from JETEC release #1823, Jan. 14, 1957

1EP1, 1EP2, 1EP11

OSCILLOGRAPH TUBES

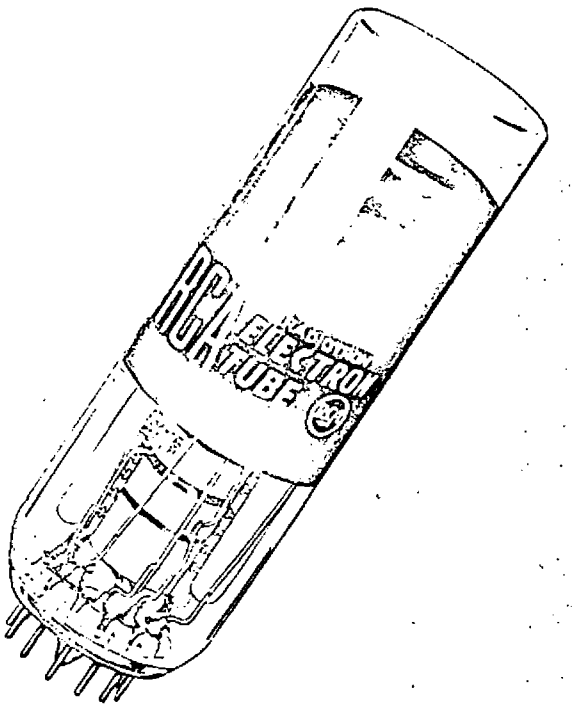
Electrostatic Focus
Electrostatic Deflection

Tubular Glass Envelope
Flat Face

1-5/16" Max. Diameter
4-1/16" Max. Length

TENTATIVE DATA

The 1E-series of "1-inch" cathode-ray tubes consists of three types--1EP1, 1EP2, and 1EP11--utilizing electrostatic focus and electrostatic deflection. They differ one from the other only in the spectral-energy emission and persistence characteristics of their respective phosphors P1, P2, and P11.



Actual Size

Design features of the 1E-types include a flat-face bulb, a minimum useful screen diameter of 1-1/16 inches, separate base-pin terminal for each deflecting electrode to permit use of balanced deflection, and a very sturdy structure.

RCA-1EP1

Medium-Persistence Type

The 1EP1 is designed especially for use in small, lightweight equipment, such as portable test equipment or aircraft equipment. It is also useful in larger equipment, such as computers or transmitters, where continuous monitoring of a waveform is desired. The 1EP1 provides a trace

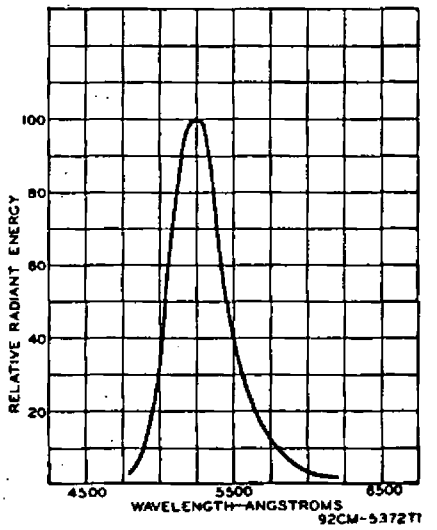


Fig. 1 - Spectral-Energy Emission Characteristic of Phosphor P1.

having high brightness at relatively low ultor voltage on a screen which has green fluorescence and medium persistence.

The spectral distribution of the energy emitted by the P1 phosphor is shown in Fig. 1; and the persistence of the P1 phosphor is given in Fig. 2. Because of its medium persistence, the 1EP1 is particularly useful where either medium-speed non-recurring phenomena or medium- and high-speed recurring phenomena are to be observed. The persistence is such that the 1EP1 can be operated with scanning frequencies as low as 20 cycles per second without excessive flicker.

The recommended minimum ultor voltage for the 1EP1 in general service is 500 volts, but a value as low as 300 volts may be used under conditions of low-velocity deflection and low ambient-light levels.

The curves in Fig. 3 show how line width of the 1EP1 varies with brightness for two values of ultor voltage.

