for proper registration of the three video signals.

The yoke should be positioned so that the end of the deflecting coils toward the base of the tube will not extend more than 3-1/2 inches from the faceplate.

The *scanning speed* must be constant in order to obtain good black-level reproduction when the 7038 is operated at high dark current with resultant higher effective sensitivity. The dark-current signal is proportional to the scanning speed. Therefore, any change in scanning speed will produce a nonuniformity in black level in direct proportion to the change in scanning speed.

The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

The *alignment coil* should be located on the tube so that its center is at a distance of 3-11/16 inches from the face of the tube, and be positioned so that its axis is coincident with the axis of the tube, the deflecting yoke, and the focusing coil.

Electrostatic shielding of the target from external fields is required to prevent interference effects in the picture. Effective shielding from the fields produced by the deflecting components is ordinarily provided by grounding a shield on the inside of the faceplate end of the focusing coil and by grounding a shield on the inside of the deflecting yoke at a point near the input of the video amplifier.

The *temperature of the faceplate* should not exceed 60° C (140° F), either during operation or storage of the 7038. Operation with a faceplate temperature in the range from about 25° to 35° C (77° to 99° F) is recommended. The temperature of the faceplate is determined by the combined heating effects of the incident illumination on the faceplate, the associated components, and the tube itself. To reduce these heating effects in film-pickup cameras and permit operation in the preferred temperature range with a high value of illumination, the use of an infrared filter between the projector and faceplate as well as a blast of cooling air directed aross the faceplate from a blower is recommended.

The dark current is doubled for every 10° C rise in the temperature of the faceplate, and halved for every 10° C decrease in the temperature of the faceplate. To obtain optimum performance, it is desirable to operate the 7038 at a pre-established value of dark current. Therefore, if the temperature of the faceplate is allowed to vary it will be necessary to adjust the target voltage to maintain the desired dark current, as shown in Fig.2. Since the sensitivity of the tube decreases with increasing temperature, the amount of faceplate illumination necessary to produce a given signal as a function of faceplate temperature is also shown in Fig.2. In addition, the lag will decrease with increasing temperature as shown in Fig.2. For live pickup, it is desirable to select an operating temperature which provides the best balance between lag and sensitivity. The faceplate should be held close to this temperature to assure stability of black level and signal-output level.

The *target voltage* should be obtained from an adjustable dc source. As the target voltage is increased, the dark current increases as shown in

Fig.3. The target voltage must be adjusted to produce the desired value of dark current depending on the type of operation. *It should be noted that individual 7038's may operate with the same value of dark current and have identical performance characteristics, but each may require a different value of target voltage. The difference may be as much as 2 to 1, as shown in Fig.4.* For proper adjustment of the target voltage on each 7038, see *sequence of adjustments* on page 9.

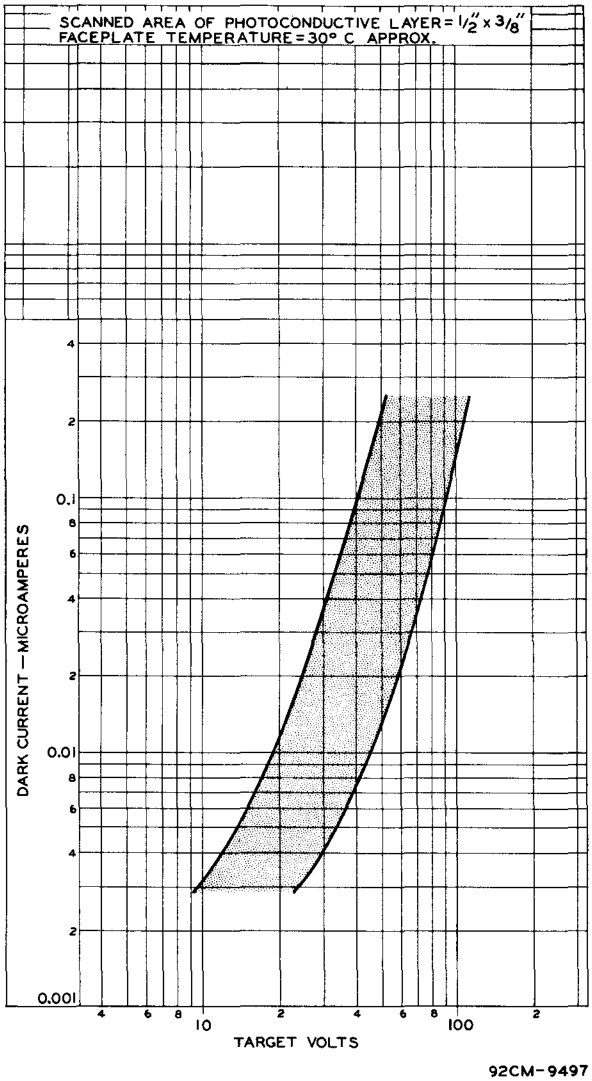


Fig.3 - Range of Dark Current for Type 7038.

The target voltage required for a particular type of operation may change gradually during the life of the tube. Therefore, it will be necessary to check this adjustment periodically. The equipment designer should make the target-voltage supply adjustable to provide means to compensate for any such change.

