No. 803,180. PATENTED OCT. 31, 1905.

O. J. LODGE.

MEANS FOR PRODUCING HIGH POTENTIAL ELECTRICAL DISCHARGES.

APPLICATION FILED OCT. 10, 1904.

3 SHEETS—SHEET 1.

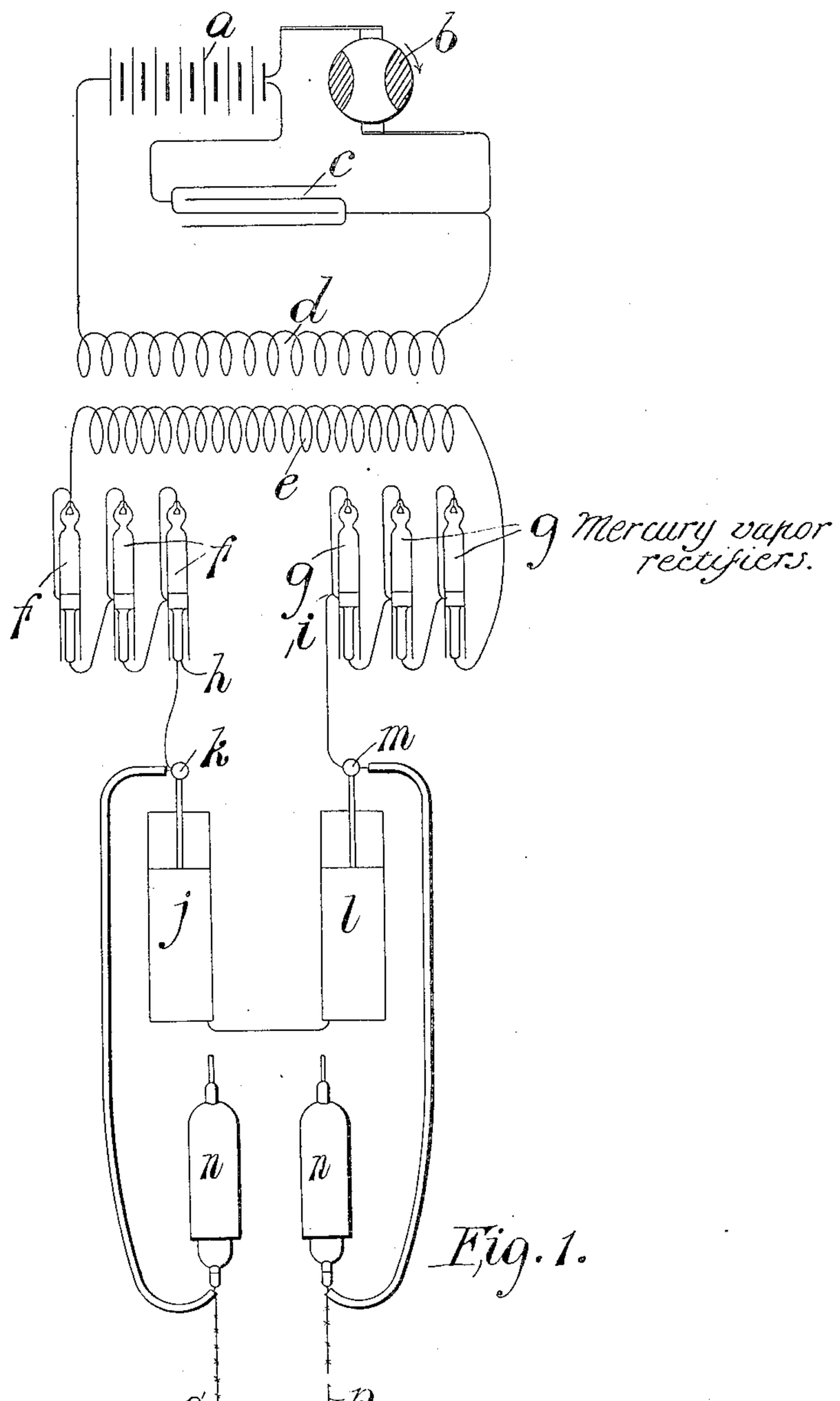

Fig. 1.

