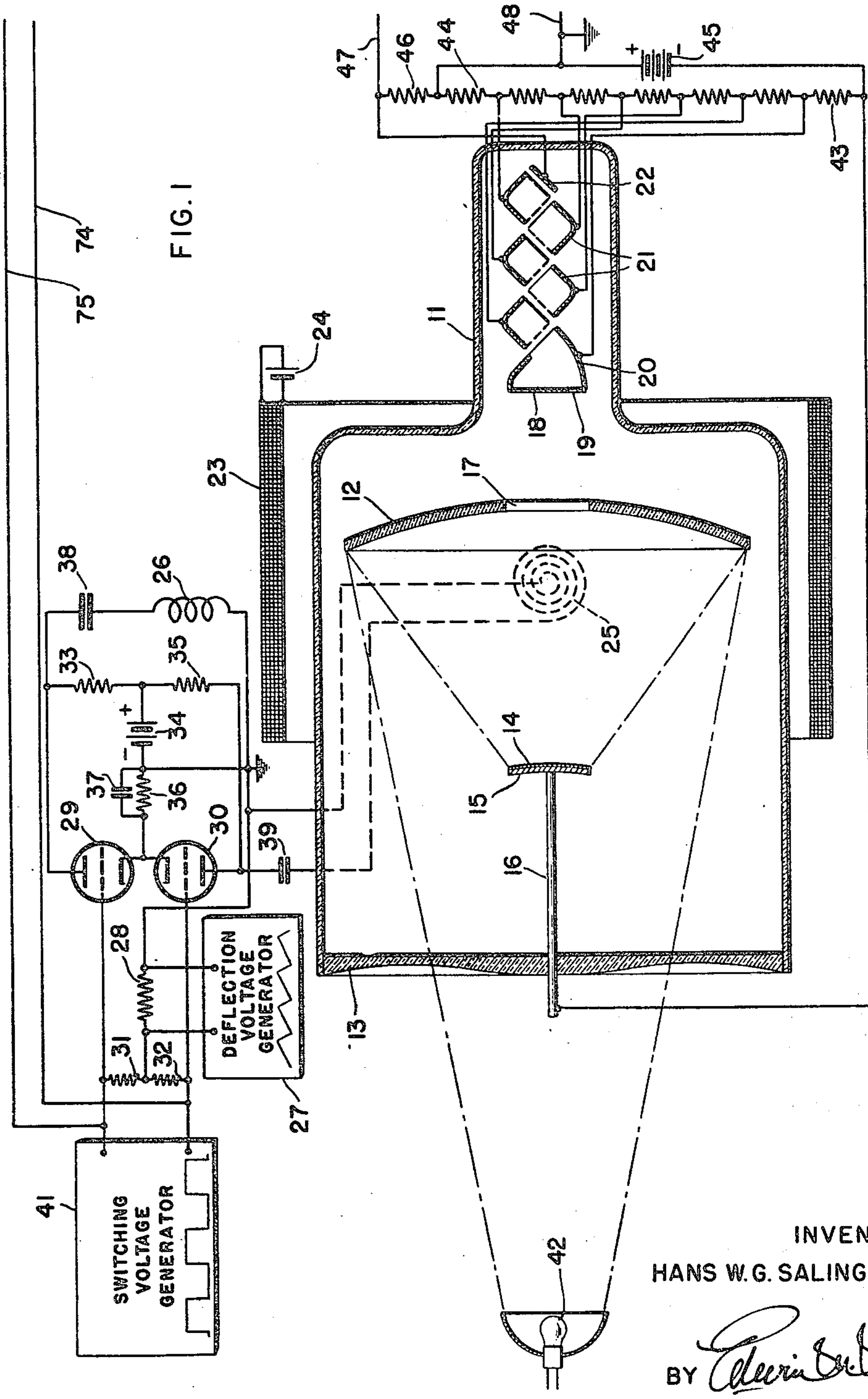
Aug. 19, 1947. H. W. G. SALINGER 2,425,956

