(No Model.)

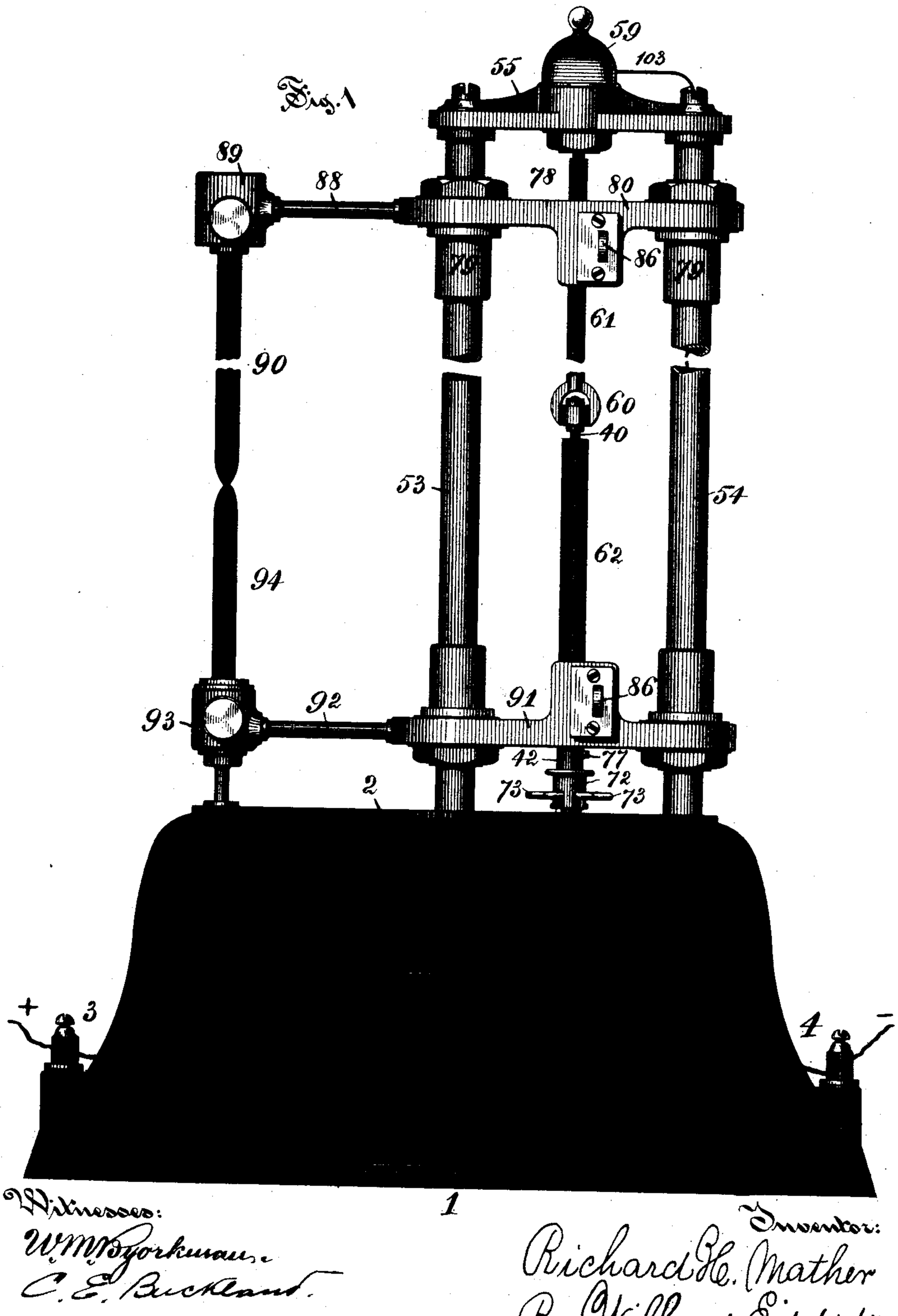
6 Sheets—Sheet 1.

R. H. MATHER.

ELECTRIC ARC LAMP.

No. 446,108. Patented Feb. 10, 1891.

Fig. 1



Witnesses:
Wm. Bjorkman.
C. E. Buckland.

Inventor:
Richard H. Mather
By Willard Eddy, Atty

(No Model.)

6 Sheets—Sheet 2.

R. H. MATHER.

ELECTRIC ARC LAMP.

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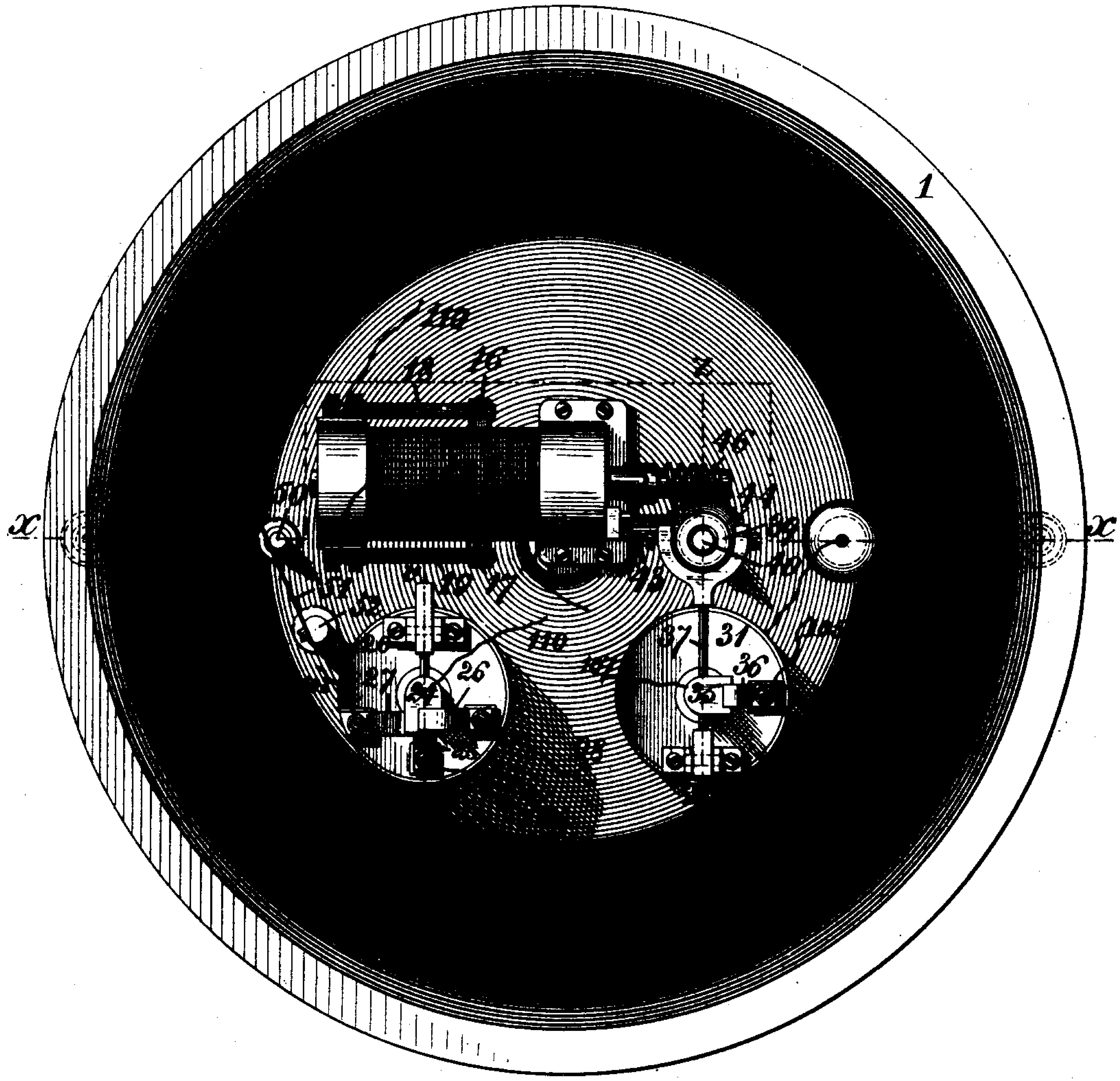
Fig. 2



