THE RADECHON, A BARRIER GRID STORAGE TUBE*

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Summary—The Radechon is a developmental barrier grid storage tube of simplified design intended for use in systems requiring one or a few electrical reproductions of the original signal with random access, half-tone rendition of about 30 gray levels, and limiting resolution of 400 lines per target diameter. Characteristic curves and resolution curves are given along with a discussion of their use in computing the tube operation in any system.

In the Radechon, information is stored in the form of an electric charge pattern on a dielectric target. The same electron beam is used for both writing and reading, the distinction of operations being made by a 20-volt switching signal applied at the target. Since the removal of charge from the target constitutes the reading signal, erasure occurs simultaneously. The concept of discharge factor, which is the efficiency of discharging the target per sweep of the beam, is discussed in relation to writing and reading. Discharge factor curves are given, and it is shown that, since the discharge factor is proportional to the slope of the chord to the characteristic curves, it may be measured directly on the characteristic curve at the operating point for any system.

Since storage devices act like low-pass filters, resolution is presented as a curve, showing the dependence of maximum output signal amplitude on the number of signal pulses stored per target diameter. Beam spot size and screen mesh limitations to resolution are discussed.

INTRODUCTION

IN the several years that have elapsed since the initial report on the barrier grid storage tube[1,2] considerable experience has been accumulated in its use. The early version of the tube was complicated by an electron-optical system for separating input and output signals. It was soon recognized that the tube must be simplified both to facilitate its manufacture and to make it easier to operate in equipment. This was desirable even though it meant making the associated

* Decimal Classification: R138.31.

[1] Arthur S. Jensen, J. P. Smith, M. H. Mesner, and L. E. Flory, "Barrier Grid Storage Tube and Its Operation," *RCA Review*, Vol. IX, pp. 112-135, March, 1948.

[2] The research on this tube has been a team project lasting over several years and credit must be given to the earlier workers, particularly R. L. Snyder, U. S. Patents 2,470,875, 2,548,405, and 2,563,500; and A. Rose, U. S. Patent 2,563,488. The early work on this tube was performed under Contract W28-003-sc-1541 with the U. S. Army Signal Corps Engineering Laboratories, Evans Signal Laboratory.

circuits more complicated so that signal separation could be accomplished externally. Such a simplified developmental tube has been designed and manufactured, and has been operated in many experimental systems applications with success.

There are several fertile fields of application for a storage tube that provides one or several reproduced copies of the originally impressed signal with random access and reasonable half-tone rendition. Simple analog signal reproduction, binary digit storage with high speed random access,[3] signal-to-noise ratio improvement by integration of repetitive signals,[4] picture storage and reproduction with random access to parts of the picture, and coordinate transformation of stored pictures are a few of the applications in which the Radechon (Figure 1), as such a storage tube, has proved successful.

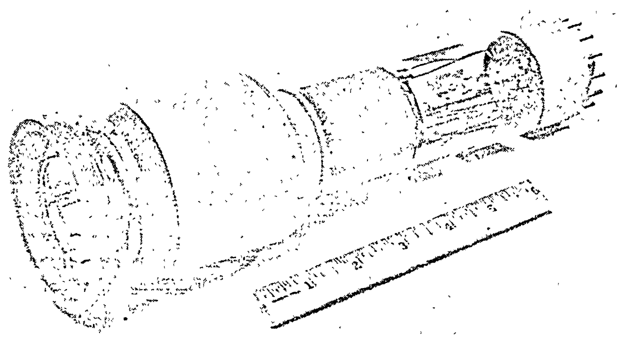

Fig. 1—Radechon.

The essential storage target structure is the same in both the present Radechon and the previous barrier grid tube. Storage time, considerations of storage action and electron optics at the target, and relationships between discharge factor, resolution, signal-to-disturbance ratio, signal output, bandwidth, etc. are all considered in the previous report,[1] and all pertain equally well to the present tube. This paper presents a more complete understanding of the tube that has been obtained through experience with its use.

The Radechon

As seen in the schematic diagram of Figure 2, the Radechon has an electron gun of relatively conventional design, chosen to provide a

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[3] E. W. Bivans and J. V. Harrington, "An Electronic Storage System," *Proc. I.R.E.*, Vol. 38, No. 2, p. 205, February, 1950.

[4] J. V. Harrington and T. F. Rogers, "Signal-to-Noise Improvement Through Integration in a Storage Tube," *Proc. I.R.E.*, Vol. 38, pp. 1197-1203, October, 1950.