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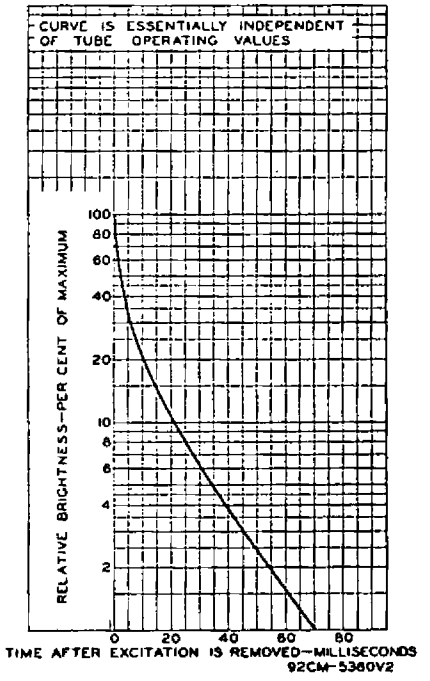


Fig. 2 - Persistence Characteristic of Phosphor P1.

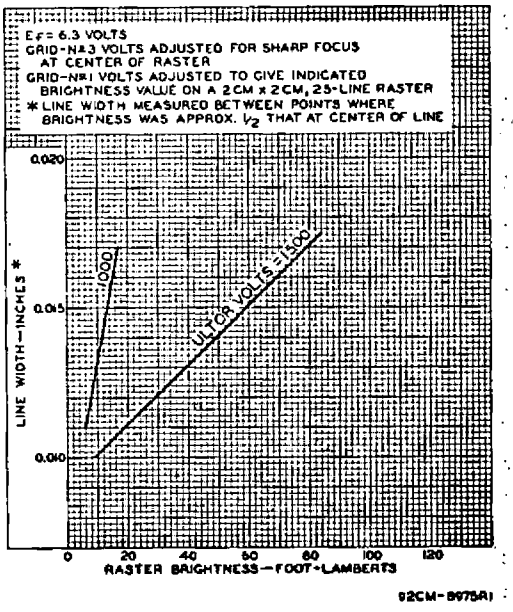


Fig. 3 - Average Characteristics of Type 1EP1.

RCA-1EP2

Long-Persistence Type

The 1EP2 is intended for use in lightweight portable equipment, or in continuous monitoring service for large electronic equipment. It is especially useful in applications where a temporary record of electrical phenomena is desired. The 1EP2 utilizes a long-persistence screen which exhibits greenish-yellow fluorescence of short persistence and greenish-yellow phosphorescence which persists for over a minute under conditions of adequate excitation and low ambient light.

The spectral distribution of the energy emitted by the P2 phosphor is shown in Fig.4; and the persistence of the P2 phosphor is given in Fig.5.

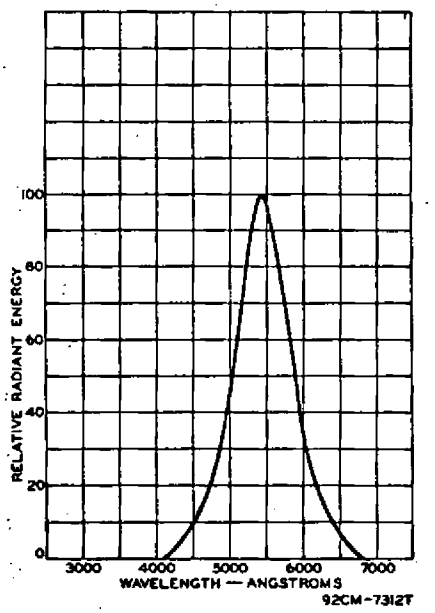


Fig. 4 - Spectral-Energy Emission Characteristic of Phosphor P2.

Because of its long persistence, the 1EP2 is particularly useful where either low-speed non-recurring or high-speed recurring phenomena are to be observed.

The persistent light of the 1EP2 permits the user to view a curve produced on the face of the tube by a single, high-speed sweep of the electron beam and, if desired, to make a tracing of the curve for record purposes.

In general, operation of the 1EP2 at an ultor voltage less than 750 volts is not recommended.

The curves in Fig.6 show how line width of the 1EP2 varies with brightness for two values of ultor voltage.

