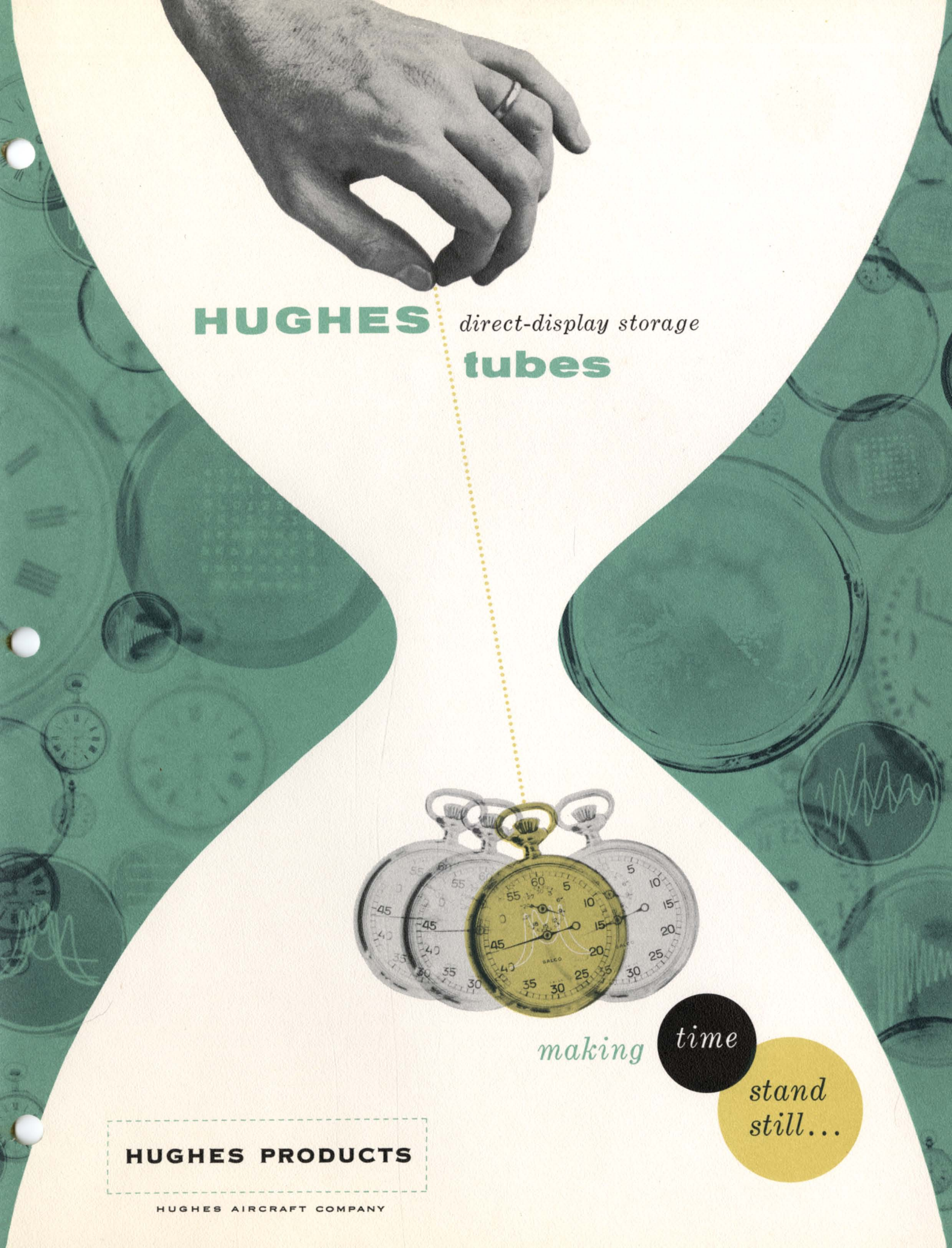
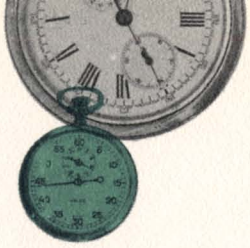


HUGHES *direct-display storage* tubes

making *time* *stand still...*

HUGHES PRODUCTS

HUGHES AIRCRAFT COMPANY



making

TIME

stand

still

modified **Crookes Tubes...** *forerunner of the modern cathode-ray tube*

a new dimension in cathode-ray tubes

Basic cathode-ray tube principles have been long established. Early forms (primarily modified Crookes tubes) were demonstrated during the first decade of the Twentieth Century, and various applications are evident everywhere — in radar displays, TV picture and camera tubes, direct pick-up X-ray tubes.

