7315

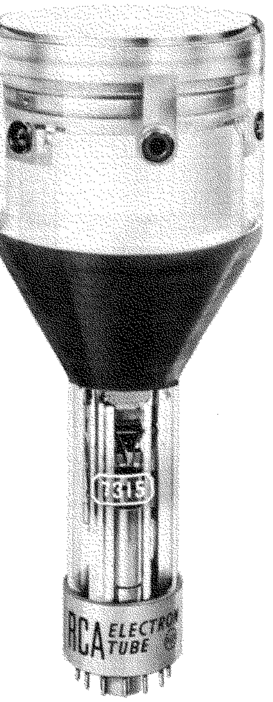
DISPLAY STORAGE TUBE

Writing Gun
Viewing Gun
Good Resolution

Direct-View Type
3.8" -Diameter Display
Non-Equilibrium Writing
Grid-Control Reading (Viewing)
TENTATIVE DATA

5.25" -Diameter Bulb
13.64" Max. Overall Length
Diheptal 14-Pin Base

RCA-7315 is a 5-inch display storage tube of the direct-view type designed for use in applications where it is desired to have a bright, non-flickering display of stored information for as long as 40 seconds after writing has ceased. Practical applications of the 7315 include: long-range radar display; airport surveillance; data transmission including half-tones; and visual communications requiring steady, non-flickering, narrow bandwidth transmission over telephone lines.



Performance of the 7315 when operated with 10,000 volts on the screen is characterized by a 3.8-inch-diameter display having brightness of about 2750 foot-lamberts; good resolution capability in half-tone displays; and a writing speed of about 3000 inches per second--a speed sufficiently slow to permit taking full advantage of the integrating and half-tone capabilities of the tube.

The 7315 utilizes two electron guns--a writing gun and a viewing gun. The writing gun utilizes electrostatic focus and produces an electron beam which is electrostatically deflected by two sets of deflecting electrodes. The viewing gun produces an electron stream which floods the electrodes controlling the storage function and the brightness of the display.

PRINCIPLES OF OPERATION

As shown in Fig. 1, the 7315 has a writing section and a viewing section. The *writing section* contains an electrostatically focused gun that produces an electron beam which is electrostatically deflected by two sets of deflecting electrodes. The *viewing section* contains an aluminized screen on the inside surface of a flat faceplate, a backplate capacitively coupled to a storage grid, and a viewing gun having five grids.

The Viewing Operation

In addition to the viewing gun with its grids No. 1 and No. 2, the viewing section contains a grid No. 3, a grid No. 4, a grid No. 5, a storage grid, a backplate capacitively coupled to the storage grid, and a screen having excellent visual efficiency. The spectral-energy emission characteristic of the screen phosphor is shown in Fig. 2.

The viewing gun provides a low-velocity electron stream which continuously floods the electrodes (grid No. 5, storage grid, and backplate) controlling the storage function and the brightness of the display. A display with high brightness is possible because the very efficient phosphor is continuously excited, rather than intermittently as in conventional cathode-ray tubes, by the high-current viewing beam. The high current can be utilized because the viewing beam is not controlled by methods ordinarily employed in cathode-ray tube guns and is consequently not limited by focusing, deflection, and modulation requirements.

Grid No. 3 consists of a conductive-coating band positioned on the bulb-wall interior as shown in Fig. 1. This figure also shows the location of grid No. 4 which consists of a metal cylinder. Grids No. 3 and No. 4 collimate (make parallel) the paths of the electrons in the stream before they reach grid No. 5. Collimation is required so that the low-velocity electrons will approach the storage grid in paths perpendicular (normal) to the plane of the storage grid. This normal approach of the electrons to every point on the storage grid together with their uniform velocity makes possible uniform control of the electrons by the storage grid.

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RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

Grid No.5 consists of a fine metal mesh. It serves to accelerate electrons in the beam; to repel any positive ions, produced by collision of electrons with residual gas molecules in the region between base and grid No.5, from landing

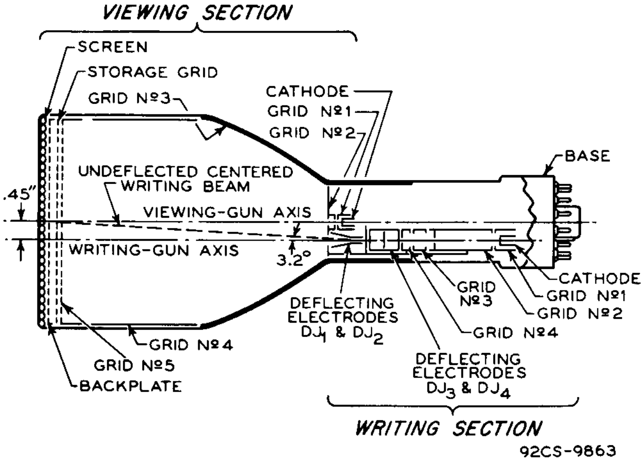

Fig.1 - Schematic Arrangement of Type 7315.

on the storage grid and thus rapidly wiping out a stored charge pattern; and to collect viewing-beam electrons turned back near the storage grid when its potential is negative.

The storage grid consists of a very thin deposit of material which has excellent insulating properties and covers the gun side of the backplate which is a fine metallic mesh. The deposit leaves the size of the openings in the mesh essentially unchanged. In effect the storage grid consists of a multiplicity of storage elements, each capacitively coupled to the mesh.

The storage grid serves to control the viewing beam so that the stored information can be displayed on the phosphor (screen). If the storage-grid potential is made sufficiently negative with respect to the viewing-gun cathode, electrons in the viewing beam are turned back as they approach the storage grid and are collected by grid No.5. Under this condition, the viewing beam is cut off.

When the storage grid is at the same potential as the viewing-gun cathode, electrons in the viewing beam approach sufficiently near the plane of the storage grid to be attracted by the viewing-screen field which penetrates the openings in the storage grid. Under the influence of this field, a majority of the viewing-beam electrons which have passed through grid No.5 are accelerated through the storage-grid and backplate openings to the phosphor (screen), and cause it to fluoresce brightly over its entire area. Under this condition, the brightness of the screen is designated as "saturated brightness".