Witnesses:

W. M. Byorkman

C. E. Buckland.

Inventor:

Richard H. Mather.

By Willard Eddy

Atty.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 6 Sheets—Sheet 3.

R. H. MATHER.

ELECTRIC ARC LAMP.

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Fig. 5

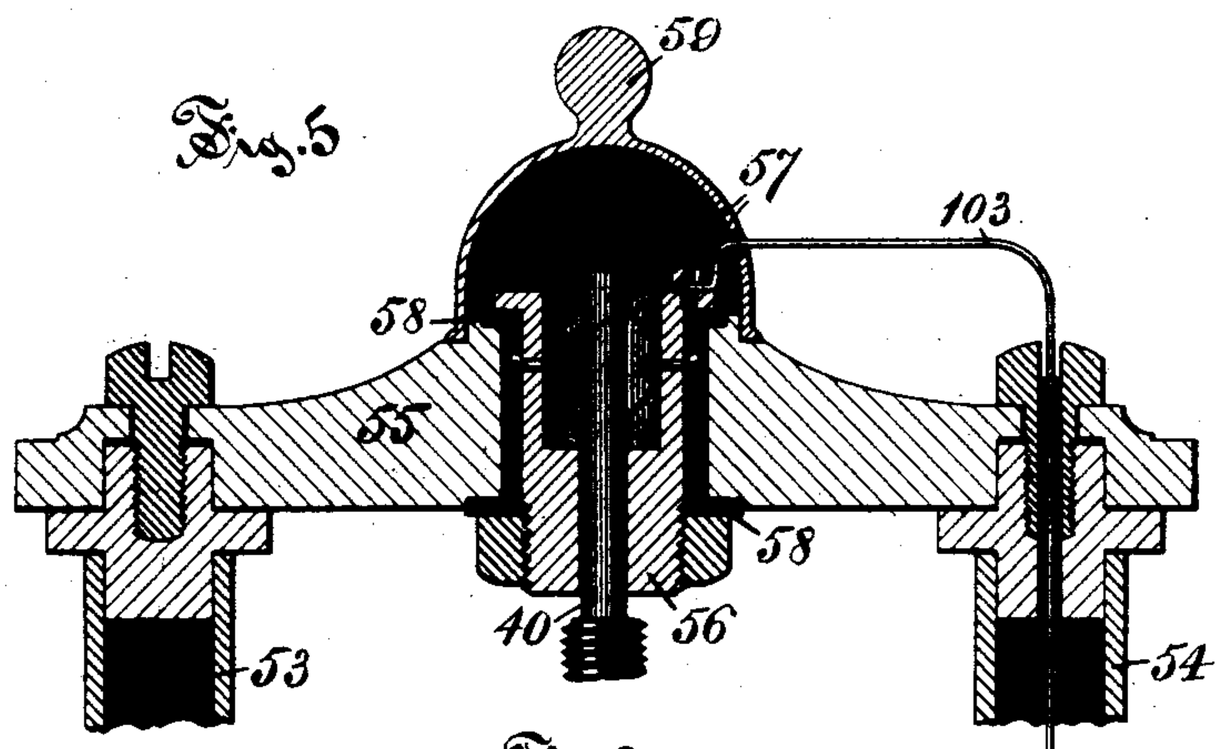


Fig. 4

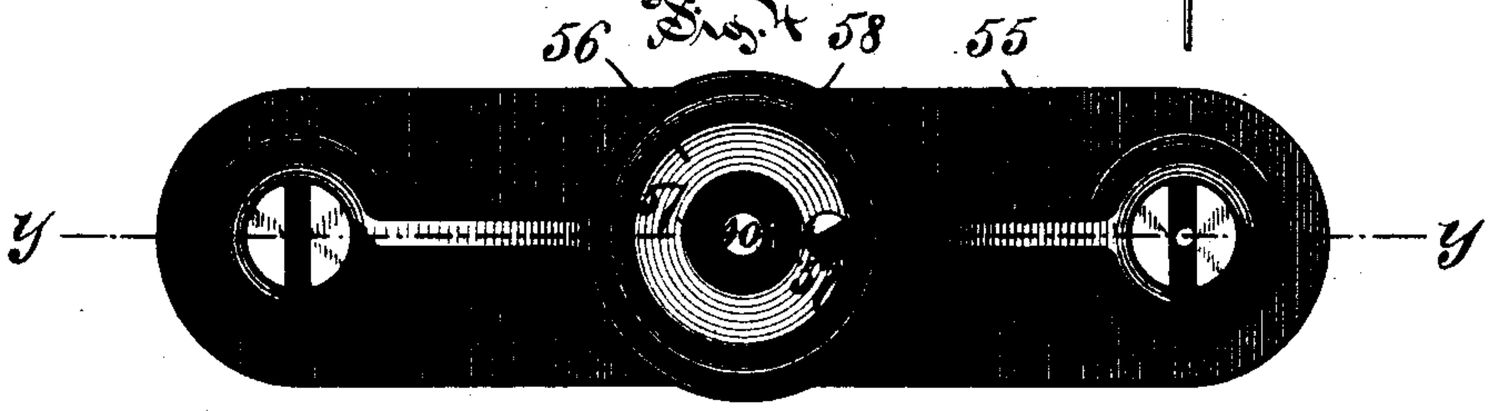
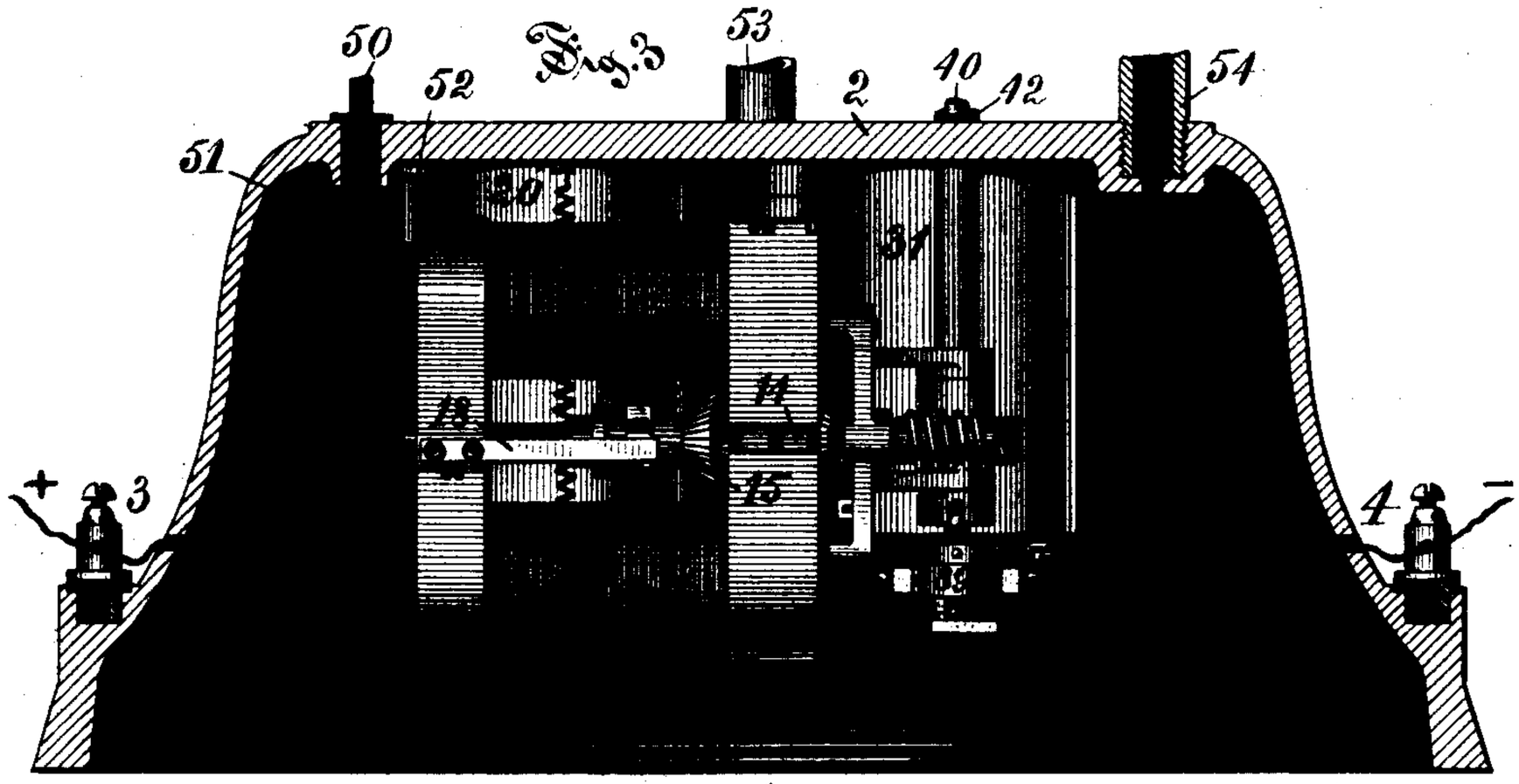


