A Storage-Tube Monitor for SSTV

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THE DISPLAY of slow-scan television, or fast facsimile, as it might better be called, suffers in the persistence of screens in CR tubes used at the present time in most monitors. The commonly used P7 phosphor has a purplish-blue fluorescence during excitation and a yellowish-green phosphorescence which persists for several minutes after excitation is removed. The initial decay of the phosphorescence is, however, very rapid, decreasing to 10 percent of its original value in a matter of five seconds. Thus, as the picture is drawn on the screen at the rate of one raster in 8 seconds, the top fades to quite a low intensity while the picture is still being drawn by a bright blue line at the bottom. A yellow filter or simply a sheet of yellow plastic may be used to remove the disturbing blue line, but nonetheless, most amateurs operate their monitors in a very subdued light to preserve the illusion of persistence.

Storage-type CR tubes operate on a principle that is ideally suited to slow-scan television. The author is presently using a Hughes Tonotron, type H-1192AP20, in a monitor with very satisfactory results. The picture is drawn in the normal manner; in fact the trigger, sweep, and video-detection circuits may be quite standard.[1] The picture appears, a line at a time, at full brightness with good gray scale and remains on the screen until erased. An erase pulse, generated by the vertical trigger pulse, completely destroys the picture when the next frame starts. An additional feature makes it possible to hold a picture on the screen for up to five or ten minutes.

Electrical and Mechanical Characteristics

The Tonotron (RCA type 6866 seems similar) is a five-inch, electrostatic-deflection CR tube, shorter than the 5ABP7, with a P20 aluminized phosphor having yellow-green fluorescence and phosphorescence. The useful screen diameter is 3.8 inches, only slightly less than for the 5ABP7. It has an integral magnetic shield and may be readily installed in a surplus Tektronix 511A CRO chassis. See Fig. 1. The electrode potentials are different from those of the 5ABP7 because of the principle of operation.

Video information is drawn by a writing gun and deflection electrodes on a storage surface exactly as in the case of the P7 CR tube monitors. Another gun, see Fig. 2, is used to project a collimated beam of electrons through the storage surface to a viewing screen. Areas of the storage surface which have not received electrons from the writing gun inhibit the passage of the low-energy flooding electrons. Areas which have been charged by the writing-gun beam permit the flooding electrons to pass through. They are then accelerated toward the viewing screen and cause it to glow brightly until an erase pulse, applied to a backing electrode of the storage surface, causes it to be charged uniformly to a slightly negative potential, thus blocking out the flooding electrons from the viewing screen. The retention time of stored information is limited by the slow dispersion of the charge written on the storage surface. Charge leakage is mainly caused by positive ions, which come from residual gas molecules within the tube. In practice this seems to limit the hold time to about five minutes.

The average deflection-electrode potential should be about 125 volts and the deflection factor is 35 to 45 volts per inch per kilovolt of accelerating potential of the writing gun. These

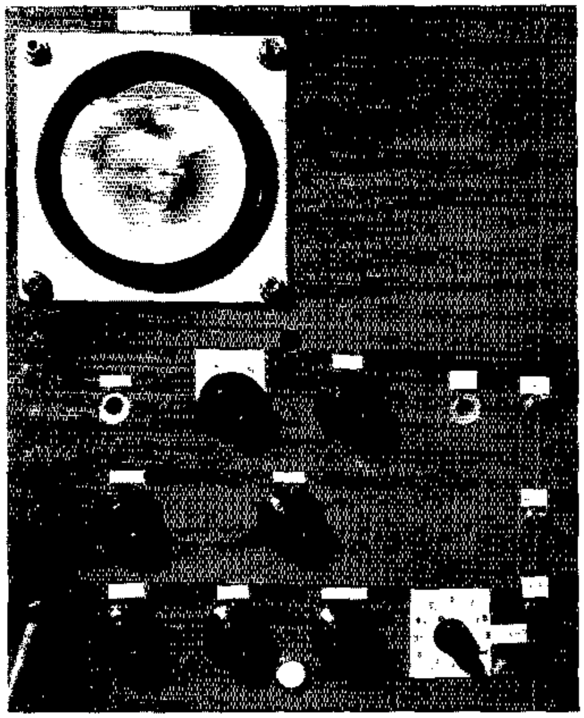

Fig. 1 — The author's SSTV monitor with storage tube. This photograph was made with available light and is not a time exposure, as the text explains.

