No. 699,225. Patented May 6, 1902.

J. S. NOWOTNY.

ELECTRIC ARC LAMP.

(Application filed Mar. 19, 1896.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

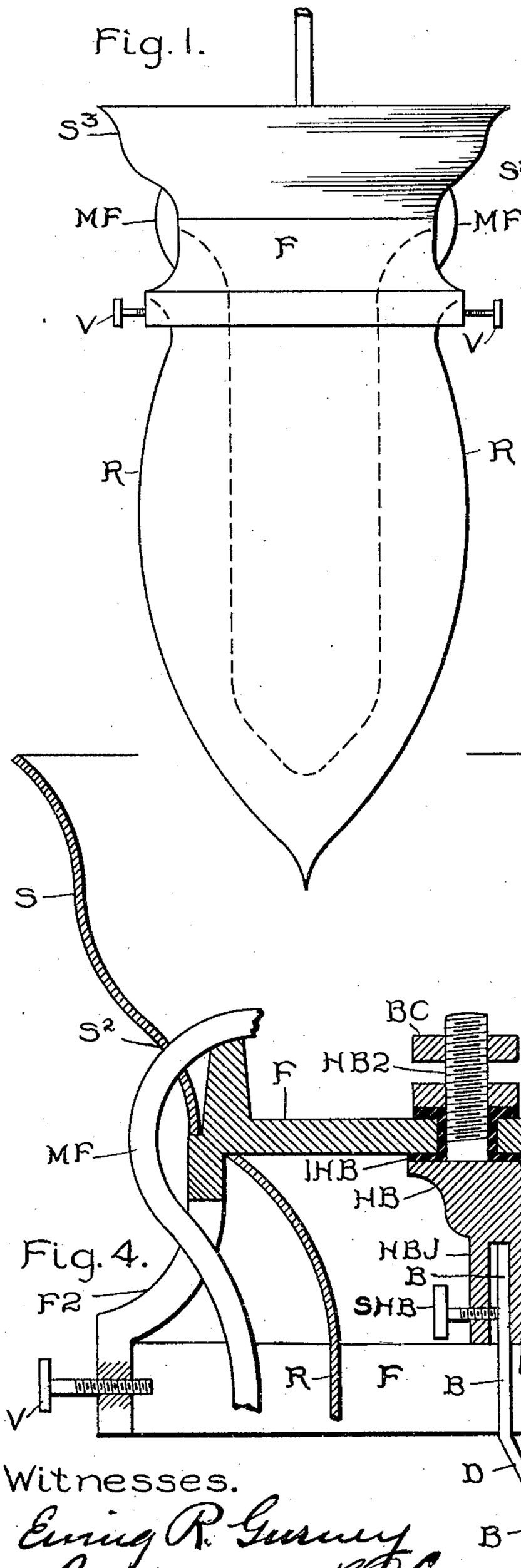

Fig. 3.

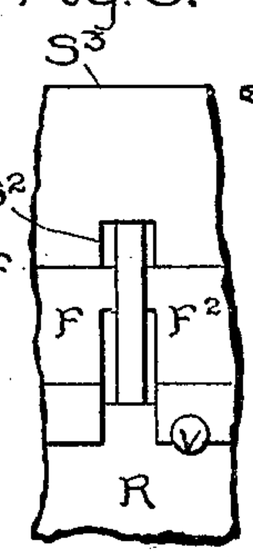

Fig. 2.