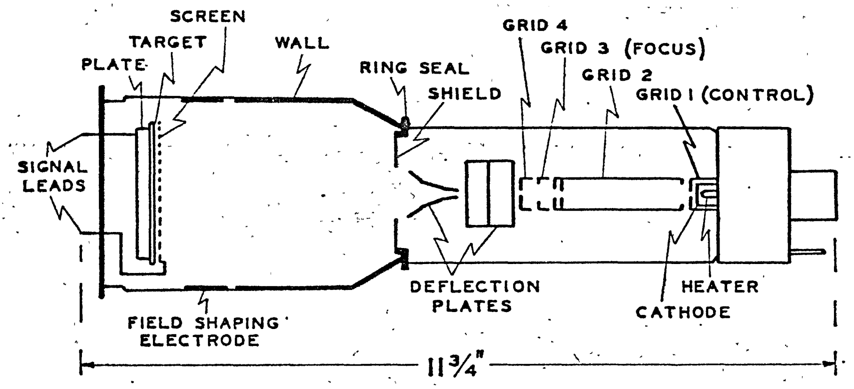


Fig. 2—Radechon construction.

high current density in a relatively small spot, with electrostatic focusing and deflection. Some experimental tubes have been made with magnetic deflection with some increase in resolution, but most applications have required electrostatic deflection to provide rapid and random access to all portions of the target. A shield is provided at the ring seal to attenuate the capacitive coupling of large high-frequency signals on the deflection plates or control grid to the target structure which is used as an output signal electrode. The primary beam from the electron gun is deflected to strike the target at the desired region where it generates secondary electrons both from the screen and the target insulator. An accelerating electric field between the screen and the collector wall (electrically connected to the shield and ring seal) causes these secondaries to go quickly to the wall where they are collected.

The target (Figure 3 shows one of several construction designs used) comprises a thin sheet of insulator, one side of which is coated with a metal layer *plate,* the other side of which is in contact with a fine mesh *screen.* In most tubes this screen is 230-mesh woven wire stainless steel of 1 mil wire diameter. Recent experimental tubes have been made with 500-mesh electroformed copper or nickel. In this target structure the surface of the insulator is one element of a

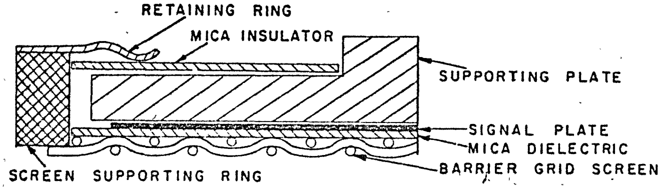


Fig. 3—Target structure.

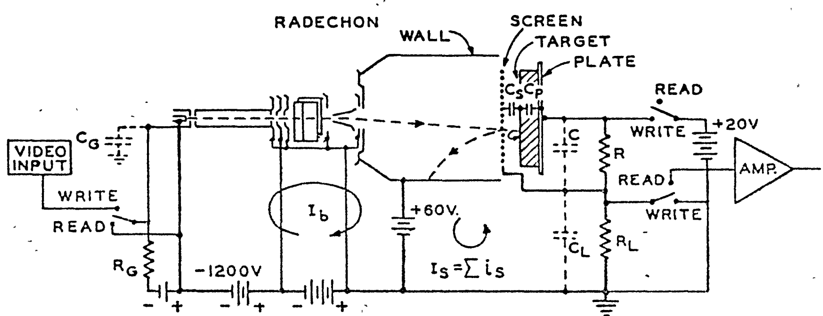
capacitor, the other element of which is the plate and the screen (schematically shown for one small area of the target in Figure 4). The target as a whole forms a continuum of such capacitors.

Signals are stored as electrostatic energy either by the deposition of electrons on, or the removal of electrons from, the surface of the insulator (the *target*) as determined by control of the secondary electrons by the screen. Usually, input signals are applied to the electron gun control grid, and the storage target discharging current constitutes the output signal current.

Operation

Target Behavior

Most investigators agree that the probability distribution per unit



$$\frac{1}{C} = \sum \frac{1}{C_S} + \frac{1}{C_P} \quad ; \quad C = 1000 \mu\mu fd.$$

$$\sum C_S + C_P = 8000 \mu\mu fd. \quad ; \quad C_S + C_P = 0.18 \mu\mu fd/\text{SPOT}$$

$$C_L = 5 \mu\mu fd. \quad ; \quad C_G = 7.4 \mu\mu fd.$$

Fig. 4—Schematic simplified tube circuit.

energy interval of secondary electrons is Maxwellian. For the plane parallel plate geometry that most closely fits the conditions of the Radechon storage target this is illustrated in Figure 5. The total integral under this curve is the product of the secondary emission ratio and the beam current. Since the tube is operated with the screen voltage about 1200 volts positive with respect to the cathode, the secondary emission ratio of the target is greater than unity (storage data indicates that it is close to 3.0) so that if the target is at screen potential, there is a net flow of electrons away from the target (secondary electron current minus the primary beam current) thus charging the target positively. As this continues, a retarding electric field is set up between the target and the screen such that slow secondaries are energetically unable to reach and pass through the screen. Since the screen is in contact with the target, these slow secondaries are constrained to return to the target within a mesh spacing from whence they came. Thus the screen prevents redistribution over the target such as occurs in many other storage tubes. Fast secondaries are still able to penetrate the screen and be accelerated to the wall. This continues until the target reaches an *equilibrium potential* for which the current of fast secondaries that escapes through the screen to the wall is just equal to the primary beam current.

