THE STORAGE ORTHICON AND ITS APPLICATION TO TELERAN*†

BY

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Summary—*An orthicon type of pickup tube, having a very high capacity target, and operating with a low beam current, has been used successfully to pick up a radar PPI presentation for television reproduction. By virtue of its large storage capacity the tube can reproduce for hundreds or even thousands of television scans information presented but once on the PPI screen.*

INTRODUCTION

FOR commercial television, time lag effects have been looked upon solely as a defect to be eliminated. For example, in some of the orthicon-type of pickup tubes a moving white object might leave behind it a white trail, whose length was a measure of the inability of the scanning beam to discharge rapidly the picture charge on the target.

More recently there have arisen several applications for a pickup tube that could "remember" what it had seen for several seconds or even minutes. One such application arises in the Teleran system of aerial traffic control.[1] Here information from a radar PPI (plan position indicator) scope is picked up on the ground and rebroadcast by television to airplanes. Another application is one of projecting on a large screen a television picture of a radar presentation for mass viewing. Still another use is in the production of a bright kinescope picture of the relatively dim PPI scope information. This paper is primarily concerned with the first application.

In conventional television practice the frame time is quite short, being only 1/30th of a second. Here persistence of vision can blend the individual pieces of information laid down by the scanning beam into a complete picture. In radar the repetition rate may be of the order of several seconds, as set by the relatively slow rotation rate of

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* Decimal Classification: R339 × 629.132.5 × R583 × R537.

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[1] D. H. Ewing and R. W. K. Smith, "TELERAN: Part I—Air Navigation and Traffic Control by Means of Television and Radar", *RCA REVIEW*, Vol. VII, No. 4, pp. 601-621, December, 1946.

the scanning antenna. In this case use has been made of the long afterglow properties of certain phosphors to produce a composite picture on the face of the PPI tube.

Such a picture might be picked up by a very sensitive pickup tube responding to this relatively dim phosphor afterglow. This actually has been done in the radar projection application mentioned above through the use of an image orthicon equipped with a Schmidt optical system.

Instead of using the time lag of the phosphor itself to produce the required storage effect, one might employ a pickup with a "memory" to look at the initial bright flash of the PPI scope. An orthicon with a very high capacity target, and employing such a small beam current that many scans are necessary to erase a given picture charge, has proven to be a means for attaining the required memory or storage.

This "memory" tube method of picture storage has appeared to have distinct advantages over the phosphor afterglow method, which advantages have recommended it for the Teleran application.

GENERAL DESCRIPTION OF THE STORAGE TUBE AND ITS OPERATION

The name "storage orthicon" has been used to differentiate between the present tube and the orthicon used for conventional television. Aside from the very high capacity target, the tube construction is the same as that which might be used were it to perform as a conventional multiplier orthicon pickup tube. Except for the target design and lack of an image section it is also very similar in construction to the "mimo" tube (miniature image orthicon, 2P22) which has been enlarged to use, as far as possible, standard size image orthicon (2P23) parts. Figure 1 shows the external appearance of the storage orthicon.

The operation of the orthicon has been described in the literature.[2] In addition several papers have appeared dealing with the operation of the image orthicon.[3,4] The latter is almost identical with the orthicon as far as the electron gun, scanning, and multiplier sections are concerned. Therefore, only a somewhat general description of the orthicon tube and its operation will be given here, while later in the paper a more detailed discussion of some of the structural and operational characteristics peculiar to the storage orthicon will be given.

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[2] A. Rose and H. A. Iams, "The Orthicon", *RCA REVIEW*, Vol. IV, No. 2, pp. 186-199, October, 1939.

[3] A. Rose, P. K. Weimer and H. B. Law, "The Image Orthicon—A Sensitive Television Pick-Up Tube", *Proc. I.R.E.*, Vol. 34, No. 7, pp. 424-432, July, 1946.

[4] P. K. Weimer, H. B. Law, and S. V. Forgue, "MIMO-Miniature Image Orthicon", *RCA REVIEW*, Vol. VII, No. 3, pp. 358-366, September, 1946.

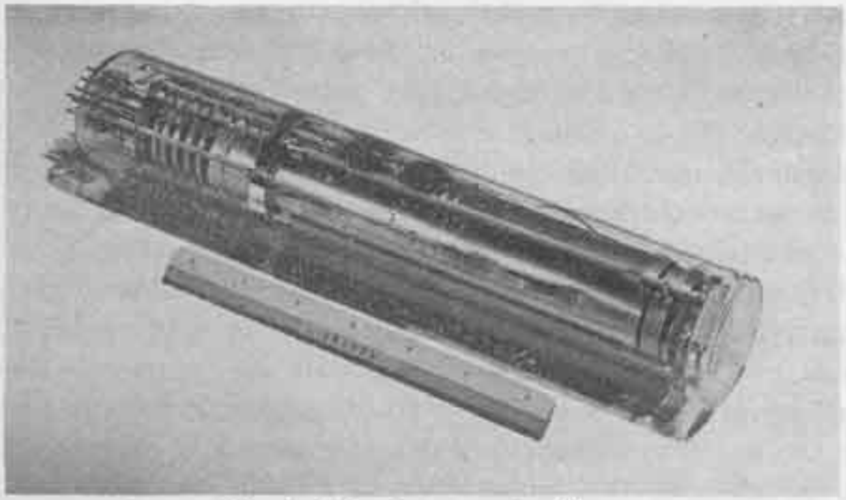

Fig. 1—The Storage Orthicon.

