July 29, 1941. F. GRAY ET AL 2,250,529

SIGNAL TRANSLATING APPARATUS

Filed Feb. 11, 1939

FIG. 1

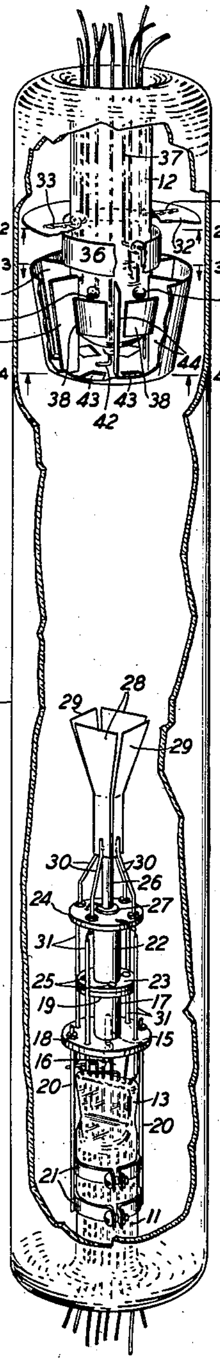


FIG. 3

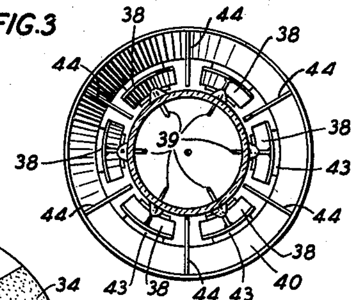


FIG. 2

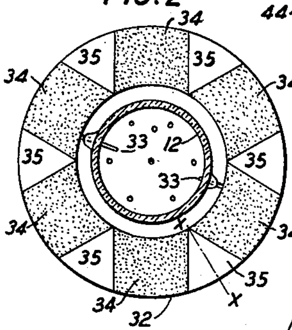


FIG. 4

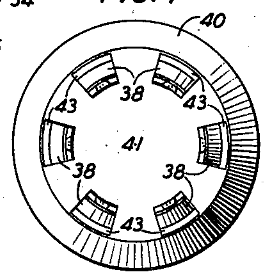
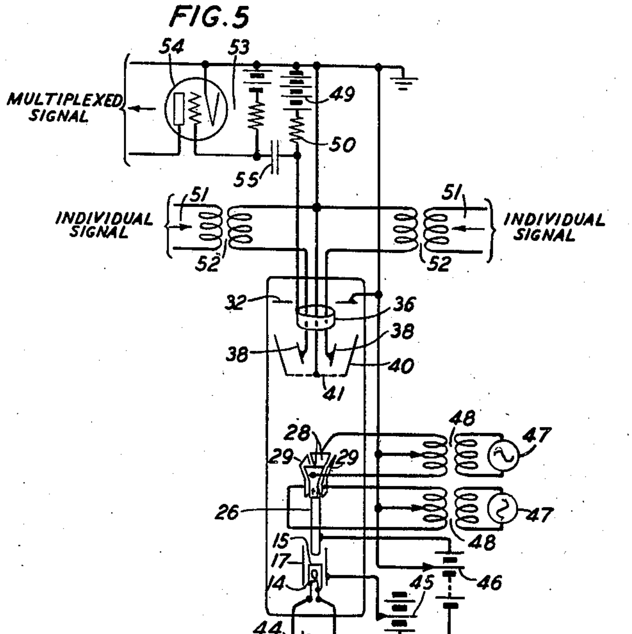


FIG. 5



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SIGNAL TRANSLATING APPARATUS

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Application February 11, 1939, Serial No. 255,899

12 Claims. (Cl. 250—152)

This invention relates to signal translating apparatus and more particularly to electronic commutators for multiplex telephone systems such as disclosed in the applications of Frank Gray, Serial No. 255,897 filed February 11, 1939, and Serial No. 255,898, filed February 11, 1939.

One object of this invention is to faithfully commutate a plurality of complex signals such, for example, as signals corresponding to speech and music.

Another object of this invention is to facilitate the accurate conversion of speech and music into electrical waves.

Still another object of this invention is to prevent electronic cross-talk and distortion in electronic commutators.

A further object of this invention is to improve and to simplify the structure of electronic commutators.

