(No Model.) 2 Sheets—Sheet 1.

C. HOFFMANN.

ELECTRIC ARC LAMP.

No. 506,503. Patented Oct. 10, 1893.

Fig. 1.

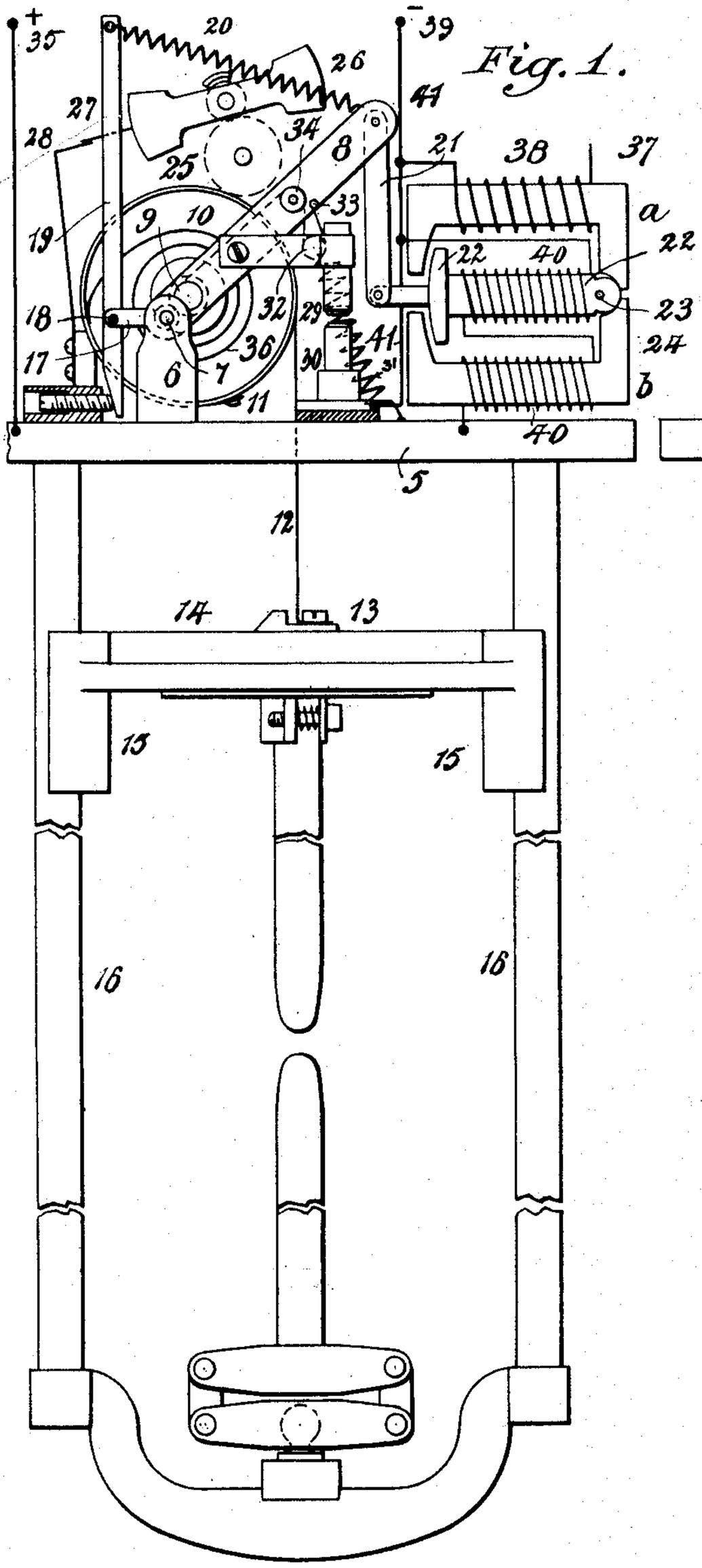
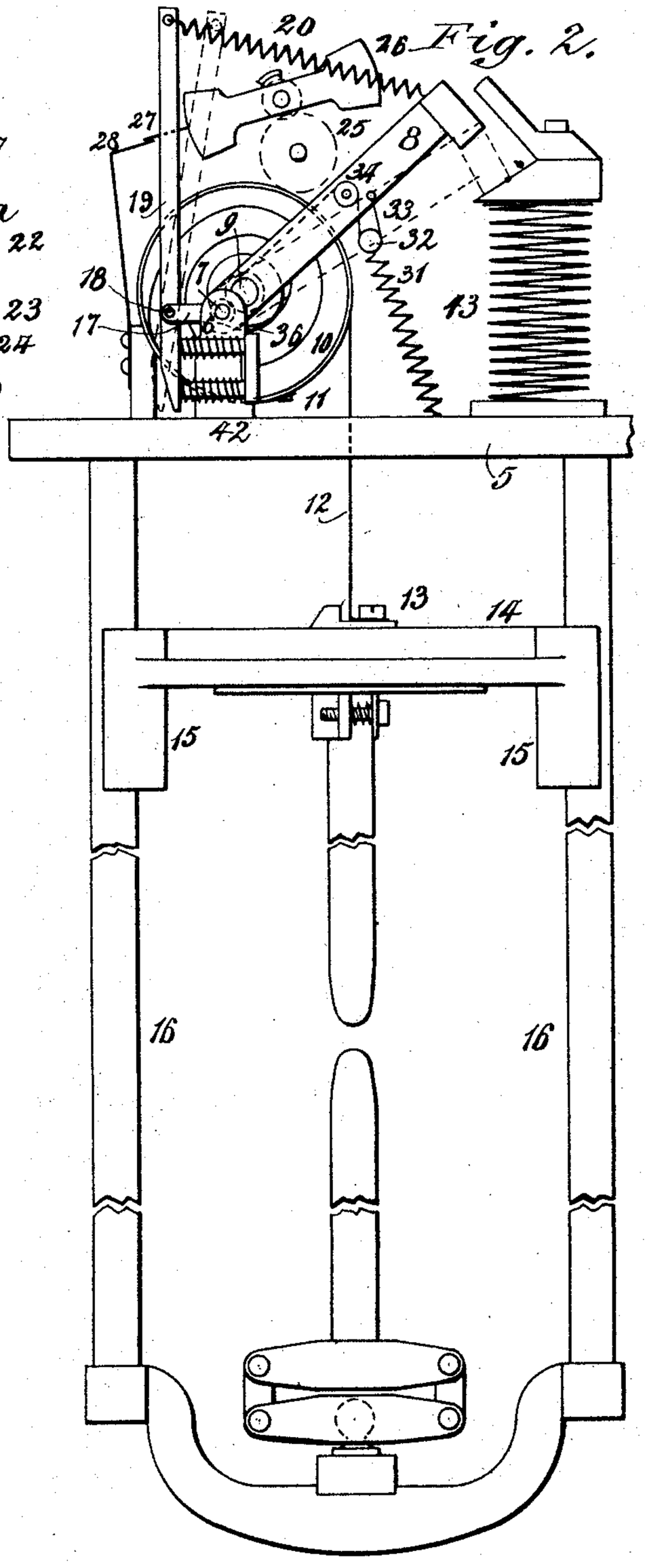