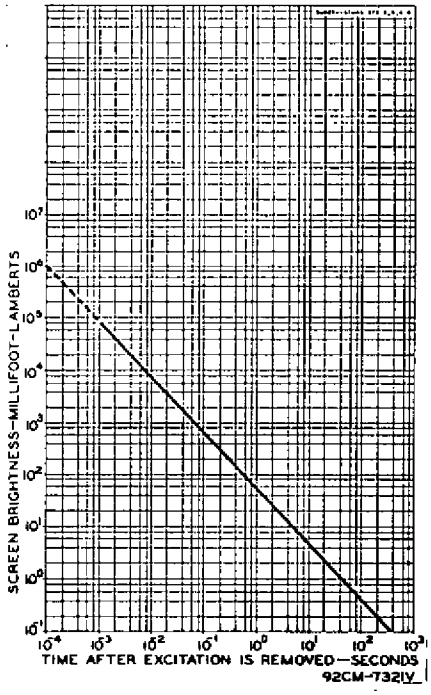


Fig. 5 - Persistence Characteristics of Phosphor P2.

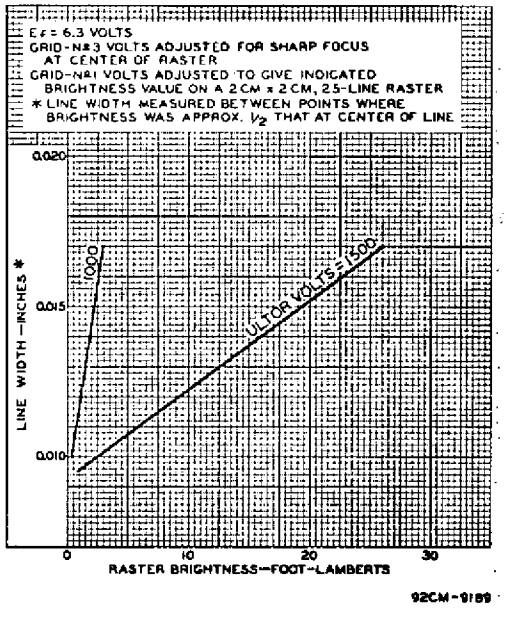


Fig. 6 - Average Characteristics of Type 1EP2.

RCA-1EP11

Short-Persistence Type

The 1EP11 is intended for use in light-weight portable equipment, or in continuous monitoring service for large electronic equipment. It is particularly useful in those applications involving photographic recording of electrical phenomena. The blue radiation of its fluorescent screen is highly actinic and has sufficiently short persistence to permit use of the 1EP11 in all photographic applications without blurring except in those where the film moves at high speed.

The 1EP11 is also quite satisfactory for visual observation of phenomena because it utilizes a phosphor having unusually high brightness for a blue screen.

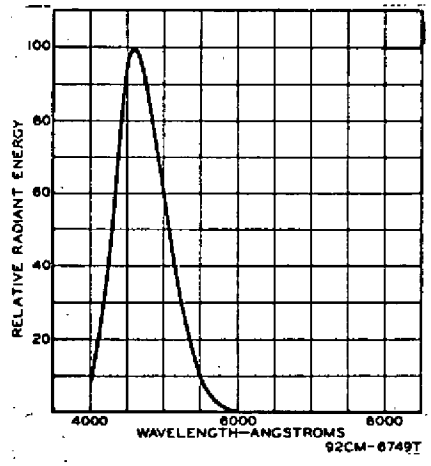


Fig. 7 - Spectral-Energy Emission Characteristics of Phosphor P11.

The spectral distribution of the energy emitted by the P11 phosphor is given in Fig. 7.

Persistence characteristics of the P11 phosphor for different screen-current densities are shown in Fig. 8. Because of its short persistence, the 1EP11 is especially useful where either high-speed non-recurring phenomena or medium- and high-speed recurring phenomena are to be observed.

In general, operation of the 1EP11 at an ultor voltage less than 750 volts is not recommended.

The curves in Fig. 9 show how line width of the 1EP11 varies with brightness for two values of ultor voltage.

In the case of moving photographic film, the use of high-contrast film and developer will minimize blurring caused by the image persistence. For maximum photographic-recording sensitivity with films generally available, the use of high-speed orthochromatic film is suitable.

In cases where a large amount of recording is to be done, the use of special, high-speed, blue-sensitive film may have an economic advantage.

