RMA Release # 295

File Release 295

May 9, 1942

CATHODE-RAY TUBE

Electrostatic-Magnetic Deflection
Electrostatic Focus
Medium Persistence Screen
16-Inch Overall Length
9-Inch Bulb

9JP1/1809-P1

RCA-9JP1/1809-P1 is a high-vacuum cathode-ray tube having a viewing screen nine inches in diameter. The tube uses a combination of magnetic and electrostatic fields for deflection of the electron beam. It features short overall length and close-spaced electrostatic electrodes to provide good deflection sensitivity. With this close spacing, the maximum spot travel caused by these electrodes is approximately two inches. The 9JP1/1809-P1 produces a luminous spot having a greenish hue, and is suitable for the observation and photography of transient and recurrent phenomena.

The indirectly-heated cathode, the control electrode (grid), the first anode, and the second anode constitute an electron gun for projecting a beam of electrons upon the fluorescent screen. The resultant luminous spot can be regulated as to spot size and intensity by suitable choice of electrode voltages.

Deflection of the electron beam is ordinarily accomplished by the use of an electromagnetic field and an electrostatic field. The electromagnetic field is usually placed so that its axis coincides with that of the electrostatic field in order that the deflection produced by one field will be at right angles to that produced by the other field. One field is controlled by the voltage under observation; the other is used for the time sweep.

The 9JP1/1809-P1 is recommended for use in oscillographic applications where the inertialess characteristic of the electron beam, the provision for two methods of beam control, the brilliant image, and the short overall length all contribute to the general utility of this type.

TENTATIVE CHARACTERISTICS and RATINGS

HEATER VOLTAGE (A.C. or D.C.)	2.5	Volts
HEATER CURRENT	2.1	Amperes
FOCUSING METHOD		Electrostatic
DEFLECTION METHOD		Electrostatic and Magnetic
Electrode DJ_1 is on same side of tube as base pin 2		
Electrode DJ_2 is on same side of tube as base pin 6		
PHOSPHOR		No.1
FLUORESCENCE		Green
PERSISTENCE		Medium
DIRECT INTERELECTRODE CAPACITANCES:		
Control Electrode to All Other Electrodes	8	μμf
Deflecting Electrode DJ_1 to Deflecting Electrode DJ_2	1	μμf
Either Deflecting Electrode DJ_1 or DJ_2 to All Other Electrodes	3.6	μμf
Cathode to All Other Electrodes	8	μμf
OVERALL LENGTH	15-11/16" ± 3/8"	
GREATEST DIAMETER of BULB	9" ± 1/8"	
MINIMUM DIAMETER of SCREEN	8"	
BULB SIDE TERMINALS	Snap Connectors	
BASE	Small Wafer Octal 8-Pin, Sleeve	
DEFLECTION YOKE: Position on Tube Neck	{Lip Flush with Bulb Reference Line (see OUTLINE DRAWING)	
Working Length for 55° Angle Deflection	2" *max.*	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

Maximum Ratings Are Based on a Line-Voltage Design Center of 117 Volts

ANODE NO.2 (High-Voltage Electrode) VOLTAGE		5000 *max.*	Volts
ANODE NO.1 (Focusing Electrode) VOLTAGE		2000 *max.*	Volts
GRID (Control Electrode) VOLTAGE		Never Positive	
PEAK VOLTAGE BETWEEN ANODE NO.2 and EITHER DEFLECTING ELECTRODE		3000 *max.*	Volts
D-C HEATER-to-CATHODE POTENTIAL		125 *max.*	Volts
GRID-CIRCUIT RESISTANCE		1.5 *max.*	Megohms
TYPICAL OPERATION:			
Anode No.2 Voltage#	2500	5000	Volts
Anode No.1 Voltage for Focus at 75% of Grid Voltage for Cut-Off (Approx.)*	785	1570	Volts
Grid Voltage for Cut-Off** ##	-45	-90	Volts
Deflection Sensitivity Electrodes DJ_1 and DJ_2	0.272	0.136	mm/volt D.C.
Deflection Factor Electrodes DJ_1 and DJ_2	93.8	187	volts D.C./in.

\# Brilliance and definition decrease with decreasing anode No.2 voltage. In general, anode No.2 voltage should not be less than 2500 volts.
* Supply should be adjustable to ± 20% of this value.
\## Supply should be adjustable to ± 50% of this value.
** Visual extinction of a stationary focused spot.

