



6474/1854

IMAGE ORTHICON

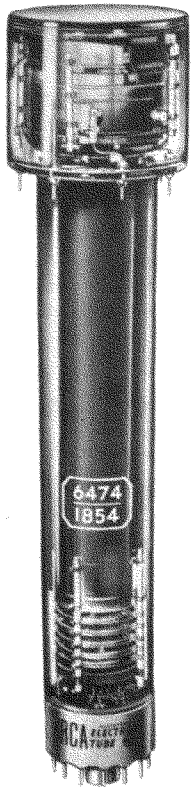
Magnetic Focus
Magnetic Deflection

For Simultaneous Color Pickup
Exceptional Sensitivity

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

TENTATIVE DATA

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).

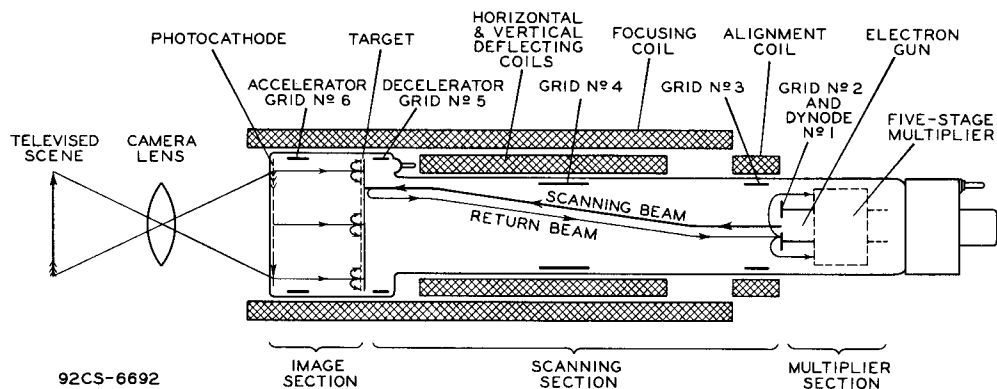


Fig. 1 - Schematic Arrangement of Type 6474.

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 (R25 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, 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.	°C
Of bulb at large end of tube (Target section).	35 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:

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	°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.

