

July 1, 1930.

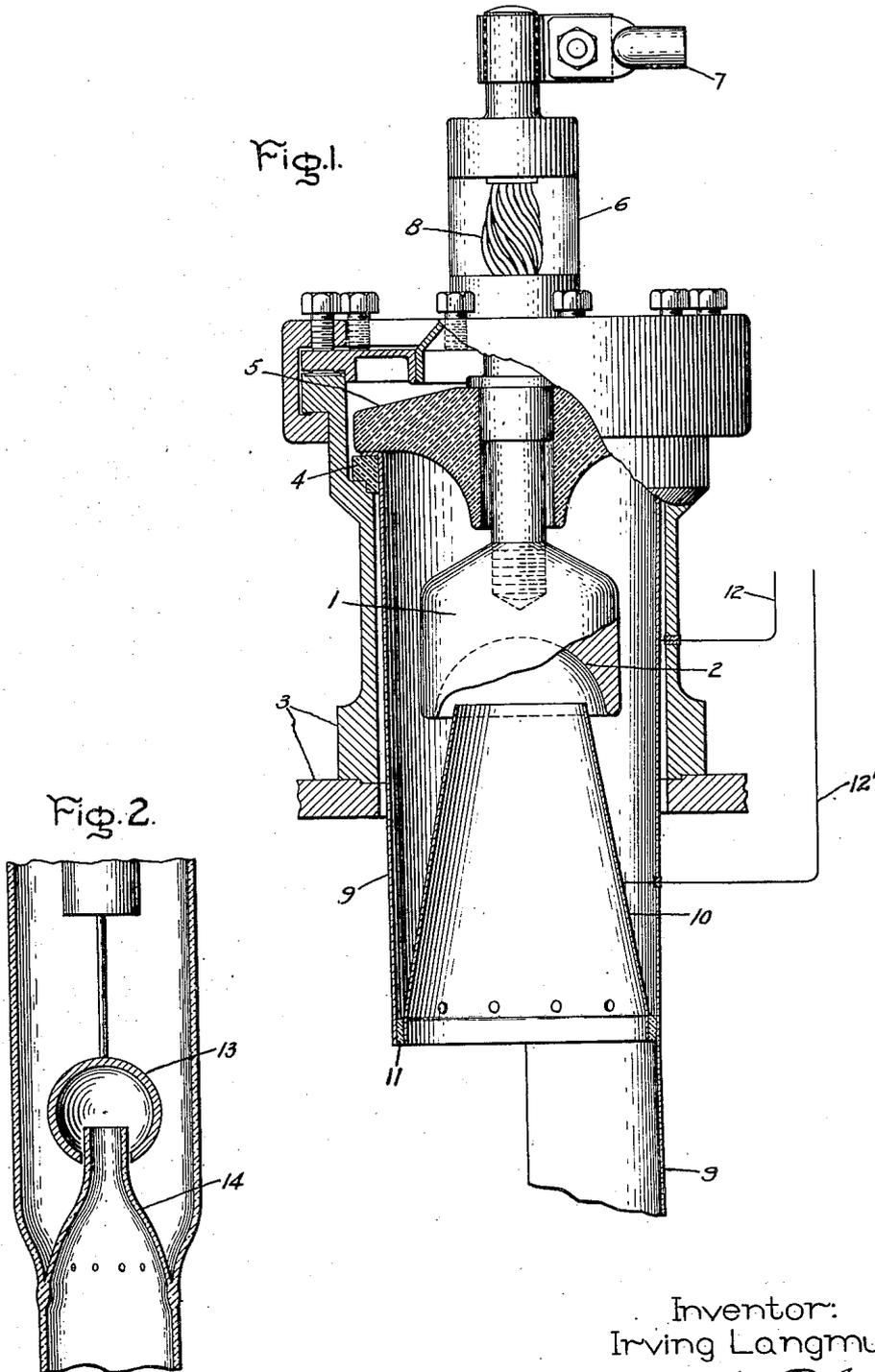
I. LANGMUIR

1,769,846

SPACE DISCHARGE APPARATUS

Filed June 16, 1927

3 Sheets-Sheet 1



Inventor:
Irving Langmuir;
by *Wm. S. Langmuir*
His Attorney.