INSTALLATION

The *base* pins of the 9JP1 fit the standard octal socket which may be installed to hold the tube in any position. The socket should be made of good insulating material; a type having insulating baffles between contacts provides an additional factor of safety.

The *bulb* of this type, except for the screen surface, should be enclosed in a grounded metal case. If an iron or steel case is used to minimize the effect of extraneous fields on tube operation, care should be taken in its construction to insure that the case is completely demagnetized.

The *heater* is designed to operate at 2.5 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 the heater winding and ground, the heater transformer should be adequately insulated to withstand the high voltage.

The *cathode* is connected to base pin No.6, to which the grid and anode returns should be made.

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The *fluorescent screen* employed in the 9JP1 is of the phosphor No.1 (medium persistence) type. It has good visual and photographic properties as well as high luminous efficiency.

The *d-c supply voltages* for the electrodes 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. For the same reason, the filter requirements are simple. A 0.5 to 2 μf condenser will ordinarily provide sufficient filtering. If this is inadequate, a two-section filter is recommended.

Two *electrodes*, located in the bulb neck, provide for electrostatic deflection of the electron beam. These two electrodes are capable of producing a deflection of approximately two inches. The deflection so produced is parallel to the lines of the electrostatic field. The d-c potential of each deflecting electrode must be maintained essentially equivalent to that of anode No.2 in order to avoid building a charge on the deflecting electrodes. A charge on the deflecting electrodes causes a permanent deflection of the beam. The d-c potential of the deflecting electrodes may be kept essentially the same as that of anode No.2 by connecting resistors having values not greater than 10 megohms between each deflecting electrode and anode No.2. This arrangement by suitable choice of resistor values minimizes pattern distortion and pattern drift resulting from unbalanced potentials on the deflecting electrodes. The smaller the resistor values, the less distortion for a given beam current. The beam current should ordinarily be kept low. At times when it is necessary to use a high value of beam current, as when photographs are to be taken, the value of the resistor should be reduced so that the zero-axis shift will be minimized. The resistor of one or both deflecting electrodes may be connected to a d-c bias voltage to obtain centering of the beam.

The *deflection sensitivity* and the *deflection factors* of the deflecting electrodes for typical anode No.2 voltages are given under TYPICAL OPERATING CONDITIONS.

A second method for deflecting the beam is provided by an electromagnetic system which consists of one or more pairs of coils. Each coil of a pair is arranged diametrically opposite its mate in such a manner that the magnetic field is at right angles to the axis of the tube. The deflection of the beam is at right angles to the direction of the magnetic field. The yoke, placed around the bulb neck close to the bulb flare, should be designed so that the deflection of the beam is accomplished within the space of not more than two inches, parallel to the tube axis, measured from the reference line shown on the OUTLINE DRAWING.

Because of the short bulb of the 9JP1, the beam must be deflected through the relatively wide angle of 55° to cover the entire screen width. A deflection yoke suitable for this tube is shown in the accompanying drawings. Although this tube requires but one pair of coils, the drawings show two pairs: one pair may be used in conjunction with the electrostatic electrodes of the tube, or both pairs of coils may be used to obtain full magnetic deflection. In the latter case, the electrostatic electrodes may also be used to introduce an additional voltage for deflection of the beam. The yoke should be placed as close as possible to the junction of the bulb cone and the cylindrical neck. This arrangement is necessary to prevent the beam striking the neck when the deflection is sufficient to reach the edge of the screen.

The high voltages at which the 9JP1 is operated are very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with these voltages. Precautions must include safeguards which definitely eliminate all hazards to personnel. All circuit parts which may be at high potential should always be enclosed and "interlock" switches should be used to break the primary circuit when access to the equipment is required.

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 because of condenser 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 charged condensers grounded.