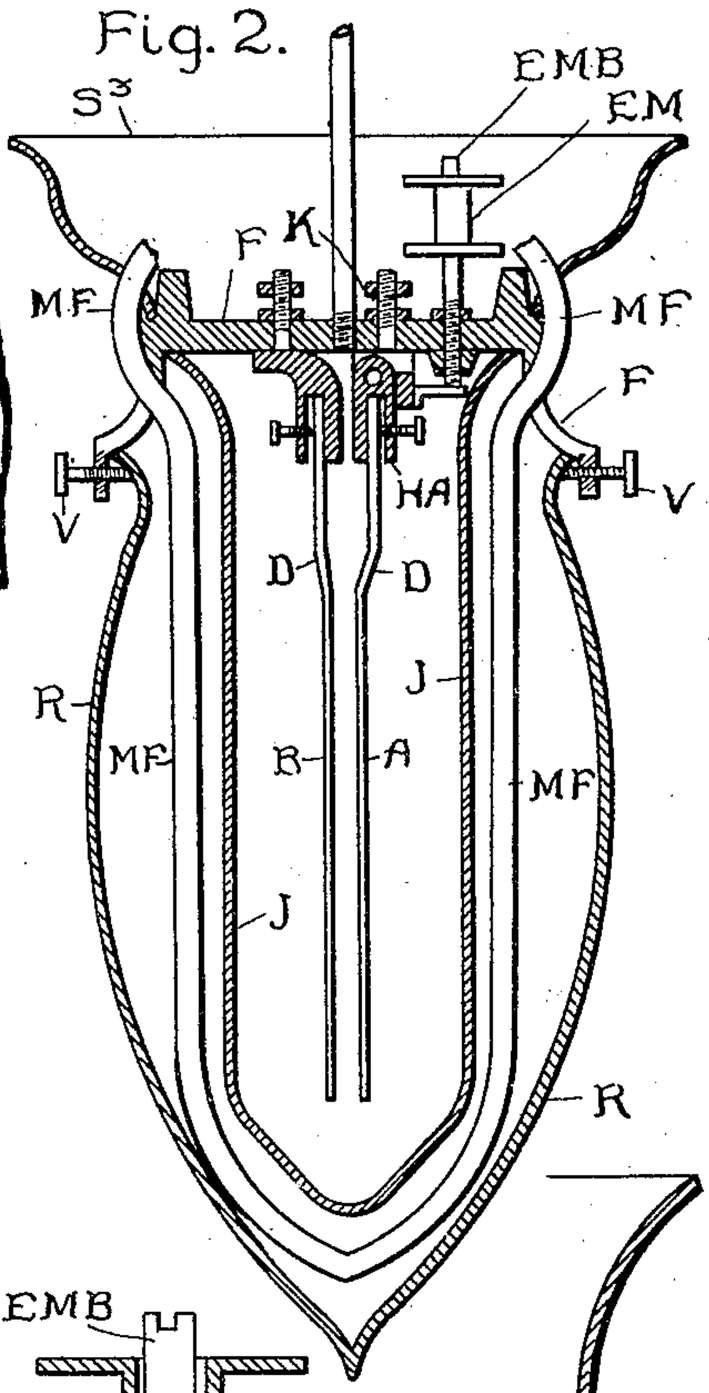

Fig. 4.

Witnesses.

Ewing R. Gurney

Benjamin B. Hines.

Inventor.

John S. Nowotny.

by Allen G. Dorr

Atty.

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Fig. 6.

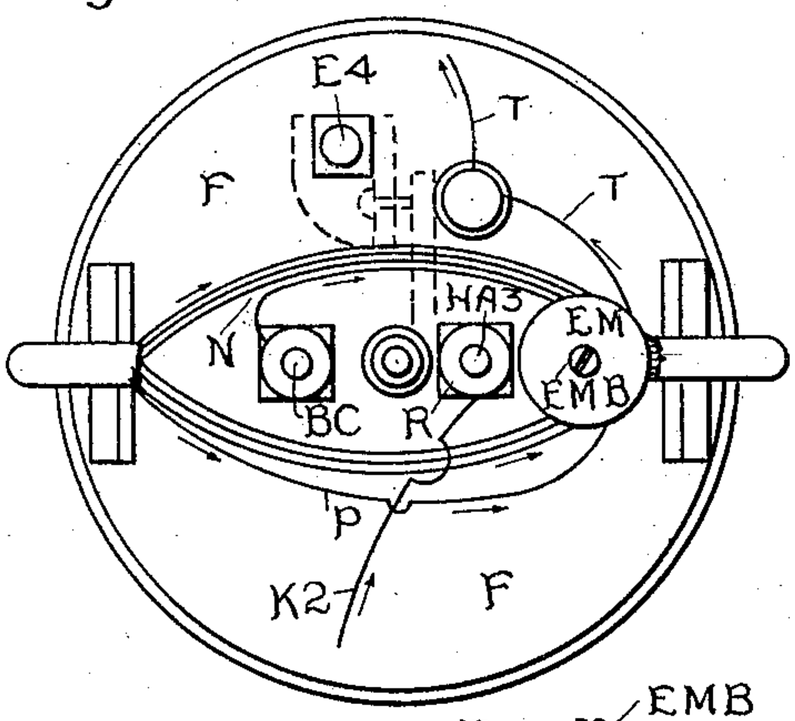


Fig. 8.

