PATENT SPECIFICATION

729,468

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COMPLETE SPECIFICATION

Electron Tube

We, TELEFONAKTIEBOLAGET L. M. ERICSSON, a Company organised under the laws of Sweden, of Stockholm 32, Sweden, do hereby declare this invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electron tube, with a revolving electron beam, to be used especially as a counting valve, that is to count electric impulses.

It is known to arrange in a magnetic field high vacuum electron valves provided with a cathode located centrally within the valve and a number of electrodes (anodes), positive in relation to the cathode and surrounding said cathode. The cathode may be cylindrical and the anodes oblong and substantially parallel to the cathode. The said magnetic field is substantially constant and its lines of force are approximately parallel to the cathode cylinder. In such a valve, negative internal resistances can be obtained for one or more of the anodes if its (their) potential is lowered below the potential of the other anodes.

In a proposed electron valve of said kind, the electrodes surrounding the cathode are of two different types, receiving electrodes (anodes) arranged to receive the electron beam emitted by the cathode, and control electrodes for directing the electron beam to one, arbitrarily, of the receiving electrodes. The receiving electrodes and the control electrodes surrounding the cylindrical cathode are shaped in cross-section as arcuate segments parallel with the cathode, the receiving electrodes and the control electrodes alternating with each other, the last mentioned electrodes having a wider dimension radially towards the cathode and having the surface facing the cathode located closer to said cathode than the receiving electrodes. A "box" comprising one or more receiving electrodes is thereby formed between adjacent control electrodes.

However, it has been found that for certain purposes, e.g., for counting impulses, the construction of a valve of the kind referred to can be considerably simplified if the receiving electrodes are connected together electrically so that each of them has the same positive potential with regard to the cathode. The control electrodes are used for controlling the electron beam by supplying one of them with a lower voltage than the others, whereby the beam is guided into a box adjacent to said control electrode. The electron beam can be made to revolve within the valve, i.e. automatically to perform a stepping movement from box to box, by successively supplying the control electrodes following each other with a low voltage. This can be effected in several different known ways, for example, by feeding a multi-phase voltage to the control electrodes.

The connection of the receiving electrodes can be arranged within the valve itself and the simplest manner is then to replace the receiving electrodes by a cylindrical anode, concentric with the cathode and located behind the control electrodes, as seen from the cathode. The stepping movement of the electron beam will naturally not be affected thereby, but can be affected in the usual way. The construction of the valve will, however, be much simpler, since a number of inlets through its glass envelope can be omitted.

According to the present invention there is provided an electron valve with a discharge space which is intended to be penetrated by a constant magnetic field when the valve is operative, comprising a cylindrical cathode located centrally within the envelope of the valve, the axis of the cathode being parallel to the direction of said magnetic field, a cylindrical receiving electrode coaxially surrounding said cathode, a plurality of radially directed, equally spaced control electrodes located in the space between the cathode and the receiving electrode, and means for connecting externally to the cathode, the receiving electrode and each control electrode, the control electrodes having such a radial extent and being mutually so located that sub-

[Price 3s. 0d.]

stantially only the control electrodes can have any influence on the movement of the electrons in the space between the cathode and the radially inner edges of the control electrodes and so that each control electrode is capable of having an equal influence on said movement of electrons.

Each part of the receiving electrode located in a box between adjacent control electrodes is provided with a hole through which a portion of the electron beam emitted from the cathode can penetrate, when it is steered into said box, it lights a corresponding part of a screen on the outside of the receiving electrode, which screen is coated with luminescent material.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made to the accompanying drawings, in which:—

Figure 1 is a diagram showing schematically an electron valve with negative internal resistance in the case where all the anodes have the same positive potential with relation to the cathode.

Figure 2 is a diagram showing the same valve as is shown in Fig. 1 but having a lower potential on one of the anodes,

Figure 3 is a diagram of an electron valve,

Figure 4 is a diagram showing an electron valve,

Figure 5 is a diagram of an electron valve,

Figure 6 shows diagrammatically a horizontal and a vertical section of an electron valve provided with a luminescent screen,

Figure 7 shows diagrammatically a horizontal section and a side-view of a valve with another kind of coating, from that shown in Fig. 6, on the luminescent screen, and

Figures 8 and 9 each show diagrammatically a side-view and a plan view of the electrode system of an electron valve.