Figure 2 shows a diagrammatic cross section of the tube in a typical operational setup. In operation, a beam of electrons leaves the small (.002-inch) defining aperture in the end of the electron gun at about 200 volts velocity, and passes through the adjustable direct-current field of a rotatable alignment coil which accurately aligns the beam with the magnetic field of the focusing coil. It is then magnetically deflected horizontally and vertically so as to scan the target in a rectilinear pattern. The two mutually perpendicular sets of deflection coils have their fields perpendicular to the tube axis, and, in conjunction with the axial focusing field, give rise to a net warped field along the lines of which the electrons travel, to a first approximation. The beam leaves the deflection field almost parallel to the

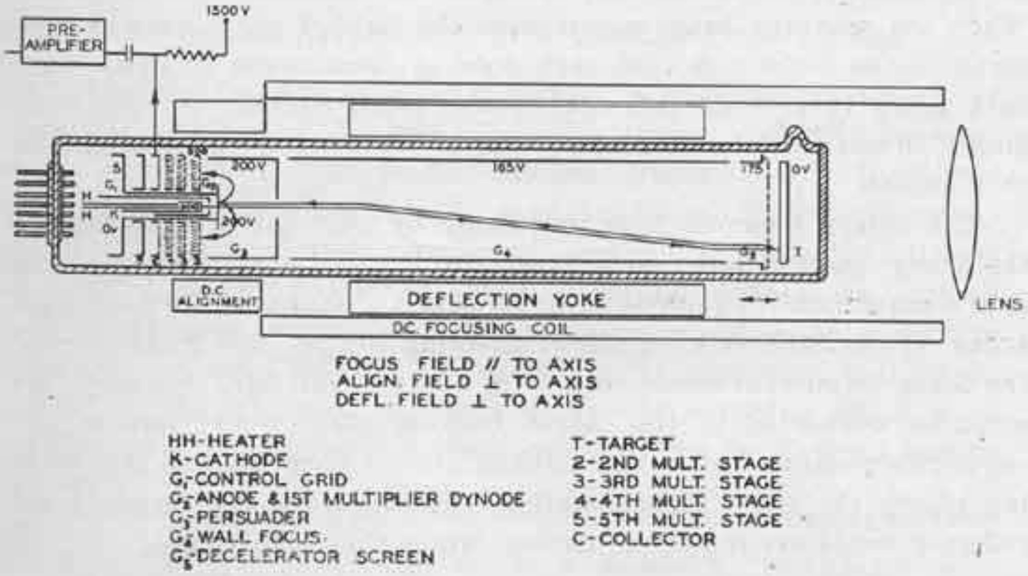

Fig. 2—Storage Orthicon—typical operation.

axis except for a small amount of helical motion imparted by the scanning field. Such helical motion means that the beam electrons have a transverse velocity component gained at the expense of the axial velocity. Because it is desirable that the beam reach the target perpendicularly, operating conditions are so chosen that this helical motion is as nearly as possible compensated for by an equal and opposite effect introduced by the electron lens in front of the target.

Principally in the region between the decelerator screen and target, the beam velocity is reduced to almost zero. As electrons striking a surface at low velocities knock out less than one secondary electron* per incident primary, on the average, the beam tends to discharge the surface down to cathode potential (or a volt or two negative if account is taken of the initial thermal emission velocities). When the insulated target surface is charged down to this potential, the beam no longer lands and cannot charge the target surface more negatively. Thus, the cathode is at a stable potential and this is the potential assumed in the absence of light and presence of the beam. In this condition the beam closely approaches the target, is reflected back approximately upon itself, and returns to the multiplier end of the tube. This is the condition for maximum direct-current output and zero signal current.

If part of the target surface is illuminated by light, (passing through the semi-transparent backing plate and dielectric) photoelectrons will leave the photosensitive (scanned) side, driving that part of the target positive. The field in front of the target is sufficiently strong to saturate this photoemission, the electrons of which are collected by the decelerator screen, wall, persuader and multiplier. When the scanning beam passes over the lighted parts, enough electrons in the beam will land each scan in these areas to drive them back down to cathode potential if the beam current is sufficiently large. In normal television operation, the current is adjusted so that this obtains.

The return beam is then modulated by subtraction according to the charge pattern left on the target by the escape of photoemission. It is a maximum for regions of no light and a minimum for high light areas. If the light were capable of effecting 100 per cent modulation of the beam, no current would return for areas of full light intensity. An amplifier connected to the target backing plate would receive (by capacitive coupling between individual picture elements and this backing plate) the video signal, while an amplifier on the return beam collector would see the beam current minus the video signal.

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* Secondary electron here is used in its broad sense to refer to both true secondaries and also reflected electrons.

In normal operation the potential swing of the target is usually not over two or three volts. A higher voltage swing would give rise to beam bending† at the target with resulting loss in resolution. In the event that the beam is insufficient to hold down the potential of a brightly illuminated area, this area can charge positively to a point which, in the storage orthicon, is determined almost entirely by the decelerator screen voltage. Usually this potential is high enough that the electrons strike at a velocity for which the secondary emission ratio is above unity and tend to maintain the high potential. To return the target to cathode potential it is necessary to lower the collector potential long enough to discharge the target and either to increase the beam or decrease the light if further charging is to be avoided.

The modulated beam returns to the first multiplier stage which also serves as the end of the electron gun. Here secondary electrons are released in a potential field configuration tending to pull them to the second stage which is struck at a velocity for which the secondary emission ratio is above unity. The 2nd, 3rd and 4th stages are "pinwheel" type multipliers. Each stage presents practically an opaque surface to impinging electrons, while the slots between the vanes permit the collecting field of the succeeding stage to leak through for the saturation of the secondary emission. The coarse mesh screen in front of each stage prevents the retarding field of the preceding stage from hindering this collection. The secondary electrons from the last stage are collected by a collector screen which runs somewhat more positive. The current to this collector constitutes the video signal.