Fig. 3



Witnesses:

W. M. Byerkman.

C. E. Buckland.

Inventor:

Richard H. Mather,

By Willard Eddy,

Atty.

(No Model.) 6 Sheets—Sheet 4.

R. H. MATHER.

ELECTRIC ARC LAMP.

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Fig. 6

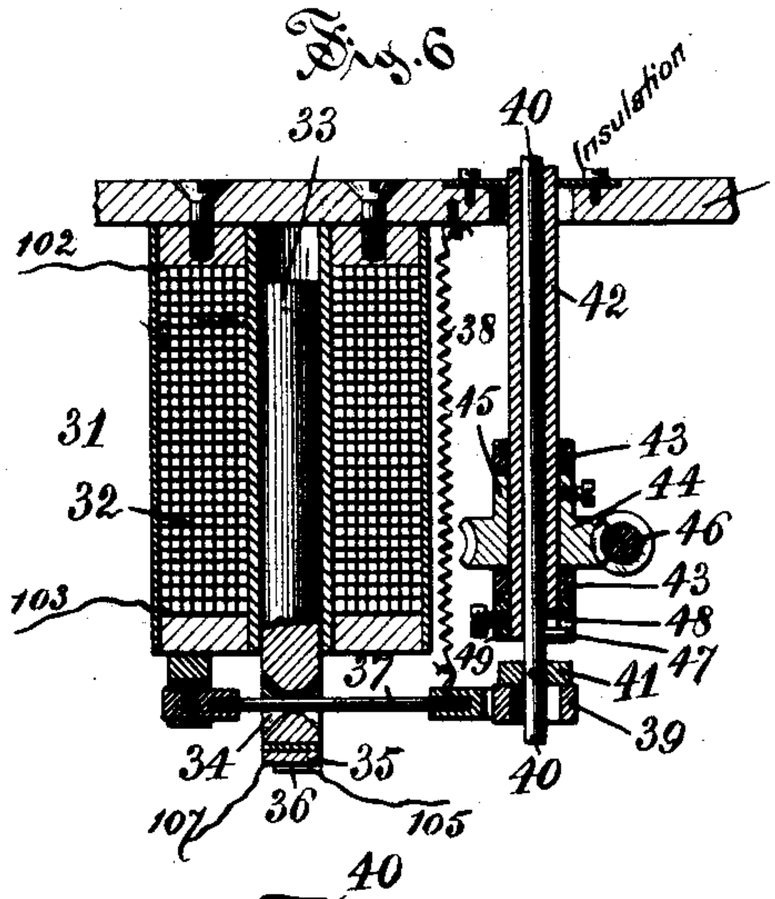


Fig. 7

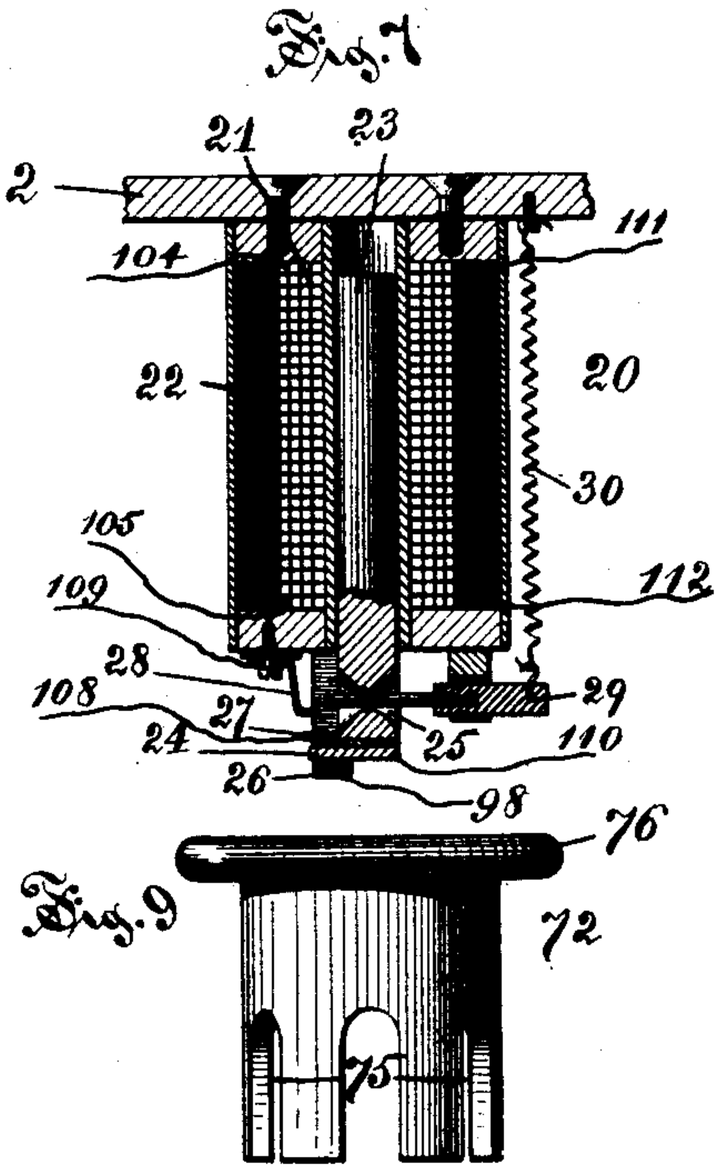


Fig. 8

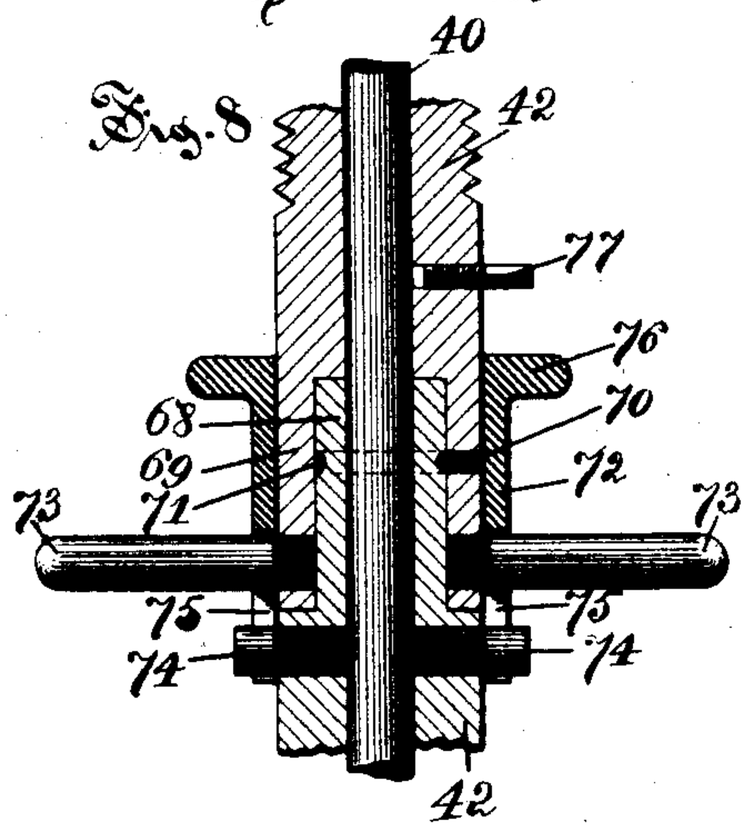
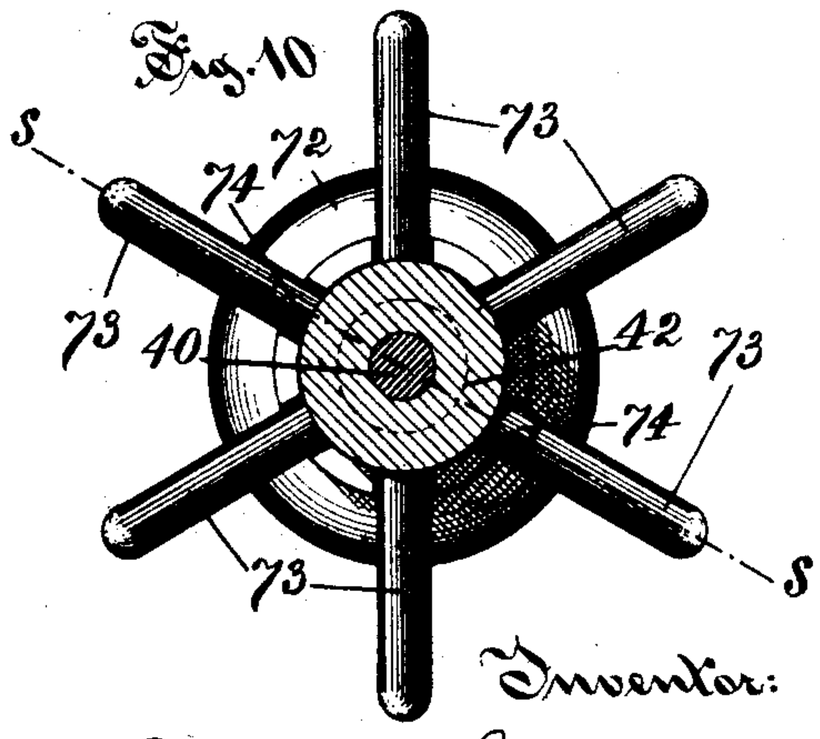


Fig. 10



Witnesses:

Wm. Byerkman, Jr.

C. E. Buckland.

Inventor:

Richard H. Mather,

By Willard Eddy, Atty.

(No Model.) 6 Sheets—Sheet 5.

R. H. MATHER.

ELECTRIC ARC LAMP.

No. 446,108. Patented Feb. 10, 1891.

