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S. R. RICH ET AL

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COMMUTATOR TUBE

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Fig. 1.

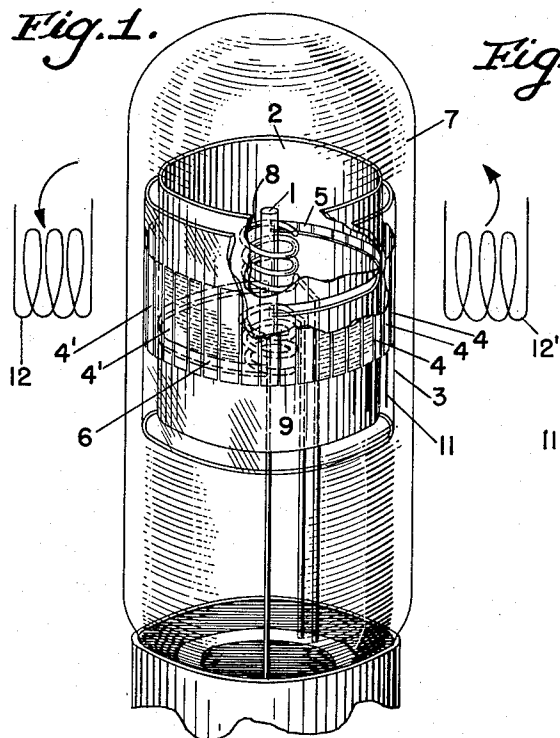


Fig. 3.

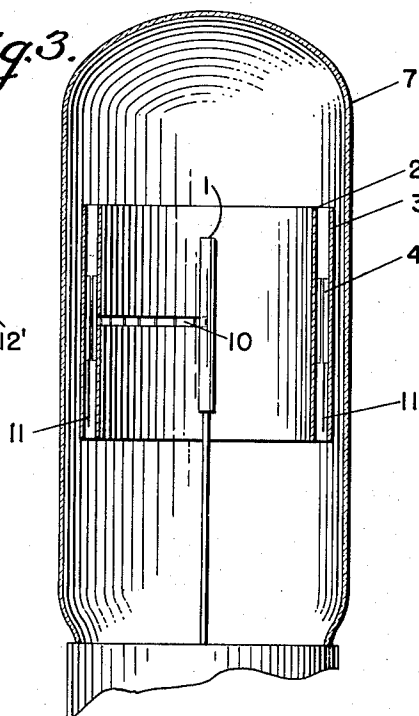


Fig. 2.

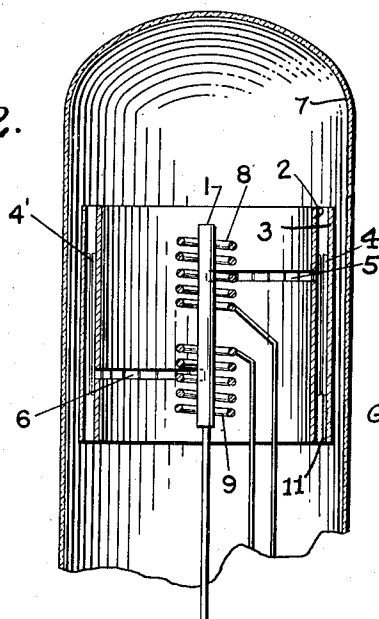
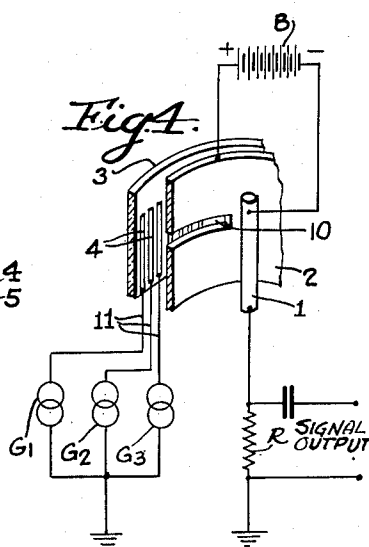


Fig. 4.



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COMMUTATOR TUBE

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8 Claims. (Cl. 313-69)

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The present invention relates to an electron tube and has for its purpose the commutation of current in successive different but associated circuits.

A feature of the present invention is the elimination of switching noises in commutation which will permit the operation of the tube with extremely low signal levels. The tube also provides smooth commutation in switching from one circuit to an adjacent circuit, thereby making it possible to use the tube in circuits for direction and distance determination with the aid of sound and electrical energy.

