3DP1-A
CATHODE-RAY TUBE

Radial Deflection Type
Medium-Persistence Screen

3-Inch Bulb
Electrostatic Deflection and Focus

RCA-3DP1-A is a high-vacuum cathode-ray tube having a radial-deflecting electrode in addition to the usual two pairs of electrostatic deflecting electrodes. This arrangement provides for the observation and photography of recurrent and transient phenomena in polar coordinates. The use of polar coordinates is especially valuable where high accuracy of measurement of one coordinate is required since the trace length can be made several times that obtainable with the usual cathode-ray tube having the same screen diameter. The 3DP1-A has a medium-persistence fluorescent screen two and three quarters inches in diameter, and produces a brilliant luminous spot having a greenish hue.

The 3DP1-A employs an improved electron gun for projecting the electron beam onto the fluorescent screen. The improved gun provides sharper focus of the beam and is designed so that its anode No. 1 takes essentially no current. This feature permits the use of a bleeder system requiring very little current and, consequently, a smaller filter capacitance. As a result of the extremely small anode-No.1 current, variation in focus which may otherwise take place with change of beam current is minimized.

Two pairs of electrostatic deflecting electrodes located within the bulb neck produce fields at right angles to each other and, consequently, provide vertical and horizontal deflections of the beam. These pairs of electrodes may be used to produce a circular trace on the screen. This trace may then be modulated by applying to the radial-deflecting electrode, located at the center of the screen, a voltage representing the phenomena under observation.

RCA-3DP1-A supersedes RCA-3DP1.

DATA

General:

Heater, for Unipotential Cathode:			
Voltage (AC or DC)	6.3	±10%	Volts
Current	0.6		Ampere
Direct Interelectrode Capacitances (Approx.):			
Grid No.1 to All Other Electrodes	8.5		μμf
Cathode to All Other Electrodes	8.0		μμf
DJ1 to DJ2	2.0		μμf
DJ3 to DJ4	2.0		μμf
DJ1 to All Other Electrodes	8.0		μμf
DJ3 to All Other Electrodes	6.0		μμf
DJ1 to All Other Electrodes except DJ2	6.0		μμf
DJ2 to All Other Electrodes except DJ1	5.0		μμf
DJ3 to All Other Electrodes except DJ4	4.0		μμf
DJ4 to All Other Electrodes except DJ3	6.0		μμf
DJ5 to Anode No.2	2.2		μμf
Phosphor			No.1
Fluorescence			Green
Persistence			Medium
Focusing Method			Electrostatic
Deflection Method			Electrostatic
Deflecting-Electrode Arrangement	See *Outline Drawing*		
Overall Length	10-7/16" + 5/16" - 3/8"		
Greatest Diameter of Bulb	3" ± 1/16"		
Minimum Useful Screen Diameter	2-3/4"		
Bulb Terminal	Small Ball Cap		
Base	Medium Shell Diheptal 12-Pin		
Mounting Position	Any		

Maximum Ratings, *Absolute Values*:

ANODE-No.2 & GRID-No.2 VOLTAGE	2200 max.	Volts
ANODE-No.1 VOLTAGE	1100 max.	Volts
GRID-No.1 (CONTROL ELECTRODE) VOLTAGE:		
Negative Value	125 max.	Volts
Positive Value	0 max.	Volts
PEAK VOLTAGE BETWEEN ANODE No.2 and ANY DEFLECTING ELECTRODE	550 max.	Volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	200 max.	Volts
Heater positive with respect to cathode	10 max.	Volts

Typical Operation:

Anode-No.2 & Grid-No.2 Voltage*	1500	2000	Volts
Anode-No.1 Voltage for Focus at 75% of Grid-No.1 Voltage for Cutoff#	430	575	Volts
Grid-No.1 Voltage for Visual Cutoff##	-45	-60	Volts
Max. Anode-No.1 Current Range▲	Between -50 and +10 μamp.		
Deflection Sensitivity:			
DJ1 and DJ2	0.169	0.127	mm/volt dc
DJ3 and DJ4	0.229	0.172	mm/volt dc
Deflection Factor:			
DJ1 and DJ2**	150	220	volts dc/in.
DJ3 and DJ4**	111	148	volts dc/in.
DJ5 and Anode No.2### ■	245	327	volts dc/in.
Ratio of DJ1-DJ2 Factor to DJ3-DJ4 Factor□	1.35	1.35	

* Brilliance and definition decrease with decreasing anode No.2 voltage. In general, anode-No.2 voltage should not be less than 1500 volts.
** Individual tubes may vary from these values by ±20%.
# Individual tubes may require between +20% and -35% of the values shown with grid-No.1 voltage between zero and cutoff.
Visual extinction of stationary focused spot. Supply should be adjustable to +50% of these values.
For one-inch diameter circle. Deflection factor for any desired circle diameter is the value for a circle of one-inch diameter, given above, multiplied by the desired circle diameter in inches.
▲ See curve for average value.
□ Individual tubes may vary from this value by +15.5%.
■ Individual tubes may vary from these values by +25%.