Fig. 11

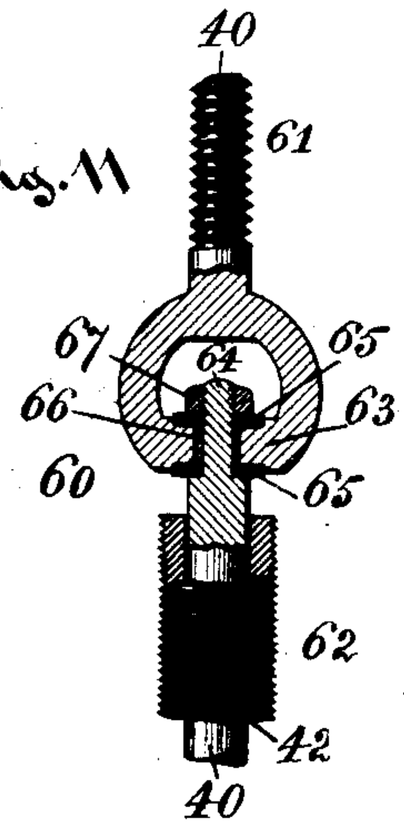


Fig. 12

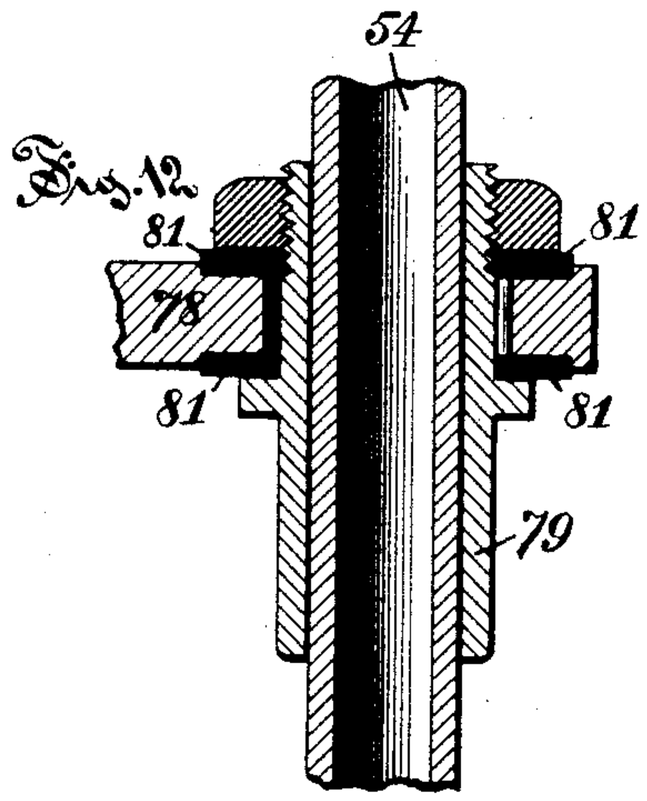


Fig. 13

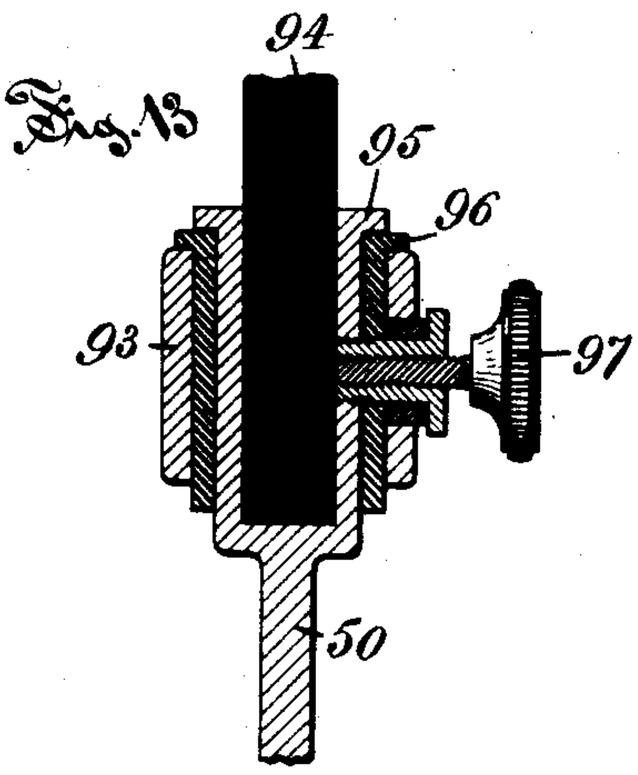
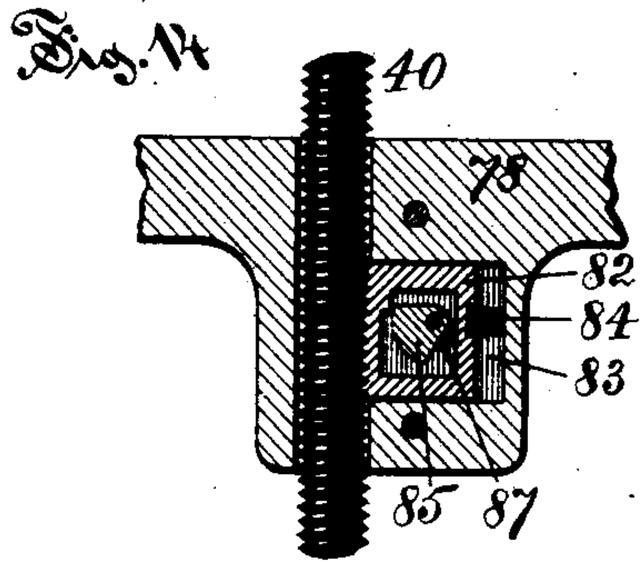


Fig. 14



Witnesses:

W. M. Boyce Workman, Jr.

