No. 705,541. Patented July 22, 1902.

J. S. NOWOTNY.

ELECTRIC ARC LAMP.

(Application filed Nov. 29, 1897.)

(No Model.) 3 Sheets—Sheet 1.

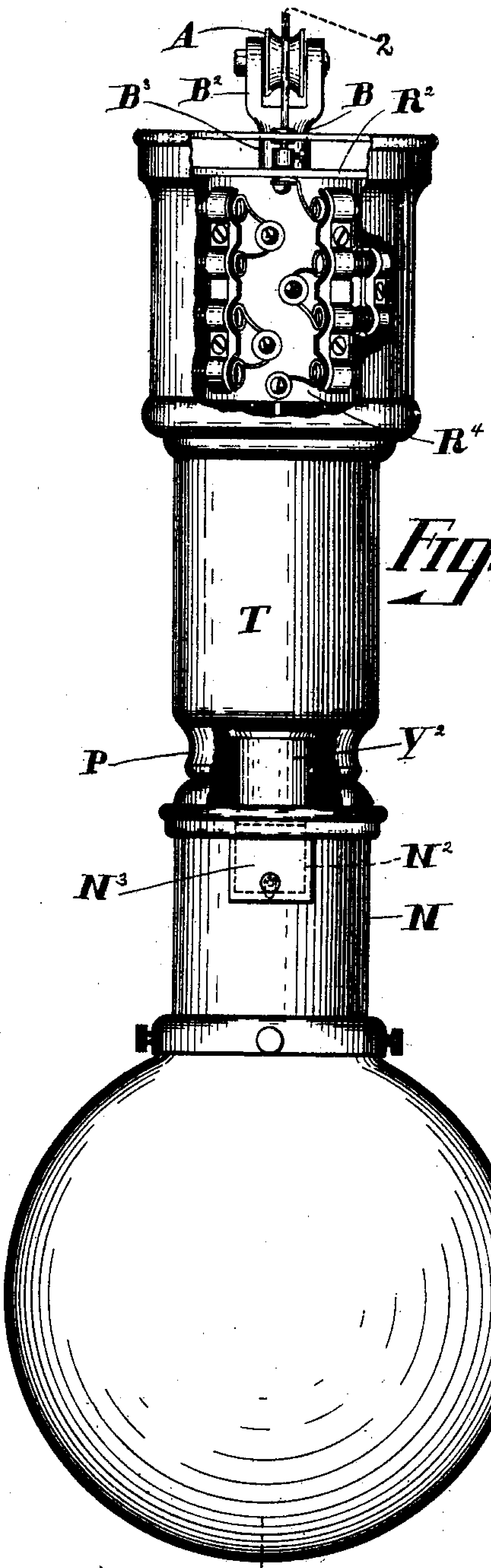

Fig. 1

