



7539

GRAPHECHON

Scan-Conversion Storage Tube

Writing Gun: Magnetic Deflection
Electrostatic Focus
Reading Gun: Magnetic Deflection
Magnetic Focus

Bombardment-Induced-
Conductivity Writing
Capacitance-Charge
Reading

26" Max. Length
3.4" Max. Diameter
Coaxial Construction
Two Duodecal Bases

RCA-7539 is a sturdy charge-storage tube designed for use in data-processing applications where signal information must be continuously transformed, with minimum loss in detail, from one time base or scanning presentation to another. In addition, the 7539 provides a means of obtaining bright displays having a continuous range of halftone information under conditions of high ambient illumination.



In a typical systems application, PPI (Plan Position Indicator) information generated by radar installations is transformed by the 7539 into TV-type signals so that the information can be viewed on direct-view and projection television monitors. If desired, a large number of such monitors may be used to repeat the display at locations remote from the master-display unit. For example, the 7539 may be used in airport-surveillance applications where aircraft-traffic-condition information may be sent over ordinary TV-type distribution systems to distant cities. Also, information from several radar installations as well as ground-map or special command information picked up by TV cameras may be readily mixed and presented as a composite display.

The characteristics of the 7539 are such that the stored information may be extracted and displayed at high-brightness levels for a period

corresponding to many TV scanning frames. Depending on the signal-to-noise ratio required, this period may be adjusted from several seconds to more than a minute by suitable choice of tube operating voltages.

The resolution capability of the 7539 is 150 range rings per display radius with a response of 50 per cent or better. To utilize fully the resolution capability of the 7539, the TV monitor system must be designed for resolution in excess of 1000 TV lines.

Design features of the 7539 include a sturdy construction utilizing special bulb supports, glass beading which locks the electrodes in permanent relation to each other, and a precision alignment of the coaxial elements. These features insure both dependable performance and close uniformity in characteristics from tube to tube. Another feature of the 7539 is the use of small recessed cavity caps as envelope terminals.

PRINCIPLES OF OPERATION

The 7539 has three sections—a writing section, a reading section, and a target section—as shown in Fig. 1.

Writing Section

The writing section contains an electron gun consisting of an indirectly heated cathode, a control grid (grid No. 1), an accelerating grid (grid No. 2), a focusing grid (grid No. 3), and a final accelerating electrode (grid No. 4) connected to the external conductive coating. The writing gun produces a high-velocity electron beam which is focused electrostatically and deflected by the magnetic fields of external deflecting coils.

Reading Section

The reading section contains an electron gun consisting of an indirectly heated cathode, a control grid (grid No. 1), and an accelerating grid (grid No. 2). The reading gun produces a

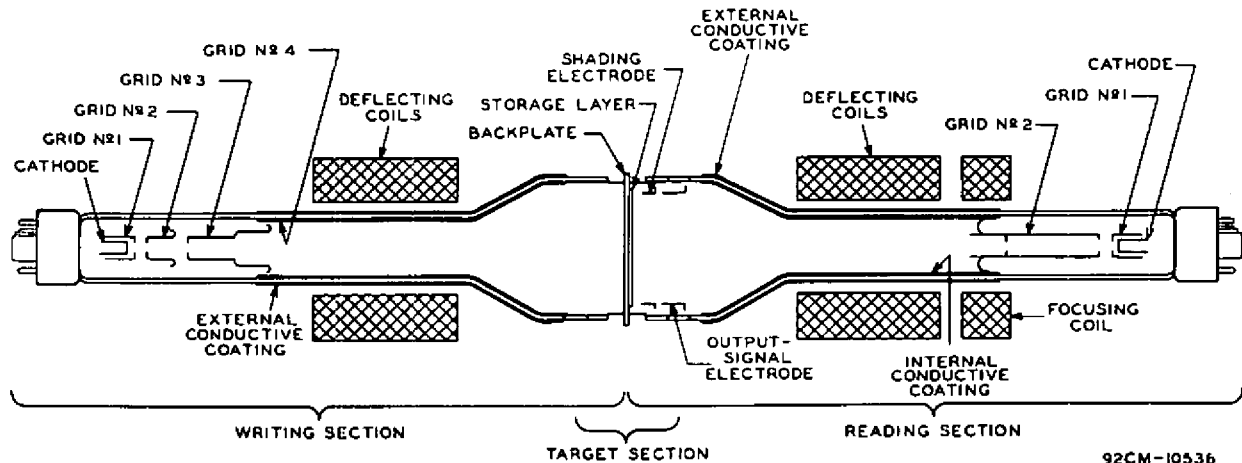


Fig. 1 - Schematic Arrangement of Type 7539.

medium-velocity electron beam which is focused and deflected by the magnetic fields of external focusing and deflecting coils.

Target Section

The target section contains a target, a shading-electrode, and an output-signal electrode. The target consists of a very thin layer of a high-resistivity material deposited on the front—the reading-gun side—of the backplate. The backplate is composed of an extremely thin layer of metal deposited on the reading-gun side of a very fine metal mesh. The backplate allows high transmission of incident writing-beam electrons. The thin layer of high-resistivity material is called the storage layer. The storage layer, under normal operating conditions, has a secondary emission ratio greater than unity. The storage layer also serves as a dielectric for the capacitor formed between the backplate and the front surface of the storage layer.

When the front surface of the storage layer is bombarded by the medium-velocity electron beam of the reading gun, secondary electrons are emitted. As the secondary-electron emission ratio of the front surface is greater than unity, the surface begins to charge in the positive direction. Under continued bombardment, the surface becomes increasingly positive with respect to the output-signal electrode until a retarding potential of a few volts is built up and equilibrium is established.

The opposite side of the storage layer—the back side—is in mechanical and electrical contact with the backplate. Because the backplate is at a negative potential with respect to the output-signal electrode, a difference of potential exists between the two surfaces of the storage layer during conditions of equilibrium. During the writing process, the high-velocity electron beam bombards the target. It passes through the backplate and penetrates the storage

layer. The resulting bombardment-induced-conductivity produced in the storage layer lowers the potentials of the front surface elements by varying degrees toward the negative potential of the backplate. The front surface of potential variations which corresponds to the input video signal. When the writing beam is removed, the storage layer gradually regains normal resistivity.

Because the output signal from any given area of the storage layer is a continuous function of the input signal, providing that area is not written beyond saturation, storage of a continuous range of halftone information is possible.

The writing or discharging characteristic of the 7539 is a function of writing-beam current, writing-beam velocity, scanning speed, and width as well as repetition rate of the input-pulse signal.

The change in potential of the storage-surface elements caused by writing-beam bombardment upsets the equilibrium conditions established by the reading beam. Secondary electrons, produced by reading-gun bombardment of the storage-surface elements that have been driven toward the negative backplate voltage by writing, are now accelerated to the output-signal electrode and constitute the output-signal current. The reading process, therefore, serves as an erasing process by removing the stored potential pattern and driving the storage surface back toward the equilibrium value. Because the storage layer does not immediately regain its normal resistivity after the writing beam is removed, and because there is relatively large capacitance between the front surface and the back surface of the storage layer, a large number of scans are required before equilibrium is reestablished. The stored signal accordingly "persists" for some time.



The reading or charging characteristic of the 7539 is a function of backplate potential and reading-gun current. Increasing backplate potential and decreasing reading-beam current result in increased charging time. By suitably adjusting these operating values, the reading time can be varied from a few seconds to over a minute.

Because the reading process removes the stored-charge pattern and brings the storage-surface elements to the equilibrium potential essential for writing, an erasing process is not ordinarily required.