The *focusing-electrode (grid No.3) voltage* may be fixed at a value of about 280 volts when focusing control is obtained by adjusting the current through the focusing coil. In general, resolution decreases with decreasing grid-No.3 voltage. Operation at a grid-No.3 voltage below 250 volts is not recommended. The necessary range of current adjustment will depend on the design of the coil, but should be such as to provide a field-strength range of 36 to 44 gausses. When it is desired to use a fixed value of focusing-coil current capable of providing a fixed strength of 40 gausses at the center of the focusing device, the grid-No.3 voltage should be adjustable over a range from 250 to 300 volts.

Definition, focus uniformity, and picture quality decrease with decreasing grid-No.4 and grid-No.3 voltage. In general, grid No.4 and grid No.3 should be operated above 250 volts.

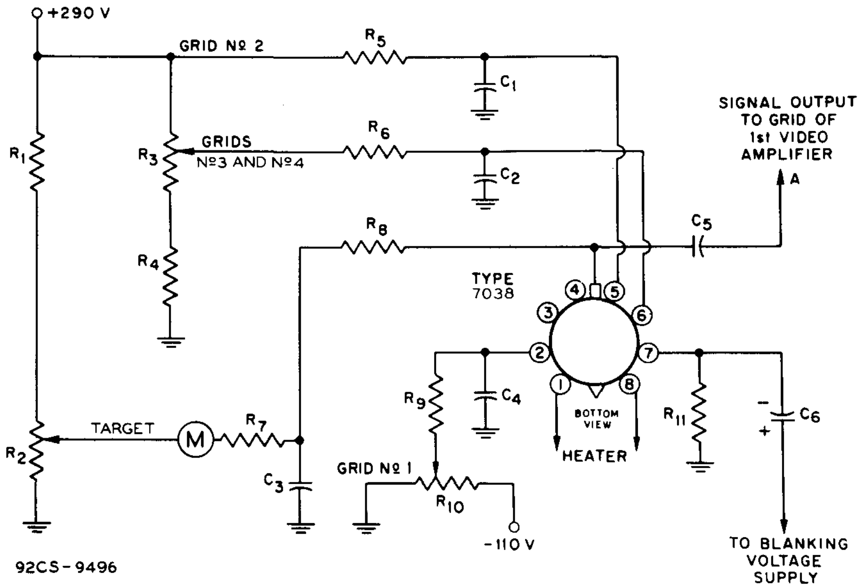
The *grid-No.1 voltage* should be adjustable from 0 to -110 volts.

The *dc voltages* required by the 7038 can be provided by the circuit shown in Fig.4.

A *blanking signal* should be supplied to grid No.1 or to the cathode to prevent the electron beam from striking the photoconductive layer during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the reproduced picture. The blanking signal is a series of negative voltage pulses when it is applied to grid No.1, or a series of positive voltage pulses when it is applied to the cathode.

Beam intensity is controlled by the amount of negative voltage on grid No.1. The beam must have adequate intensity to drive the highlight elements of the photoconductive-layer surface to cathode potential on each scan. When the beam has an intensity sufficient only to drive the lowlight elements to cathode potential, the highlight elements are not returned to cathode potential. As a result, the picture highlights all have the same brightness and show no detail. Also, when the beam has insufficient intensity, the photoconductive-layer surface which normally rises in potential by only a small fraction of the signal-electrode potential during each scan, gradually rises in potential to a value approaching nearly the full signal-electrode potential in the highlights. Under this condition, many scans are required to drive to cathode potential any element which has changed from a highlight to a lowlight because of movement of the image. As a result, the highlights tend to "stick". The loss of highlight detail and sticking of the highlights is referred to as "bloom".

On the other hand, a beam with excessively high intensity should not generally be used because the size of the scanning spot increases with resultant decrease in resolution.



C1 C4: 0.1 μf, 300 volts (working voltage)
C2: 0.1 μf, 300 volts (working voltage)
C3 C5: 0.1 μf, 200 volts (working voltage)
C6: 4 μf, electrolytic, 300 volts (working voltage)
M: Target-Current Meter, RCA Ultra-sensitive Microammeter WV-84B, or equivalent

R1: 120000 ohms, 1/2 watt
R2: 100000-ohm potentiometer, 2 watts
R3: 50000-ohm potentiometer, 2 watts
R4: 70000 ohms, 1/2 watt
R5: 5000 ohms, 1/2 watt
R6: 10000 ohms, 1/2 watt
R7: 200000 ohms, 1/2 watt
R8: 50000 ohms, 1/2 watt, non-inductive
R9: 100000 ohms, 1/2 watt
R10: 500000-ohm potentiometer, 2 watts
R11: 1000 ohms, 1/2 watt, non-inductive

Fig.4 - Typical Voltage Dividers for Supplying DC Electrode Voltages to Type 7038.

The *video amplifier system* should be designed to handle peak ac voltages corresponding to a highlight target current of 0.5 microampere through the target load resistor. Such a system is shown by the block diagram in Fig.5 (a). This system employs a low-noise, cascode preamplifier having an 8-Mc bandwidth as shown in Fig.5 (b).