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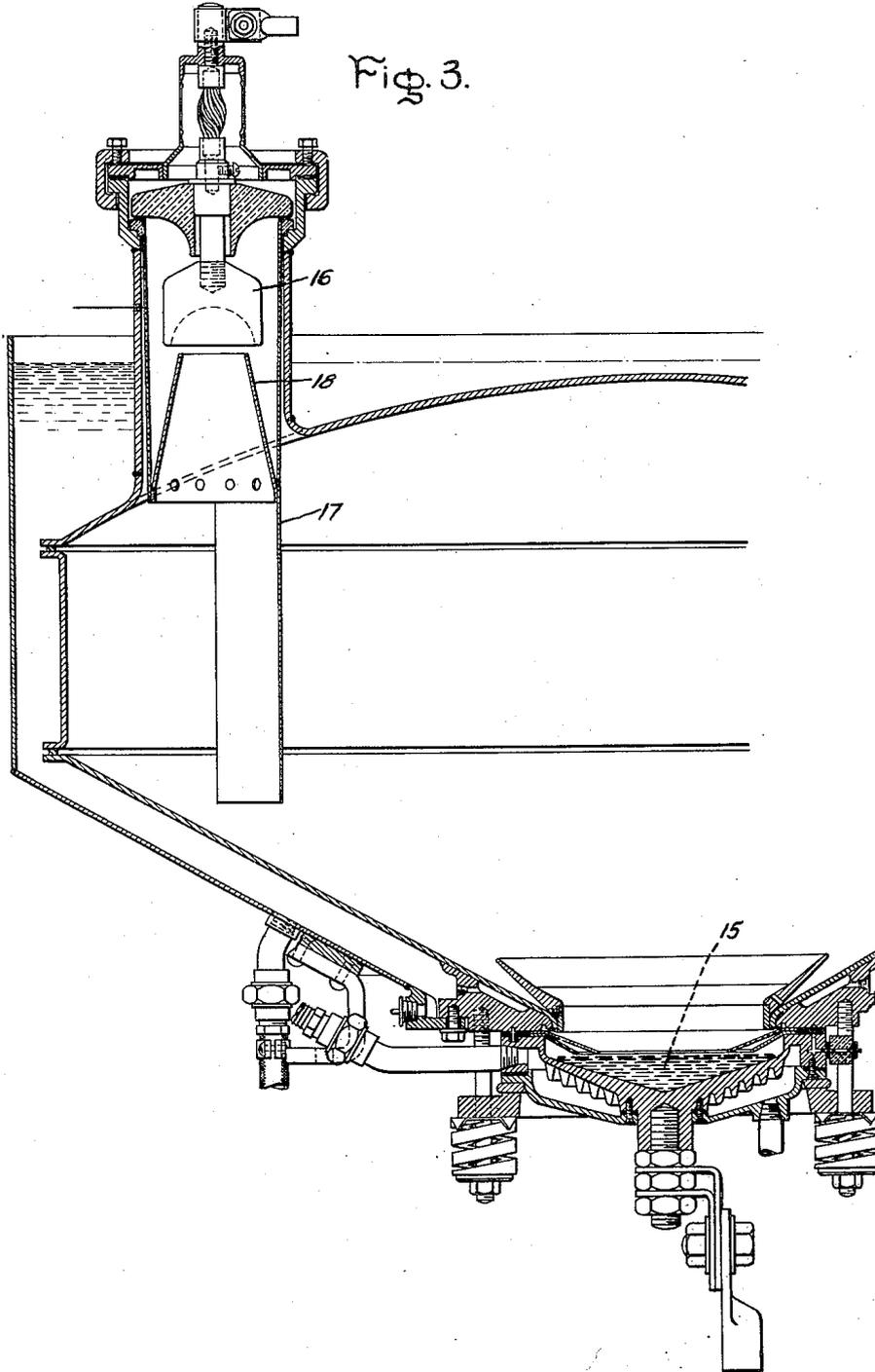
I. LANGMUIR

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SPACE DISCHARGE APPARATUS

Filed June 16, 1927

3 Sheets-Sheet 2



Inventor:
Irving Langmuir,
by *Merrill D. Lane*
His Attorney.

July 1, 1930.