TARGET SEEKING DEVICE WITH PHOTOTUBE MULTIPLIER

Filed Jan. 27, 1944 3 Sheets-Sheet 1



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TARGET SEEKING DEVICE WITH PHOTOTUBE MULTIPLIER

Filed Jan. 27, 1944 3 Sheets-Sheet 2

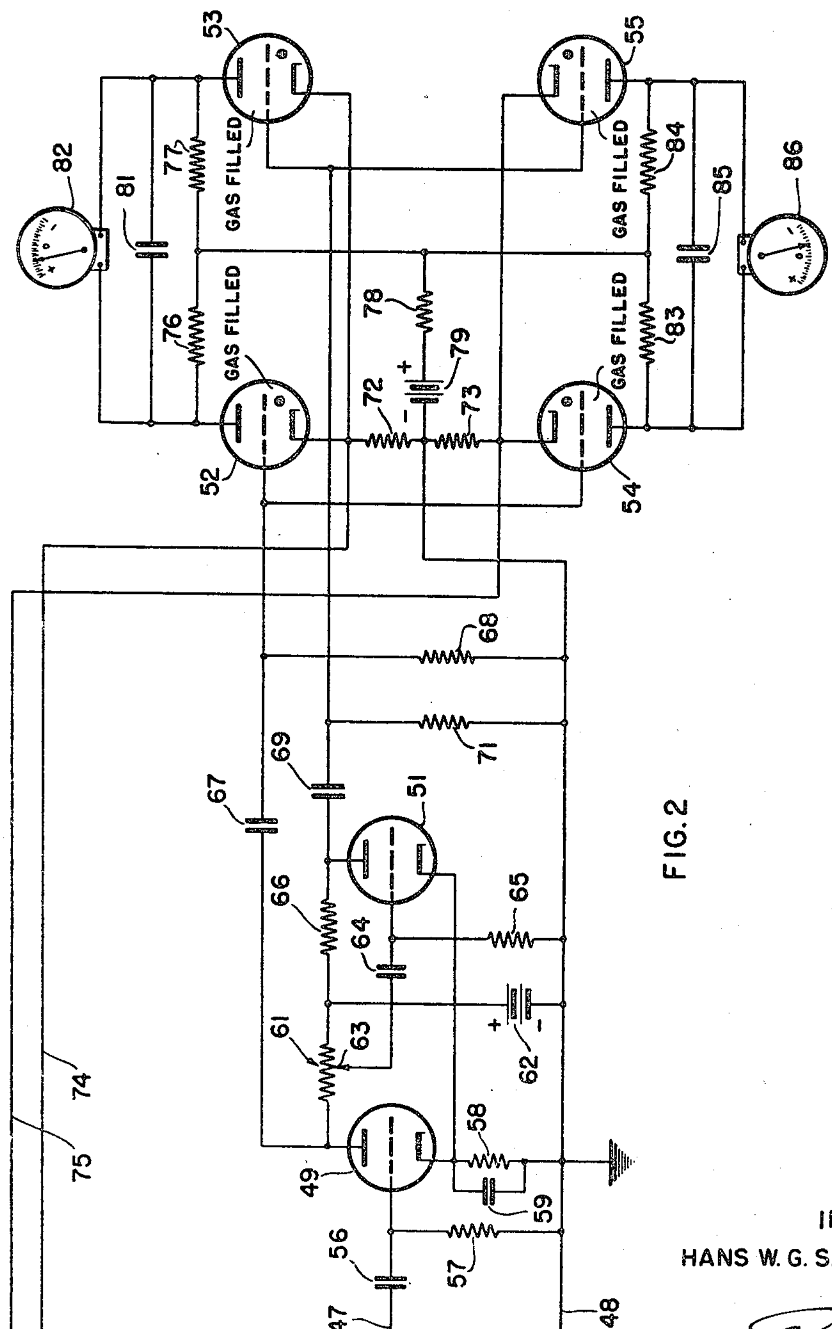

FIG. 2

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FIG. 3

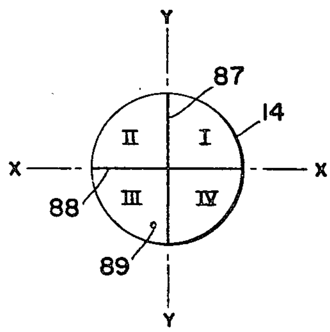


FIG. 4

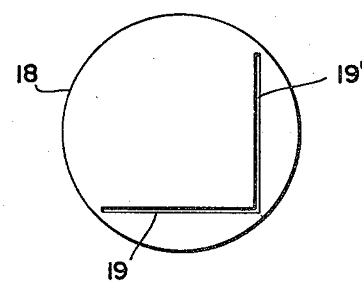


FIG. 5

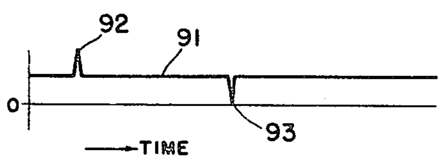


FIG. 7

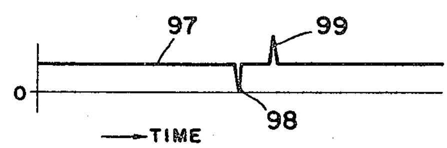


FIG. 6

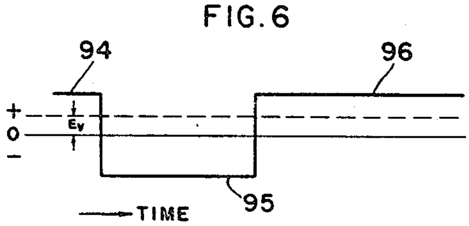
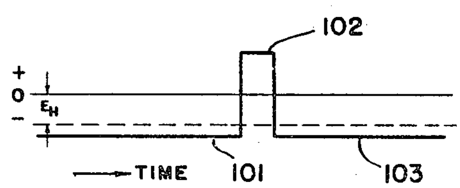


FIG. 8



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Patented Aug. 19, 1947 2,425,956

UNITED STATES PATENT OFFICE

2,425,956

TARGET SEEKING DEVICE WITH PHOTOTUBE MULTIPLIER

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Application January 27, 1944, Serial No. 519,936

8 Claims. (Cl. 250—41.5)

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This invention relates to target-locating methods and devices, and particularly to systems of this character employing photoelectric multiplier tubes.