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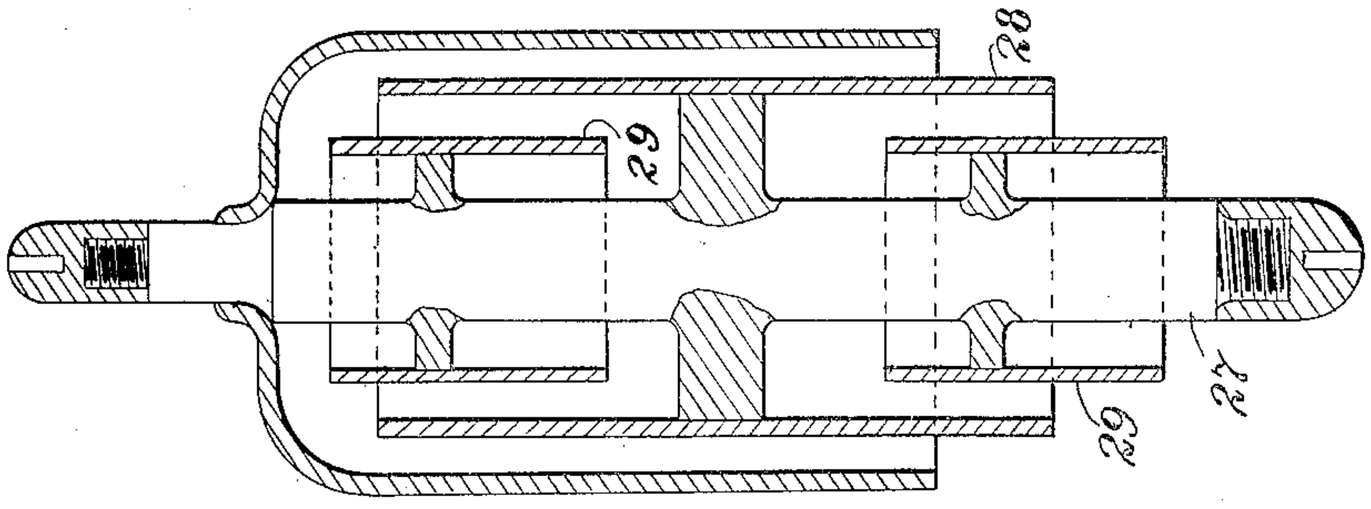

Fig. 5.