I. LANGMUIR

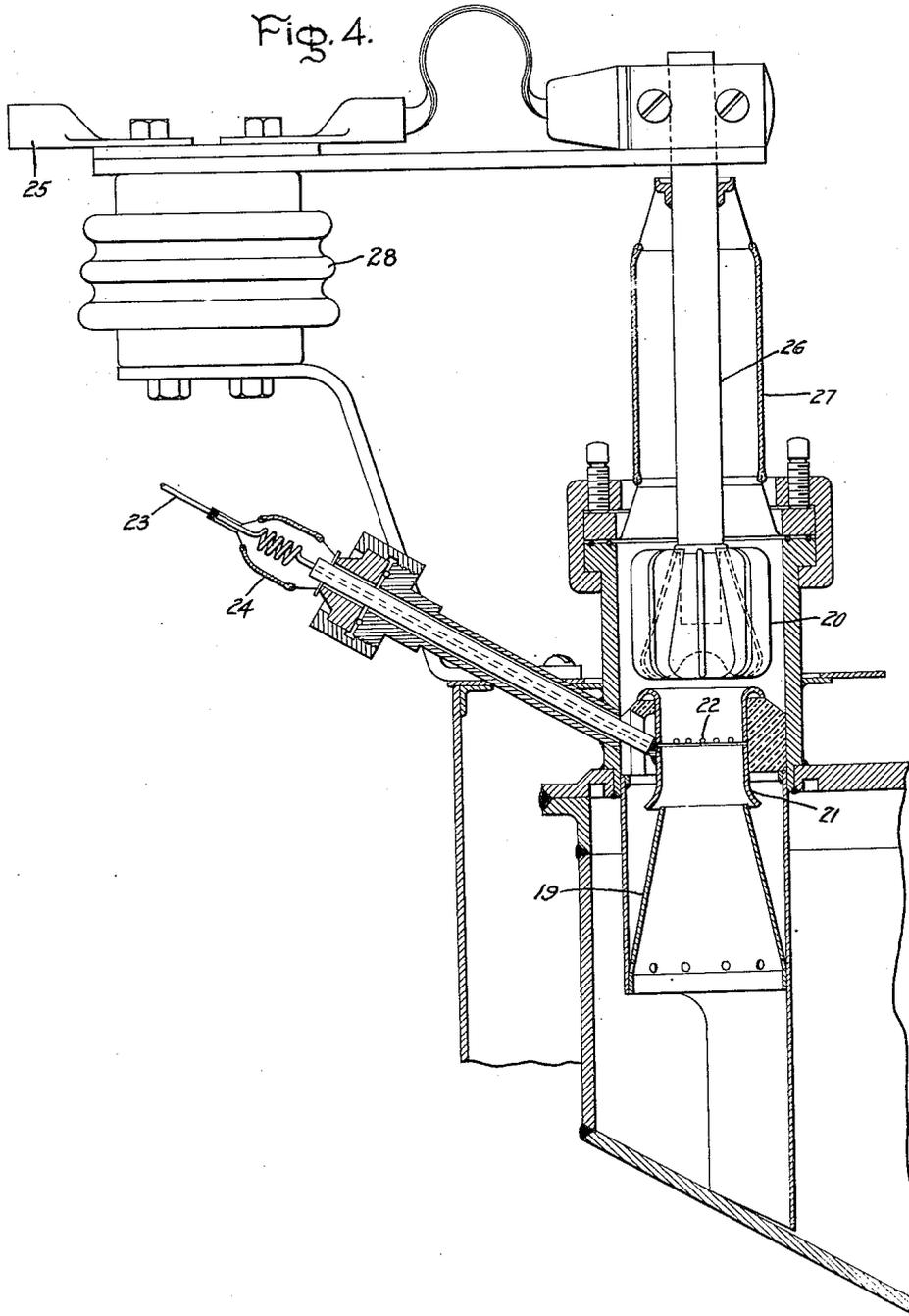
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Fig. 4.



Inventor:
Irving Langmuir,
by *Wanda S. Langmuir*
His Attorney.

UNITED STATES PATENT OFFICE

IRVING LANGMUIR, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

SPACE DISCHARGE APPARATUS

Application filed June 16, 1927. Serial No. 199,282.

My invention relates to vapor electric apparatus wherein current is transmitted between a cathode and an anode alternately charged to positive and negative polarities, and has for its principal object the provision of an improved apparatus and method of operation whereby inverse current through the anode when it is charged to a negative polarity may be prevented.

In the operation of vapor electric apparatus, such as the mercury arc rectifier, current is transmitted between the cathode and one or more positively charged anodes through an electric arc which carries a multitude of electrons and positive ions. The presence of positive ions in the vicinity of an anode is desirable when it is positively charged and is transmitting current because these ions reduce space charge and facilitate the transmission of current through the apparatus. When the anode is charged to a negative polarity, however, the presence of positive ions in the vicinity of the anode is objectionable for the reason that they are attracted to the anode and tend to raise its temperature to a point at which it is distinguished and emits electrons. If such electrons are emitted from the negatively charged anode, they are likely to ionize the vapor surrounding the anode and to produce more positive ions which are attracted to the anode thus establishing a condition likely to lead to the formation of destructive arcs between the negatively charged anode and a positively charged anode or some other part of the apparatus.

One cause of the overheating and the electron emission of a negatively charged anode seems to be the tendency of the electron stream to concentrate at one spot of the active surface of the anode during the positive half cycle of anode voltage. This tendency is believed to be due to the breaking down of the electron sheath at the anode surface by positive ions which are produced by the ionization of mercury atoms located within this sheath. Regardless of how the positive ions are produced it is desirable that they be kept away from the anode during the half cycle when it is negatively charged.