Referring now to the drawings, in Figure 1 shows a previously known electron valve of the magnetron type with negative internal resistance, the cathode 11 of which is surrounded by a number of anodes 1—8 arranged along a supposed cylindrical surface coaxial with the cathode. The discharge space of the valve is penetrated by a constant magnetic field which is parallel with the axis of the cylindrical cathode and is symbolised by the sign indicated at 15. The magnetic field is directed towards the plane of the figure. If the magnetic field is sufficiently strong and if, as indicated on the figure, all the anodes 1—8 have the same positive voltage (from the battery 14) practically no electron current will flow from the cathode to the anodes. The electrons emitted by the cathode will instead circle around said cathode in paths indicated by the designation 12. Owing to its space charge effect the thus formed electron cloud 12 will prevent further emission of electrons from the cathode.

If the potential of one of the electrodes, for example the anode 1 in Figure 1, decreases, an electron current will start flowing to said electrode (Fig. 2). With further decrease of the potential of said anode, so that said potential will lie close to the cathode potential, the current to said electrode 1 decreases and the beam 12 is displaced towards the nearest preceding anode 8. The negative characteristic appearing within a certain variation range of the voltage, i.e. the decrease of the current with increasing voltage within said range, and the stepping, which can be obtained by lowering the voltage of a certain electrode below the lowest limit of the said variation range for the voltage, can be used for counting electric impulses.

To make it possible to count impulses, the device shown in Figures 1 and 2 is suitably completed with a further electrode shaped as a cylinder surrounding the cathode 11 and the anodes 1—8. Such a valve is shown in Figure 3. Between two adjacent anodes 1—8 in said valve there is a hole through which the electron beam 12 can find its way to the cylindrical electrode 16, instead of to the nearest preceding anode as in Figs. 1 and 2, when the potential on one of the anodes 1—8 decreases. As long as the concentric electrode 16, which obviously functions as a receiving electrode for the electron beam, is positive (anode voltage from the battery 17), the different anodes 1—8, which obviously function as control electrodes, will not take up any current worth mentioning owing to a voltage decrease on the respective subsequent anode. If however the voltage on the receiving electrode 16 decreases to the neighbourhood of the cathode potential, the electron current will, at isolated voltage decrease on one of the control electrodes 1—8, however be obliged to pass over to the nearest preceding control electrode. If the control electrodes are connected to resistances, this quality can be used to count impulses which are provided between the cathode 11 and the receiving electrode 16.

The valve shown in Figure 3, has a drawback, and that is that the variations in the potential of the cylindrical receiving electrode 16 affect the electric field round the cathode and therewith the strength of the cathode current. In order to reduce this detrimental effect the control electrodes 1—8 should be shaped so as to have a larger dimension in a radial direction towards the cathode than in the peripheral direction, as is shown in Fig. 4. The qualities of the valves are further favourably influenced if the distance apart of adjacent control electrodes 1—8 is constant. In Figure 5 a valve is shown, in which the space existing between adjacent control electrodes has a con-

stant width along the whole radial extent of said electrodes.

When utilising such a valve to count electric impulses it is obvious that it is desirable to have a possibility to see in which one of the boxes existing between adjacent control electrodes the electron beam is, for example, at the beginning and at the end of the counting process. This can be achieved in a simple manner by the receiving electrode being coated with a material which becomes luminescent during electron bombardment. The receiving electrode will then gleam only at the place (indicated by the designation 18 in Figure 4) where the electron beam falls onto it.

Further embodiments of electron valves with visual indicating means are shown in Figures 6—9.

In Figure 6 a counting valve is shown, having ten receiving boxes limited by control electrodes 1—10 parallel with the cathode 11. The valve is enclosed in a glass envelope 13 and provided with vacuum-tight inlets 20 for the different electrodes. The cylindrical receiving electrode 16 is provided with a number of holes in its upper part, one in front of each one of the boxes existing between adjacent control electrodes. Two of these holes 23 and 28 are shown in the side view of the valve comprised in Figure 6. A portion of the electron beam—not shown on the drawing—when steered into the corresponding box, is capable of penetrating said hole, whereafter it impinges on a cone-shaped screen 19 coated on the inside with a luminescent material. Thus, if the valve is looked at from above, a luminous patch on the cone-shaped screen 19 will plainly indicate in which box the electron beam is steered.