The maximum number of scanning frames (copies) obtainable during the reading process depends on the magnitude of the potential variations produced on the storage-surface elements during the writing process, and the minimum value of reading-beam current that can be used in relation to the noise level of the associated amplifier.

The shading-electrode is used to reduce variation in the equilibrium potential of the storage-surface elements as a function of their location on the surface. As a result of its action, the output signal is relatively free from the effect commonly called "shading". The shading-electrode is operated at a potential somewhat positive with respect to that of the backplate.

DATA

General:

| | Writing Gun | Reading Gun | |
|---|--|-------------|-------|
| Heater, for Unipotential Cathode: | | | |
| Voltage (AC or DC) . . . | 6.3 ± 10% | 6.3 ± 10% | volts |
| Current at 6.3 volts . . . | 0.6 | 0.6 | amp |
| Direct Interelectrode Capacitances: | | | |
| Grid No.1 to all other electrodes . . . | 7 | 6 | μf |
| Cathode to all other electrodes . . . | 4.8 | 5 | μf |
| Output-signal electrode to all other electrodes . . . | | 15 | μf |
| Backplate to all other electrodes . . . | | 26 | μf |
| Focusing Method | Electrostatic | Magnetic | |
| Deflection Method | Magnetic | Magnetic | |
| Deflection Angles (Approx.) | 30° | 30° | |
| Overall Length | 25.5" ± 0.5" | | |
| Maximum Diameter | 3.40" | | |
| Minimum Useful Target Diameter | 2.25" | | |
| Base: | | | |
| Writing Gun | Tan—Small—Shell Duodecal 7-Pin, Arrangement 1, (JEDEC No. B7-51) | | |
| Reading Gun | Black—Small—Shell Duodecal 6-Pin, Arrangement 1, (JEDEC No. B6-63) | | |
| Socket (For either base) | Alden* No. 212FTSC, or Cinch** No. 9464-12, or equivalent | | |
| Bulb Terminals: | | | |
| Cap (Three) | Recessed Small Cavity (JEDEC No. J1-21) | | |
| Flange | See <i>Dimensional Outline</i> | | |
| Operating Position | Tube Axis Horizontal, or with the Black-Base End Down | | |
| Weight (Approx.) | 1.2 lbs | | |

Maximum and Minimum Ratings, Absolute-Maximum Values:

| | | | |
|--|----------|--|-------|
| OUTPUT-SIGNAL ELECTRODE-TO-BACKPLATE VOLTAGE: | | | |
| Positive value | 100 max. | | volts |
| Negative value | 10 max. | | volts |
| OUTPUT-SIGNAL ELECTRODE-TO-SHADING-ELECTRODE VOLTAGE | 100 max. | | volts |
| OUTPUT-SIGNAL ELECTRODE-TO-GRID-No.2 (Reading Gun) VOLTAGE | 100 max. | | volts |
| OUTPUT-SIGNAL ELECTRODE-TO-EXTERNAL CONDUCTIVE COATING (Reading Gun) VOLTAGE | 100 max. | | volts |
| SHADING-ELECTRODE-TO-BACKPLATE VOLTAGE | 100 max. | | volts |
| SHADING-ELECTRODE-TO-EXTERNAL CONDUCTIVE COATING (Reading Gun) VOLTAGE | 100 max. | | volts |
| BACKPLATE-TO-GRID-No.4 (Writing Gun) VOLTAGE | 100 max. | | volts |

Voltages are referred to cathode of respective gun unless otherwise indicated

| | Writing Gun | Reading Gun | |
|---|-------------|-------------|-------|
| GRID-No.4 VOLTAGE | 11000 max. | - | volts |
| GRID-No.3 VOLTAGE | 3000 max. | - | volts |
| GRID-No.2 VOLTAGE | 300 max. | 2500 max. | volts |
| GRID-No.1 VOLTAGE: | | | |
| Negative bias value | 180 max. | 0 max. | volts |
| | * | 0 min. | volts |
| PEAK HEATER-CATHODE VOLTAGE:† | | | |
| Heater negative with respect to cathode | 125 max. | 125 max. | volts |
| Heater positive with respect to cathode | 10 max. | 10 max. | volts |

Typical Operating Conditions and Characteristics:

Voltages are referred to ground[Ⓢ] unless otherwise indicated

| | Writing Gun | Reading Gun | |
|--|-----------------|-----------------------|-------|
| Grid-No.4 Voltage | 0 | - | volts |
| Grid-No.3 Voltage for Focus | -7000 to -9000 | - | volts |
| Grid-No.2 Voltage | -9800 | 0 to -30 [#] | volts |
| Grid-No.1-to-Cathode voltage for Beam-Current Cutoff | -40 to -100 | -40 to -100 | volts |
| Cathode Voltage | -10,000 | -2000 | volts |
| Cathode Current: | | | |
| Maximum Operating Value (Approx.) | 50 [□] | 200 | μa |
| Maximum Zero-Bias Value | ▲ | 3.8 | ma |
| Focusing-Coil Current ^{□□} | - | 23 | ma |
| Backplate Voltage | -4 to -7 | | volts |
| Shading-Electrode Voltage | 10 | | volts |
| Output-Signal-Electrode Voltage | 0 | | volts |

Maximum Circuit Values:

| | Writing Gun | Reading Gun | |
|--|-------------|-------------|---------|
| Grid-No.1-Circuit Resistance | 1.5 max. | 1.5 max. | megohms |

Characteristics Range Values for Equipment Design:

| | Note | Min. | Max. | |
|---|------|------|------|--------|
| Peak Output-Signal Current | 1 | 0.3 | - | μa |
| Relative Response of Output Video Signal | 2 | 50 | - | % |
| Maximum Time to Erase Stored Signal to 10% of Value Immediately Following Writing | - | - | 30 | sec |
| Minimum Number of Discernible Output-Signal Levels | 3 | 4 | - | |
| Storage Factor for Essentially Saturated Writing | 1.4 | 3 | - | μa-sec |

Note 1: Under the following conditions: The writing-gun beam is modulated with pulses whose half-amplitude



duration is between 0.5 and 1.0 microsecond. The modulated beam scans the back side of the target to produce a PPI display of 150 concentric rings. The 150th ring utilizes the maximum usable diameter of the storage-tube target.

PPI radial-scan repetition rate. 1000 cps
 PPI radial range period. 610 μ sec
 PPI scan rotational rate (Approx.) 6 rpm

The reading-gun beam scans the front side of the target to produce a square raster whose usable edges (exclusive of blanked portions) are tangent to the usable target circumference.

Vertical scan rate 60 cps
 Horizontal scan rate 28350 cps
 Frames per second. 30
 Fields per frame (Interlaced). 2
 Lines per frame. 945
 Active field time. 90 %
 Active line time 83 %
 Aspect ratio 1

The reading-beam current and/or backplate voltage is adjusted so that the output signal from the range rings drops to approximately 50% of its initial level in one PPI rotational period.

Note 2: Relative response of output video signal is defined by the expression H/H in per cent where "H" is the peak-to-peak value of output signal produced when the reading beam is scanning a 35-concentric-ring display immediately following writing and "h" is the peak-to-peak value of output signal produced when the reading beam is scanning a 150-concentric-ring display immediately following writing. This ratio is determined under the same writing and reading conditions of Note 1 except the writing section is initially scanned to produce the PPI display on the target of 35 concentric rings and then, after erasure, is scanned to produce the PPI display on the target of 150 concentric rings.

Note 3: The minimum number of discernible output-signal levels is defined as the number of output-signal levels, each related to a different input signal, which can be just distinguished from each other regardless of their relative location on the storage surface.