Light output from the screen under conditions of saturated brightness varies with the voltage applied to the screen. This relationship is shown in Fig.3 for a typical 7315 operating under conditions of optimum collimation. Because the screen is aluminized, the light output drops off very rapidly at screen voltages below 5000 volts. Operation below this value is not recommended.

At values of storage-grid potential between those which produce viewing-beam cutoff and those which produce saturation brightness, the number of electrons which penetrate the storage-grid openings, and hence the amount of light emitted

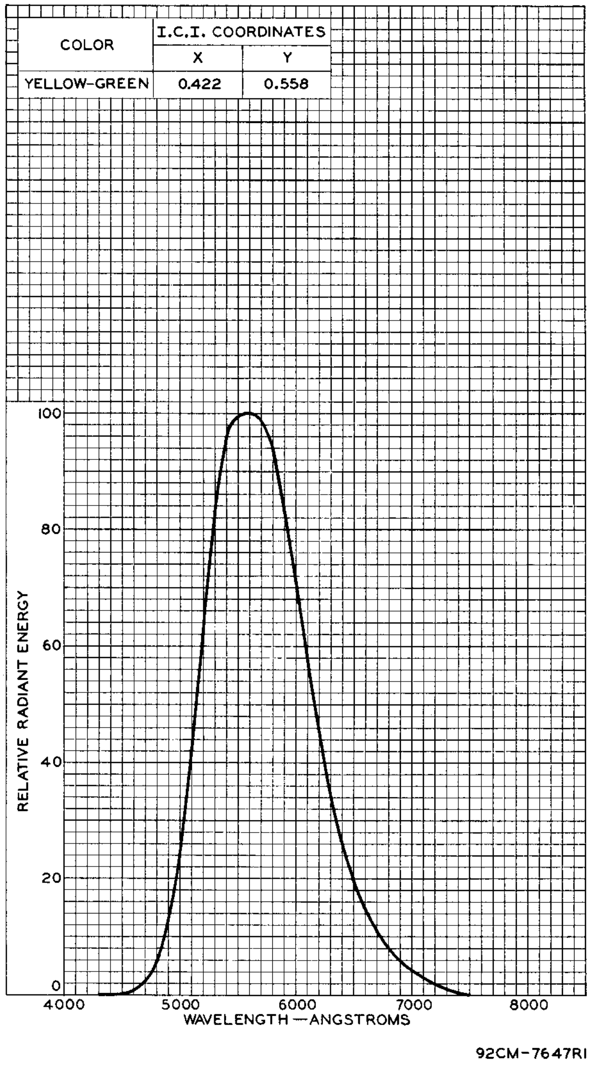

Fig.2 - Spectral-Energy Emission Characteristic of Phosphor P20 Used in Type 7315.

by the screen, is a function of the storage-grid potential, as shown in Fig.4 for conditions with a screen voltage of 10000 volts and a backplate voltage of 2 volts. For backplate and/or screen voltages more positive than those indicated in Fig.4, the storage-grid characteristic tends to shift to the left and to exhibit less slope. For backplate and/or screen voltages less positive than those indicated in Fig.4, the characteristic tends to shift to the right and to exhibit more slope.

Within the range of storage-grid potentials considered thus far, no viewing-beam electrons are attracted to the surface of the storage grid. Hence, in the absence of deliberate writing, leakage through the insulating material, or spurious charging such as might be caused by positive-ion bombardment, a charge pattern once established on the storage grid should remain indefinitely. If, however, the storage grid is made positive with respect to the viewing-gun cathode, viewing-beam electrons are attracted to the surface of the storage grid and land on it. If the electrons which land do not have sufficient energy to produce a secondary-electron emission ratio in excess of unity, a net flow of current into the storage grid will result. Because the storage grid is conductively isolated from the metallic backplate, the storage grid is free to charge negatively under the influence of this current.

This negative-charging phenomenon provides a mechanism by means of which an undesired charge pattern on the storage grid can be removed, i.e., erased. For example, assume that the entire storage grid has been charged, by writing, to zero potential with respect to the cathode of the viewing gun. The cathode of the viewing gun is usually taken as a ground reference. Now, assume that the backplate is suddenly shifted from its "dc" potential level of 2 volts to a positive potential of 10 volts. Because of the very close capacitive coupling between the backplate and the storage grid, the storage grid rises from its initial potential of zero volts to a potential of 8 volts. Viewing-beam electrons are now able to land on the storage grid and negative charging of the storage grid takes place, as explained above. Charging continues until the storage-grid potential is reestablished at zero volts. When this occurs, viewing-beam electrons can no longer land on the storage grid. Now, if the backplate potential is returned to its initial value of 2 volts, the storage-grid potential drops correspondingly to -8 volts. This negative voltage, as may be seen by referring to Fig.4, essentially cuts off the viewing beam of a typical 7315 and thus erases any charge pattern on the storage grid.

Following erasure, the time available for writing and viewing is limited by the presence of positive ions produced by collision of electrons in the viewing beam with residual traces of gas in the region between the screen and grid No.5. These positive ions are attracted to the most negative elements of the storage grid. On landing, the ions cause the elements to assume a less-negative charge and thus to increase the flow of viewing-beam electrons to the screen. Thus, the limit of viewing duration is determined by loss of contrast in the viewed pattern rather than by a decay of brightness as in the case of conventional cathode-ray tubes employing long-persistence phosphors.

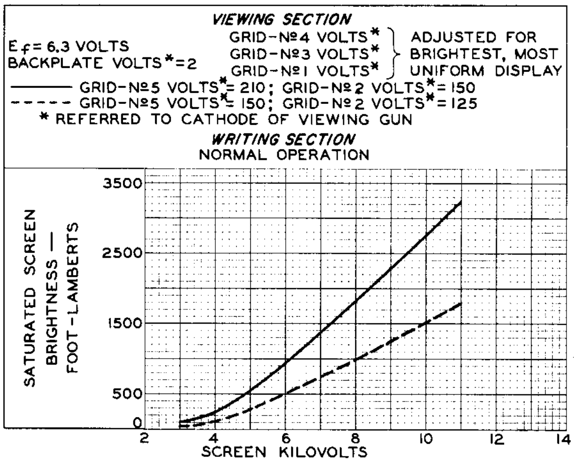

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Fig.3 - Typical Characteristics of Type 7315.