The shape of the valve appears clearly from Figure 7, which shows a modified embodiment of the screen 19 itself. This screen is not wholly coated with the luminescent material but only ten stripes of its surface are provided with such a coating. These stripes are in the figure indicated by 41—50 and are applied in a suitable manner in relation to the different holes 21—30 in the receiving electrode 16. Due to the bending of the electron beam after it has issued from said holes under the influence of the magnetic field generated by the permanent magnet 31, the said stripes do not lie in front of the corresponding holes but they are displaced (offset) to one side. In the upper portion of the figure the electron beam 12 is shown when steered into the box between the control electrodes 1 and 2, whereby part of the beam issues from said box by the corresponding hole in the receiving electrode 16 to meet the stripe 41, on which a patch with a diameter corresponding to the hole will plainly gleam to indicate that the beam is in the box between said control electrodes.

Instead of being round as in Figures 6 and 7, the holes in the receiving electrodes may have any arbitrary shape. In order to prevent the patch formed by the electron beam spreading, the screen shown in Figure 7 is only partly coated with luminescent material. Such spreading can also be prevented by dividing by means of partition walls the channel formed between the cone-shaped screen and the receiving electrode into a number of chambers corresponding to the number of boxes. Such an embodiment is disclosed in the electrode system shown in Figure 8, where the receiving electrode 16 is provided with triangular openings 21—30, from which partition walls forming tabs 51—60 have been bent between the electrode 16 and the screen 19. In said channel said tabs or partition walls limit a number of chambers 41—50, the oblique far end of which, as seen from the cathode, is formed by the screen 19 and coated with luminescent material.

In the embodiment shown in Figure 9 the receiving electrode 16 itself is on its external side, counted from the cathode, in the neighbourhood of the respective holes 21—30, provided with luminescent coatings 71—80. When the electron beam 12 issues from a hole, for example 21, it will, due to the influence of the magnetic field, be bent towards the external side of the receiving electrode, which it meets on the luminescent surface 71 arranged near said hole; the surface will thereby gleam on a patch corresponding to the section of the beam. A cone-shaped screen 19 is arranged round the upper part of the receiving electrode in the same manner as the screens shown in the preceding figures. In this case however, the screen 19 is not coated with any luminescent material but polished to shine as a mirror, so as to give upwards a reflection of the patch formed on the external side of the receiving electrode owing to the electron beam. If the valve is looked at from above, a reflection 65 of the gleaming patch will thus be visible and the position of the electron beam in the tube can be judged.

Detail-modifications of the described and shown embodiments of an electron valve according to the invention may naturally be made without the scope of the invention being departed from.

What we claim is:—

1. An electron valve with a discharge space which is intended to be penetrated by a constant magnetic field when the valve is operative, comprising a cylindrical cathode located centrally within the envelope of the valve, the axis of the cathode being parallel to the direction of said magnetic field, a cylindrical receiving electrode coaxially surrounding said cathode, a plurality of radi-

ally directed, equally spaced control electrodes located in the space between the cathode and the receiving electrode, and means for connecting externally to the cathode, the receiving electrode and each control electrode, the control electrodes having such a radial extent and being mutually so located that substantially only the control electrodes can have any influence on the movement of the electrons in the space between the cathode and the radially inner edges of the control electrodes and so that each control electrode is capable of having an equal influence on said movement of electrons.

2. An electron valve as claimed in Claim 1, wherein each part of the receiving electrode, which exists between adjacent control electrodes to form the bottom of a box, is provided with a hole, through which a part of the electron beam emitted by the cathode can, when directed into said box, issue in order to make a corresponding part of a screen, which is coated with luminescent material, luminous on the internal side of said screen.

3. An electron valve as claimed in Claim 1, wherein the receiving electrode is at its upper part facing the cathode cylinder, coated with a luminescent material.

4. An electron valve as claimed in Claim 2, wherein said screen consists of a cone-shaped shell fixed to and surrounding the upper part of the receiving electrode.

5. An electron valve as claimed in Claim 4, wherein the screen is wholly coated with a luminescent material on its internal side.