In its widest technical use — the universally known oscilloscope — the CR tube has become as standard a tool for electronic measurement as the voltmeter. However, anyone who has ever used a conventional oscilloscope in studying non-recurrent phenomena — whether it be digital information, wave forms or images — has at one time or another voiced one desire: If it were only possible to *retain* the image on the tube face long enough to study it.

In the new family of Hughes storage tubes — Typotron, Memotron and Tonotron — this wish becomes a reality. To the traditional cathode-ray tube have been added two vital elements: First, a *flood gun* and, second, a *storage target or dielectric mesh.* These innovations make possible presentations of a display of infinite or extended persistence through electrostatic storage *built into the tube.*

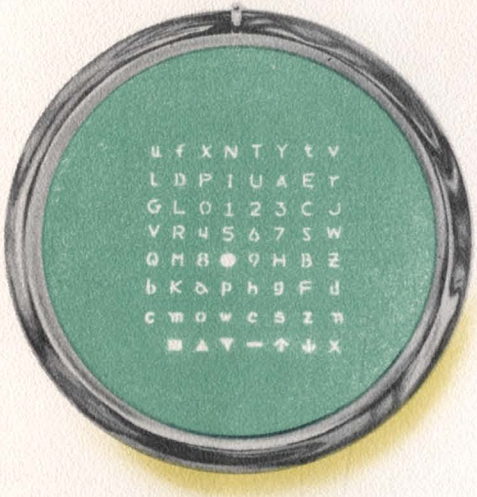
Hughes storage tubes offer several important advantages over conventional cathode-ray tubes. Because they hold their displays in *detail* for an extended length of time, it is possible to make a comprehensive study of non-recurrent phenomena . . . without the former necessity of making superfluous photographs. Uniform, high light output permits full-daylight viewing without hoods and greatly simplifies the desired photography of selected waveforms. The displays do not fade or bloom, but retain their sharpness until intentionally erased.

Each of the three Hughes storage tubes — Typotron, Memotron and Tonotron — opens many new possibilities for application. Test equipment, communication, computation, medical diagnosis and radar are but a few of the potential applications already proven for these radically different, unusually flexible cathode-ray storage tubes.

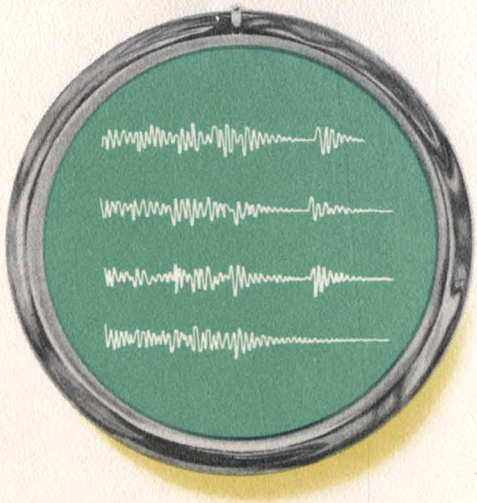
Hughes Products' applications engineers invite inquiries regarding specific uses of standard models or special modifications adaptable to new types of equipment or circuitry.

new tubes • new uses

tonotron ... to present "A" scan, "B" scan, weather radar, and plan position indicator information ... also for viewing "frozen action" in half-tone image form ... closed-circuit TV, slow scan narrow-band TV, ship-to-shore map or chart transmission, instrumentation and process monitoring, ground-to-air map or traffic-pattern transmissions.



typotron ... for high-speed read-out (25,000 characters/second) from digital computers ... display of computed radar-tracking information ... monitoring analog-to-digital conversion equipment. Ideal for visual reference; eliminates need for intermediate storage facilities to match slow, mechanical read-out devices to high-speed electronic computing units. Data can be presented in words, numbers or symbols — 63 characters are available.



memotron ... for the display of single transients, or superimposing transients for direct analysis and comparison ... plotting a family of curves ... viewing transients from shock or vibration tests and ballistics or missile tests ... monitoring phase relationships ... electrocardiographic and vectorcardiographic diagnosis ... presentation of tube or transistor characteristics.

