

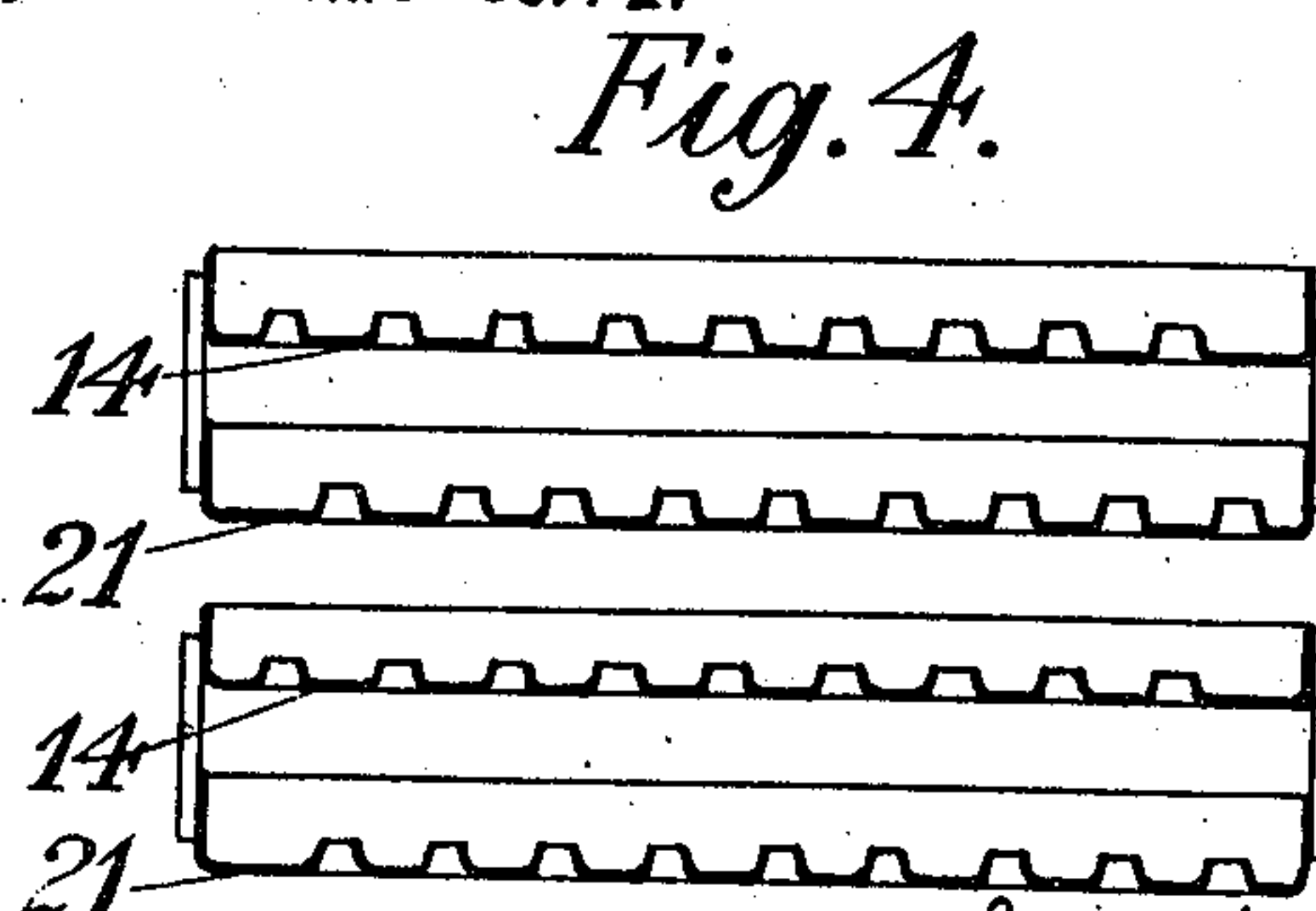