Fig. 2.



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(No Model.)

2 Sheets—Sheet 2.

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Fig. 4.

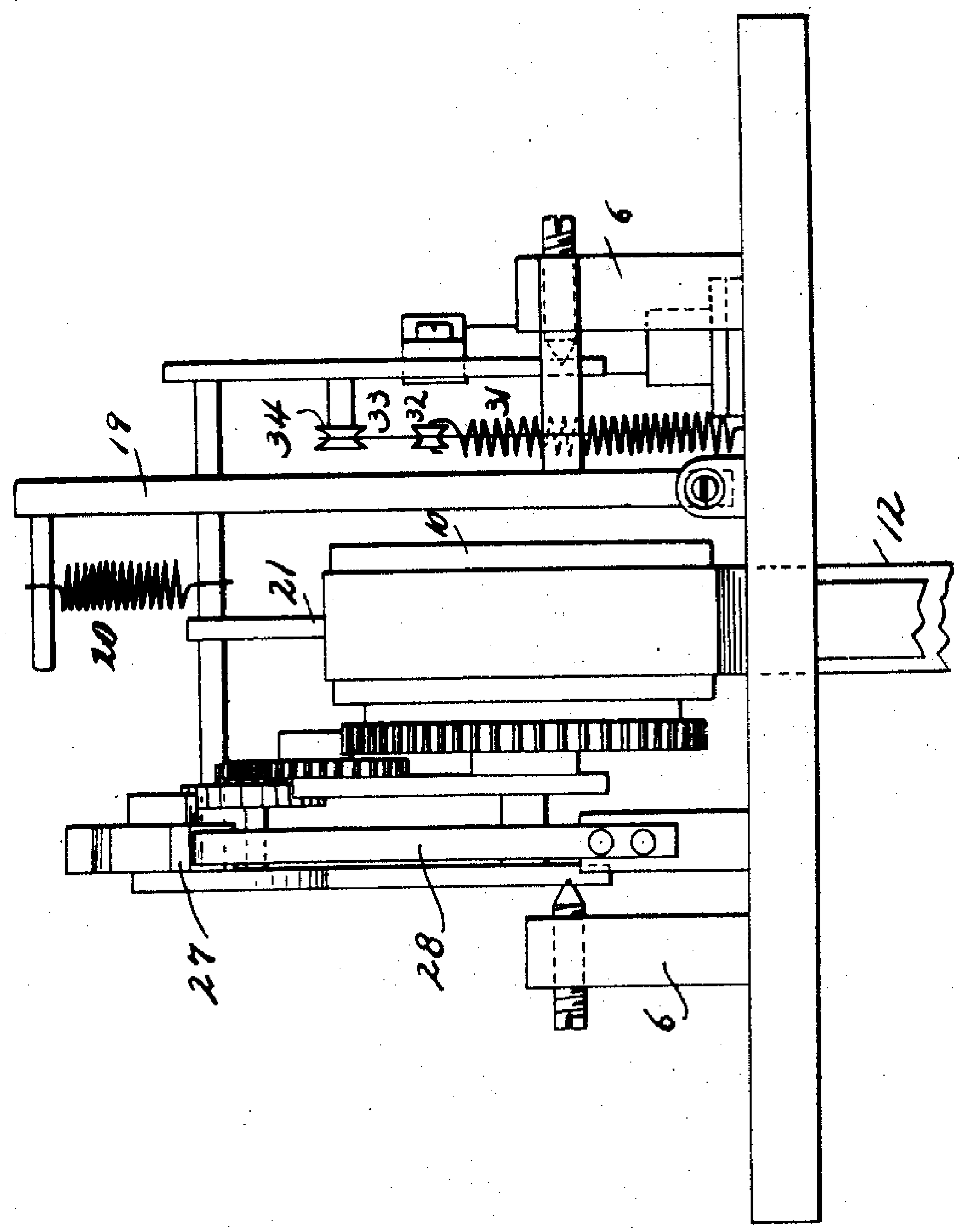
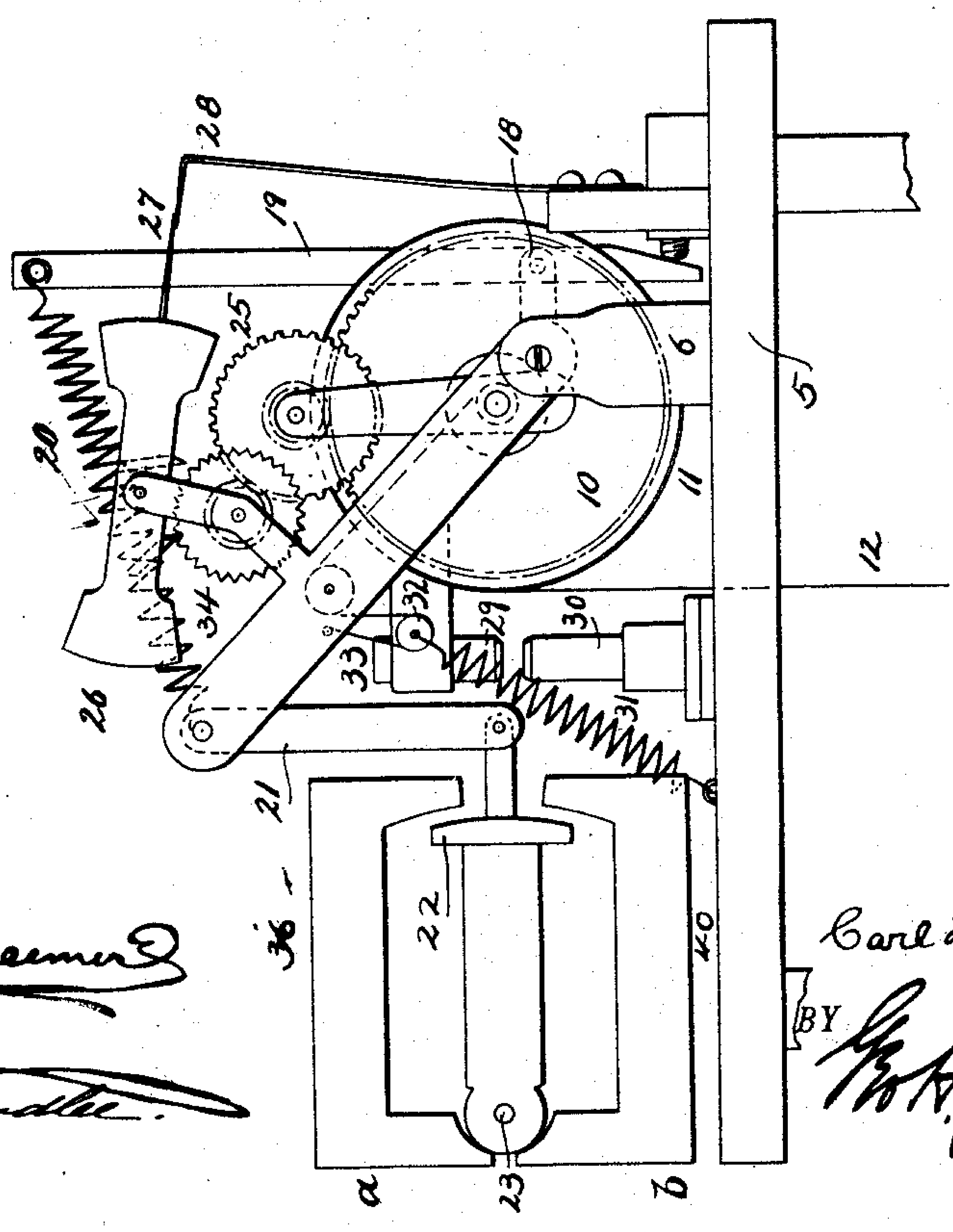