According to conventional practice phototube multiplier tubes of various types have been used to provide information regarding the location of a remote target in the form, for example, of a point of light. Generally, the tubes previously used have been of two classes. One type of tube is provided with a photoelectric cathode divided into separate areas of predetermined form such as quadrants of a circular area and has arranged cooperatively therewith an individual electron multiplier for each subdivision of the cathode area. The other type of tube employs a solid photoelectric cathode and a plurality of electron multipliers having anode structure of suitable configuration to divide the electron image as desired.

As is well known in the art, however, tubes of these types are capable only of providing information regarding the general location of the target. These tubes are incapable of supplying detailed information regarding the accurate location of the target with respect to a line of sight which conveniently may be arranged to coincide with the optical axis of the tube.

It is an object of the present invention, therefore, to provide a novel target-seeking device including a phototube, also of novel construction, for converting an image of the area including a target into electrical intelligence representative of the accurate location of the target with respect to a predetermined point in an optical system used in conjunction with the tube.

Another object of the invention is to provide a phototube multiplier having cathode and anode structure of suitable configuration to enable alternate scansions in different directions of a complete electron image.

Another object of the invention is to provide a novel method of accurately locating a point in an optical image which utilizes alternate scansions of a corresponding electron image in two directions.

Still another object of the invention is to provide a novel method of locating a target, whereby to develop electrical effects representative of the target location.

According to the instant invention, there is provided a phototube multiplier including a photoelectric cathode having an electron emissive area bounded by a set of non-emissive axes to which any point on the cathode may be referred for the

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purpose of accurately locating the point. There also is provided an electron multiplier having an anode electrode in which there is formed an aperture of suitable configuration to admit a stream of electrons from a complete line of the electron image emitted by the cathode. Preferably, the aperture is provided with two perpendicularly intersecting legs. The electron image is focused into the plane of the anode, and means are provided for deflecting the electron image over the scanning aperture alternately in two different directions. Also, in a preferred form of the invention, the entire cathode is illuminated uniformly to a predetermined intensity from a local source of light. This intensity preferably is less than that projected upon the cathode by the optical system from the distant point of light representing the target. As a consequence, the scanning of the electron image over the aperture of the multiplier effects the development of distinctive impulsive voltages representative of the target and the axes respectively. The time relationships of the impulsive voltages give an accurate measure of the location of the target with respect to the reference axes. These impulsive voltages may be translated in any suitable manner to convert the information into more intelligible or useful form.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings;

Fig. 1 is a schematic representation of a phototube multiplier and associated control apparatus embodying the invention;

Fig. 2 is a schematic illustration of apparatus adapted to translate the signals developed by the phototube multiplier tube into more intelligible form;

Fig. 3 is a face view of a photoelectric cathode embodied in the tube of Fig. 1;

Fig. 4 is a face view of an anode of the multiplier forming a part of the tube of Fig. 1; and

Figs. 5, 6, 7 and 8 are voltage wave forms which will be referred to for an explanation of the operation of the apparatus embodying the invention.

Referring now particularly to Fig. 1 of the drawings, there is shown a phototube multiplier having an evacuated envelope 11. The optical system which is used with the device may be made an integral part of the tube, if desired. In such a case it may be of the reflection type comprising a concave reflector such as the spherically shaped light reflecting member 12 supported in any convenient manner (not shown) within the tube envelope adjacent one end thereof. The other end wall of the envelope 11 comprises a lens 13 having a configuration suitable to correct for spherical aberration of the reflector 12. A photoelectric cathode 14 having a spherical surface facing the reflecting surface of the member 12 is formed upon a suitable metallic backing plate 15 which in turn is affixed to the end of a rigid metallic rod 16 sealed through the central portion of the lens 13. The reflecting member 12 is provided with a substantially circular aperture 17 at the center thereof in alignment with and of substantially the same dimensions as the cathode 14.

At the side of the reflecting member 12 remote from the cathode 14 there is disposed a multistage electron multiplier in a stem portion of the tube envelope 11. The multiplier comprises an anode 18 having an aperture 19 of special configuration. The first stage multiplier electrode 20 is provided with a form suitable to receive electrons passing through the anode aperture. The remaining multiplier electrodes may be in the form of conventional box type structures such as 21 and are supplied in numbers sufficient to effect the development of signal voltages in the output circuit of the desired magnitudes. All of the multiplier stage electrodes are provided with inner surfaces capable of secondary electron emission. The multiplier also is provided with an electron collecting electrode which may be in the form of a plate 22.