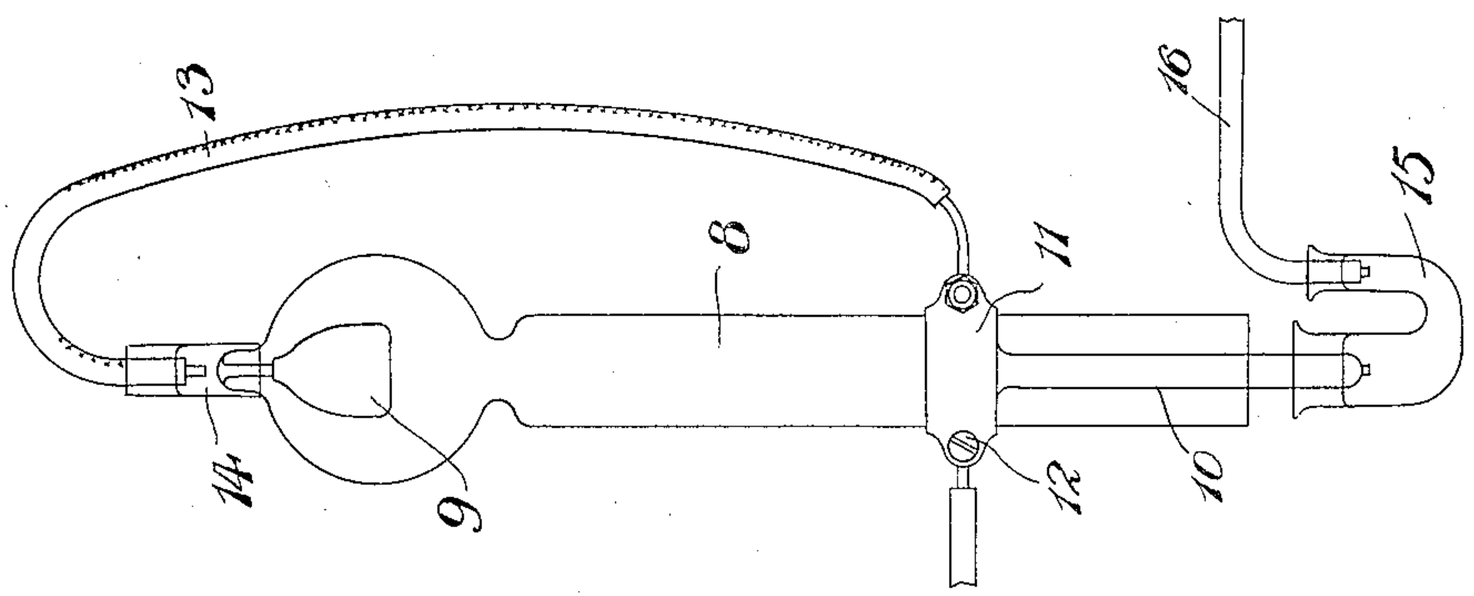

Fig. 3.