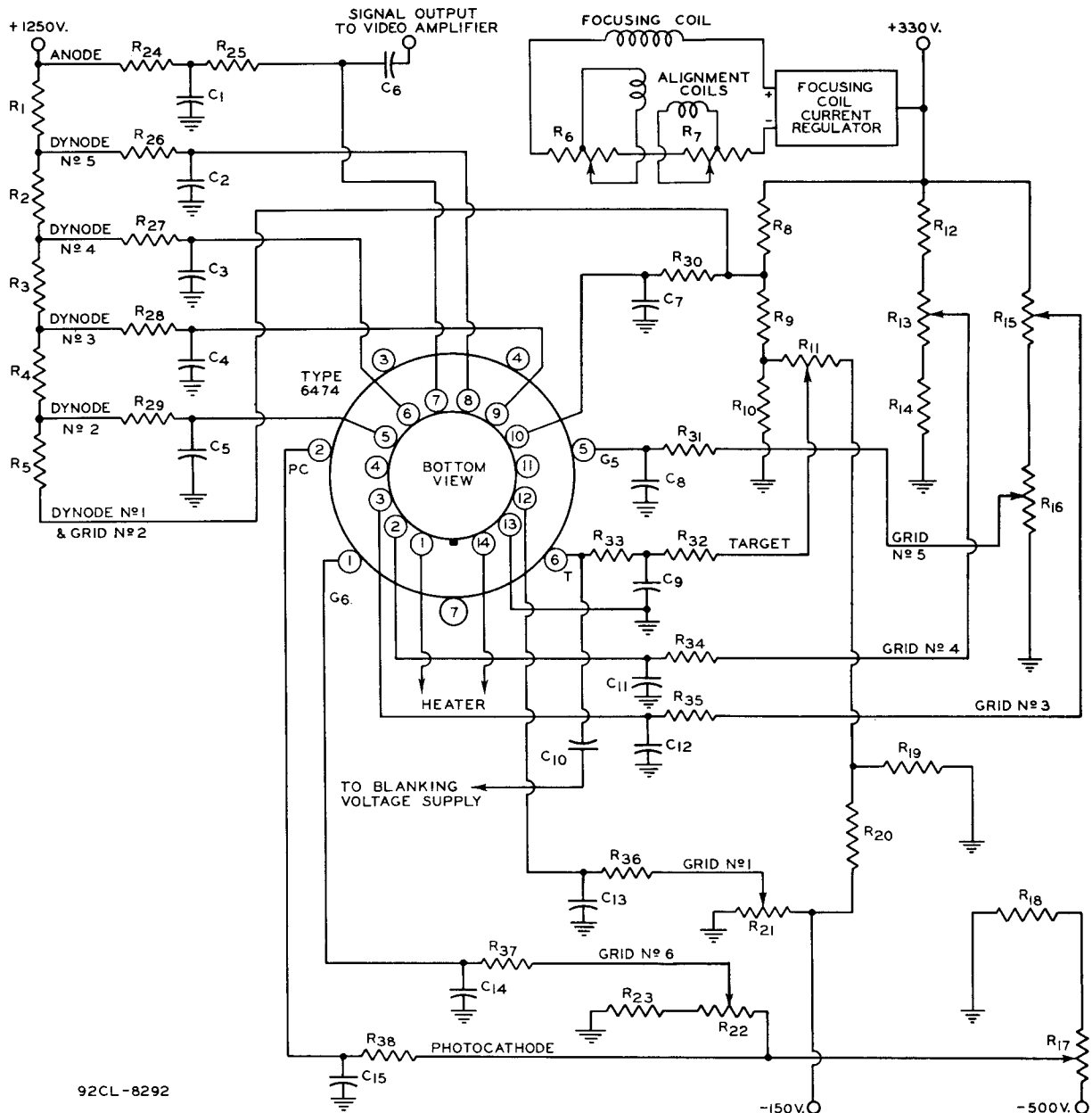
The 6474 is installed by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin No. 7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the key-pin hole in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



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C1 C2: 0.05 μ f, 1600 v working voltage
 C3: 0.01 μ f mica, 1600 v working voltage
 C4: 0.001 μ f mica, 1000 v working voltage
 C5: 0.001 μ f mica, 600 v working voltage
 C6: 0.03 μ f mineral-oil impregnated, 1600 v working voltage
 C7 C8 C9 C11 C12 C13 C14 C15: 0.001 μ f mica, 400 v working voltage
 C10: 1 μ f, 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: 5100 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 C₆ 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 (R₂₅ 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.

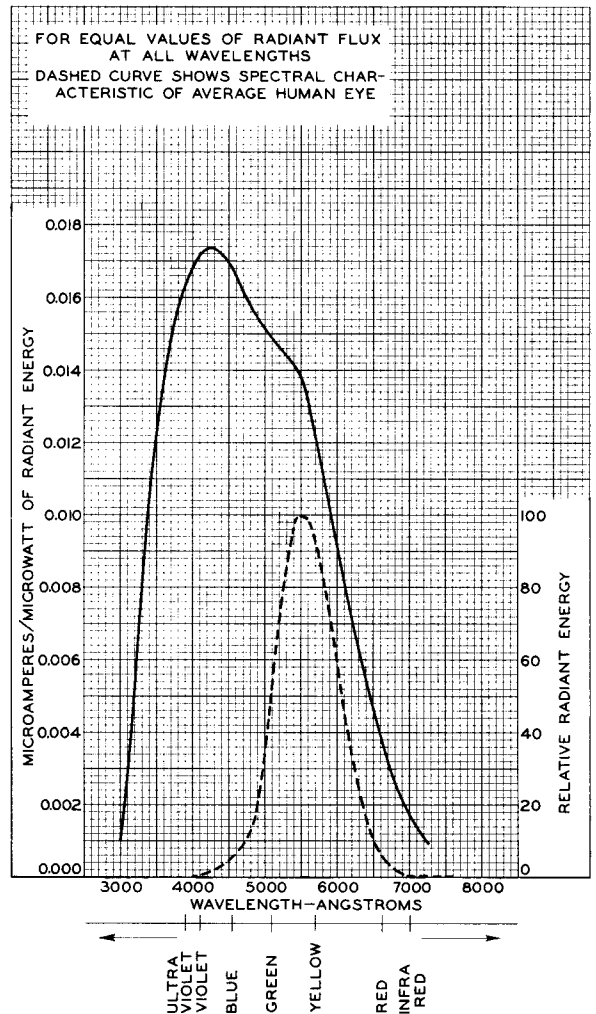
Rotation in the use of 6474's is recommended. After a 6474 is operated for 200 to 300 hours, it should be given an idle period of three or four weeks during which it generally will recover much of its original resolution and sensitivity.