Spot Position:
The undeflected focused spot will fall within a 15-mm square centered at the geometric center of the tube face and having one side parallel to the trace produced by DJ1 and DJ2. Suitable test conditions are: anode-No.2 volts, 1500; anode-No.1 volts, adjusted for focus; deflecting-electrode resistors, 1 megohm each, connected to anode No.2; the tube shielded from all extraneous fields. To avoid damage to the tube, grid-No.1 voltage should be near cutoff before application of any anode voltages.

Maximum Circuit Values:

Grid-No.1 Circuit Resistance	1.5 max.	Megohms
Impedance of Any Deflecting-Electrode Circuit at Heater-Supply Frequency	1.0 max.	Megohm
Resistance in Any Deflecting-Electrode Circuit▲	5.0 max.	Megohms

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

INSTALLATION and APPLICATION

The *base* pins of the 3DP1-A fit the diheptal (12-contact) socket which may be installed in any position. The socket alone should not be re-

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3DP1-A-6-45
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quired to support the tube; additional support in the form of a yoke or saddle arrangement should be used at or near the screen end of the tube. The socket should be made of good insulating material; a type having insulating baffles between contacts provides an additional factor of safety.

The *bulb* should be enclosed in a grounded shield made of high permeability metal having low residual magnetism in order to minimize the effects of extraneous magnetic fields. When a grounded metal shield is used around the tube, it may be necessary to insulate the tube from the shield to avoid the effects of corona or leakage currents.

The *heater* is designed to be operated at 6.3 volts. The transformer winding supplying the heater power should be designed to operate the heater at the rated voltage under average line-voltage conditions. If the circuit design is such as to cause a high voltage between heater winding and ground, the heater transformer should be adequately insulated to withstand the high voltage. The mid-tap or one side of the heater should preferably be connected to cathode. If necessary, the heater may be operated with a bias of not more than -200 volts or +10 volts with respect to cathode.

The *fluorescent screen* employs phosphor No.1 which fluoresces to produce a medium-persistence green luminescence.

The *dc voltages* for the grid and the two anodes may be obtained conveniently from a high-voltage vacuum-tube rectifier. Since a cathode-ray tube requires very little current, the rectifier system can be of either the half-wave or the voltage-doubler type. A capacitor of about 0.1 μf will ordinarily provide sufficient filtering. If this is inadequate, a two-section filter is recommended. If the electrode voltages are obtained from a bleeder circuit, a bleeder current of about 0.2 milliampere usually is satisfactory. Considerably higher values may require the use of more filtering than that provided by a single capacitor shunted across the dc supply. In most applications, it is recommended that anode No.2 be grounded in order that the deflecting electrodes may be operated at or near ground potential. With this method, the cathode and heater are at high negative potential with respect to ground.

The high voltages at which the tube is operated are very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. 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 required. In most applications, it is recommended that the anode-No.2 terminal be grounded rather than the cathode terminal. With this method, which places the cathode and heater 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 due to capacitor breakdown or to 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 charged capacitors grounded.

Focusing of the fluorescent spot produced by the electron beam is controlled by adjustment of the ratio of anode-No.1 voltage to anode-No.2 voltage. Ordinarily, the ratio is adjusted by variation of anode-No.1 voltage. For this purpose, a potentiometer is required in the bleeder circuit; the necessary range of adjustment is indicated under TYPICAL OPERATION.

Regulation of spot brilliance can be accomplished by varying the current to anode No.2. This current can be increased by decreasing the bias voltage applied to grid No.1. An increase in the current increases the spot size and the quantity of light. To obtain the smallest spot, a slight readjustment of focus may be necessary. An increase in the anode-No.2 voltage increases the beam current and the sharpness of focus and, therefore, the spot brilliance.