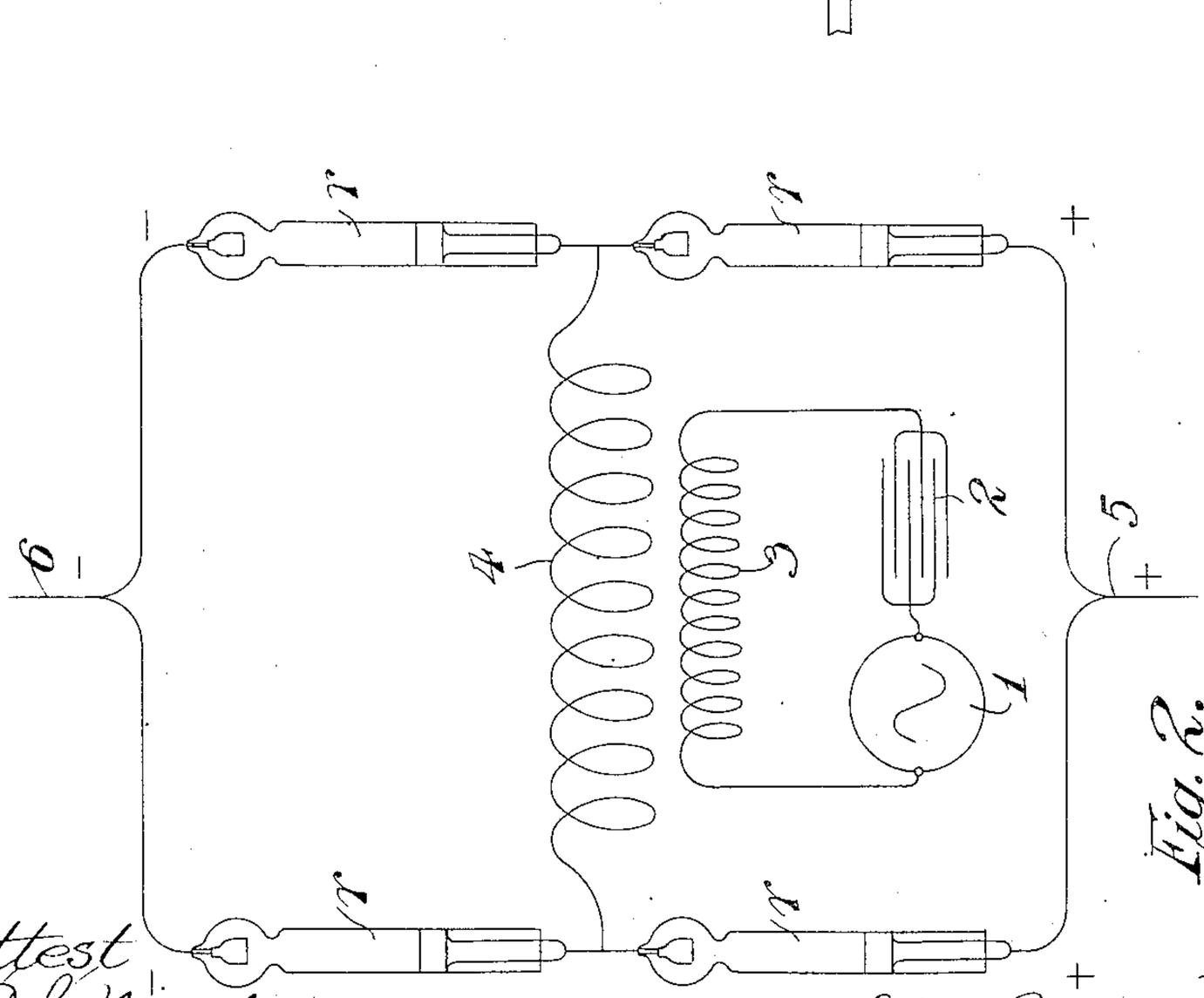

Fig. 2.

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3 SHEETS—SHEET 3.

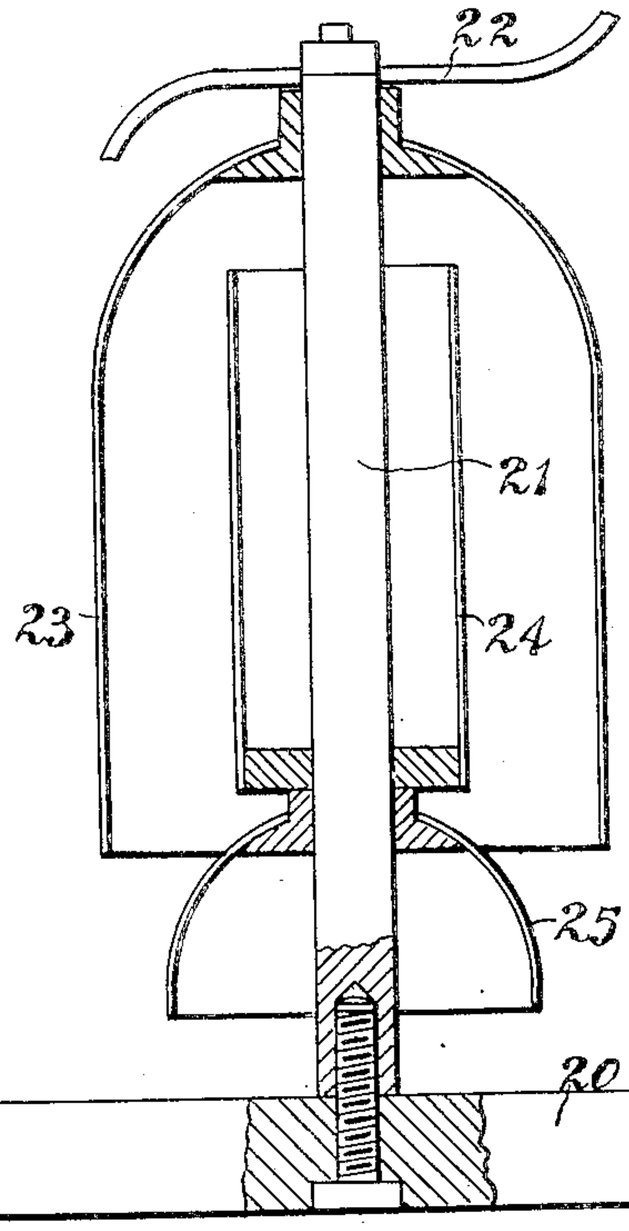

Fig. 4.