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



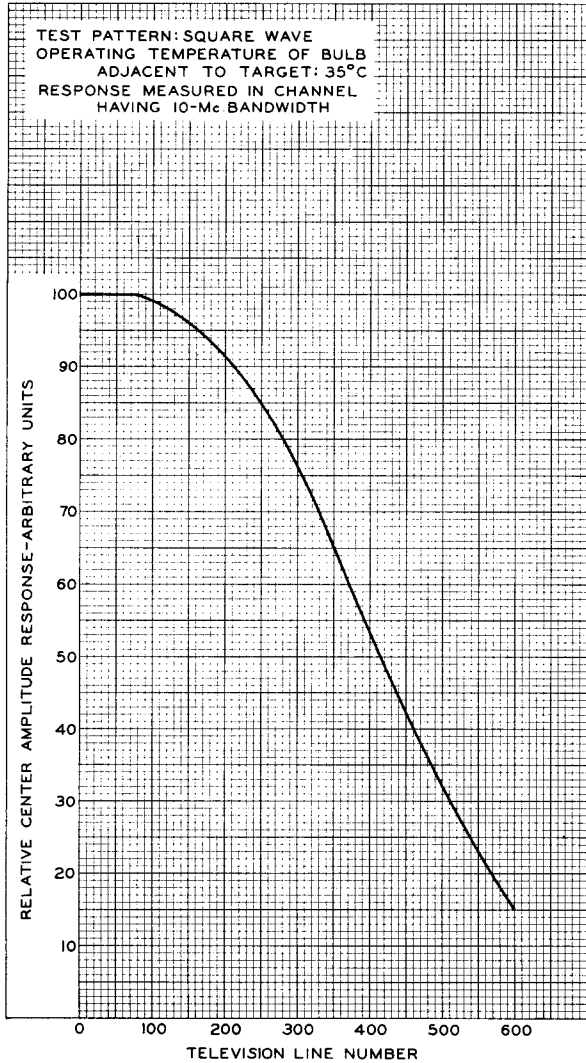
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Fig. 3 - Spectral Sensitivity Characteristic of Type 6474.

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

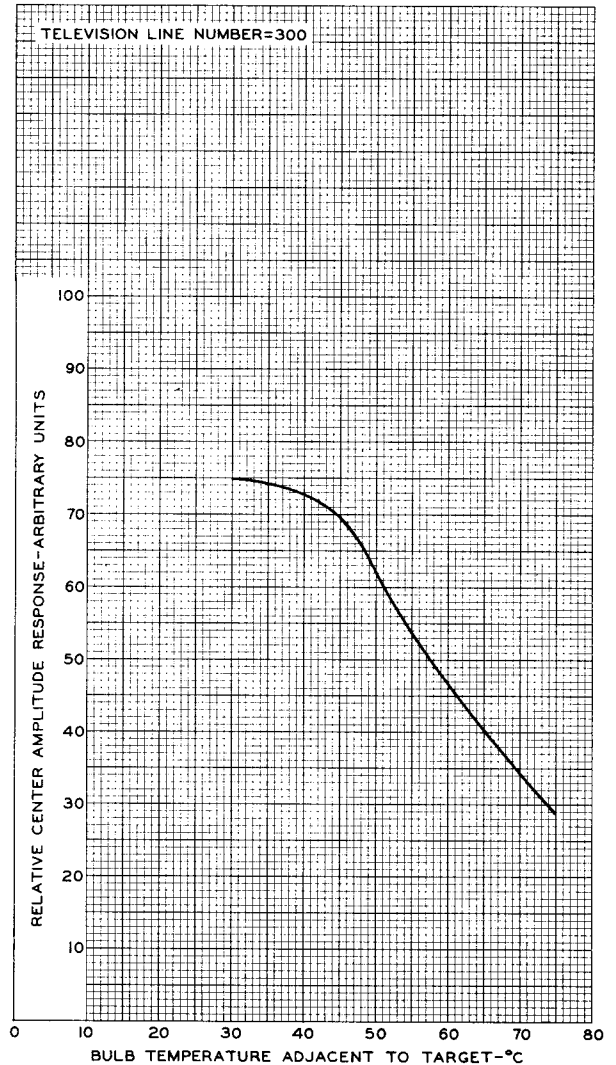
the target. Such migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 6474 may show fluctuations in performance from time to time. Strict ob-

