Jan. 20, 1959 W. F. SCHREIBER 2,870,369

CATHODE RAY TUBE COUNTING DEVICE

Filed Feb. 28, 1955

Fig. 1

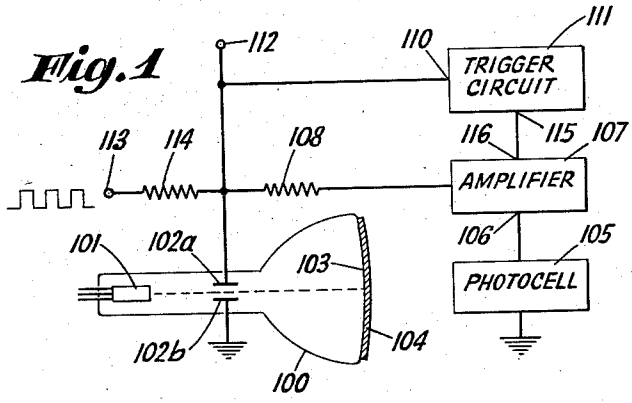


Fig. 5

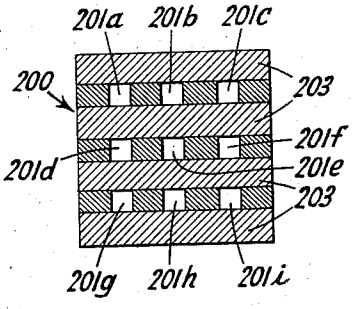


Fig. 2a Fig. 2b

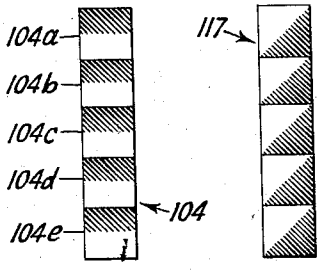


Fig. 3

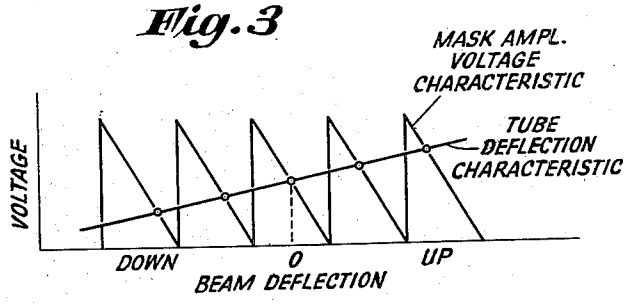
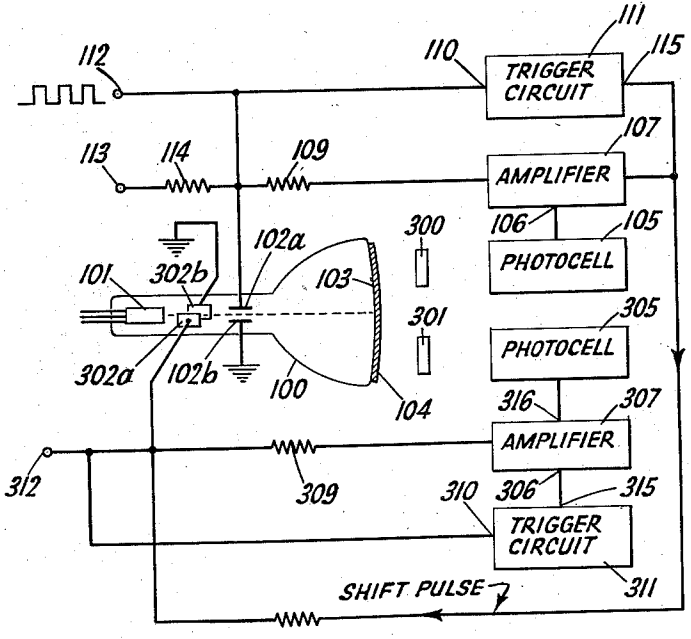


Fig. 4



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CATHODE RAY TUBE COUNTING DEVICE

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7 Claims. (Cl. 315—10)

My invention relates to electronic switching apparatus and more particularly relates to cathode ray tube circuits for use in such apparatus.

The prior art has knowledge of circuits of this type in which the cathode ray tube is provided with a plurality of anodes, the electron beam produced within the tube being directed sequentially upon each anode individually in accordance with externally supplied electric pulses. Such tubes require complicated and expensive electrode structures; further, it is a tedious, time consuming, and difficult procedure to mount these electrodes in proper manner within the tube envelope.

I have invented a cathode ray tube circuit of the character indicated in which these difficulties are obviated.

Accordingly, it is an object of the present invention to provide a new and improved cathode ray tube circuit of the character indicated.