APPLICATION

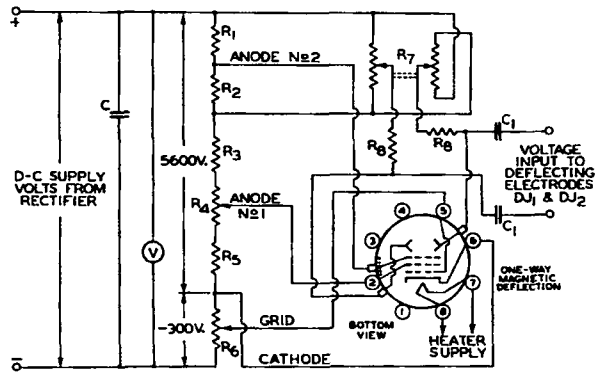
The cathode-ray oscillograph is an instrument adaptable to a wide variety of applications. A few of the more important are: the study of wave shapes and transients, measurement of modulation and peak voltages, adjustment of radio receivers, comparison of frequencies, and the indication of balance in bridge circuits.

A diagram illustrating the essential circuit for the use of the 9JP1 in an oscillograph is shown. The electrode voltages are obtained from a bleeder circuit connected across the high-voltage supply. A bleeder current of one or two milliamperes is usually satisfactory; considerably larger values may require the use of more filtering than can be provided conveniently by a single condenser shunted across the d-c supply. With small bleeder currents, a single condenser filter usually is adequate. A variable d-c voltage for the control electrode and one for anode No.1 can be obtained from potentiometers in the bleeder circuit.

Focusing of the fluorescent spot produced by the beam is controlled by adjustment of the ratio of anode No.1 voltage to anode No.2 voltage. Ordinarily, the ratio is varied by adjustment of anode No.1 voltage.

Regulation of spot size and intensity can be accomplished by varying anode No.2 current and/or voltage. The current to anode No.2 may be increased by decreasing the bias applied to the control electrode (grid). An increase in anode No.2 current increases the size and the intensity of the spot. An increase in the voltage applied to anode No.2 increases the speed of the electrons and, therefore, increases intensity and decreases spot size. The maximum anode No.2 voltage shown under MAXIMUM RATINGS is based on a line-voltage design center of 117 volts. The 9JP1 will operate satisfactorily at lower anode No.2 voltages, but brilliance and definition decreases with decreasing anode No.2 voltages. In general, anode No.2 voltage should not be less than 2500 volts. When any of these adjustments are made, consideration should be given to the limiting voltage ratings shown under MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS.

TYPICAL OSCILLOGRAPH CIRCUIT



C = FILTER CONDENSER, 0.5 to 2 μf
C_1 = ISOLATING CONDENSERS, SEE NOTE BELOW
R_1,R_2 = 0.4 MEGOHM
R_3 = 1.2 MEGOHMS
R_4 = 0.5 MEGOHM POTENTIOMETER
R_5 = 0.5 MEGOHM
R_6 = 0.15 MEGOHM POTENTIOMETER
R_7 = 1.5 MEGOHM (EACH SECTION) DUAL POTENTIOMETER FOR BEAM CENTERING
R_8 = POTENTIAL EQUALIZING RESISTORS, SEE NOTE BELOW AND TEXT

NOTE: When the cathode or the negative end of the cathode-ray high-voltage supply is grounded, blocking condensers C_1 should have a high voltage rating. When anode No.2 is grounded, condensers C_1 may be low-voltage condensers.

For d-c amplifier service, the deflecting electrodes should be coupled direct to the output of the amplifier by omitting the blocking condensers. In addition, it will usually be preferable to remove the associated deflecting electrode resistor in order to minimize the loading effect of the resistor on the d-c amplifier. With the resistor removed, it is essential, in order to minimize the spot defocusing, that anode No.2 be returned to some point in the d-c amplifier circuit such that the potential difference between anode No.2 and the average voltage across the deflecting electrodes will be as low as possible.

In applications involving extremely accurate measurements, the anode No.2 current should be reduced to the minimum consistent with the desired brilliance of pattern. Where high brightness is an important consideration, the voltage applied to anode No.2 may be increased to the maximum value. This procedure, however, is not always desirable since the greater speed of the electrons in the beam causes reduced deflection sensitivity.