Aperture correction compensates for the aperturing effect of the scanning beam in the 7038. This effect produces a horizontal square-wave response shown by the "uncompensated" curve in Fig.6. When this effect is compensated, the horizontal square-wave response of the video system is raised to approximately 100 per cent over the entire broadcast bandwidth of 4.5 Mc, and is shown by the "compensated" curve in Fig.6. This compensation, however, does not affect the vertical resolution. Combining the compensated horizontal resolution and the uncorrected vertical resolution yields the equivalent square-wave response which is shown in Fig.6 and is expressed by the equation

$$\text{Equiv. Square-Wave Response} = \sqrt{R_v \times R_h}$$

where R_v and R_h are the vertical square-wave response and the horizontal square-wave response, respectively.

The *illumination* incident on the faceplate will range from relatively high values for film pickup to relatively low values for direct pickup. For satisfactory operation of the 7038 at these extremely different light levels, it is essential that the target voltage be properly adjusted with reference to the curves in Figs.7, 8, and 11 to give the proper value of dark current for the desired service. Adjustment of the target voltage to obtain the desired dark current, is covered in *sequence of adjustments* on page 9.

For *live pickup involving low illumination levels*, a good picture can be obtained with a highlight illumination of 1 to 3 foot-candles on the faceplate of the 7038. Such a low illumination level, however, requires maximum-sensitivity operation of the 7038. For this type of operation, a dark current of 0.2 microampere is required. This value will be obtained for a target voltage within the range of 60 to 100 volts. Under such low-level illumination conditions, the lag will be somewhat greater and the black-level uniformity will be somewhat poorer than for live-pickup conditions with higher faceplate illumination and lower dark current.

When the 7038 is used for live pickup with illumination levels of 10 to 20 foot-candles on the faceplate, a dark current of 0.02 microampere is required. This value will be obtained for a target voltage within the range of 30 to 50 volts.

For *film pickup*, an average highlight illumination of 50 to 200 foot-candles is required on the faceplate of the 7038 for minimum lag and best black-level uniformity. For this range of illumination, a dark current of about 0.004 microampere is required, and the target voltage will range between 15 and 25 volts.

The exact value of target voltage to give the required dark current will depend on the individual tube and on the temperature at which its faceplate is operated. It is important that the tube be allowed to reach a stable operating temperature before the operating dark current is determined; otherwise the dark current will change as the temperature of the tube changes.

In all cases, the illumination level and/or dark current must be limited or adjusted so that the peak signal-output current does not exceed those values shown under Typical Operation. In order that the signal-output current and dark current will be known at all times, it is recommended that the camera be provided with a suitable microammeter in the target circuit of each 7038 for each 7038. From these curves, it will also be noted that the illumination must be increased about 30 times to produce an increase of 10 times in signal-output current for any given value of dark current.

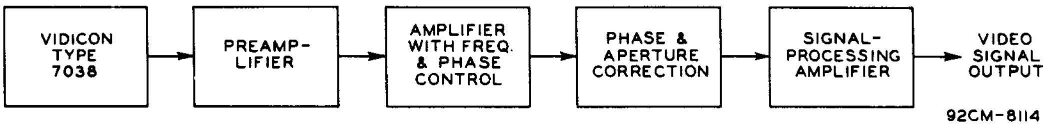
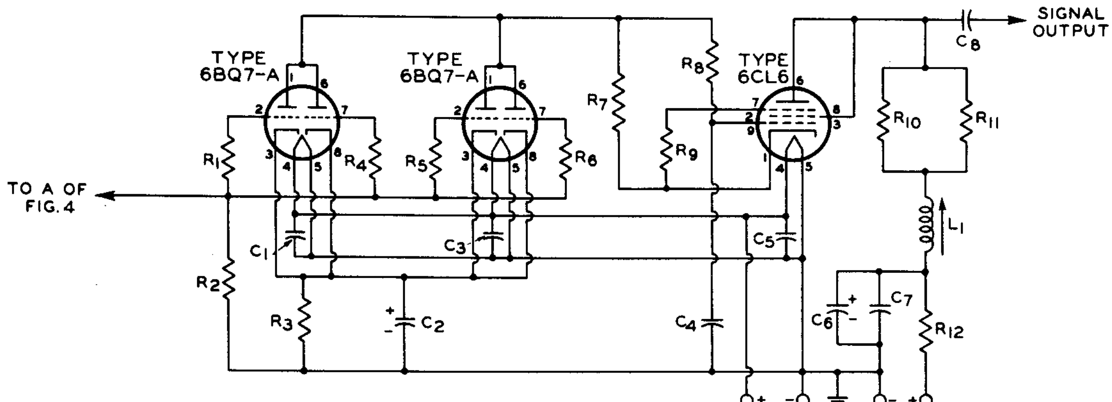


Fig. 5 (a) - Block Diagram of Video System.



NOTE: IT IS RECOMMENDED THAT THIS PREAMPLIFIER BE SHOCK-MOUNTED TO PREVENT MICROPHONIC DIFFICULTIES.

