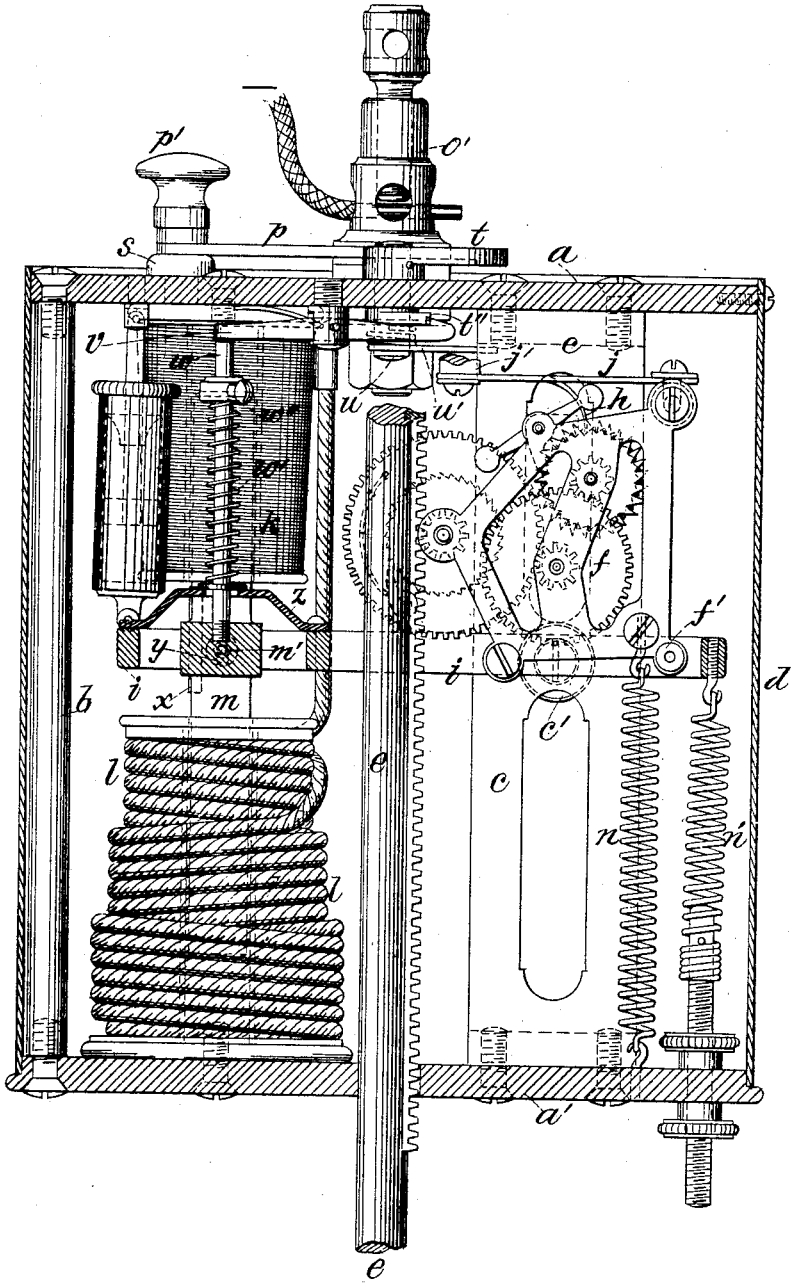
(No Model.) 2 Sheets—Sheet 1.

J. J. WOOD.

ELECTRIC LAMP.

No. 261,289. Patented July 18, 1882.

Fig. 1.