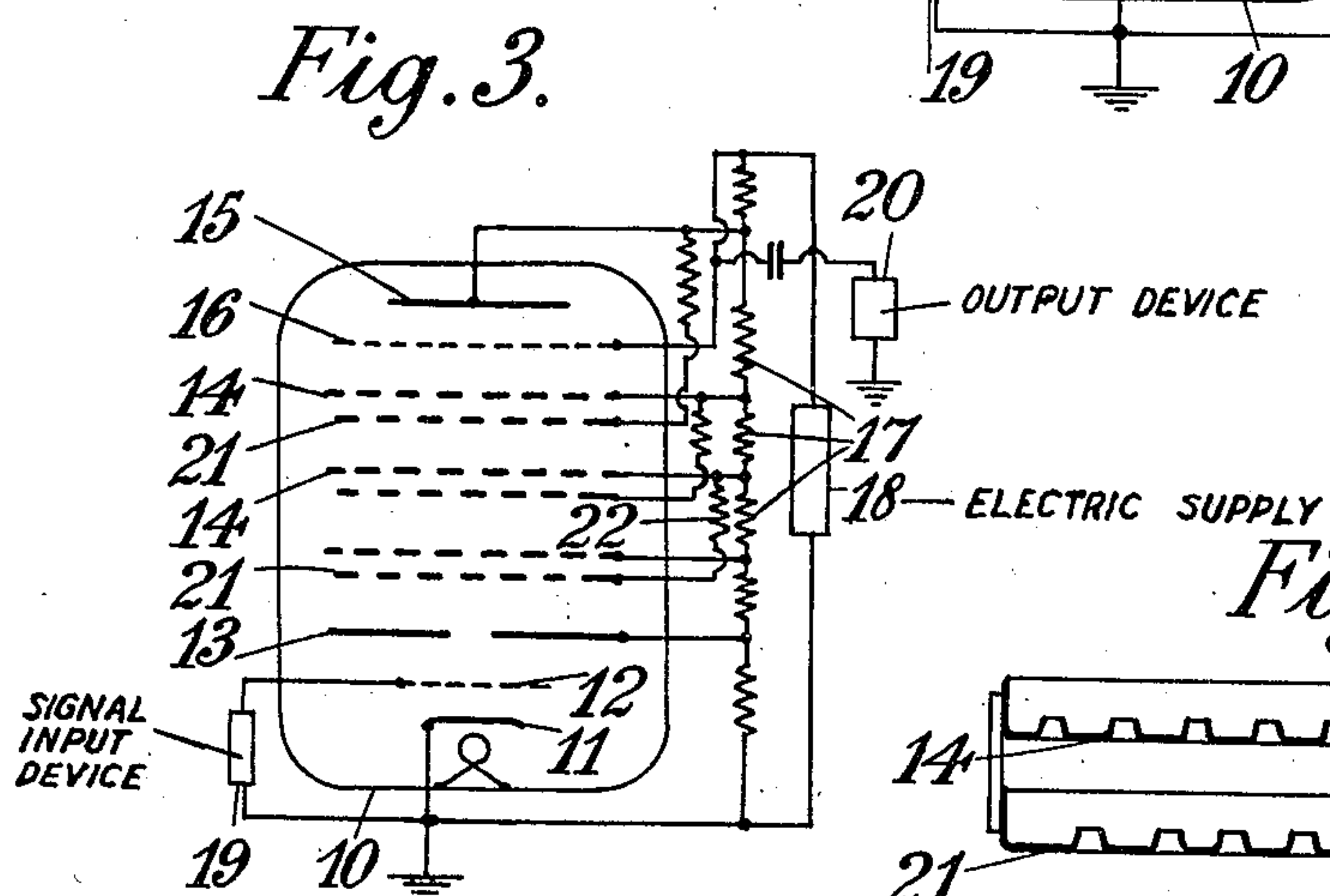
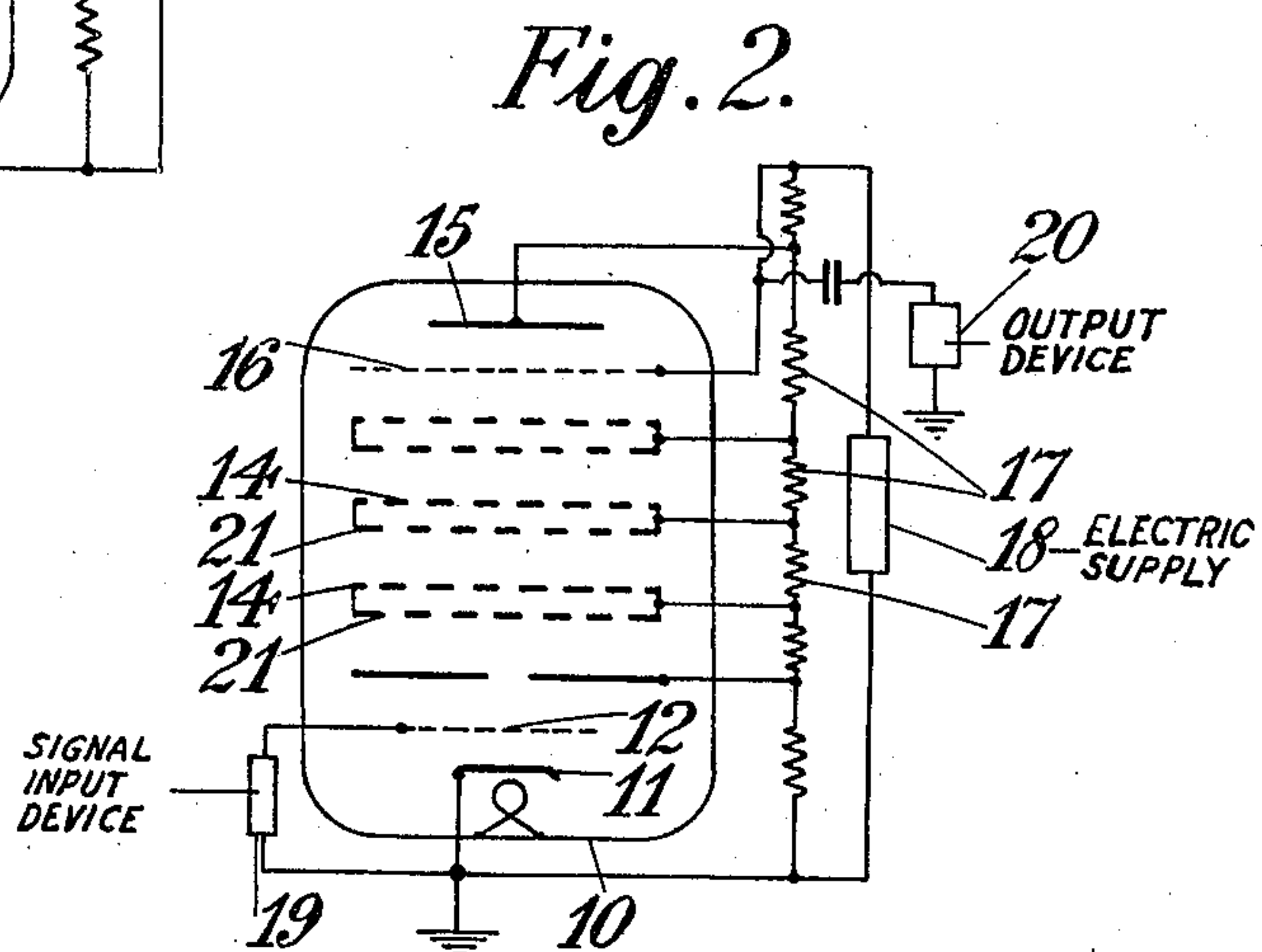