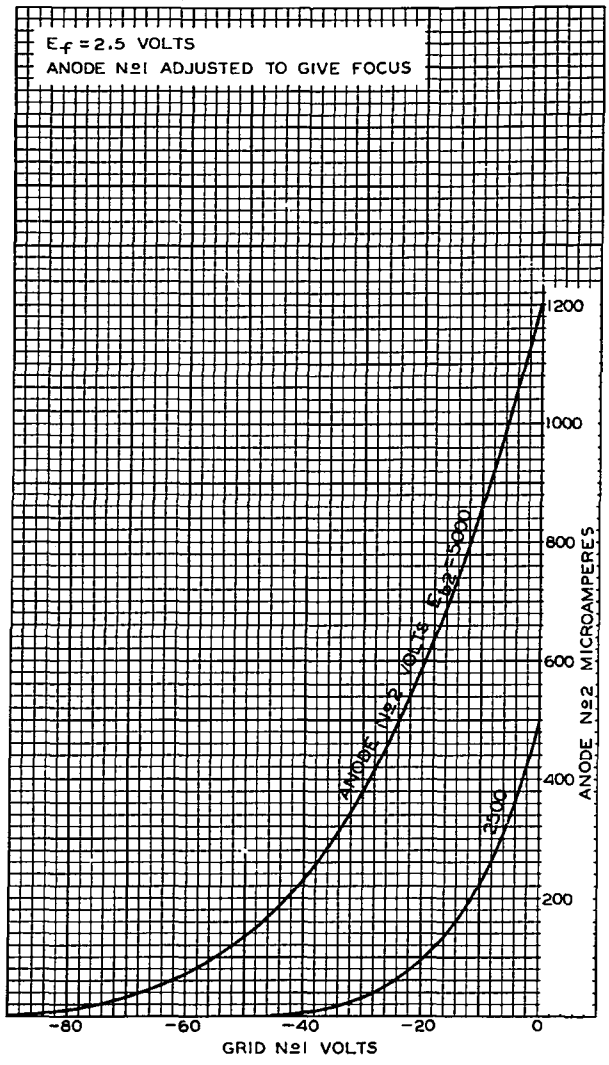
It is important to note that a beam producing a high-intensity spot will burn the fluorescent screen if the spot is allowed to remain stationary. To prevent this possibility, it is recommended that the beam be kept in motion over a reasonably large area by the application of voltage to the deflecting systems or that the brilliance be reduced to a low value by adjustment of the control-electrode voltage.

Photographs of the phenomena appearing on the screen of the 9JP1 can be made with an ordinary camera. Photographing is done preferably in a subdued light in order to obtain as much contrast as possible between the fluorescent pattern and the screen. The time of exposure will depend on the type of film or plate emulsion used, the magnification of the pattern and the brightness of the pattern. When transients are to be photographed, patterns having low brightness can easily be compensated for by longer exposure. The use of film having high green sensitivity is recommended. Verichrome-type film has been found to give excellent results.

For *high-speed photographic work* involving non-recurrent phenomena, it is permissible to increase the screen input power per sq cm, for the short time interval required to make the exposure, above that required for visual observation. The extent to which the anode No.2 current may be increased without harming the fluorescent screen is a function of the rate of beam travel and pattern size, and an inverse function of duration. Short-interval operation at increased input can be obtained by means of a temporary decrease in the control-electrode voltage. A switching arrangement should be provided to switch the control-electrode voltage rapidly between a negative and a less negative value. The exposure is made while the control-electrode voltage is at the decreased (less negative) value.

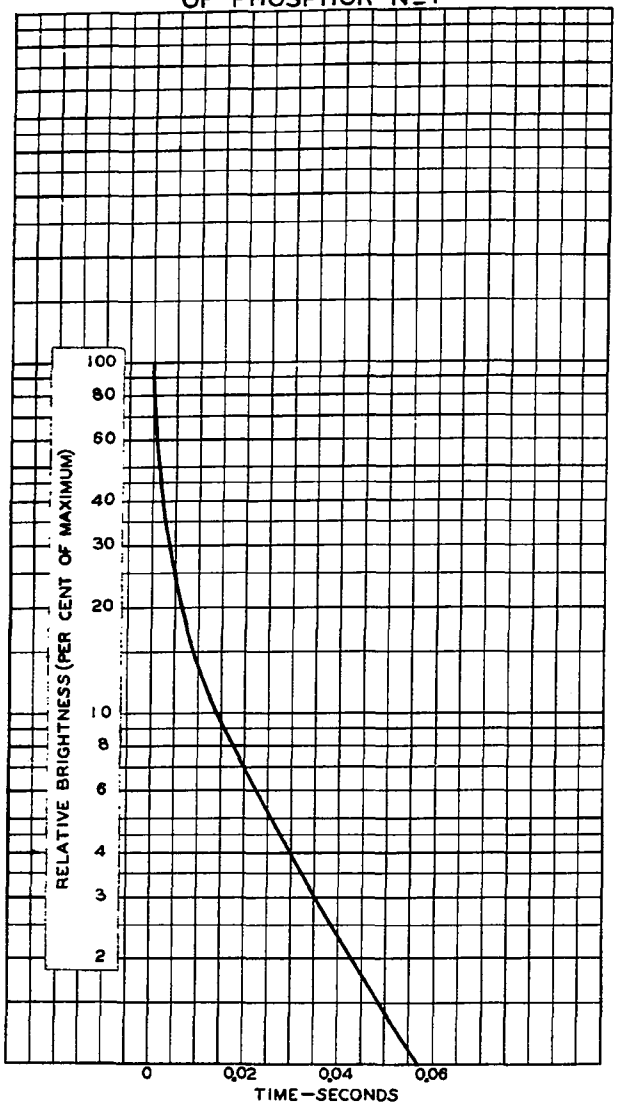
The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