All capacitor voltages are working values

C1 C3 C5: 0.01 μf, 100 volts
C2: 2000 μf, electrolytic, 3 volts
C4: 0.01 μf, 350 volts
C6: 90 μf, electrolytic, 350 volts
C7: 0.1 μf, 350 volts
C8: 0.1 μf, 300 volts
L1: 12 μh peaking coil, adjustable core to cover range from 9 to 15 μh

All resistors are of the carbon-composition type

R1 R4 R5 R6: 100 ohms, 1/2 watt
R2: 500000 ohms, 1/2 watt
R3: 15 ohms, 1/2 watt
R7: 12 ohms, 1/2 watt
R8: 100000 ohms, 1/2 watt
R9: 1 megohm, 1/2 watt
R10 R11: 1800 ohms, 2 watts
R12: 470 ohms, 2 watts

Fig. 5 (b) - Low-Noise Cascode Preamplifier Having 8-Mc Bandwidth.

to read average target current, or that a calibration pulse of the proper magnitude be fed into the input of the video preamplifier to indicate peak target currents.

The maximum amount of illumination on the photoconductive layer is limited primarily by the temperature of the faceplate which should never exceed 60° C and should preferably be maintained within the operating range from 25° C to 35° C for most satisfactory performance.

Signal Output and Light Transfer Characteristics. Typical signal output as a function of uniform 2870° K tungsten illumination on the photoconductive layer for different values of dark current is shown in Fig. 8. It is to be noted that these curves are for a typical 7038 under the conditions indicated. Because the target voltage needed to give maximum sensitivity at a dark current of 0.2 microampere may range between 60 and 100 volts, it is essential that the best operating target voltage be determined

The average "gamma", or slope, of the light transfer characteristic curves shown in Fig. 8 is approximately 0.65. This value is relatively constant over an adjustment range of 4 to 1 in target voltage, or 50 to 1 in dark current, for a signal-output current range between 0.01 and 0.3 microampere. Close uniformity in the value of gamma between individual 7038's is maintained to insure satisfactory operation of color cameras in which the signal-output currents of the three 7038's must match closely over a wide range of scene illumination. Because its transfer characteristic is approximately the complement of the transfer characteristic of a picture tube, the 7038 can produce a picture having proper tone rendition.

Uniform sensitivity over the scanned area of the 7038 can be achieved by compensating for the beam landing errors that are introduced by the deflecting and focusing components used with the tube. Without compensation for these errors, variations in sensitivity over the scanned area will occur. These variations resulting from beam landing errors are in the form of lower signal from the edges of the scanned area than from the center. However, because of the uniformity of the photoconductive layer, these variations in sensitivity are the same from tube to tube. Compensation for the beam landing errors to achieve uniform sensitivity can be obtained by supplying a modulating voltage of a suitable waveform to the cathode of the 7038. The desired waveform is parabolic in shape and of such a polarity that the cathode voltage is lowered as the beam approaches the edges of the scanned area. The modulating waveform should contain parabolic components of both the horizontal and vertical scanning frequencies. The horizontal component should have the greater amplitude and will be the most effective in obtaining uniform sensitivity.

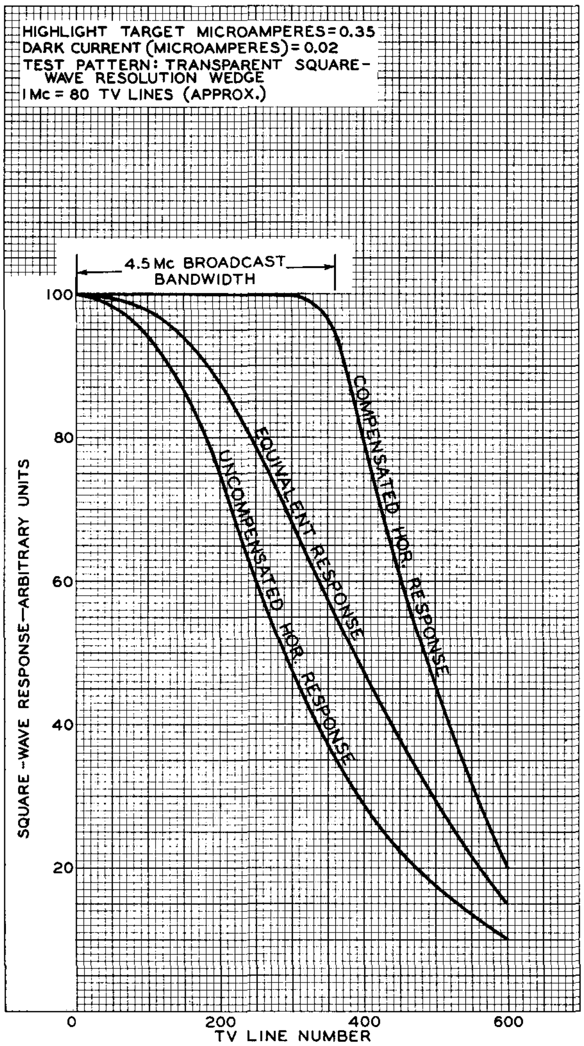


Fig. 6 - Curves Showing Uncompensated Horizontal Square-Wave Response of Type 7038 as well as Compensated Horizontal Square-Wave Response and Equivalent Square-Wave Response of the Video System Including Type 7038.