Fig. 3.



WITNESSES:

INVENTOR

BY

ATTORNEY

UNITED STATES PATENT OFFICE.

CARL HOFFMANN, OF BERLIN, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 506,503, dated October 10, 1893.

Application filed April 5, 1893. Serial No. 469,221. (No model.)

To all whom it may concern:

Be it known that I, CARL HOFFMANN, a subject of the King of Prussia, German Emperor, residing at the city of Berlin, Kingdom of Prussia, German Empire, have invented new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

In a former patent granted to F. von Hefner-Alteneck and myself on the 1st day of October, 1889, No. 412,141, there is described an electric arc lamp adapted to be employed in a system of parallel distribution.

My present invention consists in an electric arc lamp having the general features of the lamp in the patent to which I have referred, but modified in such a manner as to render it suitable for use in a system of series distribution.

My invention also consists in a new and improved manner of constructing a differentially acting arc forming and carbon regulating magnet for use in series arc lamps; further, to an improved short-circuiting device for use in such lamps, as well as to various other improvements which will first be described and then specifically pointed out in the claims.

Referring to the accompanying drawings and diagrams which serve to illustrate my invention, corresponding numerals and letters indicate like parts.

Figure 1 is a view in elevation. Fig. 2 is a similar view showing a modified form. Fig. 3 is an enlarged view of the carbon feeding mechanism and connections with the armature of the shunt magnet. Fig. 4 is a similar view of the feeding mechanism looking at right angles to Fig. 3.