C. E. Buckland.

Inventor:

Richard H. Mather,

By Willard Eddy, Atty.

(No Model.) 6 Sheets—Sheet 6.

R. H. MATHER.

ELECTRIC ARC LAMP.

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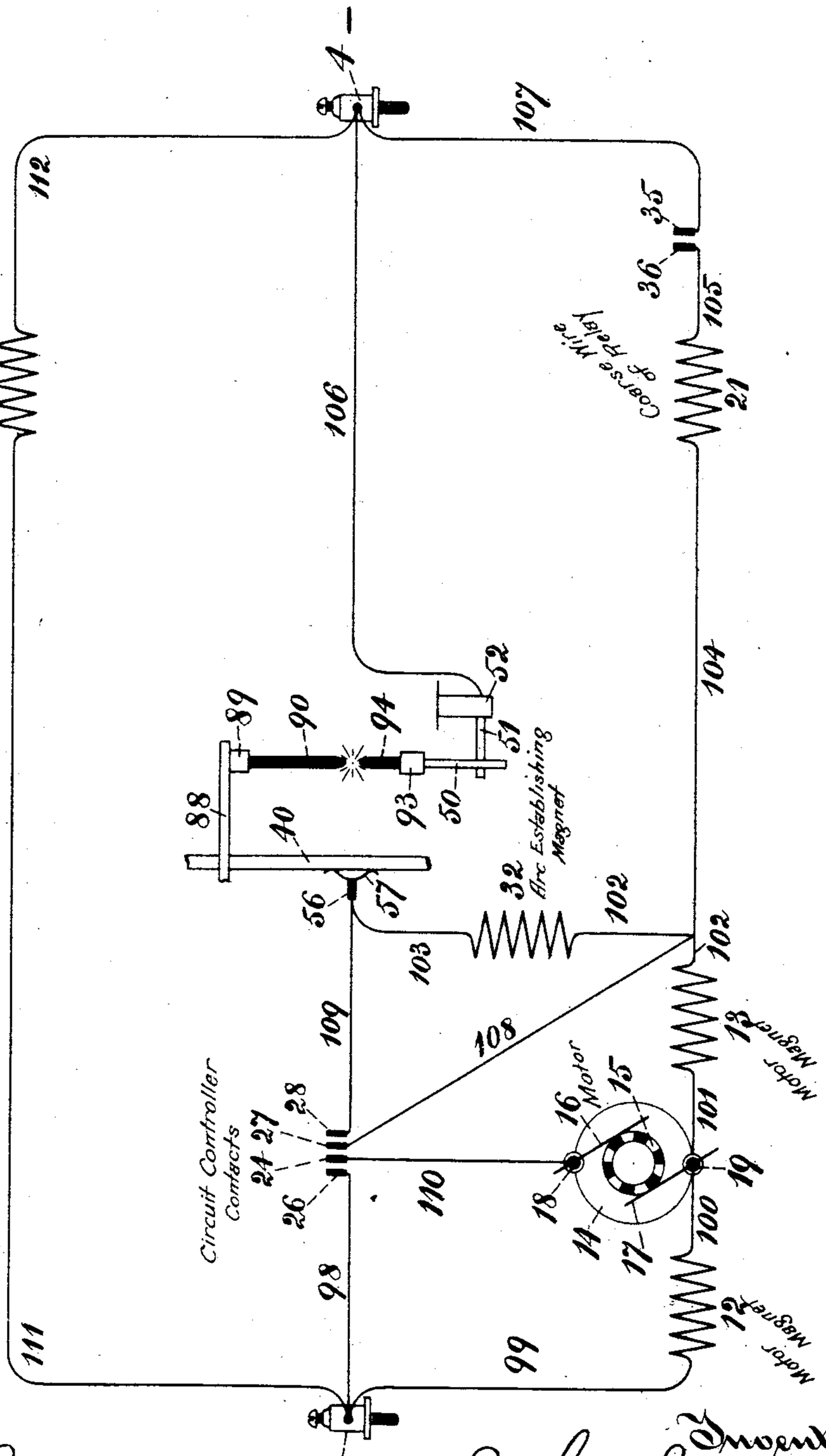
Fig. 15.