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



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Fig. 4 - Amplitude Response Characteristic of Type 6474.



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

servance 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

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.

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

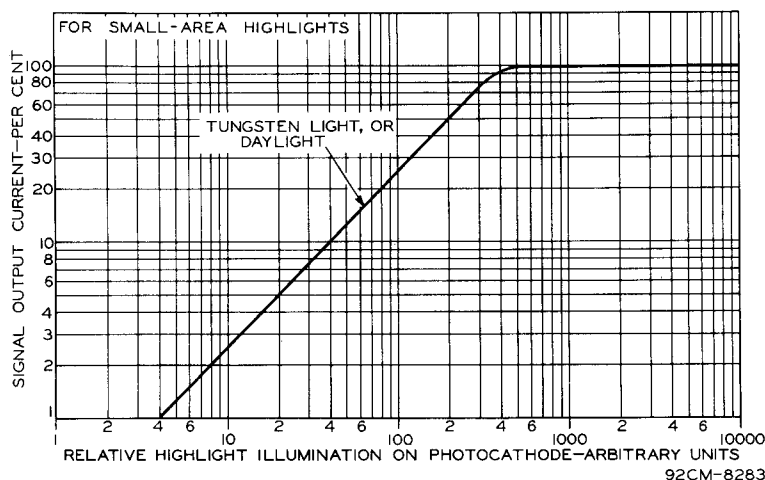


Fig. 6 - Basic Light Transfer Characteristic of Type 6474.

cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

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 discern-

able 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.

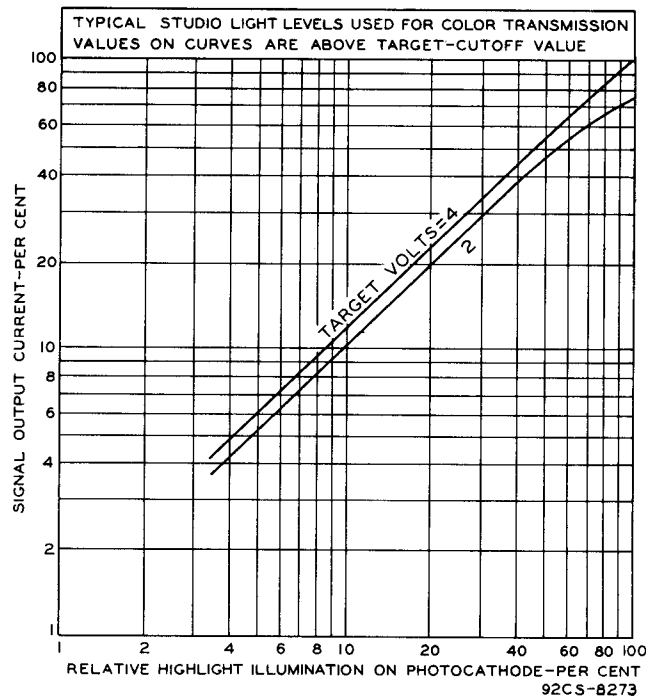


Fig.7 - Light Transfer Characteristics of Type 6474.