6. An electron valve as claimed in Claim 4, wherein the screen is provided with luminescent stripes located in such a way that one such stripe is struck by the electron beam when it is directed into a corresponding box.

7. An electron valve as claimed in Claim 2, wherein the back of the receiving electrode is arranged to function as a screen and is coated with luminescent material close to said holes.

8. An electron valve as claimed in Claim 5, wherein the holes in the receiving electrode are formed by triangular or otherwise suitably shaped tabs being bent outwards from the receiving electrode and forming partition walls which divide the space between the cone-shaped screen and the receiving electrode into a number of chambers corresponding to the number of boxes in the electron valve in order to prevent the beam from forming more than one luminous patch at a time on said screen.

9. An electron valve as claimed in Claim 7, wherein there is provided a reflecting cone-shaped screen arranged on the external of the receiving electrode in order to make the luminous patches close to the holes visible from above by reflection.

10. An electron valve with a discharge space which is intended to be penetrated by a constant magnetic field when the valve is operative, substantially as hereinbefore described with reference to any one of Figs. 4 to 7 or 8 and 9 of the accompanying drawings.

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729,468 COMPLETE SPECIFICATION
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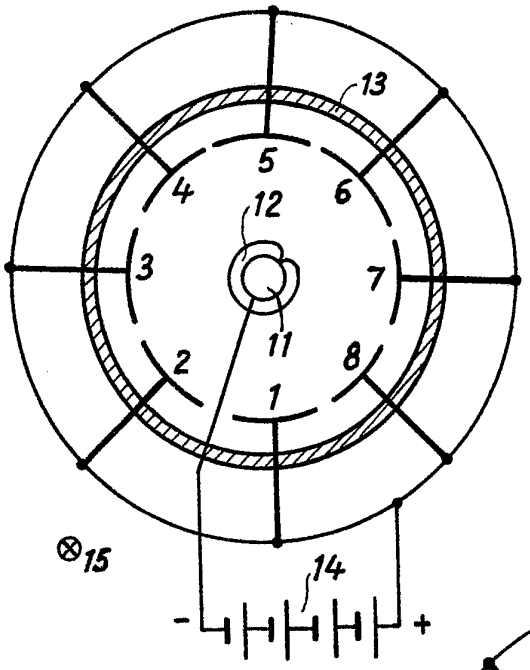