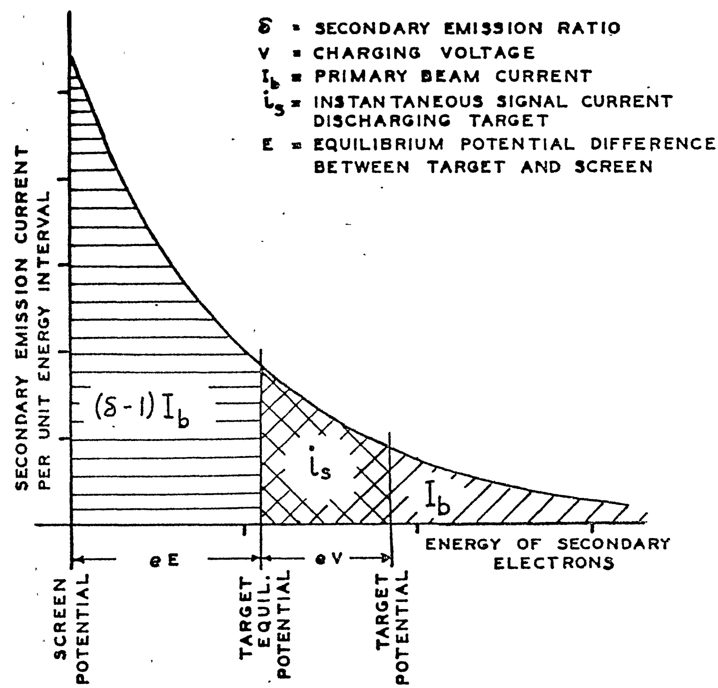


Fig. 5—Maxwellian energy distribution of secondary electrons.

The potential of the target may be changed by the application of a *charging voltage* across the capacitive divider (all the C_s and C_p in series) formed by the screen, the target and the plate (Figure 4). Since C_s is much smaller than C_p, the potential of the target is changed by nearly the entire charging voltage. With the instantaneous target potential thus different by an amount V from the equilibrium target potential (Figure 5), the net secondary electron current leaving the target is different from the primary beam current by an amount i_s, the instantaneous signal current by which the *target capacitance* (the parallel capacitance of C_p and C_s) is discharged to equilibrium potential. For a scanning beam, elemental portions of the target under the beam are at different states of discharge. Therefore, the *total signal current*, I_s, flowing in the external circuit impedance comprising C_L and R_L, is the sum, for the width of the beam along the scanning path, of the instantaneous signal currents from these target elements. This total signal current constitutes the *output signal* of the tube, particularly during the reading operation.

Characteristic curves[5] showing the relationships between the output signal current, the charging voltage, and the beam current for an

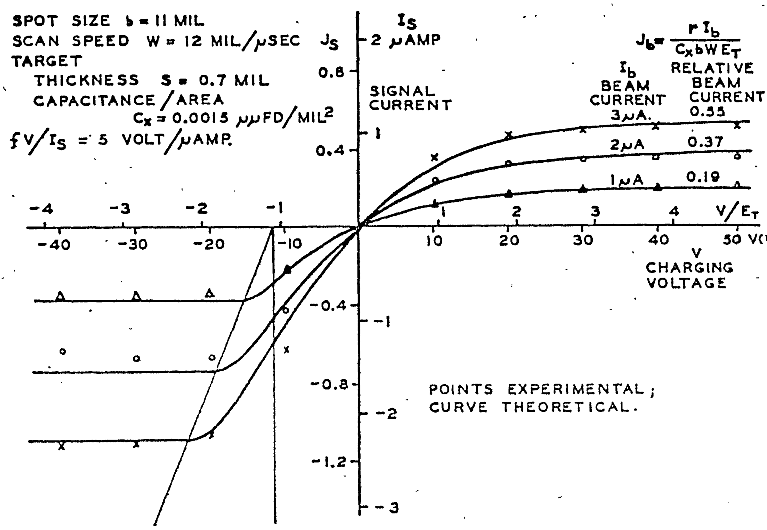


Fig. 6—Target characteristics of developmental ttype Radechon.

average developmental tube are plotted in Figure 6. In this figure the points plotted are experimentally measured data, while the curves are derived from the target-action theory.[6] Note that this figure together with Figure 6 of Reference (6) gives two views of the characteristic surface of operation of the Radechon. The shape of the curves changes somewhat with scan speed. To account for this and to provide a set of universal curves, scales for J_s, relative signal current, and V/E_T, relative charging voltage, are provided.[6]

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[5] From data taken by M. D. Harsh and W. H. Sandford, Jr. of the Tube Division, Lancaster, Pa. This work was done under contract DA-36-039-SC-42505 with the U. S. Army Signal Corps Engineering Laboratories, Evans Signal Laboratory.

[6] A. S. Jensen, "Discharging an Insulator Surface by Secondary Emission Without Redistribution," *RCA Review*, Vol. XVI, pp. 216-233, June, 1955.

Writing

Assuming that, by scanning, the entire target has been brought to equilibrium potential while the plate and screen were held at the same potential, writing is usually accomplished by one of two methods.

