No. 611,601. Patented Oct. 4, 1898.

S. BERGMANN.

ELECTRIC ARC LAMP.

(Application filed July 10, 1897.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

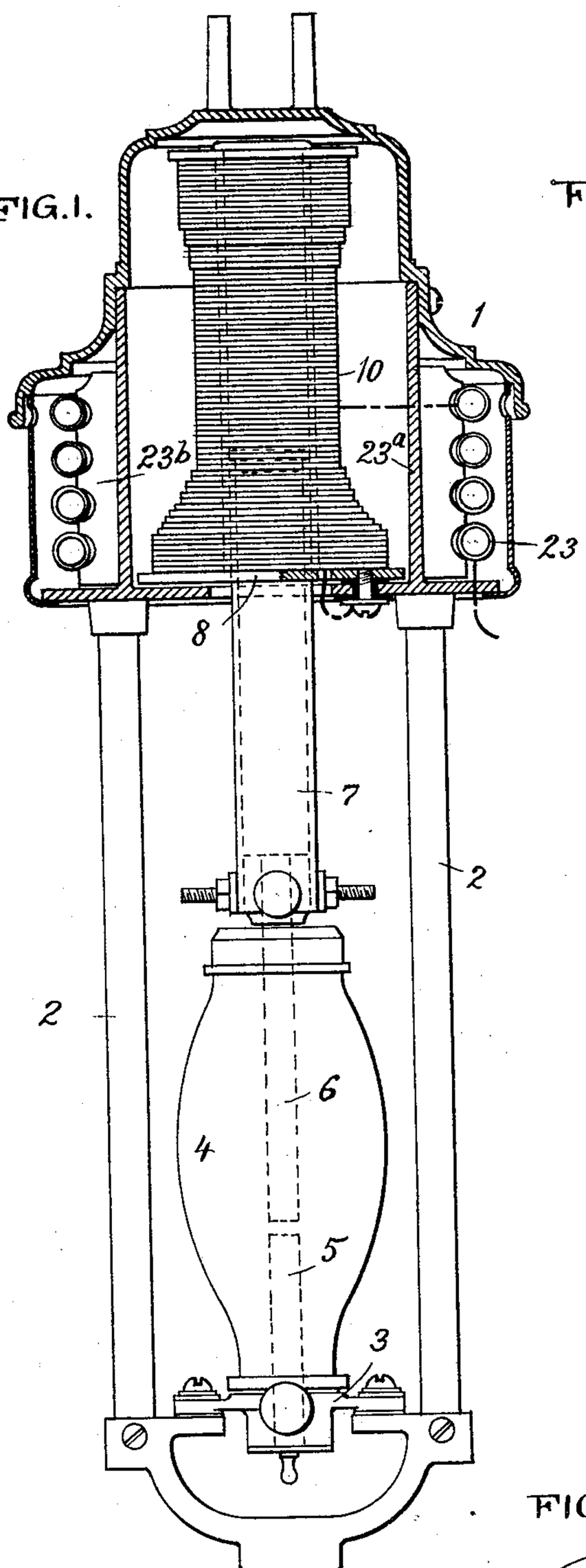


FIG. 2.