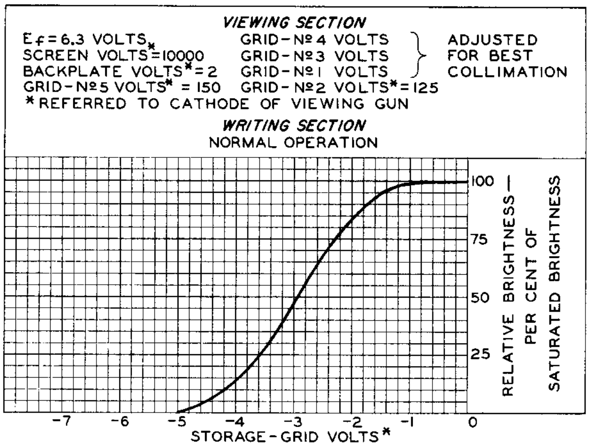

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Fig.4 - Typical Storage-Grid Characteristic of Type 7315.

The Writing Operation

The writing gun is similar to that used in electrostatically focused and electrostatically deflected oscillograph tubes, and produces a well-defined focused beam. This beam may be deflected and modulated in the same manner as for oscillograph tubes. It has a control function and contributes little to the total light output from the tube.

The cathode of the writing gun is generally operated at -2000 volts with respect to the viewing-gun cathode.

The writing-beam electrons landing on the storage grid have sufficient velocity to produce a secondary-electron emission ratio greater than unity. Thus, more electrons leave the storage grid than arrive, and those elements on the storage grid scanned by the beam assume a less-negative charge wherever the writing beam strikes. Because the secondary electrons are attracted to grid No.5 of the viewing gun, the writing beam tends to charge the storage grid to the potential of grid No.5 of the viewing gun. However, the maximum potential to which an element of the storage grid rises above cutoff is limited in normal operation of the tube by the viewing-gun beam to a potential just slightly more positive than that of the viewing-gun cathode.

The writing-beam electrons which land on a storage element determine the voltage built up across the dielectric and the corresponding net charge stored in the dielectric. By controlling the amplitude and duration of the writing-beam current, it is possible to establish on any storage element a positive charge having a value which will partially or completely counteract that element's negative charge. Consequently, a storage element can be charged to any potential intermediate between the storage-grid-cutoff voltage and zero voltage.

As considered previously, the potential of any storage element determines the number of viewing-beam electrons passing through the storage grid in the immediate vicinity of that element. When the potential is such as to allow passage of electrons, these electrons are accelerated and strike the screen directly opposite the storage element. As a result, they produce a luminescent spot having a size only slightly larger than that of the storage element and a brightness which is directly proportional to their density and their velocity which is determined by the screen potential.

Because the potential of a storage element is not changed by the viewing operation, a charge pattern established by the writing gun on the storage grid produces a corresponding visible pattern on the screen which may be viewed for a period determined by positive-ion build-up or by the predetermined erasure rate when dynamic erasure is employed.

The multiplicity of storage elements on the storage grid permits storage of half-tone patterns and their display. At a display brightness approximately 50 per cent of saturated brightness, half-tone patterns have a resolution of about 50 lines per inch as measured by the "shrinking raster" method.

The Erasing Operation

In the section headed *The Viewing Operation*, a technique for erasing stored charge patterns was described. This technique, known as *static erasure*, has the following disadvantage. During the erasing cycle and the time thereafter required to write a new pattern, the display conveys no information or incomplete information. It is also to be noted that during the static erasing cycle, the screen is uniformly illuminated at a level equal to, or greater than, the saturated brightness level.

In most applications of the 7315, it is desired that writing be followed by a gradual decay of stored information. This kind of performance is obtained by applying a continuous series of pulses to the backplate at a rate no lower than the phosphor flicker frequency (refer to section headed *The Viewing Operation*). The technique of erasing by applying a series of pulses to the backplate is known as *dynamic erasure*.

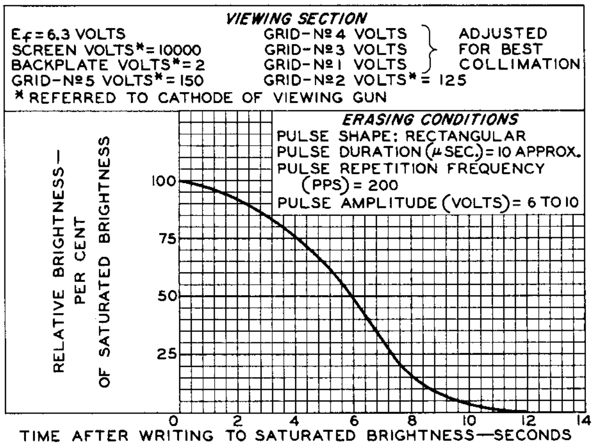

Fig.5 - Typical Erasure Characteristic of Type 7315.

The amount of charge erased during each erasing pulse is dependent on the duration, amplitude, and shape of the pulse. These factors together with the erasing-pulse repetition frequency determine the observed rate of decay of stored information.

Brightness-decay characteristic for a typical 7315 erased dynamically is shown in Fig.5.

Erasing pulses whose amplitude is smaller than the magnitude of the viewing-beam cutoff voltage do not permit complete erasure. On the other hand, erasing pulses whose amplitude is greater than the magnitude of the viewing-beam cutoff voltage eventually drive the storage grid beyond cutoff, i.e., to a value "blacker than black". The erasing-pulse amplitude should not be used to adjust the erasing speed.

With a rectangular type of erasing pulse, all storage elements are erased at nearly the same rate regardless of the charge on any storage element. The brightest elements of the viewed pattern, therefore, are visible for longer periods than half-tones.

When the pulse used for erasing is of the positive-going sawtooth type, the most positive storage elements are erased more rapidly than the others, because electrons in the viewing-beam land on these elements for a longer period. With this kind of erasure, half-tones persist as long as bright elements.

In applications where half-tone display is involved, the amplitude of the rectangular erasing pulse should be adjusted so that the storage surface is charged to exactly cutoff potential by the erasing operation.