In one illustrative embodiment of this invention, an electronic commutator comprises a plurality of secondary electron emissive targets, a collector electrode in cooperative relation with the targets, and means for producing an electron beam which impinges upon the targets in sequence and repeatedly at high frequency.

In accordance with one feature of this invention, the targets are made of varying width, for example, sectoral or wedge-shaped, and means, such as deflector plates, are provided in cooperative relation with each of the targets for deflecting the electron beam whereby the area of each target energized by the electron beam may be varied with resultant corresponding variations in the secondary electron current from each target to the collector electrode.

In accordance with another feature of this invention, means are provided in association with the beam deflecting plates for shielding the latter from one another.

In accordance with a further feature of this invention, the several targets are fabricated as a unitary structure. For example, in one specific form, the targets may be spaced radial sections of a disc of good secondary electron emissive material. The portions of the disc intermediate the targets may be treated or coated to prevent secondary emission therefrom.

The invention and the foregoing 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 a perspective view of an electronic commutator illustrative of one embodiment of this invention, portions of the enclosing vessel, collector electrode, target electrode and shield electrode being broken away to show details of construction more clearly;

Fig. 2 is a sectional view along line 2—2 of Fig. 1 showing the construction of the target electrode;

Figs. 3 and 4 are detail sectional views along lines 3—3 and 4—4, respectively, of Fig. 1, illustrating the form and association of the shield and deflecting electrodes; and

Fig. 5 is a circuit diagram illustrating one way of operating the electronic commutator shown in Fig. 1.

Referring now to the drawing, the electronic commutator disclosed therein comprises an elongated, evacuated enclosing vessel **10** having inwardly extending coaxial stems **11** and **12** at opposite ends, the stem **11** terminating in a press **13**.

Supported by the stem **11** is an electron beam producing and deflecting structure which may be of the construction disclosed in the aforementioned applications of Frank Gray. This structure comprises a cathode, which may be of the equipotential indirectly heated type, including a heater filament **14** and a cup-shaped or cylindrical sleeve **15** coated on its outer surface with an electron emissive coating. The cathode is supported by leading-in conductors **16** embedded in the press **13**. It will be understood, of course, that although a heater type cathode has been shown, other types of cathodes, for example, filamentary, may be employed.

Immediately adjacent the cathode is a concentrating electrode including a cylindrical portion **17** coaxial with the sleeve **15**, and end flanges **18** and **19**. The concentrating electrode may be supported by a plurality of rods or uprights **20** affixed to the flange **18** and carried by a pair of bands or collars **21** clamped about the stem **11**. An insulating spacer is mounted on the concentrating electrode and comprises a tubular body portion **22** coaxial with the concentrating electrode, and end flanges **23** and **24**, the flange **23** being affixed to the flange **19** as by rivets or eyelets **25**.

An elongated tubular anode **26**, of circular or other cross-section, is fitted in the bore in the body portion **22** of the insulating spacer and is provided with a flange or collar **27** seated upon the flange **24**. The anode **26** is coaxial with the concentrating electrode and preferably projects into the cylindrical portion **17** thereof as indicated in Fig. 5. The other end of the anode projects into the space bounded by deflector or sweep plates 28 and 29 which are equally spaced from the longitudinal axis of the anode. Each of the deflector or sweep plates, as shown in Fig. 1, comprises a rectangular portion and an outwardly inclined trapezoidal portion, and is supported by a rigid rod or wire 30 affixed to and carried by the flange 24. Leading-in connection to the deflector or sweep plates may be established through insulated conductors 31 extending from the press 13.

The concentrating electrode 17, anode 26 and sweep or deflector plates 28 and 29 constitute an electron lens system which has a focal point just inside the end of the anode 26 opposite the cathode 15 and which produces an image of this point on the targets to be described hereinafter.

An annular target electrode 32 is supported coaxial with the anode 26 by leading-in conductors 33 sealed in the side of the stem 12. This electrode may be a disc of a material, such as nickel or beryllium, having good secondary electron emission properties, and, as shown clearly in Fig. 2, the surface thereof toward the deflector or sweep plates may have thereon equally spaced radially extending coatings 34 of a material, such as graphite, which does not emit secondary electrons. The remaining wedge-shaped or substantially sectoral portions 35 of this surface constitute secondary electron emissive targets. Alternatively, the targets 35 may be coatings of a secondary electron emissive material, such as matrices including silver oxide, caesium oxide and some free caesium.