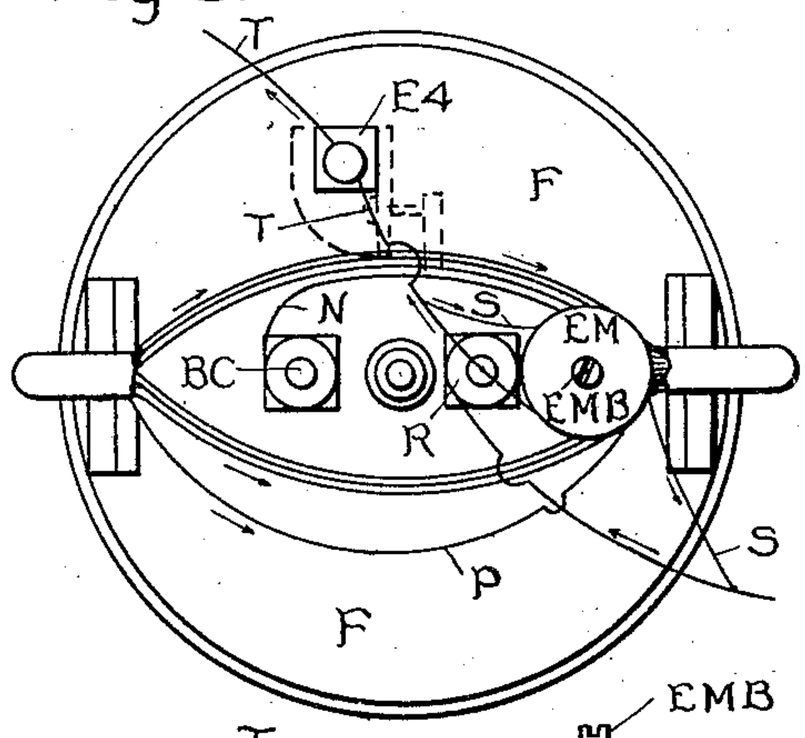


Fig. 5.

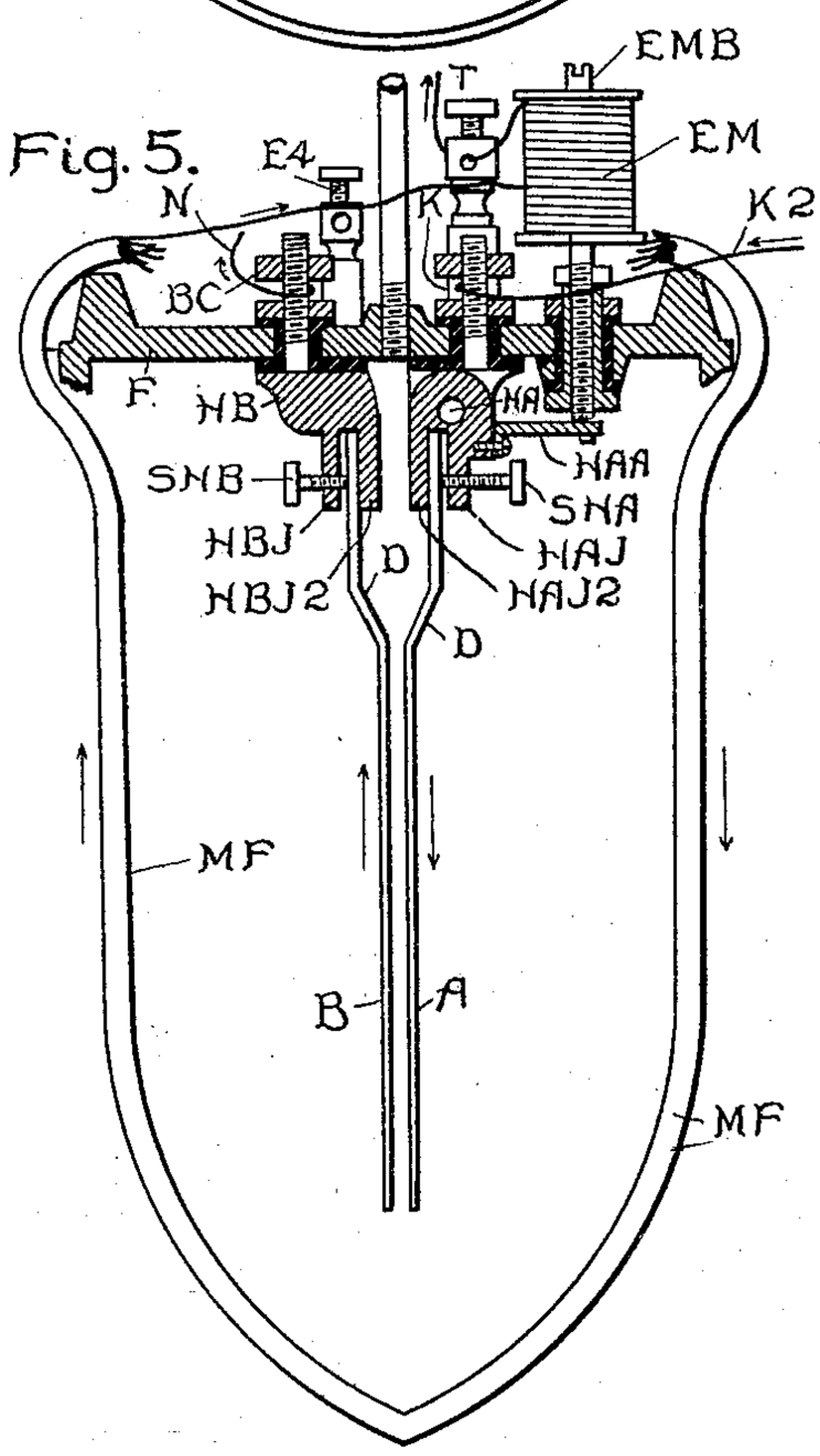


Fig. 7.

