O. O. KRUH.

VAPOR ELECTRIC APPARATUS.

APPLICATION FILED JAN. 9, 1904.

996,865.

Patented July 4, 1911.

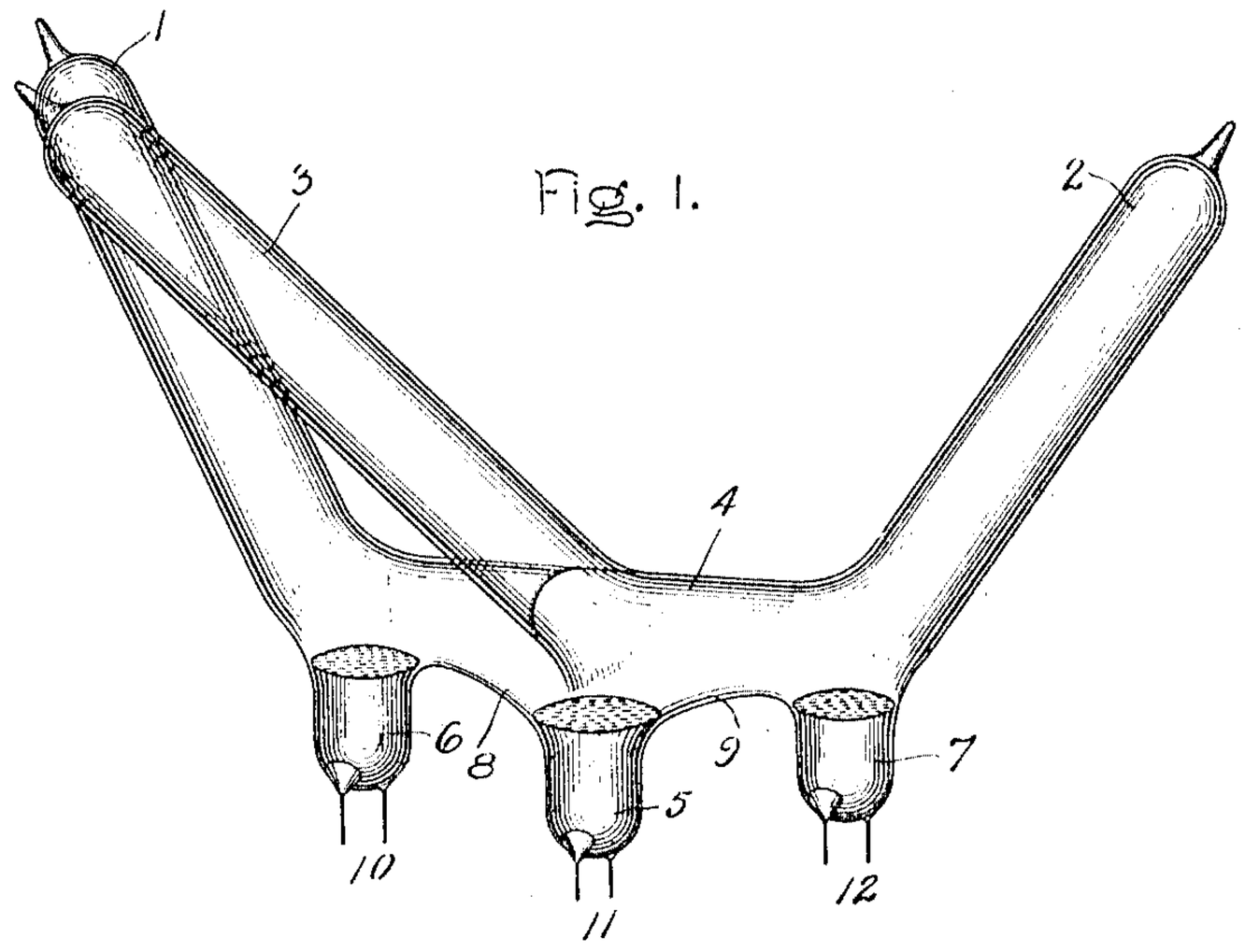
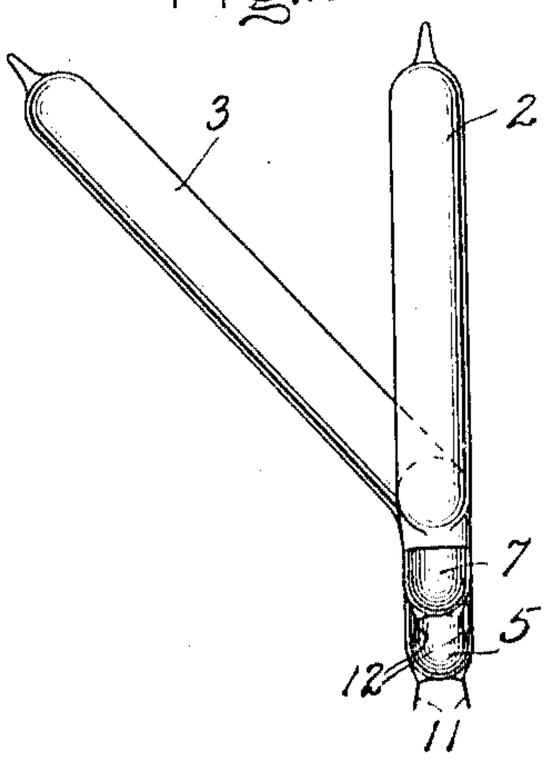
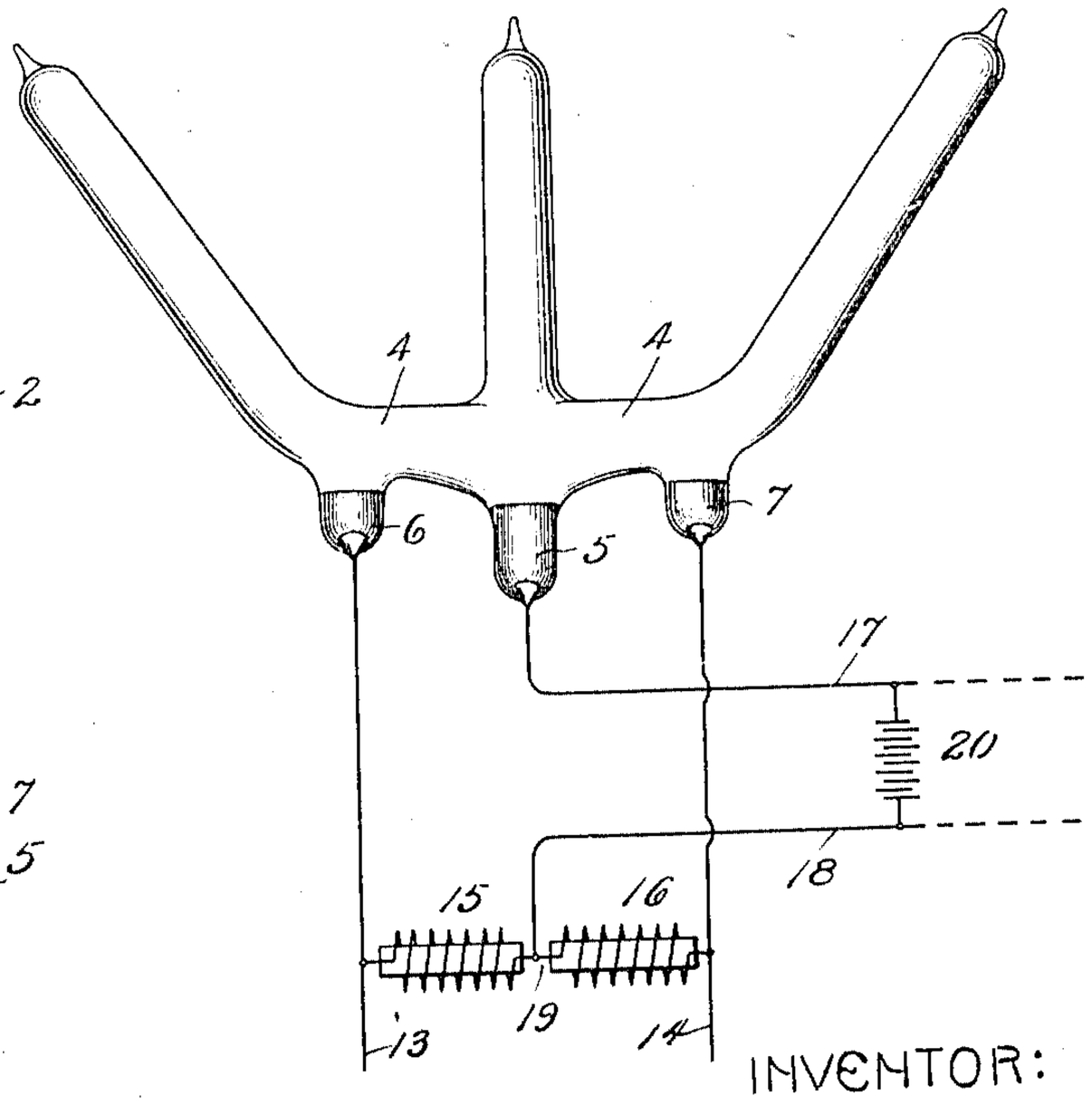


Fig. 1.