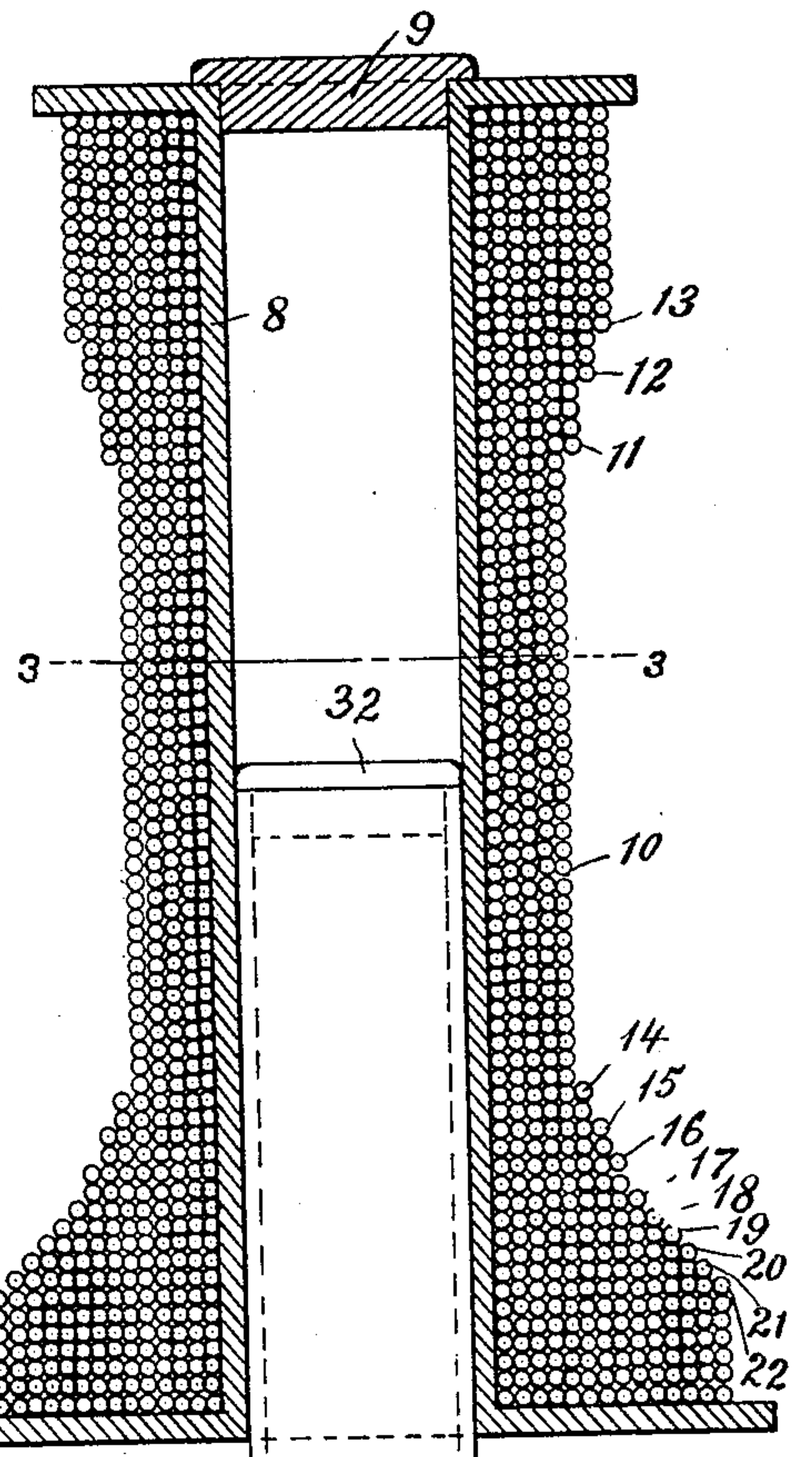
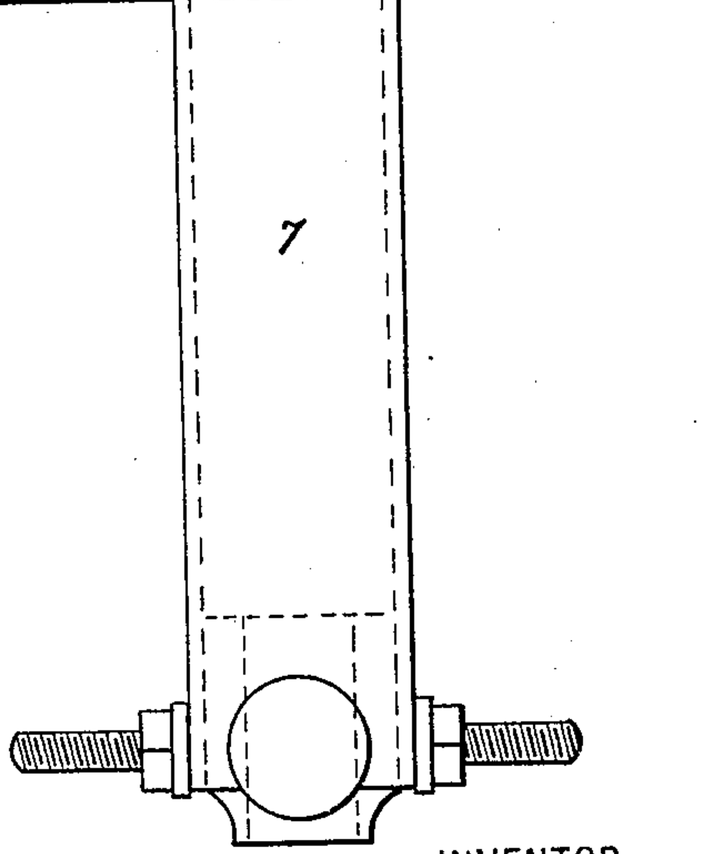
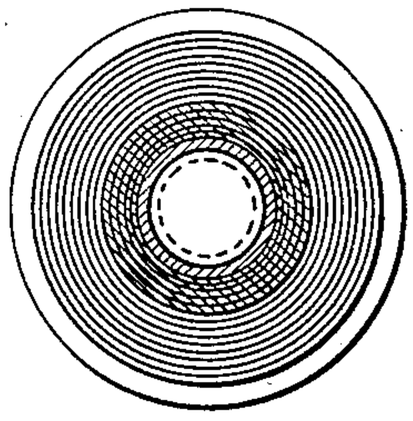