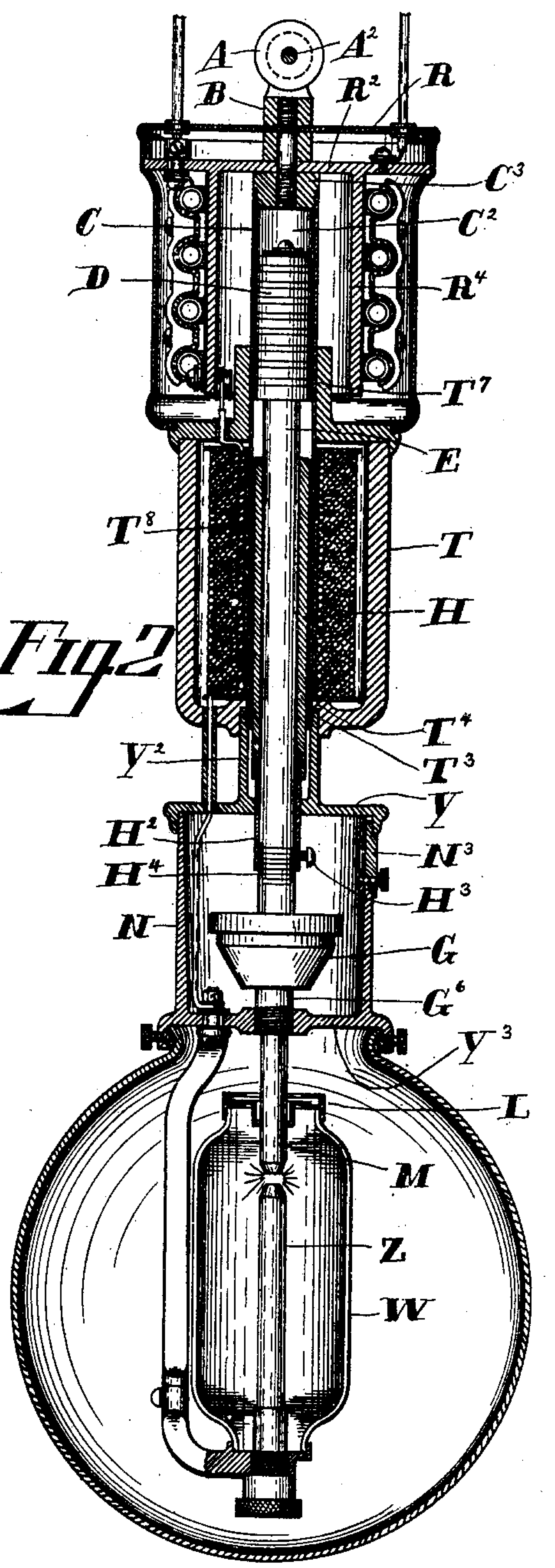

Fig. 2

WITNESSES

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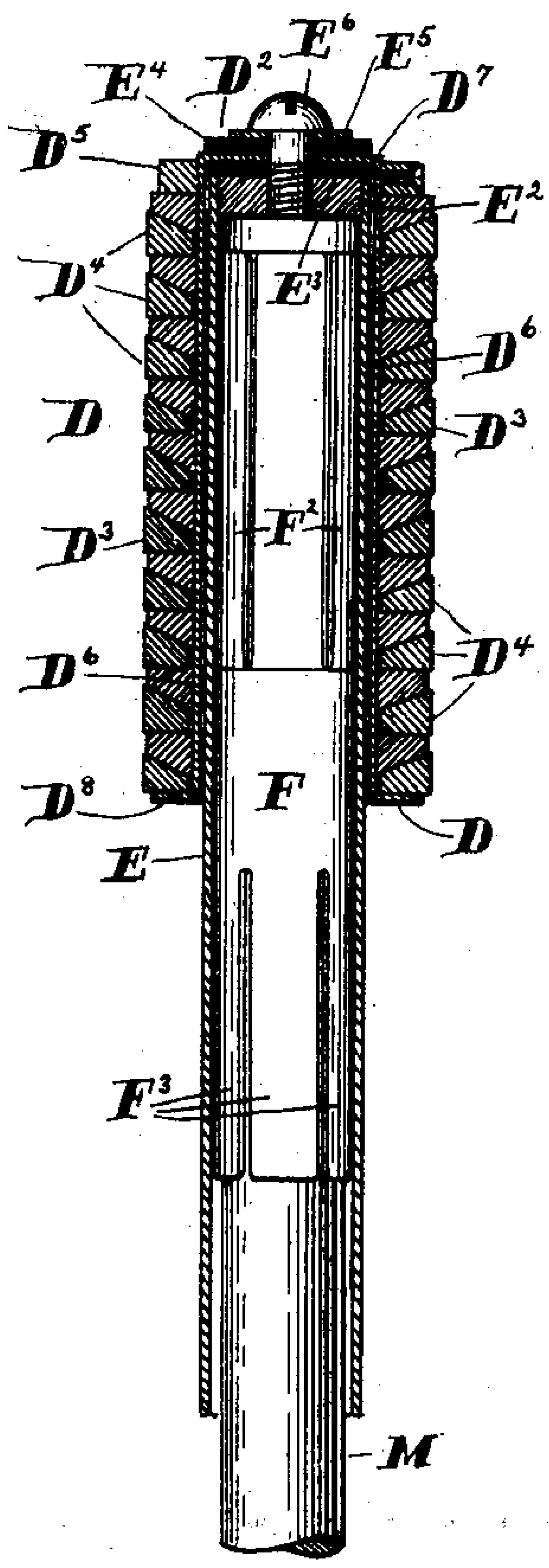
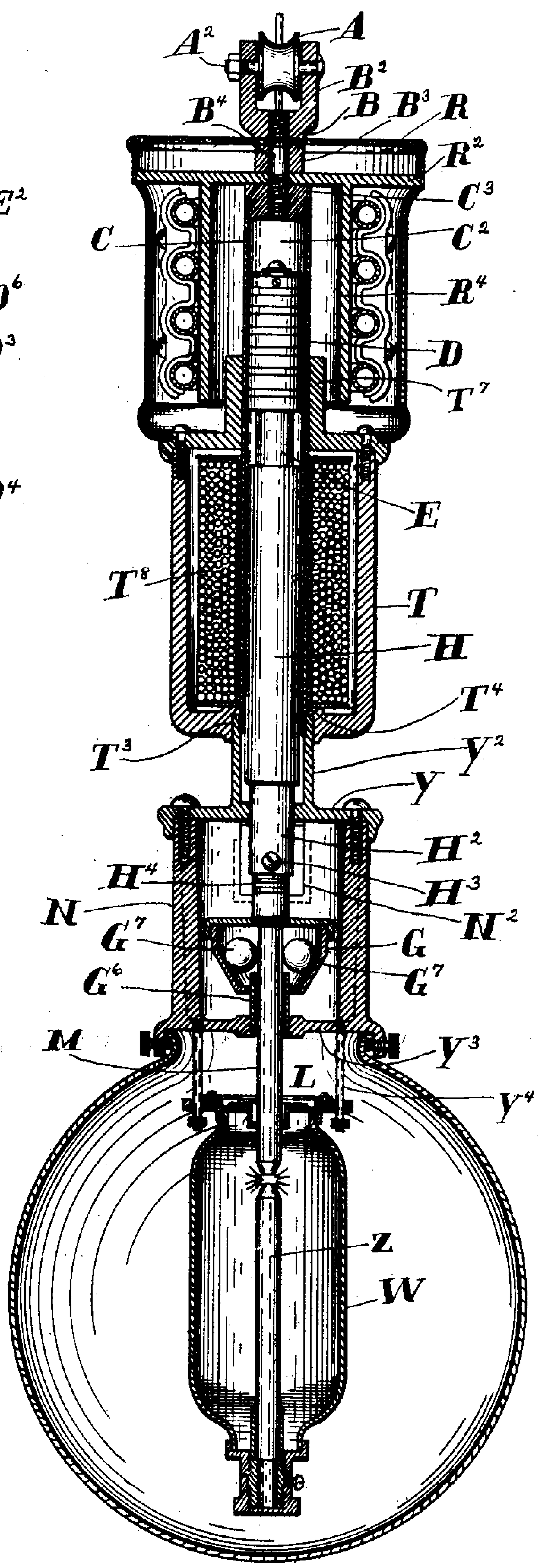