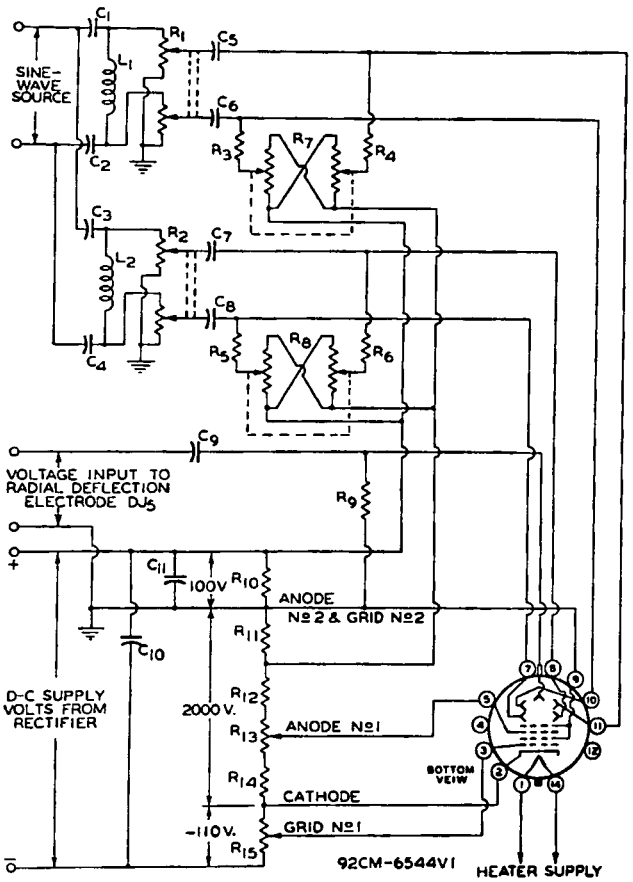
In applications involving extremely accurate measurements, the anode-No.2 current should be reduced to the minimum consistent with the desired brilliance of the pattern. In cases where high brilliance is an important consideration, the anode-No.2 voltage may be increased to the maximum rated value with due consideration to line-voltage variations. This procedure, however, is not always desirable since it results in reduced deflection sensitivity.

It is important to note that a high-intensity spot will burn the fluorescent screen if the spot is allowed to remain stationary. To prevent this possibility, it is recommended that the spot be kept in motion over a reasonably large area or that the beam current should be reduced.

Two pairs of *electrostatic deflecting electrodes*, producing fields at right angles, are located within the bulb neck to provide for deflection of the electron beam. The electrostatic field of each pair of deflecting electrodes causes deflection of the beam in the direction of the gradient lines of the field and perpendicular to the plane of the deflecting electrodes; therefore, the deflections caused by the two fields are at right angles. Each set of deflecting electrodes should be maintained essentially at the dc potential of anode No.2. To do this, each electrode of each set should be connected through a resistor of not more than 5 megohms to the anode-No.2 terminal (ordinarily at ground potential). These resistors should have approximately equal resistances. This arrangement permits a choice of resistor values

such that the electron beam is not distorted by dc potentials built up on the deflecting electrodes. If, during operation, the zero axes should shift, it usually is because the beam current is too high for the resistor value used. When it is necessary to use a high value of beam current, as when photographs are taken, the value of the deflecting-electrode resistors should be reduced to minimize the shift of the zero axes and distortion of the focused spot.

The *radial-deflecting electrode* is used to produce a trace in polar coordinates. In accomplishing this, the signal to be observed is used to modulate a circular trace.



L1 L2: Inductors, see text
C1 C2 C3 C4: Tuning Capacitors, see text
C5 C6 C7 C8 C9: Isolating Capacitors, 0.05 μf*
C10: 0.1 μf
C11: 1.0 μf
R1 R2: Dual Potentiometers, 1 Megohm Each Section
R3 R4 R5 R6: 2 Megohms
R7 R8: Dual Potentiometers, 5 Megohms Each Section
R9 R10 R11: 2 Megohms
R12: 5.5 Megohms
R13: 2-Megohm Potentiometer
R14: 1.5 Megohms
R15: 0.5-Megohm Potentiometer
*When cathode is grounded, capacitors should have high voltage rating; when anode No.2 is grounded, they may have low voltage rating.

