Nov. 8, 1955 A. A. ROTOW 2,723,360

IMAGE ORTHICON

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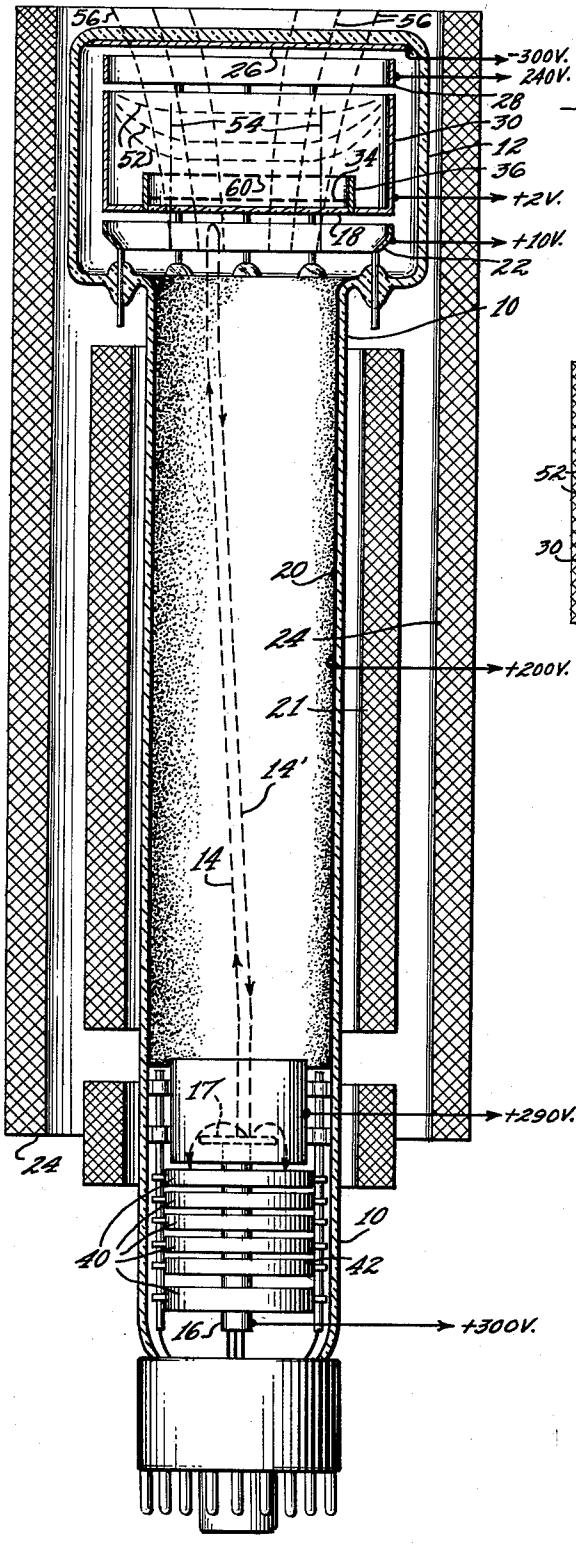


Fig. 1.

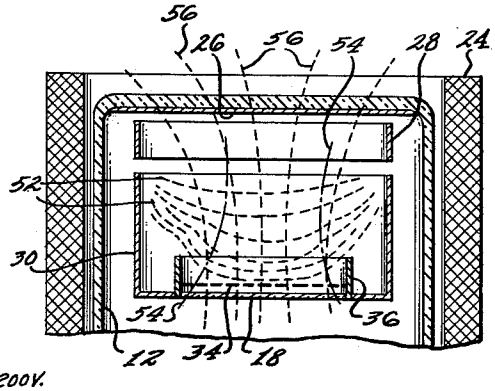


Fig. 2.

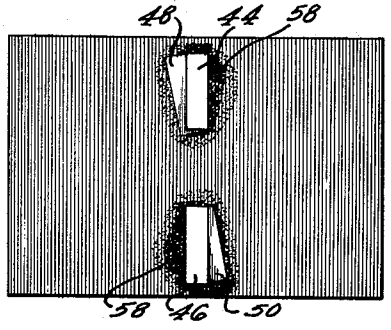


Fig. 3.