Fig. 4



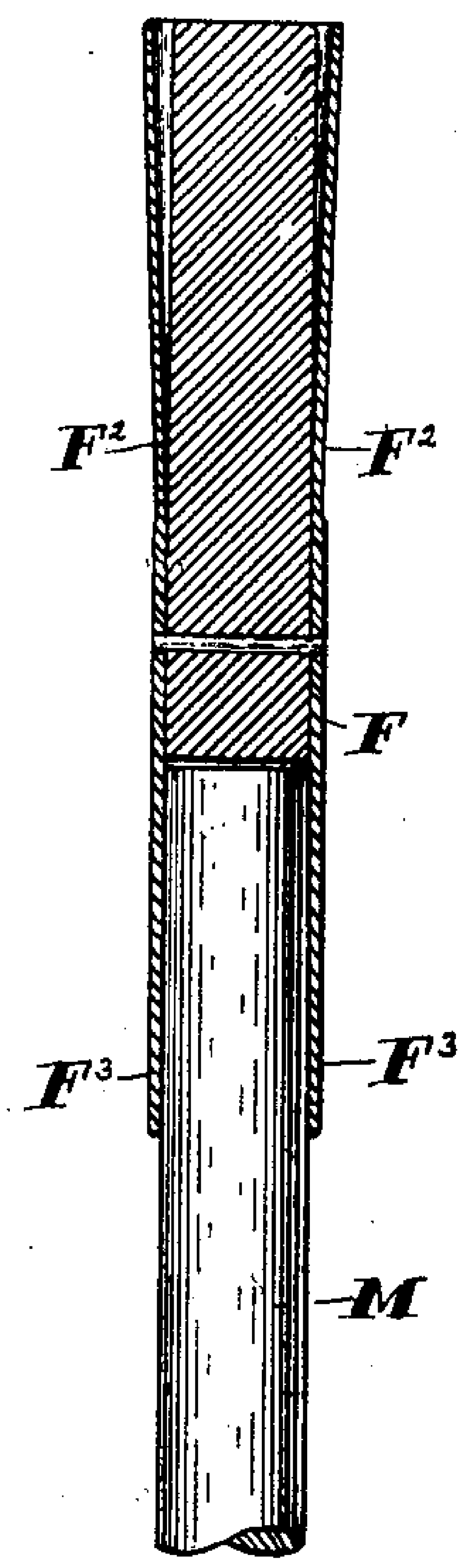


Fig. 5

WITNESSES

Fig. 3

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3 Sheets—Sheet 3.