FIG. 3.





WITNESSES:

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No. 611,601. Patented Oct. 4, 1898.

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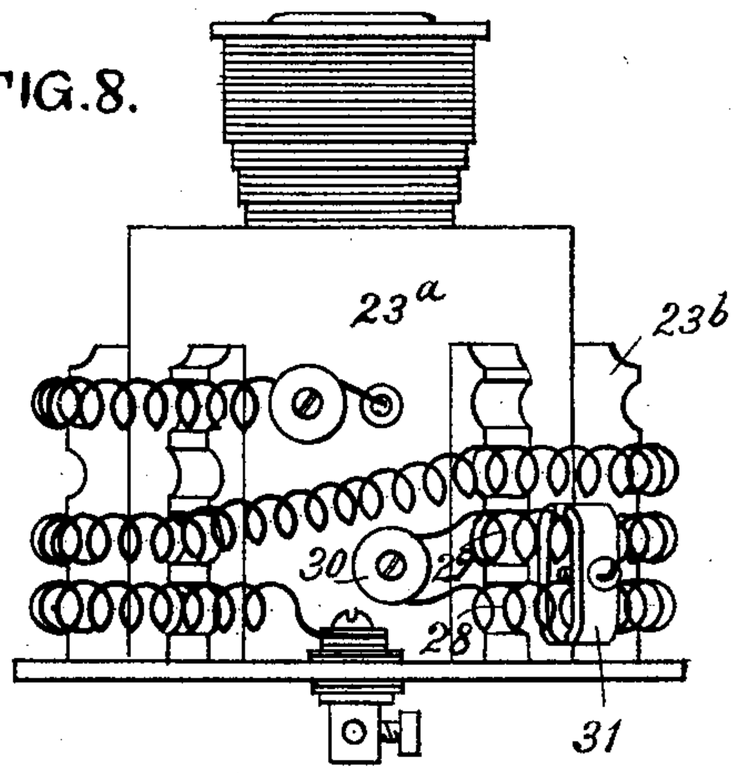
(No Model.) 2 Sheets—Sheet 2.

FIG.8.