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[1] Macdonald, "A Compact Slow-Scan TV Monitor," *QST*, March, 1964. See also Tschannen, "A Solid-State SSTV Monitor," *QST*, March, 1971.

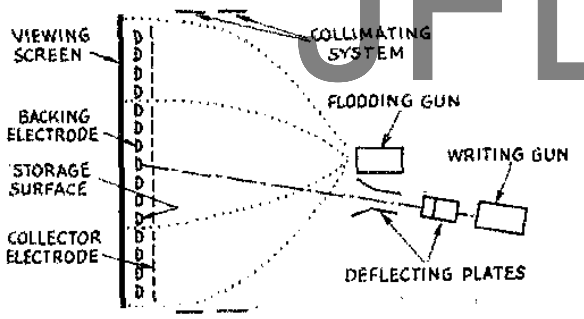
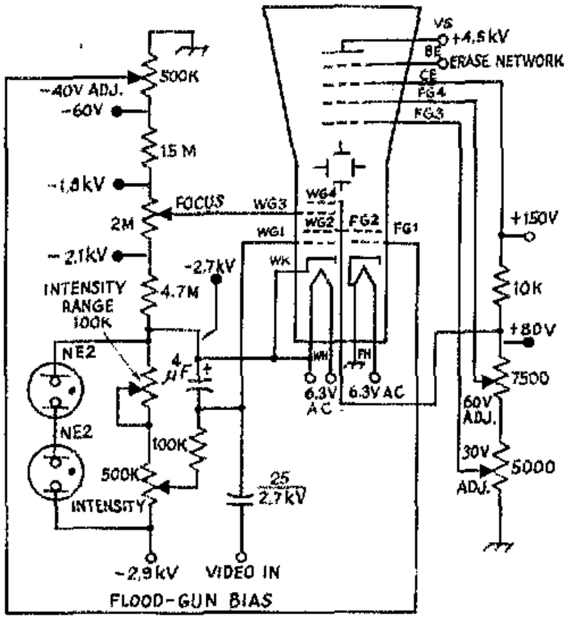


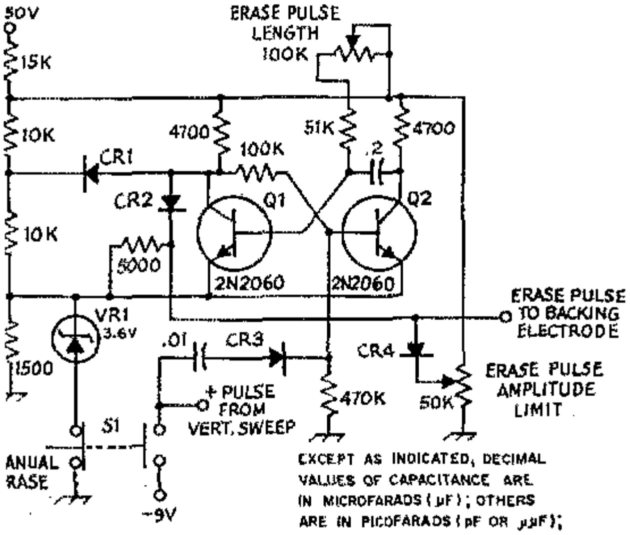
Fig. 2 — Storage-tube structure. See text for description of operation.



EXCEPT AS INDICATED, DECIMAL VALUES OF CAPACITANCE ARE IN MICROFARADS (µF); OTHERS ARE IN PICOFARADS (pF OR µµF); RESISTANCES ARE IN OHMS; k=1000, M=1000000

Fig. 3 — Circuit for providing electrode potentials for the storage tube.