In applications, such as radar, where it is desired to suppress noise in the display, a higher-amplitude erasing pulse may be used to lower the potential of the unwritten storage elements several volts below cutoff. A number of addresses by the writing beam is then required to charge the storage elements less negative than cutoff. Ideally, the erasing-pulse amplitude should be adjusted so that the noise component in the modulated writing beam charges the storage surface to just cutoff. Then, the signal superimposed on the noise signal charges the storage elements to a potential less negative than cutoff and thus is effectively displayed on the screen devoid of noise background.

DATA

General:

	Writing Section	Viewing Section	
Heater, for Unipotential Cathode:			
Voltage (AC or DC)	6.3 ± 5%	6.3 ± 5%	volts
Current	0.6	0.6	amp
Cathode Heating Time (Minimum) before other electrode voltages are applied	–	30	sec
Direct Interelectrode Capacitances (Approx., without external shield):			
Grid No.1 to all other tube electrodes	6.5	11	μμf
Cathode to all other tube electrodes	5.5	8	μμf
Backplate to all other tube electrodes	–	116	μμf
Deflecting electrode DJ_1 to deflecting electrode DJ_2. . .	1.9	–	μμf
Deflecting electrode DJ_3 to deflecting electrode DJ_4. . .	2	–	μμf
DJ_1 to all other tube electrodes	6	–	μμf
DJ_2 to all other tube electrodes	7	–	μμf
DJ_3 to all other tube electrodes	5.5	–	μμf
DJ_4 to all other tube electrodes	4.8	–	μμf
Focusing Method	Electrostatic	None	
Deflection Method	Electrostatic	None	
Deflecting-electrode arrangement	See *Dimensional Outline*	–	

Phosphor	–	P20, Aluminized
Fluorescence	–	Yellow-Green
Phosphorescence	–	Yellow-Green

Minimum Useful Viewing Diameter♥	3.8"
Maximum Overall Length	13.64"
Seated Length	12.50" ± 0.39"
Greatest Bulb Diameter	5.25" ± 0.06"
Maximum Tube Radius	2.69"
Base	Medium-Shell Diheptal 14-Pin (JEDEC Group 5, No.B14-38)
Bulb Terminals:	
Caps (Three)	Recessed Small Ball (JEDEC No.J1-22)
Cap	Recessed Small Cavity (JEDEC No.J1-21)
Temperature Range	-65° to +100° C
Operating Position	Any
Weight (Approx.)	2-3/4 lbs

Maximum Ratings, *Absolute Values:*

	Writing Section		Viewing Section		
SCREEN VOLTAGE . .	–		11000 max.**		volts
BACKPLATE VOLTAGE (Peak) . .	–		20 max.**		volts
	Equivalent Values		*Equivalent Values*		
GRID-No.5 VOLTAGE	–	–	–	300 max.**	volts
GRID-No.4 VOLTAGE	2950 max.*▲	200 max.**	–	300 max.**	volts
GRID-No.3 VOLTAGE	1200 max.*	-1550 max.**	–	200 max.**	volts
PEAK VOLTAGE BETWEEN GRID No.3 AND GRIDS No.2 & No.4	–	2950 max.	–	–	volts
GRID-No.2 VOLTAGE	2950 max.*▲	200 max.**	2950 max.*▲	200 max.**	volts
CATHODE VOLTAGE	–	-2750 max.**	–	–	volts
GRID-No.1 VOLTAGE:					
Negative bias value . . .	200 max.*		200 max.**		volts
Positive bias value . . .	0 max.*		0 max.**		volts
Positive peak value . . .	2 max.*		0 max.**		volts
PEAK VOLTAGE BETWEEN GRIDS No.2 & No.4 AND ANY DEFLECTING ELECTRODE . .	500 max.		–		volts
PEAK HEATER-CATHODE VOLTAGE:					
Heater negative with respect to cathode . .	125 max.*		–		volts
Heater positive with respect to cathode . .	125 max.*		–		volts

VIEWING SECTION**

Operating Values and Typical Performance Characteristics:

To prevent possible damage to the tube, allow the viewing-gun beam current to reach normal operating value before turning on the writing-gun beam current, and keep the viewing-gun beam on till the writing beam is turned off.

Screen Voltage	10000	10000	volts
Backplate Voltage (DC)	2	2	volts
Grid-No.5 Voltage	210	150	volts
Grid-No.4 Voltage#	50 to 150	30 to 90	volts
Grid-No.3 Voltage#	0 to 50	0 to 40	volts
Grid-No.2 Voltage▲	150	125	volts
Grid-No.1 Voltage#	0 to -80	0 to -60	volts
Maximum Screen Current	0.75	0.5	ma

Maximum Backplate Current (Peak)	2.0	1.5	ma
Maximum Grid-No.5 Current	3.0	2.5	ma
Maximum Grid-No.4 Current	3.0	2.5	ma
Maximum Grid-No.3 Current	5.0	4.0	ma
Maximum Grid-No.2 Current	3.0	2.5	ma
Maximum Cathode Current	8.0	6.5	ma
Number of Half-Tone Steps□	5	5	
Viewing Duration▲▲	20	40	sec
Maximum Erasing-Uniformity Factor□□	0.5	0.5	
Resolution⊕	50	50	lines/in
Brightness♣♣	2750	1500	fl

WRITING SECTION●

Range Values for Equipment Design:*

For any grids-No.2 & No.4 voltage▲ ($E_{c_{2+4}}$) between 1500 and 2750 volts

Grid-No.3 Voltage for Focus	17.5% to 37.5% of $E_{c_{2+4}}$	volts
Maximum Grid-No.1 Voltage for Cutoff of Undeflected Focused Spot	−4.6% of $E_{c_{2+4}}$	volts
Maximum Grid-No.3 Current	−15 to +10	µa
Maximum Cathode Current	See Fig.6	
Deflection Factors:		
DJ_1 & DJ_2	36 to 48	v dc/in./kv of $E_{c_{2+4}}$
DJ_3 & DJ_4	35 to 47	v dc/in./kv of $E_{c_{2+4}}$
Focused Beam Position	##	
Writing Speed††	3000	in/sec

Examples of Use of Design Ranges:*

For grids-No.2 & No.4 voltage ($E_{c_{2+4}}$)▲	*2000*	*volts*
Grid-No.3 Voltage for Focus	350 to 750	volts
Maximum Grid-No.1 Voltage for Cutoff of Undeflected Focused Spot	−92	volts
Deflection Factors:		
DJ_1 & DJ_2	72 to 96	volts
DJ_3 & DJ_4	70 to 94	volts

