(No Model.) 2 Sheets—Sheet 1.

D. HIGHAM.

REGULATOR FOR CONTINUOUS CURRENT ARC LIGHT CIRCUITS.

No. 515,473. Patented Feb. 27, 1894.

Fig. 1.

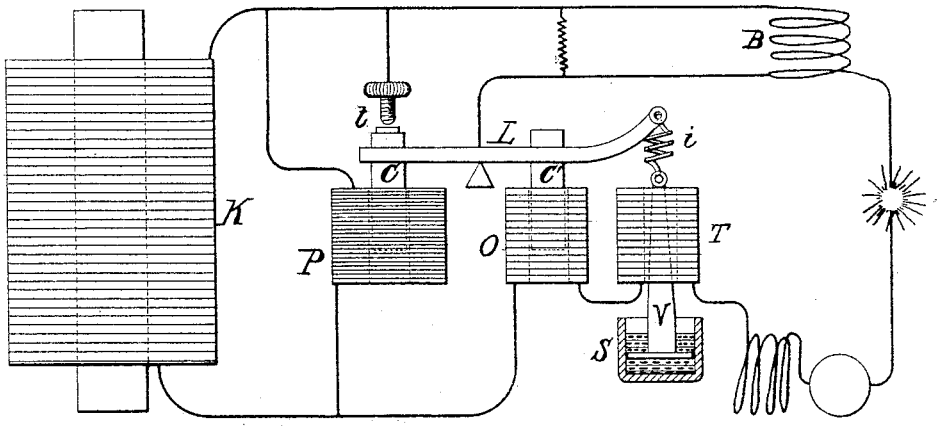


Fig. 2.

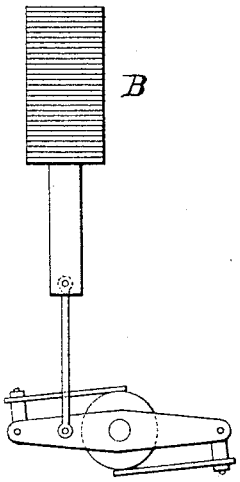
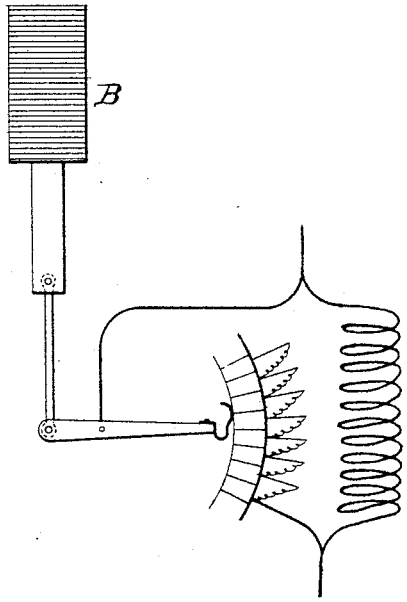


Fig. 3.



WITNESSES:

George Baumann

James Gracie

INVENTOR

Daniel Higham

BY

Howson and Howson

his ATTORNEYS.

THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

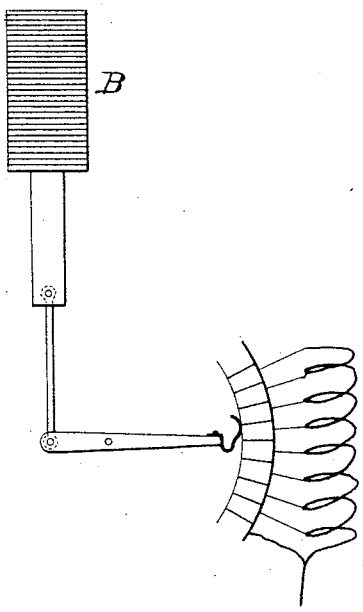


Fig. 5.

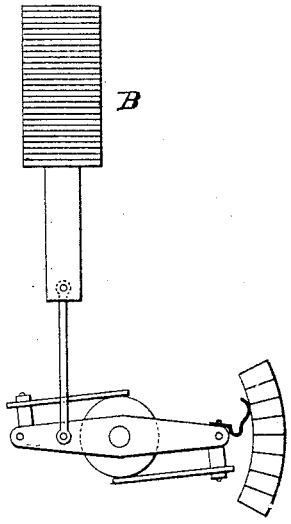


Fig. 6.

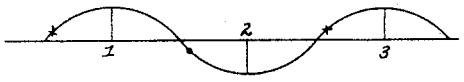


Fig. 7.

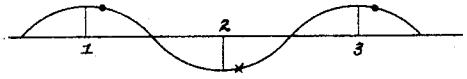


Fig. 8.

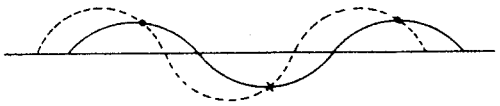
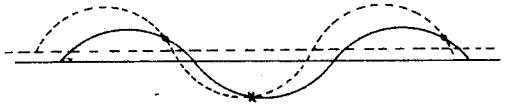


Fig. 9.