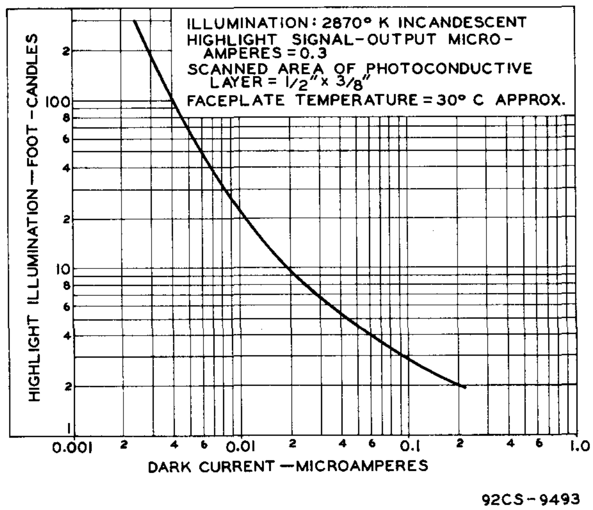


Fig. 7 - Typical Characteristic of Type 7038.

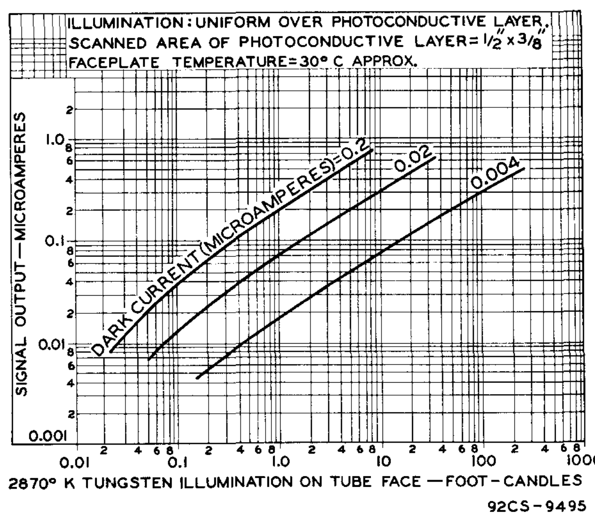
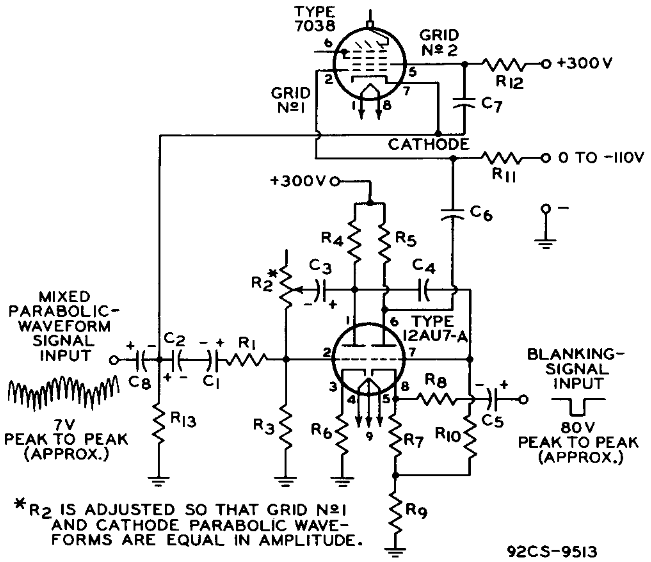


Fig. 8 - Light Transfer Characteristics of a Typical 7038 Vidicon.

The circuit of Fig.9 shows the amount of parabolic-waveform voltage required and the method of applying the waveform to the cathode, grid No. 1, and grid No. 2 of a 7038 which utilizes a deflecting-yoke and focusing-coil system of conventional design. The modulating voltage is applied to grid No. 1 and grid No. 2 as well as to the cathode to prevent modulation of the scanning beam.

The use of this modulating waveform also improves the center-to-edge focus of the vidicon and assures that sensitivity over the scanned area will be uniform for the recommended dark current for any specific service. Care must be taken that identical waveforms are applied to electrodes of each of the three tubes when using



All capacitor voltages are working values

C1 C2: 8 μf, electrolytic, 25 volts
C3: 8 μf, electrolytic, 450 volts
C4: 0.1 μf, paper tubular, 400 volts
C5: 8 μf, electrolytic, 450 volts
C6: 1 μf, paper tubular, 400 volts
C7: 30 μf, electrolytic, 450 volts
C8: 125 μf, electrolytic, 350 volts

All resistors are of the carbon-composition type

R1: 10000 ohms, 1/2 watt
R2: 50000 ohm-potentiometer, linear taper
R3: 1 megohm, 1/2 watt
R4: 20000 ohms, 1 watt
R5: 10000 ohms, 1 watt
R6: 1000 ohms, 1/2 watt
R7: 1800 ohms, 1/2 watt
R8: 10000 ohms, 1/2 watt
R9: 8200 ohms, 1 watt
R10: 1 megohm, 1/2 watt
R11: 100000 ohms, 1/2 watt
R12: 5100 ohms, 1/2 watt
R13: 1000 ohms, 1/2 watt

Fig. 9 - Typical Circuit for Applying Waveform to Compensate for Beam Landing Errors in Type 7038.

the 7038 in 3-vidicon color cameras to insure good registration of all signals over the entire scanned area.