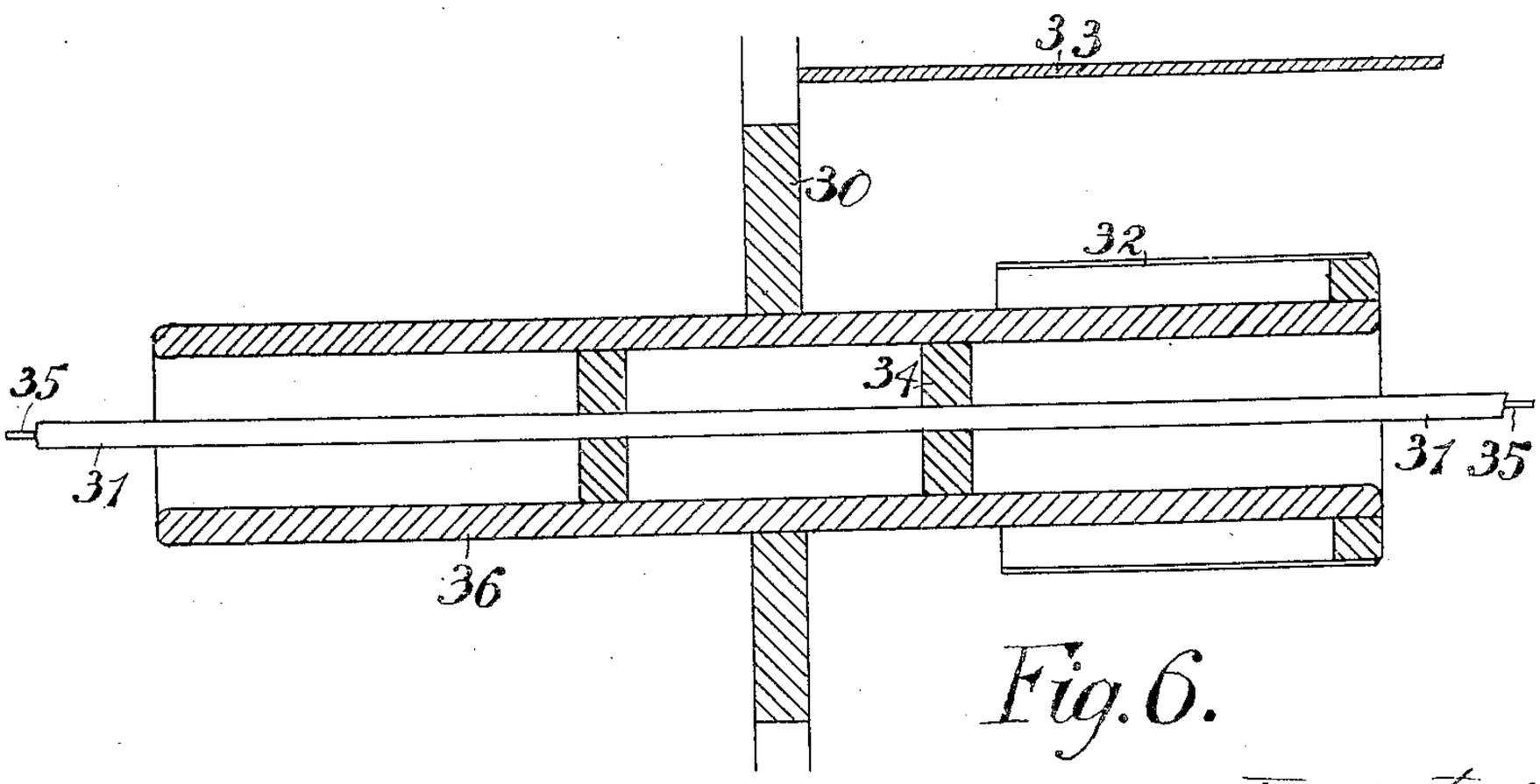

Fig. 6.

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UNITED STATES PATENT OFFICE.

OLIVER JOSEPH LODGE, OF BIRMINGHAM, ENGLAND.

MEANS FOR PRODUCING HIGH-POTENTIAL ELECTRICAL DISCHARGES.

No. 803,180. Specification of Letters Patent. Patented Oct. 31, 1905.

Application filed October 10, 1904. Serial No. 227,959.

To all whom it may concern:

Be it known that I, OLIVER JOSEPH LODGE, F. R. S., a subject of the King of Great Britain and Ireland, residing at Mariemont, Edgbaston, in the city of Birmingham, England, have invented certain new and useful Means for Producing High-Potential Electrical Discharges, of which the following is a specification.