Method A: While the screen is held at a fixed potential, a fixed charging voltage (about 20 volts) is applied to the plate, positive to the screen. The video signal to be written is applied to the electron gun control grid, usually clamped to cutoff, while the beam is scanned

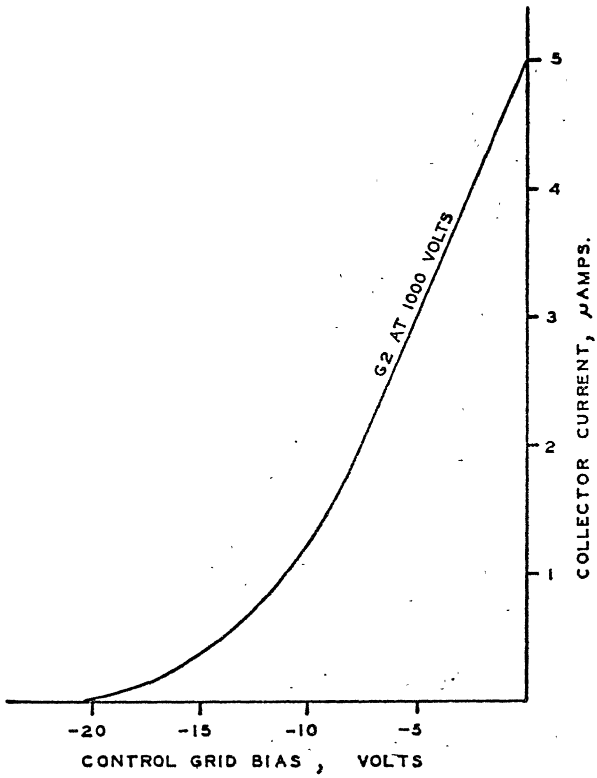

Fig. 7—Control grid characteristic of developmental Radechon.

across the target in the desired pattern or raster. This operates the tube along the reasonably linear current characteristic of Figure 6 of Reference (6) for which the plate potential is a constant. Since the electron gun control grid characteristic (Figure 7) is also reasonably linear, the entire writing process is linear. Furthermore, the high-frequency video signal amplifier need only drive the relatively small 7.4-micromicrofarad control-grid capacitance, while the relatively high 1000-micromicrofarad plate-to-screen capacitance is driven by the usually lower frequency switching between write and read conditions. This preferred method of writing is that diagrammed in Figure 4.

Method B: While the screen is held at a constant potential, and the control grid is also held at a constant potential to produce a constant beam current, the video signal is applied to the plate as a varying charging voltage. This operates the tube along a target characteristic curve of Figure 6 for which the beam current is constant. In addition to the unfavorable capacitance driving, this method inherently is unable to charge the target as fully for linear operation, and therefore is not to be favored over Method A except in special applications. However, this method does provide the very important advantage, when the tube is operated at high discharge factor, of writing the newly impressed signal on the target practically independent of previously written signals; that is, erasure of old information is accomplished simultaneously with writing of new information.

Discharge Factor

It must be remembered that the storage target is a capacitor, and that capacitors are never completely charged to the voltage applied. With a scanning beam, the beam is incident upon an elemental area of the target only for the time interval required for it to advance one beam width. For a stationary beam, it is usually pulsed on for a limited time interval. Therefore, the time during which signal current flows to discharge the target capacitor is limited by the system procedure. To facilitate the discussion of such discharging a very important concept has been evolved. The *discharge factor* is defined as the ratio between the voltage difference through which the target capacitance has been discharged by one passage of the beam and the target's initial voltage difference from equilibrium.

$$f \equiv \frac{V - V_b}{V} \quad (1)$$

where f = discharge factor; V = charging voltage applied to target, the initial potential difference of target from equilibrium; V_b = potential difference of target from equilibrium after one passage or application of beam.

Quite conveniently, this quantity is proportional to the slope of the chord of the target characteristic (Figure 6) drawn from the origin to the curve at the charging voltage applied.

$$fV/I_s = 5 \text{ volts per microampere} \quad (2)$$

for Figure 6, and

$$fV/I_s = 1.4 \text{ volts per microampere} \tag{3}$$

for Figure 4 of Reference (6). Using these relationships, one may compute the potential V_b, to which the target has been discharged by one passage of the beam.