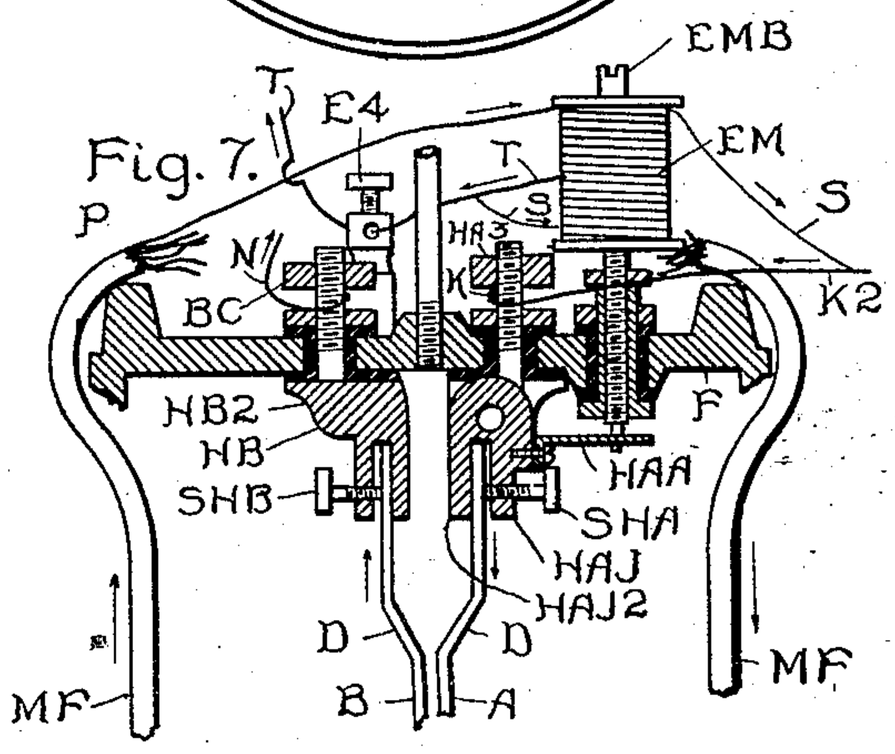
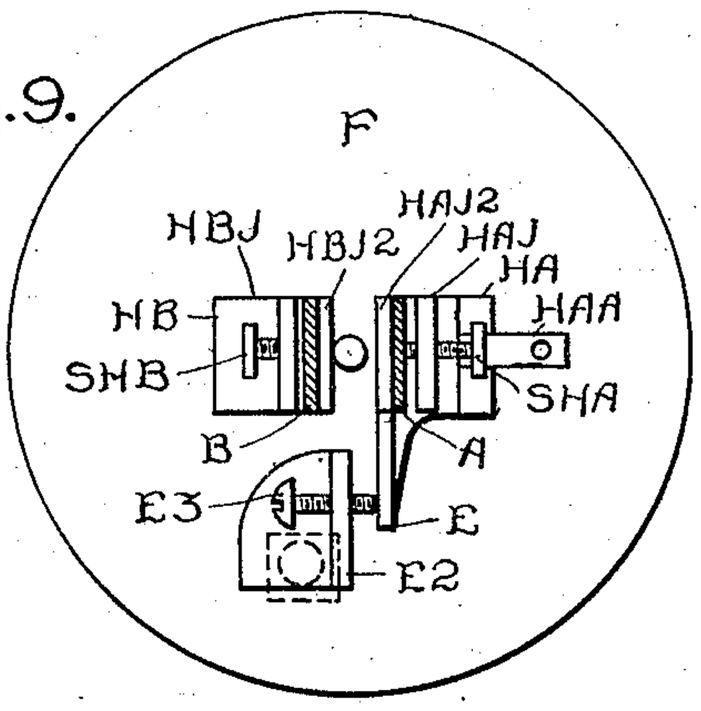


Fig. 9.



Witnesses.
Erving P. Gurney
Benjamin B. Hicks.

Inventor.
John S. Nowotny.
by Allen & Dana
Atty.

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. 699,225, dated May 6, 1902.

Application filed March 19, 1896. Serial No. 583,887. (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.