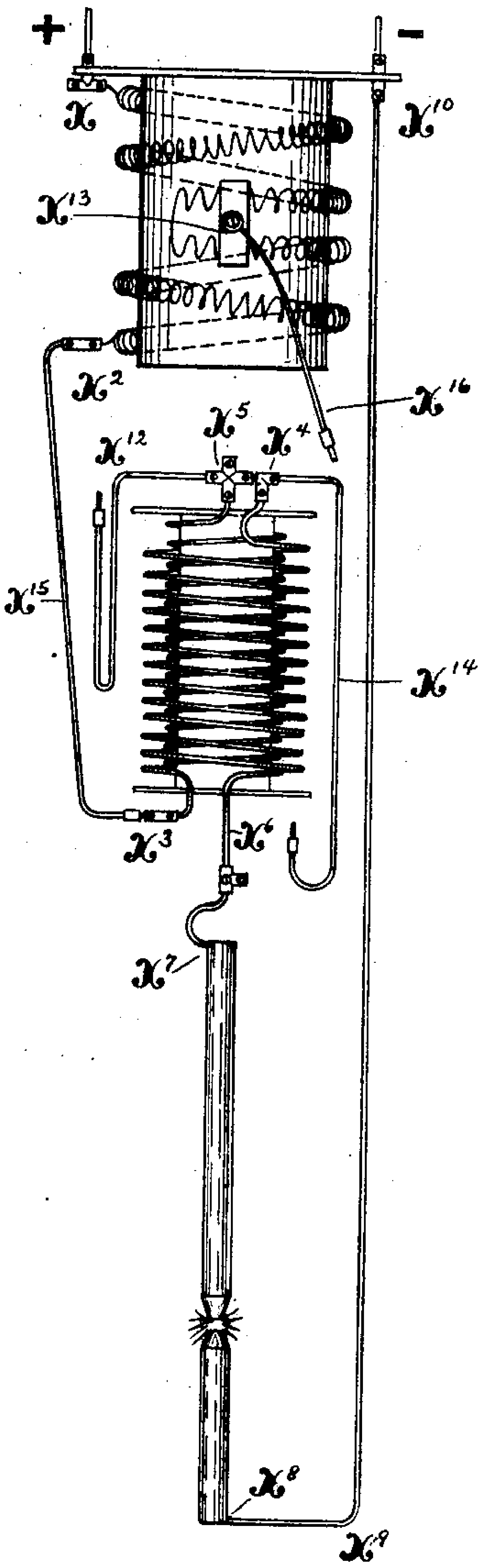

Fig. 6

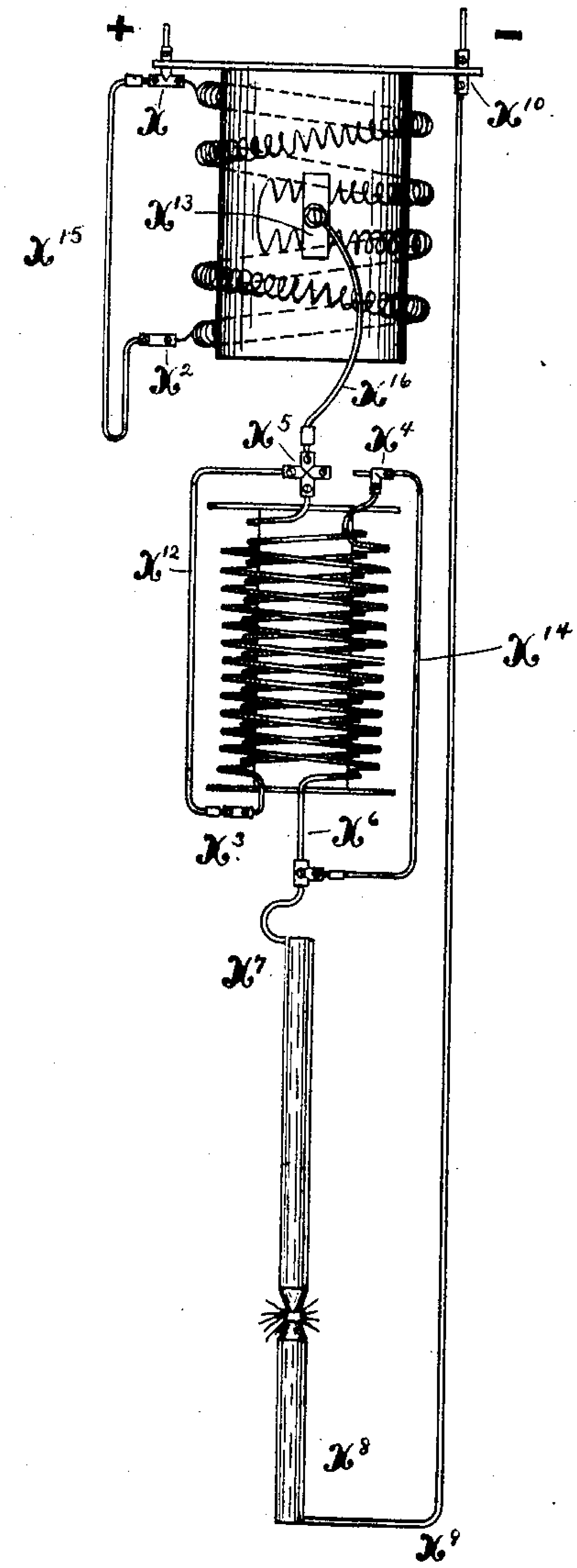

Fig. 7

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UNITED STATES PATENT OFFICE.

JOHN S. NOWOTNY, OF MADISONVILLE, OHIO, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 705,541, dated July 22, 1902.

Application filed November 29, 1897. Serial No. 660,030. (No model.)

To all whom it may concern:

Be it known that I, JOHN S. NOWOTNY, a citizen of the United States, and a resident of the town of Madisonville, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

The several features of my invention and the various advantages resulting from their use conjointly or otherwise will be apparent from the following description and claims.

In the accompanying drawings, which illustrate an embodiment of my invention, Figure 1 is an elevation of a lamp, the upper portion of the casing being broken away to disclose the construction of my improved rheostat. Fig. 2 is a vertical central section taken in the plane of the dotted lines 2 2 of Fig. 1, certain of the interior portions of the lamp being left in elevation. Fig. 3 represents a vertical central section of the lamp, the section being taken on a plane at right angles to that of Fig. 2. Fig. 4 is an enlarged view of the dash-pot piston and of its immediate connections, partly in vertical central section and partly in elevation. Fig. 5 is an enlarged sectional view of the carbon-holder. Figs. 6 and 7 are diagrammatic views illustrating the circuit connections of a lamp constructed in accordance with my invention.

The lamp is suspended by a pulley A, which is insulated or made of non-conducting material.

A^2 indicates the axle, on which the pulley is rotatable, the ends of the axle being connected to the adjacent frame-pieces B^2 of the shank B. The shank or frame B supports a tube C directly or through intermediate means in a suitable manner. Where the discal pieces R and R^2 are present, for purposes hereinafter mentioned, the suspensory frame B is preferably connected to the tube C by a bolt B^4 and piece C^3, a sleeve B^3 being preferably present between the discal piece R^2 and the frame-piece B above and the piece C^3 below. The bolt B^4 is passed through the disk R^2 and sleeve B^3, disk R, and is screwed at its upper end into part B and at its lower end into the tube-head piece C^3. The tube C is tightly closed at its upper end. In the present instance the piece C^3 is employed to close the upper end, the parts being preferably united by screw-threads. The upper portion of the tube C constitutes an air-cushioning chamber C^2 or dash-pot.

The lamp is provided with a rheostat, and when the latter is in general of the type shown in my application filed June 28, 1897, and bearing the Serial No. 642,620, and is applied to the lamp as described in that application the discal piece R^2 will be present and will aid in supporting the upper end of a cylinder R^4, the latter being preferably formed integral therewith. While the rheostat shown herein is built upon the general principles of the rheostat described in said application, it differs in the details of construction. Each ring of spirals is of less diameter than those shown in the application; but the number of rings has been increased from two to four and are connected substantially as shown. The rings are suitably upheld, preferably by the supporting-cylinder R^4 and are thereto connected. By this means of construction I am able to easily change the lamp to operate on either one-hundred-and-ten-volt or two-hundred-and-twenty-volt constant-potential circuits, one lamp being connected in multiple directly across the lines. When the lamp is intended for use on a two-hundred-and-twenty-volt circuit, I use half the cross-section of wire and double the length on the lifting or solenoid coil that is used where the lamp is intended for one-hundred-and-ten-volt circuits. I also use one-half the cross-section and double the length of wire in making up the rheostat, this being for the purpose of doubling the voltage of the arc and reducing the current flowing through the lamp to one-half, or thereabout. The consumption of watts is virtually the same in both cases, and the candle-power remains practically the same on either one-hundred-and-ten-volt or two-hundred-and-twenty-volt circuits.