The discharge factor varies inversely with scan speed since the shape of the target characteristic varies in that way. Figure 8 shows three curves of discharge factor for an average developmental tube. It will be observed that since the discharge factor cannot be 100 per cent there is never saturation, and the simple term "writing speed"

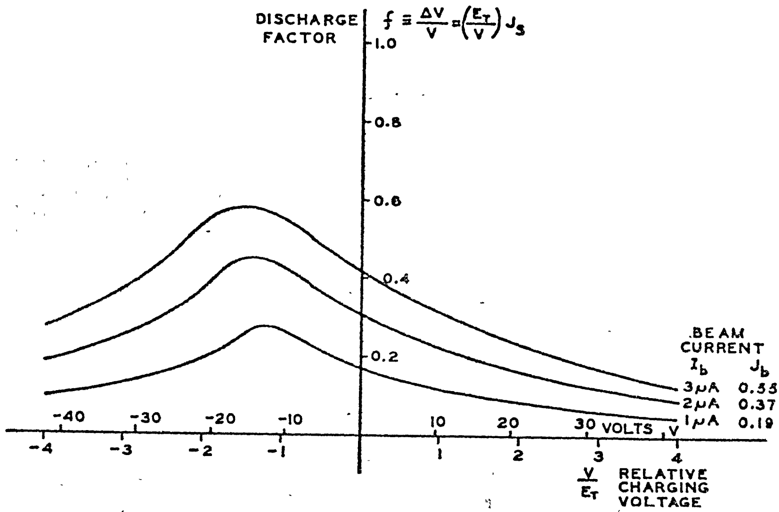

Fig. 8—Discharge factor curves for developmental type Radechon.

has no meaning unless it is simultaneously related to the discharge factor or the signal-to-disturbance ratio (See Equation (8)).

Reading

Following the writing process, reading is accomplished by first removing the charging voltage from the plate so that plate and screen are at substantially the same potential (a d-c voltage difference, constant during the entire reading process, is allowable). Now all parts of the target that were not written upon are back at equilibrium potential, whereas those portions that were written upon are negative with respect to equilibrium potential by the potential difference through which they were discharged during writing, to wit:

$$V_r = -fV = -(V - V_b). \tag{4}$$

This negative voltage V_r is the charging voltage for the reading process, and the same characteristic curves (Figure 6) can be used to compute the operation. Now both plate and screen are placed at a relatively high impedance from ground, and the reading output signal is taken from the screen (although it appears at the plate, as well) through a conventional preamplifier containing high-peaking and aperture-correction networks and stages in a manner well known in the television camera art. The beam current is held steady, usually at zero bias for one copy read-out, or at lower values to obtain several but not many copies.

Note that the tube is a high impedance device (over 100 megohms) for which the output is essentially a current. The output voltage[6] is then dependent upon the load resistor which in turn depends upon the bandwidth required, the plate and screen to collector capacitance of 5 micromicrofarads, and the output wiring capacitance (taken as 15 micromicrofarads in calculating the constant in Equation (9) below).

Reading, then, is accomplished along one of the relatively linear target characteristics of Figure 6 for which beam current is a constant and the origin is zero signal. The reading output signal can be computed from the target characteristics and four equations given. For the developmental tube, the reading output current I_{sr}, after a single writing operation in the manner described, is approximately[6]

$$\frac{I_{sr}\, W_w}{I_{bw}\, I_{br}} = 0.83 \frac{\text{mil}}{\text{microsecond microampere}} \tag{5}$$

where I_{bw} is the writing beam current, I_{br} is the reading beam current, and W_w is the writing scan speed. The reading discharge factor is taken as 0.5 or less, and this relation is valid as long as the reading beam current, I_{br}, is adjusted so that

$$\frac{I_{br}}{W_r} \leqq 0.23 \frac{\text{microampere microsecond}}{\text{mil}} \tag{6}$$

where W_r is the reading scan speed.

Erasing

Since reading is accomplished by the removal of electrons from the target and consequent discharge of it from the reading charging voltage toward equilibrium, reading is also an erasing action. Often the discharge factor during reading is sufficiently high that further erasing is unnecessary. However, in critical applications a second or several subsequent reading processes at high discharge factor may be necessary to return the target sufficiently close to equilibrium potential prior to the next writing.

RESOLUTION

In storage tubes with continuous storage area designed to reproduce picture signals with halftone response, one cannot refer to discrete target elements. Instead, it is more sensible to discuss resolution in the manner used in dealing with television pickup tubes or storage devices such as magnetic tape. For a given scan speed (or instantaneous writing speed) both the writing and reading processes appear as low-pass filters, and the customary frequency characteristic may be plotted by writing in a sine-wave signal, measuring its reading output, and plotting relative output as a function of frequency. For a more general curve, the abscissa chosen is the ratio of frequency to scan speed which has the dimensions sine-wave cycles per unit length of scan on the target. However, since the scan is never visible in the storage tube and cannot be measured, it is more meaningful to use the useful target diameter as the unit of length. (In a like manner, it is better to quote the deflection factor for the tube as 230 volts per target diameter, than to use other units of length.) In television practice it is customary to use square waves and to count both the peak *and* the trough so that

$$2 \text{ lines} = 1 \text{ sine-wave cycle,} \tag{7}$$

the unit of resolution then being *lines per target diameter*. Such resolution curves for both the developmental[5] and the experimental tubes are plotted in Figure 9.