Among the various objects of my invention may be mentioned the following: First, the production of a lamp which is economical to manufacture; secondly, to provide a lamp of exceeding simplicity of construction; thirdly, to produce a lamp of light weight; fourthly, the production of a lamp economical in its consumption of electrical energy and in its consumption of the article upon which that energy is used in the production of light—to wit, the carbon or the substance used instead of it—at the arc; fifthly, to furnish a type of lamp which can be constructed successfully and economically to operate at smaller or greater candle-power than the arc-lamps heretofore in general use; sixthly, to furnish a lamp which when once adjusted shall be accurate and substantially unerring in its operation and wholly reliable, whose candle-power shall be uniform and steady; seventhly, to provide a lamp which shall cast little or no shadow in the direction in which the light is to be thrown; eighthly, to provide a lamp in which a given amount of carbon shall last for a much longer time than in any of the ordinary types; ninthly, to furnish a lamp capable of being used with the various kinds of electrical currents and under the various electrical conditions that other arc-lamps can be used and also under conditions in which other arc-lamps cannot be used—to wit, under and subject to great vibration in the body or thing supporting the lamp—thus making my lamp advantageous for use in locomotive-engines and in connection with a large class of vibratory mechanism and devices, and in the tenth place to furnish a lamp having various other additional advantages, as hereinafter mentioned.

In the accompanying drawings, making a part of this specification, and in which similar letters of reference indicate corresponding parts, Figure 1, Sheet 1, is an exterior elevation of a lamp illustrating my invention. Fig. 2, same sheet, is a view of the same lamp, the view being in general a transverse vertical section, some of the parts being shown in elevation and some parts being omitted from this view. Fig. 3 is an outside elevation of certain details—to wit, of portions of the globe, lower outer globe and connections, and of a portion of the line of the magnetic field—all illustrating a preferred mode of combining the same. Fig. 4, same sheet, is a vertical section of the upper portion of the lamp, some of the parts thereof being shown in elevation. Fig. 5 is a view of the lamp (with outer and inner globes removed) and taken in a vertical plane substantially central, some of the parts being shown in elevation. Fig. 6 is a top view of the apparatus shown in Fig. 5 and showing certain parts which are omitted from Fig. 5 for the sake of perspicuity. Fig. 7 is a view similar to that of the upper portion of Fig. 5, but showing one mode of using the apparatus in connection with a constant current, such as used in series arc-lighting. Fig. 8 is a top view of the apparatus shown in Fig. 7 and also illustrating electrical connections, some of which are omitted for perspicuity in Fig. 7. Fig. 9 is a view of the bottom of the frame and of a preferred form of circuit-closer used in certain cases and under certain conditions.

In the arc-lamp which forms the subject of my present invention there are present two sticks or pencils of a material for enabling an electrical current passing through them to produce an arc-light. Of such materials carbon is the preferred type, and the term "carbon" as used herein will be understood to stand for any of such materials. These carbon pencils I arrange alongside of one another and comparatively close to one another for the distance of their operative arc-lighting portions, these pencils when the arc is operating being in substantially parallel planes. One of the most cogent reasons why I prefer to locate the inner or adjacent surfaces of the carbon pencils in planes substantially parallel is that I am thereby enabled to obtain and insure a uniform light under and by virtue of a uniform current flowing in a uniform length of arc and also dispense with all the otherwise necessary devices for feeding one

carbon pencil toward the other pencil or for feeding both pencils toward one another. These feeding devices are cumbrous and expensive and are never altogether accurate and efficient, as those acquainted with the art well know. The advantage of the omission of such feeding devices will be at once apparent. The free ends of these carbon sticks or pencils are to point in the direction of the axis of the hemisphere in which light is most needed. For example, should the light be most needed above the lamp the free ends of the carbon stick will point upward. In ordinary cases and for the purposes of such illumination as arc-lamps are most commonly employed—as, for instance, the lighting of streets and buildings, &c.—the lamp is usually suspended on high and above the parts or things to be lighted. In such instances the free ends of these carbon sticks will be undermost, substantially as shown in the drawings, and in the latter I have shown a suspended lamp for out and in door lighting as sufficiently illustrating my invention. In connection with the carbon pencils thus arranged one of the primary objects of my invention is to form the arc-light at the free ends of these carbon pencils. I overcome all tendency of the current to produce a light at any point along the carbons other than their free ends, and I compel them to form the arc at their free ends and to continue to do so as these free ends waste away by an ingenious, novel, and most efficacious combination of electrical means, and by these means I compel that electrical current of the circuit which passes through these carbon pencils and uses them as a part of the circuit to traverse the entire length of one carbon pencil before crossing to the other carbon pencil. The means I employ consist of a magnetic field in which are located these carbon pencils.

I provide a device whereby the free points or ends of the carbon pencils shall be in contact whenever the electrical current does not pass through them—*i. e.*, when they are cut out of the circuit—and whereby whenever an electrical circuit is established through them their free ends will instantly and automatically separate to a degree which will produce the proper length of arc with a given electrical current, and will continue so to do as long as the current flows through until their operative portions be consumed. I provide devices for holding and securing the carbon pencils in and to the lamp. I also provide devices for regulating the exact amount of distance which the free ends of these carbon pencils can be moved apart. I further provide devices for enabling the electrical current to be diverted from passing through the carbon pencils after the operative parts of them have in the process of use disappeared; and for lengthening the duration of the arc-light—to-wit, the time during which the carbon pencils will last—I combine therewith a transparent receptacle substantially air-tight as to the ingress of air, in which the carbon pencils are located and in which they are used while producing the arc-light.