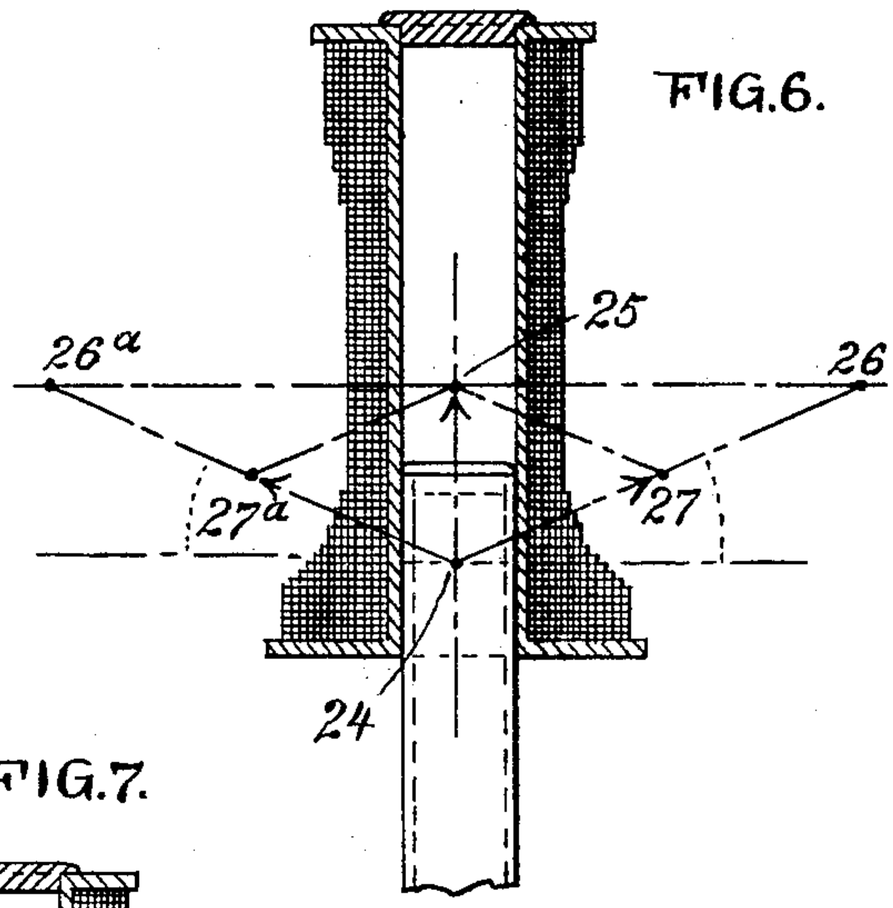
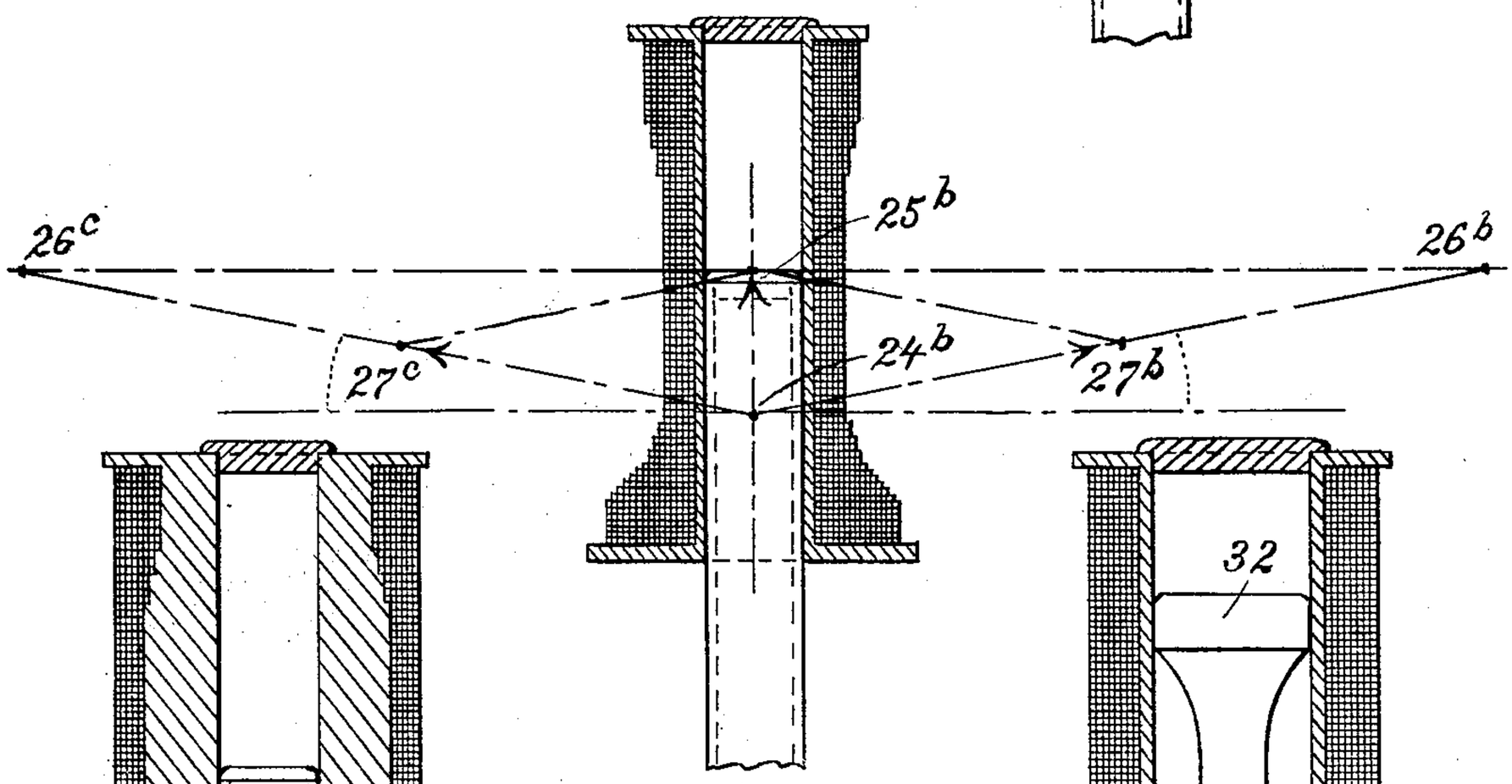


