No. 792,076. PATENTED JUNE 13, 1905.

R. H. READ.

ELECTRIC ARC LAMP.

APPLICATION FILED OCT. 10, 1902.

2 SHEETS—SHEET 1.

Fig. 1.

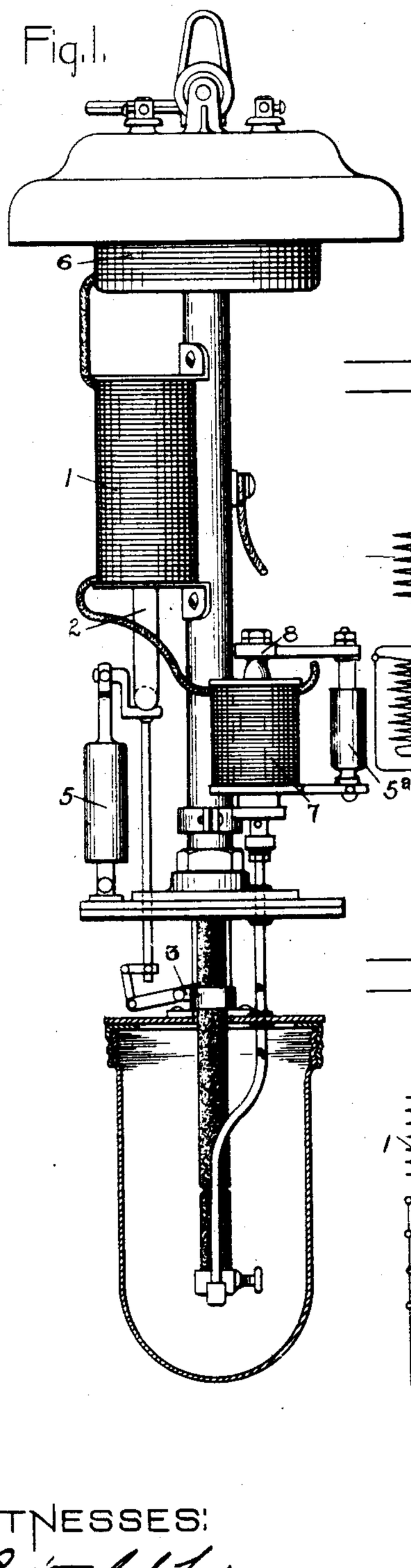

Fig. 2.