THE TELERAN APPLICATION OF A STORAGE PICKUP TUBE

It is helpful to have in mind a picture of the Teleran system as a whole to understand the characteristics that a pickup tube must possess for successful use in this system. Figure 3 is a functional diagram of the basic teleran system as planned for initial installations.[5]

In brief, a ground search radar explores the air space of interest and displays the information received on several PPI scopes, each of which corresponds to a certain altitude layer into which the vertical airspace is divided. This division prevents the confusion that would occur if all the information picked up by the scanning radar were presented on a single scope. A plane equipped for the Teleran system

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† Action of potential at one point affecting the beam landing at adjacent points.

[5] D. H. Ewing, H. J. Schrader, and R. W. K. Smith, "TELERAN: Part II—First Experimental Installation", *RCA REVIEW*, Vol. VIII, No. 4, pp. 612-632 (this issue), December, 1947.

carries a radar transponder which automatically replies to interrogation with a coded signal corresponding to the altitude of the plane. Thus, radar information is channeled to the appropriate scopes. How-

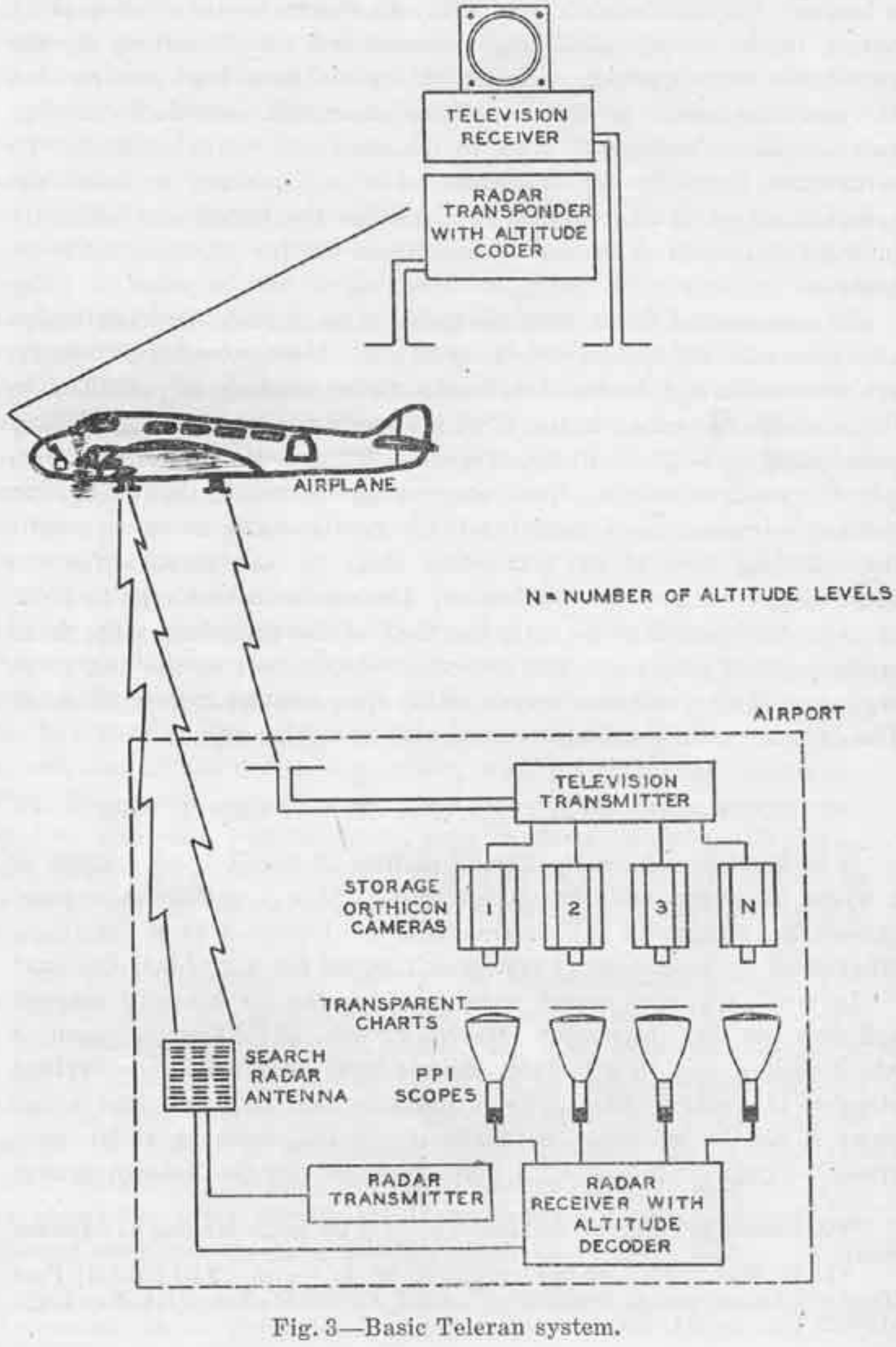


Fig. 3—Basic Teleran system.

ever, the television pictures sent to all planes are transmitted from one transmitter, but are segregated by a "time sharing" arrangement, where for n altitude levels, information about any one is broadcast approximately $1/n$th of the total time. Normally a pilot is primarily concerned with aircraft in or near his own altitude. He is able here, in addition, to look at information from other altitude levels, if he so desires.