Note 4: Storage factor is defined as the product of the initial value of the peak amplitude of the output-signal current (above background or equilibrium level) and the time required for the peak amplitude of the output-signal current to drop to 50% of its initial value.

* Alden Products Company, 117 N. Main Street, Brockton, Mass.

** Cinch Manufacturing Corporation, 1026 S. Homan Avenue, Chicago 24, Illinois.

† 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.

* Static bias-voltage value should never be less negative than value required for beam cutoff.

§ To prevent the possibility of inadvertently exceeding these ratings, it is recommended that the cathode should be connected to the center tap or one side of heater transformer.

Ⓢ External conductive coatings of the 7539 should be grounded.

- # Adjust for optimum stored-signal uniformity.
- Peak value. Average cathode current is much lower due to nature of radar video signals.
- ▲ Writing gun must never be operated at zero-bias voltage.
- ▢ With Syntronic F10B Focusing Coll. or equivalent. Focusing-coll air-gap should be approximately 6.5" from target flange.
- ◆ Adjusted for desired storage-time characteristics.

OPERATING CONSIDERATIONS

Handling. The 7539 should preferably be transported or handled with either the black-base end down or with the tube axis horizontal to prevent any loose particles within the tube from striking the storage surface and adhering to it. Care should be taken to prevent striking the glass-to-metal seals. Such rough treatment will cause either immediate or delayed cracking of these seals.

Shielding. Electrostatic, magnetic, and light shielding are required by the 7539 for satisfactory performance.

Electrostatic shielding of the target section must be provided to prevent external radiation from causing spurious signals in the output circuit. This shield must make good electrical contact with the external conductive coatings of both the reading section and the writing section of the 7539. A suitable contact to each of the external conductive coatings can be provided by phosphor-bronze spring-finger ring contacts close to and on each side of the backplate flange. Holes for terminal leads should be made through the shield material.

Magnetic shielding of the 7539 and its focusing coil and deflecting coils must also be provided to prevent external magnetic fields from affecting the writing-gun beam and the reading-gun beam, and therefore, tube performance. The amount and nature of the shielding necessary is dependent on the location and intensity of the magnetic fields produced by the components of associated equipment. The use of a canister-type shield made of a high-permeability material is suggested. The canister wall should be at least 1/32" thick with provisions for adding additional layers of shielding material if they are required.

Light shielding, which may be provided by either the electrostatic or magnetic shielding, is necessary because the storage-layer material of the target is photoconductive. Failure to provide adequate light shielding for the 7539 results in unstable output-current storage-time characteristics and unsatisfactory erasing performance.

Operating Position. The 7539 may be operated either horizontally or vertically with the black-base end down. Support for the 7539 can be effected by mounting the tube on a set of right-angle "V" blocks within the magnetic shield. Suitable straps may hold the tube in place. Care must be taken, however, not to exert excessive

radial forces on the glass necks of the tube. The V-blocks should be of a non-magnetic material and should support the tube at no more than two axial positions.

Terminal Connections. The pins of both the black and the tan duodecal bases fit a duodecal socket. Connection to the backplate flange may be made by a spring-loaded contact bearing against the rim of the flange. Connections to the output-signal electrode, the shading electrode, and grid No. 4 of the writing-gun section are made to recessed small cavity caps.

Deflection Considerations. The writing beam may be deflected by either a mechanically rotating pair of coils diametrically opposite each other or by two stationary pairs of coils. In the latter case, one pair is used for horizontal deflection; and the other, for vertical deflection.

When a rotating pair of coils is used, centering of the undeflected writing beam, as required for a PPI scan, may be accomplished by means of a centering device of either the electromagnetic or permanent-magnet type. This device is mounted on the writing-gun neck behind the rotating deflecting coils.

When stationary coils are used, centering of the undeflected writing beam is preferably accomplished by passing direct current of the required value through each pair of deflecting coils.

Application will govern the choice of deflecting yokes for the reading and writing guns. It is recommended that equipment designers select yokes providing deflection angles of at least 50° even though the tube requires substantially less deflection. The use of deflecting coils providing at least 50° deflection minimizes cross-sectional beam-distortion effects.

For PPI to TV-scan conversion, any of the deflecting coils in the Syntronic* Y15-5, Y17-5, Y25-R or Y27-R series, or their equivalents, are suggested for the writing gun. Deflecting coils in the Syntronic Y16-5 series, or equivalents, are suggested for the reading gun.

Positioning of the Deflecting Coils and Focusing Coil. Because the glass necks of the 7539 have mutual axial alignment and in turn are each aligned with the undeflected beams of the writing and reading guns, the external deflecting coils and the focusing coil must be mounted coaxially with the necks to prevent distortion in the scan-conversion process. Interference to writing-gun and reading-gun beam formation by the magnetic fields of these coils is minimized if the axial-position limitations shown in Fig. 2 are observed.

Having noted these limitations, the designer may position the deflecting coils and the focusing coil where they may best serve the requirements

of this particular system, keeping in mind the following considerations:

1. Power requirements for the deflecting coils increase as the yokes are moved closer to the backplate flange.
2. Cross-sectional beam-distortion effects resulting from off-axis deflection increase as the yokes are moved closer to the backplate flange. If yokes designed for 50° total deflection angle or more are used, this consideration is of secondary significance.
3. Resolution capabilities of the 7539 are slightly improved as the reading-gun focusing coil is moved closer to the backplate flange.
4. The overall effect of pattern distortions associated with beam scanning of a flat target is minimized if the effective deflection center of each yoke is located equidistant from the backplate flange.
5. Depending on the physical and electrical configurations of the reading-gun deflecting coils and the focusing coil chosen, moderate spacing between these components should be used.

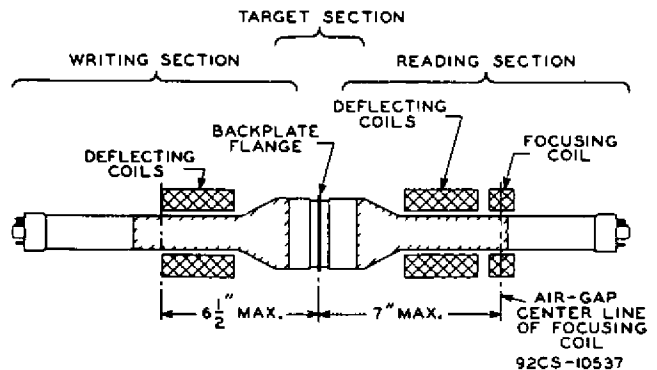


Fig. 2 - Limitations to be Observed in Positioning External Deflecting and Focusing Coils for Type 7539.