Persistence or lag of the photoconductive layer is given in Fig. 10 for two values of dark current. Each curve shows the decay in signal-output current from an initial value of 0.3 microampere after the illumination is cut off. The effect of faceplate temperature on persistence is shown in Fig. 2.

Persistence of the photoconductive layer for different values of dark current is given by the curve in Fig. 11. It is to be noted that the initial signal-output current is held constant for each value of dark current. This curve shows decreasing lag with decreasing dark current, and a small value of lag for the low value of dark current recommended for film pickup.

Signal-output-current buildup when light is applied to the photoconductive layer previously in the dark is as fast or faster than the rate of decay.

The *spectral response* of the 7038 is shown by curves A and C in Fig. 12. Curve A is on the basis of equal values of signal-output current at all wavelengths, whereas curve C is on the basis of equal values of signal-output current with radiant flux from a tungsten source at 2870° K. For comparison purposes, the response of the eye is shown in curve B.

Full-size scanning of the 1/2" x 3/8" area of the photoconductive layer should always be used. This condition can be assured by first adjusting the deflection circuits to overscan the photoconductive layer sufficiently so that the edges of the sensitive area can be seen on the monitor. Then, after centering the image on the sensitive area (see Fig. 13), reduce scanning until the edges of the image just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. It should be noted that overscanning the photoconductive layer produces a smaller-than-normal picture on the monitor.

Underscanning of the photoconductive layer, i.e., scanning an area of the layer less than 1/2" x 3/8", should never be permitted. This condition which produces a larger-than-normal picture on the monitor, not only causes sacrifice in signal-to-noise ratio and resolution, but also may cause permanent change in sensitivity and dark current of the underscanned area. An underscanned area showing such a change will be visible in the picture when full-size scanning is restored.

Failure of scanning even for a few seconds may permanently damage the photoconductive layer. The damaged area shows up as a spot or line in the picture during subsequent operation. To avoid damaging the 7038 during scanning failure, it is necessary to prevent the scanning beam from reaching the layer. The scanning beam can conveniently be prevented from reaching the layer by increasing the grid-No. 1 voltage to cutoff.

The *sequence of adjustments* in operating the 7038 for live pickup is as follows: With the Grid-No. 1 Voltage Control set for maximum negative bias (beam cutoff), Target Voltage Control set for the minimum voltage shown under *Typical Operation*, and Deflection Controls set for maximum overscan, apply other voltages to the 7038 as indicated under *Typical Operation*.

Next, with a 1/2" x 3/8" mask centered on the face of the tube, and with the iris set for minimum opening, decrease the grid-No. 1 bias to just bring out the highlight details of the picture on the monitor. Adjust the Beam-Focus Voltage Control, the lens stop, and the optical focus to obtain the best picture. Reduce horizontal and vertical scanning so that the edges of the image extend just outside the scanned area on the monitor. Then adjust the alignment field so that the center of the picture does not move as the beam-focus voltage is varied. Some readjustment of horizontal and vertical centering may be necessary after alignment.

For maximum-sensitivity operation of the 7038 in live-pickup service, proceed as follows. With no illumination on the face of the tube, increase the target voltage until a dark current of 0.2 microampere is measured. The current should be measured with a sensitive microammeter such as the RCA Type WV-84B Microammeter.

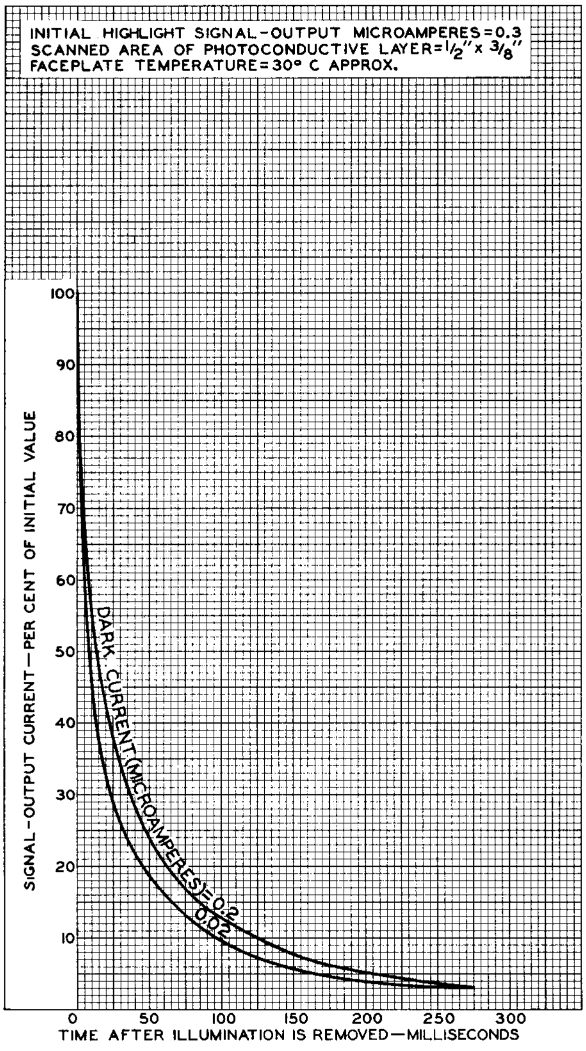


Fig. 10 - Typical Persistence Characteristics of Type 7038.