Another object is to provide a new and improved cathode ray tube circuit of the character indicated which makes use of a conventional cathode ray tube and a novel externally mounted optical mask or wedge.

Still another object is to provide a new and improved cathode ray tube circuit adapted for use in switching apparatus and including, in operative relationship, a conventional cathode ray tube, an externally mounted optical wedge or mask, a photocell and a feedback amplifier.

Yet another object is to provide a new and improved cathode ray tube circuit of the character indicated which incorporates a novel optical mask or wedge and which obtains a switching action with the use of one or two dimensional scanning.

These and other objects of the invention will either be explained or will become apparent to those skilled in the art when this specification is studied in conjunction with the accompanying drawings wherein:

Fig. 1 illustrates an embodiment of the basic invention as applied to one dimensional scanning;

Figs. 2*a* and 2*b* illustrate alternate types of optical wedges and masks for use in the apparatus of Fig. 1;

Fig. 3 is a diagram illustrating graphically the voltage-deflection characteristic of the invention of Fig. 1;

Fig. 4 illustrates a second embodiment of the basic invention as applied to two dimensional scanning; and

Fig. 5 illustrates an optical wedge or mask for use with the apparatus of Fig. 4.

In accordance with one main feature of the invention, I provide a conventional cathode ray tube provided with means for producing an electron beam, a luminescent screen upon which the beam is directed, and a pair of deflector plates for deflecting the beam in one given dimension, for example, horizontally or vertically. An optical mask provided with a plurality of like sections spaced sequentially along the given direction is positioned in front of the luminescent screen. Each section is transparent and the transparency varies from point to point within each section in the same manner. As the beam passes over each section, the passage can be observed visually. A photocell is mounted in front of the mask

and responds to the luminescent information appearing in the mask to develop a voltage proportional thereto. As the beam position within any mask section is varied along the given direction, the photocell output voltage will be varied accordingly because of the transparency variations within the section. This varying output voltage is amplified, if necessary, and then is supplied as a feedback voltage to the deflection plates. The purpose of this feedback voltage is to stabilize the beam position within any section; if voltage supply variations or the like result in beam movement within the section, the feedback voltage will act to restore the beam to its stable position within the section. A beam shifting signal, for example, in the form of discretely spaced pulses is also supplied to the deflector plates; this signal is sufficiently large to momentarily override the feedback voltage and thus shift the beam from one section to the adjacent section. Means are further provided to return the beam to its original position after the beam has been shifted through all other positions successively. In this fashion the beam attains different stable positions in accordance with the number of incoming pulses, so that my apparatus can be used, for example, as a counter or scaler.

In order to increase the number of stable beam positions beyond that available with one dimensional beam travel or scanning, and thus, for example, increase the capacity of the counter or scaler, it is necessary to use two dimensional beam deflection; this can be accomplished through the use of horizontal and vertical deflection plates normally provided within the cathode ray tube. To this end, another type of optical mask is required. This mask is divided into a plurality of like horizontal segments, each segment having a plurality of like sections. Each section has a light transmission characteristic such that variations of beam position in the horizontal direction within the section produce light variations in one band of wavelengths, while beam variations in the vertical direction produce light variations in a second frequency range. A first photocell solely responsive to light variations in the one band of wavelengths supplies a first feedback voltage to the horizontal deflection plates to maintain horizontal beam stability; a second photocell solely responsive to light variations in the other frequency range supplies a second feedback voltage to the vertical deflection plates to maintain vertical beam stability. The system otherwise responds in the same manner as before except that means are required not only to return the beam horizontally after a complete horizontal segment of the mask has been scanned but also to move the beam vertically at the same time so that the adjacent horizontal segment can also be scanned.

Referring now to Fig. 1, there is provided a conventional cathode ray tube **100** with an electron gun and beam forcusing structure identified in block form at **101**, vertical deflection plates **102***a* and **102***b*, and a luminescent screen **103**. Secured to the outside of screen is an optical mask **104**. A photocell **105** is mounted adjacent screen **103**. The output voltage produced by photocell **105** is supplied to the input **106** of amplifier **107**. The output of amplifier **107** is connected through resistor **108** to deflection plate **102***a*, to the input **110** of trigger circuit **111** and to output terminal **112**. Incoming discretely spaced pulses with the wave form indicated are supplied to input terminal **113**. This terminal is connected through resistor **114** to plate **102***a*. The output **115** of trigger circuit **111** is connected to input **116** of amplifier **107**.

