



6198

VIDICON

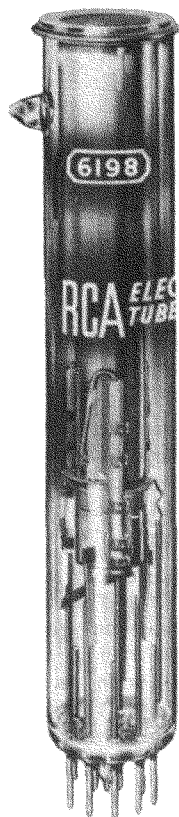
**Magnetic Focus
Magnetic Deflection**

**High Sensitivity
400-Line Resolution**

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

TENTATIVE DATA

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.

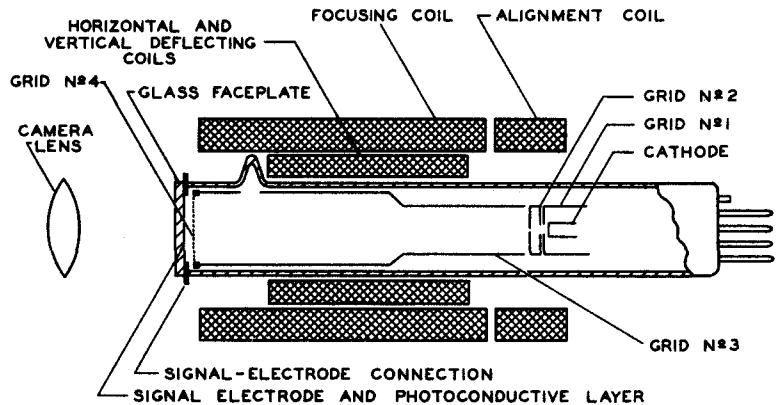
When the gun side of the photoconductive layer with its positive potential pattern is scanned by the electron beam, electrons are deposited from the beam in sufficient quantities until the surface potential is reduced to that of the cathode, and thereafter are turned back to form a return beam which 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



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.



92CS-7826

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	μf
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 is 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

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 gauss. 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 gauss 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 high-

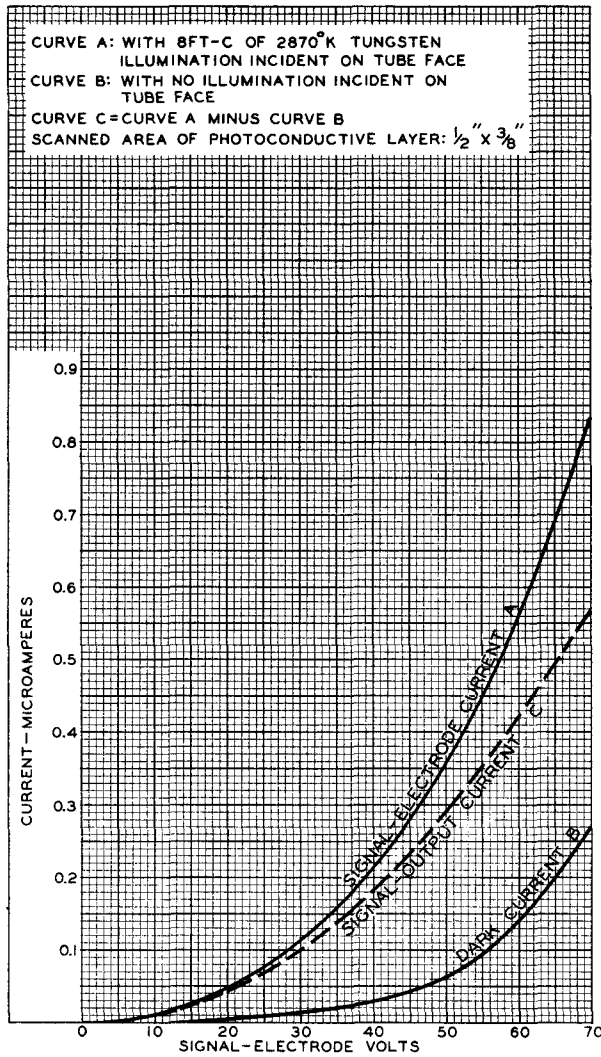


Fig. 2 - Typical Characteristics of Type 6198.

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

light 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

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.