The space between the photoelectric cathode 14 and the anode 18 within the tube envelope 11 is substantially completely surrounded by an electro-magnetic focusing coil 23. Suitable direct current energy is supplied to this coil from a source such as a battery 24.

Horizontal and vertical deflecting elements 25 and 26 respectively, which are illustrated schematically in the drawing, are provided in a well known manner externally of the tube envelope. Energy for effecting the operation of the deflecting elements is supplied by a deflection voltage generator 27. Preferably, the wave form of this voltage is saw-toothed and is provided at a relatively low frequency, such as, for example, 60 cycles per second. The deflection voltage is developed across an input resistor 28 for a pair of electron discharge devices such as the triode vacuum tubes 29 and 30. One terminal of the input resistor is connected to ground and the other terminal to the junction point between two similar biasing resistors 31 and 32. The respective terminals of the biasing resistors are connected to the control grids of the vacuum tubes 29 and 30.

The anode of the tube 29 is connected through a load resistor 33 to the positive terminal of a source of unidirectional energy such as a battery 34 of which the negative terminal is connected to ground. Similarly, the anode of the vacuum tube 30 is connected through a load resistor 35 to the positive terminal of the battery 34. The cathodes of the vacuum tubes also are connected through a self biasing resistor 36 to ground. This resistor is shunted by a bypass condenser 37.

The output circuit of the vacuum tube 29 which is derived from the anode of the tube is coupled by means of a condenser 38 to one terminal of the vertical deflecting element 26, the other terminal of which is connected to ground. In like manner the output circuit of the vacuum tube 30 which is derived from the anode of the tube is coupled by means of a condenser 39 to one terminal of the horizontal deflecting element 25 of which the other terminal is connected to ground.

There also is connected to the grid terminals of the biasing resistors 31 and 32 the output circuit terminals of a source of switching voltage 41. Preferably, this voltage has a substantially rectangular wave form and is provided at a frequency which is approximately one half of the frequency of the deflection voltage derived from the generator 27. By this means the vacuum tubes 29 and 30 are alternately conditioned for operation for successive complete cycles of the deflection voltage derived from the generator 27.

In a preferred form of the invention, the photo-electric cathode 14 of the phototube multiplier is provided with a uniform illumination of predetermined intensity. One manner of accomplishing this is by directing light from a source such as an electric lamp 42 upon the reflecting surface of the member 12. This light then is projected by reflection to flood the entire surface of the cathode 14 with light of predetermined intensity.

The phototube multiplier is provided with operating voltages derived from a voltage divider comprising a series arrangement of a plurality of resistors such as 43 and 44. The terminals of this series of resistors are connected to the terminals of a source of unidirectional energy such as a battery 45. The negative terminal of the battery is connected to the photoelectric cathode 14, and the anode 18 and multiplier electrodes such as 20 and 21 are connected respectively to taps on the voltage divider of increasingly positive potentials. The collecting electrode 22 is connected through an output resistor 46 to the grounded positive terminal of the battery 45. The voltages developed by the multiplier in the output resistor 46 are impressed by means of conductors 47 and 48 upon suitable translating apparatus by which they are converted into more intelligible form.

Having reference now to Fig. 2 of the drawings, there is shown one form of translating apparatus which may be connected to the conductors 47 and 48. This apparatus includes an amplifier tube 49, a phase inverting vacuum tube 51 and two pairs of translating tubes 52—53 and 54—55. The translating tubes are gas-filled devices having trigger operating characteristics and may be of the 2050 type or its equivalent.

Specifically, the conductor 47 is coupled by means of a condenser 56 to the control grid of the amplifier tube 49. Also connected to this grid is a leak resistor 57, the other terminal of which is connected to the grounded conductor 48. A self-biasing resistor 58 is connected between the cathode of the tube 49 and ground. This resistor is shunted by an alternating current bypass condenser 59. The anode of the tube 49 is connected through a potentiometer 61 to the positive terminal of a source of unidirectional energy such as a battery 62 of which the negative terminal is connected to ground.

The adjustable sliding contact 63 of the potentiometer 61 is connected by a coupling condenser 64 to the control grid of the phase inverting tube 51. A leak resistor 65 for the coupling condenser is connected between the control grid of the tube and ground. The cathode of the tube 51 is connected to the cathode of the tube 49 so that the input circuit of the former tube also is subject to the biasing action of the resistor 58. The anode of the tube 51 is connected through a load resistor 66 to the positive terminal of the battery 62.

The anode of the amplifier tube 49 is connected by the coupling condenser 67 to the control grids of the translating tubes 52 and 54. A leak resistor 68 for the coupling condenser 67 is connected between the control grids of the tubes 52 and 54 and ground.

In like manner the anode of the phase inverting tube 51 is connected by a coupling condenser 69 to the control grids of the translating tubes 53 and 55. A leak resistor 71 also is provided for this coupling condenser and is connected between the control grids and the tubes 53 and 55 and ground.