In the accompanying drawings, 5 indicates the metallic base plate or floor of the lamp; 6, metallic standards projecting upward from said base plate and on which is pivoted at 7 the frame 8. Carried by this frame and pivoted at 9, so as to be capable of rotation in both directions, is a drum 10. Connected at one end 11 to this drum and carried over its circumference is a flexible metallic ribbon 12 fastened at its opposite end 13 to a weighted carbon carrier 14. This carbon carrier has vertically grooved ends 15 which move over and are guided by the side rods 16 of the lamp frame.

17 is an arm secured horizontally to the standard 6, and pivoted therein at 18 is a lever 19.

20 is a spring fastened at one end to the lever and at the other end to the frame 8.

The carrier 14 is, as stated, weighted, but not sufficiently so to evercome the upward pull of the spring. The weight of the carrier is, however, supplemented by the weight of the frame 8, link 21 and armature 22. The link 21 is pivoted to the frame 8 and armature 22, which is likewise pivoted at 23 to the magnet 24. Normally, therefore, when no current is passing through the lamp, the combined weight of the parts mentioned overcomes the action of the spring 20 and the light carbons are brought into apposition, which is the position they should be in when a series arc lamp is out of circuit.

Connected to the drum 10 is a train of gears 25, only one wheel of which is shown, and an escapement 26. On the escapement 26 is a dog 27, which takes over the spring pawl 28. When the parts occupy the positions shown in Figs. 1 and 2—that is, when the dog of the escapement rests on the top of the spring pawl—the train of gears and the drum are prevented from rotating. As soon, however, as the dog is released the carbon carrier moves downward to bring the light carbons into apposition, as previously stated, or to compensate for the consumption of the carbons in the arc.

29 and 30 represent two short carbons connected respectively to the frame 8 and base plate 5, and serve as a means for automatically short-circuiting the lamp, as will hereinafter be explained.

31 is a spring fastened at one end to the base plate 5, and at the other end to a pulley 32, over which passes a cord 33 secured at one end to the frame 8 and passing over a pulley 34 thereon, and secured at the opposite end to the shaft 9, upon which the drum 10 is located. The purpose of the spring and cord is to compensate, by the increased tension of the spring as the cord is wound upon the shaft of the drum 10, for the decreasing weight of the positive carbon as consumed.

I will now describe the circuits in the lamp and in connection therewith set forth the operation of the lamp. The current from the source of energy—preferably a series wound dynamo electric machine—is led into the lamp through the positive conductor 35; thence to the metallic base plate 5, by standards 6 to spring 36, connected at one end to the standard 6 and at the other end to the inner periphery of the drum 10, to ribbon 12, positive carbon, negative carbon, conductor 37 (inclosed in one of the side rods 16), to series coil 38, which is wound on the upper leg *a* of the magnet 24; thence to the negitive terminal 39 of the lamp and back to the source of energy or positive terminal of the next lamp in series. When the circuit is established as described, the upper leg *a* of the differential magnet 24 will attract the armature 22, and the armature through link 21 will lift the frame 8 and with it the drum, ribbon, carbon carrier and positive carbon; thus establishing the arc. As the light carbons are consumed and the arc between them grows longer, a smaller portion of the current will flow through the series coil 38 on the upper leg *a* of the magnet, and a greater portion through the shunt coil 40, which is wound on the lower leg *b* of the magnet and on the armature 22. One end of the shunt coil is connected to the base plate 5 and the other end to the conductor 41, which is connected at one end to carbon 30 and at the other end to the negative terminal 39 of the lamp. As the current in the shunt coil 40 becomes greater by increase of resistance in the arc, the leg *b* now attracts the armature 22, and the armature through the link 21 draws down the frame 8, releases the escapement 26, and permits the drum 10 to rotate and the positive carbon to feed downward until the balance of resistances is again established and the arc of the proper length. Should it happen that the tension of the current transmitted to the lamp is by any cause made greater than that normal to the lamp, a new balance will at once be established, and the armature will be drawn upward, and thereby increase the length of the arc. The waste of the upper carbon in the arc will be compensated for during this abnormal condition in the same manner as previously described for the normal condition; at the same time the greater length of arc will be maintained—which is a condition desirable under the circumstances—until the tension of the current again drops to that normal to the lamp, when the previous balance will be reestablished. It will be observed that the legs *a* and *b* of the magnet have the coils wound upon them in such a direction that their polar ends are respectively north and south poles; while the coil on the armature, which is in series of the coil on the leg *b*, is wound to make the free end of the armature a north pole. The leg *a* on which the series coil is wound in the first instance, as described, attracts the armature 22, for the reason that the armature, at the moment that the current is switched into the lamp, has a polarity induced in it opposite to that of the leg *a*. When the shunt coil comes into action, the polarity of the armature is reversed and the leg *b* then attracts the armature. The attraction of the leg *b* for the armature is aided by the repulsion of the leg *a* for the armature. The result of this arrangement is that the movement of the armature downward, to release the carbon feeding mechanism, is very quick.