My invention relates to the deposit of smoke, fume, mist, fog, and the like by electrical discharges, and also in means for producing a continuous high-potential discharge of electricity in one direction only, and for the purpose of causing small particles to coalesce into larger ones, and for other purposes. In 1884 I published a discovery which I made about that time that the discharge of electricity into air had the effect of causing small particles to coalesce into larger ones, so that they were either made to fall more rapidly or to deposit upon adjacent surfaces in the neighborhood of the discharging points or flames or other means by which the electricity passes from solids into a gas or vapor. Now this property of the electric discharge, of causing the coalescent deposit of matters suspended in a gaseous medium, has many possible applications—such, for example, as the clearing away of fog or mist or the deposit of useful fumes in a closed chamber—such, for example, as lead fume in the manufacture of white lead by furnace processes—or, again, the possible use in the electrifying of clouds to produce rain by causing the mist particles to coalesce, or, indeed, it may even be possible to affect the weather in some localities by the discharge of electricity of suitable sign into the atmosphere on an extensive scale—for example, positive electricity for fine weather and negative electricity for wet. The reason for the coalescing of the particles is that the particles become electrified or polarized by the discharge and attract each other, forming larger particles, or are attracted to opposite poles. Now the discovery above mentioned has not come into practical use on account of the difficulties attendant on the use of the statical electrical apparatus, such as Voss or Wimhurst electrostatic machines employed for supplying the electricity, this class of apparatus being too delicate and easily upset for use on an extensive scale.

My invention, therefore, has for its object to provide means for maintaining the high potentials necessary for the successful application of this principle without requiring the use of delicate and uncertain electrostatic machines.

My invention consists in means and arrangements whereby the current from a dynamo, either a continuous or an alternating dynamo, is so transformed and treated as to give a practically-continuous high-potential discharge in one direction only.

My invention consists in a combination of high-potential rectifiers sometimes arranged in quadrilateral groups of four or multiples of four, but always in such a way that instead of the reverse pulses being suppressed or nonexistent, as at present, they are redressed to form the positive and negative discharging-streams required for the deposit purposes.

Referring to the accompanying drawings, Figure 1 is a diagrammatic view showing one method of carrying my invention into effect. Fig. 2 shows diagrammatically another method in which an alternating-current dynamo is used. Fig. 3 is a view of a rectifier suitable for use in carrying out my invention, while Figs. 4, 5, and 6 show various means of insulation which may be employed.

In the arrangement shown in Fig. 1 I employ a battery *a* in circuit with an intermitter *b* and the primary *d* of a large Ruhmkorff induction-coil. A condenser *c* may be placed in parallel with the intermitter *b*. The secondary *e* of the Ruhmkorff coil is connected through two series of high-potential rectifiers *f g*, preferably of the form hereinafter described, to the terminals *k m* of the insulated coatings of a pair of Leyden jars, whose outer coatings *j l* are in electrical connection. To the terminals *k m* are also attached the leads or discharging-wires *o p*, which are supported by insulators *n*.

I may, if desired, employ a dynamo in place of the battery *a* shown in Fig. 1, and I may use any form of intermitter *b*—as, for instance, a revolving mercury break, or a Mehnelt break, or a trembling break, or hand break, and only one series of rectifiers, instead of two, may be employed.

The leads or discharging-wires must be well insulated, and I prefer to use the insulators hereinafter described with reference to Figs. 4, 5, and 6. The dischargers may be points, flames, or other means whereby a free discharge can be obtained. Parallel rows of barbed wire or a barbed-wire fencing or other metallic areas may be used, one of

which areas may be insulated while the other is earthed, or both may be insulated and placed facing each other beyond sparking distance in the place where the discharge is wanted. When the apparatus is used for the removal of smoke or the like, it is preferable to insulate both dischargers. When electrification of clouds is the object, one set of dischargers would usually be earthed and the other set arranged so as to be discharged skyward by well-insulated conductors.