The tube of the present invention comprises a cylindrical cathode directly or indirectly heated with a cylindrical accelerating anode having circumferential slots of desired arc length located in a plane perpendicular to the cathode, which slot permits the electron beam to emerge for a short distance to form a virtual cathode beyond the slot in the accelerating anode. A number of commutating elements are then spaced around the slotted accelerating anode, each commutating element being connected to external circuits for control purposes.

The present invention will be more fully described in connection with the drawings illustrating the embodiment of the same in which Fig. 1 shows the tube in perspective with fragmentary sections broken away to show certain details of the tube; Fig. 2 shows a central section of the tube illustrated in Fig. 1; Fig. 3 shows a section of the invention in a slightly modified form; and Fig. 4 shows the tube as shown in Fig. 3 connected in a utilization circuit.

In the arrangement indicated in Figs. 1 and 2 there is shown a centrally positioned cathode 1 which may be of the heater type and is cylindrical in shape. Concentrically positioned with respect to this tube is an accelerating anode 2 and beyond this a separate electrically non-conductive cylinder 3, also concentrically positioned with respect to the cathode. The cylinder 3 may be made for example of glass, and has deposited on its surface, preferably inside, a set of parallelly arranged conductive segments spaced around a sector of an arc, the segments extending in the same direction as the cathode of the tube. These segments are indicated as 4, 4, etc., the spacing between the segments being quite narrow, of the order of thousandths of an inch. These segments may be a silver deposit or a deposit of other highly conductive material on the glass. The accelerating anode 2 and the segments 4, which may be termed commutator electrodes, are spaced very close together, as close as practical in tube construction, and the anode 2 is provided with a slot 5 arranged in a horizontal plane or in a plane cutting across the commutator segments. The slot 5 may be of any

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desired angular opening but is shown in Figs. 1 and 2 as approximately 180 degrees. As indicated in Figs. 1 and 2 a second slot 6 is provided in the other half of the accelerating anode 2 opposite a similar group of commutator segments 4', 4', etc., which may be the same as the segments 4, 4, previously mentioned.

The elements described are contained in an air and gas evacuated casing 7 of glass or other suitable substance, the evacuation being of the type required for an electron beam tube, such as the cathode ray oscilloscope.

Where the accelerating anode is provided with two slots opening in opposite directions to the commutator electrodes for control purposes it is necessary to provide control grid structures. This is provided in Figs. 1 and 2 in the separate concentric grids 8 and 9, the grid 8 suppressing the beam going through the upper slot 5 while the grid 9 suppresses the beam going through the lower slot 6 when a sufficiently high negative potential is impressed thereon. A magnetizing field may be provided by coils 12 and 12' externally of the tube to concentrate the beam generally in a vertical plane coincident with the axis of the tube. These coils can be rotated together about the axis of the tube, as shown by the arrows in Fig. 1. This beam will be rotated by the rotation of the magnetic field of the coils so that it will sweep across the accelerating anode through the slot forming, as earlier mentioned, a virtual cathode beyond the slot, the electrons from which will be attracted by the commutator segments as the beam progresses around the slot. Since the cathode beam substantially loses its velocity at the slot, not only are the commutator electrodes spaced near the accelerating anode, but, further than this, reflection of the beam from the commutator segments is practically avoided and a soft smooth commutation may result. The commutators for this reason are biased substantially to the potential of the cathode. A feature in helping the smooth commutator effect is also the fact that the commutator segments are spaced close together so that there is very little interruption by the beam being between any two segments. The beam is, for practical purposes, the width or less than the width of a single segment. The control grids 8 and 9 may be used to suppress either the portion of the beam passing through the top or bottom slots, respectively, so that, if only one slot is used, the circuit will be open where the beam is blocked either by the grid or by the lack of a slot in the accelerating anode.

In the arrangement indicated in Fig. 3 only one slot 10 is provided which may be 180 degrees or less, if desired. In this case no control grid is necessary as the back half of the beam, that is, the half not looking towards the slot, is always cut off from the commutator segments. The

effective working length of the cathode is short in comparison to the length of the accelerating cylinder, as indicated in Fig. 3, for the purpose of reducing the unused component of cathode current and eliminating field distortion. The accelerating anode cylinder may be made of any metallic material or perhaps graphite coated glass, this material being used for the purpose of preventing eddy current losses in the accelerating anode cylinder due to the rotating magnetic field.

