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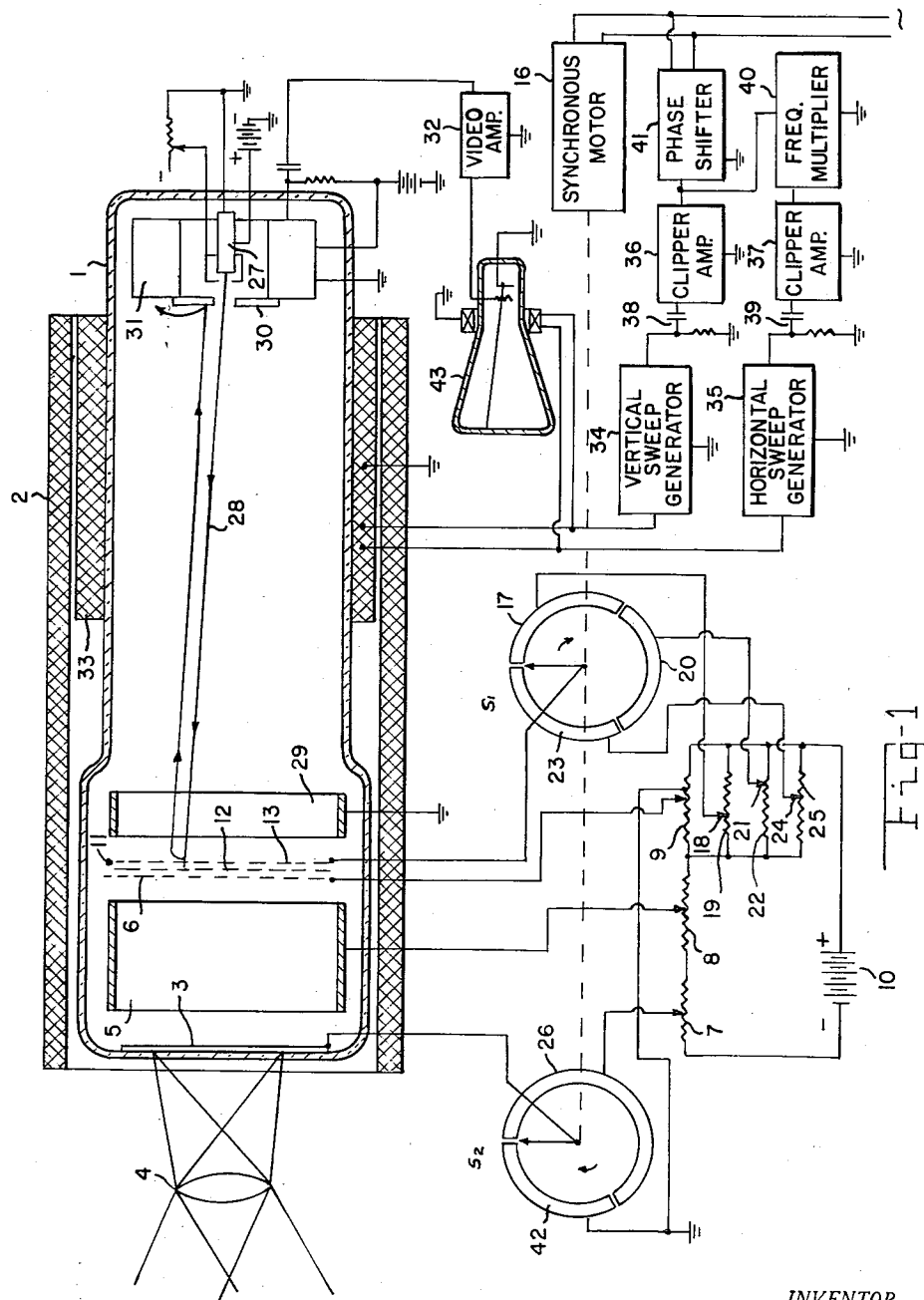
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MOVING TARGET INDICATOR WITH BACKGROUND COMPENSATION
FOR VISUAL LIGHT AND THE NEAR INFRARED