Fig. 2*a* shows one form of optical mask **104** which can be used with the apparatus of Fig. 1. It includes a plurality of sections, in this example five sections, identified as **104***a*, **104***b*, **104***c*, **104***d* and **104***e*. Each sec-

tion includes an optically transparent portion and a shaded portion which is appreciably more opaque, the opacity increasing toward the top of each portion. The mask is mounted adjacent screen **103** in such a manner that the long dimension of the screen extends along the beam deflection path.

Fig. 3 is a composite graph showing a sawtooth pattern which indicates the variation in the output voltage of amplifier **107** with electron beam deflection for the five section mask of Fig. 2*a*. Superimposed upon this pattern is a line which indicates the tube deflection characteristic (i. e., beam deflection vs. deflection voltage). The circled intersections of line and sawtooth represent stable positions of the electron beam. (The uncircled intersections are unstable because a slight random displacement in either direction results in positive feedback; this positive feedback forces the beam to move away from any unstable position.) The circled positions are stable because any voltage fluctuation at the plate will shift the beam position, and as a result of the optical properties of the mask, will change the voltage output of the photocell. The voltage output from the amplifier will change accordingly. This change in amplifier voltage will be applied to the deflection plates in such manner that the beam will be restored to its original stable position.

As can be seen from Fig. 3, there is a characteristically different amplifier output for each stable beam position. When the beam attains an extreme horizontal position, this amplifier voltage attains such a value that the trigger circuit is activated and produces a shift pulse which after amplification is supplied to the deflection plate to return the beam to its initial horizontal position.

In the absence of a shift pulse, the amplifier output voltage appearing at output terminal **112** is proportional to the horizontal beam position, and hence the apparatus of Fig. 1 can be used as a counter.

Fig. 2*b* shows an alternate type of optical mask **117** wherein each section has a wedge shaped opaque portion. This mask can be used in place of the mask of Fig. 2*a* if the electron beam is focused to produce a fairly large luminescent spot on the screen so that varying portions of the spot are concealed behind the opaque portion.

For combined horizontal and vertical scanning, the apparatus of Fig. 1 must be modified as shown in Fig. 4, and a different mask, for example as shown in Fig. 5, must be used.

The mask **200** of Fig. 5 comprises a plurality of like small clear transparent areas **201***a*, **201***b*, **201***c*, **201***d*, **201***e*, **201***f*, **201***g*, **201***h*, and **201***i*. Each of these areas represents a stable beam position. It will be seen that there are three horizontal groups or arrays, each containing three of the above areas. The number of arrays and included areas can be indefinitely extended to cover virtually the entire surface of the associated cathode ray tube screen.

The mask portions **202** horizontally adjacent to each area and identified by one type of characteristic shading are red colored and transparent. The mask portions **203** vertically adjacent to each area and identified by another type of characteristic shading are blue colored and transparent. Each of these portions acts as a light filter for any luminescent spot appearing in the tube screen and has a different frequency transmission characteristic.

The mask **200**, which in this case contains one hundred areas in a square ten areas in a side, is mounted adjacent the screen **101** of tube cathode ray tube **100** of Fig. 4. This tube is identical with that of Fig. 1 except that it is also provided with vertical deflection plates **301***a* and **301***b*.

The horizontal deflection plates **102***a* trigger circuit **111**, amplifier **106** and photocell **105** are connected in the same manner as before. However interposed between mask **200** and photocell **105** is a red filter **300**. As a result, any horizontal motions of the beam about any stable position are corrected by a feedback voltage as before; the red filter prevents the photocell **105** from being rendered responsive to any vertical motions of the beam.

Vertical deflection plate **302***a* is connected to trigger circuit **311**, amplifier **306** and photocell **305** in like manner to the horizontal plate connection. Interposed between mask **200** and photocell **305** is a blue filter **301**. As a result, any vertical motions of the beam about any stable position are corrected by a feedback voltage from amplifier **306** in the manner previously described; the blue filter prevents photocell **305** from being rendered responsive to any horizontal motions of the beam.

Trigger circuit **115** as before is activated when the beam reaches an extreme horizontal position, i. e. has scanned an array. The amplified shift pulse returns the beam to the other extreme position. Simultaneously trigger circuit **315** is activated to produce a pulse which, after amplification, shifts the beam to a position where it can scan the adjacent array.

Output terminal **112** yields an output voltage which is proportioned to the horizontal beam position in any array.

Such a voltage can be considered a units output voltage. Output terminal **312** yields an output voltage which is proportioned to the vertical position of the beam. Such a voltage can be considered a tens output voltage.

Thus the apparatus of Fig. 4 can also be used as a counter. Moreover, by connecting terminal **312** to a second like counter it is possible to use these counters in cascade and thus indefinitely increase the counting capacity of the system.