Equivalent Values of Writing-Gun Voltages Referred to Cathode of Viewing Gun:

Cathode Voltage	−1875	−1850	volts
Grid-No.3 Voltage for Focus	−1125 to −1525	−1100 to −1500	volts
Grids-No.2 & No.4 Voltage▲	+125	+150	volts

VIEWING SECTION and WRITING SECTION

Circuit Values:

Grid-No.1-Circuit Resistance (Either gun)	1.0 max.	megohm
Resistance in Any Deflecting-Electrode Circuit■	0.1 max.	megohm
Series Current-Limiting Resistor (Unbypassed) in Grid-No.5 (Viewing Section) Circuit	0.010 min.	megohm
Backplate-Circuit Resistance	0.005 max.	megohm
Series Current-Limiting Resistance in Screen Circuit	1.0 min.	megohm

♥ Minimum useful viewing area may be eccentric with respect to the tube face.

** Voltages are shown with respect to cathode of Viewing Gun.

* Voltages are shown with respect to cathode of Writing Gun.

▲ Grids No.2 and No.4 of Writing Gun are connected together and to grid No.2 of Viewing Gun within the tube.

Adjusted for brightest, most uniform pattern.

□ Observed with an RCA-2F21 Monoscope display.

▲▲ Expressed in terms of the time required for the brightness of the unwritten background to rise from just zero brightness (viewing-beam cutoff) to 10% of saturated brightness.

□□ Determined as follows: With no erasing pulse, overscan the storage surface with writing beam to obtain maximum pattern brightness. Then cut off writing beam. Apply erasing pulses having an amplitude of between 8 to 10 volts and adjust duty cycle to obtain complete erasure in approximately 10 seconds. Measure time (t_1) from start of erasing to the instant at which any area within the minimum useful viewing diameter is reduced to background-brightness level, and time (t_2) from start of erasing to the instant at which the entire area within the minimum useful viewing diameter area is reduced to background-brightness level. The erasing-uniformity factor is defined as $(t_2 - t_1)/t_2$.

⊕ Measured by shrinking-raster method at a display brightness of 50% of saturated brightness and with grids No.2 & No.4 of Writing Gun at about +2000 volts with respect to cathode of Writing Gun.

♣♣ Measured with entire storage grid written to produce saturated brightness and with screen at indicated voltage.

● The cathode of the Writing Gun is operated at about −2000 volts with respect to the cathode of the Viewing Gun which is usually operated at ground potential.

The center of the undeflected focused beam will fall within a circle having a 10-mm radius and having its center on the Writing-Gun axis (see *Dimensional Outline*) under the following conditions: grids No.2 & No.4 of Writing Gun at +2000 volts with respect to cathode of Writing Gun, grid No.3 of Writing Gun at voltage to give focus, grid No.1 of Writing Gun at voltage which will permit storage of a charge just sufficient to give a barely perceptible spot on screen, Viewing Section operating under normal conditions, and tube shielded against extraneous fields.

†† Measured under conditions of writing from just zero brightness (viewing-beam cutoff) to maximum brightness with grid No.1 of Writing Gun at −10 volts with respect to cathode of Writing Gun, and grids No.2 & No.4 of Writing Gun at +2000 volts with respect to cathode of Writing Gun.

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

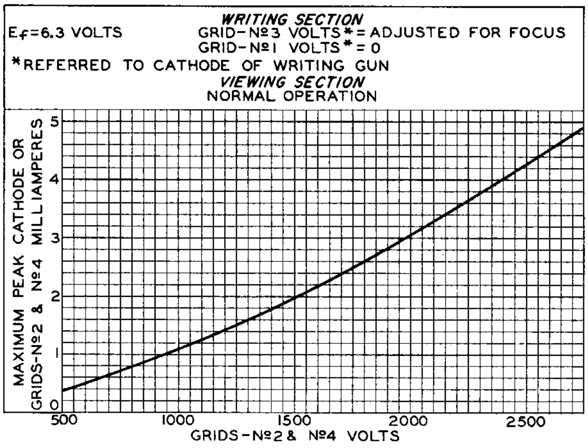

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Fig.6 - Current Characteristic for Writing Gun of Type 7315.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

Handling. The 7315 should preferably be transported or handled with the face up to prevent any loose particles in the tube from striking the storage surface and adhering to it. Care should be taken to prevent knocking or bumping the bulb caps. Such rough treatment will cause either immediate or delayed cracking of the metal-glass seals.

Support for the 7315 within the external magnetic shield may be provided by a padded clamp around the neck of the tube and by sponge-rubber supports around the tube, except near the bulb caps. The tube should not be supported by the base or socket.

Shielding. Magnetic shielding must be provided to prevent external fields from interfering with the required accurate control of the low-velocity viewing beam. A cylindrical shield of properly annealed high-permeability material about 1/16-inch thick is usually satisfactory.

Degaussing. During transportation, the 7315 can become magnetized with the result that its performance will be impaired. Before it is placed in operation, it should be degaussed as indicated below.

A suitable degaussing coil may be made by winding 900 turns of No.14 enameled wire on a 6-inch diameter form 2 inches long. After connecting the coil to an ac supply line (117 volts), slowly (taking at least 30 seconds) pass the 7315 through the coil and then slowly withdraw it completely from the ac magnetic field. Finally, disconnect the coil from the supply line. A coil having greater magnetic-field strength than that specified should not be employed because it may cause the internal elements of the tube to vibrate excessively and cause damage to the tube.

Terminal Connections. The *base pins* of the 7315 fit the diheptal 14-contact socket. The *recessed small ball caps* and the *recessed small cavity cap* require standard flexible-lead connectors.

Power-Supply Requirements. A typical power-supply circuit to provide operating voltages for the 7315 is shown in Fig.7.

The dc supply voltage for the Writing Gun should be well regulated to prevent shift in the grid-No.1 bias level. For the Writing Gun the heater winding should be insulated to withstand operation at high negative potential with respect to ground.

The high-voltage dc supply for the screen should have its negative terminal grounded, and should have at least a 1-megohm resistor in series with the screen terminal. The supply for grid No.5 of the Viewing Gun should have at least a 10,000-ohm unbypassed resistor in series with the grid-No.5 terminal.