All of the aforementioned features of construction, combination, and arrangement and the particular form and description of devices for carrying into effect the objects of my invention and obtaining the advantages thereof come within the scope of my invention.

Other features of my invention will be apparent as the specification proceeds.

I will now describe one form of construction in which my invention may be embodied.

A indicates the positive carbon pencil. The preferred shape of it is long, wide, and flat, at least in the side next to the adjacent carbon pencil B. The latter is of a similar shape. The positive carbon pencil A is secured to a holder HA, pivoted at HA^2, this pivotal connection being suitably upheld by the framework F of the lamp, preferably by means of the screw. A mode of securing the carbon pencil A to the holder consists of providing the latter with jaws HAJ and HAJ^2 and locating a set-screw SHA, screwed through the part HAJ of the holder and bearing against the jaw HAJ^2. Thus in practice the upper end of the carbon pencil is inserted between the jaws HAJ and HAJ^2 and the set-screw advanced against the jaw HAJ, thereby tightly grasping the carbon pencil and holding it securely in place.

The preferred means for upholding and securing the carbon pencil B in position consists as follows: HB indicates the holder, secured to the frame F by means of a screw or screws HB^2. In the holder are the jaws HBJ and HBJ^2. Between these one end of the carbon pencil B is inserted. A suitable device for clamping the carbon pencil is present, and consists of the set-screw SHB, screwed through a part HBJ of the holder and pressing against the carbon pencil B and the latter in turn against the jaw HBJ^2.

I make the carbon-pencil holders of metal, as a convenient means of putting the carbon pencils in the circuit, and I preferably make the frame of stoneware, vitrified or otherwise, porcelain, or other proper substance, the material being one adapted to withstand heat, or of metal bushed with insulation, where connections are made or go through. It may, however, be in electrical connection with one carbon pencil and be insulated from the other, or vice versa. I have shown it insulated from both. The broad black surfaces in the drawings indicate insulating material, and this material is of a kind which can withstand a considerable degree of heat. Mica is such a material. Thus in the lamp shown the holder HA is insulated by insulation, as IHA, and the holder HB by IHB. The holder HA is electrically connected to the wire K^2 by the contact K. The connection between holder HA and the contact K is preferably by the screw HA^3.

Returning to the carbon pencil A, I would call attention to the fact that the pivotal connection HA^2 allows this carbon pencil to oscillate and its free end to touch the free end of the carbon B. I arrange the construction of the parts which have interrelation as to this function so that the carbon pencil shall at all times when the electrical current is cut off from them automatically meet at their free ends. This function I can cause to be performed in various ways, among which may be mentioned spring-power or magnetic attraction, &c.; but the preferred means is the simple ever-acting power of gravity. Thus, for example, in a lamp suspended, as is the one in the drawings, I locate the carbon pencil B vertically, as shown, and whenever the carbon pencil A is free to follow the impulse of gravity the weight of the arm or armature HAA of the holder HA will move the latter toward holder HB, and consequently move the carbon pencil A toward the carbon pencil B and the free end of pencil A will come in contact with the free end of pencil B, and it will do this whether the carbon pencils A and B are long or short, whether full length or partially wasted by the giving off of light for a longer or shorter time. Whenever the carbon pencils thus in contact at their free ends are put into the electrical circuit, an arc is instantly formed at their free ends, and insomuch as the conditions are such that their free ends should be instantly separated for the better production of light I provide suitable means for this purpose, one description of which is shown—viz., an electromagnet EM, placed in the circuit, and an iron lever or armature HAA, fixed to the holder, is, as soon as the carbon pencils are in circuit, instantly drawn toward the magnet, and the free ends of the carbon pencils are thus instantly separated. I further provide means for regulating the distance the free ends of the carbon pencils shall separate, and a desirable form of such means which I provide is an iron bar EMB, which becomes a magnet when the magnet EM is in circuit and then attracts the said armature HAA. This bar is screw-threaded, as at EMB^2, and rotatable. As it screws toward the armature HAA it shortens the stroke or extent of movement of the latter, and hence diminishes the distance which the free ends of the carbon pencils may be separated, and vice versa. I am thus enabled to adjust the arc-light to a nicety.