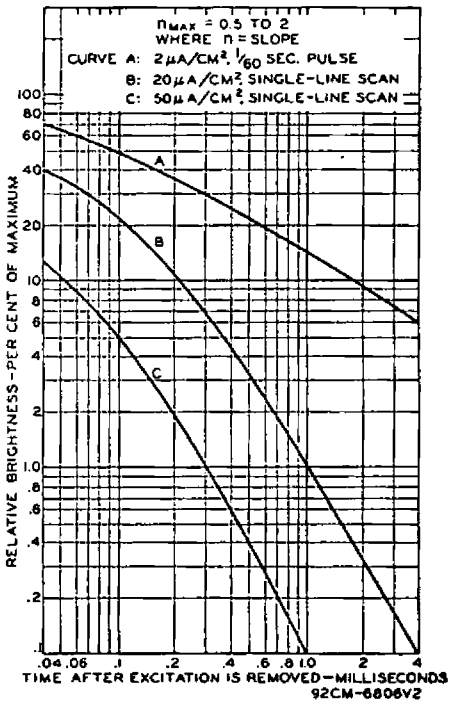


Fig. 8 - Persistence Characteristics of Phosphor P11.

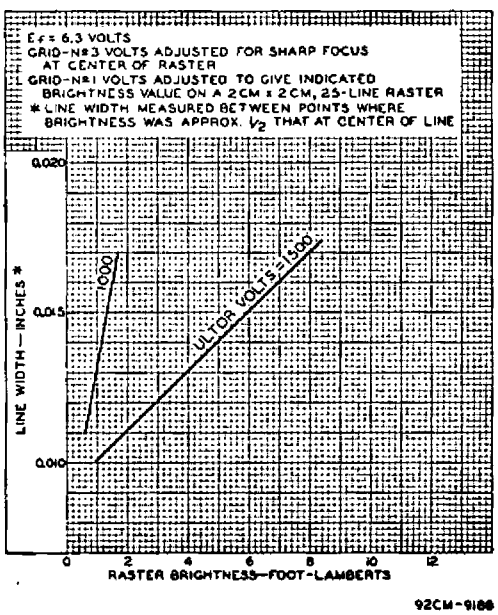


Fig. 9 - Average Characteristics of Type 1EP11.

DATA

For All 1E-Types

General:

Heater, for Unipotential Cathode:

Voltage (AC or DC)	6.3	volts
Current	0.6 ± 10%	amp

Direct Interelectrode Capacitances (Approx.):

Grid No.1 to all other electrodes	6.5	μμf
Deflecting electrode DJ_1 to deflecting electrode DJ_2	1.7	μμf
Deflecting electrode DJ_3 to deflecting electrode DJ_4	0.6	μμf
DJ_1 to all other electrodes	5.0	μμf
DJ_2 to all other electrodes	5.0	μμf
DJ_3 to all other electrodes	3.8	μμf
DJ_4 to all other electrodes	3.8	μμf

Faceplate, Flat	Clear Glass
Focusing Method	Electrostatic
Deflection Method	Electrostatic
Maximum Overall Length	4-1/16"
Seated Length	3-9/16" ± 1/8"
Diameter	1-1/4" ± 1/16"
Minimum Useful Screen Diameter	1-1/16"
Bulb	T10
Base	Small-Button Unidekar 11-Pin (JETEC No.E11-22)
Weight (Approx.)	2 oz
Mounting Position	Any

Maximum Ratings, *Design-Center Values:*

ULTOR● VOLTAGE	1500 max.	volts
GRID-No.3 VOLTAGE	1200 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	200 max.	volts
Positive bias value	0 max.	volts
Positive peak value	2 max.	volts
PEAK VOLTAGE BETWEEN ULTOR 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

Equipment Design Ranges:

For any ultor voltage (E_{c4}) between recommended minimum and 1500 volts*

Grid-No.3 Voltage for Focus	10% to 30% of E_{c4}	volts
Grid-No.1 Voltage for Visual Extinction of Undeflected Focused Spot	-1.4% to -4.2% of E_{c4}	volts
Grid-No.3 Current for Any Operating Condition	-15 to +10	μamp
Deflection Factors:		
DJ_1 & DJ_2	210 to 310 v dc/in./kv of E_{c4}	
DJ_3 & DJ_4	240 to 350 v dc/in./kv of E_{c4}	
Spot Position	##	

Examples of Use of Design Ranges:

For ultor voltage of	*500*	*1000*	*volts*
Grid-No.3 Voltage for Focus	50 to 150	100 to 300	volts
Grid-No.1 Voltage for Visual Extinction of Undeflected Focused Spot	-7 to -21	-14 to -42	volts
Deflection Factors:			
DJ_1 & DJ_2	105 to 155	210 to 310	volts dc/in.
DJ_3 & DJ_4	120 to 175	240 to 350	volts dc/in.