Fig. 1

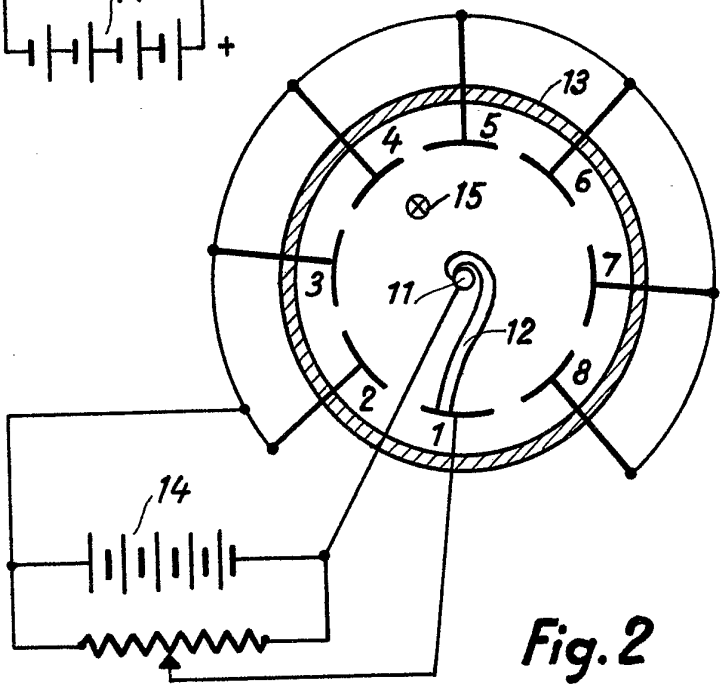

Fig. 2

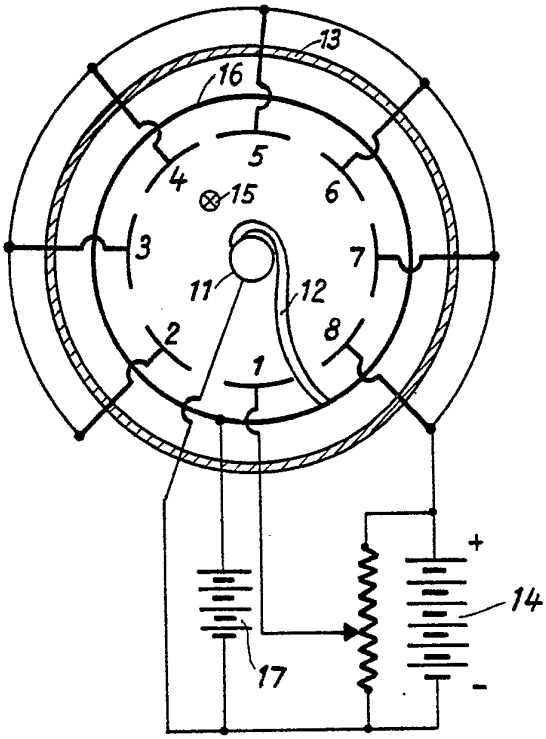

Fig.3

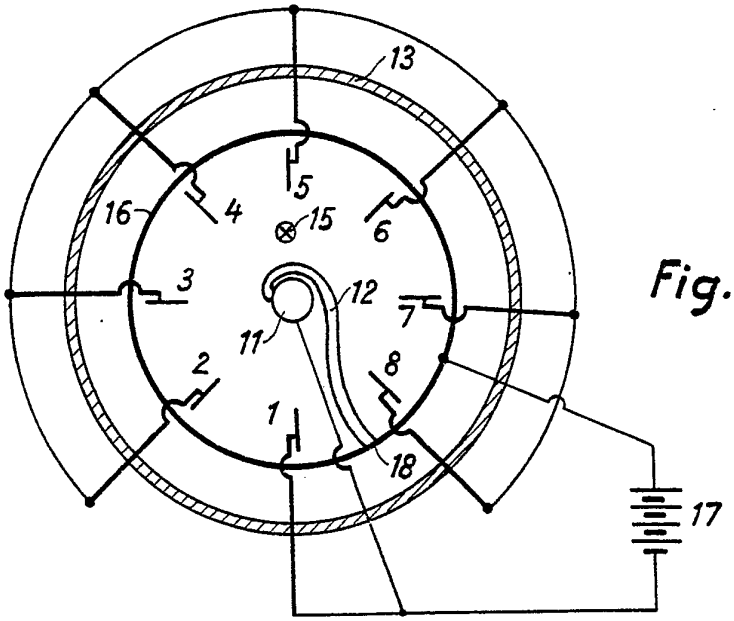

Fig.4

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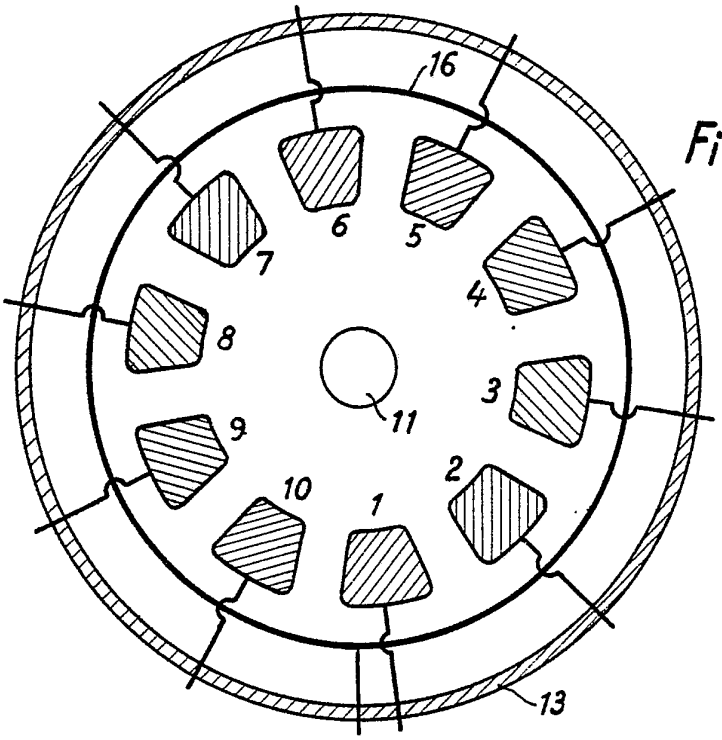
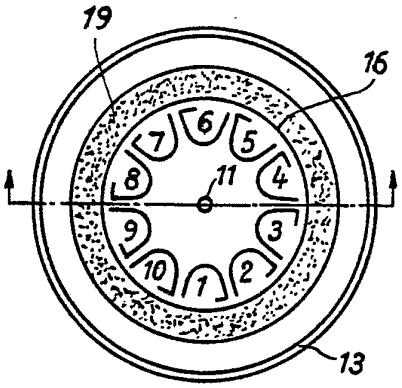