Witnesses:

Wm. Bjorkman

C. E. Buckland.

Inventor:

Richard H. Mather.

By Willard Eddy.

Atty.

UNITED STATES PATENT OFFICE.

RICHARD H. MATHER, OF WINDSOR, CONNECTICUT.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 446,108, dated February 10, 1891.

Application filed January 24, 1887. Serial No. 225,288. (No model.)

To all whom it may concern:

Be it known that I, RICHARD H. MATHER, of Windsor, in Hartford county, Connecticut, have invented certain new and useful Improvements in Focusing Electric-Arc Lamps, which are described in the following specification and illustrated by the accompanying drawings.

Said improvements relate, as already indicated, to that class of electric-arc lamps in which the luminous arc is designed to occupy an immovable position.

My invention accordingly consists of mechanism whereby the carbons of the lamp are fed together at approximately the same rates, of speed at which they are respectively consumed.

The best mode in which I have contemplated the application of the principle of my invention is shown in said drawings, in which—

Figure 1 is a side view of my improved lamp. Fig. 2 is a bottom view of the base of the lamp and contents. Fig. 3 is a vertical section of the same on line *x x* of Fig. 2. Fig. 4 is a top view of the frame of the lamp, excluding said base. Fig. 5 is a partial vertical section on *y y* of Fig. 4. Figs. 6 and 7 are sections of Fig. 2 on *z z* and *v v*, respectively. Figs. 8 to 14, inclusive, are details; and Fig. 15 is a diagram showing the appropriate electrical connections.

In describing my invention as illustrated in said drawings it is convenient to commence with the base of the lamp and with the mechanism which that base contains. Said base, which is indicated by the numeral 1 in Figs. 1, 2, and 3, is a cast-iron box having the general form of a frustum of a cone or inverted flaring cup. This box, which is open below, closes at the top in a horizontal floor 2.

Base 1 is provided with two insulated binding-posts 3 and 4, which are the positive and negative terminals of the lamp, respectively. Within base 1 is an electric motor, which is preferably of the general description contained in my application for a patent upon an electro-mechanical movement, Serial No. 200,929, filed May 3, 1886. The field-magnet of this motor (seen in Figs. 2 and 3) comprises two connecting-limbs, which are wound, as an electro-magnet, in the usual manner, with helices 12 and 13, respectively, and two pole-pieces, which are adjacent to armature 14. The latter is mounted in the usual manner upon a shaft which is journaled in said field-magnet and in a yoke 12, which is bolted thereto. A commutator 15 is also mounted upon said shaft in the usual manner between the limbs of the field-magnet aforesaid. Brushes 16 and 17, which allow commutator 15 to rotate in either direction, are held in proper positions of contact therewith by their respective brush-holders 18 and 19, which are bolted to opposite sides of said field-magnet, but are insulated therefrom. Said armature-shaft terminates in a worm 46. This motor is fastened to floor 2.

Within the same base 1 and attached to floor 2 is a pole-changer 20, which is shown in Figs. 2, 3, and 7. This pole-changer, which is seen in central vertical section in Fig. 7, comprises an electro-magnet of solenoid form, having helices 21 and 22, which are wound in one and the same direction. The cylindrical core 23 of this magnet is armed at its lower extremity with a projecting insulated copper contact-plate 24 and is perforated by a transverse slot 25. Two insulated strips of copper 26 and 27 are mounted upon the pole-changer magnet within reach of plate 24 and upon opposite sides of the same. A third insulated strip of copper 28 is similarly mounted just above copper 27. A lever 29, which is centrally pivoted in a standard projecting from the bottom of the pole-changer magnet, enters slot 25, and, being provided with a terminal spring 30, tends to depress core 23. Similarly attached to floor 2 in base 1 is a similar solenoid electro-magnet 31, which is shown in a central vertical section in Fig. 6. This magnet has a single helix 32 and a cylindrical core 33, which is perforated by a transverse slot 34, and is armed at the bottom with a projecting insulated copper contact-plate 35. Upon magnet 31 and just below and within reach of plate 35 is mounted an insulated strip of copper 36. A lever 37, which is pivoted in a standard projecting from the bottom of magnet 31, is provided with a lifting-spring 38. This lever passes through slot 34, and, as seen in Fig. 2, forks laterally at one end into two branches, between which is pivoted collar 39.

Within the same base 1 is the lower portion of the feeding-rod 40, which is a straight bar of brass passing loosely through collar 39. As may be seen in Fig. 6, said rod is provided with a stop-collar 41, which rests upon said pivoted collar 39, and with a sleeve 42. This sleeve is journaled in the two arms 43 of a double standard, which is attached by screws to the field-magnet of said electric motor. Said rod and sleeve pass through an insulated aperture in floor 2. A worm-wheel 44, whose hub 45 is located between said arms 43, is mounted immovably upon sleeve 42 in a position of constant engagement with worm 46. A pin 47, which projects radially from rod 40, passes through a longitudinal slot 48 at the lower end of sleeve 42 and through a corresponding slot continuous with slot 48 in a terminal collar 49, which is fastened to sleeve 42 by a set-screw. This pin is adapted to travel from end to end of said slot and to effect a constant engagement of rod 40 with sleeve 42. Said base also contains the lower portion of a contact-rod 50, which passes vertically through an insulated bushing in floor 2. Upon a binding post or standard 52, which depends from floor 2, is mounted a brush 51, which is constantly in contact with rod 50.

Base 1, whose principal contents have now been described, constitutes a portion of the rigid frame of the lamp. The remaining portion of that frame consists of two like vertical brass tubes 53 and 54 and a connecting-yoke 55. The lower ends of these tubes are respectively inserted in bosses on floor 2, while the upper ends of the same are secured to the opposite ends of yoke 55, as shown in Figs. 1 and 5. The middle part of yoke 55, as seen in Fig. 5, contains an insulated hollow brass plug 56, which is adapted to accommodate the upper portion of rod 40 and is supplied with internal brushes 57, which are in continual contact with said rod. The middle part of yoke 55, including plug 56, is covered over by cap 59. The electrical continuity of rod 40 is interrupted by an insulating-joint which is constructed as shown in section in Fig. 11. According to that manner of construction said rod is divided into two parts, one of which is armed with a fixed terminal collar or ring 63, while the other is reduced to the form of a tongue 64, which is provided with a terminal screw-thread. This tongue passes through ring 63 and is separated therefrom by an indefinite number of mica disks or washers 65 and by an intermediate cylindrical air-chamber 66. By means of nut 67 said mica washers are clamped together upon tongue 64 in two groups 65, each of which is partly countersunk in ring 63. That portion of rod 40 which lies between joint 60 and plug 56 is provided with a right-hand screw-thread 61, and in like manner the upper portion of sleeve 42, adjacent to joint 60, is provided with a left-hand screw-thread 62, having approximately one-half the pitch of thread 61, as shown in Fig. 11.