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 high-light 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 if 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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3. Otto H. Schade, "Electro-Optical Characteristics of Television Systems; Introduction and
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6. R. B. Janes and A. A. Rotow, "Light Transfer Characteristics of Image Orthicons", RCA Review, September, 1950.
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"--

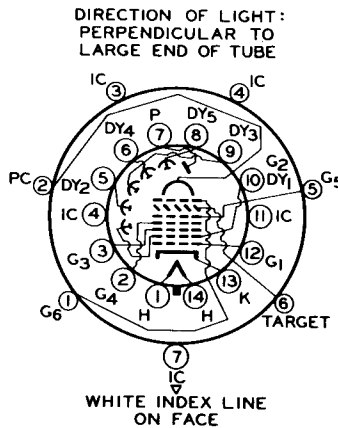
1. Allow the 6474 to warm up prior to operation.
2. Hold temperature of the 6474 within operating range.
3. Make sure alignment coil is properly aligned.
4. Adjust beam-focus control for best usable resolution.
5. Give the 6474 an idle period every 200 hours.
6. Condition spare 6474's by operating several 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

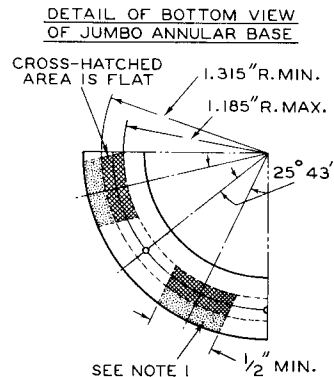
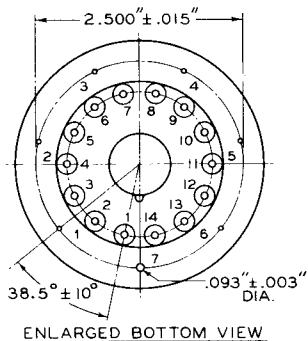
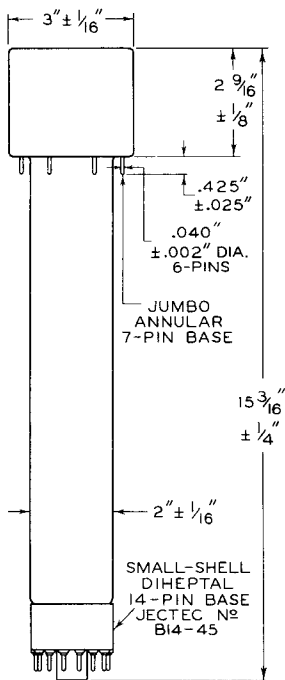
- | | |
|---|--|
| PIN 1: HEATER | PIN 9: DYNODE No.3 |
| PIN 2: GRID No.4 | PIN 10: DYNODE No.1,
GRID No.2 |
| PIN 3: GRID No.3 | PIN 11: INTERNAL CONNEC-
TION--DO NOT USE |
| PIN 4: INTERNAL CONNEC-
TION--DO NOT USE | PIN 12: GRID No.1 |
| PIN 5: DYNODE No.2 | PIN 13: CATHODE |
| PIN 6: DYNODE No.4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

KEYED JUMBO ANNULAR 7-PIN BASE

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



DIMENSIONAL OUTLINE



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 $0.065'' \pm 0.001''$ AND ONE HOLE HAVING DIAMETER OF $0.150'' \pm 0.001''$. ALL HOLES HAVE DEPTH OF $0.265'' \pm 0.001''$. THE SIX $0.065''$ HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF $0.047''$. ALL HOLES ARE SPACED AT ANGLES OF $51^\circ 26' \pm 5'$ ON CIRCLE DIAMETER OF $2.500'' \pm 0.015''$.
- b. SIX STOPS HAVING HEIGHT OF $0.187'' \pm 0.001''$, CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.
- c. RIM EXTENDING OUT A MINIMUM OF $\frac{1}{8}''$ FROM $2\text{-}13/16''$ DIAMETER AND HAVING HEIGHT OF $0.126'' \pm 0.001''$.
- d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF $2.200'' \pm 0.001''$.

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