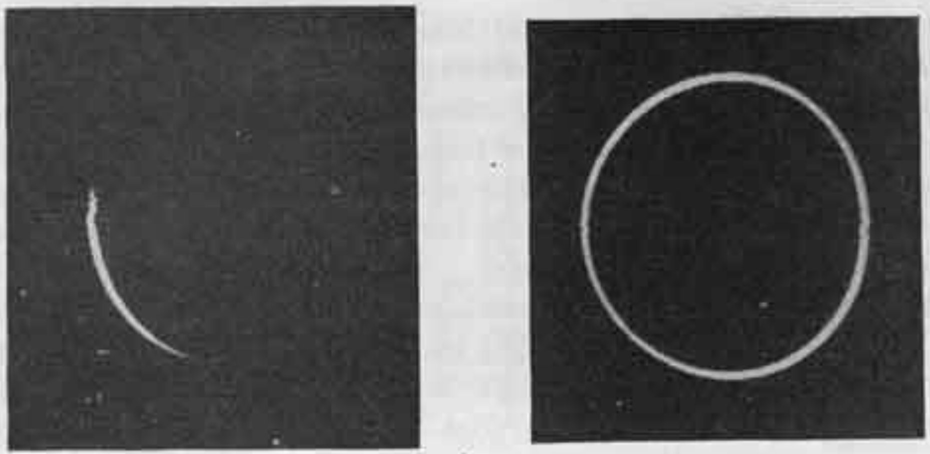
Airplanes show up on the television screen as bright spots (radar pips), with the spot corresponding to the pilot's own plane characterized by an individual bright radial line passing through it. Because of the storage elements in the system, several pips from a given plane may be seen simultaneously corresponding to several scans of the radar antenna. This permits one to determine the direction of motion of the plane with the weaker pips indicating the plane position on previous scans, and the brightest pip that on the last scan.

To indicate satisfactorily the direction of motion of a plane, it was felt that a minimum of three pips from three successive radar scans must be visible simultaneously. For a slow antenna rotational rate of say 6 revolutions per minute, and no time sharing, this means that at the end of 30 seconds (900 television scan times) an easily observable fraction of a signal pip must still be present.

With time sharing, however, as only one of the n cameras is furnishing information for transmission to a plane at any one time, each storage orthicon can operate with its beam current cut-off about $(n\text{-}1)/n$ths of the time. Thus the target signal on each tube is discharged only when signal is needed from that tube. Therefore, if a given storage orthicon has a useful time lag of t seconds under continuous operation it will have a useful time lag of nt seconds under time sharing operation, provided of course that the target electrical leakage is low enough so that the signal charge doesn't appreciably leak away in this time. (The latter condition has been easily met in practice.)

THE STORAGE ORTHICON TARGET

While the ordinary orthicon is operated so that the picture charge at any point is neutralized by a single beam scansion, it can be seen that the Teleran application requires a picture charge removal only after several hundred scans. This can be accomplished either by decreasing the beam current (see Figure 4) or increasing the target capacity. In actual practice both devices are used in the storage orthicon. Increasing the target capacity increases the storage time without sacrifice of signal-to-noise ratio. Merely decreasing the beam



a. High beam current. b. Low beam current.

Fig. 4—Reproduction of a rotating spot by the Storage Orthicon.

current increases the storage time at the expense of signal-to-noise ratio, the latter varying as the square root of the beam current.

The convenional orthicon has a mica target the capacity of which can only be increased to the point corresponding to the thinnest sheet into which mica can be split. In practice this usually turns out to be of the order of a half mil. In order to increase further the capacity it was necessary to make a target of dielectric material other than mica. Two approaches to this problem were tried. One was to make

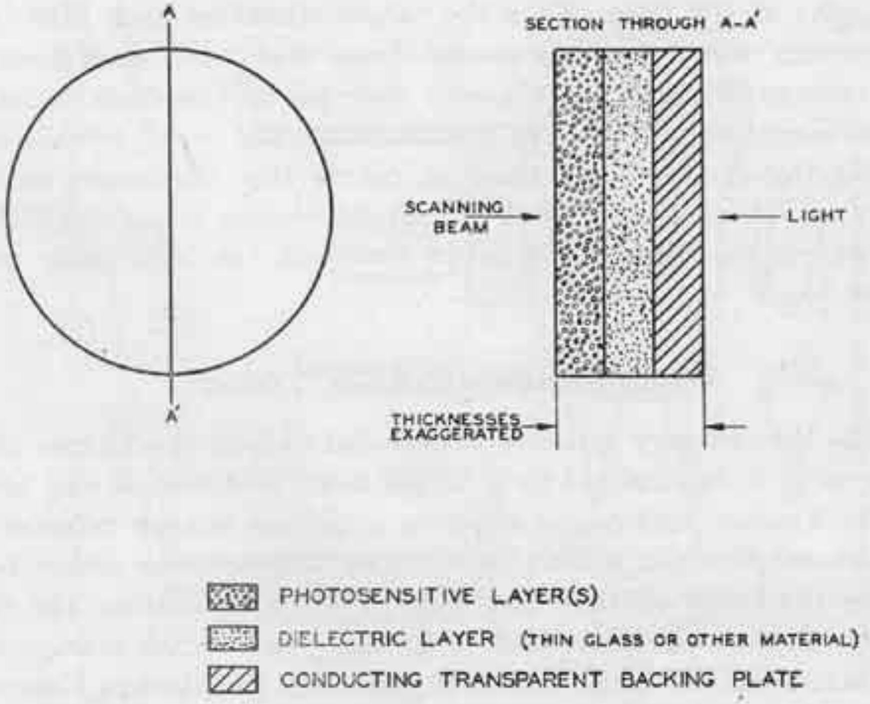


Fig. 5—Storage Orthicon target. (Section through functional layers)

a very thin glass target; the other was to form a thin dielectric layer on a transparent conducting surface.

The glass target is formed and mounted in a manner similar to that used in the production of thin glass targets for the image orthicon. However, unlike the image orthicon target, that of the storage orthicon must have a very high resistivity. A semi-transparent conducting backing plate is formed on the unscanned side of the glass surface, while one of the conventional photo-sensitive layers is formed on the scanned side after the tube has been sealed.

The storage time of the thin glass target is much longer than that of the normal orthicon by several orders of magnitude. If, however, for any reason a smaller diameter target or longer time lag than is produced by the glass type is needed in the future or for other applications, other material is available which has been found in actual operation to provide desirable and usable characteristics.