Fig. 3.

Fig. 2.





WITNESSES.

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UNITED STATES PATENT OFFICE.

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VAPOR ELECTRIC APPARATUS.

996,865. Specification of Letters Patent. Patented July 4, 1911.

Application filed January 9, 1904. Serial No. 188,403.

To all whom it may concern:

Be it known that I, OSIAS OTTO KRUH, a subject of the Emperor of Austria-Hungary, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Vapor Electric Apparatus, of which the following is a specification.

One of the difficulties met with in the operation of mercury vapor rectifiers for alternating currents is an arcing or spitting discharge between the anodes or electrodes connected to the alternating-current source. The current carried through the medium of this discharge sooner or later destroys the apparatus either by impairing the vacuum thereof or by producing such a sudden shock as to break down the glass envelop. I have devised improvements whereby troubles of the character mentioned are obviated.

The novel features of my invention I have endeavored to point out with particularity in the appended claims.

The invention itself I have sought to make clear in the following specification which is to be taken in connection with the accompanying drawings in which,

Figure 1 represents a rectifier embodying my invention and adapted to operate with single-phase alternating currents; Fig. 2 is another view of the rectifier shown in Fig. 1; and Fig. 3 is still another view in which the rectifier is shown connected in circuit.

Generally speaking the rectifier consists of a highly exhausted envelop of glass or other suitable material provided with electrodes. In that form of my invention which I have illustrated in the drawings the envelop comprises a number of inclined tubular condensing chambers opening into the electrode-containing space. These condensing chambers are indicated at 1, 2 and 3. Those numbered 1 and 2 form continuations, so to speak, of the tubular electrode-containing space 4 and are inclined thereto as shown in Figs. 1 and 3. The third condensing chamber 3 opens into the member 4 at about its middle point and directly over the central electrode indicated at 5. Like the other condensing chambers it is inclined as represented perhaps best by the side elevation of the rectifier in Fig. 2.

In addition to the electrode 5 there are two companion electrodes 6 and 7 located respectively on either side of the electrode 5 and at equal distance therefrom. All of these electrodes consist of bodies of mercury contained in pockets formed in the walls of the rectifier. These pockets are so arranged and the amount of mercury introduced so measured that when the pockets containing the bodies of mercury 6 and 7 are completely filled the level of the mercury in the middle pocket 5 then lies appreciably below that of the electrodes 6 and 7. This has the advantage that when, due to an excess of mercury, there is an overflow from one of the outside electrodes 6 and 7 toward the middle electrode 5 the mercury will run down the inclined walls 8 or 9 to the middle electrode without causing a permanent short-circuiting between the middle electrode and one of the outside electrodes as might be the case if the top surfaces of the electrodes were on the same level.

Current-flow between the electrodes and the external circuits of the rectifier is provided for by suitable leading-in conductors sealed through the walls of the envelop in any usual manner. These leading-in conductors are indicated at 10, 11 and 12.

The rectifier is connected in circuit as shown in Fig. 3. In this figure the alternating-current mains 13 and 14 are connected respectively to the outside electrodes 6 and 7. Between these supply mains inductance coils 15 and 16 are connected in series with each other. The circuit which is to be supplied with rectified current has one of its mains as 17 connected to the middle electrode 5 of the rectifier and its other main 18 to the junction 19 between the two inductance coils. The circuit receiving the rectified current may contain translating devices of any desired character. A storage battery 20 is shown as typical of such translating devices. In place thereof or in addition thereto any other translating devices may be used. The dotted extensions of the mains 17 and 18 are intended to indicate any desired additions to the consumption circuit or system.

To start up the rectifier the envelop is tipped so as to cause a momentary flow of mercury between the middle electrode 5 and one or the other of the outside electrodes. In starting the rectifier the storage battery or other translating devices are preferably replaced by a starting resistance and, after the starting operation is completed, are sub-

stituted for the resistance. The rectifier after having been started operates in a manner which so far as its electrical features are concerned is well understood and, for the present purpose, requires no special description.