Maximum Circuit Values:

Grid-No.1-Circuit Resistance	1.5 max.	megohms
Resistance in Any Deflecting-Electrode Circuit○○	2.0 max.	megohms

• The "ultor" in a cathode-ray tube is the electrode to which is applied the highest dc voltage for accelerating the electrons in the beam prior to its deflection. In the 1E-types, the ultor function is performed by grid No.4. Since grid No.4, grid No.2, and collector are connected together within the 1E-types, they are collectively referred to simply as "ultor" for convenience in presenting data and curves.

* Brilliance and definition decrease with decreasing ultor voltage. Recommended minimum value of ultor voltage for the 1EP1 in general service is 500 volts, but a value as low as 300 volts may be used under conditions of low-velocity deflection and low ambient light levels. For operation between 300 and 500 volts, it is essential that the ultor voltage be applied before beam-current flow. Otherwise, a screen charge may develop to block off or distort the scanning pattern. Recommended minimum value for the 1EP2 and 1EP11 is 750 volts.

The center of the undeflected focused spot will fall within a circle having 2.5-mm radius concentric with the center of the tube face.

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

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are working design-center maximums established according to the standard design-center system of rating electron tubes. Tubes so rated will give satisfactory performance in equipment designed so that these maximum ratings will not be exceeded when the equipment is operated from ac or dc power-line supplies whose normal voltage including normal variations falls within ± 10 per cent of the line-center value of 117 volts.

Support for the 1E-types may be provided by any convenient method required by the application. If the tube is supported by a clamp around the bulb, the clamp should be fastened only tight enough to provide mechanical support. Fastening the clamp too tight may cause glass strains with immediate or delayed cracking of the bulb.

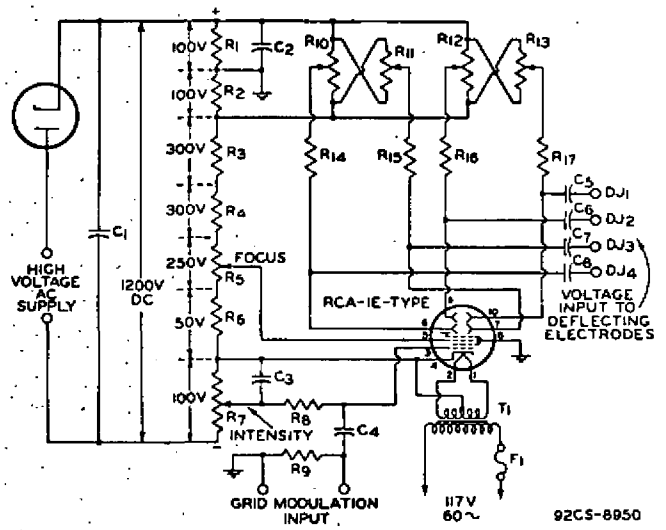
The *bulb*, except for the face, should be enclosed in a grounded shield if the tube is to be operated in the presence of magnetic fields. The shield should be made of high-permeability metal having low residual magnetism in order to minimize the effects of extraneous magnetic fields.

The *base pins* of the 1E-types fit the Unidekar 11-contact socket, such as Alden Nos.411 SBU (connector type) or 411 SBUP (with mounting plate for panel or chassis mounting), or equivalent. The design of the socket should be such that the circuit wiring cannot impress lateral strains through the socket contacts on the base pins. The point of bearing of the contacts on the base pins should not be closer than 1/8" from the bottom of the seated tube.

Two pairs of *electrostatic deflecting electrodes*, producing fields approximately at right angles to each other, provide for deflection of the electron beam in the directions of the respective fields.

Each pair of deflecting electrodes is normally operated at an *average potential* the same as that of grid No.4. Each electrode of each pair should be connected through a resistor of not more than 2 megohms to the grid-No.4 socket terminal. Under operating conditions involving high current to the screen or scanning beyond the limits of the screen, a small amount of current is collected by the deflecting electrodes. If the circuit resistance between each deflecting electrode and grid No.4 is high, the current collected by the deflecting electrodes produces negative potentials on the deflecting electrodes. Such potentials distort or shift the spot on the screen. These effects can be minimized by reducing equally the resistances of the deflecting-electrode circuits, by reducing the scanning width, by reducing the beam current, or by applying a small and equal dc compensating voltage to deflecting electrodes DJ_3 and DJ_4. This voltage should be positive with respect to grid No.4.