Witnesses:
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M. J. Leonard

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

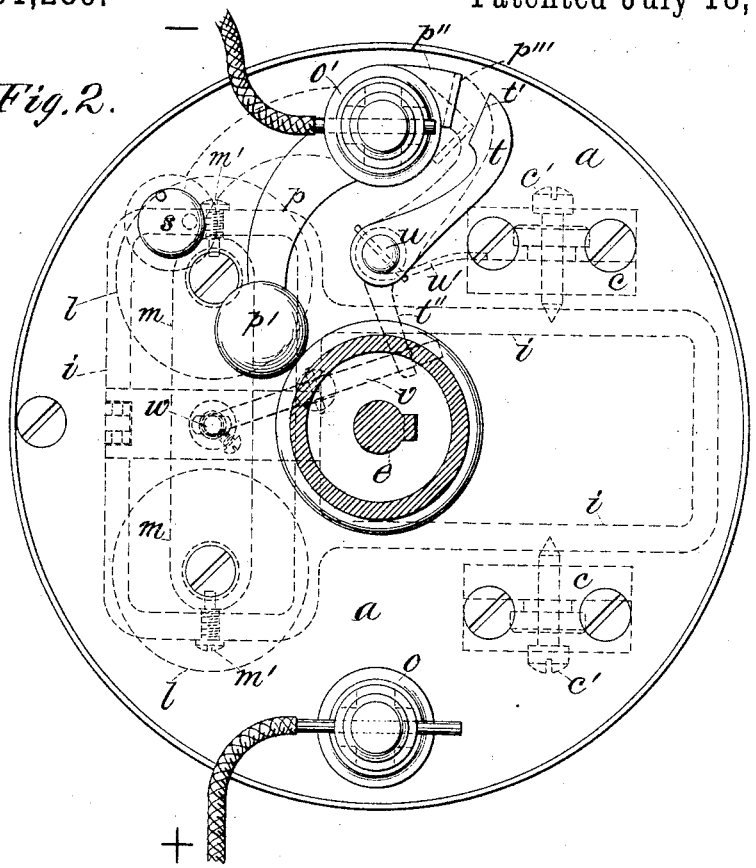
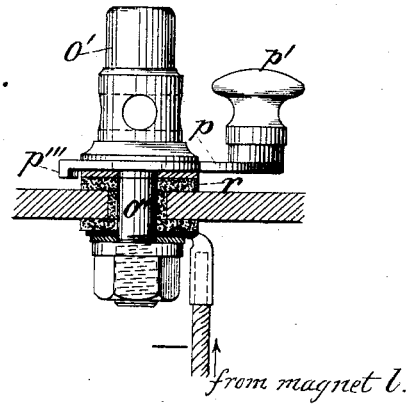


Fig. 3.



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UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF BROOKLYN, ASSIGNOR TO THE FULLER ELECTRICAL COMPANY, OF NEW YORK, N. Y.

ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 261,289, dated July 18, 1882.

Application filed January 28, 1882. (No model.)

To all whom it may concern:

Be it known that I, JAMES J. WOOD, of Brooklyn, in the county of Kings and State of New York, (assignor to the FULLER ELECTRICAL COMPANY, of New York city,) have invented certain new and useful Improvements in Electric Lamps, of which the following is a specification.

My improvement applies to arc-lamps and to devices for cutting a faulty lamp out of circuit when its arc fails or when the arc becomes abnormally long by failure of the mechanism to feed, or other cause.

Where a number of arc-lamps are circuited in a direct series it is well known that the arc in each must be kept practically uniform and of a normal length, for should an abnormally-long arc form in any one lamp its resistance would correspondingly reduce the action of all the other lamps in the circuit, and if the arc in the faulty lamp should continue to increase it would tend, from its great heat and flaming condition, to ignite surrounding wood-work or other combustibles, and thus cause fires, or by the great resistance which it presents in the circuit would finally tend to damage the lamp by burning the insulation. Lamps have therefore been provided with devices to prevent these contingencies, which devices are usually termed "automatic cut-outs" or "safety cut-outs." Heretofore this cut-out has been effected by the action of a magnet in a shunt, which, when it became abnormally attractive, due to abnormal length of arc, moves its armature, closes a contact, and thereby establishes a short free circuit independent of the arc, so as to thus extinguish the abnormal arc and switch the faulty lamp out of circuit without interrupting the current to or affecting the action of the other lamps in the series. Now, the shunt-magnet heretofore used to operate the cut-off has been a special one, distinct from and additional to the magnetic regulator of the carbons, whereas in my case I employ a shunt-magnet in the carbon-regulator, and I combine my cut-off devices with the said regulating-magnet, and thus produce a safety cut-off in a simple and efficient manner. Again, in the former case the cut-off switch is kept closed by the abnormal attraction of the shunt-magnet and opens as soon as the attraction becomes normal, and thus tends to again establish the arc in the faulty lamp. In my case, however, the abnormal attraction of the shunt-magnet acts simply to trip or release a catch or latch, and thereby release the cut-off switch, which then springs shut, and thereby closes the safety branch circuit, thus permanently cutting out the faulty lamp.