AVERAGE CHARACTERISTICS



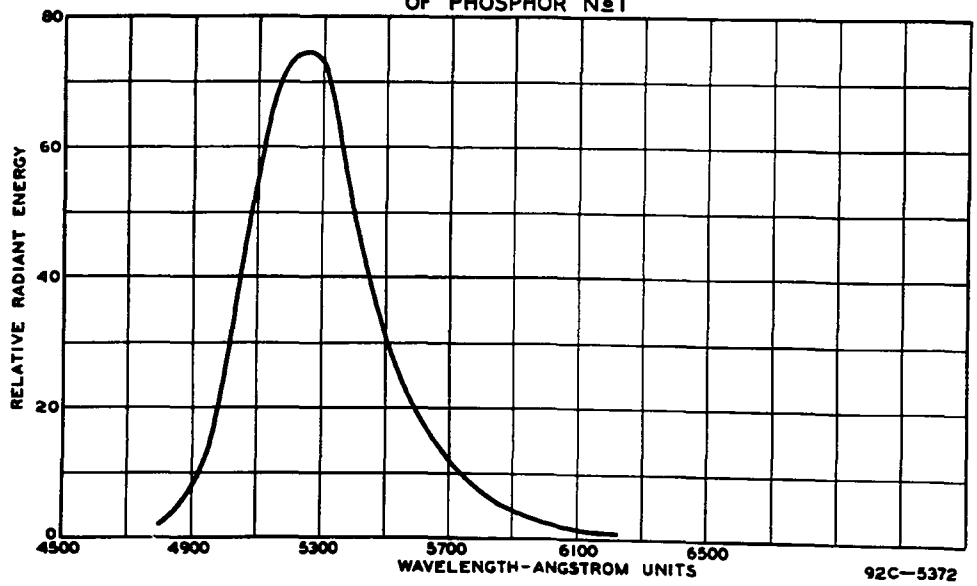
APRIL 20, 1942 92C-6390

PERSISTENCE CHARACTERISTIC OF PHOSPHOR №1



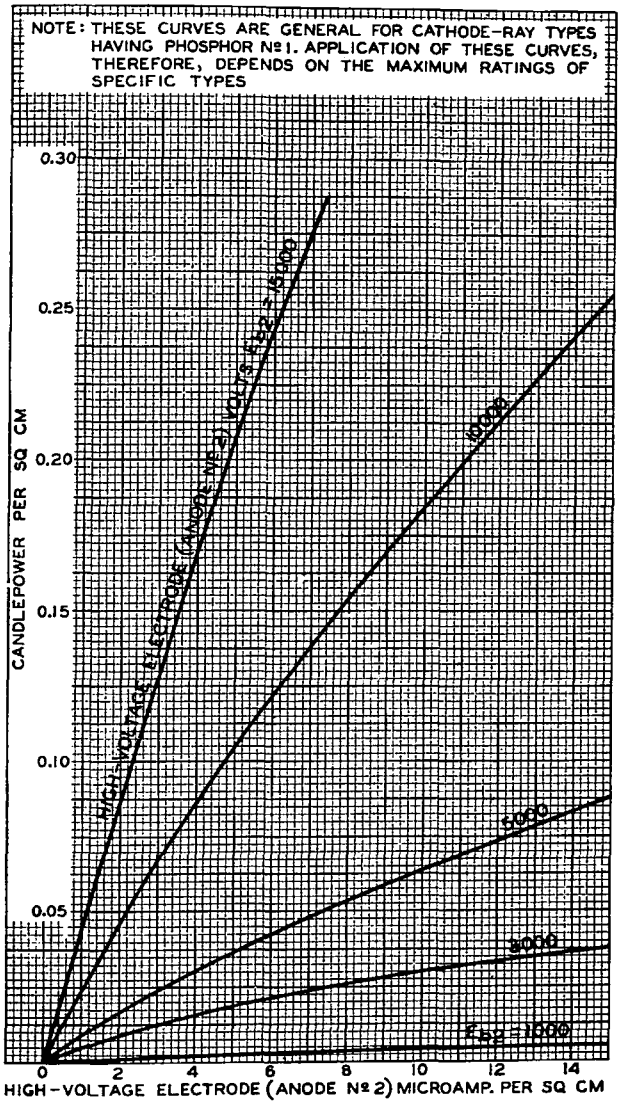
FEB. 28, 1936 92C-5380

SPECTRAL ENERGY CHARACTERISTIC OF PHOSPHOR №1