The cathodes of the translating tubes 52 and 53 are connected through a biasing resistor 72 to ground. Similarly, the cathodes of the translating tubes 54 and 55 are connected through a biasing resistor 73 to ground. The cathode terminals of the resistors 72 and 73 are connected, respectively, by conductors 74 and 75 to the output terminals of the switching voltage generator 41 of Fig. 1 for a purpose to be described in a subsequent portion of the specification.

The anodes of the translating tubes 52 and 53 are connected, respectively, through load resistors 76 and 77 and a current limiting resistor 78 to the positive terminal of a source of unidirectional energy such as a battery 79 of which the negative terminal is connected to ground. A commutating condenser 81 is connected between the anodes of the translating tubes 52 and 53. Also connected to the anodes of these tubes is a suitable utilization circuit which, in this instance, is represented as including an indicating instrument 82 such as a D. C. voltmeter which indicates both the magnitude and the polarity of the average voltage developed across the load resistors 76 and 77.

The anodes of the translating tubes 54 and 55 also are connected, respectively, through load resistors 83 and 84 and the resistor 78 to the positive terminal of the battery 79. A commutating condenser 85 also is connected to the anodes of the tubes 54 and 55. A voltage indicating device 86 is connected to the anodes of the tubes 54 and 55 in a manner to indicate the magnitude and polarity of the average voltage developed across the load resistors 83 and 84.

An important feature of apparatus embodying the invention resides in the marking of the photoelectric cathode 14 of the phototube multiplier illustrated in Fig. 1, and the relationship of the marking to the configuration of the aperture 19 formed in the tube anode 18. Reference is made to Figs. 3 and 4 for illustration of one arrangement of these tube components. The main portion of the cathode 14 is made with a photoelectron emissive surface. However, in this form of the invention the photoelectric surface is not continuous. It is traversed vertically by a slot 87 constituting a Y axis and horizontally by a slot 88 constituting an X axis. The distinctive characteristic of these slots is that they have a different emissivity from the rest of the cathode. In a preferred form they are made substantially non-emissive. An electrode of this character forms the subject matter of a copending application of Robert W. Sanders, Serial No. 540,561, filed June 16, 1944, and entitled "Image tube." In the illustrated form of the invention these slots are disposed on the cathode in a manner to be perpendicularly mutually bisecting as

shown. In this manner the surface of the cathode 14 is divided into four substantially equal electron emissive areas of quadrant shape. It has been found in practice that the width of the slots 87 and 88 preferably is from 10 to 15 thousandths of an inch which thereby renders them comparable in size to the light spot projected onto the cathode from the distant target.

The aperture formed in the anode 18 in this case comprises an L-shaped slit having a horizontal leg 19 and a vertical leg 19'. The width of each of the aperture legs preferably corresponds to that of the electron image of the cathode slots.

Referring now to the operation of the apparatus embodying the invention, assume that the optical image projected onto the photoelectric cathode 14 of the phototube multiplier is substantially dark with the exception of a single relatively small spot of light coming from the target, the position of which it is desired to locate. It is assumed that the light spot is so located with respect to the axes of the cathode that it appears in quadrant III of Fig. 3 at a point 89. By reason of the relatively low intensity illumination of the cathode 14 by the lamp 42 the electron image from the cathode has a relatively low normal value with the exception of the axes formed by the slots 87 and 88 and the point 89. The emission from the axes is substantially zero and the emission from the point 89 is somewhat in excess of the emission from other parts of the cathode.

It is assumed that a vertical deflection of the electron image produced by the photoelectric cathode is made first to develop a voltage representing the position of the point 89 with respect to the horizontal axis 88, i. e., the ordinate of the point. Secondly, a horizontal deflection of the electron image is made to develop a voltage representative of the position of the point 89 with respect to the vertical axis 87, i. e. the abscissa of the point. It is assumed also that previously a similar cycle of operation has been performed. As a result of the previous operating cycle the translating tubes 52 and 55 are left in conducting states.

The voltage derived from the output terminals of the switching voltage generator 41 is changed abruptly from a negative to a positive value, thereby biasing the switching tubes 29 and 30 so that the former is rendered operative and the latter inoperative. The development in the input resistor 28 of the saw-tooth deflection voltage derived from the generator 27 thus is ineffective to alter the conductivity of the tube 30 but is effective to vary the conductivity of the tube 29, whereby to develop an amplified saw-tooth voltage for impression upon the vertical deflecting element 26. In this manner the electron image is deflected downward across the horizontal leg 19 of the scanning aperture formed in the anode 18. In this manner successive horizontal strips of the electron image are brought into registry with the aperture leg 19.

As a result of the uniform local illumination of the cathode a relatively small number of electrons are admitted to the multiplier at all times with the exception of the scansions of the horizontal strips which include the light spot 89 and the horizontal axis 88. In the former instance there is an abrupt increase in the number of admitted electrons while the strip containing the light spot is in registry with the aperture. In the latter instance here is an abrupt decrease in the number of admitted electrons while the strip including the horizontal axis 88 is in registry with the aperture.