My improvement therefore consists mainly in the two features above outlined; and also, in addition to certain details, it further consists in the combination, with the automatic safety-switch, of a hand-switch for voluntarily circuiting or decircuiting the lamp, the said safety-switch being arranged to contact with the hand-switch, so that the safety-switch may be opened and set for action by moving the hand-switch to throw the lamp into action, as hereinafter fully set forth.

In the annexed drawings, Figure 1 presents a sectional side elevation of the mechanical portion of an electric lamp of a well-known type embodying my present improvements. Fig. 2 is a plan view thereof. Fig. 3 is a detailed sectional elevation of the negative binding-post, &c., on which the hand-switch is mounted.

The general mechanism of the lamp is identical with that shown in several former applications filed by me, and the general construction will be at first fully described in order that the present subject-matter may be better understood.

In Figs. 1 and 2, *a a* indicate two circular metallic heads, which are rigidly joined by the rod *b* and standards *c c*, which thus form the frame of the lamp, which frame sustains the included mechanism shown, and the whole is inclosed and protected by the cylindrical case *d*, as usual.

The upper-carbon holder *e* slides centrally through the heads *a a*, and has a line of rack-teeth on one side, which engage with a train of wheels carried in the pivoted gear-frame *f*. This gear-frame is pivoted at its lower outer corner, *f'*, to the armature-lever *i*, and the upper outer corner of the frame is connected with

the free end of a plate-spring, J, which is fixed at its inner end to a post, J′, depending from the upper head, *a*.

The armature-lever *i* has the form of an open skeleton frame of T shape (see Fig. 2) placed in horizontal plane, and is pivoted between the standards *c c* on the trunnion-screws *c′* at a point below the center of the gear-frame.

The wide end of the T-shaped lever lies between the spool-heads of the regulating-magnets *k l*, and to this end of the lever is hung or pivoted the armature *m* on the trunnion-screws *m′*. The magnets *k l* are preferably of the tubular or so-called "axial" form, as shown, and each consists of two coils or spools, as usual, screwed to the respective heads *a a′*, as shown. The armature is hence of H form, so that its two upper horns or poles project up into the bores of the magnet *k*, while the two lower poles hang down in the bores of the lower magnet, *l*, such as shown in my former applications filed Feburary 4, 1881, and July 15, 1881. Now, the lower magnet, *l*, is wound with coarse wire, and is hence of low resistance, and is arranged in direct circuit with the carbons, being thus the "separating-magnet," while the coils of the upper magnet, *k*, are formed of fine wire, as shown, being therefore of high resistance, and this magnet is placed in a shunt—that is, the opposite ends of the coils are connected directly to the positive and negative binding-posts *o o′*—so that it thus always offers a path of high resistance for the flow of the current independent of the carbons and arc, and forms the "feeding-magnet." The two magnets will thus antagonize each other and act in opposite directions on the armature *m*, the upper magnet, *k*, tending to pull it up, while the lower magnet, *l*, tends to pull it down.

The up-pulling action of the shunt-magnet *k* is assisted by the tension-springs *n n′*, one of which, *n*, is constant, and the other, *n′*, adjustable, as shown.

It will therefore be now understood that when the lamp is out of circuit the magnets will be powerless, and the springs *n n′* will sway the armature-lever *i* in a direction to lift the armature in the tubes of the magnets, depress the short arm of the lever and the gear-frame *f*, thus withdrawing the scape-wheel of the train from the stop-tooth *h* on the spring *j*. The gear-train will be thus released and the carbon-holder will descend slowly by its own weight till the carbon which it holds touches the lower carbon.