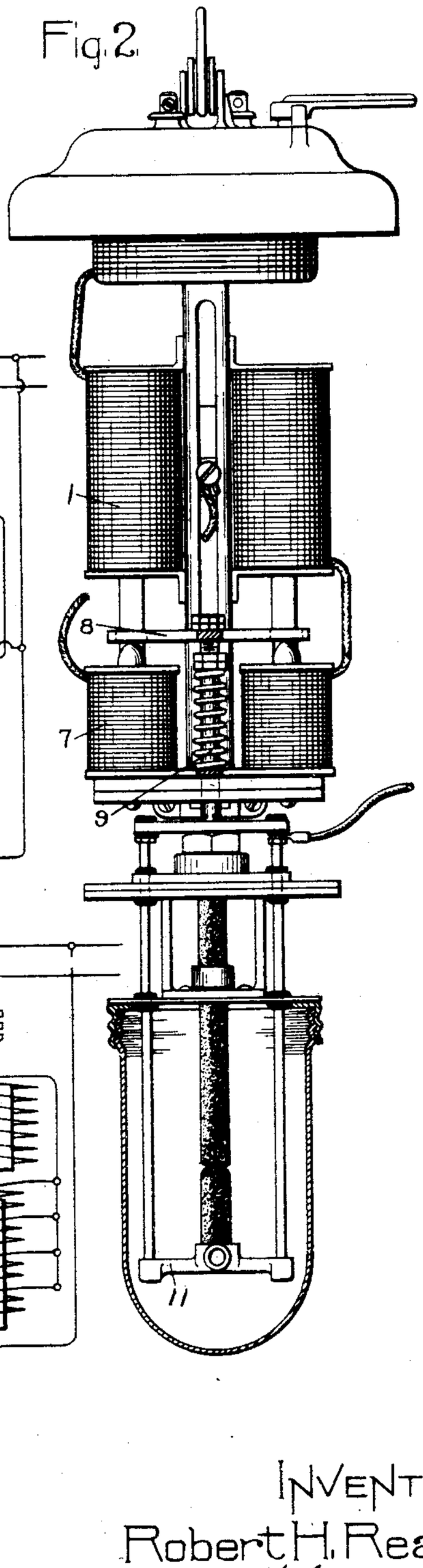

Fig. 4.

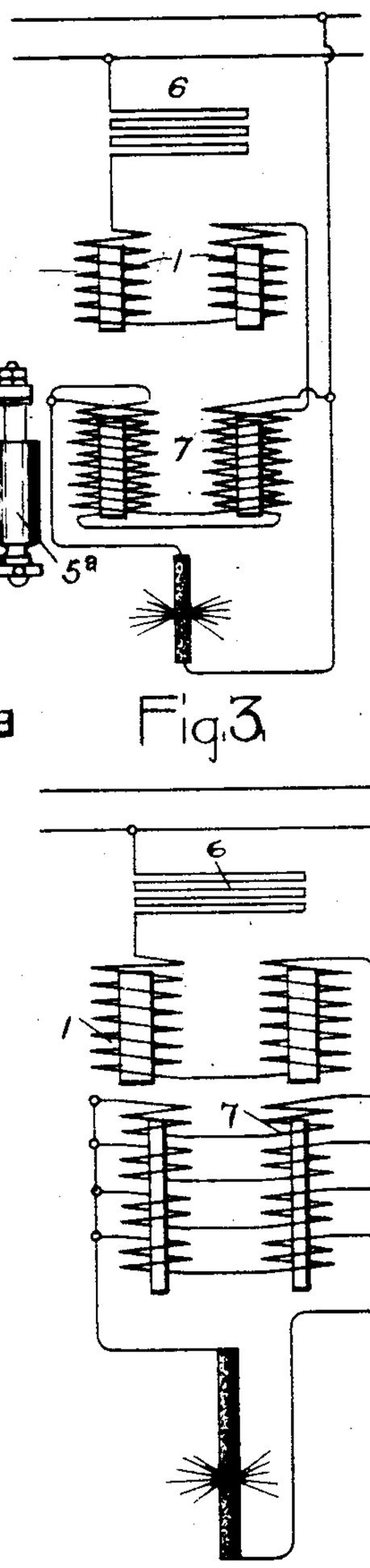

Fig. 3.

WITNESSES:

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Helen Oxford

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Atty.

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2 SHEETS—SHEET 2.

Fig. 5.