Referring now more particularly to Fig. 5, there is illustrated a curve representing the voltage developed in the output resistor 46 of Fig. 1. The horizontal line 91 represents the voltage generated during the scansion of the major portion of the electron image. The increased impulsive voltage 92 represents the scansion of the strip including the light spot 89 of Fig. 3 and the decreased impulsive voltage 93 represents the scansion of the horizontal cathode axis 88. Since these voltages are plotted against time and the axis 88 substantially bisects the cathode 14 vertically, the decreased impulsive voltage 93 occurs substantially at the midpoint of the scanning cycle. Also, since the vertical scansion is effected by deflecting the electron image from top to bottom, as illustrated and described herein, the increased impulsive voltage 92 occurs at a time prior to the occurrence of the voltage 93. The time difference between the voltages 92 and 93 thus is a measure of the distance by which the light spot 89 is removed from the horizontal axis 88. Also, the fact that the voltage 92 occurs prior in time to the voltage 93 is an indication that the light spot is located below the horizontal axis in either quadrants III or IV.

Referring again more particularly to Fig. 2, the operation of the apparatus for translating the developed voltage illustrated in Fig. 5 will be described. The connection of the switching voltage generator 41 of Fig. 1 by means of conductors 74 and 75 to the cathodes of all of the translating tubes is of a character to bias the input circuits of the translating tubes 54 and 55 sufficiently negative to prevent their operation when the polarity of the generated switching voltage is reversed from negative to positive polarity as described. At the same time this switching voltage is impressed upon the input circuits of the translating tubes 52 and 53 in a manner to condition them for operation under the control of voltages developed in the output circuits of the tubes 49 and 51.

The condition of the translating apparatus remains unchanged from the preceding scanning cycle until the voltage impulse 92 is developed. This impulse, being more positive than the voltage which precedes it, increases the conduction of space current in the amplifier tube 49 to develop a negative impulsive voltage at the tube anode which is impressed by the coupling condenser 69 upon the control grid of the translating tube 52. This tube is conducting and the negative grid voltage is ineffective to extinguish the tube so long as the anode-to-cathode voltage is maintained at a magnitude sufficient to sustain ionization.

However, the increased conduction of space current in the amplifier tube 49 also develops a negative impulsive voltage at the potentiometer contact 63 for impression upon the control grid of the phase reversing tube 51. Consequently, space current conduction in this tube is decreased whereby to produce a positive impulsive voltage at the anode thereof. This voltage is impressed by the coupling condenser 69 upon the control grid of the translating tube 53. It also is impressed upon the control grid of the translating tube 55 but is ineffective because of the described inoperative biasing thereof and also the fact that this tube is at the time conducting. The positive impulsive voltage derived from the tube 51 initiates the conduction of space current in the translating tube 53 to decrease the positive potential at the anode of the tube. The commutating condenser 81 then becomes effective in a well known manner to depress the anode-to-cathode voltage of the translating tube 52 sufficiently to effect the deionization of this tube, whereby the conduction of space current therein is interrupted.

The altered conducting conditions of the tubes 49 and 51 exist only for the duration of the impulsive voltage 92 of Fig. 5 after which the conditions revert to the normal state described. However, the altered conducting conditions of the translating tubes 52 and 53 remain effective until subsequently changed under the control of the voltages developed by the phase reversing tubes. This is true because the tubes 49 and 51 are high vacuum tubes, class A operated, while the tubes 52 and 53 are gas-filled tubes. Consequently, when the horizontal axis 88 of the cathode is scanned to develop the decreased impulsive voltage 93 of Fig. 5, the conduction of space current in the amplifier tube 49 is decreased to develop a positive impulsive voltage in the output circuit thereof. As a result, the conduction of space current in the phase reversing tube 51 is increased whereby to develop in the output circuit thereof a negative impulsive voltage. The positive voltage impulse is impressed upon the control grid of the translating tube 52 to initiate again the conduction of space current therein. The commutating condenser 81 again functions this time to extinguish the translating tube 53. These conditions of the translating tubes remain in effect for the remainder of this scanning cycle, the entire horizontal scanning cycle which follows immediately thereafter, and which will be described presently, and until the development by the phototube multiplier of a voltage impulse corresponding to 92 during the next vertical scanning cycle.

By reason of the described operation of the translating tubes 52 and 53, the polarity of the voltage developed in the load resistors 76 and 77 is continually being reversed. For example, when the tube 52 is conducting and the tube 53 is non-conducting, the polarity of the anode terminal of the resistor 77 is positive with respect to the anode terminal of the resistor 76. When the tube 53 is conducting and the tube 52 is non-conducting, the polarity of the anode terminal of the resistor 77 is negative with respect to the anode terminal of the resistor 76. Thus, the current flow through the utilization circuit, which, in this instance includes the indicating device 82, is continually being reversed in direction.

