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FOREIGN PATENTS

143,741 10/1951 Australia..... 313/73
 856,018 12/1960 Great Britain..... 313/78

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[54] **CATHODE RAY TUBE HAVING RADIAL-
 DIRECTED COMMUTATOR ELEMENTS**
2 Claims, 2 Drawing Figs.

[52] U.S. Cl..... 313/73,
 313/78, 315/21

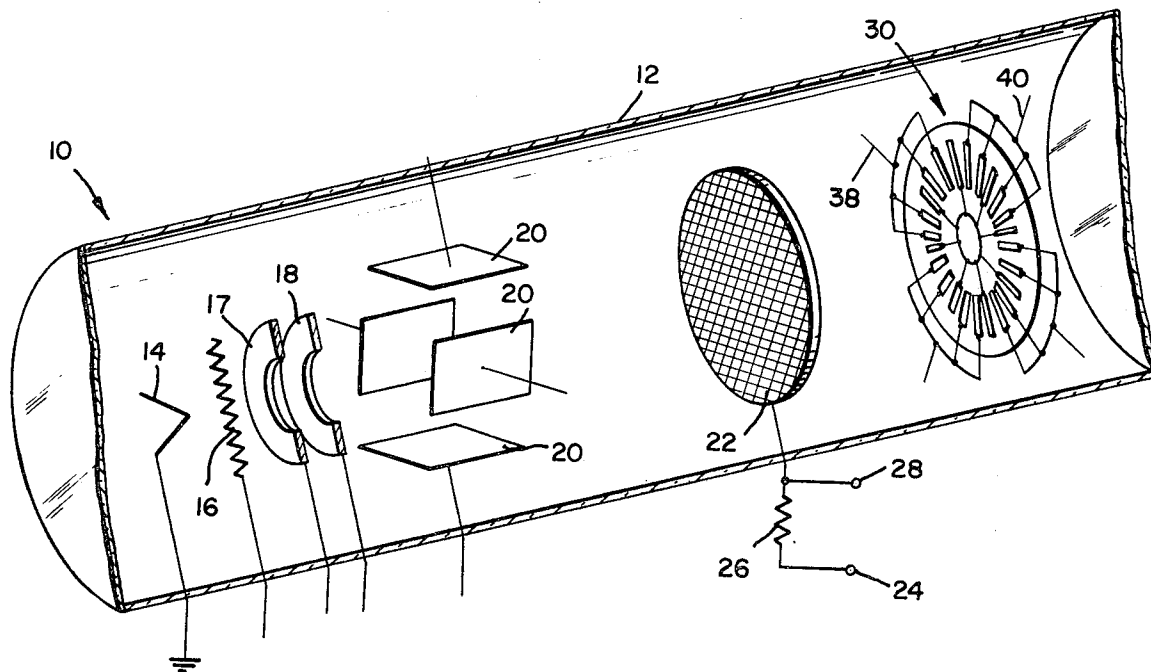
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 H01j 29/78