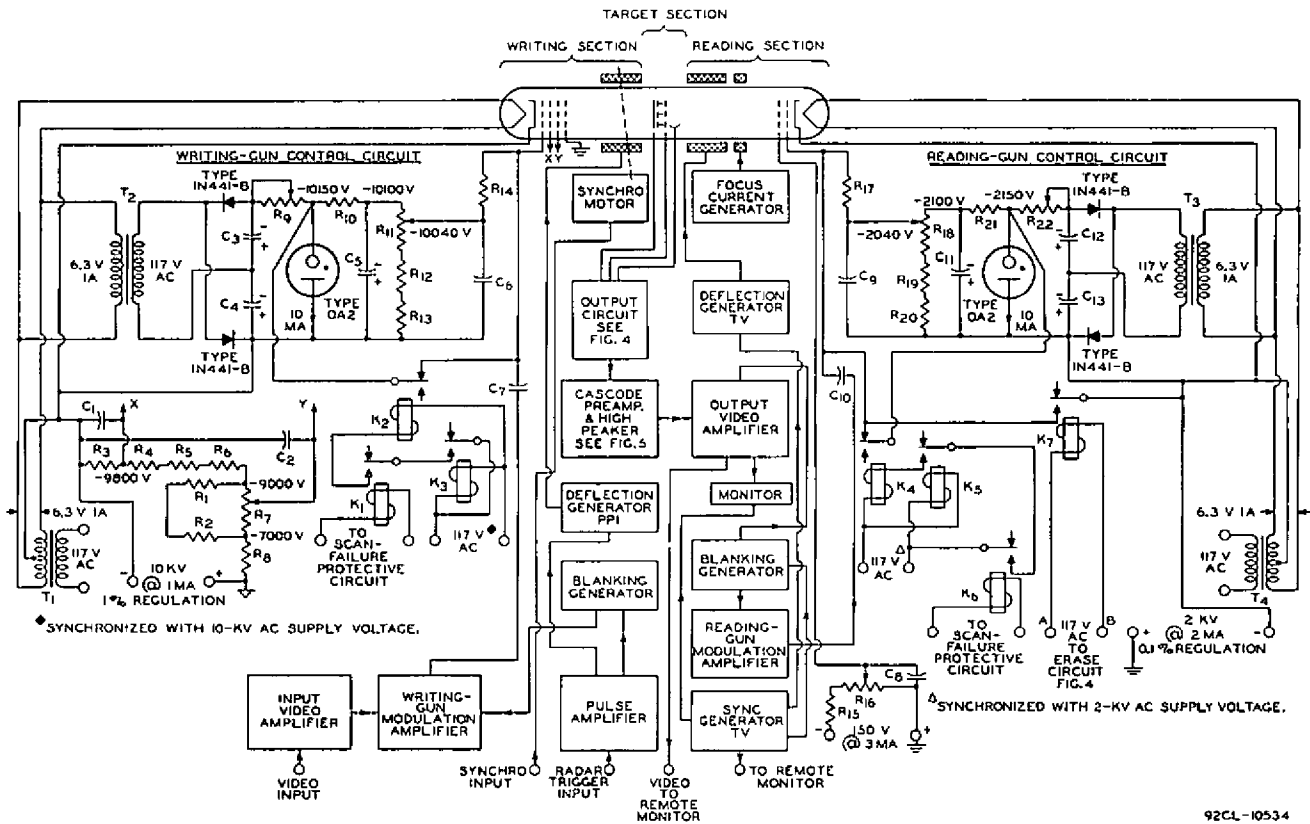
Power-Supply and Gun-Control Considerations. Typical power-supply and gun-control circuits for use with the 7539 are shown in Fig. 3. This figure also shows in block-diagram form the associated equipment required for operation of the 7539.

The coupling capacitors C_7 and C_{10} of the writing- and reading-gun control circuits have much higher voltage ratings, and therefore are larger, than the capacitors normally encountered in video circuitry. Stray wiring capacitance in these circuits should be minimized by using short, direct leads wherever possible.

The external conductive coatings of the 7539 should be grounded not only for safety reasons, but also to prevent excessive pickup of noise by the target section.

Because the cathodes of both guns are at high negative voltages, the transformers used to supply current to the heaters as well as the

* Syntronic Instruments, Inc., 100 Industrial Road, Addison, Illinois.



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All resistors may have tolerance of ± 10 per cent unless otherwise indicated

- | | |
|---|--|
| C1: 0.1 μ f, paper, 400 v working voltage | R1: 2 megohms, 5 watts, 2500 volts |
| C2: 0.1 μ f, plastic film, 5 kv working voltage | R2: 300000 ohms, 2 watts |
| C3, C4: 20 μ f, electrolytic, 150 v working voltage | R3, R4: 200000 ohms, 1 watt |
| C5: 4 μ f, electrolytic, 150 v working voltage | R5, R6: 300000 ohms, 1 watt |
| C6: 0.5 μ f, paper, 200 v working voltage | R7: 15-megohm potentiometer, IRC type HV-15, or equivalent |
| C7: 0.05 μ f, plastic film, 15 kv working voltage | R8: 7 megohms, 25 watts, 10000 volts |
| C8: 1 μ f, paper, 100 v working voltage | R9: 10000 ohms, 10 watts, adjustable |
| C9: 0.1 μ f, paper, 200 v working voltage | R10: 82000 ohms, 1/2 watt |
| C10: 0.1 μ f, plastic film, 3 kv working voltage | R11: 100000-ohm potentiometer, 1/2 watt. Bias-voltage control. |
| C11: 4 μ f, electrolytic, 150 v working voltage | R12, R13: 33000 ohms, 1/2 watt |
| C12, C13: 20 μ f, electrolytic, 150 v working voltage | R14: 1 megohm, 1 watt |
| K1: S.P.S.T. relay, normally open. Voltage rating is dependent on particular scan-failure circuit used. | R15: 39000 ohms, 1 watt |
| K2: S.P.S.T. vacuum relay, normally closed. Insulated for 15 kv. | R16: 10000-ohm potentiometer, 1/2 watt. Uniformly control. |
| K3: S.P.S.T. relay, 10-second time-delay, normally open, 117 v ac | R17: 1 megohm, 1 watt |
| K4: S.P.S.T. relay, normally closed, 117 v ac. Insulated for 3 kv. | R18: 100000-ohm potentiometer, 1/2 watt. Bias-voltage control. |
| K5: S.P.S.T. relay, 10-second time-delay, normally open, 117 v ac | R19, R20: 33000 ohms, 1/2 watt |
| K6: S.P.S.T. relay, normally open. Voltage rating is dependent on particular scan-failure circuit used. | R21: 82000 ohms, 1/2 watt |
| K7: S.P.S.T. relay, normally open, 117 v ac. Insulated for 3 kv. | R22: 10000 ohms, 10 watts, adjustable |
| | T1: Heater transformer with secondary insulated for 15 kv. |
| | T2, T3: Heater transformer |
| | T4: Heater transformer with secondary insulated for 3 kv. |

Fig. 3 - Typical Power-Supply and Gun-Control Circuits with Block Diagram of Associated Equipment for Type 7539.



sources of control-grid signals must be adequately insulated from ground. It is recommended that the cathode of each gun be connected directly to the mid-tap of its associated heater winding.

The high voltages at which the 7539 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.

Failure of Scanning. Failure of scanning while either beam is turned on may permanently damage the target. Provision should therefore be made to cut off beam current of both guns automatically in case of scanning failure. Cutoff may be effected by making the control grids—grid No. 1 of the writing gun and the reading gun—sufficiently negative with respect to the gun cathodes. The beams must be cut off nearly as rapidly as the decrease in scanning current occurs. The protective circuit for the 7539 should be capable of cutting off the writing beam and the reading beam within 50 milliseconds after scanning failure. The protective circuit may be actuated by a tube that is controlled by a portion of the scanning pulse voltage developed across the deflecting coils. It is important that the horizontal and vertical scanning each independently actuate the protective circuit in case either should fail.

Regulation of Bias Supplies. Because the output signal and reading duration are critically dependent on the beam current of both the reading gun and the writing gun, it is essential that grid-No. 1 bias supplies have good regulation if variations in output signal and in reading duration are to be avoided. In addition, the voltage supply providing the writing-beam accelerating potential must have substantially less ripple than is permitted in ordinary cathode-ray tube circuits. Ripple in this supply should be kept to a value substantially less than 0.1 volt.