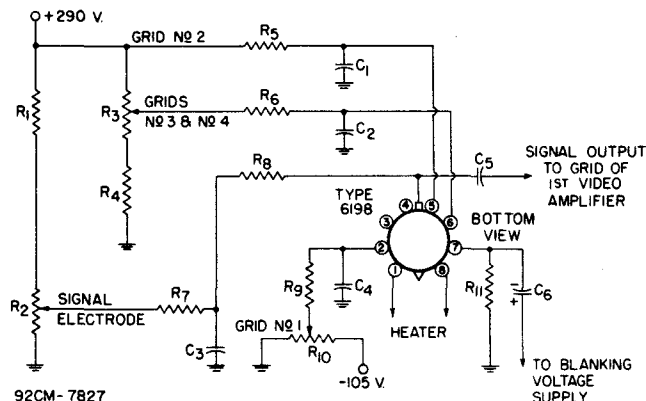
Except for very close shots, the linear magnification (m) from scene to photoconductive layer may be neglected.

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



- C1 C4: 0.01 μ f, 300 volts (working voltage)
- C2: 0.1 μ f, 300 volts (working voltage)
- C3 C5: 0.1 μ f, 200 volts (working voltage)
- C6: 4 μ f, 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.

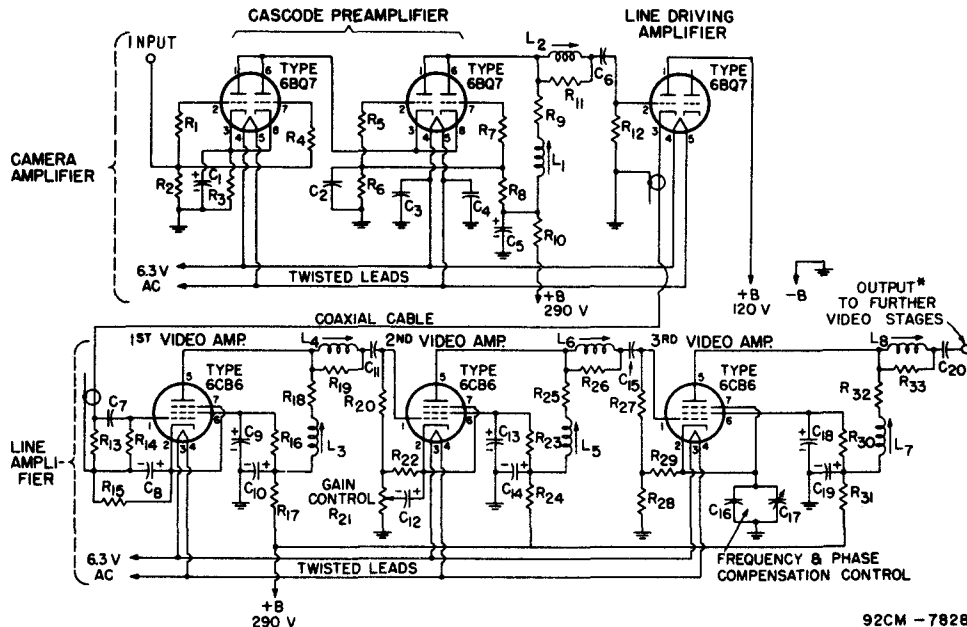
When the 6198 is operated under normal conditions with adequate but not excessive beam intensity, it will be noted that any sudden, large excess of illumination on the televised scene will cause bloom in the televised picture.

The *video amplifier* should be designed to cover a range of ac signal voltages corresponding



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.



92CM-7828

Coaxial Cable: Amphenol No. 21-025 (Army-Navy No. RG-59/U), or equivalent.

C1 C8: 50 μ f, electrolytic, 3 volts (working voltage)
C2 C11 C15 C20: 0.1 μ f, 300 volts (working voltage)
C3 C4 C7: 0.1 μ f, 100 volts (working voltage)
C5 C9 C10 C13 C14 C18 C19: 10 μ f, electrolytic, 300 volts (working voltage)

C6: 0.05 μ f, 300 volts (working voltage)
C12: 100 μ f, electrolytic, 50 volts (working voltage)
C16: 120 μ f, ceramic, 150 volts (working voltage)
C17: 50-150 μ f, ceramic, adjustable, 150 volts (working voltage)

L1: 19 μ h peaking coil, adjustable core to cover range from 15 to 23 μ h
L2 L3 L5 L7: 24 μ h peaking coil, adjustable core to cover range from 20 to 30 μ h
L4 L6 L8: 5 μ h peaking coil, adjustable core to cover range from 4 to 6 μ h