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George Baumann

James Gracia

INVENTOR

Daniel Higham

BY

Howson and Howson

his ATTORNEYS.

THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

DANIEL HIGHAM, OF BOSTON, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE HIGHAM ELECTRIC COMPANY, OF PORTLAND, MAINE.

REGULATOR FOR CONTINUOUS-CURRENT ARC-LIGHT CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 515,473, dated February 27, 1894.

Application filed May 14, 1892. Serial No. 433,057. (No model.)

To all whom it may concern:

Be it known that I, DANIEL HIGHAM, a citizen of the United States of America, and a resident of Boston, Massachusetts, have invented certain Improvements in Rendering Stable and in Regulating Arc-Light Current-Circuits, of which the following is a specification.

This invention relates to that method of obtaining stability of current in arc-light circuits which I have illustrated in Reissued Letters Patent No. 11,108, dated August 26, 1890; and its object is to provide for the more effectual carrying out of the method fully described hereinafter.

Figure 1 in the drawings represents a form of means embodying the main features of this invention. Figs. 2, 3, 4 and 5 represent different forms or modifications of controlling mechanism which may be used, and Figs. 6, 7, 8 and 9 are diagrams for illustration.

Diagram 6 represents the existing method, excepting the method described in said reissued Letters Patent, of operating the controlling mechanism of arc-light dynamos; and which consists of checking a rise of current intensity after the current rises above normal intensity and of checking a fall of current intensity after the current falls below normal intensity.

Diagram 7 represents the method of operating the controlling mechanism of arc light dynamos which I have described in said reissued Letters Patent; and which consists of checking a rise of current intensity before the current rises to normal intensity, and of checking a fall of current intensity before the current falls to normal intensity.

The star (*) in the diagrams indicates the point in the variation of current intensity where the controlling mechanism starts to move to check a rise of current intensity, while the dot (.) represents the point where the controlling mechanism starts to move to check a fall of current intensity.

The wave line represents the variation of current intensity, and the straight line represents the mean or normal intensity, while the small ordinates will serve to illustrate the duration of time.

Before going too fully into the subject matter of this application it will be well to give a brief illustration of the above two methods of operating the controlling mechanism of arc-light dynamos, in order that the distinction between the two can be more clearly understood when reference herein is made to them.

If from ordinate 1 to ordinate 2 in Diagram 6 is the time when the current intensity is falling it will be seen that more than half of this time will be spent before the controlling mechanism will start to move to check the fall of current intensity and if from ordinate 2 to ordinate 3 is the time when the current intensity is rising it will be seen that more than half of this time will be spent before the controlling mechanism will start to move to check the rise of current intensity. The first mentioned method of operating the controlling mechanism of arc-light dynamos, could not stable the current, inasmuch as the current intensity would have to keep on falling or rising in each variation until the time after the controlling mechanism started to move would be somewhat more than the time spent before the controlling mechanism started to move, whereby the wave or variation of current intensity would be increased at every oscillation or movement of the controlling mechanism until the extreme conditions of instability would be reached. It should be understood, however, that the above is not intended to mean that the current of an arc-light dynamo would be made unstable by the method of operating the controlling mechanism shown in Diagram 6, for if the dynamo had sufficient properties of stability to make up for the defects in this respect in the operation of the controlling mechanism, the current would, of course, be stabled; what is intended to be meant is that the method of operating the controlling mechanism shown in Diagram 6 is a method which possesses no properties of stability in itself; a method which would only act to maintain a constant mean intensity of current.

Now if from ordinate 1 to ordinate 2 in Diagram 7 of my patented method is the time when the current intensity is falling it will be seen then that the time spent before the controlling mechanism has started to move will be very little compared to the time which

will be spent after the controlling mechanism has started to move in checking the fall of current intensity, and if from ordinate 2 to ordinate 3 is the time when the current intensity is rising it will be seen that the time spent before the controlling mechanism has started to move will be very little compared to the time which will be spent after the controlling mechanism has started to move in checking the rise of current intensity.

The second mentioned method of operating the controlling mechanism of arc-light dynamos, therefore, would stable the current, inasmuch as the wave variation of current intensity would be shortened at every movement or oscillation of the controlling mechanism until the wave would become very small, that is to say a wave or undulation of about two or three per cent. variation, as will be apparent. The advantages of this method of operating the controlling mechanism of arc-light dynamos are that the dynamo can be made to possess some properties of unstability and, as described in said reissued Letters Patent, to yield a higher efficiency and at a lower cost of manufacture in consequence.

The first mentioned method of operating the controlling mechanism, which is the method shown in Diagram 6, I shall herein refer to as a method "acting to regulate the current," and the second method of operating the controlling mechanism which is shown in Diagram 7, I shall herein refer to as a method "acting to stable the current."