Operation with one pair of deflecting electrodes at an *average potential different from that of grid No.4* may be desired in certain applications. In such cases, the different potential should be applied to the pair of deflecting electrodes (DJ_1 and DJ_2) nearer the screen, and its average value should not differ from the operating grid-No.4 voltage by more than 15%. This type of operation causes spot-shape distortion which can be compensated by applying to deflecting electrodes DJ_3 and DJ_4 an average voltage of the same polarity as that applied to



C1: 0.5μf, 2000 volts
C2: 1μf, 200 volts
C3: 1μf, 200 volts
C4: 0.05μf, 1600 volts
C5 C6 C7 C8: 0.05μf, 600 volts
R1 R2: 510000 ohms, 1/2 watt
R3 R4: 300000 ohms, 1 watt
R5: 250000-ohm potentiometer, 2 watts
R6: 51000 ohms, 1/2 watt
R7: 100000-ohm potentiometer, 1/2 watt
R8: 510000 ohms, 1/2 watt
R9: 5 megohms, 1/2 watt
R10 R11: Dual 1-megohm potentiometer, 1/2 watt
R12 R13: Dual 1-megohm potentiometer, 1/2 watt
R14 R15 R16 R17: 1.5 megohms, 1/2 watt
T1: Transformer, with 6.3-volt/1-ampere secondary, insulated for at least 2000 volts, such as Thordarson T21F08
F1: 1-ampere fuse

Fig. 10.- Typical Oscillograph Circuit for 1E-Types.

DJ1 and DJ2 (positive or negative with respect to grid No.4).

The *dc voltages* for grid No.1, grid No.3, and grid No.4 may be obtained conveniently from a high-voltage vacuum-tube rectifier and filter. Since these cathode-ray tubes require very little current, the rectifier system can be of either the half-wave or the voltage-doubler type. Likewise, the filter requirements are simple. A 0.5 μf capacitor will ordinarily provide sufficient filtering. If this is inadequate, a two-section filter is recommended. If the electrode voltages are obtained from a voltage-divider circuit, a

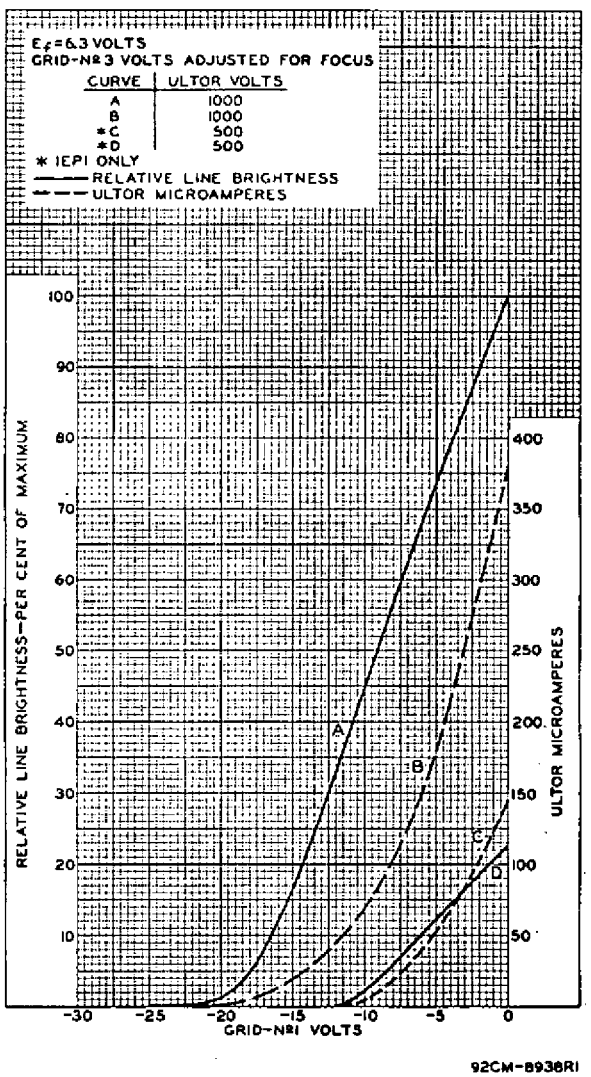


Fig. 11 – Average Characteristics for 1E-Types.

current of 1.0 milliampere through the voltage divider is satisfactory. Considerably higher values may require more filtering than that provided by a single capacitor shunted across the dc supply. A typical circuit for the 1E-types is shown in Fig.10.