Figure 5 shows diagrammatically the functional layers of the storage orthicon target.

TARGET CHARGE-DISCHARGE CHARACTERISTICS

General Remarks

Normally, in pick-up tube operation, efforts are made to insure that picture signals are completely erased each scanning cycle if the defect of time lag (fuzzing of moving objects) is to be avoided. However, this defect for conventional television operation is a definite asset for reproduction of radar scope information, and has been exploited in a greatly exaggerated form in the storage orthicon.

The storage orthicon exhibits this time lag as a result of a very high target capacity in combination with a low velocity scanning beam. These are, of course, just the conditions giving rise to a long time constant for a condenser being discharged, and it is as a condenser, charged positively by the photoemission process and discharged by the beam current, that one considers an orthicon target.

Target Charge-Up

As the field in front of the target is normally made quite high, the photoemission from the target is saturated. Therefore steady light on the target causes a steady current to leave it. Thus the target potential builds up linearly with respect to the time t, rather than following the normal exponential condenser charging curve. The slope of this charging curve is determined by the capacity C of the target and by the photo-current leaving it. This photo-current is in turn proportional to the light intensity B on the target, and to the photosensitivity S

of the target. The relation between these factors can be expressed simply by

$$v = \frac{BAS}{930C} t + V_i \tag{1}$$

where v = potential after t seconds and V_i = initial potential, in volts

B = illumination in foot-candles, A = target area in square centimeters

S = sensitivity of target in microamperes/lumen

C = capacity of target in microfarads (associated with area A).

Target Discharge

The mechanism of target discharge by the scanning beam is somewhat more involved. There are two significant ranges in the discharge cycle, each of which has its own characteristics of discharge versus time. In the "normal range" all of the scanning beam I_B reaches the target each scan, thereby reducing the target potential by a fixed amount each scanning period. In the "intrinsic range" only part of the scanning beam can land each cycle, this part being a function of the target potential found by the beam where it is landing at any instant, and is therefore also a function of time. The first range ends and the second begins when the target potential drops to a value low enough that some of the electrons within the beam no longer have sufficient axial energy to reach the target. The first range is therefore one of essentially constant output current, while the second range is one of falling output.

The axial velocity distribution within the beam is determined by the range of thermal emission velocities from the cathode and by the different amounts of helical motion imparted to the beam electrons when passing through the electron lenses and magnetic deflection field within the tube. In the production of this helical motion a transverse velocity component is imparted to the electrons at the expense of their axial velocity, for their total velocities at any point are determined by the space potential at that point. Thus electrons which would normally have sufficient energy to reach the target in the absence of this helical motion, might, in its presence, be unable to do so. Normally a tube is operated so as to minimize the helical motion, thereby insuring perpendicular approach to the target. For this reason a velocity distribution arising only from the initial thermal velocities will be considered herein.

In this case, then, the transition between the normal and intrinsic ranges will take place when the target potential just equals cathode potential, account being taken of contact potential differences. At this potential an electron with zero axial emission velocity would just reach the target. Those emitted with more than zero velocity will reach the target with their emission velocity. Since the secondary emission ratio is less than unity at these low velocities, the beam will tend to charge the target negatively. In actual operation, and in the "dark", the beam will charge the target negatively until the beam current landing equals the current leaving the target.

While the secondary emission ratio is low at these low striking velocities, it is not zero. Consequently only part of the beam striking the target sticks. Like the fraction of the beam current that is energetically unable to land, this non-sticking current returns to the multiplier where it contributes to spurious signal and lowers the overall signal-to-noise ratio. Actually the secondary emission ratio R at the target is not strictly constant, and, in a rigorous derivation, its variation with potential would have to be accounted for. But the variation is small over the narrow voltage range of importance in the storage orthicon, and so will be treated here as a constant.

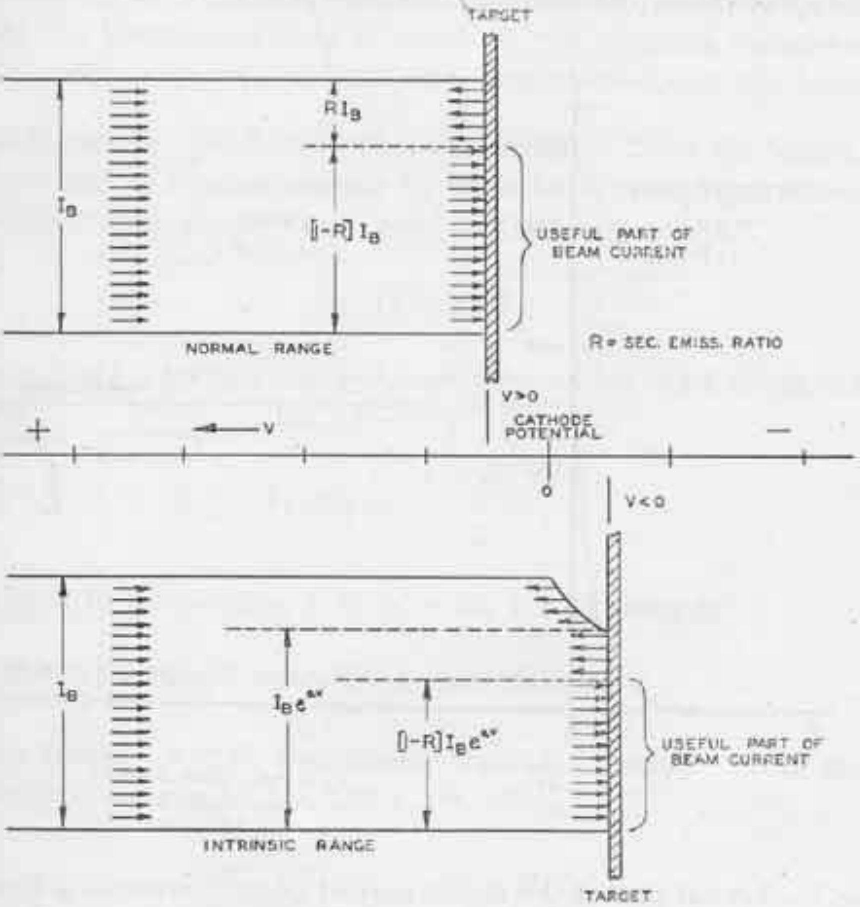


Fig. 6—Useful and non-useful parts of the beam current.