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IMAGE ORTHICON

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4 Claims. (Cl. 313—65)

This invention is directed to an electron discharge device and more particularly to a camera or pickup tube in which an optical image is converted to an electric signal.

The invention is directed to an improvement in an image orthicon type camera tube. Such a tube is one having an image section including a photocathode electrode upon which a scene to be televised is projected. Photoelectrons from the photocathode are focused upon an insulator target electrode to establish a charge pattern on the target corresponding to the optical image focused on the photocathode. An opposite surface of the target is scanned by a low velocity electron beam to discharge the charge pattern on the target surface as well as to provide modulation of the reflected portion of the scanning beam to provide a video television signal. The image orthicon camera tube is well known and is fully described in U. S. Patent to H. B. Law, 2,460,093.

In the operation of the image orthicon pickup tube, there is produced a high light flare known as a "ghost," which consists of a spurious image of high light objects on a dark background. Such spurious images appear on the transmitted scene adjacent the object itself and at a distance from it, which depends upon the location of the high light spot and the condition under which the image orthicon is operated. This flare is noticeable only if a white or very light colored object, located with a very dark background, is intensely illuminated.

The invention is specifically incorporated in means for preventing ghosts or spurious images from being transmitted by an image orthicon pickup tube. In the operation of the image orthicon pickup tube, the photoelectrons from the photocathode surface are accelerated to relatively high velocities and strike the insulator surface of the target electrode at sufficient energy to produce a secondary electron emission from the target electrode. The secondary electrons are of varying velocities and will partially pass to a collecting mesh electrode closely spaced from the target surface or will be redistributed to other positive portions of the target surface. Within the image section an electrostatic field is established between the photoelectric cathode and the target electrode to accelerate the photoelectrons toward the target surface. A coil, however, is used to provide a magnetic field, extending between the photocathode and the target surface of the image section, for focusing the photoelectrons onto the target. It has been found that due to the mount structure of the target assembly, the electrostatic field and magnetic field do not coincide within the region immediately in front of the target electrode. Secondary electrons which are redistributed on the target surface consist of both high velocity and low velocity electrons. The low velocity electrons will fall back essentially on the same portions of the target surface from which they left. However, the high energy electrons will pass through the collector mesh to a point where they are turned about and reflected back to the target surface. It has been found that since the electrostatic and magnetic fields do not coincide within this region of activity the high velocity electrons will not return to the same point from which they left on the target surface. These high velocity electrons thus strike another portion of the target surface and give rise to additional secondary electron emission, which provides a spurious charge on the target surface resulting in an unwanted signal in the output of the tube. This signal provides the ghost or spurious image on the transmitted scene.

It is therefore an object of my invention to provide means for improving the operation of an image type camera-pickup tube.

It is another object of my invention to eliminate spurious images in the transmitted picture produced from an image type camera tube.

It is a further object of my invention to provide novel structure within the image section of a camera tube to prevent spurious charges on the target surface.

It is another object of my invention to provide novel means within the image section of a camera tube to cause the magnetic and electrostatic fields within the region of the target to coincide.

My invention is to provide an additional mesh screen within the image section of a camera tube and within the region adjacent the target surface.

It has been found that providing a mesh screen in the field region, through which the high velocity secondary electrons travel, that the magnetic and electrostatic fields within this region can be made to coincide so that the high velocity electrons upon their return to the target surface will strike substantially the same points from which they left.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a cross-sectional longitudinal view of an image orthicon camera tube incorporating my invention;

Figure 2 is a schematic showing of the effect produced by a highly illuminated spot on an image orthicon tube, without my invention;

Figure 3 is a schematic showing of the effect of a highly illuminated spot on a pickup tube.

Figure 1 shows an image orthicon camera tube comprising an envelope **10** having an enlarged portion **12** at one end for enclosing an image section tube described. Within the opposite end of the tubular envelope is an electron gun structure **16** comprising a conventional heater, cathode and control grid structures (not shown), for producing an electron beam **14**. An additional accelerating electrode **20** is formed as a wall coating on the inner surface of the tube envelope, for accelerating the electron beam **14** toward a target electrode **18**. Pairs of horizontal and vertical deflecting coils are formed into a yoke structure **21** surrounding the tube envelope. The deflecting coils provide fields perpendicular to each other and to the tube axis. The deflecting coils are connected, as is well known, to saw-tooth current sources for providing frame and line scansion of the electron beam **14** over the surface of the target **18**. Such a deflecting system is well known in the art and is not described in greater detail, as it is not a part of my invention.