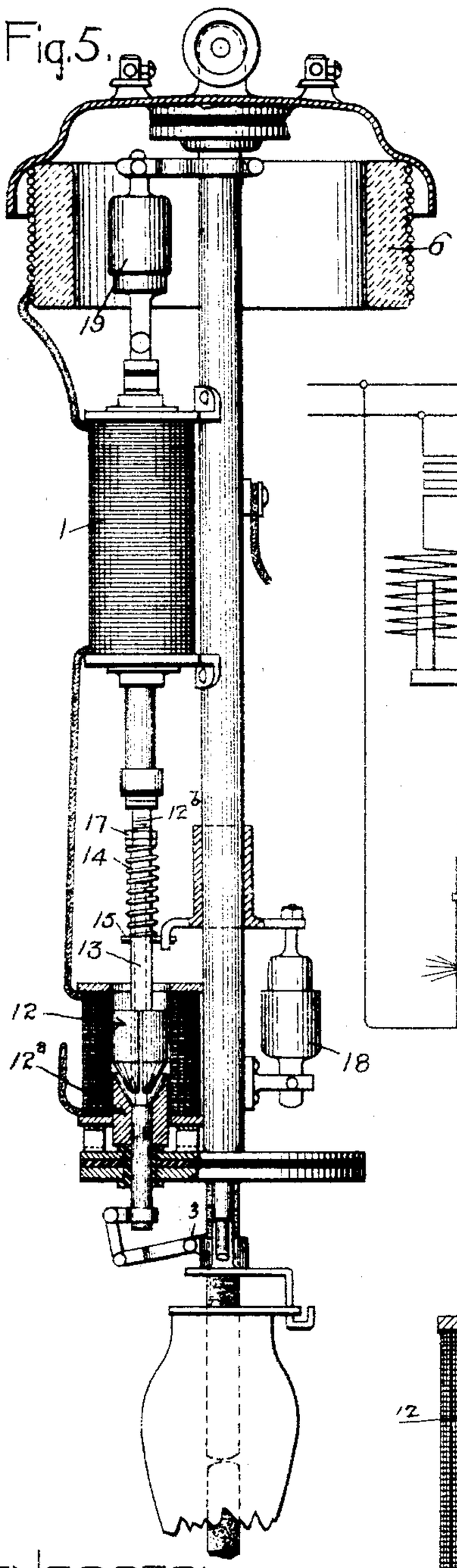

Fig. 6.

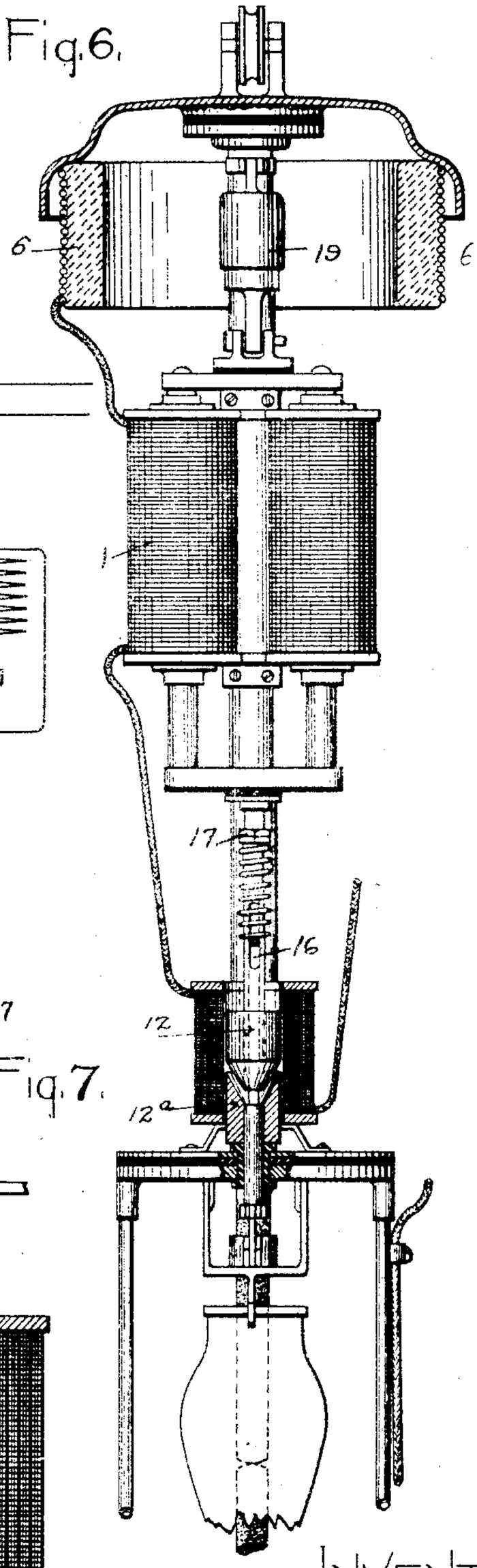

Fig. 8.