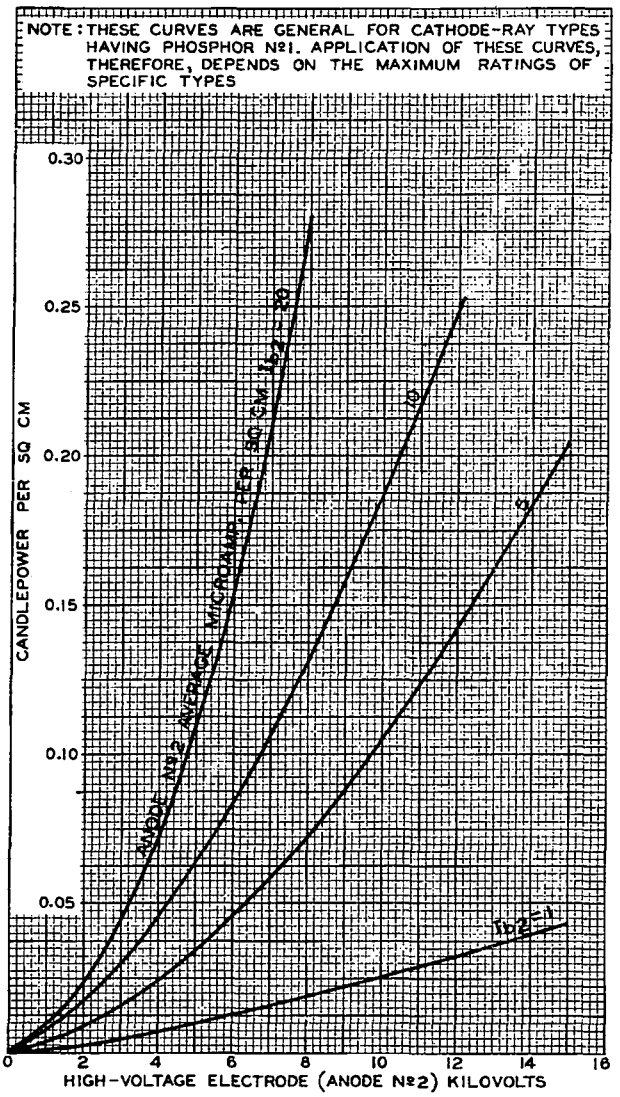
92C-5372

AVERAGE CHARACTERISTICS OF PHOSPHOR Nº 1



NOV. 23, 1938 92C-6010

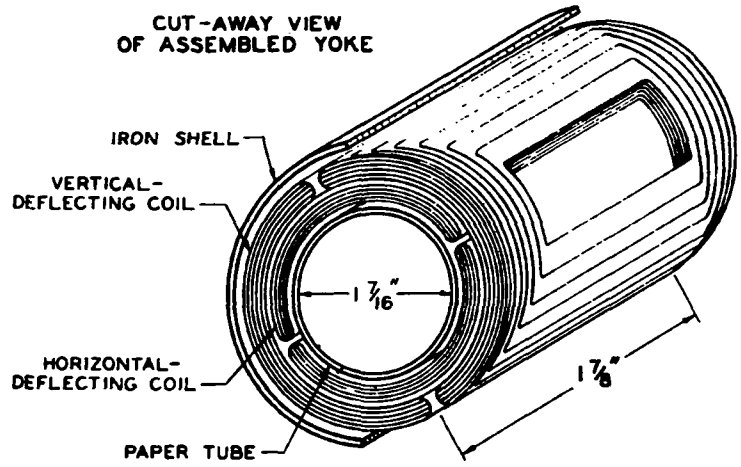
AVERAGE CHARACTERISTICS OF PHOSPHOR Nº 1