A slight distance above floor 2 sleeve 40 is provided with a joint and locking device, which are exhibited in detail in Figs. 8, 9, and 10. Fig. 8 is a section on the line *s s* in Fig. 10. Said joint is formed like a cylindrical mortise-joint in the following manner: A portion of sleeve 42 is reduced to the form of a cylindrical tongue 68, which is of less diameter than the remaining portion of said sleeve, and another portion 69 of said sleeve is enlarged internally to accommodate said tongue 68. By means of a screw 70, which is firmly seated in shell 69, and whose point extends into a circumferential channel 71 about tongue 68, said tongue 68 and shell 69 are held together in such a manner as to be susceptible of independent axial rotation. Said locking device consists of a locking-sleeve 72, which is shown in detail in Fig. 9, and locking-arms 73 and 74. Arms 74, being two in number, are fastened in sleeve 42, and radiate therefrom diametrically in opposite directions, while arms 73 radiate from shell 69 in pairs in the same manner and are large enough for convenient manipulation. Sleeve 72, being adapted to slip over the described joint in sleeve 42, is provided with numerous equidistant slots 75, which are adapted to accommodate arms 73 and 74. Sleeve 72 is also provided with an annular flange 76 for convenience of manipulation. A stop-pin 77 projects from sleeve 42 in such a position as to prevent sleeve 72 from rising away from arms 73.

A sliding yoke 78 (seen in Fig. 1) is formed on tubes 53 and 54 by means of two like metallic sleeves 79 and an intermediate cross-piece 80, which is rigidly joined to each of said sleeves and is insulated therefrom by annular laminations of mica 81, applied in the manner illustrated in Fig. 12. Yoke 78 is provided with a device for effecting an engagement with thread 61 on rod 40. This engaging device, consisting of a tubular enlargement of cross-piece 80 and a sliding engagement-block 82, which is inclosed therein, is seen in central vertical section in Fig. 14. Block 82, which is threaded on one side as a female screw for engagement with thread 61, is located in a chamber 83 at one side of rod 40 and is provided with a spring which tends to produce an engagement between said block 82 and rod 40. This block is hollow and contains a cam 85, which is pivoted in cross-piece 80, and is provided with a finger-piece 86, which is seen in Fig. 1, and with a spring 87, which is seen in Fig. 14. Cam 85 is adapted to engage a re-entrant shoulder within the hollow interior of block 82. Yoke 78 is provided with an arm 88, carrying a carbon-holder 89, which is of any approved construction and supports in a vertical position the upper and positive carbon 90. A second sliding yoke 91, similar to yoke 78, is formed on tubes 53 and 54 by means of sleeves 92 and cross-piece 93, as seen in Fig. 1, and is provided with a device similar to that which has just been described for effecting the en-

gagement and disengagement of yoke 91 with thread 62 of sleeve 42. Yoke 91 is provided with an arm 92, which is similar and parallel to arm 88 and carries a carbon-holder 93. This holder, which is seen in central vertical section in Fig. 13, consists of an internal cup 95, which contains the lower end of the lower and negative carbon 94. This cup is separated from the other parts of the holder by any proper insulation 96 and is provided with an insulated set-screw 97 and with said contact-rod 50, which is insulated from floor 2. Such being the elements of said lamp, the appropriate electrical connections are delineated in Fig. 15. Terminal 3 is connected with copper 26 by wire 98 and with helix 12 by wire 99. Brush-holder 19 is connected with helices 12 and 13 by wires 100 and 101, respectively. Helix 32 is connected with helix 13 and plug 56 by wires 102 and 103, respectively. Helix 13 is also connected by said wire 102 and by wire 104, branching therefrom, with helix 21, which is connected by wire 105 with copper 36. Terminal 4 is connected with bracket 52 by wire 106 and with copper 35 by wire 107. Copper 27 is connected by wire 108 with said wire 102. Copper 28 is connected by wire 109 with plug 56 and copper 24 by wire 110 with holder 18. Helix 22 is connected with terminals 3 and 4 by wires 111 and 112, respectively. By means of terminals 3 and 4 the lamp is placed in circuit with a generator in the usual manner.

This lamp further contains all other features and particulars of construction which are necessarily involved in its mode of operation, which is now to be explained. When no current is supplied to the lamp, lever 37 occupies the position shown in Fig. 6, and coppers 35 and 36 are consequently in mutual contact. At the same time lever 29 is deflected to such a position that coppers 24 and 26 are also held in mutual contact. If now in this position of affairs a normal current be supplied from the generator, that current passes from terminal 3 in two principal courses, as follows, viz: One principal portion of said current passes by wire 98 to copper 26, thence immediately to copper 24, thence by wire 110 to holder 18, thence successively through brush 16, commutator and armature 14 and 15, and brush 17 to holder 19, and thence onward in a course which will be presently described. A second principal portion of said current passes from terminal 3 through wire 99, helix 12, and wire 100 to said holder 19. The current so conducted in two courses to holder 19 thence passes through wire 101 and helix 13 to wire 102, and there divides into two portions, one of which goes successively through helix 32, wire 103, plug 56, brushes 57, rod 40, yoke-arm 88, holder 89, carbons 90 and 94, holder 93, rod 50, brush 51, standard 52, and wire 106 to terminal 4, while the other portion of the same passes successively through wire 104, helix 21, wire 105, coppers 36 and 35, and wire 107 to the same terminal 4. At the same time an inappreciable part of the current which is supplied passes between said terminals by the way of wires 111 and 112 and helix 22. This distribution of current, however, is but momentary, for the passage of current through the pole-changer and helix 32, as described, energizes those devices in the following manner. The action of magnet 31 instantly causes the above-mentioned portion of current passing through helix 21 to be interrupted by the separation of coppers 35 and 36. Lever 37 of magnet 31 then comes into engagement with stop-collar 41 by means of pivoted collar 39, and so lifts rod 40, yoke 78, and carbon 90 until the latter is separated from carbon 94 by a distance which slightly exceeds their normal separation. Under the action of helix 22 of the relay-magnet copper 24 is separated from copper 26 and is brought to contact with copper 27, as seen in Fig. 7. This interrupts the current which flowed in the above delineated course through armature 14 and allows current to pass from holder 19, through brush 17, through armature and commutator 14 and 15 in a reverse direction, and thence successively through brush 16, holder 18, wire 110, coppers 24 and 27, and wire 108 to wire 102. Said motor, acting upon sleeve 42, through worm 46 and worm-wheel 44, rotates that sleeve in such a direction as to move yoke 91 upward. Sleeve 42 and hub 45, engaging rod 40 by pin 47 and slot 48, rotate that rod in such a direction as to slide yoke 78 downward. Said sliding yokes, carrying said carbons, continue to approach each other in the described manner and at unequal rates of speed, dependent upon the described pitch of screw-threads 61 and 62, until the separation of said carbons is reduced to the normal length of the arc for which the lamp is adjusted. Through the diminished electro-magnetic efficiency of the pole-changer magnet the mutual contact of coppers 24 and 27 is then in turn interrupted and the motor stops. If the carbons should be at a distance from each other when the lamp is started up, the upper carbon will be carried downward and the lower carbon will be carried upward as far as may be necessary, in the manner just described and with the same result, and whenever during the operation of the lamp the carbons become unduly separated through the ordinary consumption of the same, or through any other cause, the consequent increase of resistance in the carbon-circuit so increases the current through helix 22 that coppers 24 and 27 are brought together again, and the motor is again brought into operation, in the same manner and with the same effect as before; but whenever the carbons approach too near to each other the electro-magnetic efficiency of the pole-changer magnet is reduced, contact is made again between coppers 24 and 26, current passes again through armature 14 in the course first-above described, the motor is reversed, slides 78 and