Limitations to resolution

Spot size: The target area under bombardment by the primary beam at any instant is finite in extent but is not sharply defined. A graph of beam current density as a function of distance from the center of the beam is approximately Gaussian in shape (Figure 10, top). The effect of this variation in current density is to produce a step-function current to a conducting ribbon as the beam is scanned across it (Figure 10, bottom); this current increases slowly and continuously. By this means *spot size*, or beam diameter, is often defined arbitrarily as the distance the center of the beam moves while the current to the ribbon increases from 10 to 90 per cent of maximum. This can be measured on an oscilloscope as soon as the scale of length

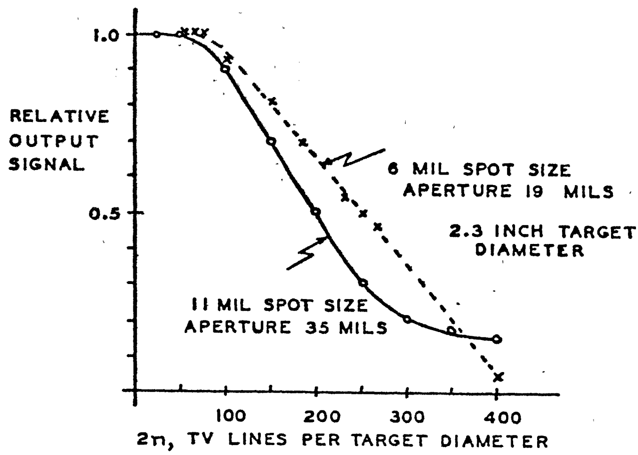

Fig. 9—Radechon resolution; solid curve for developmental-type tube, dashed curve for experimental tube.

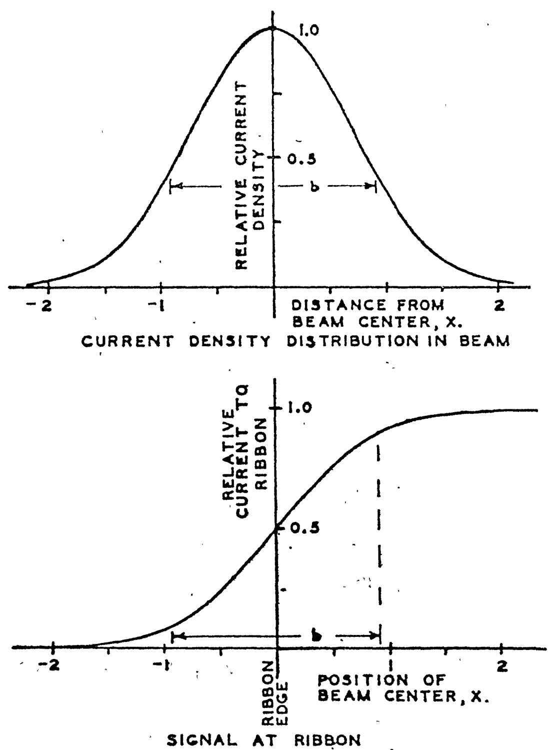

Fig. 10—(*Top*) Current-density distribution in beam; (*bottom*) signal at ribbon.

is determined from the known width of the ribbon placed on the screen for this purpose in experimental tubes. The *effective* spot size, however, must be defined in terms of the charge stored on the target. For low discharge factor this is the same as the arbitrarily defined spot size, but for high discharge factor the edges of the beam are more efficient than the center in storing charge so there is an effective increase in spot size and consequent reduction in resolution.

Furthermore, it must be remembered that a storage tube must be used in both writing and reading before a useful output is obtained. Any pulse stored on the target by a scanning beam will result in a deposition of charge one spot size longer than the distance the center of the beam moved during the pulse. Upon reading, the output signal will appear from the instant the leading edge of the spot reaches the stored charge until the trailing edge leaves it, thus effectively increasing the length of the output signal by the time required for the beam to move another one spot size. Thus the spot size enters twice to limit the resolution.

It is well known that increasing the distance between the gun lens and the target increases the spot size approximately linearly. Essentially, the "spot" should be considered as a solid angle with its apex at the gun lens. Thus to a first approximation the only way to increase the number of spots per total target area is to increase the deflection angle. The increase in number of spots per target area obtained by this method is almost independent of target size.

The measurements given here and in Reference (6) were taken with a maximum of 1200 volts between cathode and screen. However, since the secondary emission ration is about 3, which is higher than necessary, it might be sacrificed somewhat by increasing the voltage to 2000 volts or even more with the advantage of a smaller spot, better resolution and higher beam current.

Deflection stability and astigmatism: Resolution of the system can be impaired by instabilities in either the voltage supply or the deflection circuits. In addition to the usual limitations on hum and signal stability, the potentials of the cathode, the gun anodes, and the screen must be kept constant, and no signals applied to them, since they affect the deflection sensitivity, variations of which appear as a loss of resolution at the target edges. The deflection plates should be driven in push-pull with their average potential equal to that of the last gun anode to prevent their introducing excessive astigmatism.