An annular or cylindrical collector electrode 36 is disposed in juxtaposition to the targets 35 and is supported coaxial with the disc 32 by a leading-in conductor 37 sealed in the stem 12.

Disposed in circular formation about an axis coincident with that of the electrode 32 and collector electrode 36 are a plurality of curved trapezoidal deflector plates 38, each of which is supported opposite a corresponding one of the targets 35, as by a leading-in conductor 39 sealed in the stem 12, and is slightly inclined, as illustrated in Fig. 5, with respect to the stem 12.

The deflector plates 38 are encompassed by a frusto-conical shield electrode 40 having an apertured base 41 and supported coaxial with the target electrode 32 by a leading-in conductor 42. The longitudinal elements of the frusto-conical shield electrode 40, it will be noted, are substantially parallel to those of the deflector plates 38. Each of the apertures 43 in the base 41 of the shield electrode is in alignment with a corresponding one of the targets 35. The shield electrode is provided also with radially extending plate members or vanes 44, each of which extends between two adjacent deflector plates 38 and electrostatically segregates adjacent plates from one another.

During operation of the electronic commutator, the heater filament 14 is energized as by a battery 45, and the concentrating electrode is maintained at a suitable potential, positive or negative, with respect to the cathode as by a battery 46. The anode 26 is maintained at a high positive potential, for example of the order of six hundred volts, with respect to the cathode as by a battery 46. The deflector or sweep plates 28 and 29 have applied thereto a high frequency potential, for example, of the order of six thousand cycles per second, by oscillators 47 through transformers 48, the two oscillators being 90 degrees out of phase so that the deflector or sweep plates produce a rotating field. As shown in Fig. 5, the sweep or deflector plates are maintained at a positive potential, for example, of the order of three hundred volts, by connections from the mid-points of the secondary windings of the transformers 48 to the battery 46 so that these plates serve as a second anode. If desired, the deflector or sweep plates may be biased at a potential higher than that upon the anode 26, for example, at a potential of the order of three times the potential on anode 26.

The target electrode 32, the shield electrode 40 and the deflector plates have applied thereto the same potential as the sweep or deflector plates 28 and 29 and the collector electrode 36 is maintained at a positive potential, for example, of the order of fifty volts, with respect to the target electrode, as by a battery 49 in series with a resistance 50.

Individual signal channels 51, for example, telephone lines, are connected between the shield electrode 40 and the deflector plates 38 as through transformers 52.

The battery 49 and resistance 50 are bridged across the input circuit 53 of an amplifier 54, a suitable blocking condenser 55 being provided as shown. The output circuit of the amplifier 54 may be connected to a common transmission channel.

When the electronic commutator is operated, the electrons emanating from the cathode 15 are concentrated into a beam focussed upon the target electrode 32, the beam being rotated at high frequency by the field produced by the deflector or sweep plates 28 and 29 so that it impinges upon the targets 35 in succession. The impinging electrons cause the emission of secondary electrons and, consequently, a current will flow from each of the targets 35 to the collector electrode 36. Each secondary electron current may be modulated in accordance with the signal from the corresponding individual signal channel through the action of the corresponding deflector plate 38. That is to say, each deflector plate will deflect the electron beam radially substantially along an axis such as X—X shown for one target 35 in Fig. 2. Hence, the time of travel of the electron beam along each target and the area of the target energized will be varied in accordance with the potentials of the deflector plates and the currents to the collector electrode will correspond to the individual signals.

A complex current, it will be apparent, composed of the several modulated currents will flow through the common resistance 50 and corresponding variations will be produced in the potential of the grid or control electrode of the amplifier 54. Hence, the output of the amplifier will be a multiplexed signal having components corresponding to the several individual signals.

The multiplexed signal may be transmitted over a common transmission channel to a receiving distributor and there analyzed as described in the application Serial No. 255,897, filed February 11, 1939, of Frank Gray.

Although the electron beam has been described as rotated by an electrostatic field, it may be rotated also by a magnetic field produced, for example, by external coils. It will be understood also that, although a specific embodiment of this invention has been shown and described, 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. Signal translating apparatus comprising means for producing an electron beam, a plurality of similar, secondary electron emissive targets each target being of varying width from the beam axis outwardly, a single collector electrode in cooperative relation with all of said targets, means for deflecting said electron beam to impinge upon said targets in sequence, and means for controlling the secondary electron current from each of said targets including means for deflecting the electron beam in directions substantially normal to the width of said targets.