VS — Viewing screen.	FG — Flooding gun.
BE — Backing electrode.	WG — Writing gun.
CE — Collector electrode.	FH — Flooding-gun heater.
	WH — Writing-gun heater.



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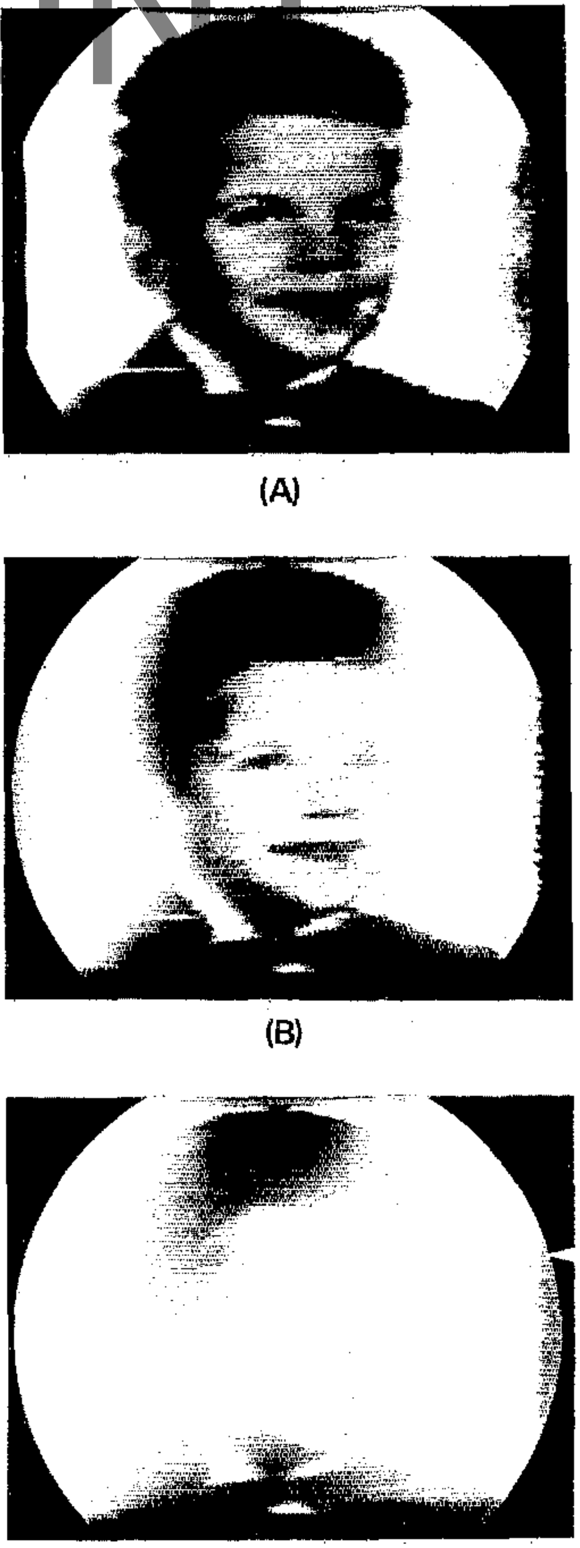
(A)

(B)

(C)

Fig. 5 — Storage-tube display with monitor on HOLD. At A is the initial presentation; at B, two minutes later; and at C, five minutes later.

Fig. 4 — Erase circuit used by author.
CR1-CR4, incl. — Any small-signal silicon diode.
◀ Q1, Q2 — Silicon npn transistor, 500 mW.
S1 — Push-button type, momentary.
VR1 — Zener diode, 1N747 or equiv.

figures are comparable to those for the 5ABP7. The electrode potentials used in my monitor are shown in Fig. 3.