Fig.5



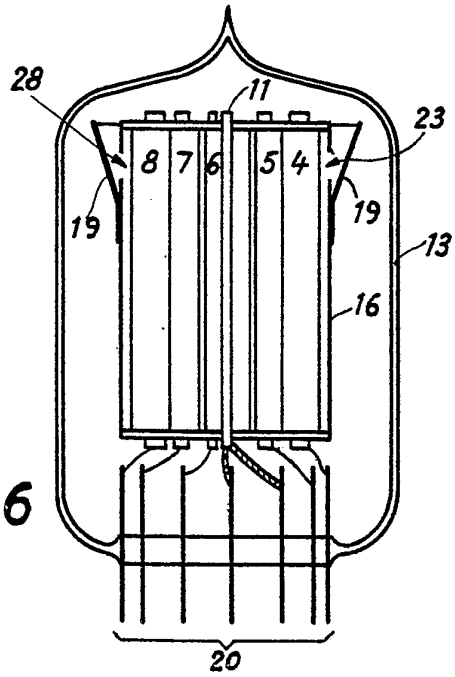


Fig.6

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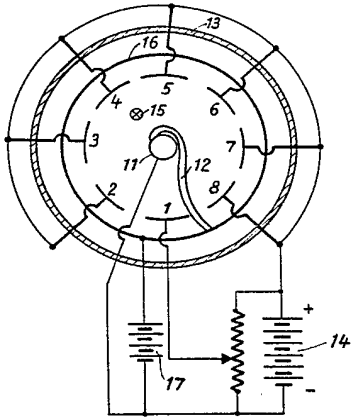


Fig.3

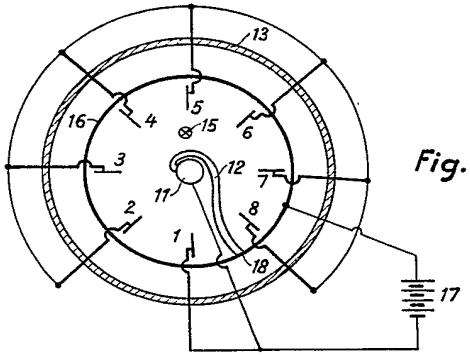


Fig.4

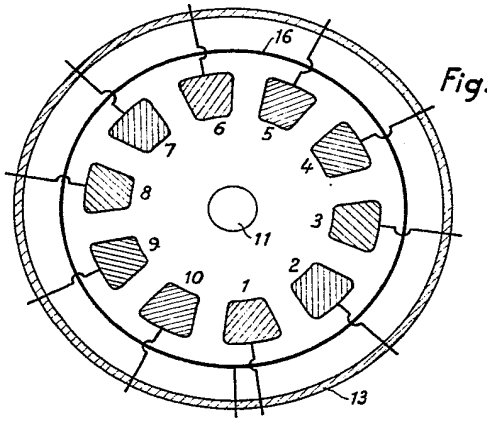
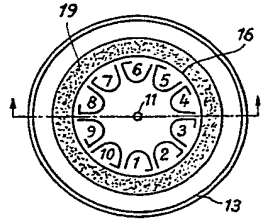