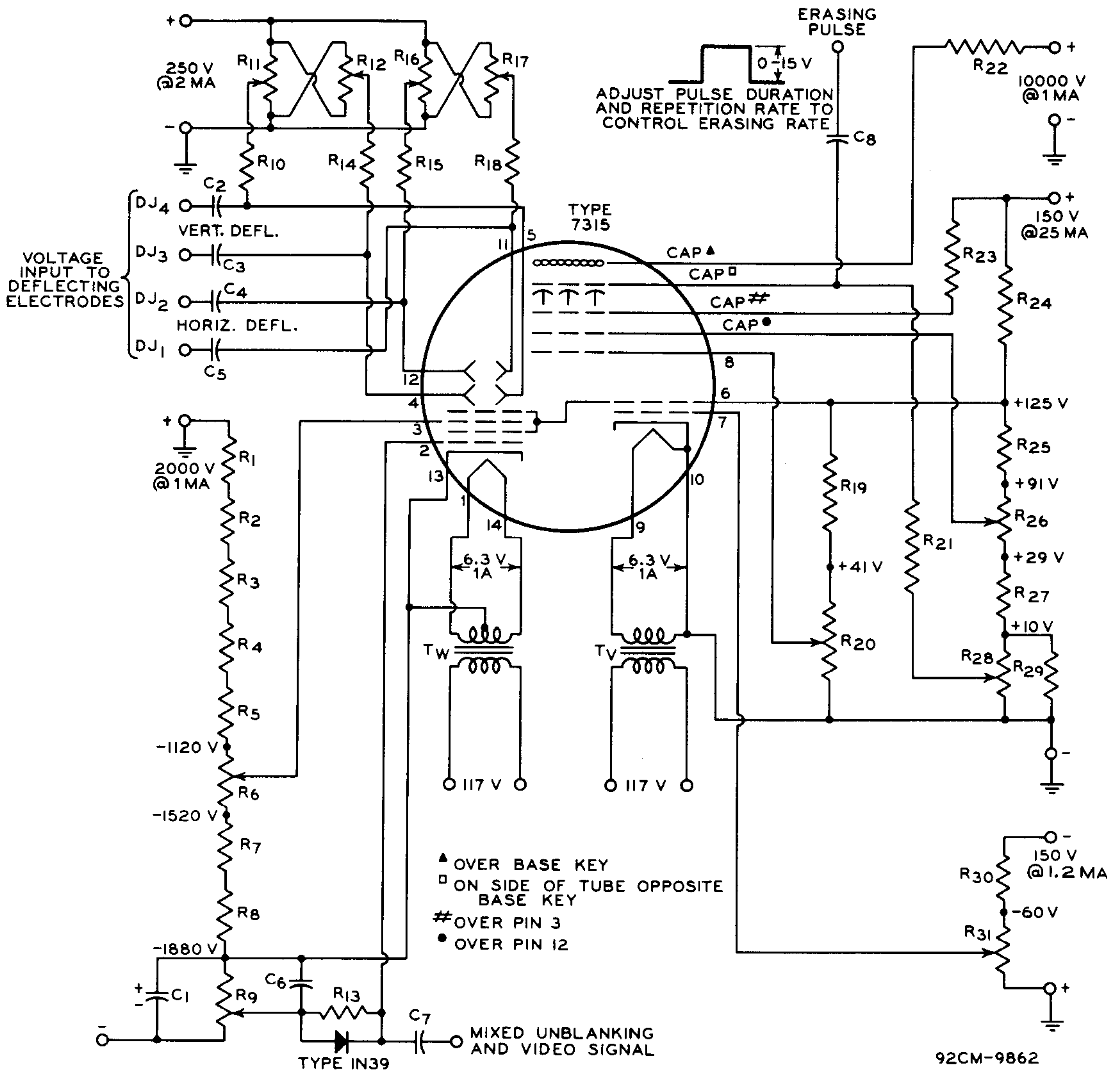
The high voltages at which the 7315 is operated may be very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. Safety precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is desired.

In the use of high-voltage tubes, it should always be remembered that high voltages may appear at normally low-potential points in the circuit as a result of capacitor breakdown or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off, and both terminals of any capacitors grounded.

Deflection Considerations. As with conventional oscillograph tubes, balanced electrostatic-deflection circuits should be employed to prevent distortion of the writing beam. *Each pair of the deflecting electrodes should be operated at an average potential the same as that of grids No.2 & No.4 of the Writing Gun.*

The undeflected focused writing beam is normally close to the Writing-Gun axis (see *Dimensional Outline*). However, to compensate for variation from tube to tube, designers should provide an adjustable and reversible supply of at least 20 volts dc per kilovolt of grids-No.2 & No.4 voltage (Writing Gun) for application between deflecting electrodes DJ_3 and DJ_4, and a supply adjustable from 2 to 42 volts dc per kilovolt of grids-No.2 & No.4 voltage for application between DJ_1 and DJ_2. The positive side of the supply should be connected to DJ_1. By adjustment of these dc voltages on each pair of the deflecting electrodes, the beam may be centered. The circuit shown in Fig.7 will supply sufficient centering voltage to position the writing beam anywhere on the storage grid.

Video-Drive Considerations. The information to be stored and displayed by the tube should be applied as a video signal to the control grid (grid No.1) or cathode of the Writing Gun. In determining the writing drive requirements, it should be remembered that writing is essentially a charge-depositing process. The instantaneous



