

Sept. 11, 1951

A. E. ANDERSON

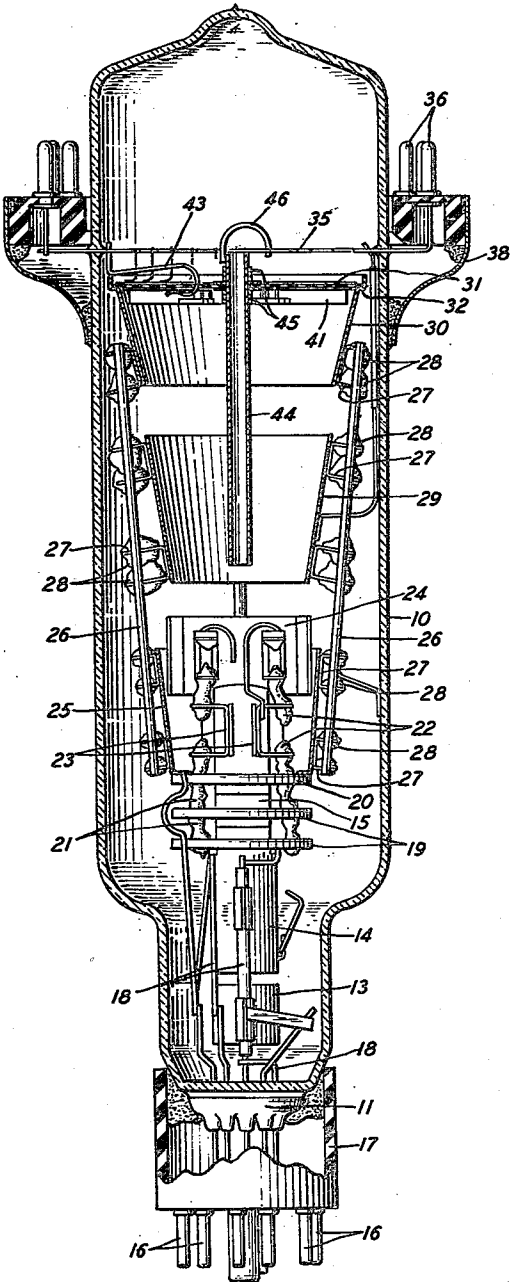
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ELECTRON DISCHARGE APPARATUS