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

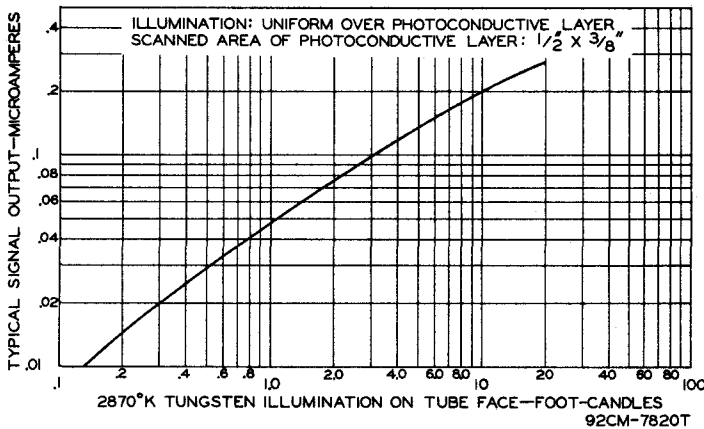


Fig. 5 - Typical Signal Output of Type 6198.

minimize smearing, the use of more illumination full-size scanning 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.

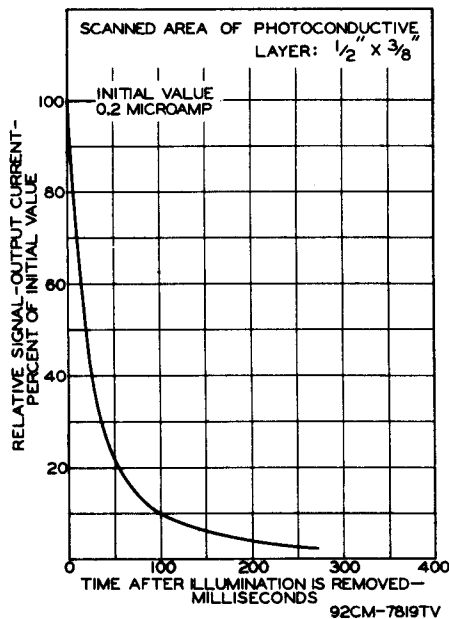


Fig. 6 - Persistence Characteristic of Type 6198.

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.

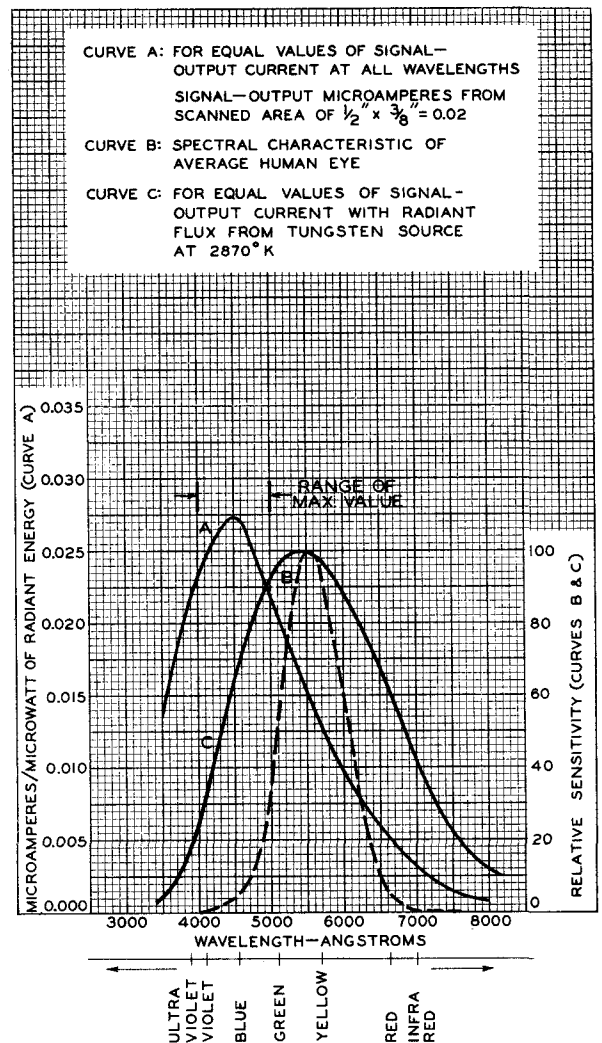


Fig. 7 - Spectral Sensitivity Characteristic of Type 6198.



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.