It has been seen that only a fraction of the full beam I_B leaving the gun is useful for discharging the target. In the normal range (target positive) all of I_B lands, but in the intrinsic range (target negative) only part of I_B has enough energy to land. It can be shown that the part of I_B that can reach the target when negative is given by $I_B e^{av}$ where $a = -\frac{e\,10^7}{kT}$ and $v =$ potential after t seconds. In either range only part of the beam that lands is absorbed, the ratio of absorbed to landing current being given by $(1-R)$. Figures 6 and 7 summarize the information of this paragraph.

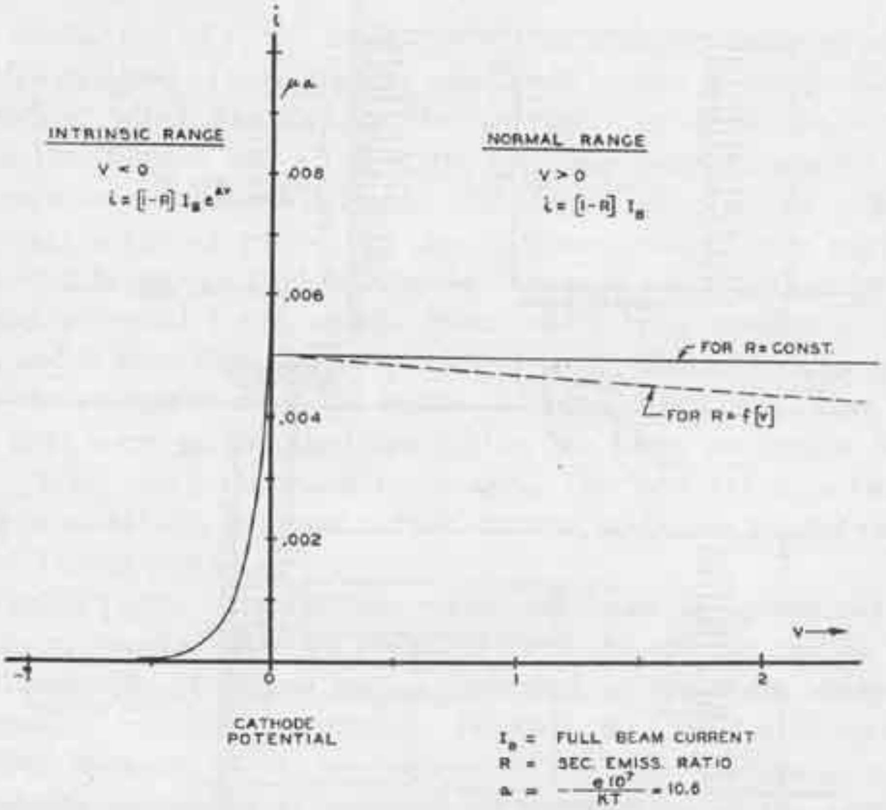


Fig. 7—Typical plot of the useful part of beam current as a function of the target potential.

After the storage orthicon target has been charged up by an exposure to light, the principal consideration is the rate at which the target discharges over periods of time very long compared to a scan time. Thus the fact that the potential of a picture element drops by a discrete amount each scan can be ignored and the potential can be treated as though it were dropping continuously. The entire target may be considered as a single condenser, initially charged up to some potential V_0 by uniform light over the whole target, and discharged by the beam acting through all of each frame time. It is legitimate thus to consider the whole target as a unit rather than to consider a small picture element alone, even though it may be the potential of the latter that is eventually wanted. This is true because the charge present on a given area and the length of time the beam is on that area are both proportional to that area. Thus the potential of a small element drops by the same amount each scan as would the potential of the entire target if the latter were charged to the same initial potential.

The discharge curves for the storage orthicon after the target is charged up by an exposure to light may now be considered. Leakage currents can be ignored here as the tube can retain a picture charge for hours after exposure to light and in the absence of the beam.

Normal Range ($v > 0$; Steady Output Current): Here the target, after being charged to some potential V_0 by a flash of light, is discharged *at a constant rate* by the useful part of the beam current,

$$i = (1 - R)\, I_B \tag{2}$$

The voltage v for any value of time t for which $v > 0$ is immediately given by:

$$v = V_0 - \frac{(1 - R)\, I_B}{C}\, t \tag{3}$$

where I_B is in microamps, V is in volts, t is in seconds

$C =$ total target capacity in microfarads.