Crosstalk. At a writing-gun accelerating-electrode (Grid No. 4) voltage of 10 kilovolts, less than 20 per cent of the writing-beam current appears in the output-signal electrode circuit. For most applications, writing beam current is low and feed-through is not discernible in the output display. However, if cancellation of crosstalk is desired, simple mixing, in opposite phase or polarity, of a writing-beam sample with

the output signal of the tube should be adequate. RF carrier separation techniques need not be used. Operating the writing gun of the 7539 at reduced accelerating voltages also reduces crosstalk to a negligible value but this procedure also reduces tube resolution.

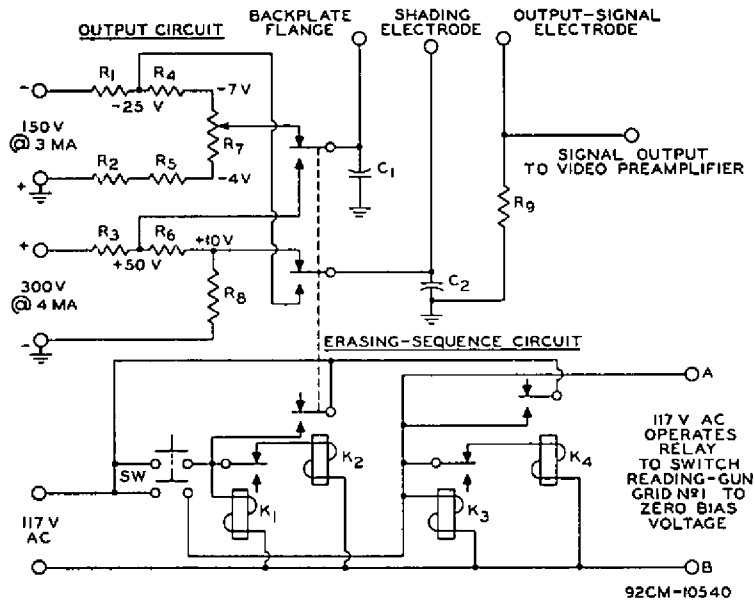
Reading Duration Control. Reading duration may be adjusted by control of reading-beam current and to a lesser degree by control of backplate voltage. The basic control of this performance characteristic should be effected by adjustment of reading-gun beam current.

Erasure. Ordinarily there is no need to program an erasing sequence but under certain conditions—such as radar-range changes—rapid clearing of information may be desirable. The following procedure should be used for erasure:

1. Simultaneously adjust backplate voltage to +50 volts, shading-electrode voltage to -25 volts, and the reading-gun grid-No. 1 bias voltage to 0 volts.
2. After a 10-second interval, readjust backplate- and shading-electrode voltages to their normal operating voltages.
3. Allow a 10-second interval before readjusting the reading-gun grid-No. 1 bias voltage to its normal operating voltage.
4. An additional 10-second delay permits associated equipment to regain stability.

As indicated in Fig. 4, the erasing sequence may be effected by using time-delay relay circuitry.

Video-Drive Considerations. Information to be stored by the 7539 should be applied as a video signal to the control grid (grid No. 1) or the cathode of the writing gun. Video signals are treated the same as if they were to be displayed on ordinary cathode-ray display tubes. Grid-No. 1 bias voltage is first adjusted to cut-off completely writing-beam current. An unblanking pulse, coincident in time with the writing-beam scanning waveform, is then applied to grid No. 1 to allow the writing-beam current to reach the threshold of writing. For PPI displays, a larger writing-beam current is required to obtain this threshold at the edges of the PPI pattern than is required at the center. The necessary current waveshape is obtained by additively mixing a sawtooth waveform with the basic rectangular unblanking pulse. The amplitude of the sawtooth component depends on the range and azimuth repetition rates, and the scanning times associated with the particular radar system. The video signal may be either mixed with this composite unblanking signal and applied to grid No. 1 of the writing gun, or the video signal may be applied directly to the cathode of the writing gun with the composite unblanking signal applied to grid No. 1 of the writing gun. Regardless of the method used, the amplitude of the video signal is dependent on the particular parameters of the radar system used.



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All resistors may have tolerance of ± 10 per cent unless otherwise indicated

- | | | |
|---|--|--|
| C_1, C_2 : 1 μ f. paper, 100 v working voltage | K_4 : S.P.S.T. relay, normally open, 117 v ac | R_7 : 1000-ohm potentiometer, 1/2 watt. Storage-time control. |
| K_1 : S.P.S.T. relay, 10-second time-delay, normally closed, 117 v ac | R_1 : 43000 ohms, 1 watt | R_8 : 2400 ohms, 1/2 watt |
| K_2 : 3 P.D.T. relay, 117 v ac | R_2 : 1000 ohms, 1/2 watt | R_9 : 47000 ohms, 1/2 watt. Representative value. |
| K_3 : S.P.S.T. relay, 20-second time-delay, normally closed, 117 v ac | R_3 : 62000 ohms, 2 watts | Sw : D.P.S.T. momentary contact (spring return), normally open. "Push-to-erase" switch. |
| | R_4 : 6200 ohms, 1/2 watt | |
| | R_5 : 330 ohms, 1/2 watt | |
| | R_6 : 10000 ohms, 1/2 watt | |

Fig. 4 - Output Circuit and Erasing-Sequence Circuit for Type 7539.

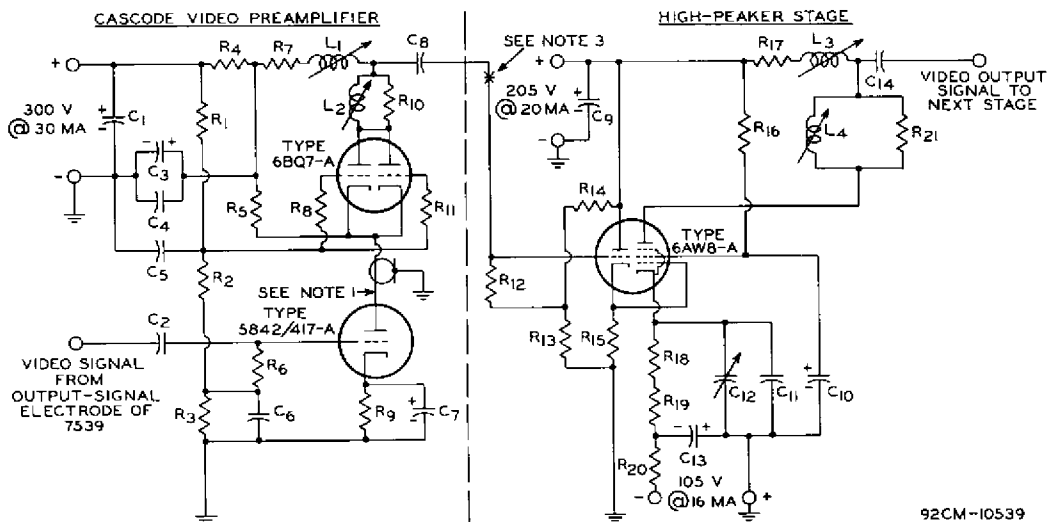
Video-Amplifier Circuitry. Typical video amplifier circuits for the 7539 are shown in Fig. 5. In most applications, the peak-to-peak output signal current of the 7539 is in the order of tenths of a microampere. Video amplifiers should, therefore, be designed for high gain and low noise. A cascode-type preamplifier followed by appropriate high-peaker stages is highly recommended because of the extremely low equivalent-noise-input current that can be realized with this type of amplifier system. For example, such a system designed for a noise-equivalent bandwidth of 18 Mc may have an equivalent-noise-input current of less than 0.02 microampere rms value. An amplifier having a noise-equivalent-bandwidth of at least 18 Mc is necessary to fully utilize the capabilities of the 7539 in scan-conversion systems employing 945 lines per frame and 30 frames per second.