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2 Sheets-Sheet 1

FIG. 1



INVENTOR  
A. E. ANDERSON  
BY *J. J. McCarty*  
ATTORNEY

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A. E. ANDERSON

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2 Sheets-Sheet 2

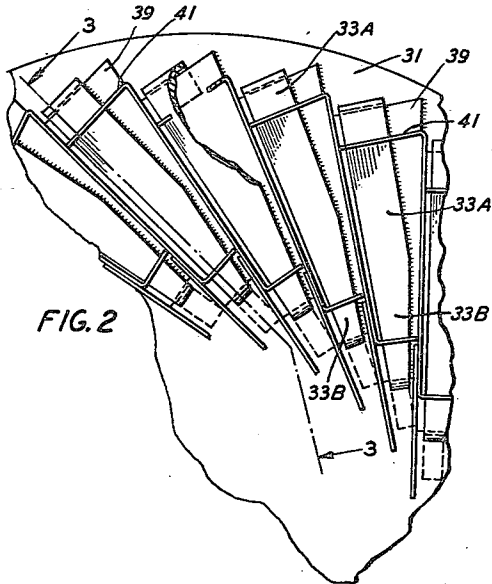


FIG. 2

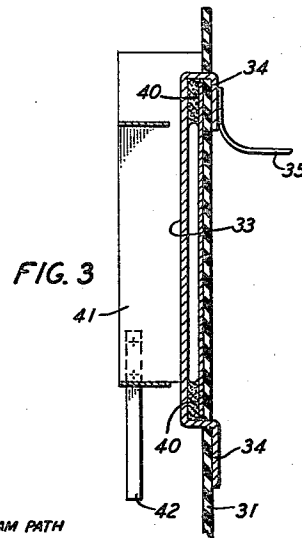


FIG. 3

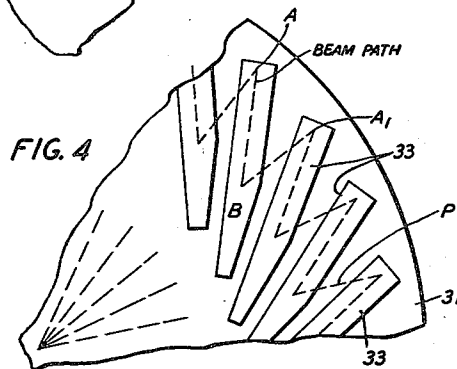


FIG. 4

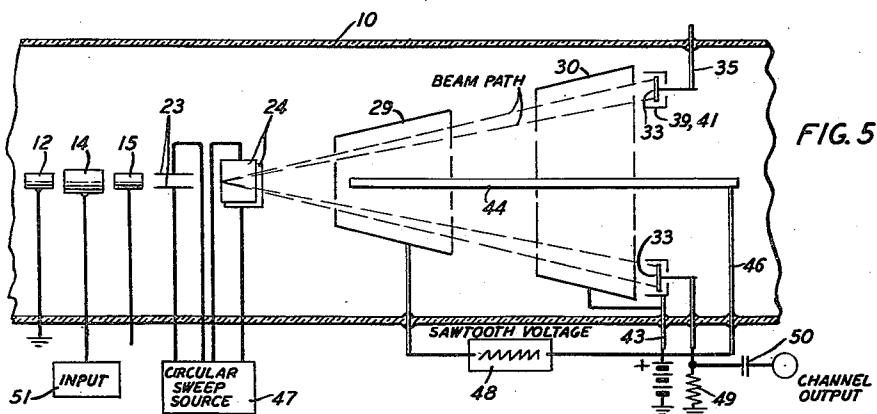


FIG. 5

INVENTOR  
A. E. ANDERSON  
BY *R. J. Guenther*  
ATTORNEY

## UNITED STATES PATENT OFFICE

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## ELECTRON DISCHARGE APPARATUS

Alva Eugene Anderson, Chatham, N. J., assignor  
to Bell Telephone Laboratories, Incorporated,  
New York, N. Y., a corporation of New York

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12 Claims. (Cl. 315—21)

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This invention relates to electron discharge apparatus and more particularly to cathode ray devices especially suitable for use as receivers in multichannel or time division multiplex communication systems.

Such devices comprise, in general, a plurality of target electrodes, an electron gun for projecting an electron beam toward the target electrodes, and a deflection system for directing the beam so that it impinges upon the target electrodes in succession thereby to close or energize output channels associated with the electrodes.

Heretofore, in order to obtain effective segregation of the several target electrodes to minimize or eliminate cross-talk between the channels, it has been necessary to provide a substantial space between adjacent target electrodes. This results in substantial limitation upon the usable portion of each deflecting cycle, for the spacing or guard space involved represents lost time. Further, it limits the number or size, or both, of target electrodes that can be utilized in a device of specified dimensions. Limitation of the number of target electrodes restricts the number of channels that may be employed. Limitation of the electrode size may restrict the power that can be translated.

One general object of this invention is to improve cathode ray devices for multiplex communication systems.

More specifically, objects of this invention are to reduce the guard space in such devices, increase the number of target electrodes which may be incorporated in a device of given dimensions, assure good electrical segregation of the several output channels, enhance the power capacity and output, and facilitate the construction of cathode ray devices including a multiplicity of target electrodes.

In accordance with one general feature of this invention, the aforementioned and other objects are realized by a particular construction of target electrode assembly and by correlation of the electron beam deflection system therewith.