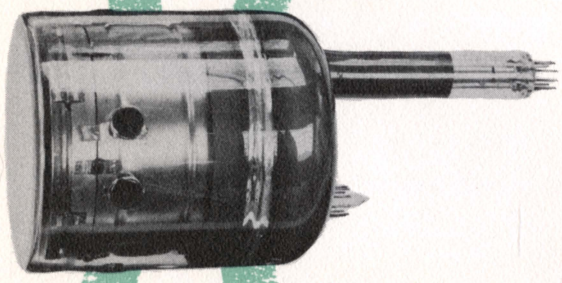
tonotron*

The Tonotron storage tube presents a complete spectrum of grey shades for high-fidelity picture reproduction. High brightness and controlled persistence are the outstanding characteristics of the Tonotron electron tube. This new method of direct display may be presented at brightness in excess of 1500 foot lamberts. A conventional cathode ray tube used in radar environment operates with brightness of less than one foot lambert.

The Tonotron has the elements of a standard cathode-ray tube in addition to a storage surface, a secondary-electron collector, and a flood gun. Writing guns are available with electrostatic focus and either electrostatic or electromagnetic deflection.

The storage surface is an electroformed nickel mesh coated with dielectric on the side facing the electron guns. Initially, the dielectric has a negative potential with respect to the flood-gun cathode, so that the tube surface appears black. When the writing gun bombards the dielectric with high energy electrons, secondary emission causes the storage mesh to become positively charged in the written areas. The secondary electrons liberated from the storage mesh are attracted to the secondary-electron collector mesh. Flood electrons penetrating the mesh in the charged areas are accelerated to the viewing screen where they produce the corresponding pattern. The storage mesh, acting like a control grid, regulates the quantity of flood electrons striking the viewing screen. A high positive charge corresponds to a bright area. At intermediate potentials only part of the flood beam passes through the viewing screen, thus producing intermediate shades of grey or half tones.

Since the flood electrons reproduce the charge pattern but do not regenerate it, the maximum retention time is limited. Degeneration of the charge is produced primarily by the positive ions produced from residual gas molecules. Thus, the maximum storage time for the tube operating in standard conditions is approximately one minute. It is possible, however, by utilizing pulsing techniques, to extend this time to more than five minutes. Either instantaneous erasure or a controlled gradual decay may be effected by applying a single positive pulse or series of pulses to the storage electrode.

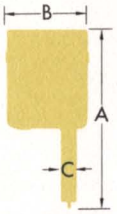


persistence and rate of decay can be controlled to suit specific application

GENERAL SPECIFICATIONS

TYPE 7033

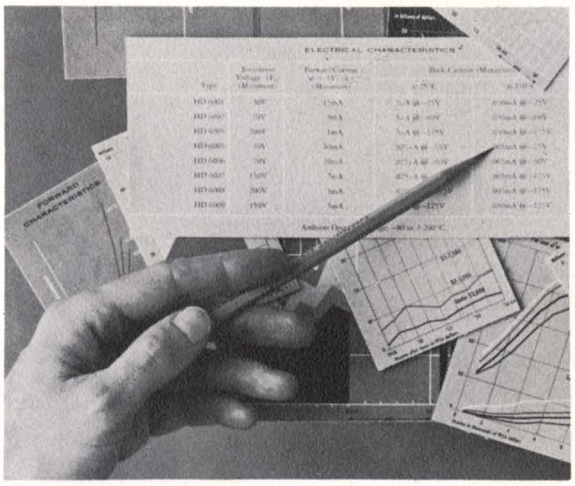
Heaters (two) . . . . . 6.3 volts
Phosphor . . . . . Yellow P20, aluminized (others available on special order)
Focusing method . . . . . Electrostatic
Deflection method . . . . . Magnetic
Resolution . . . . . 65 lines/inch
Writing speed . . . . . 100,000 inches/second
Erasure time . . . . . 125 milliseconds
Brightness at 9000 volts . . . . . 2000 foot lamberts
at 4000 volts . . . . . 300 foot lamberts