2. Signal translating apparatus comprising means for producing an electron beam, a plurality of similar, secondary electron emissive targets, each target being of varying width from the beam axis outwardly, a collector electrode in cooperative relation with said targets, means for deflecting said electron beam to impinge upon said targets in sequence, and means for controlling the secondary electron current from each of said targets including means for deflecting the electron beam in directions substantially normal to the width of said targets, said targets being wedge-shaped and mounted in circular formation about an axis coincident with the longitudinal axis of said collector electrode.

3. Signal translating apparatus comprising means for producing an electron beam, a plurality of similar secondary electron emissive targets, each target being of varying width from the beam axis outwardly, a collector electrode in cooperative relation with said targets, means for deflecting said electron beam to impinge upon said targets in sequence, and means for controlling the secondary electron current from each of said targets including means for deflecting the electron beam in directions substantially normal to the width of said targets, said controlling means comprising a plurality of deflecting plates, one for each of said targets, each deflecting plate being in alignment with a corresponding one of said targets.

4. Signal translating apparatus comprising a collector electrode, a plurality of secondary electron emissive targets mounted in a circular boundary coaxial with said collector electrode, means for producing an electron beam, means for rotating said beam so that it impinges upon said targets in succession, each target varying in dimension normal to the direction of the trace of said beam thereon, means for varying individually the area of each target impinged upon by said beam including means for deflecting said beam along radii of said circular boundary.

5. Signal translating apparatus comprising a collector electrode, a plurality of secondary electron emissive targets mounted in a circular boundary coaxial with said collector electrode, means for producing an electron beam, means for rotating said beam so that it impinges upon said targets in succession, each target varying in dimension normal to the direction of the trace of said beam thereon, and means for varying the area of each target impinged upon by said beam including means for deflecting said beam along radii of said circular boundary, said deflecting means comprising a plurality of deflecting electrodes mounted in a boundary coaxial with said collector electrode, each of said deflecting electrodes being in cooperative relation with a corresponding one of said targets.

6. Signal translating apparatus comprising a collector electrode, a plurality of secondary electron emissive targets mounted in a circular boundary coaxial with said collector electrode, means for producing an electron beam, means for rotating said beam so that it impinges upon said targets in succession, each target varying in dimension normal to the direction of the trace of said beam thereon, means for varying the area of each target impinged upon by said beam including means for deflecting said beam along radii of said circular boundary, said targets being radially extending wedge-shaped portions of an annular member, and non-emissive coatings upon the portions of said member intermediate the wedge-shaped portions.

7. Signal translating apparatus comprising a collector electrode, a plurality of secondary electron emissive targets mounted in a circle coaxial with said collector electrode, means for producing a rotating electron beam impinging upon said targets in succession, the dimension of each target in the direction of the trace of the beam thereon varying outwardly with respect to the center of said circle, a plurality of beam deflecting electrodes, each in alignment with a corresponding one of said targets, and shield members between successive deflecting electrodes.

8. Signal translating apparatus in accordance with claim 7 comprising a shield electrode encompassing said deflecting electrodes.

9. Signal translating apparatus comprising a collector electrode, a plurality of secondary electron emissive targets mounted in and along radii of a circular boundary coaxial with said collector electrode, each of said targets varying in dimension normal to the corresponding radius of said boundary, a plurality of deflector plates, one for each of said targets and in alignment therewith, said plates being mounted in a boundary coaxial with said collector electrode, a hollow electrode encompassing said deflector plates, coaxial with the boundary thereof, and defining a substantially annular passageway therewith, means for producing an electron beam, and means for rotating said beam in said passageway to impinge upon said targets in succession.

10. Signal translating apparatus in accordance with claim 9 wherein said hollow electrode comprises a base having therein a plurality of apertures, one for each of said targets, each aperture being in alignment with the corresponding target.

11. Signal translating apparatus in accordance with claim 9 comprising shields for screening said deflector plates from one another.

12. Signal translating apparatus in accordance with claim 9 comprising a plurality of radially extending vanes integral with said hollow electrode, each vane projecting between two successive deflector plates.

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