Filed Aug. 17, 1959

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

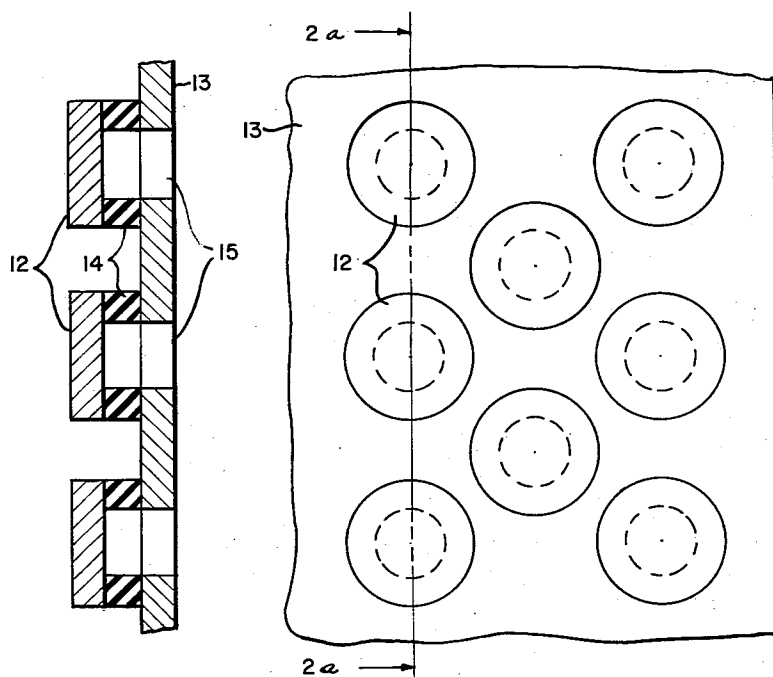


Fig-2a

Fig-2b

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MOVING TARGET INDICATOR WITH BACKGROUND COMPENSATION FOR VISUAL LIGHT AND THE NEAR INFRARED

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2 Claims. (Cl. 315—11)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

The recognition of targets on a television screen which also reproduces the background is very difficult, particularly when the target blends with the background and when such blending is enhanced by camouflage techniques.

The purpose of this invention is to provide a television pick-up tube which will produce a video signal that is devoid of background information and representative of moving targets only. This signal, when applied to a kinescope, produces a visual display of the moving targets in the field of view with the background absent. Briefly, the technique involves forming successive positive charge and negative charge patterns of the field of view on a storage element through controlling its secondary emission ratio. These oppositely charged patterns neutralize each other for stationary objects while leaving a residual charge in the case of objects that have changed position. The residual charge is then converted by a scanning beam into the moving target video signal.

A more detailed description of the invention will be given with reference to the specific embodiment thereof shown in the accompanying drawings in which—

Fig. 1 is a schematic diagram of a moving target indicator in accordance with the invention, and

Figs. 2a and 2b illustrate the construction of a suitable storage element.

Referring to Fig. 1, the pick-up tube comprises an evacuated envelope 1 surrounded by a coil 2 for providing a magnetic focusing field parallel to the longitudinal axis of the tube. An image of the field of view is formed on the outer surface of photocathode 3, with visible or infrared light, by a suitable optical system represented by lens 4. The presence of the optical image causes the photocathode to emit electrons from its inner surface with an electron density distribution pattern conforming to the light intensity distribution in the optical image. Accelerating electrode 5 and fine wire electron pervious grid 6 are normally maintained at increasingly greater positive potentials relative to photocathode 3 by means of a voltage divider made up of resistors 7, 8 and 9 energized from direct current source 10. Under the influence of these electrodes and the magnetic field produced by coil 2, the electrons emitted from the surface of photocathode 3 travel in straight lines parallel to the tube axis through grid 6 and impinge on storage element 11.

The construction of the storage element 11 is illustrated in Figs. 2a and 2b. It consists of a multitude of minute metal discs 12 supported on a metallic substrate 13 by means of washer-like insulators 14. The metal discs and insulators are concentric with circular openings 15 in the substrate. Storage electrodes of this type are constructed by the use of photoetching techniques.