Dimensions

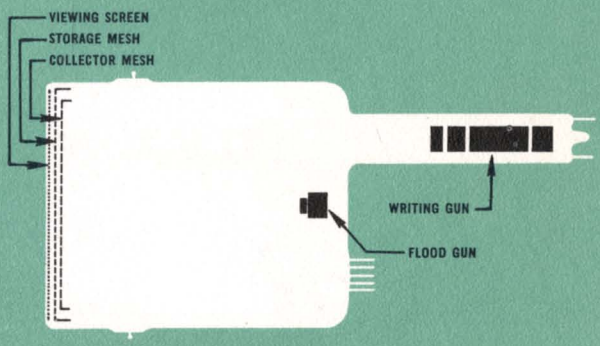
A. Overall length . . . . . 11-1/2" ± 3/8"
B. Greatest diameter of bulb . . . 5-1/4" ± 1/8"
C. Neck diameter . . . . . 1" ± 1/16"

Useful screen diameter . . . . . 4"
Body base connections (Miniature 7-pin JETEC No. E7-1)
Neck base connections (Miniature 7-pin JETEC No. E7-1)



With a Tonotron tube, sharp, clear pictures may be transmitted over conventional telephone lines through use of slow-scan, narrow-band, closed-circuit television. This eliminates the need for costly coaxial cable transmission. High fidelity pictures may be examined at very slow rates, even "frozen" for photographing.

High light output of the Tonotron storage tube presents a brilliant half-tone picture on weather radar even when viewed in full daylight without the requirement for a hood. Length of persistence and rate of decay may be selected.



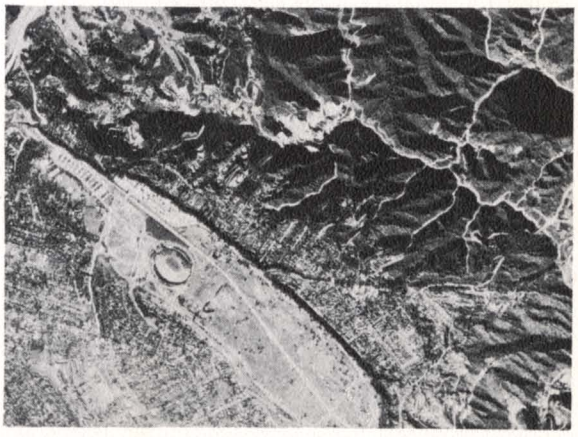
TYPICAL OPERATING CONDITIONS*

Viewing-screen voltage . . . . . 4000 to 9000 volts
Storage-mesh voltage . . . . . 0 to 5
Collector-mesh voltage . . . . . 120 volts
Third-anode voltage . . . . . 30 volts
Second-anode voltage . . . . . 10 volts
First-anode (flood gun) voltage . . . . . 80 volts
Cathode (flood gun) voltage . . . . . 0 volts
Cathode (writing gun) voltage . . . . . —2500 volts
Control-grid (writing gun) voltage* . . . . . —40 volts
First-anode (writing gun) voltage for focus* . . . . . 350-750 volts

*All voltages are given with respect to the flood-gun cathode, except those starred, which are given with respect to the writing-gun cathode.