The novel arrangement of condensing chambers in the rectifier serves, however, to do away practically entirely with such incidental troubles as arcing between electrodes normally of the same polarity. In rectifiers as heretofore constructed the condensed mercury vapor forms small globules on the walls of the condensing surface and these globules when they become detached from the walls roll therefrom and drop through the main working arc of the rectifier into the anodes or positive electrodes corresponding to the electrodes 6 and 7. Destructive arcs between the anodes frequently follow as the result of this dropping of the mercury globules. While it cannot be said with certainty as to why this result takes place it seems probable that the action may be as follows: When a mercury globule drops into or against an anode the surface tension of the anode receives a shock and the surface is more or less broken up depending upon the violence of impact. Now if at the moment of impact the polarity impressed upon the anode by the alternating-current mains is negative the sudden shock to the mercury surface may result in a disengagement of negative ions. The electrode, or at least a portion thereof, therefore becomes a cathode and, acting in conjunction with a coöperating anode, permits an arc to jump from anode to anode which arc is, of course, supplied by current flowing directly from one alternating-current main through the arc to the other main. The low-resistance of the arc path thus causes what amounts to a short-circuit and may, and frequently does, destroy the rectifier as well as produce trouble in the supply system.

If the anodes instead of being mercury are of some solid material as graphite or the like the same result may take place due to the vaporization of the mercury globule as it strikes the anode. The ionized vapor necessary to make the anode a cathode temporarily is thus furnished by the material of the globule. The mercury globule probably acts also in another manner either to promote the objectionable arcing or to initiate the same. Thus as the globule falls through the arc which normally exists in the rectifier, it is more or less vaporized and thus causes an increase in the amount of mercury vapor present in the envelop. An increase in the amount of vapor causes, as is well understood, an increase in the voltage at the terminals of the apparatus and a corresponding decrease in current. As this action takes place suddenly the corresponding variation of current, acting through the reactance of the supply system, may cause a momentary high voltage to be impressed upon the terminals. A voltage of this character is particularly apt, when there is an excess of mercury vapor in the envelop, to cause an arc to take place. The arcing which is actually observed is probably due to one and perhaps to both of the causes mentioned. To obviate this trouble I cause the condensing chambers as 1 and 2 to be inclined so that the globules of condensed mercury, instead of dropping through the normally existing arc roll slowly down the walls of the condensing chamber and quietly coalesce with the bodies of mercury forming the anodes. Disturbance of the surface of the anodes is thus prevented and at the same time the production of an excess of mercury vapor is obviated. In order still further to reduce the tendency to arcing between the anodes I provide the inclined condensing chamber 3 which opens into the space directly above the cathode 5. This condensing chamber relieves the pressure of mercury vapor over the cathode, where most of the vaporization takes place, and by withdrawing mercury vapor from the space between the anodes 6 and 7 greatly increases the resistance to a high voltage discharge between the anodes.

Although I have above described one embodiment of my invention which I have found particularly valuable, it is obvious that numerous variations in the construction thereof may be made without departing from the spirit of my invention, for which reason I do not wish to be limited to the exact details shown and described. Thus for example my invention may be applied to rectifiers for multiphase current as well as to those for single-phase current.

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

1. In a vapor electric apparatus, the combination of a highly exhausted envelop provided with electrodes, one at least of which is of vaporizable material, and a plurality of inclined condensing chambers for minimizing the impact caused by the return of the products of condensation.

2. In an alternating current vapor electric device, the combination of an exhausted envelop having a plurality of anodes subject to differences of potential, and a cathode, at least one of said electrodes being of vaporizable material, and a condensing chamber extending obliquely upward from the vicinity of each electrode.

3. In a vapor electric apparatus, the combination of an envelop, electrodes therein, a plurality of which are of the same polarity, and a condensing chamber opening over each of the electrodes of the same polarity and each inclined to the vertical.

4. In a vapor electric apparatus, the com-

bination of an envelop provided with a plurality of electrodes situated at different levels and subject to differences of potential and a separate inclined condensing chamber extending upward from the surface of the lowermost electrode away from the current carrying path and returning condensed material directly to said electrode.

5. In an alternating current vapor electric apparatus, the combination of a vaporizable negative electrode, a plurality of positive electrodes differing in potential, and an exhausted envelop including said electrodes, said envelop having a condensing chamber for returning products of condensation directly to the negative electrode and also having condensing chambers for the other electrodes.

6. In a vapor electric apparatus, the combination of an exhausted envelop, a cathode, and a plurality of anodes in said envelop, a tubular condensing chamber opening into the space between the anodes and an inclined condensing chamber for each anode.

7. An alternating current vapor electric apparatus, an envelop having a plurality of anodes subject to difference of potential, and a cathode, one at least of said electrodes consisting of vaporizable material, and an inclined tubular condensing chamber discharging condensed material laterally into the current carrying path near the surface of the vaporizable electrode.

In witness whereof, I have hereunto set my hand this 8th day of January, 1904.

OSIAS O. KRUH.

Witnesses:

BENJAMIN B. HULL;

HELEN ORFORD.