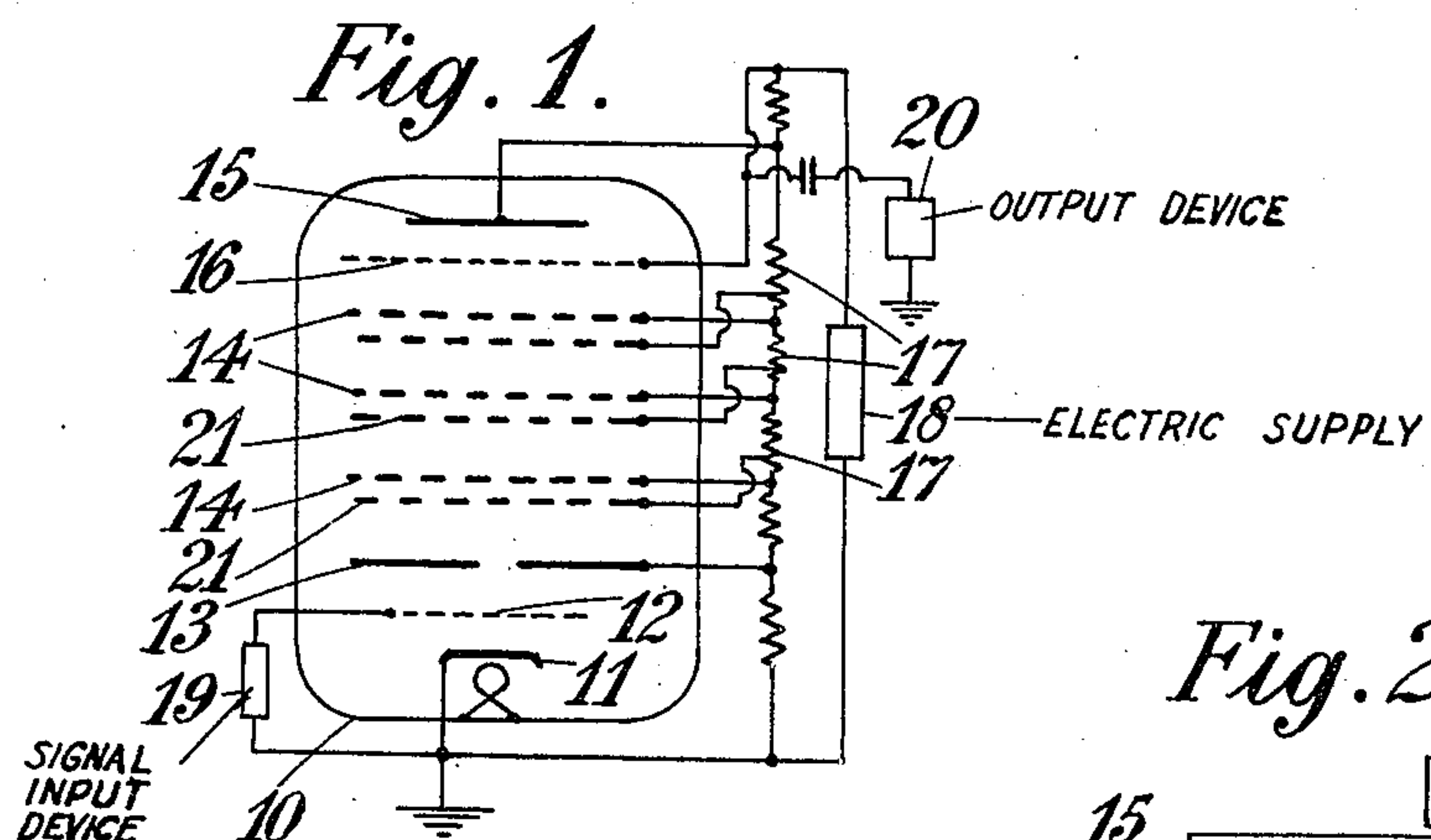
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ELECTRON MULTIPLIER APPARATUS