OTHER MODELS AVAILABLE:

3 inch, One gun, electrostatic deflection
4 inch, Two gun, electrostatic deflection
5 inch, One and two gun, electrostatic deflection
5 inch, Two gun, "selective erasure," electrostatic deflection
21 inch, Magnetic deflection

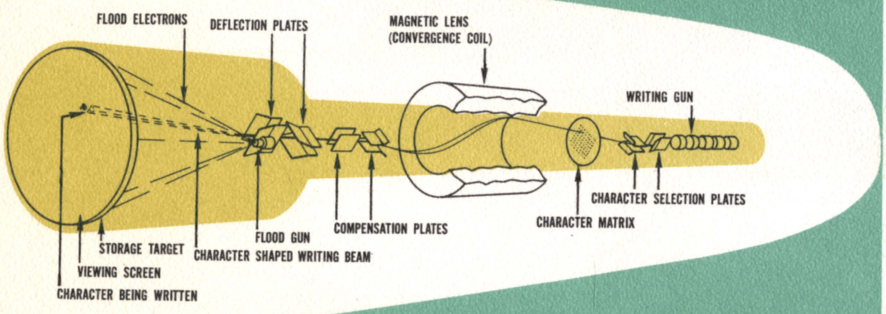


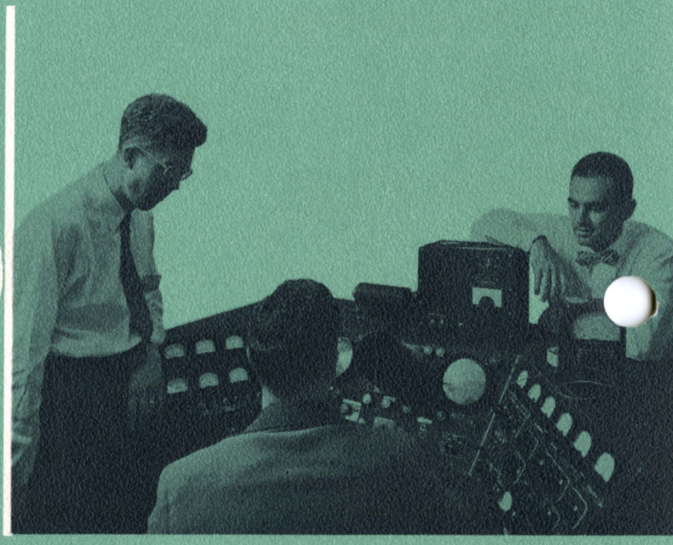
Used in a radar PPI display scope, the Tonotron electron tube has the ability to cover the complete grey scale spectrum and provides maximum contrast for easy identification of cloud formations, ground clutter, and targets. Persistence may be adjusted for maximum duration over most of the 360 degrees, fading to black just ahead of the sweep.

typotron®

In the Typotron storage tube a choice of 63 characters is available for the presentation of data in words, numbers or symbols. The Typotron tube writes characters ⅛ inch in size at speeds of at least 25,000 characters per second; the characters can be photographed or recorded for later examination. Able to present information which remains visible indefinitely without fading or blooming until intentionally erased, the Typotron is used as a read-out computer device in such applications as the radar-tracking console shown in the accompanying illustration.

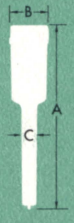
Heart of the Typotron electron tube is a character matrix or stencil comprising the letters, numbers and symbols. The desired character is selected by applying the proper voltage to the two pairs of selection plates. The magnetic lens or convergence coil inverts the image of the character and focuses it on the storage screen. Compensation plates redirect the image along the tube axis and between the deflection plates. Positioning voltages applied to these deflection plates place the image at any desired place on the tube face. A flood gun mounted alongside one of the deflection plates covers the entire storage target with a barrage of low-velocity electrons to produce a bright visible picture. The bistable storage target is described under "Memotron."





GENERAL SPECIFICATIONS

Heaters (two)	6.3 Volts
Phosphor	Green P1
Focusing Method	Electrostatic
Deflection Method	Electrostatic
Imaging of Characters	Magnetic
Writing Speed	25,000 characters/sec
Erasure Time	100 milliseconds
Brightness	50 foot lamberts



