Sept. 6, 1949. D. E. SUNSTEIN 2,480,978

CATHODE-RAY TUBE SIGNAL COMPARATOR

Filed Feb. 26, 1947

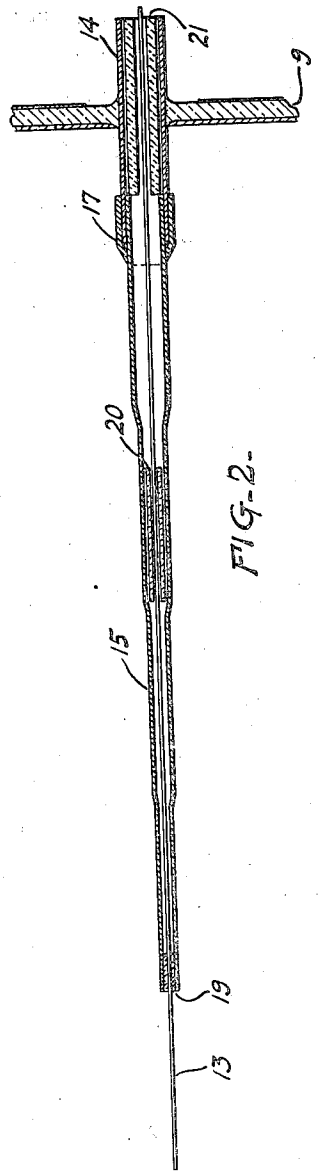


FIG-2-

FIG. 1

INVENTOR.
DAVID E. SUNSTEIN
BY
Brown, Denk & Synnestvedt
AGENTS

Patented Sept. 6, 1949 2,480,978

UNITED STATES PATENT OFFICE

2,480,978

CATHODE-RAY TUBE SIGNAL COMPARATOR

David E. Sunstein, Cynwyd, Pa., assignor to Philco Corporation, Philadelphia, Pa., a corporation of Pennsylvania

Application February 26, 1947, Serial No. 730,885

6 Claims. (Cl. 250—158)

1

The invention herein described and claimed relates to improvements in cathode ray tube structures. More specifically it relates to a particular arrangement of an electrostatic deflecting electrode within a cathode ray tube, whereby the tube is rendered especially suitable for use in a comparator of the waveforms of electrical signals occurring in time-spaced relationship. Such a comparator is particularly useful in radar target motion indicating systems.

Electrical signal waveform comparators are well known in which the electron beam of a cathode ray tube is caused successively to scan the tube screen under the control of signals occurring in time-spaced relationship whose waveforms are to be compared. If an electron beam is caused repeatedly to describe the same trace on a screen consisting of a dielectric material, such as glass, a point is reached, after but a few scans, at which no change in secondary electron emission from the screen obtains between successive scans. However, when a new trace is scanned, differing at least in part from the old one, a change in secondary emission results. If secondary electrons emitted by the screen are drawn away to a collecting electrode as rapidly as they are emitted by the screen, this scanning of a new trace will produce a change in the net charge on the screen. This change is readily detectable by means of a capacitive pick-up electrode disposed in proximity to the screen, and which may be substantially coextensive therewith.

In an arrangement of this sort it is convenient to increase the effective length of the trace, and hence the duration of signals which can be compared, by causing the electron beam to describe a spiral trace on the screen and by modulating the deflection of the beam radially to cause it to depart from said trace in response to signals which are to be compared. Circuits are known for producing the required damped sinusoidal deflecting waves for application to the horizontal and vertical deflecting plates of a conventional electrostatically deflected cathode ray tube to produce such a spiral trace. In the past, however, some difficulty has been experienced in providing for the radial deflection of the cathode ray beam in the course of describing the spiral trace. One method of accomplishing this is to modulate the normal horizontal and vertical deflecting signals, used to produce the spiral trace, by the input signal. This, however, necessitates the use of separate balanced modulators—one for each deflecting signal. These must either be of

2

rather large power output or, alternatively, additional amplification must be provided, which introduces further difficulties because of the wide frequency band which must be passed. It was recognized that radial deflection from the spiral path might conveniently be produced by means of an electrode axially disposed with reference to the tube axis. This, however, would either require a lead from this electrode to be taken off through the side of the tube envelope in such manner that it would interfere with the electron beam so as to produce discontinuities in the trace; or, alternatively, it would require a lead from the axial electrode through the screen itself at a point corresponding approximately to the center of the spiral trace. This latter method has not until now been considered feasible owing to the presence of the capacitive output electrode in the vicinity of the screen which, by capacity coupling, would tend to pick up signals from the lead in addition to those induced in it from the screen itself. Attempts to counteract the effect of such coupling by neutralization have not proven successful because of the large ratio of the undesired to the desired signal.