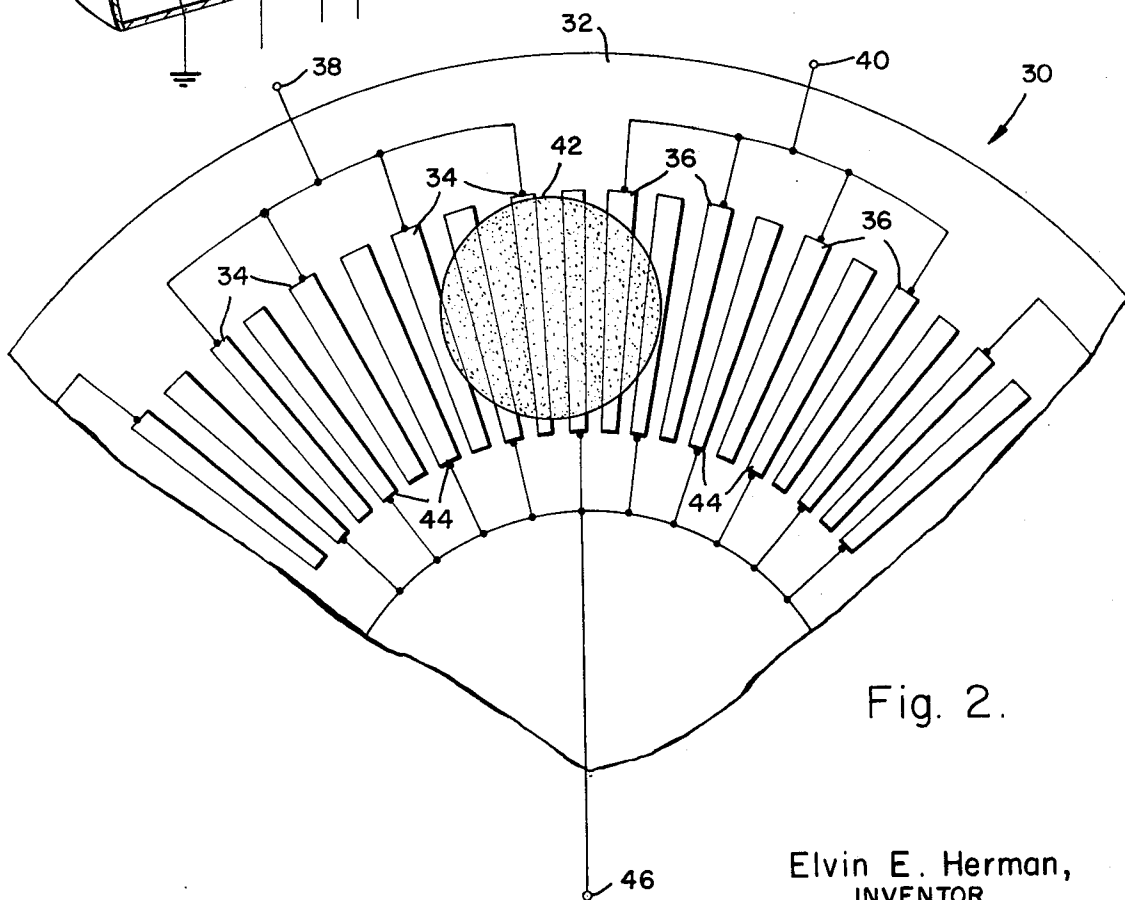
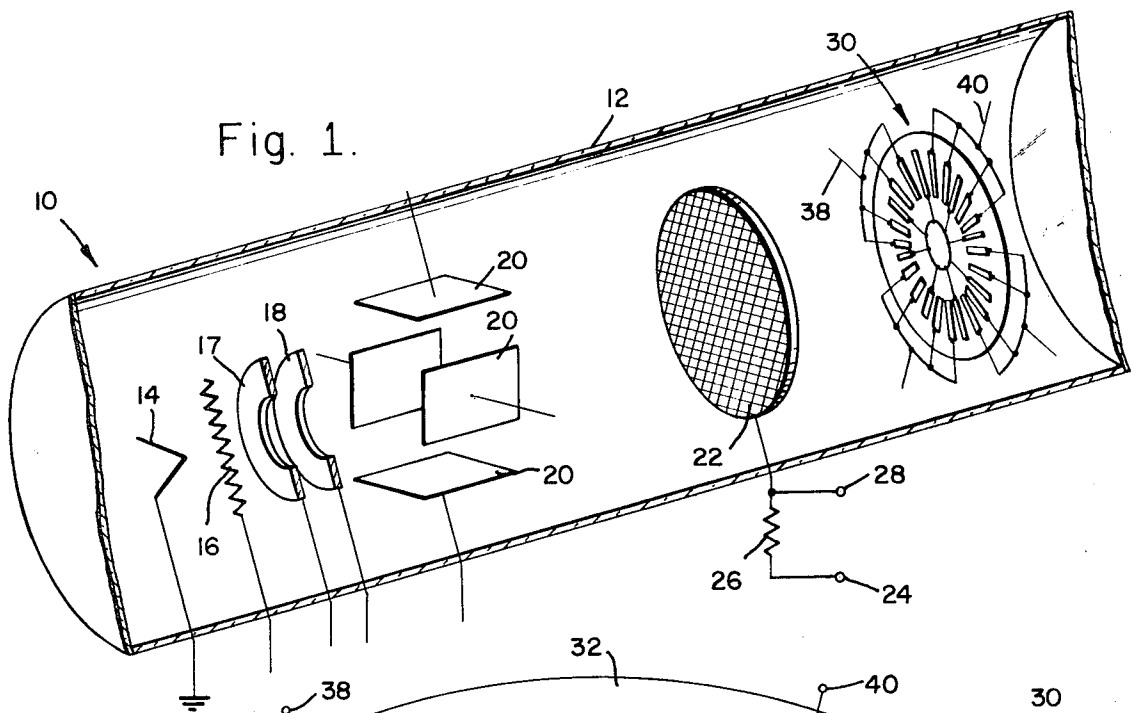
[50] Field of Search..... 313/78, 73