A decelerating electrode **22**, formed as a ring, is mounted within the envelope immediately in front of target electrode **18** and on the scanned side thereof. The low potential of the decelerating electrode brings the velocity of the electron beam to substantially zero, in front of the target surface. Surrounding the tube envelope is a single coil **24** for providing a magnetic field having lines of force parallel to the axis and extending from the end of the gun structure **16** beyond the end of the en-

velope portion **12**. The field of coil **20** provides a focusing action on the electrons of beam **14** to bring them to a small, well defined point of focus on the surface of target **18**.

At the opposite end of the tube envelope, there is formed a photocathode electrode **26**. Such a photocathode surface is one such as formed from a sensitized alloy of silver and bismuth as set forth in co-pending application Serial No. 79,328 of R. E. Johnson, filed March 3, 1949, now Patent No. 2,682,479.

A pair of accelerating electrodes **28** and **30** are mounted coaxial to the tube envelope and are closely spaced from the photoelectric surface of cathode **26**. These electrodes provide an accelerating electrostatic field in front of the photocathode **26** and urge the photoelectrons therefrom toward the target electrode **18**. Target electrode **18** is formed of an insulator such as a thin film of glass having a slight conductivity and as set forth in the Patent 2,473,220 to Albert Rose. Photoelectrons from photocathode **26** will strike the adjacent surface of the glass film **18** and provide a secondary emission therefrom greater than unity. A fine mesh screen **34** is closely spaced from the photocathode side of the glass film **18**. Screen **34** serves as a collector electrode and prevents the glass target surface from changing to a potential higher than that of the screen **34**. The glass film **18** is mounted within a short tubular ring-like mounting member **36**, to which the metal mesh screen **34** is also attached intermediate the ends of ring **36**. As indicated in Figures 1 and 2, mounting ring **36** is in turn fixed within a restricted or flanged portion of accelerating electrode **30**. The potential of electrode **30** and thus mesh **34** is maintained at several volts positive relative to the potential of the cathode of electron gun **16**.

The operation of the tube of Figure 1 is briefly as follows. With no illumination on photocathode **26**, electron beam **14** is scanned across the target surface and so that the surface is brought to substantially zero or gun cathode potential. When a light pattern is focused on the photocathode **26**, photoelectrons are emitted from each illuminated portion of the photocathode in an amount proportional to the light intensity thereon. The photoelectrons strike the surface of insulator glass target sheet **18** and initiate a secondary emission from the bombarded areas to drive them in a positive direction, toward the potential of collector screen **34**. In this manner, there is set up on the photocathode side of the glass film **18** a charge pattern corresponding to the pattern of light or illumination focused upon the photocathode **26**. Due to the extreme thinness of the glass target sheet **18**, there is established a potential pattern on the scanned side of film **18** corresponding to the charge pattern on the photoelectric side of the target. Accordingly, the potential of the scanned surface of target **18** will vary from point to point, from substantially zero volts to several volts positive up to the potential of collector screen **34**.

The electron beam **14** approaches target electrode **18** at very low velocity immediately in front of the target surface. When the beam approaches target areas which are at zero potential, it is reflected back toward the electron gun **16**. However, more positive areas of the target surface will cause electrons from the approaching beam to land in numbers sufficient to neutralize the positive potential charge at the respective target area, and thus, drive the charged area of the target to cathode potential. At this point, the remaining electrons of the beam are then reflected back to the gun end of the tube. In this manner, then, as the electron beam is scanned over the target surface, there is reflected toward the gun end of the tube a modulated return beam **14'**. The return beam follows substantially the same path as the incident beam **14** and strikes the end **17** of the gun structure which is formed as a dynode electrode and as the first stage of a multiplier section **40**. The multiplier **40** is of a type disclosed in U. S. Patent 2,433,941 to P. K. Weimer. The modulated electron beam **14'** is converted, as is well known, into an output video signal from the collector electrode **42**.