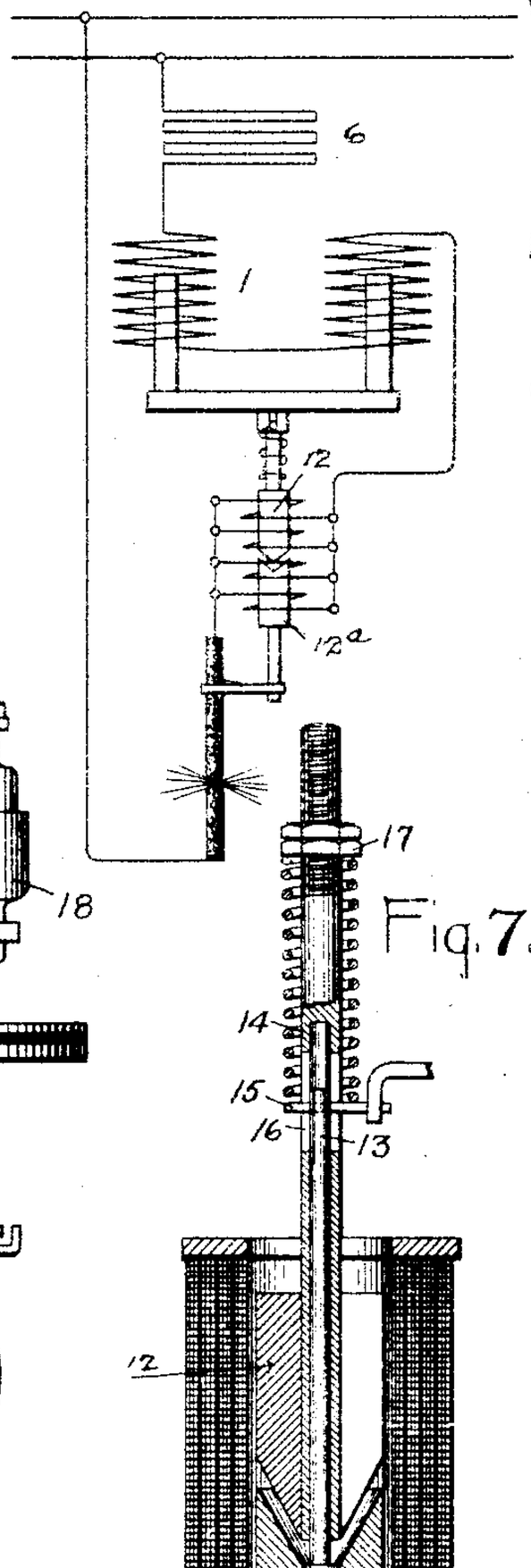

Fig. 7.

WITNESSES:

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INVENTOR:

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No. 792,076. Patented June 13, 1905.

UNITED STATES PATENT OFFICE.

ROBERT H. READ, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 792,076, dated June 13, 1905.

Application filed October 10, 1902. Serial No. 126,668.

To all whom it may concern:

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

In using electric-arc lamps on circuits of constant potential it is the common practice to connect a considerable dead resistance in series relation to the lamp. As lamps are commonly constructed this is found necessary to steady the arc, as without the auxiliary resistance almost the entire drop of electromotive force in the lamp is across the arc, creating such a considerable change of voltage under imperfections of the carbons or when a fluctuation at the line-terminal occurs that the arc is suddenly extinguished and the lamp must restart. An absolutely pure carbon permits a smaller external resistance to be employed than when the carbon is not pure or homogeneous; but even omitting every consideration of changes of voltage due to such cause the changes at the line-terminals must be contended with. The employment of a considerable idle resistance ameliorates these interfering conditions by absorbing a considerable portion of the drop across the lamp-terminals, and thus rendering the voltage fluctuation at the arc of smaller value. The employment of such a resistance, however, is objectionable from an economical standpoint as wasting in heat a considerable amount of energy absorbed by the lamp.