The designer may wish to add one or more video-amplifier stages between the cascode pre-amplifier and the high-peaker stage. It is good practice to amplify the output signal from the cascode preamplifier to a high level—avoiding overload conditions—before feeding the signal into the high-peaker stage. In Fig. 5 the output signal of the preamplifier stage is approximately 0.25 volt. If additional amplification is desired, one or two video-amplifier stages each having a gain of 5 are recommended.

SET-UP PROCEDURE

The following steps should be followed when first placing the 7539 in operation:

1. Insert the 7539 in its mount, position the external deflecting and focusing coils, and attach sockets.
2. Make certain that the deflection circuits are functioning properly to cause the beams to scan the target.
3. Be sure the grid-No. 1 voltage of each gun is adjusted beyond beam cutoff and then apply voltages as indicated under *Typical Operation*. This procedure is essential to avoid possible damage to the target.
4. Adjust the reading-gun grid-No. 1 bias voltage so that a picture of the 7539 target becomes visible on the system display monitor.
5. Adjust reading-beam deflection circuitry as required. In a typical PPI to TV system, the edges of the useful target area should lie tangent to the reading raster.
6. Adjust reading-gun focusing-coil current for sharpest picture of the 7539 target as seen on the system display monitor.
7. Set backplate voltage to -4 volts and reading-gun grid-No. 2 voltage to -25 volts.
8. Without applying the input video signal,



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All resistors may have tolerance of ± 10 per cent unless otherwise indicated

- | | |
|---|--|
| C ₁ : 10 μ f, electrolytic, 450 v working voltage | R ₈ : 200 ohms, 1/2 watt |
| C ₂ : 0.1 μ f, paper, 100 v working voltage | R ₉ : 680 ohms, 1 watt |
| C ₃ : 10 μ f, electrolytic, 450 v working voltage | R ₁₀ : 4700 ohms, 1/2 watt |
| C ₄ : 0.01 μ f, paper, 400 v working voltage | R ₁₁ : 200 ohms, 1/2 watt |
| C ₅ : 0.22 μ f, paper, 200 v working voltage | R ₁₂ : 1 megohm, 1/2 watt |
| C ₆ : 0.001 μ f, ceramic disc, 600 v working voltage | R ₁₃ : 82000 ohms, 1/2 watt |
| C ₇ : 500 μ f, electrolytic, 25 v working voltage | R ₁₄ : 1 megohm, 1/2 watt |
| C ₈ : 0.22 μ f, paper, 400 v working voltage | R ₁₅ : 5600 ohms, 1/2 watt |
| C ₉ , C ₁₀ : 40 μ f, electrolytic, 250 v working voltage | R ₁₆ : 22000 ohms, 1 watt |
| C ₁₁ : 150 μ f, mica, 500 v working voltage | R ₁₇ : 750 ohms, 1 watt |
| C ₁₂ : 20 to 200 μ f, ceramic trimmer, 500 volts. This trimmer provides compensation over a range of 30 to 50 μ f for the high-frequency-response attenuation caused by the capacitance at the 5842/417-A grid. | R ₁₈ , R ₁₉ : 3600 ohms, 2 watts, 5 per cent tolerance |
| C ₁₃ : 300 μ f, electrolytic, 150 v working voltage | R ₂₀ : 1000 ohms, 1/2 watt, 5 per cent tolerance |
| C ₁₄ : 0.1 μ f, paper, 400 v working voltage | R ₂₁ : 4700 ohms, 1/2 watt |
| L ₁ : 5 μ h | |
| L ₂ : 10 μ h | |
| L ₃ : 5 μ h | |
| L ₄ : 10 μ h | |
| R ₁ : 330000 ohms, 1/2 watt | |
| R ₂ : 270000 ohms, 1/2 watt | |
| R ₃ : 47000 ohms, 1/2 watt | |
| R ₄ : 750 ohms, 2 watts | |
| R ₅ : 12000 ohms, 2 watts | |
| R ₆ : 510000 ohms, 1/2 watt | |
| R ₇ : 750 ohms, 2 watts | |

NOTE 1: BECAUSE THIS IS A LOW-IMPEDANCE PART OF THE CIRCUIT, THE 5842/417-A SHOULD BE LOCATED CLOSE TO THE 7539 TO PERMIT USE OF A SHORT, DIRECT INPUT LEAD TO MINIMIZE STRAY INPUT CAPACITANCE. THE CONNECTION FROM THE 5842/417-A PLATE TO THE 6BQ7-A CATHODE MAY BE A LOW-IMPEDANCE CABLE UP TO 18" IN LENGTH.

NOTE 2: VALUES SHOWN FOR L₁, L₂, L₃, L₄, R₇, R₁₀, R₁₇, AND R₂₁ ARE APPROXIMATE VALUES FOR AN AMPLIFIER BANDWIDTH OF 15 MC. THE INDUCTORS SHOULD BE SLUG-TUNED FOR INDIVIDUAL TRIMMING OF THE FREQUENCY RESPONSE CHARACTERISTIC.

NOTE 3: THE INDIVIDUAL DESIGNER MAY WISH TO ADD ONE OR MORE ADDITIONAL VIDEO-AMPLIFIER STAGES BETWEEN THE CASCODE PREAMPLIFIER AND THE HIGH-PEAKER STAGE.

Fig. 5 - Typical Video Preamplifier Circuit and High-Peaker Amplifier Circuit for Type 7539.

- adjust writing-gun grid No. 1 and/or unblanking signal level so that bombardment of the 7539 target by the writing beam is just evident.
9. Adjust writing-beam deflection circuitry as required.
10. Adjust the shape of the sawtooth waveform which is superimposed on unblanking pulse and concurrently adjust writing-gun grid-No. 1 bias voltage for threshold writing over all areas encompassed by the writing scanning pattern.
11. Adjust reading-gun grid-No. 1 bias voltage so that writing is just below threshold.
12. Apply video signals (e.g. range marks) to produce writing pattern. Adjust input video-signal amplitude to a value just below that which produces visual evidence of crosstalk on system display monitor.
13. Adjust writing-gun grid-No. 3 voltage for best focus of writing pattern as seen on system display monitor.
14. Readjust reading-gun grid-No. 4 voltage for minimum variation of intensity of output signals. At optimum value of reading-gun grid-No. 2 voltage, the output display will show more detail than otherwise.



15. Apply video signal which is to be processed for display.
16. The reading-gun grid-No.1 bias voltage may now be adjusted to give the desired reading duration (i.e. display persistence). Secondary control of reading duration may be effected by adjustment of backplate voltage within range shown under *Typical Operation*.

REFERENCES

- L. Pensak, "Picture Storage Tube", Electronics, Vol.22, No.7, pp.84-88 (July, 1949).
- L. Pensak, "The Graphicon--A Picture Storage Tube", RCA Review, Vol.X, No.1, pp.59-73 (March, 1949).
- A.H. Benner and L.M. Seeberger, "Graphicon Writing Characteristics", RCA Review, Vol.XII, No.2, pp.230-250 (June, 1951).
- M. Knoll and B. Kazan, "Storage Tubes and Their Basic Principles", John Wiley & Sons, Inc., New York. (1952).

DOS and DON'TS on Use of RCA-7539

Here are the "dos"—

1. Handle the 7539 with care.
2. Use extreme caution when installing the 7539.
3. Be sure that both beams are always cut off before applying operating voltages.
4. Operate the reading gun first so that effects of subsequent writing-beam operation may be observed on monitor.

Here are the "don'ts"—

1. Don't strike glass-metal seals of the 7539.
2. Don't operate the 7539 without scanning.
3. Don't use excessive writing-beam current.