C_1: 20μf, electrolytic, 250 volts
C_2 C_3 C_4 C_5: Values depend on frequency of deflecting-voltage waveforms
C_6: 1μf, paper, 200 volts
C_7: 0.05μf, plastic film, 2500 volts
C_8: 0.01μf, paper, 600 volts
R_1: 240,000 ohms, 0.5 watt
R_2 R_3 R_4 R_5: 220,000 ohms, 0.5 watt
R_6: 400,000-ohm potentiometer, 2 watts
R_7 R_8: 180,000 ohms, 0.5 watt
R_9: 125,000-ohm potentiometer, 2 watts
R_{10}: 75,000 ohms, 0.5 watt
R_{11} R_{12}: Dual 50,000-ohm potentiometer, 2 watts
R_{13}: 1 megohm, 0.5 watt
R_{14} R_{15}: 75,000 ohms, 0.5 watt
R_{16} R_{17}: Dual 50,000-ohm potentiometer, 2 watts
R_{18}: 75,000 ohms, 0.5 watt
R_{19}: 8200 ohms, 2 watts
R_{20}: 4000-ohm potentiometer, 2 watts
R_{21}: 4300 ohms, 0.5 watt
R_{22}: 1 megohm, 1 watt
R_{23}: 10,000 ohms, 1 watt
R_{24}: 1000 ohms, 2 watts
R_{25}: 2200 ohms, 1 watt
R_{26}: 4000-ohm potentiometer, 2 watts
R_{27}: 1200 ohms, 1 watt
R_{28}: 1000-ohm potentiometer, 2 watts
R_{29}: 2000 ohms, 0.5 watt
R_{30}: 75,000 ohms, 0.5 watt
R_{31}: 50,000-ohm potentiometer, 2 watts
T_w: Heater transformer with secondary insulated for 2500 volts
T_v: Heater transformer

Fig.7 - Typical Power-Supply Circuit for Type 7315.

writing-beam current needed for saturated writing varies nearly directly with the speed at which the writing beam is deflected across the storage grid and varies inversely with the number of times a given storage element is written upon in one complete scan period.

Operating Procedure. The following steps should be followed when first placing the 7315 in operation. *Electrode voltages are referred to the cathode of the viewing gun unless otherwise specified.*

To prevent possible damage to the tube, allow the viewing-gun beam current to reach normal operating value before turning on the writing-gun beam current, and keep the viewing beam on till the writing beam is turned off.

1. *Viewing Gun*--Apply power to the heater of the viewing gun and allow 30 seconds for the cathode to reach normal operating temperature. Then in turn apply grid-No.2 voltage (+125 volts); adjust grid-No.1 voltage to zero volts; apply grid-No.5 voltage (+150 volts); set backplate voltage to +2 volts; set grid-No.3 voltage to about +30 volts; set grid-No.4 voltage to about +70 volts; and apply screen voltage (+10000 volts). The storage property of the tube can be observed by increasing the backplate voltage to +8 volts for several seconds and then reducing it to +2 volts. As the backplate voltage is reduced the screen should go dark. The 7315 is now storing an overall "black picture" and stays in this condition until the screen begins to brighten as a result of the storage grid being gradually discharged by positive ions landing on it.

2. *Writing Gun*--Apply power to the heater of the writing gun and allow 30 seconds for the cathode to reach normal operating temperature. Then, with reference to the typical operating values shown in the tabulated data under *Writing Section--Examples of Use of Design Ranges, and Equivalent Values for Examples of Writing-Gun Voltages Referred to Cathode of Viewing Gun,* set the grid-No.1 voltage to cutoff, and apply dc voltages to the electrodes of the writing gun. With the screen made dark by the charging method described under (1), the grid-No.1 bias is reduced until the writing beam is seen as a spot on the screen. If the beam is caused to move, either by centering adjustment or by application of deflection voltage, it should leave a bright trace. After an area has been written to full brightness, the writing-beam spot may be seen as a slightly brighter spot on the bright background. Writing-beam focus can then be optimized by adjusting the grid-No.3 voltage.

3. *Collimating Adjustments* (Refer to *Principles of The Viewing Operation* on Page 1)--Now make adjustments to provide full coverage of the useful viewing area of the screen by the viewing beam and the best uniformity of cutoff over this area as follows: bias off the writing beam and leave the viewing beam on. Increase the backplate voltage to +8 volts for a few seconds and then reduce it to +2 volts. Observe the uniformity of cutoff. Then discharge the storage grid by turning on the writing beam and scanning over the entire surface of the storage grid. Adjust the viewing-gun grid-No.3 voltage, grid-No.4 voltage, and the grid-No.1 voltage to obtain the combination which gives full coverage of the useful viewing area of the screen by the viewing beam and which produces the most uniform cutoff over this area of the screen. For the most uniform collimation, it is recommended that the grid-No.3 voltage and the grid-No.4 voltage be adjusted to the minimum values which will still supply a full-size display. Grid-No.1 voltage should be adjusted to eliminate "flaring" at the edge of the display. Repeat the charging and cutoff cycle and voltage adjustments if necessary to obtain best collimation and cutoff. When dynamic erasure is to be used, erasing pulses may be employed in adjusting for optimum collimation.

4. *Writing-Gun Drive Adjustments*--The dc bias and the video-signal amplitude applied to grid No.1 or cathode of the writing gun should be adjusted to set the black level and the highlight level in the display. These adjustments depend on the scanning rate used. Resolution decreases with increasing writing-gun beam current. Excessive writing-gun beam current will produce screen saturation and any further beam-current increase will not produce additional highlight brightness and may also decrease half-tone rendition. It is recommended that the writing-beam current always be adjusted to a minimum value to produce the best display without saturation of highlight brightness.

Runaway Charging. A condition of runaway charging of the storage grid may result if the writing beam is allowed to land on the storage grid with the viewing beam turned off, if the writing beam is incident on an area of the storage grid not covered by the viewing beam, or if the density of the writing beam exceeds that of the viewing beam. Such a runaway condition can occur because of the non-equilibrium writing process involved.

Because the electrons in the writing beam land with an energy such that the secondary-emission ratio of the storage-grid surface is greater than unity, this surface charges positive toward the potential of grid No.5 of the viewing section. Normally, the landing on the storage grid of the viewing-beam electrons keeps any portion of the storage-grid surface from charging above viewing-beam cathode potential. When this limiting action of the viewing beam is not present, the storage-grid surface may charge under the action of the writing beam to a value such that sparking occurs through the insulating layer between the storage-grid surface and the backplate. This sparking is observed as random bright flashes on the screen. In the event of sparking, permanent damage (loss of the ability to store a signal in localized areas) to the storage grid may result. Such damage can usually be avoided if the writing process is quickly stopped.

A condition of runaway charging can also occur if the writing beam is allowed to move slowly or to remain stationary in a spot on the storage grid even with the viewing beam turned on.

Failure of scanning while the writing beam is turned on may permanently damage the storage grid. Therefore, provision should be made to cut off automatically the writing-beam current in case of a scanning failure. The writing-beam current can be cut off by an electronic switch which applies -200 volts bias to grid No.1 of the writing gun. This switch should be actuated by a portion of the scanning voltages applied to both sets of deflecting electrodes.