It is the object of this invention to partially dispense with this resistance, so that a smaller resistance may be employed than has commonly been the case, thereby permitting a larger proportion of the energy consumed by the lamp to be dispensed in the arc and increasing the lighting efficiency.

One of the chief structural features which renders necessary in the usual form of constant-potential lamp the steadying resistance is the sluggish action of the arc-regulating mechanism, due principally to the sluggishness of the regulating-coil, a large current variation being necessary to permit the regulating-cores to change position. I overcome this difficulty by employing regulating mechanism of peculiar construction.

One feature of my invention involves the employment of an auxiliary quick-acting magnet of short time constant to store energy in a spring when the arc is struck, holding the arc-adjusting device under stress, so that a very small range of current variation will permit the spring to respond and shorten the arc. Thus in case the voltage at the arc approaches the danger limit where extinguishment is likely to result the current declines, the magnet of low time constant is weakened, and the strained spring instantly reacts and shortens the arc. This quick-acting auxiliary regulating-magnet may be employed to assist the main regulating-coil in acting upon the positive carbon, or may be independently employed to regulate the negative carbon and may be excited alone by the current or a part of the current which passes through the lamp, or excited by a differential shunt-current around the arc in addition to the series current. With an organization of this kind a lamp may be burned at a much closer point to the line voltage than usual and the economy of its operation considerably enhanced.

The novel features of the invention reside in the employment of a regulating-magnet of short time constant in addition to or in coöperation with the main regulating-magnet of the lamp.

It comprises also the employment, together with an arc-striking magnet, of a part of relatively small inertia, in which energy is stored when the lamp is burning, ready to quickly respond on a slight decline of current in the lamp.

It comprises also other features of novelty, which will be more particularly hereinafter described, and will be definitely indicated in the claims appended to this specification.

In the accompanying drawings, which illustrate the invention, Figure 1 is a side elevation, partly in section, of an inclosed arc-lamp embodying my improvements. Fig. 2 is a view, similar to that of Fig. 1, on a plane at right angles to that of said figure. Fig. 3

is a diagrammatic illustration of the lamp of Figs. 1 and 2. Fig. 4 is a diagrammatic illustration of a modification. Fig. 5 is a side elevation, partly in section, of a lamp in which the regulation is effected solely by the movement of the positive electrode. Fig. 6 is a view at right angles to that of Fig. 5. Fig. 7 is an enlarged sectional detail of the lamp of Figs. 5 and 6, and Fig. 8 is a diagram of the circuits of said lamp.

Referring first to Figs. 1, 2, 3, and 4, 1 represents the main regulating or lifting magnet, comprising two spools acting on the U-shaped core 2 and connecting, through a clutch 3, with the positive carbon, a dash-pot 5 being connected between the core and the frame. 6 represents a small steadying resistance, which may absorb from eight to ten per cent. of the drop across the lamp-terminals. 7 represents an auxiliary magnet of short time constant. As shown in these drawings, this magnet is provided with iron cores and a yoke on the lower side, the pole-tips being tapered, as seen in Fig. 2, to coöperate with an armature 8, mounted so as to have a true vertical movement against a helical spring 9, a set-screw and jam-nut being employed to adjust the tension of the spring. This tension should be sufficient to cause a quick lift of the lower carbon, which is mounted in a yoke 11, rigidly connected, through connecting-rods, with the armature. Where an inclosure around the arc is provided for the lamp, these rods may be worked through lava or other refractory insulating-bushings mounted in the globe-cover, as indicated in the drawings. In order to prevent too quick striking of the arc when the lamp-circuit is first closed, I prefer to employ also an additional dash-pot 5^a to govern the regulation due to the additional magnet 7. As thus organized the main function of the magnet 1 is to strike the arc. It is therefore given a long range of lift, whereas the regulating-magnet 7 need have only a short stroke. Small and quick fluctuations of current, whether due to hard spots or irregular conducting spots in the carbon or to fluctuations of line voltage, are compensated by the magnet 7, the lifting-magnet 1 being too slow to respond to any except very considerable ranges of voltage. The energy stored in the spring 9 conduces toward rendering the auxiliary magnet quick-acting; but this effect may be enhanced by a special form of magnet construction, as by giving the latter a short core, by laminating its core, and by exciting it by a number of parallel branches of the regulating-circuit. Besides this the weight of the parts which effect the regulation is less than where the heavy arc-striking core must also be moved. There is therefore much less mechanical inertia to be overcome in regulation. Fig. 3 shows this arrangement. Any form of construction which renders the magnet more quickly responsive to demagnetization or which quickens the response of the shortening of the arc may be employed within the lines of the invention. It will be observed that both carbons float freely in obedience to their magnets, the one straining a spring to insure quick regulation on decline of current. In Fig. 4 the time constant of the magnet is reduced by giving it a differential winding, one branch being in series with the arc and the other in shunt. The response of a magnet of this kind is particularly prompt, as a decline in current strength due to increase of arc resistance causes also a rise of current strength in the shunt-coil, the magnitude of the demagnetizing effect on the magnet being thereby doubly enhanced.