In most applications, it is recommended that the ultor (grid No.2, grid No.4, and collector) be grounded in order that the deflecting electrodes

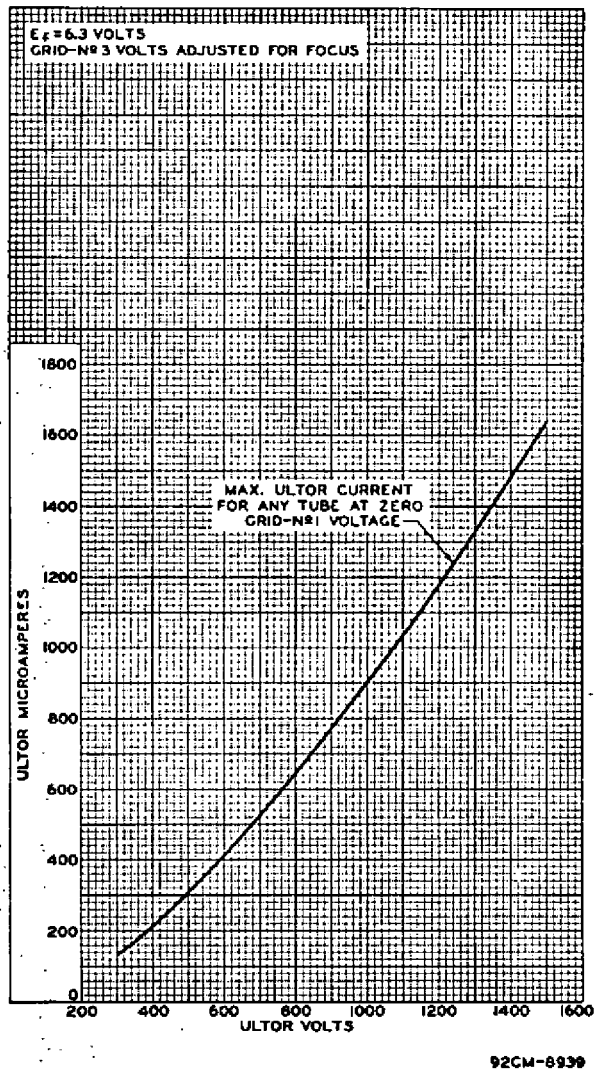


Fig. 12 – Maximum Ultor-Current Requirements from Power Supply for 1E-Types.

may be operated at ground potential. With this method, the cathode and heater are at high negative potential with respect to ground.

The high voltages at which these types are 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 circuits of the power supply when access to the equipment is

required. In most applications, it is recommended that the ultor terminal be grounded rather than the cathode terminal. With this method, which places the heater and cathode at high negative potential with respect to ground, the dangerous voltages can more easily be made inaccessible.

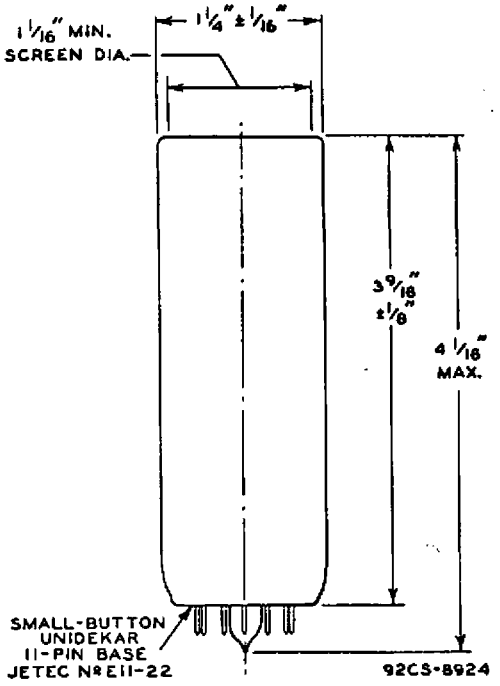
In the use of cathode-ray tubes, it should always be remembered that high voltages may appear at normally low-potential points in the circuit as a result of capacitor breakdown or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned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

The *undeflected focused spot* is normally close to the geometric center of the tube face. However, to compensate for stray magnetic fields, such as that of the earth, and for variation from tube to tube, designers should provide an adjustable and reversible supply of at least 35 volts dc per kilovolt of ultor voltage (balanced to ultor) for application between the two deflecting electrodes of each pair. By adjustment of this dc voltage on each pair of the deflecting electrodes, the spot may be centered.