In accordance with my invention, the active surface of the anode is made of a form which prevents or retards concentration of the electron stream at one spot and means are provided for producing a high concentration of electrons at the anode surface so that the last trace of residual ionization is rapidly removed at the beginning of the negative half cycle of anode potential.

My invention will be better understood from the following description when considered in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

Referring to the drawings, Figs. 1 to 3 illustrate the application of different forms of my invention to a mercury arc rectifier; and Fig. 4 illustrates my invention as utilized in combination with a grid or control electrode.

The modification of my invention illustrated by Fig. 1 comprises an anode 1 which is provided with a concave surface 2 at its lower end and is insulated from a casing 3 by means of insulators 4 and 5 and a glass seal cylinder 6. The casing 3, which is shown in greater detail by Fig. 3, is evacuated to a low pressure and encloses one or more anodes 1 and a mercury cathode. The anode 1 is suspended from the insulator 5 and is connected to an external lead 7 by means of a flexible connection 8 which extends through the glass cylinder 6 and the metal collars sealed to the ends of this cylinder. This much of the illustrated construction is old and will be readily understood by those skilled in the art without further explanation.

A shield 9 supported between the insulators 4 and 5 is arranged to extend downwardly into the evacuated chamber formed by the casing 3 for protecting the anode from the hot blast of mercury vapor projected from the cathode which is located at the bottom of the evacuated chamber as shown more clearly in Fig. 3. A contracting nozzle 10 supported within and insulated from the shield 9 by an insulator 11 is arranged to produce a high concentration of the ions and electrons in the gas close to the anode so as to produce a negative anode drop and facili-

tate a rapid removal of the last trace of residual ionization by the collection of the positive ions on the walls of the nozzle when the anode potential changes from its positive to its negative half cycle. It should also be understood that the negative drop at the anode has the effect of materially decreasing the heating of the anode due to the fact that the anode drop is lessened and the drop of the arc at some distance from the anode is increased.

The active surface of the anode 1 is preferably made with a curvature such that the positive ions formed within the electron sheath on the anode are discharged into the nozzle and are taken away by the walls of this nozzle. Suitable control of the potentials of the nozzle 10 and the shield 9 may be effected by means comprising the conductors 12 and 12' which are diagrammatically shown as arranged to extend out through insulation bushings in the casing 3.

As indicated by Fig. 2 the anode may be made in the form of a sphere 13 provided at its lower side with an opening arranged to surround the discharge end of a contracting nozzle 14 which is attached to an anode shield.

Fig. 3 shows an apparatus wherein current is transmitted through an arc produced between a cathode 15 and an anode 16 which may be connected to any suitable source of current. In the operation of this apparatus, the arc passes through a shield 17 similar to the shield 9 of Fig. 1 and through a contracting nozzle 18 which, unlike the nozzle 10 of Fig. 1, is not insulated from the anode shield. The operation of this apparatus is similar to that of the apparatus illustrated by Fig. 1 and will be readily understood without further explanation.

The apparatus illustrated by Fig. 4 differs from those previously described in that it comprises a contracting nozzle 19 having its discharge end separated from the concave surface of an anode 20 by an insulated conductive member 21 which supports a grid or control electrode 22. It will be noted that the grid 22 is connected to an external lead 23 through a glass seal 24, that the anode 20 is connected to an external lead 25 through a rigid conductor 26 which extends through a glass sealing cylinder 27, and that the weight of the lead 25 is supported upon the casing of the evacuated chamber through means comprising an insulator 28.

The operation of this modification of the apparatus is similar in some respects to that previously set forth but different therefrom in that the positive ions in the vicinity of the anode at the end of the positive half cycle of anode voltage are collected by the insulated grid 22 and rapidly removed.

The embodiments of the invention illustrated and described herein have been select-

ed for the purpose of clearly setting forth the principles involved. It will be apparent, however, that the invention is susceptible of being modified to meet the different conditions encountered in its use and I therefore aim to cover by the appended claims all modifications within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A vapor electric device comprising an anode provided with a concave surface, a shield surrounding said anode, and a contracting nozzle supported by said shield with its discharge end opposed to said surface.

2. A vapor electric device comprising an anode shield, a contracting nozzle supported within said shield, and an anode mounted within said shield and provided with a surface having a curvature such that the positive ions emitted therefrom are projected into said nozzle.

3. A vapor arc device comprising a cathode and an anode insulated from one another and supported within an evacuated chamber, a shield arranged to surround said anode, and a contracting nozzle mounted within said shield to contract the arc of said device at a point near the surface of said anode.

4. A vapor electric device comprising an anode provided with an active surface, means for producing a concentration of electrons at said surface, a control electrode mounted between said means and said surface, and a shield surrounding said anode, said means and said control electrode.

In witness whereof, I have hereunto set my hand this 14th day of June, 1927.

IRVING LANGMUIR.

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