Although the viewing screen may be operated at up to 11,000 volts, with resultant increase in brightness, I have found that the screen is bright enough for full daylight viewing and has a better gray-scale range with only 4500 volts applied. CR tubes with P7 phosphors exhibit a build-up to their phosphorescence which significantly affects their gray-scale sensitivity. This characteristic is not present with the storage tube. Consequently it is much more sensitive to writing beam intensity. The use of a lower-than-normal viewing-screen voltage seems to widen the range of gray-scale excitation.

Unique to the storage tube monitor is the erase operation. The circuit I use for this is shown in Fig. 4. The length of the erase pulse is more important than its amplitude, which must be less than 20 volts. My erase pulse is 0.4 second long at about 6 volts amplitude. This is generated when a vertical trigger pulse starts the vertical sweep. A push button on the front panel permits me to erase and start over at any time. This is convenient since I use a vertical sweep which, once started, proceeds to the end in a little over 8 seconds, unaffected by noise or spurious trigger pulses.

The **HOLD** feature on my monitor is simply a relay that is operated by a negative fly-back pulse derived from the vertical sweep. I cock the circuit at any time during a vertical sweep. The frame being drawn will be completed and held, for when the relay closes it shorts the input and applies a "black" potential to the writing gun (video) grid.

Fig. 5 shows the gradual dissolving of the image when the monitor is on **HOLD**. The images shown in the photographs are not time exposures. They are, rather, snap shots of the images displayed by the playback of a tape recording made directly from my receiver. Fig. 1 was made at 1/5 second at *f*/8 using a Mamiyaflex camera and Plus X film with available light. Fig. 5 was made at 1/25 second at *f*/8 using a Polaroid oscilloscope camera. Thanks go to W1VRK and his superior signals which I taped. QST

DDRR Antenna

(Continued from page 31)

$$I_{eff} = I_O - I_O\cos\varphi = I_O(1 - \cos\varphi) \qquad (64)$$

where ϕ = length of antenna in degrees
I_O = current at antenna base

Now in order for the system to provide its rated field for a given power, the current at the base must be increased so that the new current, I_n, satisfies the equation

$$I_O = I_n(1 - \cos\phi),\ \text{or}\ I_n = \frac{I_O}{1 - \cos\phi} \qquad (65)$$

From the law of the conservation of energy, the radiation resistance referred to the antenna base thus becomes

$$R_T{}^1 = R_T(1 - \cos\phi)^2 \qquad (66)$$

Where $R_T{}^1$ = new radiation resistance (with capacitor)
R_T = original radiation resistance (absence of capacitor)

For example, if the antenna at some low frequency in a given band were 80° long ($\phi = 80^\circ$), the radiation resistance of .095 ohm as calculated by eq. (39), would instead become

$$R_T{}^1 = .095(1 - \cos 80^\circ)^2 = .095(1 - 0.17635)^2 = .0645\ \text{ohm} \qquad (67)$$

The use of this antenna, in conjunction with the ohmic losses already discussed, would necessarily lead to even a still smaller efficiency than the 2.75 percent efficiency found by eq. (52).

It is therefore recommended that the DDRR antenna be constructed to be no shorter than is required to tune with the tuning capacitor at its minimum when tuned to the highest frequency to be used in the band of interest.

Conclusion

This study of the DDRR antenna indicates that the advantages of the antenna over others are the compactness, low profile, and inconspicuousness of the installation. The disadvantages of the antenna are its relative low radiation efficiency and comparatively narrow bandwidth. The efficiency is low because the radiation resistance is very low (.095 ohm) so that conductor ohmic losses consume most of the available power. The narrow bandwidth necessitates the use of a variable tuning arrangement to bring the system to something approaching unity power factor.

It is suggested that increasing the vertical height could improve the efficiency very appreciably because the radiation resistance for short vertical heights varies as the square of the height. Increasing the height to 3-1/2 feet (instead of 1 foot) would raise the radiation resistance to about 1.16 ohms, which, coupled with a ground and conductor loss of the same magnitude as in the study (3.355 ohms) would increase the efficiency from 2.75 percent to 25.8 percent, or provide 9.8 dB increase in signal strength. QST