The significance of each of these "dos" and "don'ts" in obtaining optimum performance from the 7539 is explained in the preceding pages of this bulletin.

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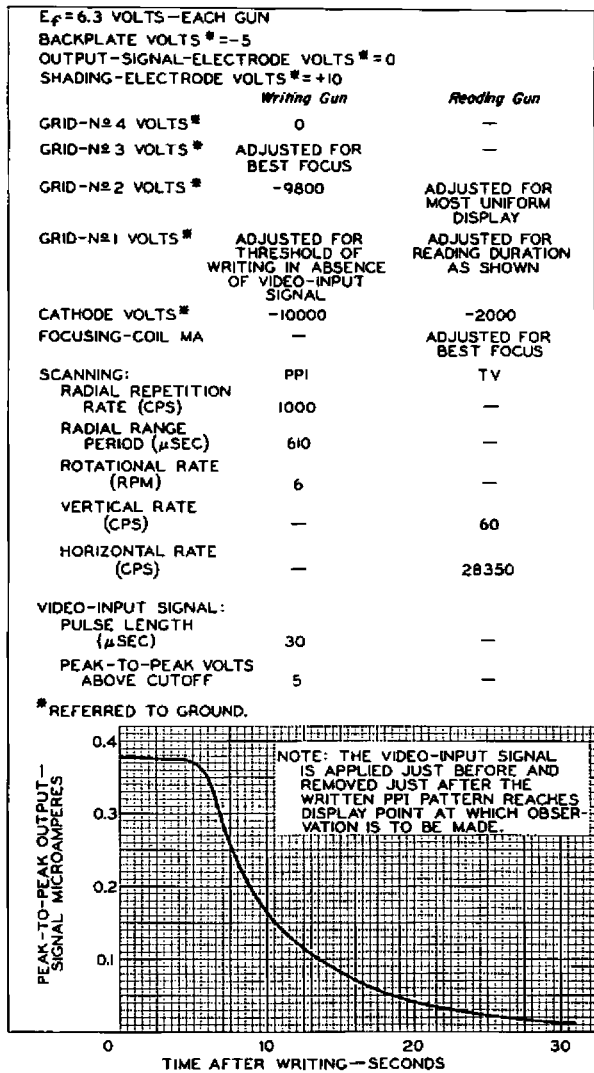


Fig. 6—Typical Storage Characteristic of Type 7539.

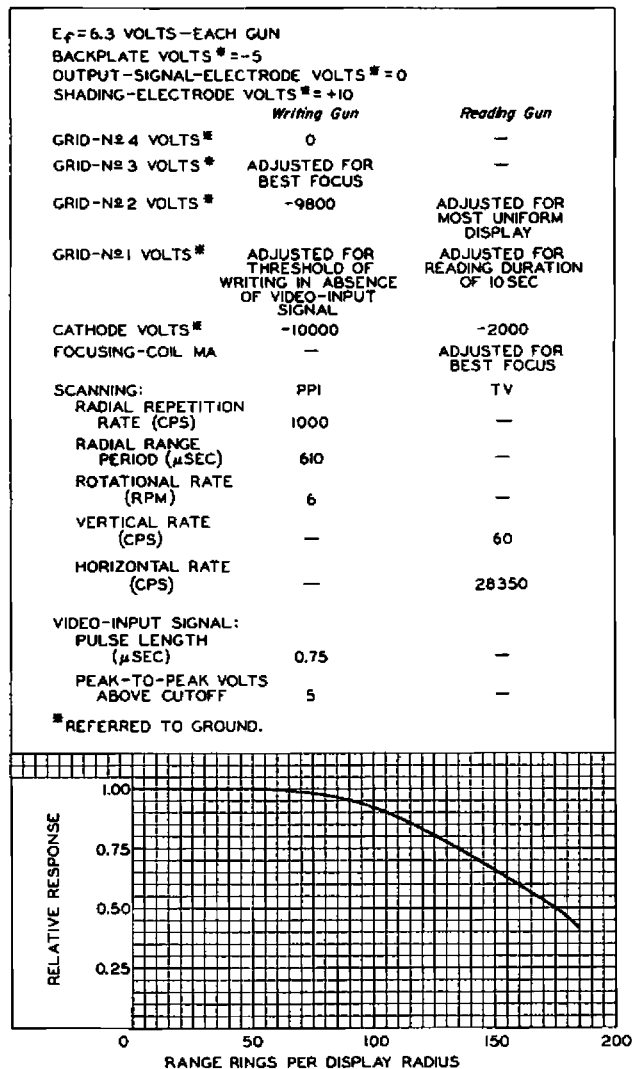
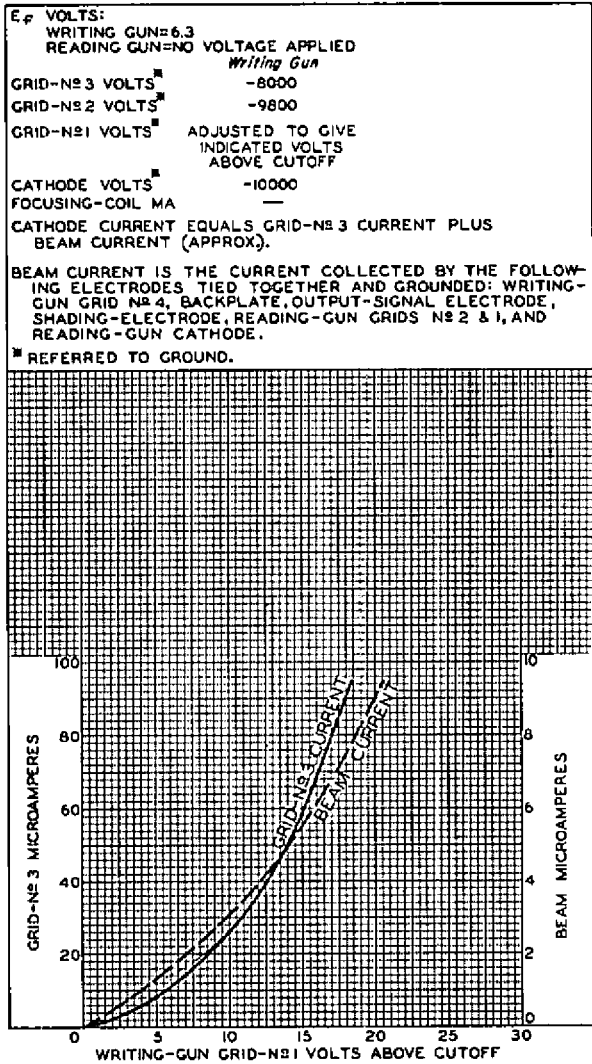
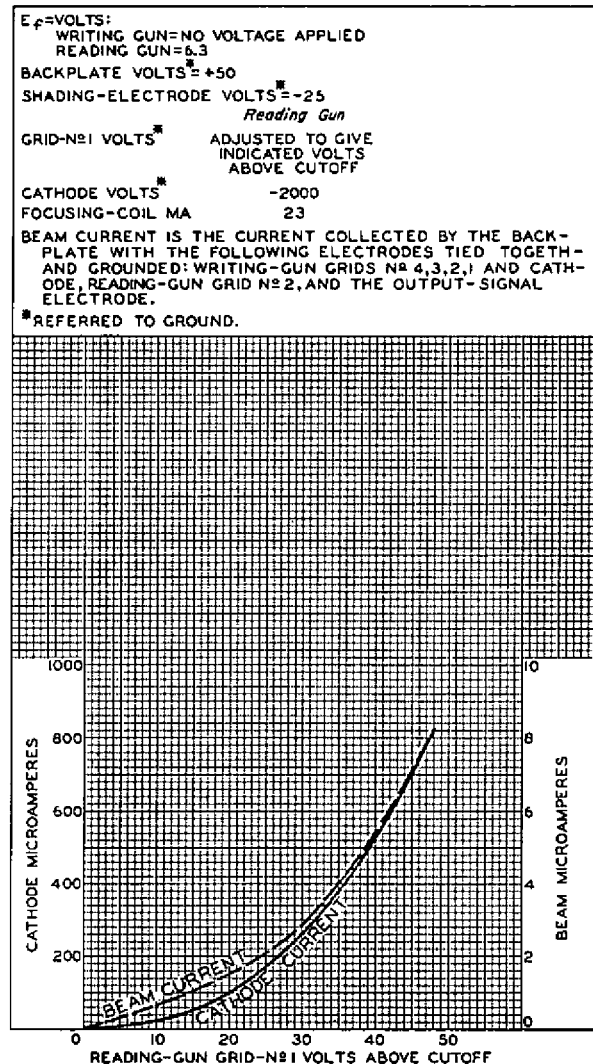