[56] **References Cited**
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ABSTRACT: A focused electron beam is circularly deflected. It is directed at a commutator target and passes through a positive collector mesh. The target comprises a plurality of separate, conductive spokes. Alternate spokes are connected together and serve as a shield electrode, which is held slightly positive with respect to the cathode. The remaining alternating spokes are grouped with three to five of the spokes being connected together to form an input channel. Input channel level ranges are typically from -5 volts to zero, so that when a group is more negative, the electron beam is prevented from landing on the shield electrode, and is returned to the collector grid or mesh. When an input is near zero volts, a large percentage of the electron beam lands on the shield electrode. Thus, between these values, electron beam current returning to the collector mesh is modulated by the input signal levels applied to the various spoke groups. In this manner the voltage levels on the different sets of input spokes are commutated as the electron beam is circularly deflected. The commutated signal can be read as collector mesh current.





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CATHODE RAY TUBE HAVING RADIALY DIRECTED COMMUTATOR ELEMENTS

BACKGROUND

This invention is directed to an electron beam commutator for commutating a plurality of signals and combining them into a single output signal.

In quite a number of systems the signals from a plurality of inputs are progressively sampled to result in a single output which is a time multiplexed output representing commutation of the plurality of inputs. Conventional techniques which have previously been used to accomplish this commutation or time multiplex function have employed analog electronic gating circuits actuated in sequence. However, when switching rates become high, the bandwidth of the sampling circuits becomes large, and the circuits become complex. With such complex circuits, it is difficult to achieve a close match in the bandwidth, zero signal rest potential, and dynamic range in a multiplicity of such electronic switching channels.

One particular application for the commutation of input signals is with such sensors as airborne infrared scanners. Such scanners usually employ a multiplicity of sensor elements or cells, when they are used for ground mapping. These sensor elements are commutated in one coordinate and are typically mechanically scanned, sometimes by a rotating mirror in the other coordinate which is oftentimes the crosstrack direction. When a plurality of cells are arranged in an array, for example in the track direction, the signals must be properly interpreted. Such interpretation normally includes commutation of the signals, so that the signals are successively and repetitively read out as the rotating mirror causes the array elements to assume successive positions in the scan direction with direction orthogonal to that of commutation. Typically, when multiple cells are employed in such an array, it is necessary to sequence or commutate them into a single channel for processing and/or display purposes.

In the past, electron beam commutator tubes have been employed to limited extent, but their use has been restricted for several reasons. These prior tubes usually have pedestal voltages present in their output, and it is difficult to maintain all of these pedestal voltages at the same level. Other difficulties include the problem of achieving wide output bandwidth, wide dynamic range of analog gating channels, uniformity in transfer characteristics, proper signal to noise ratio, and minimized channel-to-channel crosstalk. Thus, the presently available electron beam commutator tubes have not been fully satisfactory.

SUMMARY

In order to aid in the understanding of this invention, it can be stated in essentially summary form that it is directed to an electron beam commutator. The commutator includes a focused electron beam which is substantially circularly deflected and is directed through a positively charged collector mesh toward a commutator target assembly. The commutator target assembly comprises a plurality of separate elements. Alternate elements are connected together as a shield electrode, which is maintained somewhat positive. The remaining elements are connected together in groups, each group receiving an electrical signal input to be commutated into a common output. As the beam is scanned, the amount of beam arriving at the shield electrode or returning to the collector mesh is a function of the input voltage on the elements then under the beam. When the voltage is close to zero, most of the electron beam current reaches the shield electrode. On the other hand, when the input is more negative, most of the beam is returned to the collector mesh. Thus, collector mesh current or shield electrode current can serve as a commutated output.

Accordingly, it is an object of this invention to provide an electron beam commutator which includes a focused and deflected electron beam, which is directed through a collector mesh toward a commutator target, the target being connected

to a plurality of inputs so that the instantaneous signal output is a function of the signal input voltage applied to that portion of the commutator target at which the electron beam is directed. It is a further object to provide a commutator target assembly which comprises a plurality of separate substantially radial spokes, with spokes being connected in groups to input connections so that as an electron beam directed at the commutator target assembly is deflected, it strikes different spokes connected to different inputs. It is a further object to connect a plurality of the spokes on a commutator target together to act as a shield electrode. It is another object to connect alternate spokes on a commutator target assembly together as a shield electrode, with the remaining electrodes connected together in groups to serve as inputs.

Other objects and advantages of this invention will become apparent from a study of the following portion of the specification, the claims and the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic drawing of an electron beam commutator, with the near portion of the housing broken away.