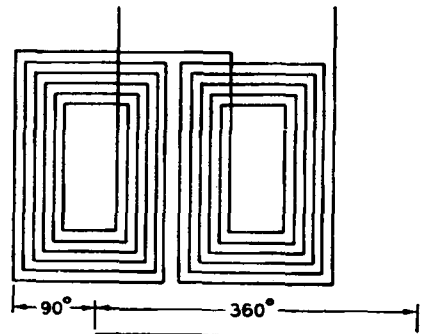
NOV. 23, 1938 92C-6009

DEFLECTING YOKE
FOR WIDE-ANGLE DEFLECTION

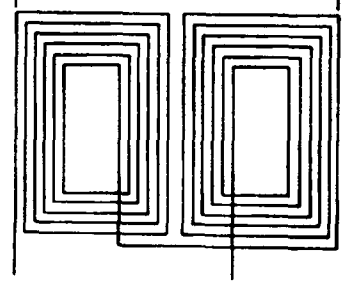
CUT-AWAY VIEW
OF ASSEMBLED YOKE



SCHEMATIC DIAGRAM OF
HORIZONTAL WINDINGS
425 TURNS EACH COIL

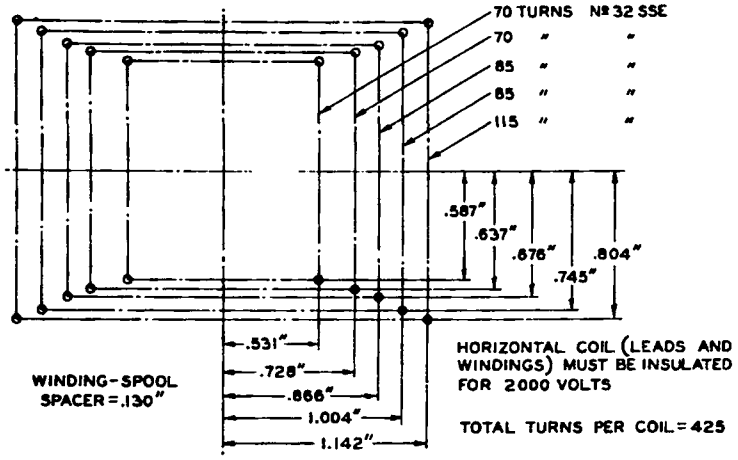


SCHEMATIC DIAGRAM OF
VERTICAL WINDINGS
500 TURNS EACH COIL

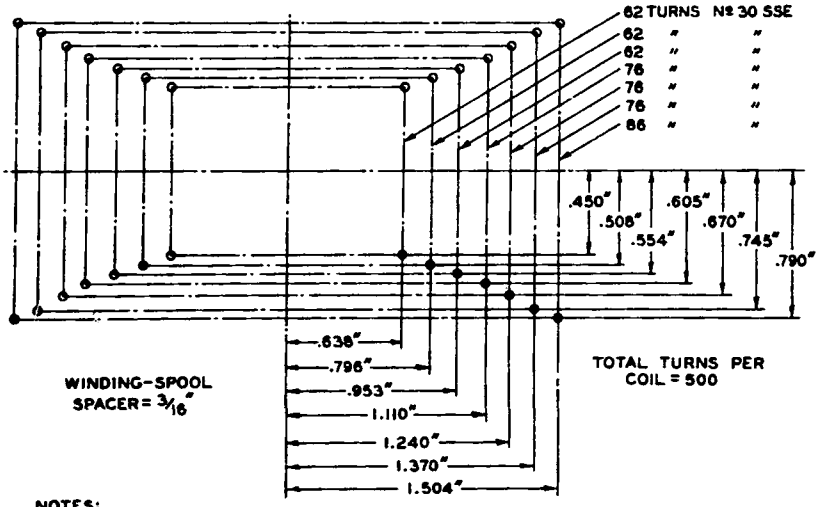


WIDE-ANGLE YOKE DATA

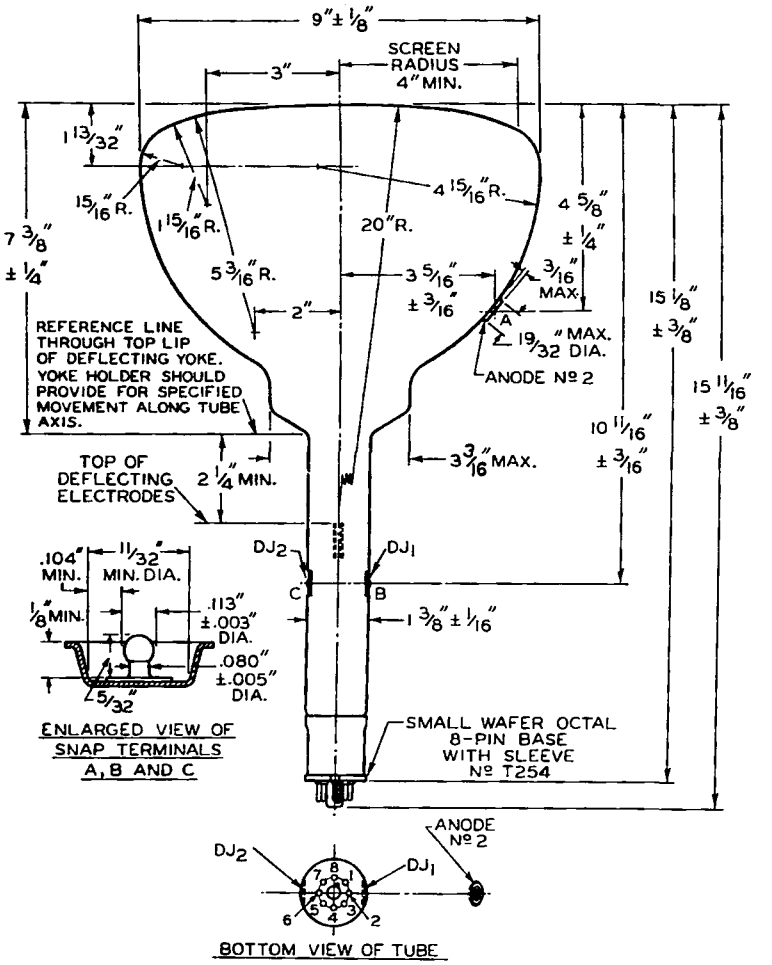
HORIZONTAL COIL FORM
AND WINDING DATA



VERTICAL COIL FORM
AND WINDING DATA



NOTES:
IRON SHELL = 3 LAYERS OF .020" TO .030" SWEDISH IRON
DRILL HOLES FOR PINS WITH Nº 55 DRILL
INSULATION AND SHIELD = 1/32" BETWEEN HORIZONTAL AND VERTICAL COILS

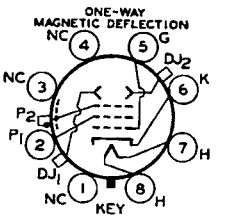


THE PLANE THROUGH THE TUBE AXIS AND EACH OF THE FOLLOWING ITEMS MAY VARY FROM THE PLANE THROUGH THE TUBE AXIS AND ANODE NO.2 TERMINAL BY THE ANGULAR TOLERANCES (MEASURED ABOUT THE TUBE AXIS) AS SHOWN:

ITEM	TOLERANCE
PIN NO.2	± 9°
DJ_1	± 5°
DJ_2	±13°
TRACE PRODUCED BY DJ_1 & DJ_2	± 7°

92C-6331

Bottom View of Socket Connections



DJ_1, DJ_2 = DEFLECTING ELECTRODE
P_2 = ANODE NO.2
P^2 = ANODE NO.1
G^1 = GRID (CONTROL ELECTRODE)
H = HEATER
K = CATHODE
NC = NO CONNECTION