The tube C affords a convenient means for supporting the horizontal frame-piece or cap Y. Surrounding the tube C is a magnet-coil T^8. I have discovered that the magnetic effect of a cylindrical magnetic shield surrounding the magnet-coil is far superior to a mere yoke. I have therefore provided such a cylindrical magnetic shield T in the preferred following manner: From the cap Y rises an annular wall Y^2, Fig. 3, the upper end of which is screwed to the lower end of the tube C. The lower apertured annular end T^3 of the shield embraces the tube C and wall Y^2 at the point where they are joined together. The end of the shield has an annular shoulder T^4, which rests upon the upper end of the wall Y^2 and is thereby well supported.

Within the frame-tube C is a carbon-containing tube E, supported by means which allows it to oscillate sufficiently to enable the upper carbon M to assume a correct vertical position and to duly keep in alinement with the lower carbon Z. The preferred device for this purpose consists of a hollow piston D, which closely fits the tube C, so that when it is raised it will compress the air above it in the chamber C^2 of the tube C, and consequently by the well-known elastic resistance of the air be compelled to move slowly and gently upward, this upward movement being dependent on the rate at which air can pass between the piston and cylinder of the dash-pot. The cylindrical body portion of the piston is extended below the head D^2 for some distance, and the entire piston D is thus kept in perfect alinement within the tube C and slides accurately therein. A carbon-containing tube E of less diameter than the bore of the cylinder or flange D^8 is concentrically suspended from the head D^2 of the cylinder-piston D and so arranged that the tube can oscillate sufficiently to allow the upper carbon M to properly aline with the lower carbon. Heretofore I have constructed the peripheral portion of the piston D of brass. One of the features of my present invention consists in a very advantageous and valuable change of material of which the peripheral portion of the piston is composed and in the construction and arrangement of the parts. I now make this peripheral portion of the piston of asbestos treated with graphite. I find that such a material and such a construction have many advantages over a brass structure. The old-style brass piston contracted and expanded to a considerable degree, thus at times having a tendency to stick in the frame-tube C and then at times (when contracted) to allow more room between it and the tube C for the air to pass. A provision to overcome and counteract this expansion and contraction of the brass piston would be expensive and cumbersome. Furthermore, this brass piston contracted and expanded unequally, so that no provision could well be made to allow for its uncertainties of action. The graphite structure does not change with heat to any considerable extent, and hence it avoids all the disadvantages attending the use of brass pistons and cylinders. The asbestos does not contract or expand to any extent, and the graphite is a self-lubricator. Therefore the friction between the piston D and the tube C is reduced to a minimum. I construct this asbestos-graphite packing and combine it with its support, &c., in a novel and advantageous manner, Fig. 4. A cylindrical frame D^6 is provided having a top or end D^7. The lower end of this frame has an annular outwardly-extending flange D^8 for supporting the packing. The asbestos-graphite packing D^3 is made in rings D^4, having parallel inner and outer walls and of such diameters that when placed in position around the frame D^6 their peripheries will quite closely fit the bore of the tube C. The sections are wedge-shaped in cross-section, and one or both of the meeting faces may be inclined. Above the rings and engaging the top one is an annular nut D^5, having a thread which engages a screw-thread on the cylinder-frame D^6. By screwing down the nut D^5 it presses down the packing and compresses the rings D^4 between it and the bottom flange D^8. This compression presses the rings outward and increases the diameter of the piston. The packing will then press harder against the inner surface of the tube C and make a closer fit and will obviously offer a greater resistance to the movements of the upper carbon. By unscrewing the nut D^5 the pressure on the packing is diminished, and the wedge-shaped sections can slip back toward the frame D^6 and diminish the diameter of the packing and allow the cylinder D^3 to slide more easily in the tube C. Thus the fit between the packing D^3 and the tube C can be readily adjusted and the amount of resistance offered to movement can be regulated at will. The connection between the asbestos-graphite piston and the tube E is also novel in construction and possesses certain advantages. To the upper end of the tube E is screw-threaded a plug or end E^2. Upon this I locate a disk E^3, of asbestos, which covers the end and also the upper edge of the tube E. The disk E^3 makes contact with the under side of the top D^7. Upon the top D^7 is located a disk E^4, made of asbestos, and on the latter is a metal washer E^5. A screw E^6 passes down through the washer E^5, disk E^4, disk E^3 into the upper end E^2 of the tube E for securing the parts. The asbestos being compressible, opportunity is afforded for tube E to oscillate as much as is necessary to enable the upper carbon to aline with the lower carbon.

Within the frame-tube E slides the upper-carbon holder F, the latter being provided with elastic arms F^2, which press outward against the inner surface of the tube E and convey current to the carbon. The lower elastic arms F^3 of the holder press inwardly and securely hold the upper carbon M in place and yet permit the stump of the carbon to be withdrawn after use and a new one substituted. The tube E is connected with a device for grappling or clutching the upper carbon at proper times and also at proper times for releasing it, as in feeding. The tube E is a connective between the grappling device and the core of the magnet-coil. In the present illustrative instance the grappling device or clutch is one which is fully set forth in the specification of my previous application and in general comprises a cage G, carrying balls G^7 and having apertures above and below, through which the upper carbon M passes. These balls are preferably made of vitrified material, thus being non-conductors and at the same time very durable. A continuation N Y^3 of the frame supports a device, such as a tube G^6, for disengaging the balls from the carbon as the tube E when operated by the magnet-core descends. The core H embraces tube E and is adjustable thereon. The advantages of such adjustability are substantially as follows: The shifting of the iron core on the tube brings the core into position where the magnetic influence is greater or less, depending upon the relative positions. By shifting the magnetic core to a higher position the magnetic influence exerted on the core will be greater, due to the core passing into a denser magnetic field, and will necessarily draw a longer arc. This will cause the resistance at the arc to be increased and a less amount of current will flow. By elevating the core to a still higher position it will in like manner enter a magnetic field of still greater density and increase the length of the arc and at the same time decrease the flow of current.