In Figs. 5, 6, 7, and 8 I have shown my improvements as applied to a lamp in which the regulation is effected entirely through the positive electrode. In this type I place between the arc-striking magnet-core and the clutch a sectional core $12\,12^a$, operating within the field of the auxiliary regulating-magnet of short time constant, one member of this core, as 12, being secured to a rod 12^b, forming a firm attachment of the core of the lifting-magnet, and the other being connected to a rod 13, moving within a tubular part of the rod and acting against the helical compression-spring 14 by means of a pin 15, secured to the rod and projecting through slots 16 in the side of the tube. The core-sections $12\,12^a$ are tapered conically at their confronting ends and are slotted, as indicated in Figs. 5 and 7, to prevent sluggishness due to Foucault currents in the cores. An adjusting-nut 17, coöperating with a suitable jam-nut, is provided to vary the tension of the spring 14. A dash-pot 18 is provided to prevent too sudden striking of the arc due to a quick shortening of the sectional core, and a dash-pot 19, as usual, for the lifting-magnet. It will be noted that here also both parts of the arc-governing system—that which strikes the arc and that which regulates it—float in a magnetic field. On first closing the lamp-circuit the auxiliary magnet is first to respond; but its governing dash-pot prevents too sudden separation of the carbons, and therefore insures the proper heating of the carbon-points before the arc is drawn. The slower lifting-magnet is then acting on its core, and the arc is lengthened to its full limit. At the same time the spring of the auxiliary magnet has been put under stress, and the auxiliary magnet has been assisting the main lifting-magnet in separating the carbons. On a fluctuation of voltage in the arc, due to any cause, the magnet of short time constant permits its core to lengthen in obedience to the reaction of the control-spring and the arc is quickly shortened, an increase of current effected, and a greater volatilization of carbon, and therefore a better condition for the maintenance of the arc, promoted. It will be no-

ticed that in this organization the advantages of the spring are obtained without an increased effort on the part of the lifting-magnet, and therefore without any detraction from the length of the arc. Control-springs have heretofore been employed in lamps, but mainly in such a way as to operate against the length of the arc. In arc-lamps, particularly of the inclosed type, it is desirable to burn the arc at as great a length as possible in order to increase the zone of illumination and prevent shadows.

One distinctive feature of the invention is the reduction of the inertia of the arc-adjusting parts without interfering with the freedom of the arc-striking magnet to draw a long arc, and I wish it understood that this feature may be carried out with other magnetic systems than those shown, any magnetic system which stores energy in a quickly-movable arc-regulating part of the lamp without reducing the arc length falling within its scope. For example, the sectional core might move within the main arc-striking solenoid. Modifications will easily occur to those skilled in the art.