In tubes of the type described above, an effect is produced of a high light flare or "ghost," which can be seen on the transmitted picture as a spurious image somewhat displaced from the actual image of the transmitted high light. This flare is noticeable particularly if a white or highly illuminated object of light color is located on or before a very dark background. Thus, if a televised scene consists of a black screen with highly illuminated windows in it, or of for example, a man in black clothes having a white shirt, or a white handkerchief in his pocket, the scene is transmitted by the tube described above, but there is also reproduced a high light flare, which is seen beside the transmitted picture and slightly displaced from it. For example, in Figure 3, there is disclosed what would be seen if a pair of white spots on a black background were transmitted. The transmitted picture would appear as white spots **44** and **46** on a black background. But also there would appear a darker black hallation about the white spots, and also, as is shown, a ghost or grayish picture of the white spots, as indicated at **48** and **50**. The resulting picture, in which such spurious images appear, is obviously very undesirable.

Figure 2 shows a detailed view of the image section of a conventional image-type camera tube, in which structures identical to those of Figure 1 have the same reference numbers. It has been found, that in the specific structure of the tube described, the accelerating fields between the photocathode electrode **26** and the surface of target **18** is substantially that shown in Figure 2, in which the equipotential surfaces of the field are indicated by dotted lines **52**. The field lines **52**, as they approach the mounting ring **356** dip into the ring and are somewhat distorted indicating that the field, immediately in front of the target surface **18**, is not uniform. The electrostatic lines of force of this field are substantially perpendicular to the equipotential surfaces and are represented schematically by the pairs of lines **54** shown in Figure 2. Also, within this region, immediately in front of the surface of glass target **18**, are the field lines produced by the magnetic coil **24**. These field lines are indicated at **56** and run somewhat in the general direction as the electrostatic field lines **54**.

It is apparent from Figure 2 that the electrostatic field and the magnetic field, immediately in front of the target surface **18**, do not coincide since the field lines interesect at angles to each other. It has been found that the secondary electrons bombarded from the surface of target **18** by the electrons of photocathode **26** have energies varying through a range from several volts to about the voltage of the photocathode. That portion of the low velocity electrons, which do not pass to the collector mesh **34**, fall back onto the target surface and in the close vicinity of the point from which they left the target surface. These low energy electrons strike the target surface at very low velocity and remain thereon to provide a black border around the high lights. This is shown particularly in Figure 3 by the darkened areas **58** about the bright spots **44** and **46**. This black border or area is a desirable effect since it helps preserve the contrast of the picture at high lights.

The high energy secondary electrons bombarded from the surface of target **18** tend to pass through the collector mesh **34** until they are reflected back to the target surface by the field of accelerating electrodes **28** and **30**. Since the high energy secondary electrons travel a relatively greater distance, they pass through the crossed magnetic and electrostatic fields represented by field lines **54** and **56** respectively. In doing so, these electrons acquired a radial velocity depending upon their displacement from the center of the target **18**. In accordance with the laws of electron optics, this radial velocity component causes a displacement of the electron trajectories in a plane

normal to the magnetic lines 56. Because of this displacement, the high energy secondaries will not fall back onto the target surface at the same point from which they had been emitted but somewhat to the side of the emission point. Also, due to their relatively high energy, these secondary electrons will bombard additional secondary electrons from the target to provide a charge pattern, which modulates the electron beam of the gun to provide the ghost images shown at 48 and 50 in Figure 3.

In accordance with my invention, there is mounted on the edge of mounting ring 36 (Figure 1), facing the photocathode electrode, a foraminous electrode, such as a second fine mesh screen 60. As shown in Figure 1, the addition of screen 60 causes the equipotential surfaces of the electrostatic field 52 to flatten out in the region immediately in front of the surface of target 18. This flattening of the field causes the electrostatic field lines 54 to substantially coincide with the magnetic field lines 56. Under these conditions, and because of the mesh screen 60, the high energy electrons will then tend to fall back onto the target surface from more nearly the same points as from those from which they were emitted. That is, the high energy secondary electrons will not acquire an additional radial velocity and will return substantially on the same path as those along which they were projected from the target surface.