Fig.5



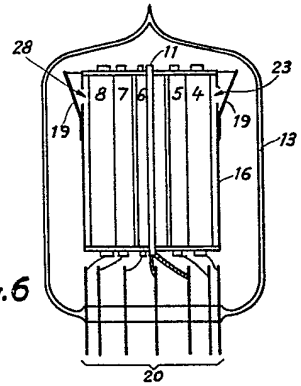


Fig.6

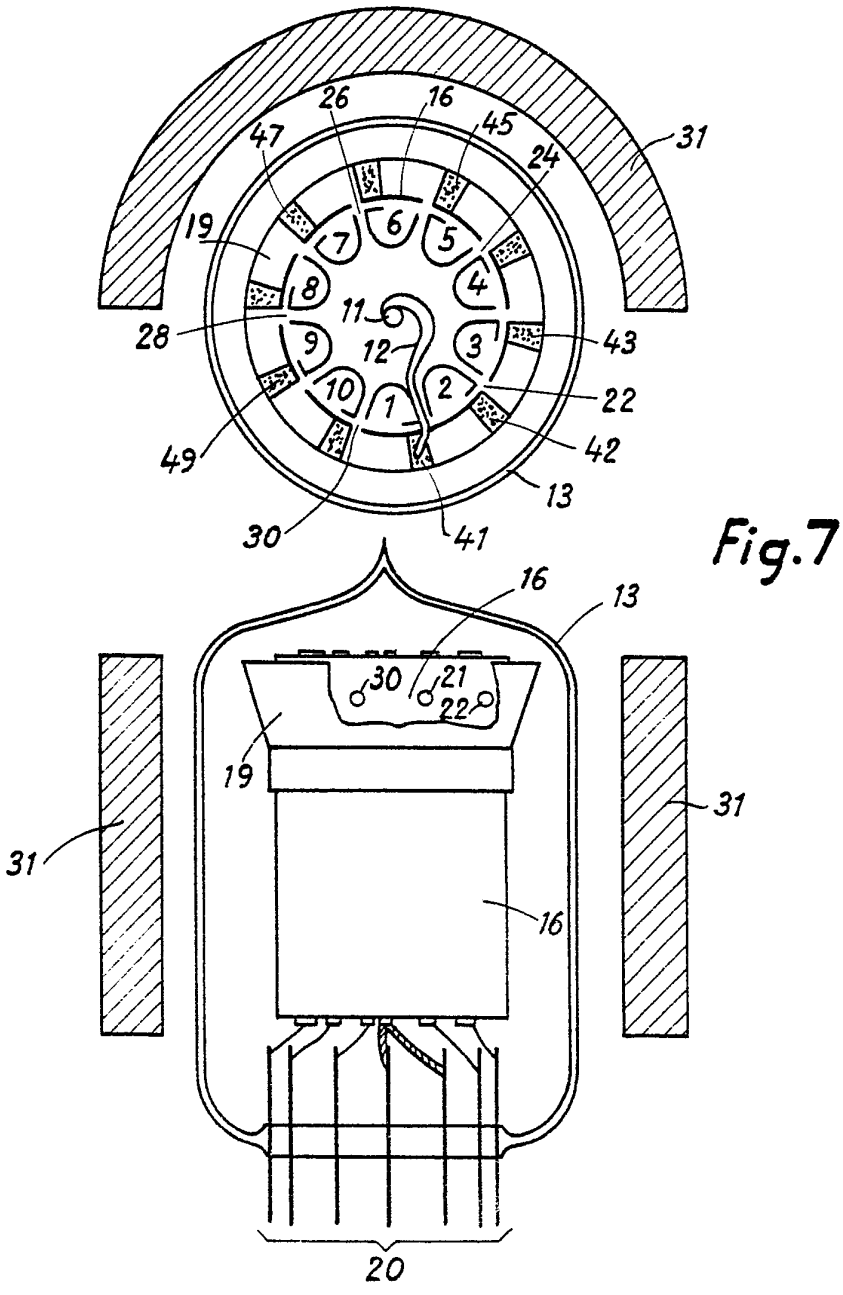

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Fig.7

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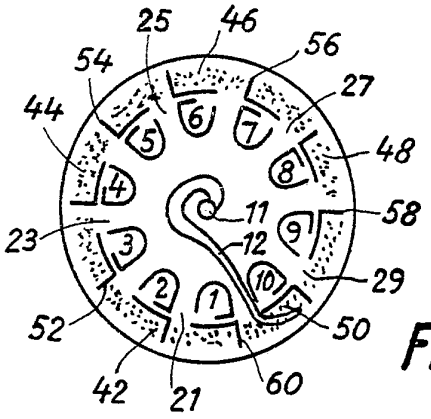
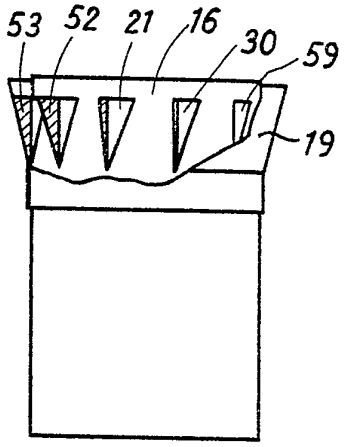