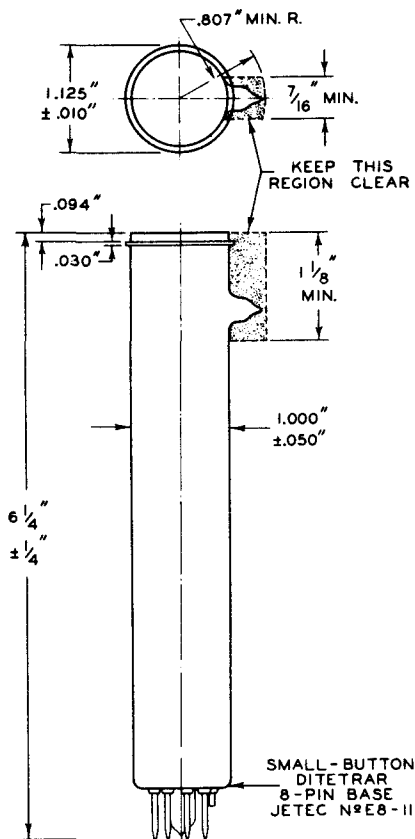
The *sequence of adjustments* in operating the 6198 is as follows: With the grid-No.1 voltage control set for maximum bias (beam cutoff) and with the camera lens iris closed, apply voltages to the tube as indicated under Typical Operation. Make certain that the deflection circuits are functioning properly 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 in 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.

REFERENCES

- Albert Rose, "Photoconductivity in Insulators," RCA Review, Vol. XII, No.3, Part 1, September, 1951.
- Paul K. Weimer, Stanley V. Forgue and Robert R. Goodrich, "The Vidicon--Photoconductive Camera Tube," Electronics, Vol. 23, No.5, May, 1950. Reprinted in RCA Review, Vol. XII, No.3, Part 1, September, 1951.
- Paul K. Weimer and A. Danforth Cope, "Photoconductivity in Amorphous Selenium," RCA Review, Vol. XII, No.3, Part 1, September, 1951.
- S. V. Forgue, R. R. Goodrich and A. D. Cope, "Properties of Some Photoconductors, Principally Antimony Trisulfide," RCA Review, Vol. XII, No.3, Part 1, September, 1951.
- Albert Rose, "An Outline of Some Photoconductive Processes," RCA Review, Vol. XII, No.3, Part 1, September, 1951.
- B. Kazan and M. Knoll, "Fundamental Processes in Charge-Controlled Storage Tubes," RCA Review, Vol. XII, No.4, December, 1951.
- B. H. Vine, R. B. Janes and F. S. Veith, "Performance of the Vidicon, A Small Developmental Television Camera Tube," RCA Review, Vol. XIII, No.1, March, 1952.

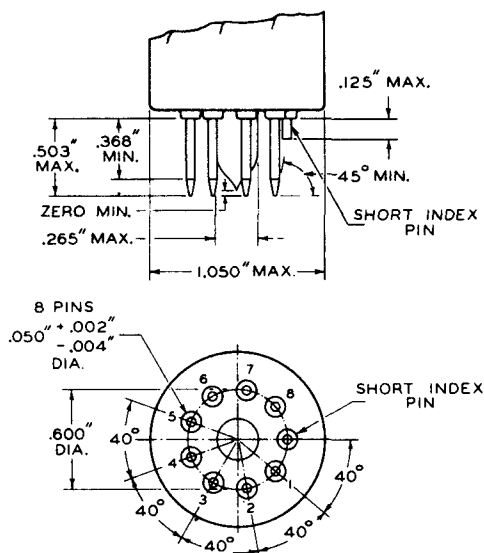
DIMENSIONAL OUTLINE



92CS-7772

BASE DRAWING

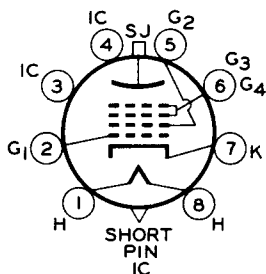
SMALL - BUTTON DITETRAR
8-PIN BASE
JETEC NºE8-11



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 $0.0700" \pm 0.0005"$ so located on a $0.6000" \pm 0.0005"$ diameter circle that the distance along the chord between any two adjacent hole centers is $0.2052" \pm 0.0005"$. Gauge is provided with center hole having diameter of $0.300" \pm 0.001"$ 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

PIN 7: CATHODE
PIN 8: HEATER
FLANGE: SIGNAL ELECTRODE (SJ)
SHORT INDEX PIN: INTERNAL
CONNECTION--
MAKE NO
CONNECTION

DIRECTION OF LIGHT:
INTO FACE END OF TUBE