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The photoelectrons emitted by photocathode 3 are accelerated toward grid 6 as previously mentioned. Most of them pass through the grid and strike the metal discs 12 from which they liberate secondary electrons. The potential of discs 12 is determined by the potential of substrate 13 to which they are in effect capacitively coupled. The number of secondary electrons emitted by discs 12 that flow to grid 6 and therefore do not return to the discs is determined by the potential of the discs relative to grid 6. If the disc potential is reduced sufficiently relative to grid 6 enough secondary electrons will go to grid 6 to leave a net positive charge on the discs. This corresponds to a secondary emission ratio greater than unity. On the other hand, if the disc potential is raised relative to grid 6 by a sufficient amount the number of secondary electrons reaching grid 6 can be reduced to the point where a net negative charge is left on the discs. This corresponds to an effective secondary emission ratio of less than unity. Therefore, by proper selection of the lower and higher potentials of the storage electrode, it is possible, for a fixed electron incidence, to have the negative charge produced on the storage electrode during its higher potential just equal the positive charge produced during its lower potential and exactly cancel it. This is the principle that is used to cancel the background in the field of view as will be explained below.

Rotary switch S_1 is provided to control the potential of the storage electrode 11. This switch is rotated at constant speed by synchronous motor 16. When the contactor of S_1 is on segment 17, the storage electrode is connected to adjustable tap 18 of potentiometer 19 and the electrode has its lower potential. When the contactor of S_1 is on segment 20, the storage electrode is connected to adjustable tap 21 of potentiometer 22 and the electrode has its higher potential. A third segment 23 is also provided for connecting the storage electrode to tap 24 of potentiometer 25 during the scanning period as will be referred to later.

Rotary switch S_2 , which is driven in synchronism with switch S_1 , operates to apply the electron image produced by the photocathode 3 to the storage electrode 11 during the time that S_1 contactor is passing over segments 17 and 20 and to prevent its application during the scanning period, to be discussed later, when the S_1 contactor is passing over segment 23. Accordingly, segment 26 of S_2 has the combined angular extent of segments 17 and 20 of S_1 . When the contactor of S_2 is passing over segment 26, the photocathode 3 is connected to a point on potentiometer of low potential relative to accelerating electrode 5 and grid 6. Under these conditions the electrons emitted by photocathode 3 impinge upon the storage electrode 11 in the manner already explained. Therefore, as the S_1 contactor passes over segments 17 and 20 the storage electrode is bombarded with electrons from the photocathode. During the time that the S_1 contactor is on segment 17, electrode 11 is at its lower potential and its secondary emission ratio is greater than unity so that a positive charge pattern is formed on the discs. Similarly, during the following equal interval when the S_1 contactor is on segment 20, electrode 11 is at its higher potential and its secondary emission ratio is less than unity so that a negative charge pattern is formed on the disc 12. The electron density distribution in the cross section of the electron emission from photocathode 3 constitutes an electron image of the field of view and the two charge patterns likewise constitute positive charge and negative charge images of the field of view. By proper adjustment, at contacts 18 and 21, of the lower and higher potentials of storage electrode 11, it is possible to arrange that the positive and negative charge images of all stationary background objects in

the field of view, for which the electron images remain constant and fixed, are equal so that the net charge left on the storage electrode as a result of the presence of these objects is zero. For a moving object in the field of view the electron image occupies different positions during the formation of the corresponding charge images so that the charge images are formed at slightly different positions on the storage electrode and, as a result, the negative charge image does not completely cancel the positive charge image. A residual positive charge is therefore left on the storage electrode in the case of a moving object in the field of view.