More particularly, in accordance with features of this invention, in a cathode ray device for multiplex systems, the assembly above mentioned comprises a plurality of elongated target electrodes mounted in circular array and extending obliquely with respect to radii of a reference circle, the electrodes being disposed in partly overlapping relation relative to the radii. The deflection system is constructed and arranged to produce a beam trace at the electrode assembly of circular saw-tooth form, alternate sections of the trace being parallel to or coincident with the longitudinal axis of respective electrodes and the other sections of the trace being radial or substantially so. Advantageously, the beam is controlled so that it is on during the sweep thereof

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along each target electrode and is extinguished during the radial portions of the beam trace.

The beam current to any target electrode may be utilized directly as the output. Advantageously, however, the target electrodes are constructed to have a coefficient of secondary emission greater than unity, and a collector electrode structure is provided for receiving the secondary electrons emanating from the target electrodes. The output current at each target electrode, then, is proportional to the difference between the beam current to the electrode and the secondary electron current away therefrom. The collector electrode structure includes conductive barriers or shields interposed between adjacent target electrodes.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational view mainly in section of an electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is a fragmentary plan view showing details of the target and collector electrode assembly included in the device illustrated in Fig. 1;

Fig. 3 is a view in section taken along line 3—3 of Fig. 2;

Fig. 4 is a diagram illustrating the beam path or trace at the target and collector electrode assembly; and

Fig. 5 is a circuit schematic illustrating one manner in which the device shown in Fig. 1 may be operated.

Referring now to the drawing, the electron discharge device shown in Fig. 1 comprises an evacuated, vitreous enclosing vessel 10 having an external stem 11 at one end, from which an electron gun and deflector plate assembly is supported. The electron gun, which may be of generally conventional construction, comprises a cathode, illustrated at 12 in Fig. 5, which is encompassed by a cylindrical anode 13, a cylindrical control electrode 14, and a cylindrical focussing electrode 15, the several electrodes being connected to respective terminals 16 upon a base 17 by leading-in conductors 18. The control electrode 14 and focussing anode 15 are associated in coaxial relation by discs or platforms 19 and 20 mechanically coupled in fixed relation by insulating masses or bodies 21.

Supported from the disc or platform 20 by insulating bodies 22 are two pairs of deflector plates 23 and 24, the two pairs being in space quadrature and the plates being connected electrically to respective terminals 16 by associated leading-in conductors 18. Also supported by the disc or platform 20 and coaxial with the gun electrodes is a frusto-conical metallic shield 25.

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A plurality of rigid, insulating supports or rods 26 are secured to the shield 25 by U-shaped brackets 27 affixed to the shield, as by welding, and to the rods as by masses 28 of insulating cement. The supports or rods 26 mount a frusto-conical deflecting electrode 29 and a metallic shield 30, both coaxial with the electron gun and secured to the rods by brackets 27 and masses 28 of insulating cement.

The shield 30 mounts a target and collector electrode assembly which, as shown in detail in Figs. 2 and 3, comprises a circular insulating disc 31, for example of mica, seated upon an internal flange or shoulder 32 on the shield. The assembly includes also a plurality, for example twenty-four, of identical target electrodes disposed at equal angles to corresponding radii of the disc 31, each of the target electrodes comprising a rectangular portion 33A and an inwardly tapered portion 33B and having bent end parts 34 defining locking tabs extending through slots in the disc 31. The target electrodes are of a material, such as, for example silver-magnesium alloy, having a coefficient of secondary emission greater than unity. Alternatively, the faces of the target electrodes toward the electron gun may be coated with a material having a high secondary emission coefficient. Individual electrical connection to these electrodes may be established by leading-in conductors 35 which are sealed through the side wall of the enclosing vessel 10 and are connected to terminals 36 carried by an insulating support 37 within a dished shell 38 secured to the vessel 10.

The assembly includes also a plurality of metallic shield-collector electrode elements, one for each of the target electrodes. Each of these elements comprises a base portion 39 seated upon the insulating disc 31 and affixed to the respective target electrode by masses 40 of insulating cement, and comprises also an integral upstanding Z-shaped portion 41, the intermediate part of which, as shown in Fig. 2, extends between adjacent target electrodes. The several shield-collector elements are tied together electrically by connecting tabs 42 and are connected to one of the terminals 36 by a leading in conductor 43.