A *high intensity spot* will burn the fluorescent screen if the spot is allowed to remain stationary. To prevent this possibility, the beam should always be kept in motion over a reasonably large area, or the beam current should be reduced. Such burning is especially noticeable when the IE-types are operated with ultor voltages less than 1000 volts.

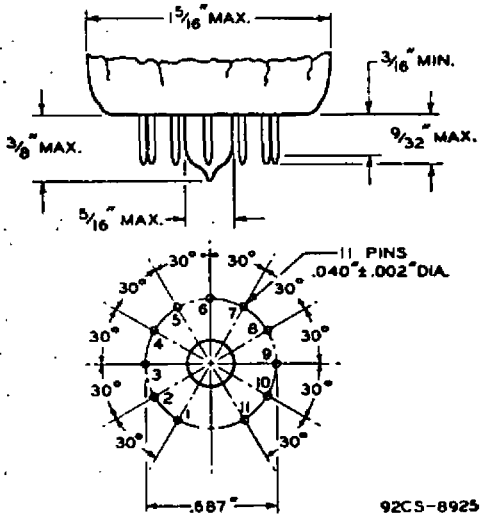
Devices and arrangements shown or described herein may use patents of RCA or others. Information contained herein is furnished without responsibility by RCA for its use and without prejudice to RCA's patent rights.

DIMENSIONAL OUTLINE



BASE DRAWING

SMALL-BUTTON UNIDEKAR
11-PIN BASE
JETEC Nº E11-22



DJ_1 AND DJ_2 ARE NEARER THE SCREEN: DJ_3 AND DJ_4 ARE NEARER THE BASE. WITH DJ_2 POSITIVE WITH RESPECT TO DJ_1, THE SPOT IS DEFLECTED TOWARD THE MIDPOINT BETWEEN PINS 6 AND 7. WITH DJ_3 POSITIVE WITH RESPECT TO DJ_4, THE SPOT IS DEFLECTED TOWARD THE MIDPOINT BETWEEN PINS 9 AND 10.

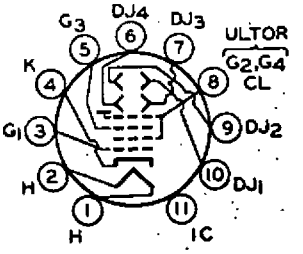
THE ANGLE BETWEEN THE TRACE PRODUCED BY DJ_3 AND DJ_4 AND ITS INTERSECTION WITH THE PLANE THROUGH THE TUBE AXIS AND THE MIDPOINT BETWEEN PINS 9 AND 10 DOES NOT EXCEED ± 10°. THE ANGLE BETWEEN THE TRACE PRODUCED BY DJ_3 AND DJ_4 AND THE TRACE PRODUCED BY DJ_1 AND DJ_2 IS 90° ± 3°.

BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT THE PINS WILL FIT A FLAT-PLATE GAUGE HAVING THICKNESS OF 1/4" AND TWELVE HOLES 0.0520" ± 0.0005" SO LOCATED ON A 0.6870" ± 0.0005" DIAMETER CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS 0.1778" ± 0.0005" THE GAUGE IS ALSO PROVIDED WITH A HOLE 0.3750" ± 0.0100" CONCENTRIC WITH THE PIN-CIRCLE DIAMETER. PIN FIT IN GAUGE SHALL BE SUCH THAT THE ENTIRE LENGTH OF PINS WILL, WITHOUT UNDUE FORCE, ENTER INTO AND DISENGAGE FROM THE GAUGE.

SOCKET CONNECTIONS

Bottom View

PIN 1: HEATER
PIN 2: HEATER
PIN 3: GRID No.1
PIN 4: CATHODE
PIN 5: GRID No.3
PIN 6: DEFLECTING ELECTRODE DJ_4



PIN 7: DEFLECTING ELECTRODE DJ_3
PIN 8: ULTOR (GRID No.2, GRID No.4, COLLECTOR)
PIN 9: DEFLECTING ELECTRODE DJ_2
PIN 10: DEFLECTING ELECTRODE DJ_1
PIN 11: INTERNAL CONNECTION— DO NOT USE

11V