91 separate, and thus the normal separation of the carbons is restored. If any stoppage occurs in the operation of the lamp, and if said carbons in consequence remain unduly separated, the energy exerted by the pole-changer magnet is increased, and copper 24, pressing upward with unusual force against the bottom of copper 27, bends the latter to a position of contact with copper 28. The current from wire 102, through helix 32 and wire 103 to plug 56, is thus short-circuited by the way of wire 108, coppers 27 and 28, and wire 109 to plug 56, and magnet 31 is inactive. Copper 35 consequently falls to contact with copper 36, and thus the carbon-current is short-circuited through the field-magnet helices and the armature of the motor and through pole-changer helix 21. The pole-changer magnet then holds coppers 24 and 27 in mutual contact, as above described, and the carbon-current remains short-circuited, as described, so long as the stoppage continues. If through accident or inattention the carbons, having run by, should be found partly side by side when current is supplied to the lamp, the motor will feed backward until said carbons are duly separated in the manner already described.

By means of the mechanism whose operation has now been described said carbons are fed together at approximately the same rates of speed at which they are respectively consumed, and hence the position of the voltaic arc is rendered practically uniform so far as respects all variations which might result from the unequal but uniform consumption of said carbons. If any unequal hardness in said carbons, or in either of them, or any other irregularity, should cause said arc to remove from its normal position, the focus is restored in the following manner: Sleeve 72 is raised by hand so as to be clear of arms 74, and then the upper section of sleeve 42, carrying yoke 91, is rotated independently both of rod 40 and of the lower section of sleeve 42 by means of arms 73 until the lower carbon-point is raised or lowered, as the case may require, to its normal position. The upper and lower sections of sleeve 42 are then locked together again by means of sleeve 72, as shown in Fig. 1. During the operations of raising and lowering said lower carbon by hand, as just described, the upper carbon, moving upward or downward in the manner already described, maintains its normal separation from said lower carbon.

Having now described the construction and operation of my improved lamp, I claim as my invention—

1. In an electric-arc lamp, a rotary sleeve consisting of two parts which are provided with radiating pins or arms and are united by a joint allowing independent rotation of said parts, in combination with a locking-sleeve which surrounds said rotary sleeve and is adapted to engage said pins, substantially as and for the purpose specified.

2. In an electric-arc lamp, a rotary feeding-rod and a surrounding sleeve consisting of two parts which are united by a joint allowing independent rotation of said parts, in combination with mechanism for locking said parts together, substantially as and for the purpose specified.

3. In an electric-arc lamp, a rotary feeding-rod, a surrounding sleeve consisting of two parts which are susceptible of independent rotation, and mechanism for locking said parts together, in combination with carbon-carrying mechanism which is adapted to engage said rod and sleeve, substantially as and for the purpose specified.

4. In an electric-arc lamp, a feeding-rod, a surrounding sleeve composed of two independently-rotatable parts, one of which is fastened to said rod, mechanism for locking said parts together, and an electric motor which is adapted to rotate said rod and sleeve, in combination with carbon-carriers which engage the same, substantially as and for the purpose specified.

5. In an electric-arc lamp, a rotary feeding-rod which is provided with a screw-thread, a surrounding sleeve consisting of two independently-rotatable parts, one of said parts being provided with a screw-thread and the other of said parts being fastened to said rod, mechanism for locking said parts together, an electric motor, and a worm and worm-wheel, whereby said motor engages said sleeve, in combination with carbon-carriers engaging said rod and sleeve by means of said threads, substantially as and for the purpose specified.

6. In an electric-arc lamp, two carbon-carrying slides, an electric motor which is provided with a worm, a feeding-rod which is provided with a screw-thread engaging one of said slides, and a sleeve which is located upon said feeding-rod, and is provided with a worm-wheel engaging said worm and with a screw-thread engaging the other of said slides, in combination with an electro-magnet and intermediate lifting mechanism between said electro-magnet and said feeding-rod, substantially as and for the purpose specified.

7. In an electric-arc lamp, two movable carbon-carriers, a reversible electric motor having two field-magnet helices, an electric switch having one of its points connected to the field-magnet circuit on one side of said helices and having a second point connected to said circuit on the other side of said helices, and a connection from said switch to said circuit at a point between said helices, said connection containing the armature of said motor, in combination with an electro-magnet actuating said switch and intermediate driving mechanism between the armature-shaft of said motor and said carriers, substantially as and for the purpose specified.

8. In an electric-arc lamp, two carbon-carrying slides, a reversible electric motor, a feeding-rod which engages one of said slides

by means of a screw-thread, a feeding-rod sleeve which engages said motor by means of a worm and worm-wheel and engages the other of said slides by means of a screw-thread, in combination with a three-point pole-changer having two helices which are located in shunt-circuits about the carbons of said lamp and an electro-magnet which engages said feeding-rod by means of intermediate lifting mechanism and is provided with circuit-breaking mechanism which is applied to one of said shunt-circuits, substantially as and for the purpose specified.

9. In an electric-arc lamp, two carbon-carrying slides, a reversible electric motor, intermediate converting mechanism whereby said motor engages said slides, a three-point pole-changer controlling said motor and having two helices located in shunt-circuits about the carbons of said lamp, in combination with a lifting-magnet which is provided with a circuit-breaking mechanism applied to one of said shunt-circuits, substantially as and for the purpose specified.

10. In an electric-arc lamp, two carbon-carrying slides, an electric motor which is provided with a worm, a feeding-rod which is provided with a screw-thread engaging one of said slides, and a feeding-rod sleeve which is provided with a worm-wheel engaging said worm and with a screw-thread engaging the other of said slides, in combination with an electro-magnet which is provided with lifting mechanism and with circuit-breaking mechanism, substantially as and for the purpose specified.

11. Upon the feeding-rod of a focusing electric-arc lamp, a sleeve formed of two independently-rotatable parts which are provided with pins radiating therefrom, in combination with a locking-sleeve which is provided with slots for the accommodation of said pins, substantially as and for the purpose specified.

In testimony whereof I have hereunto signed my name in the presence of two witnesses.

RICHARD H. MATHER.

Witnesses:
W. M. BYORKMAN,
WILLARD EDDY.