If the lamp is now put in circuit, the current will flow from the positive binding-post *o*, through the metallic frame of the lamp, the carbon-holder *e*, and the upper carbon, to the lower one. From the lower carbon the current will flow by the usual path (not shown in the drawings) to one end of the coils of the direct magnet *l*, and, flowing through said coils, will finally pass off by the negative insulated post *o′*, and thence return to its source. Upon the current thus flowing while the carbons are together the direct magnet *l* will become strongly attractive and immediately depress the armature *m*, sway the lever *i* against the stress of the springs *n n′*, and lift the train of gearing and the carbon-holder *e* bodily, thus separating the carbons, causing the arc to flash out between them, and finally bringing the scape-wheel against the stop-tooth *h*, thereby holding the carbon in suspension to maintain the arc. Now, of course, in proportion as the carbons burn away, so as to lengthen the space or arc between them, the resistance to the passage of the current through the arc and direct magnet *l* increases, and a greater proportion of current flows through the shunt-magnet *k*, which will thus finally become strong enough to overcome, with the assistance of the springs *n n′*, the pull of the direct magnet *l*, and thus sway the parts slightly in the opposite direction, sufficiently to either depress the carbon-holder bodily or release the train of wheels momentarily, so as to give the necessary down-feed to the carbon to shorten the arc or restore it to its normal length. The magnet *l* thus separates and the magnet *k* feeds, and the armature thus floats, as it were, between the two, so that when the arc is of a normal length the attraction of the two magnets is equalized and the armature and other connected parts remain stationary, the constant tendency of the described mechanism being thus to keep the arc at a normal length. The normal length may be one-quarter of an inch, according to the nature of the lamps, the generator, or of the current produced thereby, or other conditions, and this length may be varied as required by adjusting the spring *n′*, a greater tension of which will produce a shorter arc and a less tension a longer one. When a series of lamps, however, are adjusted for a certain length of arc which is found to give the best effect it should be maintained uniformly in all the lamps, for should any one increase abnormally it would interfere with the perfect working of the rest. This abnormal arc might occur from some clog in the mechanism of the lamp or other failure of the carbons to feed, and if the arc should continue to increase—say for an inch or more—it would, as before stated, not only interfere with the other lamps, but might injure the lamp, and from the intense heat and flame emitted by the long arc would be likely to cause fires.

My improved cut-off device, which is added to the before-described mechanism to prevent these contingencies, will be therefore now readily understood.

In Figs. 1 and 2, *p* indicates a hand-switch, by which the lamp may at any time be voluntarily thrown into or out of circuit. This switch has the usual form of a curved lever, made of course of metal, with a non-conducting knob *p′* on its manipulating end, while its opposite end is mounted on the stem *o″* of the negative binding-post *o′*, as shown best in Fig. 3, so as to turn freely thereon, yet always re-

main in electrical connection with the negative post.

The switch-lever, as seen in Fig. 3, turns on the stem o'' between the base of the negative post and an underlying washer, and the post and switch are of course insulated from the metallic lamp-head a by the usual insulating-sleeve, r. When the switch is closed its free end seats on the metallic boss or seat s, which is in metallic connection with the head a. Consequently when the switch is thus seated or closed, as shown by full lines in Fig. 1 and dotted lines in Fig. 2, the lamp will be designedly thrown out of circuit, as the switch will form a direct free passage for the current from the positive post o (see Fig. 2) through the head a to the negative post o', as will be readily understood. The lamp will, however, be instantly thrown into action by opening the switch, as shown by full lines in Fig. 2, which will of course cause the current to take its active path through the magnets and carbons. Now, the switch-lever p is formed with a short arm, p'', Fig. 2, on the end opposite to the manipulating end, which short arm is formed with a broad flat contact-making face, p''', formed by overbending the edge of the metal plate which forms the switch-lever and filing its face smooth, as shown best in Fig. 3. Now, arranged in relation to this contact-making face p''' is the automatic or safety cut-out switch t, which, in both shape and action, is similar to a pistol-hammer. This hammer or lever t of the safety-switch is formed at its free end with a broad contact-making face, t', to meet with the face p''' of the hand-switch, and at its pivotal end it is formed with a hub, which rests upon the lamp-head a and is keyed to a pivotal stud, u, which passes through and turns freely in the lamp-head a, as shown best in Fig. 1.

Immediately under the lamp-head a small trigger or catch-arm, t'', is keyed to the stud, and below this a spiral spring, w', is fitted on the end of the stud, with one end fixed to the stud and the opposite end bearing against the side of the fixed standard c. Now, when the safety-switch is closed it will contact with the face p''' of the hand-switch, as shown by dotted lines in Fig. 2; but when opened it will be moved away from the hand-switch, as shown by full lines, and this motion will flex the spring w' and move the trigger-arm t'' over the hooked end of a trigger or catch-lever, v, which will thus hold the switch in its open position, as shown by dotted lines in Fig. 2 and full lines in Fig. 1. This catch-lever v is pivoted just under the head a, as seen in Fig. 1, with its hooked arm projecting in the path of the trigger t'', while its opposite and operating arm is depressed by a spring, v', so as to keep the hooked end in constant engagement with the switch, as shown, and this operating-arm of the catch-lever projects between the spools of the shunt-magnet k, and its end directly overlies the center of the cross-bar of the H-shaped armature m, as clearly shown in Figs. 1 and 2.