The target electrodes and shield-collector elements, it will be noted, constitute a plurality, e. g. 24, of substantially identical units mounted in circular array coaxial with the electron gun. As will be pointed out in detail presently, the elements function to collect secondary electrons emanating from the target electrodes. Also, these elements and specifically, the upstanding portions 41 thereof, shield and segregate adjacent target electrodes from one another. Particularly advantageously the elements 39, 41 are treated or coated to minimize secondary electron emission therefrom.

Extending coaxially within the deflector electrode 29 is a second, cylindrical deflector electrode 44 which is supported from the disc 31 by flanged collars 45 affixed to the electrode 44 and locking it to the disc 31. Electrical connection to the deflector electrode 44 may be established by way of a leading-in conductor 46 connected to one of the terminals 36.

In the operation of the device, as illustrated in Fig. 5, the electrodes constituting the electron gun are energized appropriately to produce a concentrated electron beam which is projected between the deflector plates 23 and 24. These plates are energized from a source 47 to produce a circular motion of the beam. The coaxial de-

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flector electrodes 29 and 44 are energized from a source 48 applying a saw-tooth voltage between them. The two deflecting voltages, that is, those due to the sources 47 and 48, are correlated so that the beam trace or path at the target electrodes 33 is of circular saw-tooth form as indicated by the dotted line P in Fig. 4. The shield-collector elements 39, 41 are operated at a potential positive with respect to both the cathode 12 and the target electrodes 33, and the shield 30 may be tied directly to these elements as illustrated. Individual output channels each including an output resistor 49 and series condenser 50 are connected to the target electrode 33, only one such channel being illustrated in Fig. 5. Alternatively, transformer-type output coupling may be used.

The multiplex signal to be translated, which may be of any one of a number of forms, such as amplitude modulated or pulse length modulated, is applied to the control electrode 14 by way of a suitable input circuit 51, the beam sweep cycle being synchronized, of course, with the transmitter producing the multiplex signal so that each non-radial section such as AB in Fig. 4 of the beam trace corresponds to the period of a respective transmitter channel. Advantageously, the input circuit 51 includes appropriate apparatus for extinguishing the beam during the period corresponding to each radial section, such as BA<sub>1</sub>, of the beam trace.

The input signal controls the intensity of the beam and, thus, the beam current to each target electrode is varied in accordance with the respective time segment of the multiplex input signal. Whenever the beam impinges upon one of the target electrodes, secondary electrons flow therefrom to the associated collector element 39, 41. The current in the output channel coupled to this electrode is determined, then, by the difference between the beam current to this electrode and the secondary electron current away therefrom.

It will be appreciated that because of the arrangement of the target electrodes 33 and the form of the beam trace, and particularly in cases where the beam is extinguished for the periods corresponding to the radial sections, such as BA<sub>1</sub>, of the trace, electronic segregation of the several target electrodes is realized without substantial sacrifice of space in the target electrode assembly. Stated in another way, the guard space required is minimized and there is a minimum of lost or wasted time between channels during each sweep cycle. A large proportion of each sweep cycle, therefore, is usable for the translation of signals so that a large ratio of duty time to guard time obtains. Further, because of the factors mentioned, it will be noted that the target electrodes may be closely spaced physically so that a large number of such electrodes may be utilized in any given and relatively small space. Also, the target electrodes may be large, having, for example, a width somewhat greater than the beam diameter and a length several times the beam diameter, whereby large output currents may be attained and whereby, further, the relative currents in the several channels are independent of the transverse current distribution in the electron beam.

It will be appreciated additionally that the several target electrodes are highly shielded from one another and from external fields. Stray secondary electrons, such as may emanate from the elements 41 are drawn to the shield 30, so that distortion is minimized.

Although in the construction heretofore described secondary electron emissive targets of particular form and arrangement and associated collector elements are employed, it will be appreciated that the principles of the invention may be utilized also in devices wherein an apertured plate between the electron gun and the targets is employed. In one such construction, for example, a plate or mask having apertures of the form and arrangement of the targets as illustrated in Fig. 4 may be employed, a target electrode being provided behind each aperture to receive the beam current passing therethrough. The target beam current may be utilized as the output current. Such construction differs functionally from that illustrated and described in the sense of the current variations in the output channels.