Fig. 7—Typical Resolution Characteristic of Type 7539.



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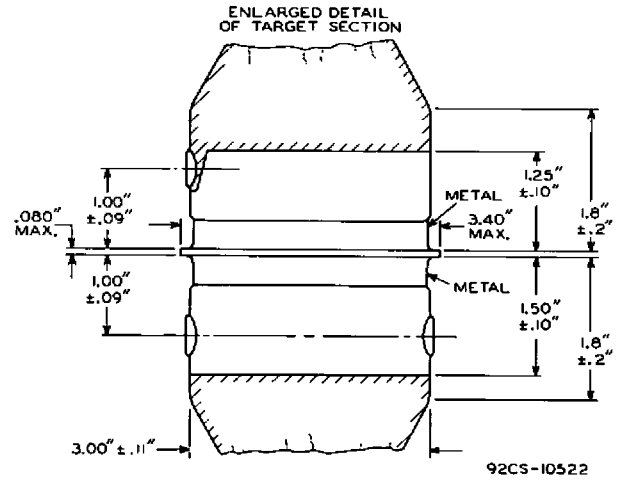
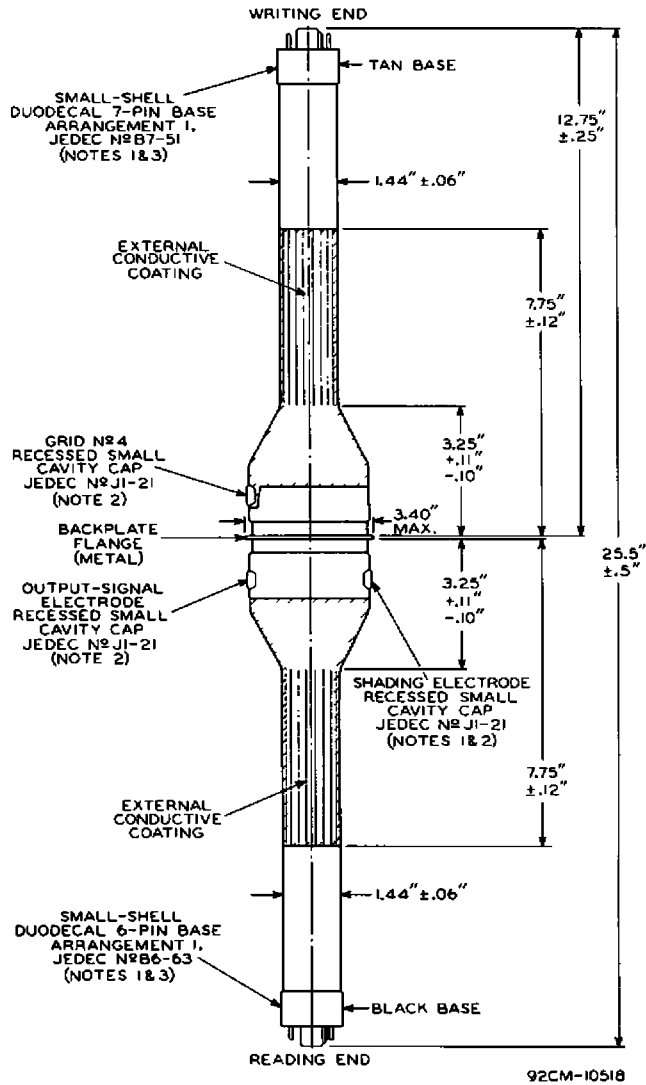
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Fig. 8 - Writing-Gun Control-Grid Characteristics of Type 7539.

Fig. 9 - Reading-Gun Control-Grid Characteristics of Type 7539.



DIMENSIONAL OUTLINE



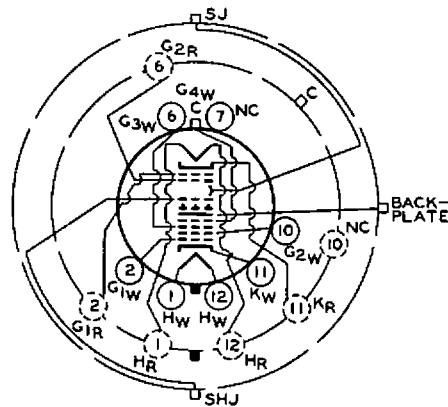
NOTE 1: THE PLANE THROUGH THE TUBE AXIS AND THE KEY OF EITHER DUODECAL BASE MAY VARY FROM THE PLANE THROUGH THE TUBE AXIS AND ϕ OF THE SHADING-ELECTRODE CAP BY AN ANGULAR TOLERANCE OF $\pm 10^{\circ}$ MEASURED ABOUT THE TUBE AXIS.

NOTE 2: THE PLANE THROUGH ϕ OF THE OUTPUT-SIGNAL-ELECTRODE CAP AND GRID-NO. 4 CAP MAY VARY FROM THE PLANE THROUGH ϕ OF THE SHADING-ELECTRODE CAP AND THE TUBE AXIS BY AN ANGULAR TOLERANCE OF $\pm 10^{\circ}$ MEASURED ABOUT THE TUBE AXIS.

NOTE 3: THE AXIS OF EITHER DUODECAL BASE WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE AXIS OF THE TUBE ENVELOPE.



BASING DIAGRAM



WRITING SECTION

End View of Duodecal 7-Pin Base Depicted by Solid Lines

PIN 1: HEATER
PIN 2: GRID NO.1
PIN 6: GRID NO.3
PIN 7: NO CONNECTION
PIN 10: GRID NO.2
PIN 11: CATHODE
PIN 12: HEATER
CAP ON WRITING
GUN SIDE OF
FLANGE (Cap located
on side of tube
opposite base key): GRID NO.4, EXTERNAL
CONDUCTIVE COATING

READING SECTION

End View of Duodecal 6-Pin Base Depicted by Dashed Lines

PIN 1: HEATER
PIN 2: GRID NO.1
PIN 6: GRID NO.2
PIN 10: NO CONNECTION
PIN 11: CATHODE
PIN 12: HEATER
C: EXTERNAL CONDUCTIVE COATING

TARGET SECTION

FLANGE: BACKPLATE
CAP ON READING
GUN SIDE OF
FLANGE (Cap located
on side of tube
over base key): SHADING ELECTRODE
CAP ON READING
GUN SIDE OF
FLANGE (Cap located
on side of tube
opposite base key): OUTPUT-SIGNAL ELECTRODE