Dimensions

A. Overall Length	31″ Maximum
B. Greatest Diameter of Bulb	5-5/8″ Maximum
C. Neck Diameter	2-1/4″ ± 3/32″

Useful Screen Diameter	4″
Base	23 Pin Glass Stem
Mounting Position	Any

TYPICAL OPERATING CONDITIONS

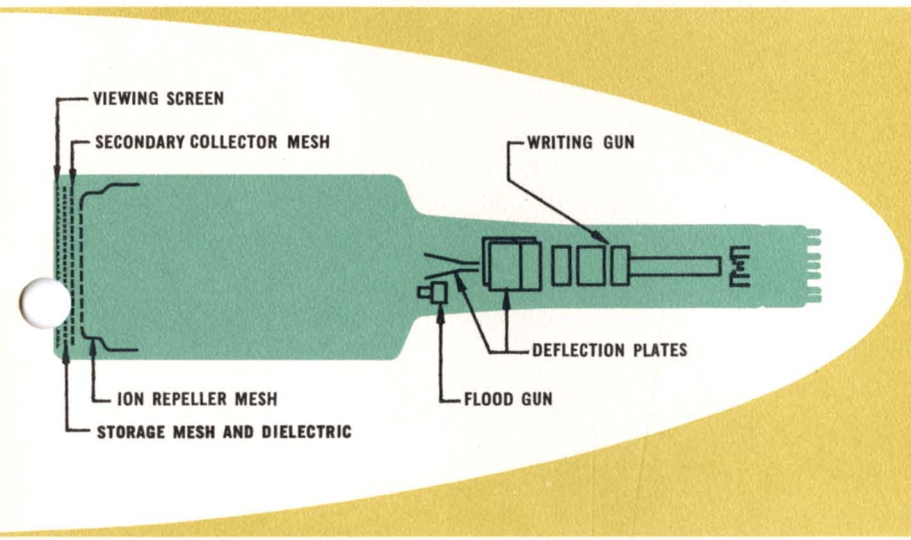
Viewing Screen Voltage	3000 volts
Ion Repeller Mesh Voltage	250 volts
Second Anode Voltage	200 volts
Collector Mesh Voltage	150 to 200 volts
Third Anode Voltage	150 volts
Storage Mesh Voltage	0 volts
Control Grid (Flood Gun) Voltage	—50 to —200 volts
Cathode (Writing Gun) Voltage	—3100 volts
First Anode (Writing Gun) Voltage, for focus	300 to 800 volts*
Control Grid (Writing Gun) Voltage, for cutoff	—40 to —70 volts*
Convergence Coil Current	50 ma

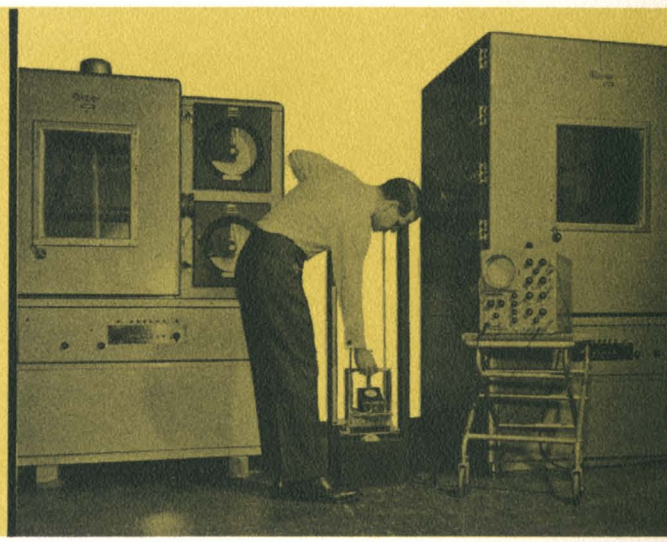
*All voltages are given with respect to the flood gun cathode potential except those marked (*) which are given with respect to the writing gun cathode.

memotron®

The Memotron storage tube captures and retains electrical traces and transients which could formerly be analyzed only after elaborate photography or reliance on the operator's visual acumen. For comparison of successive wave forms, transients may be superimposed one upon the other or vertically stacked. Displays occur at uniform brightness regardless of writing speeds, so are easily photographed. The presentation will remain bright enough for viewing in a well lighted laboratory or even in broad daylight until intentionally erased. A typical application—Memo-Scope by Hughes, a storage type oscilloscope applied to view transients in shock testing—is shown in the accompanying illustration.