Typical Oscillograph Circuit

The *circular trace* is produced by supplying voltages in suitable phase to the coordinate-deflecting electrodes; a phase-splitting circuit for the purpose is included in the circuit diagram. In the circuit, a sine-wave voltage is split by means of a balanced branch circuit into two phases, separated by 90°. The design values of the phase-splitting circuit depend on the frequency of the sine-wave supply voltage. Inductors L1 and L2 are tuned to resonance by adjusting their respective pairs of capacitors C1 and C2, and C3 and C4. The capacitance of capacitors C1 and C2 is *reduced* to the point where the voltage developed across L1 is 0.707 times that at resonance. Similarly, the capacitance of C3 and C4 is *increased* to the point where the voltage developed across L2 is 0.707 times that at resonance. The voltages across the two inductors are then 90° out of phase. The magn tude of the voltage of each phase is adjustable by means of dual potentiometers R1 and R2, and R3 and R4. The use of dual potentiometers for controlling the voltage for each phase provides voltage balance to ground of the associated pairs of deflecting electrodes. The capacitors in each branch (C1 and C2, and C3 and C4) permit the use of low-voltage capacitors.

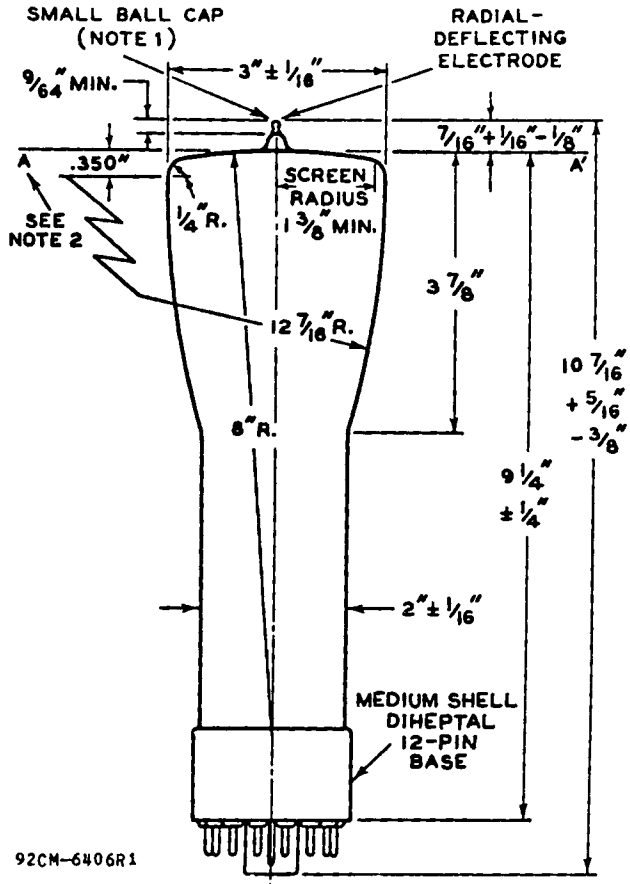
This method of obtaining phased voltages effectively eliminates harmonics from the circular trace. Any harmonics in the trace will cause irregularities which can be confused with the deflection caused by the radial-deflecting electrode.

The deflection sensitivities and the deflection factors for each pair of deflecting electrodes for typical anode-No.2 voltages are given under TYPICAL OPERATION. The deflection factor for the radial-deflecting electrode is given under TYPICAL OPERATION for a one-inch diameter circle. The deflection factor varies with the size of the basic circle and for any given circle size is found by multiplying the deflection factor by the circle diameter in inches.