A long pin, w, is fixed in and rises from the middle of the cross-bar of the armature, as shown in Fig. 2, and terminates just under the operating-arm of the catch-lever v, as shown in Fig. 1. Now, in all the normal movements of the armature m and armature-lever i down or up to regulate the position of the carbons the pin w does not touch or affect the trigger-lever v.

The armature-lever, in producing its regulating movement, plays of course between the spool-heads of the magnets k l, as seen in Fig. 1, and its play is limited by the pin x, which projects from the lever toward each spool-head. Now, the armature-lever may be raised to the limit of its up motion to produce the feed of the carbon, where the stop-pin x will strike the head of the shunt-magnet k, (see Fig. 1,) yet the tripping-pin w on the armature will not touch or affect the trigger-lever v, although it will closely approach it, as seen in Fig. 1. Now, when the armature-lever is thus raised to the limit of its up motion the carbon-holder should of course descend freely to give the necessary "feed" to the carbons. If, however, the carbon thus fails to feed—on account, say, of some derangement of the gearing or other mechanism, or from any other cause—the carbon points will then continue to burn apart, thus increasing the length and resistance of the arc and correspondingly increasing the strength of the shunt-magnet k. Now, the parts are so adjusted that when the arc gets seriously or dangerously long—say half of an inch if the normal length be one-quarter—the shunt-magnet will become sufficiently strong to bodily lift the armature m a slight distance off the armature lever i, or, rather, off the pivotal points of its trunnion-screws m', (see Fig. 1,) for in this lamp it is to be noted that the armature is capable of a limited upward play on its trunnion-screws by reason of the short downwardly-extending slats y on the sides of the armature, in which the pivots of the screws enter, as shown by the dotted lines in Fig. 1, whereas heretofore the armature has been trunnioned to the armature-lever without play. This independent upward movement of the armature, after the armature-lever is raised to the limit of its up motion, will, as may be readily seen on reference to Fig. 1, force the trip-pin w against the end of the trigger-lever v, thereby moving the lever so as to depress its hooked end and release the safety-switch, which will now be instantly moved by its spring w' so as to throw the switch-hammer t into firm contact with the contact-face p''', thereby instantly extinguishing the lamp and cutting it out of circuit, and at the same time establishing a free passage for the current to the other lamps in the circuit, for it will be noted on reference to Fig. 2 that when the safety-switch is thus closed the current will flow directly from the positive post o through the head a to the switch-lever t, and

thence to the negative post, and off to the next lamp. Now, in order that the strength of the shunt-magnet *k* shall not have to increase to a very great extent in order to bodily lift the armature *m* and trip the safety-switch, a part of the weight of this armature is always supported by a spring, *w'*, which encircles the pin *w* and bears at its lower end on a washer, which rests on a bridge, *z*, fixed to the armature-lever, and at its upper end bears on a collar, *w''*, adjustably fixed on the pin by the set-screw shown. Hence, as the tension of this spring is increased by setting the collar down, the lifting power of the shunt-magnet will be more assisted and the switch will be tripped by a smaller departure from the normal arc, whereas, if the tension of the spring is reduced by setting the collar up, the shunt-magnet will be less assisted and a greater length of arc will form before the safety-switch becomes tripped and closed. Hence the adjustment of the collar *w'* determines the limit in the length of arc allowed before the lamp will be automatically extinguished. When the defective lamp is thus extinguished and cut out of circuit the attention of the attendant will thus be called to the same; and in going to examine the lamp to remedy the defect he will first close the hand-switch *p*, as shown by dotted lines in Fig. 2. This movement of the hand-switch, as will be noted, by reason of its arm *p''* contacting with the hammer *t* of the safety-switch, will automatically move the hammer into its cocked or open position, where it will be immediately engaged and held ready for its next automatic action, if ever required.