The arc-regulating device can move over the range of arc length and is always ready to respond instantly to small variations of current such as would not effect regulation through the lifting-solenoid except sluggishly. I term this a "floating regulator," since the quick-regulating device can move over or be floated through the arc length by the lifting-magnet and at any stage of its movement can respond independently of the lifting effort of the main magnet. In the type shown in Fig. 2 this result is effected by the sectional lifting system and in the type shown in Fig. 5 by the sectional core governing the negative electrode.

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

1. An electric-arc lamp having a lifting-magnet and armature for the movable carbon, and means responsive to the lamp-current for regulating the arc length, said means being movable independently of the position of the armature and the lifting-magnet.

2. An electric-arc lamp having electrodes relatively movable to strike the arc, an arc-striking magnet, a movable element of small inertia to regulate the arc, and means for storing energy during normal operation to act on said element to shorten the arc.

3. An electric-arc lamp having an arc-striking magnet, an armature, an electrode governed thereby, and means responsive to minor current variations for regulating the arc length independently of the armature.

4. An electric-arc lamp having a floating arc striking and regulating mechanism, the regulating element being sectional and adapted to store energy when the arc is struck to insure quick response independent of the lifting element when current declines.

5. An electric-arc lamp provided with a lifting-coil and armature having a long range of movement and a short-range regulating-magnet of relatively shorter time constant both acting simultaneously to regulate the arc.

6. An electric-arc lamp provided with a lifting-coil and core having a long range of movement, a short-range regulating-magnet of relatively shorter time constant both acting on the arc, and a spring opposing only the short-range magnet.

7. An electric-arc lamp provided with two operating-magnets, one of long range to strike the arc, and the other of short range and of relatively short time constant to regulate the arc, both magnets acting continuously and simultaneously on the arc both responsive to the energy consumed in the lamp.

8. An electric-arc lamp provided with two arc-regulating magnets, one of long range to strike the arc, the other of short range to adjust it, both acting simultaneously in response to energy consumed in the lamp, a spring opposing the short-range magnet, and an adjusting device for varying the tension of the spring.

9. A constant-potential electric-arc lamp provided with two arc-regulating magnets, one of long range to strike the arc, the other of short range to adjust it, both acting simultaneously in response to the energy consumed in the lamp, and a small steadying resistance in series with the lamp.

10. An electric-arc lamp provided with two arc-regulating magnets, one of long range and the other of short range both responsive to energy consumed in the lamp, a spring strained by the latter, and a dash-pot acting in conjunction with each magnet.

11. An electric-arc lamp having two arc-regulating magnets, and a two-part regulating mechanism, said magnets both acting simultaneously and independently of said parts.

12. An electric-arc lamp provided with means for striking the arc, a sectional carbon-lifting mechanism, a spring acting between the sections, means for establishing the arc, and an arc-regulating magnet for putting the spring under stress.

13. An electric-arc lamp provided with means for striking the arc, a sectional carbon-lifting mechanism, a spring acting between the two sections, means for establishing the arc, a regulating-magnet for straining the spring, and a dash-pot for damping the straining movement of the spring.

14. An electric-arc lamp provided with two arc-regulating magnets acting tandem on the same carbon-lifting mechanism, a sectional core in said lifting system controlled by one magnet, a spring governing the core-sections, and a dash-pot for damping the straining movement of the spring.

15. An arc-lamp provided with a long-range magnet, a sectional core between said magnet

and the lamp-clutch, a spring acting between the core parts, and a magnet of short time constant for straining the spring.

16. An arc-lamp provided with a long-range magnet to strike the arc, a sectional core between said magnet and the lamp-clutch, a spring tending to separate the core parts, a magnet of short time constant responsive to energy consumed in the lamp for straining the spring, and means for damping the movements of the clutch.

17. An arc-lamp provided with an arc-striking magnet, a regulating-magnet having a sectional core and a spring tending to separate the core-sections, said core-sections telescoping into one another.

In witness whereof I have hereunto set my hand this 8th day of October, 1902.

ROBERT H. READ.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.