Each commutator strip has a conductive element 11 by means of which connections are made to the external circuit, and the elements of the tube are insulatingly supported in the manner usual in the art.

The commutator tube as above described operates, as the name implies, to commute current to any one of the segments of the tube or to make electrical connections with any one of the segments of the tube, thereby providing a selective circuit mechanism as the cathode beam is rotated or controlled through the aid of a magnetic field provided by the coils 12, 12' which may be rotated about the tube as indicated by the arrows to rotate the cathode beam. Any other well known means that is desired may be employed to rotate or sweep the beam, for example a plurality of fixed rectangularly disposed focusing coils, energized in phase quadrature from a common source of sinusoidal sweep voltage.

The tube of the invention may be employed in circuits where rapid and smooth commutation from one signal source to another is desired, as shown for example in Fig. 4, where G1, G2, and G3 are separate and distinct sources of signal voltages, and R is a common load resistor. The accelerating anode 2 is made positive with relation to the cathode 1 by means of a suitable source of anode potential such as the battery B. Each commutator electrode 4 is connected to one of the signal sources G1, 2, 3, there being a commutator electrode provided for each signal source that is to be included in the circuit. The other side of each signal source is grounded. The load resistor R, across which the output signal voltage is to appear, is connected at one side to the cathode and at the other side to ground. With this connection, the cathode 1 and the commutator electrodes 4 are all at the same potential as far as direct current is concerned, while each signal source G1, 2, 3, provides a voltage which appears across the resistor R when the cathode beam is in contact with the thereto connected commutator electrode 4.

Having now described our invention, we claim:

1. An electronic commutator tube comprising a cathode, an accelerating anode spaced away from and extending around said cathode, a plurality of electrodes positioned externally of the accelerating anode, and a slot in the anode extending transversely across the position of said electrodes.

2. An electronic commutator tube comprising a cathode, an accelerating anode spaced away from and extending around said cathode and having a slotted opening formed therein, and a plurality of commutating electrodes spaced close together extending around at least a portion of said accelerating anode opposite and each disposed transversely to the direction of the long dimension of said slotted opening.

3. An electronic commutator tube comprising a centrally positioned cathode, an accelerating anode extending symmetrically with respect to

the cathode, said accelerating anode having a slotted opening therein, and a plurality of commutating electrodes positioned symmetrically with respect to said accelerating anode opposite the slotted opening and each disposed transversely to the direction of the long dimension thereof.

4. An electronic commutator tube comprising a cylindrical cathode, a concentric cylindrical accelerating anode having a slotted opening formed in a plane perpendicular to the axis, and a plurality of commutating electrodes spaced close together opposite the slotted opening beyond the accelerating anode and each disposed transversely to the direction of the long dimension of the slot.

5. An electronic commutator tube comprising a cathode, an accelerating anode having a slotted opening spaced away from said cathode and a plurality of commutating electrode spaced beyond the accelerating anode opposite the slotted opening, and each disposed transfer to the direction of the long dimension thereof, and magnetic means to concentrate an electron beam from said cathode in the vicinity of said slot to form a virtual cathode in the slotted opening in front of the commutating electrodes.

6. An electronic commutator tube comprising a cylindrical cathode, a cylindrical accelerating anode having a plurality of slotted openings extending in planes perpendicular to the axis of the cathode, a plurality of suppressor grids surrounding said cathode for each of said slotted openings and a plurality of commutating electrodes concentrically positioned with respect to the accelerating anode but beyond the same opposite the slotted openings and each disposed transversely to the direction of the long dimensions thereof.

7. An electronic commutator tube comprising a cathode and accelerating anode having a slotted opening therein spaced away from the cathode, a plurality of commutating electrodes each disposed transversely to the direction of the long dimension of and spaced close to and opposite the slotted opening in said accelerating anode, and magnetic means to concentrate an electron beam from said cathode in the vicinity of said slot whereby said slotted opening serves to form a virtual cathode in the opening and the virtual image at the accelerating anode will be substantially the same width as a commutating electrode.

8. An electronic commutator tube comprising a cathode, an accelerating anode spaced away from said cathode, said anode having a slot, a plurality of electrodes positioned closely adjacent each other on the side of said accelerating anode away from said cathode, said electrodes being arrayed side by side in the direction of said slot and each disposed transversely thereto, magnetic means for forming the electron stream from said cathode into a narrow beam the thin dimension of which is in the direction of the long dimension of the slot and means for sweeping the beam in the direction of said long dimension.

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