One form of means embodying the main features of the present invention I have shown in Fig. 1 and it consists of a coil K of high self induction connected in the main or working circuit, a coil P of low self-induction, compared to coil K, connected in parallel circuit with coil K, a coil O connected in the main or working circuit and arranged by its magnetic pull on core C′ to oppose the magnetic pull of coil P on core C through rocker arm L, a contact *t* connected in a short circuit around the controlling mechanism B, (all of which can be said to be the means necessary to stable the current, and the following the means for regulating the current) a coil T connected in the main or working circuit, a spring *i*, acting both for tension and compression, connecting arm L to core V, and a dash-pot S to make the movement of core V very slow.

The operation is as follows: If the current flowing through coils K and P were varied or waved in intensity, the resistance to the current in each would vary in respect to each other, inasmuch as the self-induction of one is higher than the other, and as it will take longer for the current to change in the high self-induction coil K than it will in the low self-induction coil P, which is in the branch circuit, it follows that the phase difference in the current wave of coil P will be ahead of the current wave in the main or working circuit; that is, the current wave of coil P will be ahead in time, or in other words in the direction the dotted line is to the full line in Diagram 8. The wave of current in coil K will, of course, be slightly behind in phase of the current wave in the main or working circuit, but as this has nothing to do with the direct action of the form of means shown in the drawings it will not be considered. The responsive action of the means shown is dependent upon the difference in phase between the current waves through coil P and coil O. Supposing the full line in Diagram 8 to be the wave of current intensity in coil O and working circuit, the dotted line the wave of current intensity in coil P, and supposing for the sake of clearness in illustration that the opposing forces of coils P and O are equal when the intensities of the currents as illustrated by the dotted and full lines in the diagram are equal. Now it can be clearly seen when coil P will have a stronger or weaker attactive force than coil O to open and close the contact *t* and also when the movement of the controlling mechanism will be started to check a rise or fall of current intensity which is indicated in the diagram by the dot (.) and the star (*). This it will be seen is the method of operating the controlling mechanism shown graphically in Diagram 7. In other words the action of this much of the means shown will be to stable the current.

The coil T which is connected in the main or working circuit should be just strong enough to lift the core V when the current rises above the desired or normal intensity and just weak enough to lower the core V when the current falls below the desired or normal intensity, or in other words its action on rocker arm L through spring *i* will be to regulate the current. The action of coil T, however, is a very slow one, responding only to variation of mean intensity of current, being made so in the present instance by a dash-pot S. The action of coils P and O will, of course, be a very quick one, responding to wave variations of current intensity; the connection of rocker arm L to core V is, therefore, not a fixed connection but a spring connection, which will permit of a quick rocker arm movement and a slow movement of core V as will be understood.

The effect of the action of coil T on the action of coils P and O will be, when the mean current intensity in the main or working circuit rises above normal, the same as though the current intensity in coil P had risen more than the current intensity in coil O.

In Diagram 9 I have illustrated the combined action of coil T and coils P and O in this sense by drawing the mean intensity of current in coil P as being higher than in coil O from which it will be seen that the contact *t* will be held open a little longer than closed, when the mean intensity of current rises above normal, and on the other hand, as will

be understood, will be held a little longer closed than open when the mean intensity of current falls below normal. Fig. 2 in the diagram represents the controlling mechanism B as consisting of means for shifting the commutator brushes of the supply generator. Fig. 3 shows means varying a resistance around the field-magnet coils. Fig. 4 shows means for effecting the control by cutting in and out sections in the field magnet coils. Fig. 5 shows means for varying the field magnet intensity and shifting the commutator brushes at the same time, all of which will be understood. There are also other forms of means beside those shown in Fig. 1 which would embody the main features of this invention, but as the precise form of means has nothing to do with the real scope of this invention it will not be necessary to illustrate them.

What I wish to claim in this application is a device or means responding to wave variations of current intensity in the main or working circuit and acting to regulate the current in the sense described above, combined with a second device or means responding slowly to variation of mean intensity of current in the main or working circuit and acting to regulate the current in the sense described above; the whole constituting a current controller for arc-light generators.

In said reissued Letters Patent I have shown means for regulating and stabling the current, but the means shown for regulating the current did not respond to variations of mean intensity in the main or working circuit separately from the means acting to stable the current, as is the case with the present invention and which will permit of the means acting to stable the current being made extremely sensitive.

I therefore claim as my invention—

1. In a current controller for arc-light generators, an electro-magnetic device or means responding to wave variations of current and acting to stable the main or generated current, combined with a second device or means responding slowly to variations of mean intensity of current and acting to regulate the main or generated current, substantially as described.

2. In a current controller for arc-light generators, an electro-magnetic device or means responding to wave variations of current and acting to stable the main or generated current, combined with a second electro-magnetic device or means responding slowly to variations of mean intensity of current and acting to regulate the main or generated current, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

DANIEL HIGHAM.

Witnesses:
H. GREGORY, Jr.,
DANIEL B. WHITTIER.