It is desirable in constructing a magnet to carry out the above described operation, to provide that the magnetism of the leg *a* shall be sufficient under normal conditions to reverse the polarity of the armature, when the armature is in its middle position—that is to say, at such time when the majority of the current is passing through the series coil on the leg *a* of the magnet.

The coil on the armature 22 is, as stated, a part of and in series of the shunt coil on the leg *b*, but wound so that the polarity of the free end of the armature shall be a north pole, while the polar end of the leg *b* shall be a south pole. By this arrangement, when the current is increased in the shunt, the polarity of the armature is immediately changed from a south polarity, induced by its forming a part of the magnetic circuit of the leg *a*, to a north polarity, and the current traversing the coil quickly destroys all residuary magnetism in the armature.

It will be evident that the coils on the magnet may be otherwise wound to produce the differential action and operation of the parts as above described, but the form and connections as shown and described have been found to answer admirably for the purpose and to produce the best results.

In place of employing a differentially wound magnet, as shown in Fig. 1, I may use two independent magnets, as shown in Fig. 2; one a series wound magnet 42, and the other a shunt wound magnet 43. The shunt wound magnet 43 is arranged, connected and operates substantially as shown in Patent No. 412,141, to which I have previously referred. The series wound magnet 42 is so located that the lower leg of the lever 19 forms its armature; thus, when the current is first established in the lamp, the magnet 42 is brought into action, and its attraction of the lower leg of the lever 19 exerts tension on the spring 20, which acts to lift the frame 8 and with it the carbon carrier and carbon to establish the arc.

In lamps of the character described, it is necessary to provide some means for short-circuiting the lamp. Should it happen that the upper carbon is totally consumed, or that the carbon carrier becomes arrested in its movement downward by sticking in the frame, &c., the current will be diverted to the shunt, coil or magnet, which will act powerfully and draw the carbons 29 and 30 into apposition, and thereby short-circuit the lamp; the cur-

rent flowing from the base plate 5 to carbon 29, carbon 30, conductor 41 to negative terminal of the lamp. The contacts 29 and 30 are normally in contact when no current is in the lamp, but are separated slightly in advance of that of the main light carbons, when the current is turned into the lamp. By this means but a very small spark is formed between the carbons 29 and 30.

My improved lamp may be operated with either direct or alternating currents of electricity.

It will be obvious from the above description, that very many modifications may be made in the construction of my improved lamp, without departing from the intent of my invention. For instance, if the magnet 24 and coils thereon are properly balanced, the retractile spring 20, in the form shown in Fig. 1, may be dispensed with and also the lever 19. It will also be obvious that my improved construction of differential magnet with floating armature may be used in connection with mechanism other than that described for striking the arc and regulating the carbon feed in arc lamps, as well as for various other purposes.

Having thus described my invention, I claim—

1. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism carried thereby, a differentially wound magnet, a pivoted armature therefor, independent of said frame said magnet located so as to be actuated by the current circulating in the coils of said magnet, and mechanism interposed between said armature and said frame whereby the frame is lifted to form the arc and lowered to permit action of the carbon feeding mechanism.