For the purpose of effectually and readily cutting the lamp out of circuit either by short-circuiting or opening the circuit in the lamp, also preventing the carbon-pencil holders from being unduly heated when the operative parts of the carbon pencils have been wasted and consumed, I form the carbon pencils as follows: That portion of each carbon pencil which is to form the arc is straight. Beyond this portion the shape of each pencil is such that they respectively diverge from each other before entering their respective holders. This divergent portion I denominate D. The function of the divergent portions of the carbon pencils and of the contact E is as follows: The carbon pencils in forming the arc-light waste and the arc reaches the divergent portions D of the pencils. These in turn waste away until the free ends of the remaining portions of the pencils are so far removed that the current from one to the other is interrupted in case the lamp is burning on constant-potential circuits, at which time the magnetic attraction of magnet EM ceases, and the holder being freed therefrom automatically moves toward the holder HB and impinges against a suitable stop, which prevents the remaining portions of carbon and the carbons from coming into contact or approaching so near as to make electrical connection through them. In case the lamp is burning on constant-current circuits the device for cutting out the lamp is as hereinafter described. By such a mode I successfully prevent the current from heating the carbon pencils at the holders and destroying the latter. Such would be the preferred arrangement when an alternating current or a direct constant-potential current is employed. However, in series lighting when constant current flows through the lamp and forms the arc then a provision for a short circuit is present, and one form of such provision is as follows: The holder HA carries a contact-piece, flange, or arm E. An opposing contact E^2 is supported by the frame F and is provided with an adjustable contact-terminal E^3, consisting of a screw engaging the contact E^2 and capable of being adjusted toward or from the contact E. This contact E^2 E^3 is duly insulated from the frame and extends upward to the contact or terminal E^4 in connection with the wire T. Then when the operative parts of the carbon pencils waste away and the resistance of the arc is increased in proportion to the resistance of the shunt-winding on the differential coil the magnet weakens, and then the holder HA moves forward and carries contact E against this contact E^2 E^3, and the current is thus short-circuited, the remnant of the carbon pencils and the holder HB being out of circuit. Before closing the description of this feature of invention I would remark that it is not necessary that the stud or contact E be located on the holder nor attached to it; but it should be operated by one or both holders, according to the exigencies and requirements of the construction followed. Obviously this same device E E^2 E^3 can be used as a stop in connection with the alternating or direct constant-potential current, and in such event the stops would not establish a circuit.

I establish a suitable magnetic field in which the carbon pencils are located in various ways. I cause an electrical conductor to be placed at a distance from one carbon pencil and in a line parallel or substantially parallel to the length of this pencil and then across

the axis (if the latter were extended from the free ends) of the pencils and then along substantially parallel to the length of the second pencil. This conductor may make one or more turns around the carbon pencils, as described. The current flowing through this wire or wires induces lines of magnetic force which operate to attract (or repel, as the case may be) the arc to the free ends of the carbon pencils and to maintain it there. The magnetic field may be increased in strength by increasing the number of ampere-turns of the coil MF in any suitable manner. It will be understood that the electrical current may travel in either direction through the lamp.

In the construction illustrated in Figs. 5 and 6 I connect the holder HB through the contact BC and wire N with one terminal of the exciting-coil MF of the magnetic field and the other terminal of the coil through the wire P with the electromagnet EM aforesaid. The latter is connected to the other terminal wire T. Thus the electrical current passing through the line K and through the holder HA carbon pencil A forms an arc at the free end of this and of the opposite pencil B and passes through B, thence through holder HB, thence via line N to the magnetic field, thence through the latter, and thence via the line P to the magnet EM, and thence to the terminal wire T, or vice versa. At the instant the current passes through the magnet the latter attracts the free end of the iron armature HAA, separating the carbon pencil A from the free end of the carbon pencil B and forming the arc.

This lamp may be used with a constant current, in which event I employ a differential magnet in lieu of the simple electromagnet. Such a magnet is shown in Figs. 7 and 8, the terminals of the shunt-coil being indicated by SS in said figures. With the employment of the constant current the stop E E^2 E^3 E^1 becomes a contact, short-circuiting the current after the pencils have been consumed away. The passage of the current through the apparatus of Figs. 7 and 8 while the lamp is burning will be substantially the same as in the apparatus of Figs. 5 and 6, except that the shunt-coil of the differential magnet is connected across the terminals of the arc and the current of the shunt-winding will flow in the opposite direction to that of the series winding.

For economizing the use of the carbon pencils and to save frequent renewal of the same I inclose the same in a glass vessel or chamber J, which latter when fitted to place substantially prevents the ingress of air under ordinary working conditions into the chamber. Outside of this glass chamber J, I locate a second glass chamber or guard R to prevent moisture in the shape of rain, snow, &c., from reaching the inner heated glass J and cracking the same and also for the purpose of ornamentation. The shape of my apparatus enables me to employ a glass chamber R of a number of symmetrical and beautiful forms, of which latter one is shown in the drawings. The conductors carrying current producing the magnetic field will pass through suitable openings F^2 F^2 in the flange of frame F and through openings S^2 S^2 of the annular piece S. A collar, ring, or frill S^3 may be located so as to extend from the edge of the frame F upward, as shown, for obvious purposes. The several glass accompaniments J R may be secured by set-screws V, as shown, or otherwise to the frame F.