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ELECTRON MULTIPLIER APPARATUS

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7 Claims. (Cl. 250—27)

This invention relates to electron multiplier apparatus comprising an electron multiplier having an electrode system including a primary cathode, one or more secondary cathodes for secondary electron emission and a collector, together with means for applying to the secondary cathode or cathodes and the collector, positive potentials with respect to the primary cathode of progressively increasing magnitude. In operation, electrons emitted by the primary cathode impinge on a secondary cathode and liberate other electrons which impinge on the next secondary cathode, when more than one, and so on in succession to the collector. The present invention is concerned with electron multipliers employing secondary cathodes which are in the form of a wire grid or mesh or perforated plate or are of any other construction providing a surface on which approaching electrons may impinge and an aperture or apertures through which the secondary electrons may pass to a succeeding electrode. With such secondary cathodes some of the approaching electrons may pass through the apertures without producing secondary emission but if the apertures are decreased in size to minimise this action then there is the disadvantage that the field of the next following electrode does not penetrate the apertures so well for the purpose of accelerating the secondary electrons. The object of the present invention is to minimize this disadvantage.

According to the present invention there is provided an electron multiplier apparatus comprising an electron multiplier having a secondary cathode with apertures for the passage of electrons and an additional secondary electrode emitting electrode spaced from the secondary cathode and also having apertures for the passage of electrons and means for applying to the secondary cathode and the additional electron emitting electrode positive potentials of the same order of magnitude. With this arrangement the provision for secondary emission is increased without reducing the aperture size and consequently the penetration by the field of the next following electrode. In one arrangement in which the additional electrode is disposed in front of the secondary cathode in the direction of approach of electrons the positive potential applied to the additional electrode is higher than that applied to the secondary cathode but substantially less than that applied to the next following electrode.

A further feature of the invention consists in that the additional secondary electron emitting electrode is connected by a resistance or other

impedance to means for applying to it a potential greater than that applied to the following secondary cathode.

The invention also comprises the construction of electron multiplier having one or more secondary cathodes consisting of two or more electron emissive grids; perforated plates or like members spaced apart and electrically interconnected within the multiplier. In a preferred construction the secondary cathode consists of two or more perforated plates spaced apart and arranged with the perforations of the plates out of line.

Specific embodiments of the invention are illustrated diagrammatically and by way of example in the accompanying drawing, in which—

Figures 1, 2 and 3 are diagrams of different forms of electron multiplier according to the invention, and

Figure 4 is an enlarged detail view of a construction of secondary cathode.

Referring to Figure 1, there is shown an electron multiplier 10 comprising a thermionic primary cathode 11, together with a control grid 12 and an accelerator 13 for the primary electrons. In addition, there is a plurality of secondary cathodes 14 each in the form of a grid, perforated plate or like apertured member, a final secondary cathode 15 in the form of an imperforate plate and a grid-like collector 16. Positive potentials with respect to the cathode 11 are applied to the accelerator, the secondary cathodes and the collector from appropriate tapplings on a potential divider 17 across which an electric supply indicated at 18 is connected. A signal input device 19 is connected to the control grid 12 and the cathode 11 and an output device 20 is connected to the collector electrode 16.

In front of each of the secondary cathodes 14 there is an additional electrode 21 which, like the cathode 14, is sensitised for secondary emission and is in the form of a grid or perforated plate or the like. Each electrode 21 is connected to the potential divider so as to have a potential somewhat higher than the secondary cathode 14 immediately following it but substantially lower than the potential of the next secondary cathode 14. For instance, if the potential difference between two secondary cathodes 14 is 300 volts the potential of the electrode 21 in front of the first of these secondary cathodes may be of the order of 20 volts positive thereto.

In the arrangement shown in Figure 2 each secondary cathode 14 and associated additional electrode 21 are joined together within the mul-

tiplier so as to have the same positive potential derived from the potential divider 17.

Each of the secondary cathodes 14 and the additional electrode 21 in front of it are preferably in the form of perforated plates, for example, as described in the specification of my U. S. Patent No. 2,254,128, and in the preferred arrangement of the electrodes according to this invention the plates are disposed with the apertures of the two plates in staggered relationship. For example, as shown in Figure 4, the main secondary cathode 14 and the additional electrode 21, each consisting of a perforated plate, are joined together to form a unitary electrode. The apertures in the two plates are staggered.