Accordingly the principal objects of the invention are:

(1) To provide an improved form of cathode ray tube particularly adapted for use in an electrical signal waveform comparator; and

(2) To provide an improved cathode ray tube structure of the sort above referred to, comprising an axially disposed radial deflecting electrode and a capacitive electrode associated with the tube screen, in which undesired coupling between said deflecting and said capacitive electrodes is minimized.

According to the invention, means are provided whereby the lead from the axial electrode is carried out through the screen and through an aperture in the capacitive output electrode, while at the same time undesirable coupling between the lead and the output electrode is effectively avoided. To this end the lead is electrostatically shielded from the output electrode. The shield employed may be of tubular form, sealed into the screen of the cathode ray tube and extending appreciably within the tube envelope in the direction of the electron gun or beam-forming means. It is preferably constructed to have sufficient rigidity so that it need be supported only at the point where it is sealed into the tube screen. Within it, and insulated from it, is disposed an electrode which protrudes within the tube envelope appreciably beyond the end of the

shield so as to provide an active beam-deflecting portion. At some point within the shield there is provided a substantially airtight seal between the shield and the lead. Further means may be provided within the shield—for example, insulating sleeves of ceramic or other suitable material—to insure that the lead will remain substantially coaxially disposed with relation to the shield.

The structural details of an embodiment of the invention will be more fully understood and other objects and features thereof will become apparent from a consideration of the following description with reference to the accompanying drawings, in which:

Figure 1 illustrates a cathode ray tube, in accordance with the invention, connected in a signal comparator circuit, and

Figure 2 illustrates, in detail, the structure of the axial deflecting electrode and associated shield as employed in the tube illustrated in Figure 1.

Referring now to Figure 1, the embodiment there illustrated, of a cathode ray tube in accordance with the invention, comprises an evacuated envelope of glass or other suitable dielectric material customarily employed for this purpose. This envelope may be of the usual configuration, comprising an elongated relatively constricted neck portion and a substantially frusto-conical portion. The smaller end of the latter is joined to the neck portion, while the larger end is closed by a substantially plane portion, forming a screen upon which electrons are adapted to impinge. The other end of the constricted neck portion may be provided with a base 2, of Bakelite or other suitable material having contact pins embedded therein to provide connections from the exterior of the tube to the various elements within it, as is customary in cathode ray devices. Within the constricted neck portion, in the vicinity of base 2, are provided means for generating, forming and controlling an electron beam which may normally be directed along the axis of the tube so as to impinge on screen 9. These means may comprise the usual cathode, intensity controlling grid and anodes employed for this purpose, and are here generally represented by cylinder 3. Spaced axially from this electron gun or beam-forming means are disposed horizontal and vertical electrostatic deflecting plates 4 and 5 for the purpose of deflecting the electron beam horizontally and vertically as in conventional cathode ray tubes. Likewise, as in the usual form of cathode ray tube, the interior of the frusto-conical portion of the tube envelope may be almost completely covered with an aquadag coating 8. When the tube is in operation, this coating may be grounded, through a suitable connection 10, so as to prevent the accumulation of electrical charges on the interior surface of the glass, in response to secondary emission from screen 9 on which the beam impinges. Thus undesirable random deflection of the electron beam is avoided.

In accordance with the invention, a tubular conductive shield 12 is sealed into the screen 9 of the tube envelope so as to enter it substantially centrally and extend an appreciable distance within the tube envelope in a direction toward electron gun 3 and substantially coinciding with the axis of the tube. As shown in the drawing this shield may extend within the tube appreciably beyond the aquadag coating 8. Within shield 12, and insulated therefrom, is disposed a conductive electrode 13 which extends beyond the shield at both ends. Its exposed portion within the tube envelope provides a deflecting electrode adapted to produce radial deflection of the cathode ray beam in response to deflecting signals supplied to the portion of the electrode which protrudes from the other end of the shield.