FIG.6.

FIG.7.



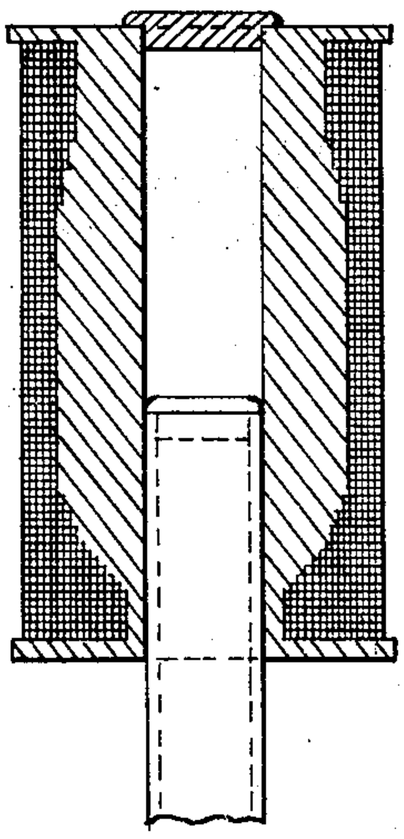


FIG.4.

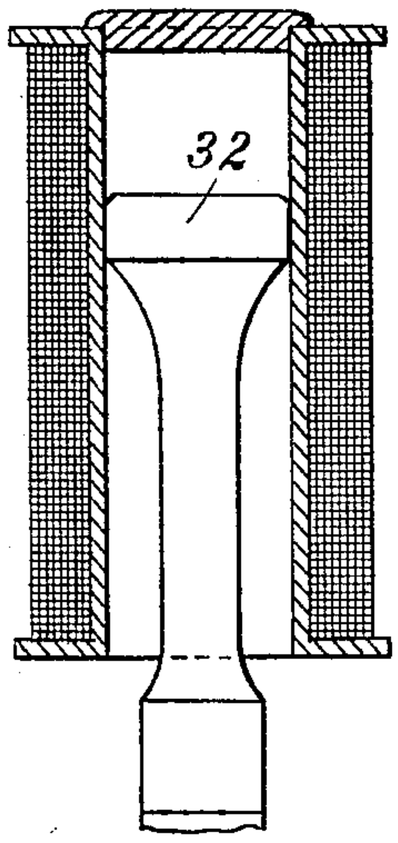


FIG.5.

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UNITED STATES PATENT OFFICE.

SIGMUND BERGMANN, OF NEW YORK, N. Y., ASSIGNOR TO THE GENERAL INCANDESCENT ARC LIGHT COMPANY, OF NEW YORK.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 611,601, dated October 4, 1898.

Application filed July 10, 1897. Serial No. 644,144. (No model.)

To all whom it may concern:

Be it known that I, SIGMUND BERGMANN, a citizen of the United States, residing at New York, State of New York, have invented new and useful Improvements in Arc-Lamps, of which the following is a specification.