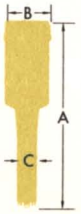
The unique storage feature of the Memotron tube is made possible by an arrangement of meshes behind the viewing screen. A storage mesh coated with a dielectric retains a positive charge pattern, due to secondary emission wherever it is struck by the writing beam. A positively charged collector mesh—directly behind the storage mesh—collects secondary electrons, preventing them from neutralizing the charge formed on the storage dielectric. The stored image, achieved by the bistable characteristics of the storage dielectric, is continuously maintained and visually displayed on the phosphor-coated tube face by a low-velocity beam of electrons from the flood gun. The flood electrons are passed through the charged areas and receive additional energy from the post-accelerating potential applied to the viewing screen. The image is erased by momentarily lowering the secondary-collector voltage. This prevents collection of secondary emission electrons from the dielectric, causing "written" portions of the dielectric to be neutralized by flood-gun electrons.





GENERAL SPECIFICATIONS

Heaters (two)	6.3 volts
Standard phosphor	Green PI (others available on special order)
Focusing method	Electrostatic
Deflection method	Electrostatic
Resolution	60 lines/inch
Writing speed	100,000 inches/second
Erasure time	100 milliseconds
Brightness	50 foot lamberts



Dimensions

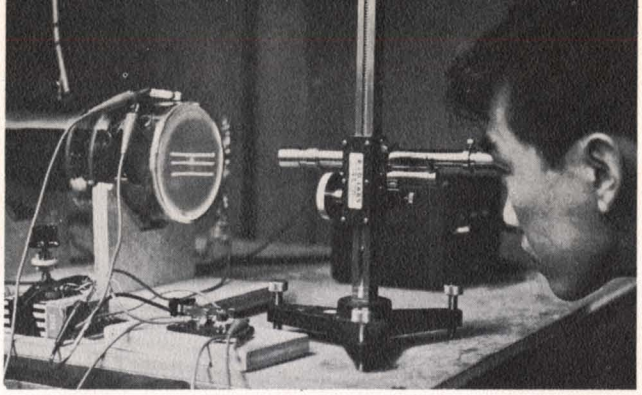
A. Overall length	18-1/2″ ± 1/2″
B. Greatest diameter of bulb	5-5/8″ maximum
C. Neck diameter	2-1/4″ ± 3/32″

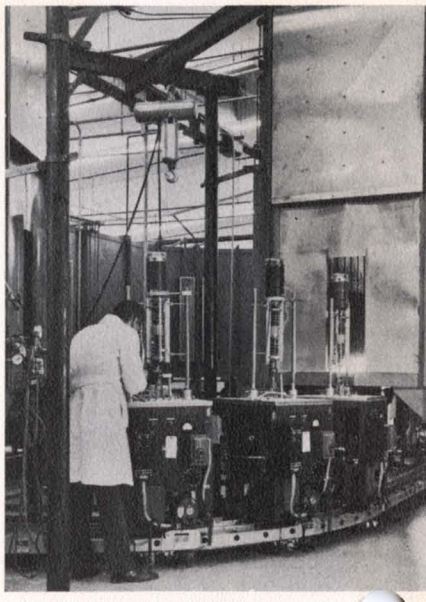
Useful Screen Diameter	4″
Base (JETEC No. B14-38)	Small-shell di-heptal 14 pin

TYPICAL OPERATING CONDITIONS

Viewing screen voltage	3000 volts
Ion repeller mesh voltage	250 volts
Second anode voltage	200 volts
Collector mesh voltage	85 to 200 volts
Third anode voltage	150 volts
Storage mesh voltage	0 volts
Control grid (flood gun) voltage	—20 to —200 volts
Cathode (writing gun) voltage	—3000 volts
First anode (writing gun) voltage, for focus	450 to 1050 volts*
Control grid (writing gun) voltage, for cutoff	—40 to —80 volts*

*All voltages are given with respect to the flood gun cathode potential except those marked (*) which are given with respect to the writing gun cathode.





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