In the operation of the apparatus the current generated in the battery or dynamo is interrupted by the intermitter and induces intermittent pulses of violently high potential in the secondary coil of the Ruhmkorff coil. These pulses are transmitted through the rectifiers, positive pulses through the series *f* and negative pulses through the series *g*, to the insulated coats of the two Leyden jars. The object of each series of rectifiers is to transmit a current easily in one direction and to strongly oppose a passage of current in the opposite direction. By this means the intermittent supply from the induction-coil is enabled to maintain the jar or jars steadily charged. The higher the potential desired the more numerous are the rectifiers required in each series, and I have found that six in each series is a convenient number to use where it is required to keep up a practically-continuous discharge between the dischargers at a potential of about a quarter of a million volts.

Fig. 2 shows an arrangement in which the source of current is an alternating-current dynamo. The dynamo 1 is placed in circuit with a condenser 2 and the primary 3 of an alternating-current transformer, which may in this case have a closed magnetic circuit. The high-potential rectifiers *r*, arranged in a quadrilateral, are combined in four groups, each of which contains one or more rectifiers in series. Only one rectifier in each group is shown in Fig. 2, but two, three, or more may be used, the number depending on the potential required. Two of the groups of rectifiers similarly directed are connected between the terminals of the secondary coil 4 and the positive discharging means 5, and the other two, both directed in the opposite direction, are connected between the terminals of the coil 4 and the negative discharging means 6. In this arrangement I may employ an alternating-current dynamo giving an excessively-high frequency—say three thousand to four thousand alternations per second—or I may employ the alternating discharge of condensers, such as Leyden jars. I may also in this case, as in the arrangement shown in Fig. 1, connect Leyden jars between the rectifiers and discharging means, thereby obtaining a more continuous discharge.

The rectifier which I prefer to use in carrying out my invention and which I have shown in Fig. 3 is similar to the Cooper-Hewitt mercury-vapor lamps and is formed from thick glass tube 8, having an iron anode 9 at the top and provided at the bottom with a mercury-pool cathode 10, surrounded by an outside metallic band 11. The positive terminal 2 is formed on this band, which is connected to the anode 9 by an insulated wire 13, the contact being made by placing the end of the wire 13 in a vessel 14, containing mercury formed at the top of the tube 8. A U-tube 15, containing mercury, is placed so that the contact leading from the mercury-pool is under the surface of the mercury in the U-tube, as is also the end of the wire 16, leading from the cathode. The object of the mercury-contacts 14 and 15 is to avoid the loss which would otherwise occur at the exposed points on the conductors when used to convey electricity at the high potential necessary for the purpose of my invention. In some cases I may submerge the rectifiers in oil in order to lessen the liability to loss and spitting off; but this is not usually found to be necessary.

Figs. 4, 5, and 6 show various forms of insulator which I have found suitable for insulating the leads and dischargers used in carrying out my invention.

In Fig. 4 the conductor 22 is supported on an ebonite or glass or earthenware rod or other suitable insulator 21 from a supporting-beam 20. The rod is protected by two umbrella-shaped inverted covers 23 and 25 and a cylindrical vessel 24, open at the top, all of which are constructed of ebonite, earthenware, glass, mica, or other suitable material.

Fig. 5 shows a modification in which the conductor is suspended from a rod 27, protected by cylindrical vessels 28 29, all being constructed of suitable insulating material.

Fig. 6 shows a form of insulation suitable for insulating a conductor passing through a wall. The conductor 35 passes through an insulating-tube 31, supported by insulating-partitions 34 in a tube 36, which passes through an ebonite window. An insulating umbrella-shaped piece 32 is fixed to one or both ends of the tube 36, and further protection against damp may be given by an insulating-roof 33, supported from the wall 30 in any suitable manner.

By a suitable arrangement of the discharging means my invention can be applied to various purposes, some only of which are indicated above, in which continuous high-potential discharge in one direction is required. For instance, where it is desired to utilize the high-potential discharge in causing the deposit of lead fume in the manufacture of white lead by furnace processes I may provide a flue and settling-chamber through which the gaseous products containing the

fume are passed, and I may place my insulated dischargers parallel to each other beyond sparking distance along the length of the flue, or I may provide only one discharging means, the other terminal leading from the Leyden jars or rectifiers being earthed. The particles in the fume will thus be caused to coalesce and will be much more readily deposited on the walls of the flue than would otherwise be the case, and the metal thus deposited may be recovered in any suitable manner.