With the secondary cathode arrangement according to this invention some of the approaching electrons will pass through the apertures in the electrode 21 and impinge on the electrode 14 to liberate secondary electrons. The remaining approaching electrons will impinge on the electrode 21 and liberate secondary electrons. The accelerating field of the next following electrode penetrates the apertures in the electrode 14 for collecting or accelerating the secondary electrons emitted by this electrode and at least the secondary electrons emitted at high velocity by the associated electrode 21. In the arrangement shown in Figure 3 each of the additional electrodes 21 is connected by means of a resistance 22 or other impedance with the second following secondary cathode 14 so as to have a nominal potential which is considerably higher than the secondary cathode which immediately follows it. In this way, a portion of the standing current of the multiplier is diverted through the resistance or other impedance with the result that the primary electron space current can be increased to a corresponding extent without increasing the standing current through the output of the multiplier. This resistance or impedance is preferably such that the drop in potential across it, due to the diverted standing current, lowers the potential on the electrode 21 to a value approximately equal to or slightly higher than the potential applied to the following secondary cathode 14.

In a specific construction of the electrodes 14 and 21 they consist of perforated plates, as shown in Figure 4, spaced apart preferably by a distance of 1 mm., which spacing may, however, be increased up to, say, 2.7 mm. The plates have perforations of tapering form of which the smallest diameter is from 1.2 to 1.5 mm. and there are approximately 14 perforations per sq. cm. of plate. This construction is for an operating voltage of 300 volts per stage of the multiplier. It will be understood, however, that the invention is not restricted to this specific construction, and furthermore, that two or more additional electrodes 21 may be provided in front of one another and for example, directly electrically connected with one another and with the secondary cathode 14.

I claim:

1. An electron multiplier apparatus comprising the combination with an electron multiplier having a primary cathode, a secondary cathode with apertures for the passage of electrons and a collector, an additional secondary electron emitting electrode spaced from the secondary cathode and also having apertures for the passage of electrons of means for applying to the said secondary cathode and the additional electron emitting electrode

fixed positive potentials of the same order of magnitude.

2. An electron multiplier apparatus comprising the combination with an electron multiplier having a primary cathode and a group of electrodes comprising at least one secondary cathode with apertures for the passage of electrons and a collector, means applying to the electrodes of said group positive potentials of progressively increasing value with respect to the primary cathode and an additional secondary electron emitting electrode spaced from said secondary cathode to the front thereof in the direction of approach of electrons of means for applying to said additional electrode a positive potential which is higher than that applied to said secondary cathode but is substantially less than that applied to the next following electrode of said group.

3. An electron multiplier apparatus comprising the combination with an electron multiplier having a primary cathode and a group of electrodes comprising at least one secondary cathode with apertures for the passage of electrons and a collector, means applying to the electrodes of said group positive potentials of progressively increasing value with respect to the primary cathode and an additional secondary electron emitting electrode spaced from said secondary cathode to the front thereof in the direction of approach of electrons, a resistance connected to said additional electrode of means for applying to said additional electrode through said resistance a potential which is higher than that applied to the next following electrode of said group.

4. An electron multiplier apparatus comprising the combination with an electron multiplier having a primary cathode and a group of electrodes comprising at least one secondary cathode with apertures for the passage of electrons and a collector, means applying to the electrodes of said group positive potentials of progressively increasing value with respect to the primary cathode and an additional secondary electron emitting electrode spaced from said secondary cathode to the front thereof in the direction of approach of electrons, an impedance connected to said additional electrode of means for applying to said additional electrode through said impedance a potential which is higher than that applied to the next following electrode of said group.

5. An electron multiplier comprising a primary cathode, at least one secondary cathode and a collector electrode, said secondary cathode consisting of at least two multi-apertured members spaced apart and directly connected with one another and both adapted to emit secondary electrons.

6. An electron multiplier comprising a primary cathode, at least one secondary cathode consisting of at least two perforated plates spaced apart with the perforations of the plates out of line and electrically interconnected with one another and both adapted to emit secondary electrons, a collector electrode, and means for applying a fixed potential to the connected plates.

7. An electron multiplier comprising a primary cathode, at least one secondary cathode and a collector electrode, said secondary cathode consisting of two multi-apertured members spaced apart and directly connected with one another so as to provide an unobstructed equipotential field.

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