Next, open the lens and adjust the aperture to give a peak signal-output current of 0.2 to 0.3 microampere. A good procedure for doing this is to focus the camera on a uniform white area having the same brightness as the highlights in the scene to be televised. The image of this white area must at least cover the scanned area of the tube face. The current read on the microammeter will be the dark current plus the peak signal-output current, i.e., highlight target current.

A waveform-oscilloscope monitor can be used to compare the peak signal-output current produced by any scene to the peak value measured with the microammeter when the camera is focused on a uniformly bright scene. When a camera is adjusted in this manner, video gain should be kept constant and the light level on the tube face should be controlled to maintain the constant predetermined value of peak signal as observed on the oscilloscope.

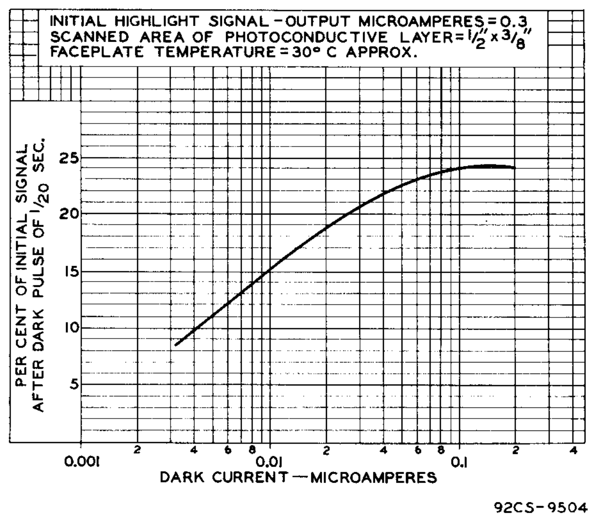


Fig. 11 - Typical Persistence Characteristic of Type 7038.

After adjusting the light level to obtain the correct signal-output current, the grid-No. 1-bias voltage should be adjusted to just discharge the highlights. Too much current will result in poor resolution and poor picture quality. After the grid-No. 1 bias is properly adjusted, it will be necessary to check and readjust the dark current and the peak signal-output current.

Proper adjustment of the dark current, the peak signal-output current, and the grid-No. 1 bias, will result in a picture of good quality with minimum smearing of moving objects.

For average-sensitivity operation of the 7038 in live-pickup service, the adjustments are similar to those for maximum-sensitivity operation except that the target voltage should be adjusted to produce a dark current of 0.02 microampere. When sufficient light is available, decreased lag can be obtained by operating with this lower value of dark current.

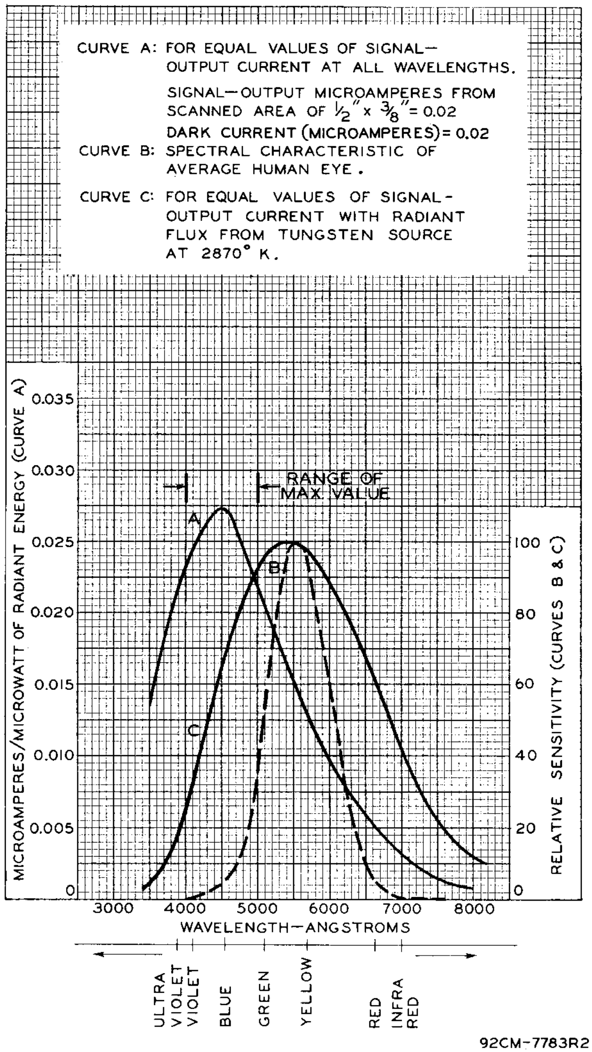


Fig. 12 - Spectral Sensitivity Characteristics of Type 7038.

For film-pickup operation of the 7038, the adjustments will be similar to those for live pickup except that the target voltage should be adjusted to produce a dark current of 0.004 microampere and the peak signal-output current should be adjusted to the desired value by controlling the light level on the faceplate of the tube.

In setting up three 7038's in a color camera, particular attention must be given to proper alignment, best obtainable focus, and identical centering of scanned areas on the photoconductive layers. For best color balance and color tracking over a wide range of light levels, the light level in each color channel should be controlled so that each of the three 7038's develops the same value of peak signal output for white portions of a scene. Observation of these operating conditions will assure good registration and good color balance.