Under the conditions resulting from the assumed location of the light spot 89 of Fig. 3 relative to the horizontal axis 88, the voltage conditions in the utilization circuit are represented by the curve of Fig. 6. Prior to the development of the increased impulsive voltage 92 of Fig. 5, the voltage in the utilization circuit of the translating apparatus may be of a positive polarity with respect to ground as indicated by the line 94. In the time interval between the voltage impulses 92 and 93 the utilization circuit voltage is of negative polarity as represented by the line 95, after which it reverts to its original positive polarity as indicated by the line 96. It is evident that, during the greater part of a scanning cycle, the utilization circuit voltage is in the positive region.

Consequently, any device such as the indicating instrument 82, which is responsive to the average polarity of the utilization circuit voltage, will function according to, or will indicate, a positive voltage such as that designated E_v in Fig. 6. The average polarity of the utilization circuit voltage is indicative of the location of the light spot relative to the horizontal axis and the magnitude of this voltage is a measure of the distance by which the light spot is removed from this axis.

Following the described vertical scanning cycle the polarity of the voltage developed at the output terminals of the switching generator 41 of Fig. 1 reverses so as to render operative the vacuum tube 30 and to render inoperative the vacuum tube 29. In this manner the deflection voltage derived from the generator 27 is effective to energize the horizontal deflecting element 25, whereby to effect a horizontal deflection of the electron image over the vertical leg 19' of the anode aperture.

Referring now more particularly to Fig. 7, the voltage developed in the output circuit of the multiplier is illustrated for a horizontal scanning cycle. The horizontal line 97 represents the normal voltage developed by the scansion of the portions of the cathode illuminated solely from the local source. As viewed in Figs. 3 and 4 the horizontal scansion is effected by deflecting the electron image from left to right. In this case the normal multiplier developed voltage is unaffected until the vertical axis 87 is scanned. At this time there is developed a decreased impulsive voltage 98. Subsequently, the scanning of the vertical strip, including the light spot 89 effects the development of an increased impulsive voltage 99. The voltage impulse 98 occurs substantially at the midpoint of the scanning cycle as in the previous instance. Inasmuch as the light spot 89 is in quadrant III and quadrants I and IV are scanned completely before the vertical axis 87 is scanned, the voltage impulse 99 is not developed until after the voltage impulse 98 is generated. Also, the time interval between the development of the voltage impulses 98 and 99 is a measure of the distance by which the light spot is removed from the vertical axis.

Referring again more particularly to Fig. 2, it will be recalled that the translating tube 55 is conducting as originally assumed. Also, during the horizontal scanning cycle the polarity of the conductors 74 and 75 is reversed as previously described, whereby to inoperatively condition the translating tubes 52 and 53 and to operatively condition the translating tubes 54 and 55. Consequently, when, under the control of the voltage impulse 98, a positive impulsive voltage is impressed upon the control grid of the translating tube 54 and a negative impulse voltage is impressed upon the control grid of the translating tube 55, there is initiated the conduction of space current in the former tube. The commutating condenser 85 functions to extinguish the tube 55. In a similar manner the devedopment of the increased impulsive voltage 99 effects the reoperation of the translating tube 55 and the extinguishing of the translating tube 54.

In Fig. 8 the illustrated curve represents the voltage variation in the utilization circuit including the indicating device 86. The line 101 represents the polarity of the utilization circuit voltage during the first half of the horizontal scanning cycle and a portion of the second half of this cycle. The positive utilization circuit voltage represented by the line 102 is developed in the manner described during the time interval between the generation of the voltage impulses 98 and 99. Subsequently, the utilization circuit voltage reverts to a negative polarity as indicated by the line 103. It is clear that, for the greater portion of a horizontal scanning cycle, the utilization circuit voltage is in the negative region. Consequently, the average polarity of the voltage indicated by the instrument 86 is negative and is designated E_h in Fig. 8. The fact that the polarity of the average voltage is negative is an indication that the light spot is either in quadrants II or III of the electron image. The magnitude of the average utilization circuit voltage is a measure of the distance by which the light spot is removed from the vertical axis.

It is apparent, therefore, that the combination of the information indicated by the instruments 82 and 86 is adequate to accurately locate the light spot with respect to the intersection of the horizontal and vertical axes of the photoelectric cathode. The instrument 82 indicates by the polarity of its reading that the light spot is either in quadrants III or IV, i. e. its ordinate (y in Fig. 3) is negative. The distance by which the light spot is removed from the horizontal axis, i. e. the value of y is equal to the magnitude of the scale reading of the instrument. Likewise, the instrument 86 indicates by the magnitude and polarity of its reading the abscissa x of the light spot. Therefore, the precise location of the line spot with reference to the intersection of the axis is obtainable from the information provided.

It is believed to be obvious without further explanation that the apparatus is capable of providing the requisite information to locate accurately the light spot in any other quadrant. It is contemplated to be within the scope of the invention to position the reference axes on the photoelectric cathode in other than the described manner and also to employ anode apertures of suitable configuration to cooperate therewith.