In a successfully operated tube, the mesh screen 60 is one having substantially 200 openings per inch and approximately 80 per cent transmission. The mesh screen is one formed by an electroplating method and in which the wires are all substantially in the same plane. That is, it has been found that a woven mesh screen with larger transmission provides a distortion of the accelerating fields in front of the target 18 due to a lens effect provided by the apertures of the woven screen, due to the fact that a woven screen is much thicker than that of the electroplated screen. It has been found that a mesh screen of approximately 200 mesh per inch mentioned above provides an optimum result. A similar screen having smaller openings and more mesh per inch would cut down the electron transmission through the screen.

Screen 60 is spaced from the target surface by approximately ¼ inch. This spacing is not critical but should be sufficient so that the shadow of the screen will not fall on the target surface and be transmitted as part of the picture. Screen 60 may also be covered, in any well known manner, by gold sputtering or coated with carbon to cut down secondary emission from the wires of the screen itself due to bombardment by the photoemission from cathode 26.

The use of the fine mesh 60 in the manner described above completely eliminates the ghost portion of the picture as shown in Figure 2, and completely corrects the ghost or spurious image transmitted to the televised picture by the tube because of high light objects on a dark background.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

I claim:

1. An electron discharge device comprising, a source of electron emission, a target sheet spaced from said electron source, an accelerating electrode between one surface of said target and said electron source for maintaining an electrostatic accelerating field therebetween for urging electrons from said source to said target, means forming a magnetic field with lines of force extending between said electron source and said target surface for maintaining an electron focusing magnetic field therebetween, a collector mesh screen closely spaced from said target surface and between said surface and said accelerating electrode, and a foraminous electrode adjacent said target surface and spaced between said collector mesh screen and said accelerating electrode for causing said electrostatic and magnetic fields to coincide.

2. An electron discharge device comprising a photoelectric cathode electrode, a target sheet of insulating material spaced from said photoelectric cathode, an accelerating electrode between said photoelectric cathode and said target sheet for maintaining an electrostatic accelerating field therebetween for urging photoelectrons from said cathode to said target, a magnetic coil surrounding the space between said photoelectric cathode and said target for maintaining an electron focusing magnetic field therebetween, and a first mesh screen closely spaced from said target sheet surface and between said target and said accelerating electrode for collecting secondary electrons therefrom, and a second screen between said first screen and said accelerating electrode for causing said electrostatic and magnetic fields to coincide.

3. A photosensitive discharge device comprising, a photocathode electrode, a target sheet of insulating material spaced from said photoelectric cathode, a short tubular mounting ring positioned with its axis extending between said photoelectric cathode and said target sheet, said target sheet being mounted within said ring and adjacent the edge of said ring remote from said photoelectric cathode, a fine mesh screen within said mounting ring intermediate the ends thereof, a tubular accelerating electrode coaxially mounted between said photocathode and said insulator target sheet for maintaining an electrostatic accelerating field therebetween for urging photoelectrons from said cathode to said target, a coil surrounding the space between said photocathode and said insulator sheet for maintaining an electron focusing magnetic field therebetween, and a second mesh screen fixed to the edge of said mounting ring between said first fine mesh screen and said accelerating electrode for causing said electrostatic and magnetic fields to coincide adjacent said insulator target sheet.

4. A camera tube comprising, an envelope, a photoelectric cathode electrode mounted across one end of said envelope, an insulator target sheet spaced from said photoelectric cathode and within said tube envelope, a mounting ring fixed within said envelope with its axis extending between said photoelectric cathode and said insulator target sheet, said target sheet being mounted at the edge of said mounting ring remote from said photoelectric cathode, a tubular accelerating electrode mounted within said envelope between said photoelectric cathode and said insulator target sheet for maintaining an electrostatic accelerating field therebetween, a magnetic coil surrounding said tube envelope between said photoelectric cathode and said insulator target sheet for maintaining an electron focusing magnetic field therebetween, and a fine mesh screen mounted across the end of said mounting ring adjacent said photocathode electrode for causing said electrostatic and magnetic fields to coincide, a second mesh screen fixed within said mounting ring intermediate said fine mesh screen and said insulator target sheet for collecting secondary electrons resulting from bombardment of said target sheet by said photoelectric emission, and means within said envelope and spaced from the side of said insulator target sheet remote from said photocathode electrode for discharging the charge pattern established by secondary emission from said target electrode.

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