2. In an electric arc lamp, the combination of a pivoted frame, a carbon feeding mechanism carried thereby, a flexible support for the carbon, a differentially wound magnet, a pivoted armature therefor, independent of said frame said armature adapted to be moved in opposite directions by the current circulating in the respective coils of said magnet, and mechanism interposed between said frame and said armature, substantially as and for the purpose set forth.

3. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism carried thereby, said mechanism provided with a rocking escapement, a stop for said escapement connected to the lamp frame, an electro-magnetic device responsive to the current transmitted through the lamp, a pivoted armature independent of said frame and mechanism connected therewith to lift said frame, and mechanism thereon to separate said carbons and strike the arc and to lower said frame, and mechanism to release the escapement and permit the feeding of the upper carbon to compensate for the consumption in the arc.

4. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism carried thereby, a magnet in series with the arc, mechanism operated by said magnet and acting to lift said frame, and mechanism thereon to separate the light carbons and form the arc, a magnet in a derived circuit around the arc, a pivoted armature also in said circuit mechanism operated by said armature and acting to lower said frame, release the feeding mechanism and permit the upper carbon to feed.

5. In an electric arc lamp, the combination of an arc forming and carbon feeding mechanism, an electro-magnet having two coils thereon, one a coil in series with the arc, the other a coil in a shunt around the arc, an armature common to said magnets, and inclosed by the legs thereof a coil on said armature in series with the shunt coil, said armature pivoted at one end to the yoke of said magnet and extending outwardly, whereby its free end may be caused to reciprocate between the poles thereof, and mechanism interposed between the free end of said magnet and the arc forming and carbon feeding mechanism, substantially as and for the purpose set forth.

6. In an electric arc lamp, the combination of an arc forming and carbon feeding mechanism, an electro magnet provided with two legs, arranged one above the other a series coil upon the upper leg of said magnet, a shunt coil on the lower leg of said magnet, an armature pivoted at one end to the yoke of said magnet, and extending outwardly to be reciprocated between the poles thereof a shunt coil on the armature, and mechanism interposed between said armature and said arc forming and carbon feeding mechanism.

7. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism carried thereby, a retractile spring connected to said frame, and having electro-mechanical means for increasing its intensity a magnet in series with the arc, a magnet in a shunt around the arc, and mechanism actuated by said magnets to lift and lower said frame, substantially as and for the purpose set forth.

8. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism, a magnet in shunt circuit around the arc, an armature independent of said frame and acting to lower said frame and release the feeding mechanism, and a short circuiting device independent of said armature and having one point carried by said frame in a manner to be brought into apposition with a second point on the lamp base, said short circuiting device being in circuit between the frame and the negative terminal of the lamp and acting to cut the lamp out of circuit when the current in said shunt magnet exceeds a predetermined amount.

9. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism carried thereby, a differ-

entially wound magnet, an armature therefor, pivoted at one end and embraced by the legs of the magnet, its free end extending to be reciprocated between the poles of said magnet, said armature having wound thereon a coil in series of the shunt coil of said magnet, and interposed mechanism between said frame and said armature, substantially as and for the purpose set forth.

10. The combination with the arc forming and carbon feeding mechanism of an electric arc lamp, of a magnet having one leg wound with a coil in series with the arc, another leg with a coil in shunt around the arc, and an armature for said magnet pivoted at one end and inclosed by the legs of the magnet and having thereon a coil in series with the shunt coil.

11. In an electric arc lamp, the combination of a pivoted frame, a carbon supporting and feeding mechanism thereon, a divided shunt circuit around the arc, one branch thereof including an electro magnet having an armature independent of the said frame and pivoted to said magnet and inclosed by the legs thereof, said armature having connections with the frame to lower it and release the feeding mechanism, the other branch of the shunt circuit including a short circuiting device independent of said armature and consisting of a contact point secured to the lamp base, and a second contact point secured to the pivoted frame in a position to be brought into apposition with the base contact point when the said frame is lowered to its maximum degree due to an abnormal current passing through its actuating electro magnet.

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

CARL HOFFMANN.

Witnesses:
MAX WAGNER,
MAX PIEPER.