The residual positive charge is removed and converted into a video signal by an electron beam scanning technique. The method used is the same as that employed in the image orthicon television camera tube. Tubes of this type are well known in the art and described in the literature, for example, in an article entitled "The Image Orthicon" by Rose, Weimer and Law appearing the July 1946 issue of the Proceedings of the Institute of Radio Engineers. Essentially, the scanning apparatus comprises an electron gun 27, which directs a beam of electrons 28 toward the storage electrode 11. The velocity of the electrons in the beam are reduced to a low value before striking the storage electrode by the low potential of decelerating electrode 29 and by the low potential of the target electrode itself. A sufficient number of electrons from the beam pass through opening 15 (Fig. 2a) in the storage electrode to neutralize the positive charges on the discs 12. The remainder are repelled and return to the relatively high potential of the first dynode 30 of an electron multiplier 31 which surrounds the electron gun 27. It is apparent that, if the beam is made to scan the storage electrode, the density of the return electron flow will be inversely modulated by the positive charge distribution on the storage electrode. This modulation constitutes the moving target video signal which, after amplification in electron multiplier 31, is applied to video amplifier 32 for further amplification and phase reversal, the final moving target video signal appearing in the output of this amplifier.

The beam is caused to scan the storage electrode by means of vertical and horizontal sawtooth currents caused to flow in the vertical and horizontal deflection windings of deflection yoke 33 by vertical and horizontal sweep generators 34 and 35, in accordance with standard practice. The sweeps are synchronized with switches S_1 — S_2 by deriving the trigger pulses for generators 34 and 35 from the voltage of the alternating current source energizing synchronous motor 16. This sine wave of voltage is converted into rectangular waves by clipper-amplifiers 36 and 37 from which sharp trigger pulses are derived by differentiating circuits 38 and 39. Frequency multiplier 40 provides for the required number of horizontal sweeps per frame. Phaseshifter 41 permits the proper phasing to be obtained between the vertical sweep and the rotary switch S_1 — S_2 . The duration of the vertical sawtooth is made equal to the time required for the S_1 contactor to move across segment 23 and the S_2 contactor to move across segment 42. During this interval the storage electrode 11 is connected to tap 24, which is at or near the potential of decelerating electrode 29, and photocathode 3 is connected to ground. This latter connection causes accelerating electrode 5 and grid 6 to be negative relative to the photocathode and prevents the electron image from reaching the storage electrode during the scanning cycle.

The moving target video signal at the output of video amplifier 32 may be converted into a visual image if desired by application to the beam intensity control electrode of kinescope 43, the sweeps of which are synchronized with those of the pick-up tube.

The pick-up tube is not limited to use with a storage element 11 of the type shown in Figs. 2a and 2b, but may employ any type of storage element operating on the secondary emission principle such, for example, as the thin glass plate used in the image orthicon.

I claim:

1. Apparatus for producing a video signal representative of the moving objects only in an optical image comprising: a pick-up tube containing a photocathode for converting said optical image into an electron image; a secondary emissive charge storage element positioned to receive said electron image for converting same into a corresponding charge pattern the polarity of which depends upon the secondary emission ratio of said storage element; cyclic means for controlling the secondary emission ratio of said storage element and the application of said electron image thereto, each cycle of operation of said cyclic means being divided into three consecutive intervals during the first of which said electron image is applied to said storage element and a secondary emission ratio greater than unity is established therefor, during the second of which said electron image is applied to said storage element and a secondary emission less than unity is established therefor, and during the third of which said electron image is prevented from reaching said storage element; and electron beam scanning means synchronized with said cyclic means and operative during said third interval to scan said storage element for converting the charge pattern thereon into a video signal.

2. Apparatus for producing a video signal representative of the moving objects only in an optical image comprising: a pick-up tube containing a photocathode for converting said optical image into an electron image; a secondary emissive charge storage element positioned to receive said electron image for converting same into a corresponding charge pattern; an electron previous grid situated between said photocathode and said storage element and close to said storage element; cyclic means for controlling the potential between said photocathode and said grid and between said grid and said storage element, each cycle of operation of said cyclic means being divided into three consecutive intervals during the first of which said grid has a high potential relative to said photocathode and the potential of said grid relative to said storage element is such that said storage element has a secondary emission ratio greater than unity, during the second of which said grid has a high potential relative to said photocathode and the potential of said grid relative to said storage element is such that said storage element has a secondary emission ratio less than unity, and during the third of which the potential of said grid relative to said photocathode is sufficiently low to block the electron image from said storage element; and electron beam scanning means synchronized with said cyclic means and operative during said third interval to scan said storage element for converting the charge pattern thereon into a video signal.

No references cited.