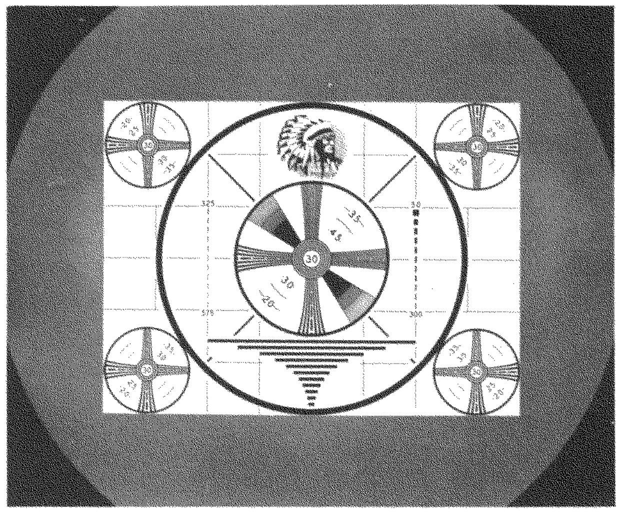


Fig. 13 - Illustration Showing Proper Positioning of Image on the Face of the Vidicon.

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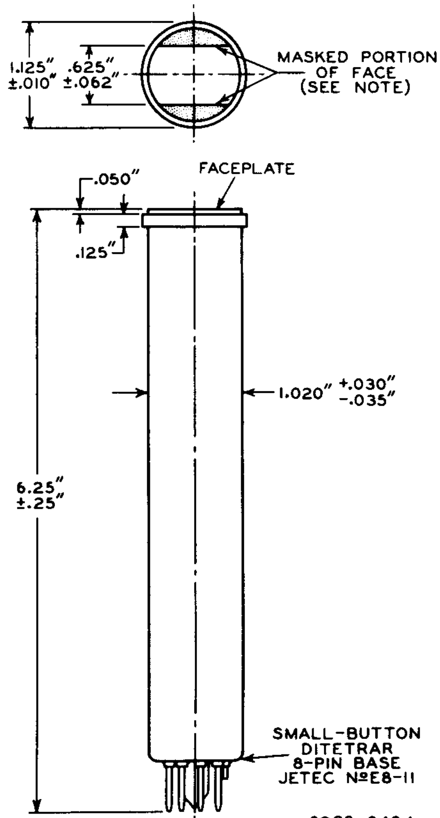
DIMENSIONAL OUTLINE

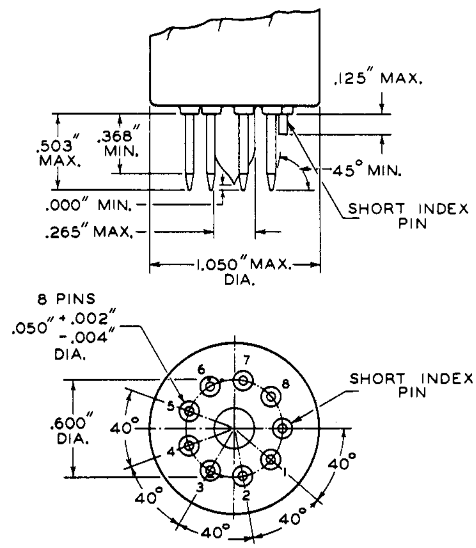


92CS-9494

NOTE: STRAIGHT SIDES OF MASKED PORTIONS ARE PARALLEL TO THE PLANE PASSING THROUGH TUBE AXIS AND SHORT INDEX PIN.

BASE DRAWING

SMALL - BUTTON DITETRAR
8-PIN BASE
JETEC No E8 - 11



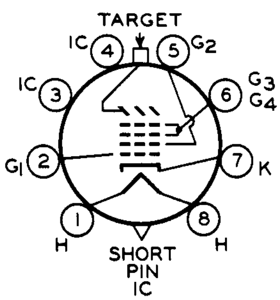
92CS-7765R1

BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT ENTIRE LENGTH OF PINS WILL, WITHOUT UNDUE FORCE, PASS INTO AND DISENGAGE FROM FLAT-PLATE GAUGE HAVING THICKNESS OF 1/4" AND NINE HOLES WITH DIAMETERS OF 0.0700" ± 0.0005" SO LOCATED ON A 0.6000" ± 0.0005" DIAMETER CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS 0.2052" ± 0.0005". GAUGE IS ALSO PROVIDED WITH A HOLE HAVING DIAMETER OF 0.300" ± 0.001" CONCENTRIC WITH THE PIN CIRCLE.

SOCKET CONNECTIONS

Bottom View

PIN 1: HEATER
PIN 2: GRID No.1
PIN 3: INTERNAL CONNECTION—DO NOT USE
PIN 4: INTERNAL CONNECTION—DO NOT USE
PIN 5: GRID No.2
PIN 6: GRIDS No.3 and No.4



PIN 7: CATHODE
PIN 8: HEATER
FLANGE: TARGET
SHORT INDEX PIN: INTERNAL CONNECTION—MAKE NO CONNECTION

DIRECTION OF LIGHT:
INTO FACE END OF TUBE

8HM

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