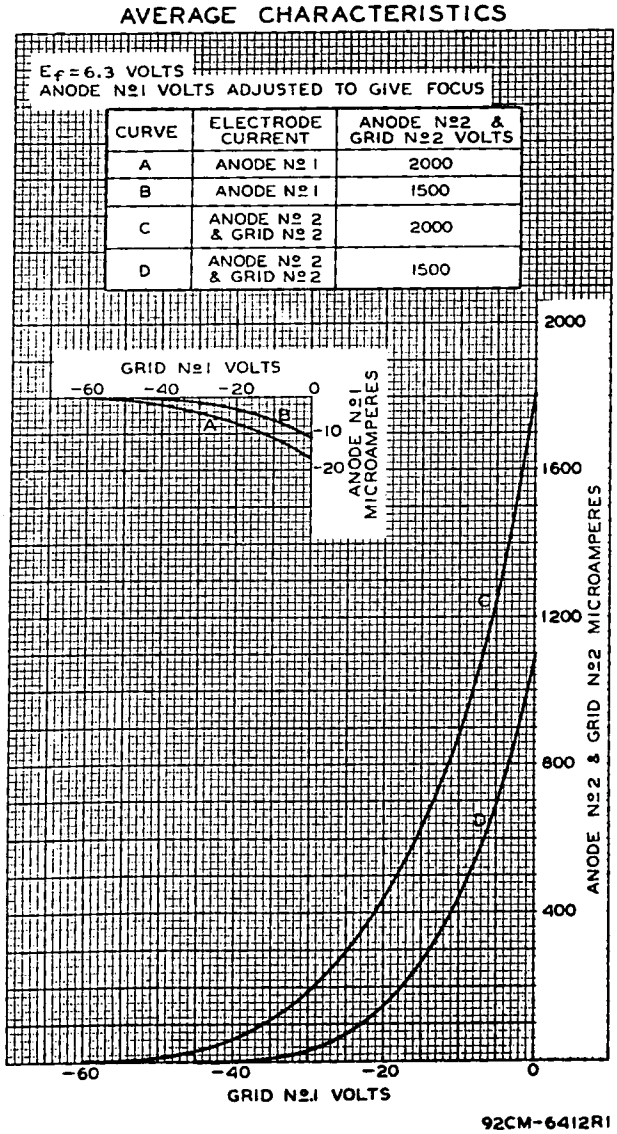
Photographs of the phenomena appearing on the viewing screen can be made with an ordinary camera. The photographing is done preferably in complete darkness in order to obtain as much contrast as possible between the fluorescent pattern and the screen. The time of exposure will depend on the speed of the camera lens, the kind of film or plate emulsion used, and the brightness of the pattern. Where transients are to be photographed, maximum brightness may be required because of the short duration of the phenomena; where recurrent wave forms are to be photographed, patterns having low brightness can be compensated for by longer exposure. The use of emulsions having high green sensitivity is recommended; orthochromatic types of film and high-speed films have been found to give excellent results.

For high-speed photographic work involving non-recurrent phenomena, it is permissible to

increase the trace brightness, for the short interval required to make the exposure, above that required for visual observation. The extent to which the anode current may be increased without harming the screen is proportional to the velocity of beam travel and pattern size, and an inverse function of the duration of the phenomena. Short-interval operation at increased current can be obtained by means of a temporary decrease in the grid-No.1 voltage. A switching arrangement should be provided to switch the grid-No.1 voltage rapidly between a negative and a less negative value. The exposure is made while the grid-No.1 voltage is at the less negative value.



AVERAGE CHARACTERISTICS



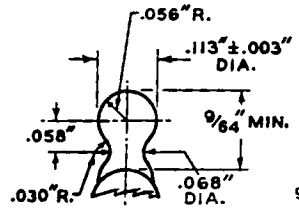
℄ OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT CENTER OF BOTTOM OF BASE.

THE PLANE THROUGH THE TUBE AXIS AND PIN 5 MAY VARY FROM THE TRACE PRODUCED BY DJ1 AND DJ2 BY AN ANGULAR TOLERANCE (MEASURED ABOUT THE TUBE AXIS) OF 10°. ANGLE BETWEEN DJ1-DJ2 TRACE AND DJ3-DJ4 TRACE IS 90° ± 3°.

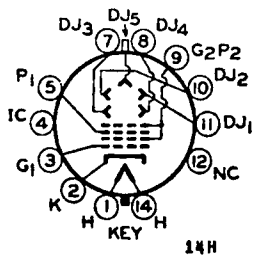
WITH DJ1 POSITIVE WITH RESPECT TO DJ2, THE SPOT IS DEFLECTED TOWARD PIN 5; WITH DJ3 POSITIVE WITH RESPECT TO DJ4, THE SPOT IS DEFLECTED TOWARD PIN 2.

NOTE 1: CAP MAY BE ECCENTRIC WITH RESPECT TO TUBE AXIS BY 1/16" MAX.
NOTE 2: LINE AA' IS PERPENDICULAR TO THE AXIS OF THE TUBE AND INTERSECTS THE FACE CONTOUR 5/16" FROM CENTER OF FACE.

Small Ball Cap



Bottom View of Socket Connections



PIN 1: HEATER
PIN 2: CATHODE
PIN 3: GRID NO.1
PIN 4: INTERNAL CONNECTION; DO NOT USE
PIN 5: ANODE NO.1
PIN 7: DEFLECTING ELECTRODE DJ3
PIN 8: DEFLECTING ELECTRODE DJ4
PIN 9: ANODE NO.2 & GRID NO.2
PIN 10: DEFLECTING ELECTRODE DJ2
PIN 11: DEFLECTING ELECTRODE DJ1
PIN 12: NO CONNECTION
PIN 14: HEATER
CAP: DEFLECTING ELECTRODE DJ5

14H