Also there may be provided, on the interior surface of the envelope in the vicinity of the portion of electrode 13 which is exposed, a second coating of aquadag which is distinct and insulated from the coating 8. This coating provides a frusto-conical annular conductive surface which is adapted to cooperate with the interior exposed portion of electrode 13 to produce radial deflection of the cathode ray beam. Further, in accordance with the invention, the exterior of the screen portion 9 of the tube envelope is covered with a conductive coating forming a capacitive pick-up or output electrode, through the medium of which it is possible to detect changes in the electrical charge produced on the screen portion in response to bombardment by the electron beam and the resultant emission of secondary electrons therefrom. This coating is insulated from shield 12 by leaving a relatively narrow uncoated ring completely surrounding the shield. The coating may comprise a thin film of gold, which may be of the order of one-half wavelength in thickness for light, and hence transparent. Alternatively, it is possible to use a relatively fine wire mesh screen cemented to the face of the tube. Although it is not necessary to the operation of the tube in accordance with the invention that screen 9 be provided with an internal coating of phosphor, so as to produce a visible trace in response to bombardment by the electron beam, it may be convenient to include such a coating to be used for test purposes.

As shown in Figure 2, shield 12, of the tube according to Figure 1, may comprise a relatively short tubular portion 14 and a relatively longer tubular portion 15. The latter is preferably formed in one piece and comprises longitudinally contiguous portions of progressively diminishing cross section. This is done in order to provide adequate rigidity of the structure, while at the same time reducing its cross section in the portion which is nearest to the source of the electron beam. Thus interference by the shield with the beam is minimized. Preferably both shield 12 and electrode 13 are of chrome-iron having a coefficient of expansion closely approximating that of glass. By constructing the shield in two pieces, the manufacture of the tube is simplified, in that the tubular portion 14 may first be sealed in the screen portion of the envelope, and later the longer tubular portion 15 can be soldered within the shorter tubular portion 14. Also there may be provided a collar 17 which is adapted to reinforce the junction between the tubular portions 14 and 15 and improve the quality of the vacuum seal at this point. Electrode 13 is disposed within the tubular shield, and a glass seal 19 is provided between it and the shield, preferably at the most constricted portion of the latter. To center the electrode within the shield and to insulate it therefrom, there may be provided tubular ceramic collars 20 and 21 disposed at suitable intervals within the shield.

In operating the tube in accordance with the invention, damped sinusoidal oscillations in substantially phase-quadrature relationship are supplied from sources 24 and 25, through connections 6 and 7, to horizontal and vertical deflecting plates 4 and 5. These signals are adapted to pro-

duce deflection of the cathode ray beam so as to cause it to describe a trace of substantially spiral form on screen 9 of the tube. To the outer end of electrode 13 are supplied video input signals which may be derived from a conventional radar equipment (not shown). These signals will produce radial deflection of the electron beam and will cause it to depart from the normally spiral trace produced in response to the signals applied to deflecting electrodes 4 and 5 from sources 24 and 25. The amount of such departure at a given point on the trace will, of course, depend on the instantaneous magnitude of the video input signal to electrode 13. The coating 11 on the inner surface of tube envelope 1 may be grounded as shown, or, if preferred, the video input signals may be applied in push-pull relationship to electrode 13 and coating 11. In either case the electrode and the coating will cooperate to produce deflection of the beam. If these signals recur at the same rate as the spiral trace on the tube screen, the cathode ray beam will be deflected by like amounts at corresponding points on successive traces. Hence successive traces will be identical, and an equilibrium condition will soon be established (usually as soon as a single trace has been scanned) in which no change in secondary emission from the screen takes place between successive scans. This will be the case when the signal from the radar is produced in response to signals from fixed targets only. However, if the input signal to electrode 13 fails to recur at the trace repetition rate, the beam will not be deflected from the spiral trace by like amounts at corresponding points on successive scans, and successive traces will differ. Thus the beam will be caused to describe a new area of the screen and the secondary emission from the screen will change. This will be the case when the signals from the radar are produced in response to targets in motion, and hence do not recur periodically. The change in secondary emission will produce a like change in the charge on screen 9, which, in turn, will induce a signal in the conductive coating deposited on the external surface of screen 9. This signal may be supplied through connection 26 to a suitable video amplifier 27 to yield an output at terminals 28 and 29 which will be indicative of departures of the video input signals from periodicity at the trace repetition rate. Such departures may, in a system of this sort, be taken as indicative of target motion.

Thus, by the invention, there is provided a cathode ray device in which the electron beam can be deflected so as normally to describe a spiral or circular trace on the tube screen; in which, in response to signals applied to an axially disposed deflecting electrode which enters the tube envelope through the tube screen, the beam is adapted conveniently to be deflected radially to cause departures from said trace; in which, by means of a conductive coating on the external surface of the tube screen in the vicinity of said electrode and overlying at least a portion of said screen, there are conveniently derived signals which vary in response to variations in the secondary emission from said screen produced by alterations in the trace scanned by said beam; and in which, by means of a conductive shield enclosing said axial electrode throughout an appreciable portion of its length, said conductive coating is prevented from responding capacitively to the deflecting signals applied to the axially disposed deflecting electrode.