Intrinsic Range ($v < 0$; Decreasing Output Current): Here the useful current i is given by $(1 - R)\, I_B e^{av}$, whence

$$\frac{dv}{dt} = -\frac{i}{C} = -\frac{(1 - R) I_B}{C}\, e^{av} \tag{4}$$

Solving this for v, and inserting the condition that $v = 0$ when $t = \dfrac{CV_0}{(1 - R)\, I_B}$ from (3) gives

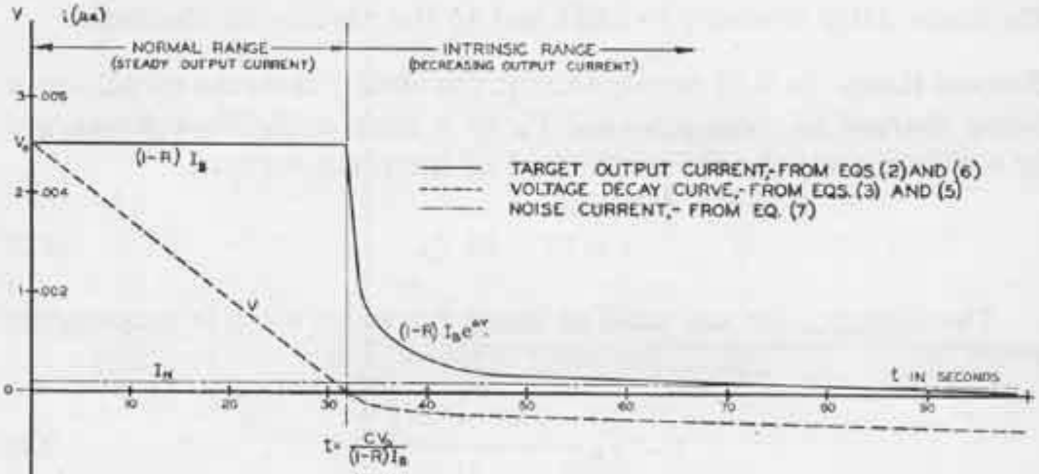
$$V = -\frac{1}{a}\, Ln \left[1 - aV_0 + \frac{a\, (1 - R)\, I_B\, t}{C} \right] \tag{5}$$

and the useful current is

$$i = -C\frac{dv}{dt} = \frac{(1-R)\,I_B}{\left[1 - aV_0 + \frac{a\,(1-R)\,I_B\,t}{C}\right]} \tag{6}$$

where $a = -\dfrac{e\,10^7}{kT} = 10.6,$ $\qquad e = -1.59 \times 10^{-19}$ coulombs

$k = 1.37 \times 10^{16}$ ergs/k°, $\qquad T = 1100°\ K$



Cathode Potential $= 0$ Volts
Full Beam Current $= I_B$
Sec. Emission ratio $= R$
Noise Current $= I_N$
TargetCapacity $= C$
$a = -e\,10^7/KT = 10.6$

Fig. 8—Typical decay after single exposure to light.

A typical plot of the current and voltage as a function of time is shown in Figure 8. The useful current is proportional to the output current of the tube where the factor of proportionality is the multiplier gain. We see that the beam current tends to charge the target more and more negative as time progresses, but at an ever decreasing rate. The useful signal current eventually decreases to the point where it is masked by the noise current I_N associated with the full beam current I_B. The noise current is expressed by

$$I_N = (2e\,\Delta f)^{\frac{1}{2}}\,I_B^{\frac{1}{2}} = 1.26 \times 10^{-6}\,I_B^{\frac{1}{2}} \tag{7}$$

where $e = 1.59 \times 10^{-19}$ coulombs

$\Delta f =$ band pass, taken as 5 megacycles

The dot-dash curve of Figure 8 shows the noise current associated with the beam current used for plotting the two other curves of the figure.

Steady Light: If a steady light image is projected on the target, parts exposed to the image will come to an equilibrium potential such that the average current landing from the beam and sticking, just equals that leaving in the form of photoemission I_s. This equilibrium potential can be shown to be expressed by

$$V_e = -\frac{1}{a} Ln \frac{(1-R)\, I_B}{I_s} \qquad (8)$$

Operation under steady light conditions takes place only at a voltage near zero (cathode) potential for I_s almost equal to $(1-R)I_B$, or at more and more negative voltages as I_s approaches zero. This is so, because anywhere in the "normal range" I_s must equal $(1-R)I_B$ if the voltage is not to change for a given value of I_s. This is not an equilibrium operating condition, however, for if the light intensity (and therefore I_s) increases somewhat, there is then not enough useful beam current $(1-R)I_B$ available to hold the target potential down, and the target "goes positive". If, on the other hand, the light is decreased slightly, the useful beam current is more than enough to neutralize the photoemission and charges the target to zero or below.

As opposed to this, the intrinsic range is a relatively stable operating range. If the light is increased so that the target would climb in potential because of the greater photoemission, more useful beam current $(1-R)\ I_B e^{av}$ becomes available and tends to hold the target down. Likewise a decrease in light is followed by a decrease in beam current landing, the two effects tending toward balance.

There can also be stable operation in the immediate vicinity of zero volts, where the photoemission swings the target just above zero volts before passage of the beam and the latter charges the target back down to slightly below zero volts. This resembles operation of the standard orthicon in normal television practice, where, however, the capacity of the target is so much lower, and the currents so much higher, that these voltage swings above and below the axis are much greater, and take place within a frame time.

SOME MISCELLANEOUS CHARACTERISTICS

Half Tone Reproduction

In the normal range, by definition, all of the beam lands each scan irrespective of the actual potentials existing on the target. Half tone steps therefore would not be reproduced as long as the secondary emission ratio at the target were a constant over the small range in target potentials encountered. If the secondary emission ratio did vary significantly, half tone steps could be reproduced, but in reversed polarity. This is true, because the secondary emission ratio increases for higher target potentials (higher light) which means that more electrons (RI_B) would return from the lighter areas. On the other hand, in the intrinsic range, the current landing is a function of the target potential found by the beam. Here half tone steps can be discerned, and in the correct polarity.

Coplanar Grid Effects and Stray Light

If a bright pip corresponding to a plane is to be picked up successfully by the storage orthicon, it must be bright enough to charge up the target to the desired voltage in one sweep of the PPI beam. The momentary photoemission from such a pip is many times that of the useful storage tube beam current.