The screen: The major purpose of the screen is to prevent redistribution of secondary electrons across the target with its consequent reduction in resolution and signal output. In order to accomplish this the screen must be in contact with the target with no spacings through which secondaries might find a way to reach other parts of the target. Ideally, the screen should be fastened to the insulator over the entire target. Redistribution within a mesh sets the lower limit to the fineness of the mesh required at about 2 to 3 meshes per spot size. This is actually a lower limit to the effective spot size. In the developmental tube having a woven screen with 530 meshes per target diameter, this and the true spot size are roughly equally limiting to the resolution. The experimental tube with 900 meshes per target diameter is limited in resolution only by spot size.

An important function of the screen is the electrostatic shielding of adjacent portions of the target from each other. In order to accomplish this, the ratio of mesh opening to screen thickness must be less than 2 (a slightly greater ratio is satisfactory if signals are small). It was for this reason that woven wire screen was used until recently when thick electroformed screen was made available. When thin screen of higher ratio is used, negative charges on the target set up electric fields extending outside the screen to inhibit secondary emission from adjacent portions of the target, a phenomenon referred to as *coplanar grid effect*. A schematic diagram of the equipotentials of such a field, Figure 11, indicates how this is brought about. Note how the relative potentials along a path normal to a point on the target may go through values negative with respect to the potential of the target at that point. This type of interaction between adjacent large areas is apparent as a loss of resolution in regions of large signal differences.

Disturbance: This has been discussed previously,[1,6] but it is important to emphasize that screen disturbance depends primarily on the ratio of screen wire diameter to spot size and is only weakly related to transmission ratio. The electroformed screen used in the experimental Radechon[6] has finer wires (0.7 mil) which enable the use of a smaller spot to obtain better resolution with no loss in signal-to-disturbance ratio. This screen disturbance, or modulation of the beam while it scans over the screen, is the most important disturbance other than shading. It is about 7 times as large as thermal noise at the input of the pre-amplifier and 100 times as large as the shot noise. The required signal-to-disturbance ratio, D, is the real limitation to useful writing speeds since, for the recommended tube operation, they are related according to:

$$\frac{D\,W_w\,n}{I_{bw}} = 15\ \frac{\text{cycles}}{\text{microsecond microampere}} \tag{3}$$

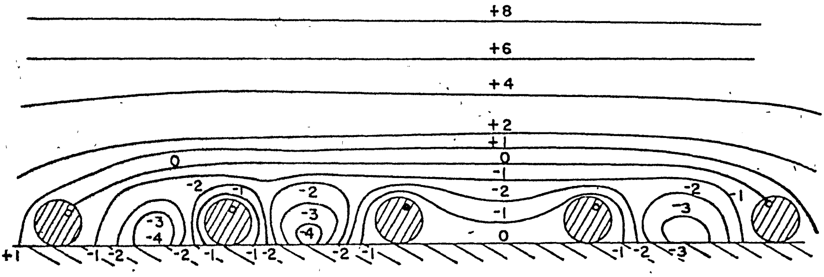

Fig. 11—Equipotentials showing coplanar grid effect with open mesh (schematic).

where n is the resolution, in cycles per unit length of scan on target, for which the system is designed. The signal-to-noise ratio, (S/N), is somewhat of a limitation to the reading conditions also since:

$$\frac{(S/N)\ W_w W_r n}{I_{bw}\ I_{br}} = 420 \ \frac{\text{mil cycles}}{\text{microsecond}^2\ \text{microampere}^2}. \tag{9}$$

Both signal-to-disturbance ratio and signal-to-noise ratio are inversely dependent on the designed resolution of the system. The constants in both Equations (8) and (9) are for the output circuit bandwidth being properly chosen for $2n$ lines per target diameter resolution in the developmental type Radechon operated in the recommended mode (Method A).

In the present Radechon, since the signal is taken from the screen and not a particular collector, shading from variation in collection efficiency is greatly reduced compared to that in earlier tubes (Figure 12).

RESULTS

Experimental Procedure

The measurements from which the characteristic curves were plotted were taken by writing a few pulses on the target fourteen times along a single line to charge the target nearly completely, then reading off this charge fourteen times. In Figure 13 the top line is

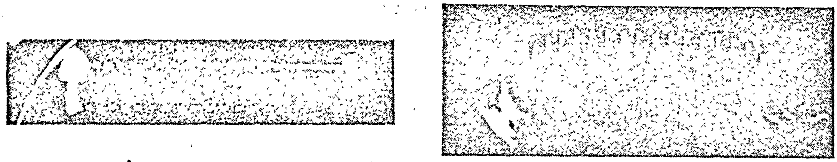

Fig. 12—(*left*) Input square waves; (*right*) Output showing shading.

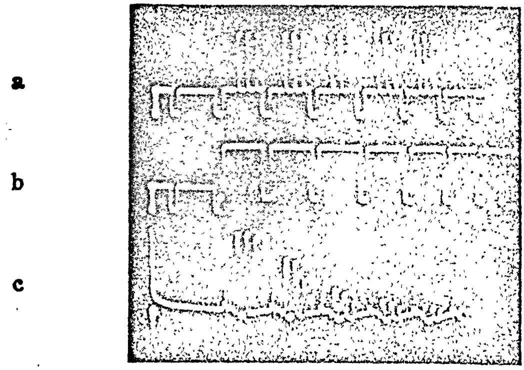

Fig. 13—(a) Writing input to G1; (b) Reading input to G1; (c) Reading output at screen.

the input to the control grid during the writing of several of these lines, the positive-going pulses turning the beam on for writing, the negative-going pulses blanking the beam during the horizontal retrace. The peaks of the writing pulses are clamped to zero bias. The second line is the input to the control grid during reading; the peak value of these reading pulses can be adjusted independent of the writing signal. The bottom line is the reading output signal.