Also, although in the constructions illustrated and described the beam trace includes radially extending portions, such as BA<sub>1</sub> in Fig. 4, the targets may be arranged and the beam deflecting system correlated therewith so that such portions as BA<sub>1</sub> of the trace are other than radial whereby additional guard space is introduced between adjacent target electrodes.

It will be understood further that the specific construction shown and described is but illustrative of the invention and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. Electron discharge apparatus comprising a plurality of elongated targets arranged in a circle and extending at oblique angles to respective radii of said circle, means for projecting an electron beam toward said targets, and means for sweeping said beam over said targets in succession and in the direction, at each target, of the length thereof.

2. Electron discharge apparatus in accordance with claim 1 wherein said targets are secondary electron emissive, the apparatus comprising also collector electrode means for receiving secondary electrons emanating from said targets.

3. Electron discharge apparatus comprising means for projecting an electron stream, means for deflecting said stream to produce a circular, saw-tooth trace at a preassigned region, and a plurality of targets at said region, said targets extending along respective alternate sections of said trace.

4. Electron discharge apparatus comprising a plurality of like, rectangular targets mounted in a circle and extending at equal oblique angles to respective radii of said circle, means for projecting an electron beam toward said targets, and means for deflecting said beam to sweep it over said targets in succession and in the direction of the length of each target.

5. Electron discharge apparatus comprising a row of targets each inclined with respect to the direction of the row, means for projecting an electron beam toward said targets, and means for sweeping said beam over said targets in succession and in the direction, at each target, of the inclination thereof.

6. Electron discharge apparatus comprising a plurality of elongated targets mounted in aligned, laterally adjacent relation and inclined with respect to the direction of alignment thereof, means for projecting an electron beam toward

said targets, and means for subjecting said beam to a saw-tooth deflecting field to sweep it over said targets in succession and in the direction, at each target, of the length thereof.

7. Electron discharge apparatus in accordance with claim 6 wherein said targets have secondary electron emission coefficients greater than unity, the apparatus comprising also collector electrode means adjacent said targets for receiving secondary electrons emitted thereby.

8. Electron discharge apparatus in accordance with claim 7 wherein said collector electrode means comprises shield portions extending between adjacent targets.

9. Electron discharge apparatus comprising a plurality of substantially identical elongated targets mounted in a circle and extending at substantially equal angles to respective radii thereof, an electron gun coaxial with said circle for projecting an electron beam toward said targets, and deflection means comprising coaxial deflecting electrodes intermediate said gun and said targets for rotating said beam to produce, at the targets, a saw-tooth trace alternate sections of which are substantially coincident with the longitudinal axes of adjacent targets.

10. Electron discharge apparatus comprising an insulating disc, a plurality of target electrodes mounted by said disc and in circular array, said target electrodes having a secondary electron emission coefficient greater than unity, and a plurality of collector electrodes, one for each target electrode, mounted upon said disc, each of said collector electrodes being adjacent a respective target electrode and having a shield portion extending between two adjacent target electrodes.

11. Electron discharge apparatus comprising an insulating disc, a plurality of collector electrodes mounted by said disc and in circular array, each of said electrodes having a base portion opposite one face of said disc, and a plurality of target electrodes each overlying the base portion of a respective collector electrode, each of said target electrodes having a secondary electron emission coefficient greater than unity, and each of said collector electrodes having a shield portion extending between two adjacent target electrodes.

12. Electron discharge apparatus comprising a plurality of elongated targets mounted in a circle and inclined with respect to respective radii thereof, electron gun means for projecting an electron beam toward said targets, means for subjecting said beam to a deflecting field such that at the targets the beam trace is of saw-tooth form and includes a plurality of saw-tooth sections, one for each target and extending in the direction of the length thereof, and control means for interrupting said beam at times corresponding to preassigned points on said trace.

ALVA EUGENE ANDERSON.

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