Another feature of the present invention is to provide improved means for adjusting the core relative to the tube E and also with respect to the clutch or grappling device and to the magnet-coil. These improved means are as follows: To the bottom of the core H is secured a tube or equivalent device H^2, the lower end of which extends down far enough to enable it to be readily reached without disturbing any portion of the frame or other permanent mechanism of the lamp. Near the lower end of the tube H^2 is a set-screw H^3, screwed through this tube and impinging against tube E. As the tube H^2 is secured to the core by screw-thread or otherwise, the core can be moved up and down on the carbon-containing tube E by means of tube H^2. When the core has been properly located relative to the tube E and to the magnet-coil T^8, it may be fixed there by means of the set-screw H^3. The tube E bears graduated or index marks H^4, respectively, at different heights on the tube, located with reference to a fixed point on the tube E. The length of the arc may thus be regulated, and upon this regulation depends the resistance of the lamp, the amount of electromotive force necessary to overcome it, and incidentally the amount of light given by the lamp. Holes or steps can be employed instead of marks H^4 and the set-screw H^3 or other suitable fastening device be made to engage these steps or holes. In such event instead of a tube H^2 or device for embracing the tube E a straight narrow piece of metal containing at its lower end the fastening device, as set-screw H^3, may be present. I prefer to make the tube H^2 of brass or of a metal not magnetically acted upon by the magnet-coil, because if made of iron it would be an undue extension of the core and tend by its magnetic action to disturb the definite and desired action of the feeding mechanism.

The foregoing construction enables the tube H^2, carbon-containing tube E, and set-screw H^3 to be readily reached and permits of the core being adjusted relatively to the lamp by an operator and without taking down the lamp.

It is to be noted that the features above mentioned can be made use of in any lamp having a solenoid-magnet coil.

The lamp is provided with an arc-inclosing globe W, having a gas cap or cover L, which is supported by the upper end of the globe and is prevented from dropping, when the globe is removed, by the side rods Y^4.

The other features of my invention consist, in general, of an annular wall of iron T^7, extended from and above the shield. Such a construction creates a magnetic dash-pot. This iron wall, extending above the shield, extends the magnetic field of the shield, the latter being arranged to surround the magnet-coil. The effect or action of this arrangement on the iron tubular core H is to create a cushioning effect on the core and at the same time to give it a longer range of movement. By this construction I am enabled to shift the position of the iron core or armature in relation to the position of the coil of wire and the yoke proper and cause the iron core to strike an arc of more or less length, owing to the relative strength of the field which it travels in. I am also enabled to vary the resistance at the arc and not only regulate the amount of energy passing through the arc, but vary the candle-power at the same time without inserting wasteful resistance in the circuit with the lamp and without the use of any springs or complicated mechanism.

For the purpose of protecting certain parts of the lamp from dirt and intrusion I provide covers of a cylindrical form, also supports for the same. Upon the discal support Y is set a cylindrical cover P, Fig. 1, which envelops the parts between the cylinder T and the disk Y. I also set a cylindrical cover N upon the outer edge of the disk Y^3, and this cover embraces the cylindrical wall Y^2 and extends up to the discal piece Y. In this cover is an opening N^2, closed by a door N^3. By opening this door the parts within the cylinder N, especially the device for adjusting the tube E relatively to the core H, can be readily reached.

In the drawings and specification I have shown and described a type of lamp designed to operate on constant-potential direct-current circuits, and the electromagnetic coil is composed of one continuous wire, which is in series relation with the arc and with the rheostat of the lamp. The winding is so proportioned and arranged that a certain portion of the wire or turns accurately balances the arc and maintains the proper voltage at the arc. By the use of what is known as a "differential coil" this same construction may be utilized for lamps that are intended to be operated in series on direct constant-current circuits.

The circuit arrangements are best shown in Figs. 6 and 7. Current enters the lamp, Fig. 6, at the positive terminal and passes into the rheostat at X, thence through the entire spiral of resistance-wire and passes out at X^2. It then enters the outer winding of the solenoid-coil at X^3 and passes through a number of layers or turns to the L-shaped connector X^4, the latter being connected to the connector X^5, made in the form of a Maltese cross. The current from this point enters another winding on the solenoid-magnet and travels through the requisite number of layers or turns of wire, the windings tending to produce similar poles at each end. The current then passes to terminal X^6 and thence through the mechanism of the lamp to the upper carbon, as shown at X^7, and through the arc and through the lower carbon, as shown at X^8. It then passes to the negative connector X^9, which is connected to the negative terminal X^{10} of the lamp, and thence back to the line.

With the connections arranged as described it will be noticed that the flexible leads X^{16}, X^{12}, and X^{14} are idle, and it will be apparent upon observation that all of the resistance-wire is directly in series, with the exception of that portion shown in the form of a loop, which is short-circuited by the adjustable metal bridge X^{13}. It will be noted that the winding of the solenoid-coil is in series with the arc. With this arrangement of connections the coils are all in series and the lamp is intended to operate at its highest voltage. The drawings show the lamp as described connected to operate and balance properly when connected singly directly across two-hundred-and-twenty-volt direct constant-potential mains.