In Fig. 1, to illustrate this cocking action, the closed position of the hand-switch is shown by dotted lines and the open position of the safety-switch by full lines; and it may be also noted that the contact-face *p'''* of the hand-switch, when moving to set the safety-switch, scrapes angularly against the contact-face of the safety-switch, and this keeps the surfaces bright and clean to insure good conduction. Hence when the hand-switch is thus closed it not only opens and cocks the safety-switch for future action, but still keeps the defective lamp out of circuit, so that the attendant can examine the mechanism of the lamp and adjust it or remove the defect without fear of receiving a shock or of establishing the arc before the lamp is ready for action. If he finds that the defect is easily remedied without removing the lamp or sending it to the repair-shop, or if he finds, for instance, that there is no defect in the lamp mechanism, but its extinguishing was due simply to the breaking or exhaustion of one of the carbons, he will, after correcting the derangement, open the hand-switch, as shown by full lines in Fig. 2, which will throw the lamp again into full luminous action, while the safety-switch remains set ready for action, if ever necessary. This open position of the two switches is shown by full lines in Fig. 1; and it may be here noted that as the hand-switch is thus thrown open it will break contact with the safety-switch before it breaks contact with its seat *s*. Consequently any spark that may be emitted at the breaking of the switch-circuit will not be emitted at the safety-switch, but at the seat *s* of the hand-switch, which, however, will do no injury, as the contact-surface here is large and frequently subjected by the motions of the hand-switch to strong frictional scrapes, which will keep the parts in good electrical condition.

It will therefore be seen that this safety-switch mechanism fulfills all the important requirements stated at the outset, and is simple and efficient in action and complete in its capabilities. Furthermore, no other magnets or armatures are used to operate the switch devices than those usually employed and necessary for the carbon-regulating mechanism, and the safety-switch is always set for action by the necessary motions of the hand-switch.

While I, of course, greatly prefer to employ the armature of the regulating shunt-magnet to operate the safety-switch, yet a special shunt-magnet might be employed for this purpose, but in combination with my automatic switch-releasing devices; or, again, in lieu of a shunt-magnet operating by an increase of attraction due to increased arc, a magnet arranged in the direct circuit and operating by decrease of attraction due to the same cause might be arranged to operate or release the safety-switch, for it may be readily seen that the peculiar form of the switch setting and releasing devices is not confined to any particular kind or arrangement of operating-magnet.

Instead of employing a spring, *w'*, to give a constant tendency to close the safety-switch, any equivalent might be used—for instance, a weight or a magnet; but these are not recommended.

What I claim is—

1. The combination, in an electric-arc lamp, of a safety-switch acting when closed to cut the lamp out of circuit, a spring or equivalent device acting constantly to close the said switch, a trigger catch or latch acting to hold said switch open, and an electro-magnet circuited in such relation with the arc that an abnormal length of arc shall cause the armature or movable part of said magnet to trip the said trigger-catch, release the switch and allow it to spring closed, and thereby automatically throw the abnormal lamp out of circuit, substantially as herein set forth.

2. The combination, in an electric-arc lamp, of an electro-magnet circuited in operative relation with the arc and a corresponding armature operatively connected with mechanism for regulating the positions of the carbon-points, with a safety-switch arranged in operative relation with the said armature, constructed to be normally open, but when closed to cut the lamp out of circuit, and an operative connection from the said armature to the said switch, having an idle play or movement

during the normal feeding movements of said armature, but which connection actuates the switch and closes the same when the said armature moves beyond the limit of its feed-motion due to an abnormal length of arc, substantially as herein shown and described.

3. The combination, in an electric-arc lamp, of a safety-switch normally open, but acting when closed to cut the lamp out of circuit, an electro-magnet circuited in a shunt from the arc-circuit, a corresponding armature operatively connected with mechanism to feed or regulate the position of the carbons, and having a limited idle play in its connection with said mechanism and an operative connection between said armature and safety-switch, whereby the armature becomes independently moved from the regulating mechanism when the latter is moved to its feeding limit by an abnormal attraction of the shunt-magnet due to abnormal arc, and thereby operates the safety-switch to throw the abnormal lamp out of circuit, substantially as herein described.

4. The combination, in an electro-lamp, of a hand-switch adapted for voluntarily circuiting or decircuiting the lamp, with a safety-switch adapted to close automatically by the mechanism of the lamp on the formation of abnormal arc or abnormal separation, the said safety-switch being arranged in operative relation with the hand-switch, whereby the closing and opening of the hand-switch automatically set the safety-switch in its open position, substantially as herein set forth.

5. The hand-switch p, formed with a contact-face, p''', on one arm thereof, in combination with a safety-switch hammer, t, with means for retaining the same in open position, and arranged when closed to contact with said face p''', whereby the movement of the hand-switch will move and set the safety-switch, substantially as herein shown and described.

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