My invention relates to electromagnetic governing devices, and is more specifically designed to be applied to the governing or regulation of electric-arc lamps.

While the invention is applicable in a general way to all kinds of electric-arc lamps, it is most successfully employed in connection with lamps having the arc inclosed in a small glass globe, known in the trade as the "inclosed-arc" lamp, in which a less extended amount of feed of the carbon-carrier is necessary than in lamps where the arc is exposed.

By reason of the great simplification of the governing mechanism resulting from the use of my invention I am also able to dispose the other parts of the lamp, such as the resistance-coil, about the solenoid in compact form, resulting in other features of novelty and improved construction.

The preferred form of my invention is illustrated in the accompanying two sheets of drawings, in which—

Figure 1 is a side elevation and partial section of my improved form of lamp. Fig. 2 is an enlarged detail of the preferred form of solenoid and coöperating soft-iron core. Fig. 3 is a section on line 3 3 of Fig. 2. Figs. 4 and 5 illustrate modifications of my invention. Figs. 6 and 7 are diagrams illustrating the principle of the invention. Fig. 8 is an enlarged detail view showing the arrangement of resistance-coils rendered possible by the simple form of lamp.

Throughout the drawings like reference-figures refer to like parts.

1 represents the casing for the governing mechanism of the lamp.

2 2 are the side rods supporting the lower-carbon holder 3.

4 is the small glass globe inclosing the arc formed between the lower carbon 5 and the upper carbon 6.

7 is the upper-carbon holder, which is a soft-iron hollow cylinder forming a core closely fitting into the spool 8 of the solenoid 10.

9 is a cover or button closely fitting into and closing the upper end of the spool 8 air-tight. The winding of the solenoid 10 is increased at either extremity, there being the extra coils 11, 12, and 13 on the upper end of the solenoid and the extra coils 14, 15, 16, 17, 18, 19, 21, and 22 on the lower end of the solenoid.

23 represent the resistance-coils, which reduce the tension of the currents supplied to the arc and which are wound around the inner casing 23^a of the lamp, being supported on porcelain or other non-conducting cleats 23^b. These resistance-coils are preferably reversed in their direction at one or more points, passing around an insulating-button 30 for this purpose, so as to form two adjacent portions of the coil 27 28, through which the current runs in opposite directions. An adjustable metallic clamp 31, being movable along the loop thus formed, cuts out more or less of the loop from the circuit, and thereby adjusts the amount of resistance in the lamp.

The electrical circuit of the lamp is through the resistance-coils 23, through the solenoid 10 to the spool 8, from the spool to the carbon-carrying core 7, and out by way of any suitable connections with the lower-carbon holder 3.

The method of operation of my invention is as follows: The winding of the solenoid in the manner represented in Fig. 2 coöperates with the soft-iron core 7 in such manner that the vertical component of the various magnetic attractions exerted by the solenoid upon that portion of the core within the solenoid shall always be the same as long as the core has at least a given short portion of its upper end in the solenoid and is not elevated beyond a point which leaves its extremity a short distance below the cover 9, which closes the upper end of the spool. This results from the state of facts indicated in the diagram, Figs. 6 and 7. Assuming the core to be in the position indicated in Fig. 6, then the center of effect of the magnetic actions on it may be assumed to be at the point 24, which is approximately the central point of that portion of the core within the solenoid. This magnetic pull or attraction will be exerted principally by the coils composing the adjacent portion of the solenoid and those shortly above, so that the point at which these radial