When the connections are made as shown in diagram Fig. 7, the lamp is intended to work on approximately one-half of the line voltage mentioned in the first case. The connections shown are made when the lamp is intended to be operated on one-hundred-and-ten-volt direct-current constant-potential circuits, each lamp to be operated singly and connected directly across the positive and negative mains in multiple. The flow of current through the lamp is as follows: Current enters at X and then divides, one portion flowing through the wire rheostat to the metal bridge X^{13}, another portion of the current flowing through the flexible connector X^{12} and entering the lower extremity of the spiral resistance-wire at X^2, thence through the remaining half of the rheostat to the metal bridge X^{13}. At this point the current unites with that from the circuit first described and passes through the flexible lead X^{16} to the connector X^5. At this point the current divides again, one portion passing through a connecting-wire and entering the solenoid-coil at X^3 and through one half of the layers or turns on the solenoid-coil. From this point it passes to the flexible lead X^{14}, thence through said lead to the connection X^6. The other portion of the current flowing through the solenoid-coil enters the coil at X^5 and passes through the remaining half of the layers or turns of the winding. After flowing through the coil it unites with the current from the first half of the coil X^6 and passes through the mechanism of the lamp and the upper carbon to the arc and lower carbon. It then passes by the negative conductor X^9 to the negative terminal X^{10} of the lamp and thence back to line. It will readily be seen that by this method of connections the rheostat, as well as the two separate windings on the solenoid-coil, is connected in multiple series, which causes the mechanism to adjust the arc-voltage with one-half the potential and double the amperage that will be required when the connections are arranged as shown in Fig. 6, and in either case the watt consumption will remain practically the same and the candle-power practically the same, except when the lamp is connected for a higher tension, in which case a slightly-higher economy is obtained. It may readily be understood that when all the coils of the lamp are connected in series, as shown in Fig. 6, for a higher potential service the length of the arc would be approximately double that in the case where the connections are made as shown in Fig. 7. The effect of making the connections as shown in Fig. 7 as contrasted with the arrangement shown in Fig. 6 is to afford a path for the flow of current in which the conductors in the rheostat, as well as the magnet-coil, have double the cross-section and half the length of wire. This is due to their being connected in parallel with one another. In the case shown in Fig. 6 the current flows through the resistance-coil and magnet-coil in series, the cross-section of the conductor being one-half and the length approximately double as compared with the arrangement of Fig. 7. In Fig. 6 the connections are arranged for the lamp to operate properly on a potential of two hundred and twenty volts and in Fig. 7 to operate at one hundred and ten volts; but the lamp illustrated is not limited in its use to currents of the potentials named. For example, these connections can be employed to cause the lamp to operate correctly on five-hundred-volt circuits and form an arc of not less than one and five-eighths inches long, and the connections could be placed in parallel, and the lamp could then be connected to balance the arc properly while on a potential of two hundred and fifty volts, and in the latter case the arc would be approximately half the length, or about thirteen-sixteenths inch long. I may, of course, adjust the winding and resistance to meet any given condition. The object of this combination of circuits is to make a lamp which is capable of operating on circuits having great variations in potential and to connect them singly across the line.

I have shown the carbons in the drawings as being separated from each other by a short distance. This is merely illustrative of the fact that they are separated when in use, but does not attempt to show the exact separation for any particular voltage.

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

1. In an arc-lamp, the combination of a clutch for holding and feeding the upper carbon, a cylinder, a piston therefor, elastic material forming the peripheral portion of the piston and adapted to yield laterally, means for adjusting the diameter of said piston, a connection between the clutch and the piston, and a holder for the upper carbon.

2. In an arc-lamp, the combination of a clutch for holding and feeding the upper carbon and keeping its lower end in alinement with the lower carbon, a cylinder located above the clutch, a piston therein, elastic asbestos forming the peripheral portion thereof adapted to yield laterally, a connection between the clutch and piston, a guide for said connection, a nut for slightly adjusting the diameter of the piston, and a holder for the upper carbon.

3. In an electric-arc lamp, the combination of a tube, a second tube surrounding the first and forming the body portion of a piston, a piston-body for the second tube, and a flexible connection between the tubes which permits of a limited amount of independent movement.

4. In the feeding device for an arc-lamp, the combination of a dash-pot, a tube forming a support for the piston, a piston having an outer surface adapted to slide within the dash-pot, a head for the piston, an asbestos disk, and means for uniting the head and disk.

5. In a feeding device for an arc-lamp carbon, the combination of a device for grappling the carbon at suitable times, a dash-pot having a piston provided with an outer cylindrical portion made of asbestos and graphite, a tube or cylinder, a head for the tube, an asbestos disk for the head, and a clamping device for uniting the parts.

6. In an arc-lamp, the combination of a fixed solenoid-magnet, a reciprocating tubular device for guiding the carbon and sustaining it, and a downward extension from the core extending below the magnet and provided with a device within easy reach for setting the position of the core relative to the magnet-coil without dismounting the lamp.

7. The combination of the carbon, a slidable carbon-holder, a tubular device in which the carbon-holder slides, a magnetic solenoid-coil, an iron sheath or magnet-core located within the coil and accompanying the tube, and adjustable vertically relatively to the tube, the adjustment to be accomplished by an operator outside of the lamp and without dismounting the latter.

8. In an electric lamp, the combination of a dash-pot having a piston carrying a cylindrical frame, annular rings comprising asbestos and graphite, which rings are wedge-shaped and laid upon one another, a nut for varying the compression of the rings, a magnet-core, a tube, a head for the tube, an asbestos disk, and a screw for connecting the parts.

9. The combination of a carbon, a slidable carbon-holder, a tubular device in which the carbon-holder slides, a solenoid-coil, an iron sheath or core located within the coil and accompanying the tube, the core being adjustable vertically relatively to the tube, and an extension for the core having a set-screw or setting device for holding it in a fixed and desired position relative to the magnet-coil.