On the other hand the light intensity from a steady image, such as a map pattern projected on the storage tube, may be quite low, and must in fact be low enough that the photoemission from an area is equal or less than the average useful beam current to the area. This is to prevent the target from "going positive". Accordingly, when the map projection is suddenly turned on, it may take an appreciable time for the target to build up to operating potential. This is epecially true if it has previouly been discharged by the beam all the way down to its dark potential.

If, as is likely to be the case, the map information consists of narrow white lines, or small white dots on a dark background, the low potential of the large adjacent dark areas may cause enough of the potential barrier in front of the light areas that the beam cannot land on these areas (coplanar grid action) until the photoemission has charged them above their normal equilibrium potential. This, of course, greatly exaggerates the time necessary for build-up. The same grid action prevents small areas from charging to collector potential under normally excess lighting conditions. If such a transient effect temporarily prevents the beam from landing, the situation may be corrected by the use of a judicious amount of uniform stray light falling upon the target. This stray light falling on the previously very negative dark areas charges them up sufficiently so that their coplanar grid effect no longer is sufficient to prevent the beam from landing on the light areas. Although this stray light may only be needed long enough to put the tube back into operation, it may be helpful to use a permanent small part of it to prevent the high velocity electrons in the beam from charging the dark areas too negatively.

Photoemission Streaking

In the presence of a bright pip or strobe line on the PPI scope, very strong and objectionable horizontal lines or dashes were frequently found to be transmitted by the storage orthicon. These spurious signals were generated by the photoemission from the brightly illuminated parts of the target reaching and scanning the multiplier in the same manner that photoemission in an image dissector tube scans over its defining aperture. The corresponding aperture here is the persuader (G_3) aperture (see Figure 2).

The lengths of the streaks in the transmitted picture have been correlated with the time that the bright pip or strobe signals of the PPI are on. If one is dealing with only one or at most a few pip signals which are on but a few microseconds total time, this effect is usually negligible. On the other hand, if, as is usually the case, there are many pips visible each radar scan, or if the radar strobe is on some of the time, this streaking effect is likely to be objectionable. By reducing the size of the persuader aperture area by a factor of five in later model tubes this effect has been reduced in about the same ratio.

SIGNAL TO NOISE RATIO DISCRIMINATION

It was found in operation that the storage orthicon could effectively reproduce PPI information even when the signal-to-noise ratio of the latter was quite low. In some tests made* to ascertain what minimum signal-to-noise ratio could be transmitted, it was found that ratios below about 1:1 could still be reproduced. Signals that could not be discerned visually from a noise background on a PPI screen, could be successfully picked up by the storage orthicon and then viewed on a Kinescope screen.

RESOLUTION

Under carefully set-up laboratory conditions, resolutions greater than one thousand television lines have been observed.

CONCLUSIONS

The operating characteristics of the storage orthicon tube have been described with particular reference to its application to Teleran.

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* These tests were carried out by G. L. Fernsler and H. Kihn of RCA Laboratories Division.

These characteristics include optical insertion of the signal, storage and continuous reproduction of the signal for tens of seconds (see Figure 9) and discrimination against noise equal to or better than that of the eye in viewing PPI presentations directly. Other applications of the tube, for example, for the purpose of obtaining bright radar pictures, large screen presentation and remote transmission are clearly suggested.

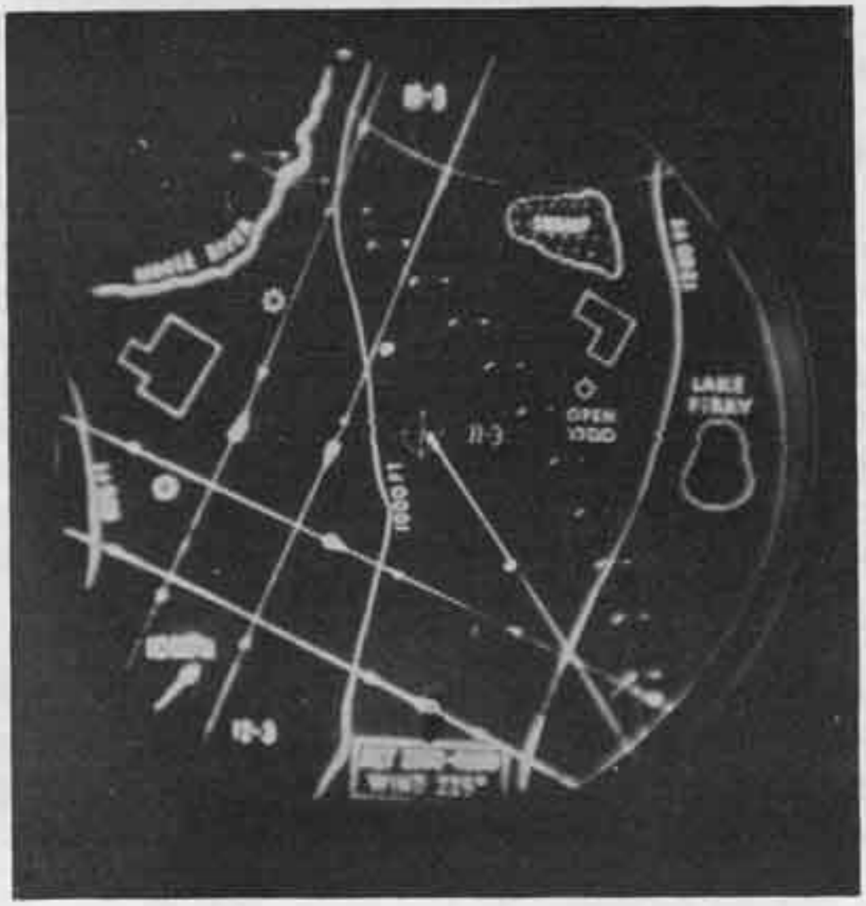

Fig. 9—PPI information and optically superimposed aerial map simultaneously picked-up by a Storage Orthicon.

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