FIG. 2 is an enlarged drawing of a portion of a commutator target assembly for use in the electron beam commutator of this invention.

DESCRIPTION

Referring to the drawings, the electron beam commutator is generally indicated at 10. The commutator comprises a tube 12 which serves as an enclosure or housing for the internal components. In view of the fact that the components include electron beam devices, tube 12 is of such construction that a suitable vacuum can be drawn therein to provide for the proper environmental characteristics for proper electron beam operation.

Positioned within tube 12 is a cathode 14 which emits an electron beam which is suitably focused and directed down the length of the tube. Grid 16 suitably controls the beam. Conventional accelerating electrodes and focusing electrodes, such as are shown in Hansen, U.S. Pat. No. 2,806,175, are preferably also included to provide a focused electron gun.

Accelerating electrode 17 and focusing electrode 18 are schematically indicated and are provided and are suitably connected to accelerate and focus the electron beam emitted from the cathode to a spot at the target of appropriate size. The accelerating and focusing electrodes are suitably connected to an external source to accomplish this function.

Beam deflection is provided by deflection plates 20 which serve to electrostatically deflect the beam. Alternatively, magnetic deflection means can be used. The deflection means is externally connected to provide a circular scan pattern. This circular scan can be accomplished by means of applying 90° phase-shifted sine waves to the deflection means. If desired, other scanning sequences can be employed, but for the circular commutation target disclosed herein as the preferred embodiment, the circular pattern is, of course, the best.

Collector mesh 22 is positioned in the path of the circularly scanned beam adjacent to the target. It is connected through resistor 26 to a suitable voltage source which is positive with respect to cathode by means of terminal 24. The voltage appearing across resistor 26 at the terminal 28 is a function of the collector mesh current, i.e., it provides a commutated output voltage corresponding to the instantaneous collector mesh current.

The commutator target assembly is shown at 30. An enlarged sector of the commutator target assembly is shown in FIG. 2. The assembly comprises a highly resistive substrate 32 of a material such as quartz. Positioned on the substrate are a plurality of commutator bars, which are of conductive material. Ordinarily the surface leakage properties of the highly resistive substrate will suffice to prevent accumulation of undesired surface charge on the exposed areas between commutator bars; however, if desired, an additional coating of highly

resistive material can be placed between the commutator bars after they are positioned. An example of such highly resistive material is chromium oxide. The commutator bars are placed on the substrate, by any convenient means, such as by vapor depositing them through a mask, or the like.

Referring particularly to FIG. 2, a first group of commutator bars is indicated at 34 and a second group of bars is indicated at 36. These bars are radially positioned on substrate 32 and are respectively connected together to provide terminals 38 and 40 for respective external connection to these groups of bars. The number of groups is equal to the number of signal inputs to be commutated, and if necessary, one or more unconnected groups are provided in order to provide flyback time for cathode ray tube display. Four groups are illustrated in FIG. 1, but a considerably larger number can be employed. The electron beam image as it impinges upon the commutator target assembly is indicated at 42. The individual commutator bars are preferably of greater radial extent than the diameter of the image, and the number of bars in a group preferably are of greater circumferential dimension than the diameter of the image. Alternate bars on substrate 32 are not connected to the groups of bars to which signals are applied. These alternate bars are indicated at 44 and are connected together to an external connection 46. Alternate bars 44 comprise a shield electrode.

In operation, cathode 14, grid 16, accelerator electrode 17, focusing electrode 18, and deflection means 20 are energized to provide an electron beam which is circularly scanned so that its image circularly scans the plurality of bars on commutator target assembly 30. If the bars are considerably longer than the electron beam image diameter, focusing and deflection need not be as accurately performed, without loss in signal. Collector mesh 22 has its terminal 24 connected to a source which is positive at several hundred volts with respect to cathode 14. Plus 500 volts is an appropriate value. Alternate bars 44 which form the shield electrode are connected by terminal 46 to an appropriate source of positive voltage, for example, plus 10 volts with respect to the cathode.

The ratio of emitted secondary electrons to impinging primary electrons is below unity for small voltages. With higher voltage it reaches unity at the first crossover, with still higher voltages it is above unity until it again declines to unity at the second crossover. The fact that the collector mesh is operated between the first and second crossover points, with a ratio of secondary to primary electrons above unity, is not detrimental, for most of the secondary electrons do not reach the target region. In fact, if the collector mesh is operated at the highest potential in the tube, most of the secondary electrons emitted therefrom will return thereto. Therefore, minor variations in the secondary emissive ratio over the collector mesh surface will not contribute as a noise output. The potential of the shield electrode is such that impinging electrons arrive at sufficiently low velocity that few secondary electrons are emitted therefrom as compared to the number of incoming electrons. In other words, the shield electrode is operated well below first crossover on the curve of secondary emission versus net electron accelerating voltage.