The circuit elements shown in block form in Figs. 1 and 4 are conventional in type and are not shown in schematic detail. The photocells and amplifiers, for example, can be of the type shown in item J, Fig. 236–II, on page 314, of "The Electronic Engineering Handbook," published in 1944, by Electronic Development Associates. The trigger circuits, for example, can be of the type shown in Fig. 6.6 on page 324 of "Cathode Ray Tube Displays," published in 1948 by McGraw-Hill.

While I have shown and pointed out and described my invention in one preferred embodiment, it will be apparent to those skilled in the art that many other modifications can be made within the scope and sphere of my invention as defined in the claims which follow.

What is claimed is:

1. In combination, a cathode ray tube provided with electron beam generating means, deflection plates for deflecting said beam along a given path, and a luminescent screen for visually displaying the path of the deflected beam; an optical mask covering a portion of said screen and extending along the beam deflection path, said mask being provided with a plurality of like sections which extend along corresponding segments of the beam deflection path, each section having a light transmission characteristic at which one section subarea exhibits substantially no light attenuation while all other subareas exhibit appreciable light attenuation; means coupled to the deflection plates to position said beam successively in a like plurality of discrete positions, each position being within a corresponding segment of the deflection path; a photoelectric cell responsive to the light transmitted through each mask section to produce a control voltage proportioned to the transmitted light; and means to supply said control voltage to said deflection plates in a direction at which the beam positions are confined to the portions of deflection path segments which correspond to the unattenuated section subareas.

2. The combination as set forth in claim 1 wherein each section is divided into two subareas, one area being optically transparent, the other area being optically opaque.

3. In combination, a cathode ray tube provided with an electron beam source, horizontal and vertical deflection plates for respectively deflecting said beam along

horizontal and vertical deflection paths, and a luminescent screen responsive to the deflected beam; an optical mask adjacent said screen and provided with a first plurality of small equal optically transparent sections arranged in horizontal and vertical arrays, adjacent horizontal sections being separated from each other by mask material having a first light frequency transmission range, adjacent vertical sections being separated from each other by mask material having a second light frequency transmission range, said ranges being separated in frequency; means coupled to said deflection plates to cause said beam to successively scan areas corresponding each horizontal array, the beam being discretely shifted from one section to the adjacent section within each horizontal array; first photoelectric means optically associated with the mask and optically sensitive only to the first frequency range to produce a first control voltage only when the beam is horizontally positioned outside of said sections; second photoelectric means optically associated with the mask and optically sensitive only to the second frequency range to produce a second control voltage only when the beam is vertically positioned outside of said sections; and means to apply said first and second voltages to said horizontal and vertical plates respectively, whereby stable beam positions are confined to areas corresponding to said sections.

4. A counter responsive to an incoming pulse train comprising a cathode ray tube provided with an electron beam generator, horizontal and vertical deflection plates for deflecting said beam both horizontally and vertically, and a luminescent screen for visually displaying the path of beam deflection; an optical mask containing a first plurality of horizontal arrays, each array containing a second plurality of small clear transparent areas equally spaced and horizontally separated by first mask material which is transparent only to light falling within a first frequency range and is otherwise opaque, each area being separated from vertically adjacent areas by second mask material which is transparent only to light falling within a second and different frequency range and is otherwise opaque; means responsive to said pulse train and coupled to the horizontal plates to deflect said beam horizontally in accordance with said pulses to scan a horizontal array; first photoelectric means optically associated with the mask and optically responsive only to the first range to produce a first control voltage when the beam is horizontally displaced outside of any of such areas; means to supply said first control voltage to the horizontal plates in a direction

opposing said horizontal displacement in the absence of supplied pulses; means responsive to said first control voltage and coupled to said horizontal plates to return said beam to the initial horizontal scanning position at the instant any horizontal array has been scanned; second photoelectric means optically associated with the mask and optically responsive only to the second range to produce a second control voltage when the beam is vertically displaced outside of any of said areas; means to supply said second control voltage to the vertical plates in a direction opposing said vertical displacement; and means responsive to said second control voltage and coupled to the vertical plates to shift the beam from one horizontal array to an adjacent horizontal array at the instant the one array has been scanned, whereby the first and second control voltages together indicate the pulse count.

5. A counter as set forth in claim 4 wherein each photoelectric means is provided with a light filter formed from material which has the same light transmission characteristic as the associated mask material.

6. A counter as set forth in claim 5 wherein each of the means responsive to a corresponding control voltage and coupled to corresponding deflection plates includes a trigger circuit.

7. An optical mask provided with a first plurality of horizontal arrays, each array containing a second plurality of small clear transparent areas equally spaced from each other and horizontally separated by mask material transparent only to light falling within a first frequency range, vertically adjacent areas being equally spaced from each other and vertically separated by mask material transparent only to light falling within a second and different frequency range.

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