Without dwelling upon many of the obvious modifications of certain of the features of my invention, I would call attention to the fact that both holders may be pivoted, and in which case means are to be provided to move both toward and away from each other, as specified. As a duplication of the illustrated devices for moving holder HA would be applicable for moving holder HB, further description thereof is here deemed unnecessary.

To the better carry into effect the purposes of my invention and for adding to the efficiency and bulk of the light, I employ pencils of a novel shape—to wit, of a broad, flat, and thin shape—and while I can use pencils of other shapes and their use, as indicated, would come within the scope of my invention I nevertheless prefer the novel shape mentioned. The relative thickness or proportion in bulk of the the two pencils to one another and their size will be determined in view of the nature of the electric current employed, including a consideration of its kind and its voltage and quantity and also of the magnetic field with which I encircle the pencils and of the amount and duration of the light required.

In view of the fact that when my apparatus is operated on a direct current the negative pencil or electrode wastes slower than the positive one I prefer to make the operative portion of the negative pencil of somewhat less caliber than the operative portion of the positive pencil when my apparatus is to be used with a direct current; but when operated with an alternating current both pencils waste equally, and their operative portions will be made of equal size.

What I claim as new and of my invention, and desire to secure by Letters Patent, is—

1. An arc-lamp in which the carbons lie parallel with one another, for that part of each which is for illumination, each carbon from that part being inclined at an angle to the first-named part, and then provided with a carbon handle or stick whereby the carbon can be held, the distance being greater between the carbons near or at the point where the carbons are held in their respective carbon-holders, the length of the arc being increased automatically when the proper amount of carbon is consumed, substantially as and for the purposes specified.

2. An arc-lamp in which the carbons lie parallel with one another, for that part of

each which is for illumination, each carbon from that part being inclined at an angle to the first-named part, and then provided with a carbon handle or stick whereby the carbon can be held, the distance being greater between the carbons near or at the point where the carbons are held in their respective carbon-holders, the length of the arc being increased automatically when the proper amount of carbon is consumed, combined with an inclosing vessel adapted to place said carbons in a partial vacuum, substantially as and for the purposes specified.

3. In an arc-lamp, two parallel carbons, capable of being approximated at their working (arcal) ends, and having straight portions, and then an angulated portion, and another or third portion substantially parallel to the first portion, those portions of the carbons which are to be used in illumination being at a given distance, and the other parallel portions being farther apart, substantially as and for the purposes specified.

4. In an arc-lamp, two parallel carbons, capable of being approximated at their working (arcal) ends, and having straight portions, and then an angulated portion, and another or third portion substantially parallel to the first portion, those portions of the carbons which are to be used in illumination being at a given distance, and the other parallel portions being farther apart, in combination with a coil or coils or an electromagnet, setting up magnetic lines of force that attract or repel the electric arc so as to maintain the arc at the extreme ends of the carbons, and an inclosing vessel, said carbons being inclosed in a partial vacuum, substantially as and for the purposes specified.

5. In an arc-lamp, the combination of two carbon electrodes, substantially parallel, a supporting-frame, one carbon-holder stationary with the frame, the other carbon-holder pivotally suspended from the frame, the armature HAA, fixed thereto, electromagnet, core E, M, carrying screw-thread, support provided with interior screw-thread engaged by the screw of the core, the core extending down and bearing against the armature HAA, and adapted by the construction aforenamed to be adjusted in a direction toward or away from the armature, substantially as and for the purposes specified.

6. In an arc-lamp, the combination of two carbon electrodes, substantially parallel, a supporting-frame, one carbon-holder stationary with the frame, the other carbon-holder pivotally suspended from the frame, the armature HAA, fixed thereto, electromagnet, located above the supporting-frame, core E, M, thereof adjustable through the frame, by means of screw-thread on it, and, below the frame, bearing against the armature HAA, and adapted by the construction aforenamed to be adjusted in a direction toward or away from the armature, substantially as and for the purposes specified.

7. In an arc-lamp, the combination of two carbon electrodes, substantially parallel, a supporting-frame, one carbon-holder stationary with the frame, the other carbon-holder pivotally suspended from the frame, the armature HAA, fixed thereto, electromagnet, located above the supporting-frame, core E, M, of the electromagnet extending through the latter, insulating-bushing in the frame, having interior screw-thread, core having a screw-thread, engaging the screw-thread of the bushing, and extending therethrough and down against the armature, the core being rotatable, substantially as and for the purposes specified.

JOHN S. NOWOTNY.

Attest:
WM. E. JONES,
K. SMITH.