magnetic attractions center on any one side might be represented at 26 and the force of each set of these radial components represented by the length and direction of an arrow at 24 27. Of course there would be a number of pairs of these forces, as 24 27 and 24 27^a, and their common resultant would be represented by the diagonal 24 25 of the parallelogram of forces. When the core is raised to the higher position, as shown in Fig. 7, then the center of magnetic attraction 24^b would still be the center of the larger portion of the core now within the solenoid, which would be raised considerably above the point 24, as shown in Fig. 6. The centers of magnetic attraction might be represented in this case at 26^b and 26^c, which would also be higher than the points 26 and 26^a; but the increase of height of these points would not be as great as the increase in height of the point 24 to 24^b. In other words, the angle which the radial components of magnetic attraction would make with the horizontal plane (assuming the solenoid to be vertical) would decrease as more and more of the core is inserted in the helix, and by properly winding the helix, as represented, this decrease in the angle can be made to be approximately proportionate to the increase in the strength of these radial components of magnetic attraction, (represented by the increased length of the arrows 24^b 27^b and 24^b 27^c,) which would of course result from bringing more and more of the solenoid into action. If this proportion is preserved, it is evident that the vertical resultant 24^b 25^b (being the diagonal of the parallelogram 24^b 27^b 25^b 27^c) will be the same as the resultant 24 25, (being the diagonal of the parallelogram of forces represented in Fig. 6—24 27 25 27^a.) Consequently the desired result—to wit, obtaining of a uniform vertical lift on the core at its various positions within the helix—will have been secured. I arrive at the proper winding to secure this by trial, being guided by the variation in the amperage of current necessary to maintain the core in such position as to produce the proper length of arc when a straight solenoid is employed and different positions of the core are experimented with. By then increasing the winding at the various corresponding portions of the solenoid, so as to give the ampere terms which I have empirically determined to be necessary to sustain the core in that position, I obtain an almost perfect result.

It is evident that certain variations could be made in the design of the helix and core so long as the relative relation between the masses above indicated is preserved. Thus the helix might be wound upon a wooden spool, so that its external walls would be straight, as shown in Fig. 4, while the variations in winding would be produced by variations in the thickness of its interior walls. Again, a straight helix might be used, and a core of varying cross-section would then be employed with it, as illustrated in Fig. 5. The constant magnetic pull then resulting from the variable amount of iron in the core submitted to the action of the helix instead of from the reverse arrangement, as shown in Fig. 2.

In every case it is desirable to have the core 32, or at least the upper portion thereof, which I prefer to make of brass, fit tightly to the bore of the spool 8, so that the air will be trapped between it and the cover 9 (closing the upper end of said spool) and thereby produce a dash-pot action, steadying the core in its feeding action as the carbon is consumed and the core lowered by a weakening of the magnetic action of the solenoid, produced by a weakening of the current through the elongation of the arc.

The adjustable resistance illustrated in Fig. 8 is of special importance, inasmuch as the voltage of commercial circuits varies within certain limits, and it is impossible for the manufacturer of lamps to make a lamp which will exactly fit all commercial circuits for the above reason.

With the construction illustrated in Fig. 8, however, one can manufacture a lamp containing a resistance equal to the maximum voltage in use in commercial circuits employing that type of lamp, and then the person putting the lamp in position can cut the resistance down to suit the conditions by moving the adjustable clamp 31 along the loop formed by the portions 28 and 29 of the resistance.

I have stated in general terms that the angle which the radial components of magnetic attraction make to the horizontal plane should decrease approximately in an inverse ratio as the strength of that magnetic attraction increases. As these angles are always small, this statement is sufficiently accurate for practical purposes. The mathematician will understand, however, that to be accurate I should say that the sine of the angle decreases in inverse proportion to the increase in strength of the magnetic attraction.

With small sizes of angle the variation of the angle in degrees is nearly equal to the variation in the sine of the angle, so that the simpler statement before given is probably sufficient for practical purposes and will be more readily understood by those not familiar with trigonometrical terms.

It is evident that various changes could be made in my invention without departing from the principle thereof so long as the relative arrangement and operation of parts are preserved.

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

1. In an electric-arc lamp the combination of the governing-helix, the movable soft-iron core therefor, and the carbon-carrier mounted thereon, the resistance-coils wound around the exterior of said helix, one or more por-

tions of said resistance-coils being reversed so as to form a loop with the next adjacent portion, and an adjustable metallic clamp connecting the two portions of the loop of resistance-coils thus formed, whereby a greater or less portion of said loop may be cut out and the resistance adjusted accordingly, substantially as described.

2. An adjustable electrical resistance consisting of a series of resistance-coils arranged in one or more loops, and a movable metallic clamp engaging the two portions of the loop and capable of adjustment along said loop, whereby a greater or less portion of said loop of resistance-coils, may be cut out of circuit, substantially as described.

In testimony whereof I affix my signature in the presence of two witnesses.

SIGMUND BERGMANN.

Witnesses:

W. FOSTER,

WM. FRANKSEN.