It will, of course, be understood that the structure of the tube, in accordance with the invention, is susceptible of considerable variation from that shown and described, without departing from the scope of the invention as defined by the appended claims.

I claim:

1. A cathode ray tube structure comprising: means for forming an electron beam; a screen upon which said beam is adapted to impinge to cause secondary electrons to be emitted, said screen being displaced from said beam forming means and extending transversely to the path of said beam; a deflecting electrode disposed interjacent said beam forming means and said screen and substantially displaced from said screen; a connection for applying deflecting signals to said deflecting electrode, said connection extending toward and passing through said screen; a conductive electrode at least partially coextensive with said screen and adapted capacitively to respond to variations in the electrical charge on said screen owing to variations in the secondary emission from said screen; and a conductive shield interposed between said last-named electrode and said connection for appreciably reducing capacitive coupling between said output electrode and said connection.

2. A cathode ray tube structure comprising: means for forming an electron beam; a screen upon which said beam is adapted to impinge to cause secondary electrons to be emitted, said screen being displaced from said beam forming means and extending transversely to the path of said beam; a conductive electrode disposed in proximity to said screen and adapted capacitively to respond to variations in the electrical charge on said screen owing to variations in the secondary emission from said screen; a deflecting electrode disposed interjacent said beam forming means and said screen and substantially displaced from said screen; a connection for applying deflecting signals to said deflecting electrode, said connection passing in the vicinity of said output electrode; and a conductive shield surrounding at least a portion of said connection for appreciably reducing capacitive coupling between said first-named electrode and said connection.

3. A cathode ray tube structure comprising: an envelope of dielectric material, means enclosed in said envelope for forming a beam of electrons and for directing said beam against a portion of said envelope to cause it to emit secondary electrons, a tubular conductive shield sealed into said envelope and extending appreciably within said envelope in the direction of said beam forming means, an electrode disposed within said shield and insulated therefrom, said electrode extending within said envelope appreciably beyond said shield to provide a beam deflecting portion, and a conductive electrode at least partially coextensive with said portion of said envelope, said last-named electrode being electrically insulated from said shield and adapted capacitively to respond to variations in electrical charge on said portion of said envelope owing to variations in the secondary emission from said screen.

4. A cathode ray tube structure comprising: an envelope of dielectric material, means disposed within said envelope for forming an electron beam adapted to impinge upon the inner surface of said envelope to cause it to emit secondary electrons, an electrode extending through the wall of said envelope and an appreciable distance within said envelope in the direction of said beam forming means, a conductive shield enclosing said

electrode throughout its length except for a portion displaced from said envelope wall in the direction of said beam forming means, said exposed portion being adapted to effect deflection of said beam in response to potentials applied to said electrode, and a capacitive electrode disposed in proximity to a portion of the wall of said envelope immediately surrounding said first-named electrode and said shield.

5. A cathode ray tube structure comprising: an envelope of dielectric material, means disposed within said envelope for forming an electron beam adapted to impinge upon the inner surface of said envelope to cause it to emit secondary electrons, an electrode extending through the wall of said envelope and an appreciable distance within said envelope in the direction of said beam forming means, a conductive shield enclosing said electrode throughout its length except for a portion displaced from said envelope wall in the direction of said beam forming means, an annular electrode substantially coaxial with said first-named electrode and substantially coextensive axially with the unshielded portion of said first-named electrode, said annular electrode being adapted to cooperate with the unshielded portion of said first-named electrode to effect deflection of said electron beam in response to deflecting signals applied to at least one of said electrodes, and a capacitive electrode disposed in proximity to a portion of the wall of said envelope immediately surrounding said first-named electrode and said shield.

6. A cathode ray signal detector comprising means for forming an electron beam; a screen upon which said beam is adapted to impinge to cause secondary electrons to be emitted, said screen being displaced from said beam forming means and extending transversely to the path of said beam; a deflecting electrode disposed interjacent said beam forming means and said screen and substantially displaced from said screen; a connection for applying deflecting signals to said deflecting electrode, said connection extending toward and passing through said screen; conductive means adjacent to said screen and adapted to respond to variations in the electrical charge on said screen owing to variations in the secondary emission from said screen; and means for reducing appreciably capacitive coupling between said conductive means and said connection.

DAVID E. SUNSTEIN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,929,067	Hund	Oct. 3, 1933
2,200,745	Heymann	May 14, 1940
2,328,259	Christaldi et al.	Aug. 31, 1943
2,408,415	Donaldson	Oct. 1, 1946
2,412,965	Chevigny et al.	Dec. 24, 1946