Fig.8



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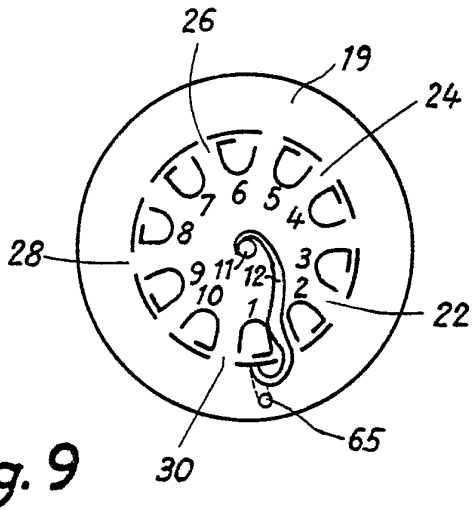
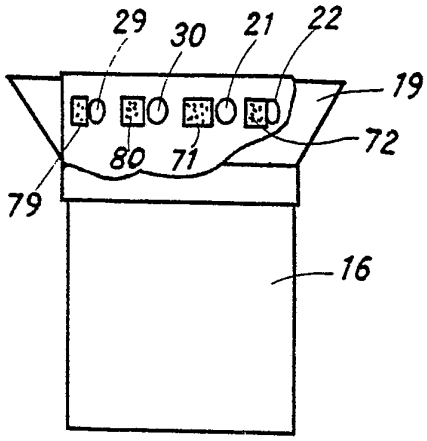


Fig. 9



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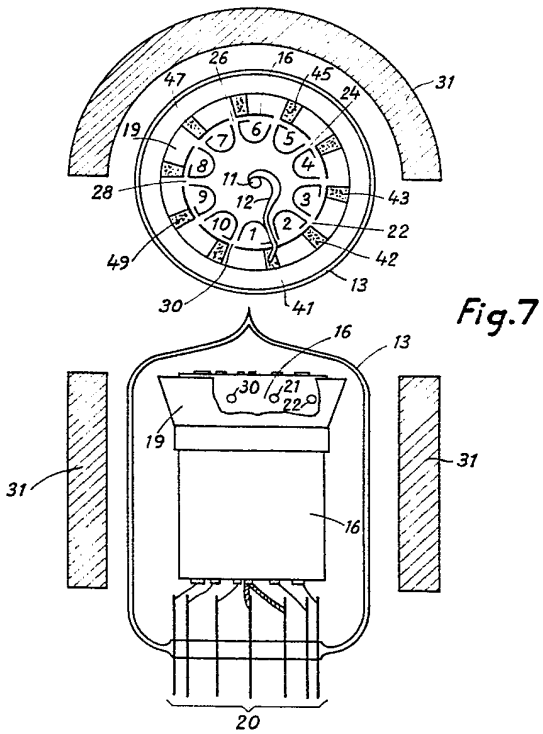


Fig.7

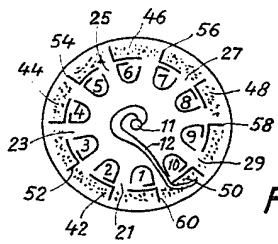
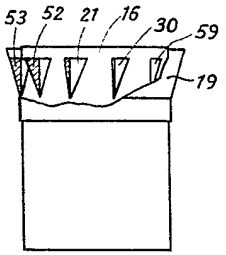


Fig.8



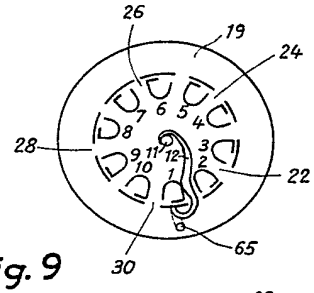


Fig. 9