In some cases—as, for example, in depositing valuable factory-dust—I may use in combination with my electrical discharge apparatus a centrifugal dust-separator or quick centrifugal settling-chamber for the purpose of effecting quicker and better separation of the previously-electrified dusty air and for the more convenient collection of the dust deposited. In all cases, however, it will be seen that an essential feature of my invention is the utilization of an alternating or intermittent current of extremely-high potential by rectifying or disposing of it so as to separate the electrodes of opposite sign and to obtain from them continuous-current discharges positive at one place, negative at another.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. Means for producing a continuous high-potential discharge of electricity in one direction comprising in combination; means for supplying electrical current pulses of high potential; high-potential mercury-rectifiers connected to said current-supplying means and adapted to transmit said pulses always in one direction; condensers adapted to receive said pulses; and discharging means connected to said condensers; substantially as described.

2. Means for producing a continuous high-potential discharge of electricity in one direction, comprising in combination; means for supplying current pulses of electricity; a primary coil adapted to receive said pulses; a high-potential secondary coil inductively arranged with respect to said primary coil, high-potential mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction; and discharging means connected to said mercury-rectifiers; substantially as described.

3. Means for producing a continuous high-potential discharge of electricity in one direction, comprising in combination; means for supplying current pulses of electricity; a primary coil adapted to receive said pulses; a high-potential secondary coil inductively arranged with respect to said primary coil, high-potential mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction; condensers adapted to receive said pulses; and discharging means connected to said condensers, substantially as described.

4. Means for producing a continuous discharge of electricity in one direction, comprising in combination; a source of current; an intermitter; a primary coil in series with said source and intermitter; a high-potential secondary coil inductively arranged with respect to said primary coil; mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction; and discharging means connected to said mercury-rectifiers; substantially as described.

5. Means for producing a continuous discharge of electricity in one direction, comprising in combination; a source of current; an intermitter; a primary coil in series with said source and intermitter; a high-potential secondary coil inductively arranged with respect to said primary coil; mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction; condensers adapted to receive said pulses; and discharging means connected to said condensers; substantially as described.

6. Means for producing a continuous discharge of electricity in one direction, comprising in combination; a source of current; an intermitter; a condenser in parallel with said intermitter: a primary coil in series with said source and intermitter; a high-potential secondary coil inductively arranged with respect to said primary coil; mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction; and discharging means connected to said mercury-rectifiers; substantially as described.

7. Means for causing small particles to coalesce, comprising in combination; means for supplying electrical current pulses of high potential; high-potential mercury-rectifiers connected to said current-supplying means and adapted to transmit pulses always in one direction; and discharging means connected to said mercury-rectifiers, having a number of discharging-points; as and for the purposes described.

8. Means for causing small particles to coalesce, comprising in combination; means for supplying current pulses of electricity; a primary coil adapted to receive said pulses; a high-potential secondary coil inductively arranged with respect to said primary coil; high-potential mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction, and discharging means connected to said mercury-rectifiers having a number of discharging-points; as and for the purposes described.

9. Means for causing small particles to coalesce, comprising in combination; a battery; an intermitter and primary coil in series with said battery; a high-potential secondary coil

inductively arranged with respect to said primary coil; high-potential mercury-rectifiers connected to said secondary coil, and adapted to transmit pulses only in one direction, and discharging means connected to said mercury-rectifiers having a number of discharging-points; as and for the purposes described.

10. Means for causing small particles to coalesce, comprising in combination; a battery; an intermitter and primary coil in series with said battery; a condenser in parallel with said intermitter, a high-potential secondary coil inductively arranged with respect to said primary coil; high-potential mercury-rectifiers connected to said secondary coil and adapted to transmit pulses only in one direction, and discharging means connected to said mercury-rectifiers having a number of discharging-points; as and for the purposes described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

OLIVER JOSEPH LODGE.

Witnesses:

HENRY CHARLES CHAMBERS,

HENRY HERBERT OLIVER.