If vertical deflection is applied so the signals are written on and read off the target in five groups of fourteen lines each, the output appears on a kinescope as in Figure 14, the target being overscanned purposely so that its outline can be seen in this picture. In this picture, each pulse was written once and read once in each frame. Their vertical spacing is such as to permit roughly 250 pulses per target diameter.

Ordinarily the wall and ring seal are operated about 60 volts positive with respect to the screen and act as a collector of secondary electrons, the only screen current being the difference between its second-

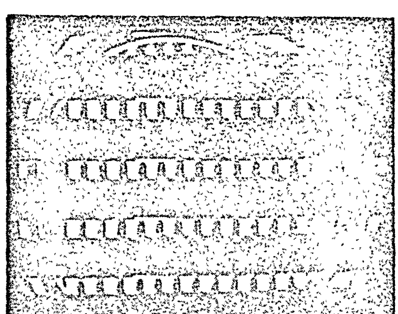

Fig. 14—Stored signal output of pulses displayed on kinescope with target ring overscanned. Five groups of 14 lines each.

aries and the primary beam current it intercepts. However, it is interesting to know how this varies with wall potential, particularly in that range where the screen also collects secondaries from the target. Such a curve is shown in Figure 15.

The slope of this curve is exactly the "plate resistance" of the tube — over 100 megohms at the operating point. Furthermore, its becoming quite flat at negative wall potentials indicates that the screen can collect all the primary beam. But this screen current, when pulsed, as it is by the blanking signals, appears as a video signal through the output amplifier onto the oscilloscope where it can be directly compared with the output reading signal independent of amplifier gain. Measurement of the d-c beam at the clamp reference bias then provides the scale factor to measure the output reading signal directly in current. Once the scale factor has been determined this means may be used to measure reading and writing beam currents at other biases without recourse to further d-c beam measurements. In Figures 13 and 16 all the signals were actually observed in this manner at the output of the pre-amplifier so that writing beam current, reading beam current, and reading output signal current are all on the same scale and can be compared directly.

Halftones

Figure 16 is a direct demonstration of the halftone rendition of the Radechon. The bottom line is the beam current during writing, while the top line is its reproduction 1/150 second later, read out with maximum constant beam current.

Target Life

One experimental Radechon[7] was in operation in systems application for 3000 hours over a period of 2 years with no appreciable degradation of signal. Although this was one of the earlier types of tube with collector output, it is considered to be representative since the target was similar to that used in the later tubes.

The only effect observed so far that limits the life of a target is the permanent marking of the screen when the raster is so small that the average beam current per unit length of scan is greater than 0.5 microampere per inch. This changes the secondary emission ratio of the screen and that area then appears as a disturbance signal.

Storage Time

For most applications, milliseconds of storage is sufficient. One

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[7] Personal communication from J. V. Harrington, E. W. Bivans, and T. F. Rogers of the Air Force Cambridge Research Laboratories, Cambridge, Mass.

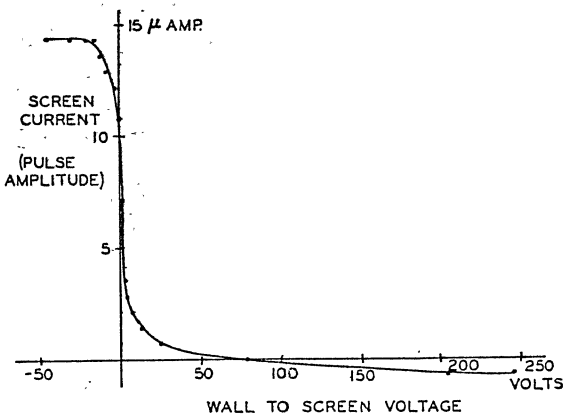

Fig. 15—Screen current versus wall storage.

measure of storage time is the length of time required for a charge on a given element of the target to decay to one half of its initial value. With the beam current continuously operating at maximum, either reading or writing on *other* portions of the target, the figure for this storage time is about 5 seconds (accumulated time if the beam is not on continuously), the decay being due to scattered electrons. With the beam turned off, however, this storage time is about 100 hours.

a

b

Fig. 16—Halftone storage. (a) Stored output at screen 1/150 second after writing; (b) Writing input to grid 1.

CONCLUSIONS

While the Radechon is not a universal storage tube, there are many applications in digit storage, integration, aperiodic access, and two dimensional reproductions of halftone pictures where it is finding increasing application. Its simplicity and freedom from spurious effects together with its relatively high signal output make it attractive from a circuit standpoint.

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