REFERENCES

MIT Radar School Staff, *"Principles of Radar"*, McGraw-Hill Book Co., Inc.

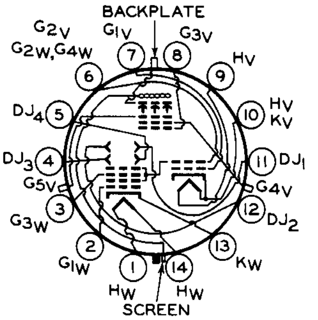
M. Knoll and B. Kazan, *"Storage Tubes and Their Basic Principles"*, John Wiley and Sons, Inc.

M. Knoll, P. Rudnick and H.O. Hook, *"Viewing Storage Tube with Halftone Display"*, RCA Review, Vol.14, No.4, December, 1953.

M. Knoll, H. O. Hook, and R. P. Stone, *"Characteristics of a Transmission Control Viewing Storage Tube with Halftone Display"*, Proc. I.R.E., Vol.42, No.10, October, 1954.

SOCKET CONNECTIONS

Bottom View



PIN 1: HEATER OF THE WRITING GUN

PIN 2: GRID No.1 OF THE WRITING GUN

PIN 3: GRID No.3 OF THE WRITING GUN

PIN 4: DEFLECTING ELECTRODE DJ_3 OF THE WRITING GUN

PIN 5: DEFLECTING ELECTRODE DJ_4 OF THE WRITING GUN

PIN 6: GRID No.2 OF THE VIEWING GUN, GRID No.2 AND GRID No.4 OF THE WRITING GUN

PIN 7: GRID No.1 OF THE VIEWING GUN

PIN 8: GRID No.3 OF THE VIEWING GUN

PIN 9: HEATER OF THE VIEWING GUN

PIN 10: HEATER AND CATHODE OF THE VIEWING GUN

PIN 11: DEFLECTING ELECTRODE DJ_1 OF THE WRITING GUN

PIN 12: DEFLECTING ELECTRODE DJ_2 OF THE WRITING GUN

PIN 13: CATHODE OF THE WRITING GUN

PIN 14: HEATER OF THE WRITING GUN

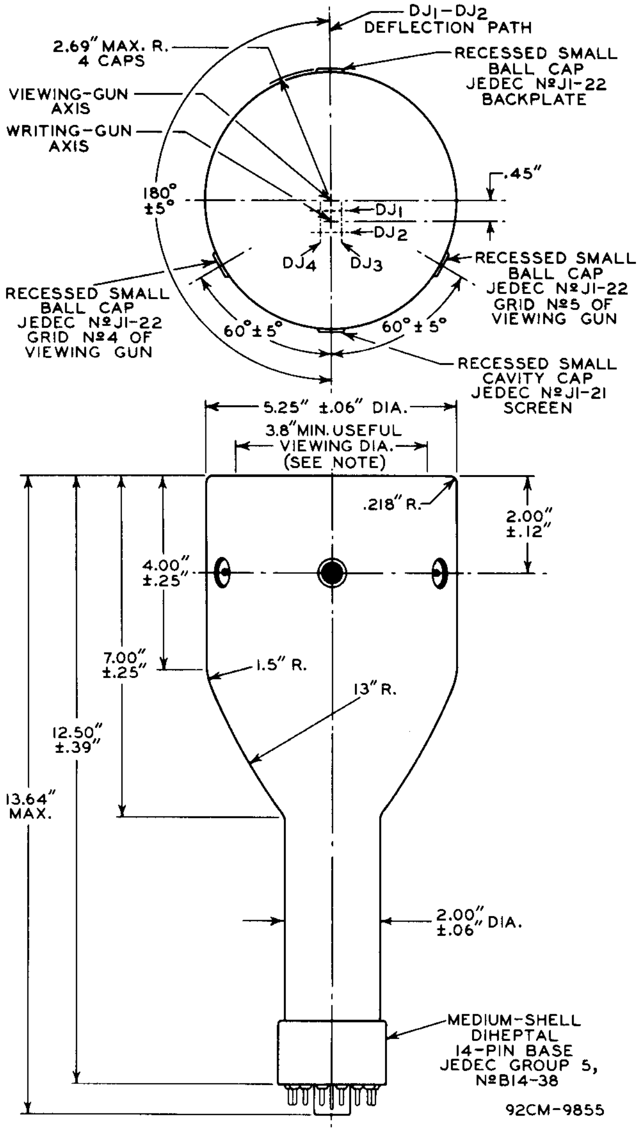
RECESSED BALL CAP:
Over Pin 3 -- GRID No.5 OF THE VIEWING GUN

Over Pin 12 -- GRID No.4 OF THE VIEWING GUN

On Side of Tube Opposite Base Key -- BACKPLATE

RECESSED CAVITY CAP:
Over Base Key -- SCREEN

DIMENSIONAL OUTLINE



NOTE: MINIMUM USEFUL VIEWING AREA MAY BE ECCENTRIC WITH RESPECT TO THE TUBE FACE. THE MINIMUM USEFUL VIEWING AREA WILL HAVE DIAMETER OF 3.8".

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

DEFLECTING ELECTRODES DJ_1 AND DJ_2 ARE NEARER THE SCREEN: DEFLECTING ELECTRODES DJ_3 AND DJ_4 ARE NEARER THE BASE. WITH DJ_1 POSITIVE WITH RESPECT TO DJ_2, THE SPOT WILL BE DEFLECTED TOWARD PIN No.8; LIKEWISE, WITH DJ_3 POSITIVE WITH RESPECT TO DJ_4, THE SPOT WILL BE DEFLECTED TOWARD PIN No.4.

THE ANGLE BETWEEN THE DEFLECTION PATH PRODUCED BY DJ_1 AND DJ_2 MAY VARY FROM THE PLANE THROUGH THE TUBE AXIS AND THE BASE KEY BY ANGULAR TOLERANCE (MEASURED ABOUT THE TUBE AXIS) OF ± 10°. ANGLE BETWEEN DJ_1 – DJ_2 DEFLECTION PATH AND DJ_3 – DJ_4 DEFLECTION PATH IS 90° ± 3°.