10. The combination of the carbon, a slidable carbon-holder, a tubular device in which the carbon-holder slides, a solenoid-coil, an iron sheath or core located within the coil and accompanying the tube, the core being adjustable vertically relatively to the tube, a piece attached to the core and provided with a set-screw or setting device for holding it in a fixed and desired position relative to the magnet-coil, a cover for inclosing the same, which is provided with an opening to permit the adjustment of the parts, and a door for said opening.

11. In an electric-arc lamp, the combination of a cylindrical magnetic shield, a winding therefor, a cap having a cylindrical wall formed thereon which extends into the shield, a shoulder formed between the shield and wall which acts as a support, and a frame-tube which is connected to the wall and passes through the winding.

12. In an arc-lamp, the combination of a frame-tube, a dash-pot, a carbon-containing tube, a core mounted thereon and located within the frame-tube, a magnet-coil embracing the frame-tube, a cylindrical magnetic shield for the coil having an apertured annular lower end, a shoulder formed on the shield, and a wall engaging with the shoulder for supporting the shield.

13. In an electric lamp, the combination of a piston, a carbon-holder, a magnet-coil, a cy-

lindrical core for the magnet, a shield for the magnet which embraces the coil and is provided with an extension that projects upwardly, the said projection having a bore of such diameter that the core can pass through it, and a tube which forms the cylinder of the dash-pot and also passes through the extension and the coil.

14. In an electric-arc lamp, the combination of a magnet, an iron sheath or core, a nonmagnetic extension secured thereto, and a setting device carried by the extension for shifting the position of the magnetic core in the field of force for the purpose of varying the resistance of the arc.

15. In an electric-arc lamp, the combination of a solenoid or hollow magnet surrounded by an iron magnetic yoke with an extension or annular iron ring formed integral therewith at its top, a magnetic core located within the coil and attached to a tube, a clutch-chamber secured to the tube and containing two or more balls which surround and clutch the upper carbon, the said carbon passing up through the tube and being surrounded by said solenoid magnetic coil, the magnet-core being also located within the coil and surrounding the tube containing the carbon and adjustable vertically on said tube for the purpose of shifting its position into a field of more or less density and also to vary the resistance of the arc according to the relative position of the magnet-core in a magnetic field by reason of the greater or less movement of the carbon under the action of the clutch.

16. In an electric-arc lamp, the combination of a solenoid-magnet, a yoke for said magnet, a dash-pot cylinder, a movable tube mounted within the magnet, an armature adjustably mounted on the tube so that the extent of movement from an extreme position to one of magnetic equilibrium can be changed, and means for connecting the magnet-winding in such manner that the resistance in one case is approximately one-half what it is in another case, thereby adapting the lamp to work on circuits of a given voltage or on those of approximately double the voltage.

17. In an electric-arc lamp, a rheostat constructed in the form of a drum, its outer surface being insulated and having attached to it a continuous spiral composed of resistance-wire and arranged in the form of loops surrounding the drum and held in position by means of clips insulated from said resistance-wire, and connections arranged so as to throw the loops of resistance-wire into series or parallel with the arc, for the purpose of increasing or decreasing the length of the resistance-wire and diminishing or increasing its cross-section as the case may be, the purpose being to operate the lamp on a given voltage or on double that voltage.

18. In combination with an electric-arc lamp, a compound magnet-coil made up of separate coils surrounding each other with terminal endings so arranged that the coils can be connected in series with one another and work in harmony, means for changing the connections whereby the coils can be connected in parallel with one another, the coils in both cases uniting so as to form one compound coil for the purpose of maintaining an electric arc in the lamp when connected on lines of a higher or lower potential, and mechanism for enabling the lamp, when the coils are connected in parallel with one another to operate on the lower-tension circuits, and when the coils are connected in series with one another to operate on higher-tension circuits.

19. In an electric-arc lamp, the combination of a magnet-coil having two windings acting to produce corresponding poles, and means for connecting the coils in series or in parallel to enable the lamp to be operated on high or low potential circuits.

20. In an electric-arc lamp, the combination of a magnet comprising two distinct windings acting to produce corresponding poles at the ends, means for connecting the windings in series to operate on circuits of high potential, means for connecting the coils in parallel to operate on circuits of low potential, and a feeding mechanism correspondingly acted upon by the windings to feed the carbon.

21. In an electric-arc lamp, the combination of a resistance, means for causing the current to pass through the coils in series or parallel, magnet-windings, means for connecting the magnet-windings in series or parallel relation with each other and in series with the resistance, and carbon-feeding mechanism which is under control of the magnets.

22. In an arc-lamp, the combination of a rheostat comprising a body of conducting material of high resistance and arranged to work in the same circuit with the arc, the rheostat having two paths for the current, connections so arranged that all of the current can be directed through one path by including all of the resistance-wire in series, and connections so arranged that the two paths through the resistance material can be thrown into parallel relation, thereby affording double the length of conductor with half the cross-section in one case, or double the cross-section with half the length of conductor, in the other case.

23. In an electric-arc lamp, the combination of a resistance-support, a coil of resistance material mounted thereon, means for retaining the coil in place, a connection leading from an intermediate portion of the coil, and other connections for uniting the portions of resistance material in series or parallel relation.

24. In an electric-arc lamp, the combination of a cylinder, a piston mounted therein which is composed of a sleeve having an elastic cov-

ering, and a carbon-containing tube secured to the sleeve by means of a flexible connection.

25. In an electric-arc lamp, the combination of a dash-pot cylinder, a piston therefor comprising a sleeve with a covering of asbestos rings, a carbon-containing tube mounted within the sleeve and slightly separated therefrom on the sides, a mechanical connection between the upper end of the sleeve and the tube, and flexible disks which form a part of said connection, thereby permitting the tube to have a slight movement independent of the sleeve.

JNO. S. NOWOTNY.

Attest:
A. S. LUDLOW,
WM. E. JONES.