Similarly, it is believed to be within the skill of those versed in the art to employ the information derived in the manner described for other than the illustrated purpose. For example, the utilization circuit voltages may be employed to actuate suitable mechanism whereby to alter the direction in which the phototube multiplier is pointed whereby to bring its line of sight into alignment with the distant target. In like manner the directing or aiming of any other type of device may be effected by the use of the voltages developed in the described utilization circuits.

While there has been described what, at present, is considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A target-seeking device comprising, means including a photoelectric cathode for producing an electron image including a representation of a light emitting target in a predetermined plane remote from said cathode, an electrode having a slit type aperture comprising two angularly disposed legs, means located adjacent the space between said cathode and said electrode for alternately deflecting said electron image across the respective legs of said aperture, and means in-

cluding an electron multiplier located behind said electrode for converting said deflected electron image into two signals representative of the position of said light source with respect to a predetermined point of said electron image.

2. A target-seeking device comprising, a photoelectric cathode having axes of different emissivity from that of the rest of the cathode, means including said cathode for producing an electron image including a representation of a light emitting target in a predetermined plane opposite said cathode, an electrode located in said predetermined plane and having a double slit aperture comprising two angularly disposed legs, horizontal and vertical deflecting elements, means coupled to said horizontal and vertical deflecting elements to energize said deflecting elements in alternation, thereby alternately to deflect said electron image horizontally and vertically across said aperture, and means including an electron multiplier positioned to receive electron energy from said electrode aperture for converting said electron image into two voltages representative of the coordinates of said light source with respect to the axes of said cathode.

3. A target-seeking device comprising, an envelope having a transparent wall, a photoelectric cathode in said envelope and having perpendicularly intersecting non-emissive axes, means outside of said envelope for uniformly illuminating said cathode through said transparent wall, means including said cathode for producing an electron image including a representation of a distant light emitting target, an anode having an L-shaped aperture, the respective legs of said aperture being substantially parallel to the electron image of said cathode axes, horizontal and vertical deflecting elements, a pair of electronic devices each coupled respectively to said horizontal and vertical deflecting elements, means including a source of switching energy coupled to said electronic devices in a manner to render them operative in alternation, thereby alternately to deflect said electron image horizontally and vertically across said aperture, and means including an electron multiplier positioned to receive electron energy passing said anode aperture for converting said electron image into two voltages representative of the coordinates of said light source with respect to the axes of said cathode.

4. A target-seeking device comprising, a transparent evacuated envelope, a photoelectric cathode in said envelope and having perpendicularly mutually bisecting non-emissive axes, means outside of said envelope for illuminating said cathode at a predetermined uniform intensity, means including an optical system embodied in said envelope for focusing upon said cathode an optical image of an area surrounding a distant light emitting target, said cathode thereby producing a composite electron image including said target, an anode facing said cathode having a two-legged L-shaped aperture, the respective legs of said aperture being substantially parallel to said cathode axes, horizontal and vertical deflecting elements, a source of saw-tooth energy, a pair of electronic devices each coupled respectively between said horizontal and vertical deflecting elements and said saw-tooth energy source, a source of switching energy having a periodicity equal substantially to one-half of the periodicity of said saw-tooth energy coupled to said electronic devices in a manner to render them operative in alternation, thereby alternately to deflect said electron image horizontally and vertically across the two legs of said aperture, and means including an electron multiplier positioned to receive electron energy passing said anode aperture for converting said electron image into two voltages representative of the coordinates of said light source with respect to the axes of said cathode.

5. A phototube comprising, an evacuated envelope, a photoelectric cathode disposed in said envelope, said cathode having an electron emissive area provided with two bounding portions of different emissivity, and an anode disposed opposite to said cathode, said anode being provided with a slit type scanning aperture having legs disposed substantially parallel respectively to said cathode bounding portions.

6. A phototube multiplier comprising, an evacuated envelope, a photoelectric cathode disposed in said envelope, said cathode having an electron emissive area bounded on two sides by non-emissive slotted portions, an electron multiplier in said envelope, and an anode disposed intermediate of said cathode and said multiplier, said anode being provided with a slit type scanning aperture having legs disposed substantially parallel respectively to said cathode slots.

7. A phototube multiplier comprising, an evacuated envelope, a photoelectric cathode disposed in said envelope, said cathode being divided into a plurality of electron emissive areas of predetermined form by two perpendicularly intersecting non-emissive slotted portions, an electron multiplier mounted in said envelope opposite to said cathode, and an anode disposed intermediate of said cathode and said multiplier, said anode being provided with a double slit scanning aperture having perpendicularly intersecting legs disposed substantially parallel respectively to said cathode slots.

8. A phototube multiplier comprising, an evacuated envelope, a photoelectric cathode disposed in said envelope, said cathode being divided into quadrants by two perpendicularly mutually bisecting non-emissive slotted portions, a multistage electron multiplier mounted in said envelope opposite to said cathode, and an anode disposed intermediate of said cathode and said multiplier, said anode being provided with an L-shaped scanning aperture having the legs thereof disposed substantially parallel respectively to said cathode slots.

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