Signal inputs to be commutated are connected to the several groups of bars. For example, the first signal is connected to terminal 38 to the first group of bars 34, and a second signal is connected to terminal 40 to the second group of bars 36. With typical geometries, these signals vary from -5 volts up to zero. When a particular input signal is at -5 volts, the electron beam will pass through the collector mesh and, because of coplanar grid action imposed by the signal voltage on the particular group of commutator bars, the electron beam will be prevented from landing on the shield electrode. Thus, it will be totally reflected or returned to land on the collector. When the signal input lies at about -3 volts, about half of the electron beam will be returned to the collector mesh, while the remainder will fall on the shield electrode.

Thus, the percentage of the electron beam returned to the collector mesh, versus the percentage allowed to land on the

shield electrode, will be related to the signal input to the particular group of bars which form an input channel.

Since the beam current reflected to the collector mesh is thus a function of signal, the collector mesh current will represent the commutated signal of the plurality of groups of bars as the beam image is circularly scanned. The commutated output will thus be the serial result of the voltage present at the individual channel inputs. In addition, the intercept current of the collector mesh resulting from electrons impinging from the cathode side will contribute an incidental, but constant DC term to the output.

In a particular example, assuming a beam current in the order of 3 to 5 microamperes, the device is capable of commutation rates of at least 10 channels per microsecond, particularly when the output signal is extracted from the collector mesh, since its capacitance to ground and to the shield is relatively low. The signal transfer characteristics of the individual channels approximate that of a typical storage tube target, that is, exhibiting a triode-type characteristic near cutoff, a linear portion, and then tapering off to zero slope near the potential where all of the electrons passing through the collector mesh are allowed to land on the shield electrode.

Of course, since the division of beam current is between the shield electrode and the collector mesh, the output signal could also be extracted from the shield electrode. However, with a higher capacitance due to the proximity of the other commutator bars, response frequency will be lower and some capacitive cross coupling from each input channel to the output will occur even when the beam is not commutating the particular channel.

As is seen in FIG. 2, the diameter of the electron beam image on the target assembly is such that it encompasses several target elements. This provides an averaging effect. As long as there are a plurality of commutator bars extending in the circumferential direction greater than the diameter of the image, an averaging effect will take place and the output level will remain at full level for considerable motion of the beam image along its scan path. Additionally, with proportions as shown, there will be negligible cross-channel effects due to beam landing. Additionally, the frequency component due to the individual commutator bars will be several times the channel commutation rate, and thus it will not substantially affect the output signal or can be readily filtered out of it.

This invention having been described in its preferred embodiment, it is clear that it is susceptible to numerous modifications and embodiments within the ability of those skilled in the art and without the exercise of the inventive faculty. Accordingly, the scope of this invention is defined by the scope of the following claims.

I claim:

1. An electron beam commutator, said electron beam commutator comprising:
 - electron beam means, said electron beam means being arranged to project an electron beam along a path, and means for circularly deflecting said electron beam for commutation;
 - a collector mesh positioned in the path of the electron beam, said collector mesh being adapted to be connected to a source of positive potential to establish a collection field and collect electrons, the electron flow being a function of signal current;
 - an interdigitated commutator target on the side of said collector mesh remote from said electron beam means, said target having a plurality of radially directed commutator fingers mounted in the path of the electron beam as it is deflected;
 - a first group of alternate commutator fingers electrically connected together to form a shield electrode, the current of which is a function of signal current;
 - a plurality of inputs, each comprised of groups of fingers, interdigitated with said alternate commutator fingers of said shield electrode, each said group being made up of a plurality of fingers electrically connected together, each

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said group being larger than the beam spot in the direction of deflection and said fingers being longer than the beam spot in a direction normal to the direction of deflection, each of said inputs being connectable to a signal current.

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2. The electron beam commutator of claim 1 wherein said commutator target comprises an insulative substrate with said commutator fingers thereon, and with a high resistance coating on said substrate between said commutator fingers.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,579,013 Dated May 18, 1971

Inventor(s) Elvin E. Herman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 42, after "electron", insert --beam such as is provided by conventional focused electron--.
(Page 5, lines 21 and 22).

Signed and sealed this 2nd day of May 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents