

(No Model.)

2 Sheets—Sheet 1.

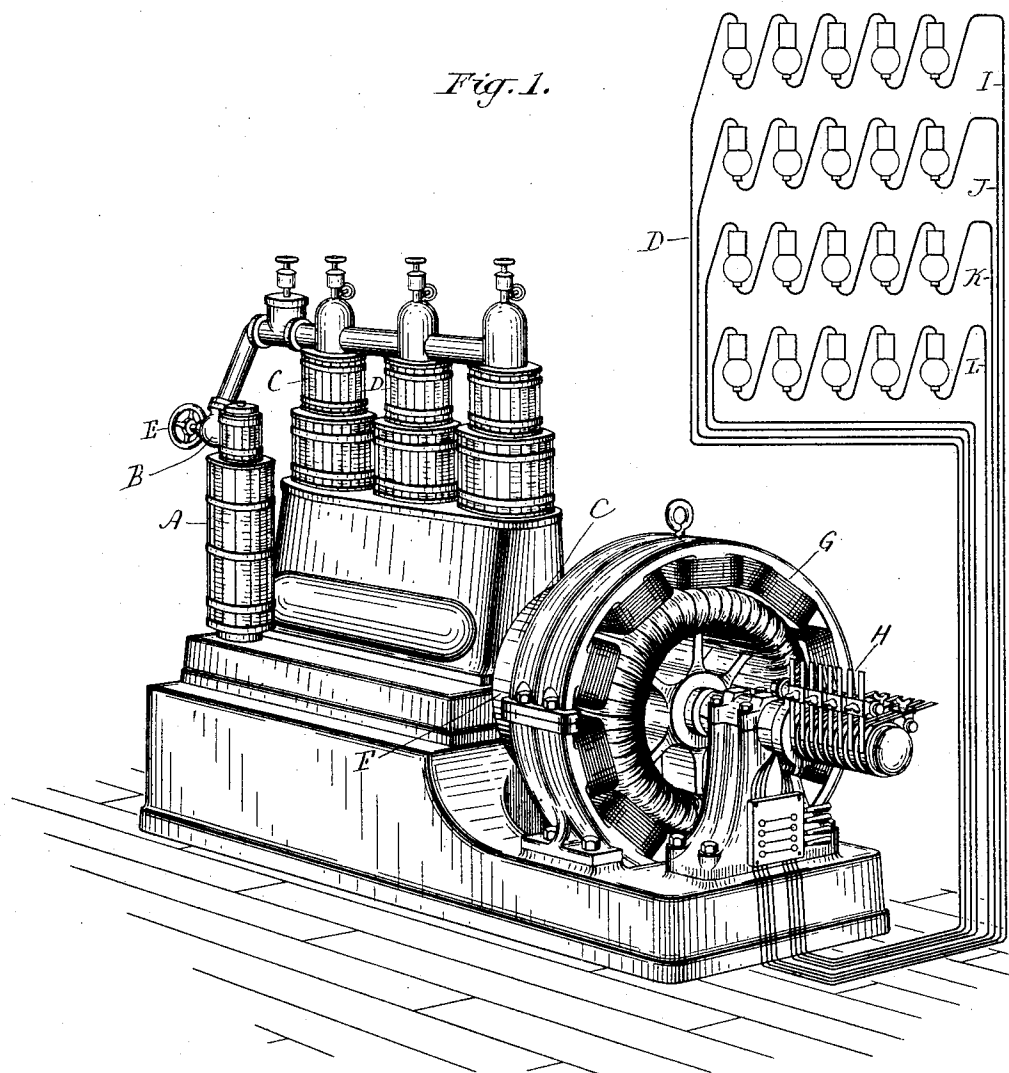
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APPARATUS FOR GENERATING CONSTANT ELECTRIC CURRENTS.

No. 587,921.

Patented Aug. 10, 1897.

Fig. 1.



Witnesses.

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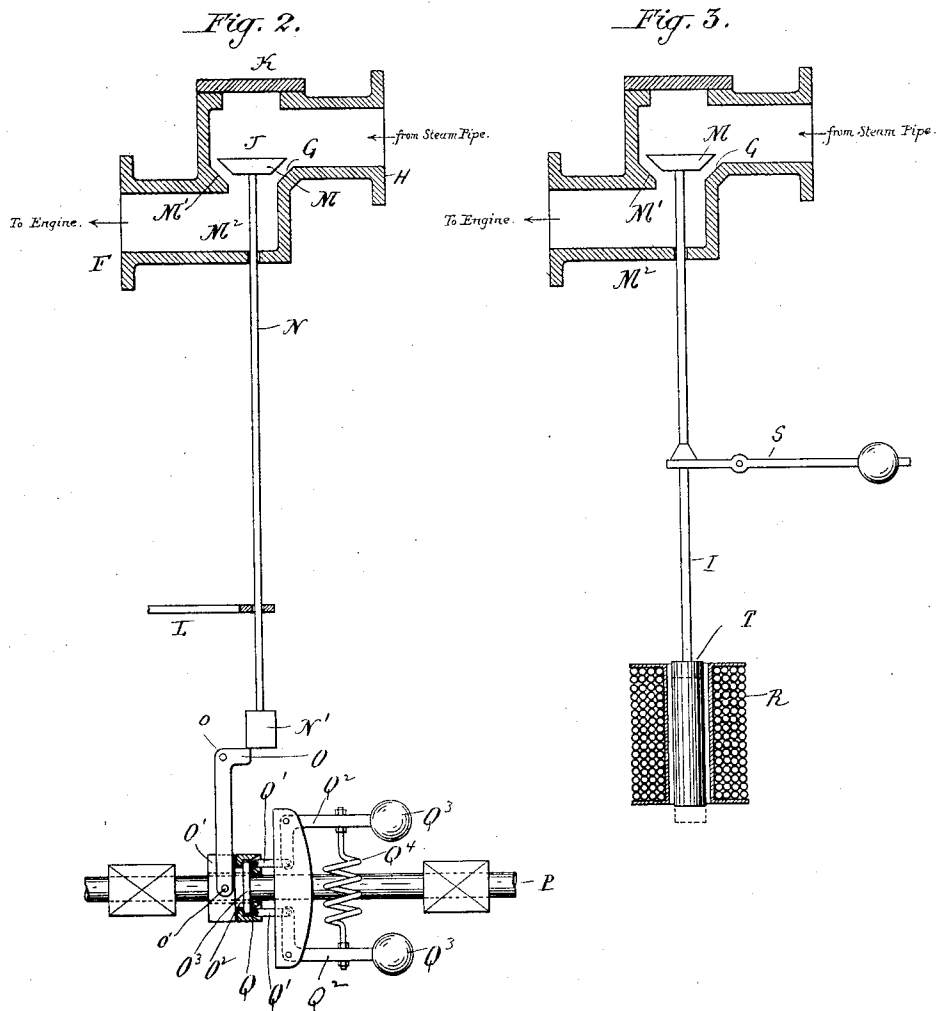
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APPARATUS FOR GENERATING CONSTANT ELECTRIC CURRENTS.

No. 587,921.

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CHARLES N. BLACK, OF NEW HAVEN, CONNECTICUT.

APPARATUS FOR GENERATING CONSTANT ELECTRIC CURRENTS.

SPECIFICATION forming part of Letters Patent No. 587,921, dated August 10, 1897.

Application filed April 26, 1897. Serial No. 633,843. (No model.)

To all whom it may concern:

Be it known that I, CHARLES N. BLACK, of New Haven, in the county of New Haven and State of Connecticut, have invented a new Improvement in Apparatus for Generating Constant Electric Currents; and I do hereby declare the following, when taken in connection with the accompanying drawings and the letters of reference marked thereon, to be a full, clear, and exact description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a perspective view of one form which an apparatus constructed in accordance with my invention may assume, this view also containing a diagrammatic representation of four separate lamp-circuits which are connected in series with and between the independent armature-circuits of an open-coil arc-dynamo; Figs. 2 and 3, detached views showing two of the forms which my improved automatic safety steam cut-off may assume.

My invention relates to an improved apparatus for generating and safely handling an enormous electric current by means of a steam-engine and a constant-current arc-dynamo connected upon the multicircuit plan—that is, with its working or distributing circuits connected in series with and between its independent armature-circuits—the object of the invention being to secure the maximum of economy and safety in generating and handling enormous electric currents, whether the same are used for illuminating, power, or other purposes.

With these ends in view my invention consists in the combination, in an apparatus for generating a constant electric current with a steam-engine having a fixed point of cut off, of a constant-current dynamo connected upon the multicircuit plan—that is, with its working or distributing circuits connected in series with and between its independent armature-circuits—and an automatic steam cut-off constructed and arranged to cut the steam off from the engine when the same exceeds its rated speed.

My invention further consists in certain details of construction and combinations of parts, as will be hereinafter described, and pointed out in the claims.

Before proceeding to the description of the

form of apparatus and the two forms of automatic cut-off which I have chosen for illustration I will briefly set forth the principle on which my invention is based and first so far as the steam-engine is concerned.

It is well known that the power delivered by any steam-engine depends upon the pressure of the steam, the area of the piston, the length of the piston stroke, and the speed. It is also well known that the power required to drive a dynamo depends upon the speed, the number of turns of wire on the armature, the current, and the magnetic flux. If now we make the area of the piston multiplied by twice the length of the stroke multiplied by the speed equal the number of armature turns multiplied by the magnetic flux multiplied by the speed and eliminate these from the power equation, we have left steam-pressure equaling current. Consequently if the steam-pressure is kept constant the current remains constant. In order, however, to maintain the current constant, the speed of the engine must vary. Therefore when there is any change in the external resistance of the circuit connected with the dynamo, causing the current to rise above its normal value or fall below the same, the speed of the engine will respond to the said rise or fall and increase or decrease, so as to restore the current to its normal value. The current being constant in the armature and field circuit of the dynamo the point of commutation is so nearly stationary that no automatic shifting device for the commutator-brushes is required, whereby the dynamo is greatly simplified, both its initial cost and its cost of maintenance being reduced. The engine being run at a fixed point of cut off requires no constantly-acting governor or regulator, the expense of constructing and maintaining which is saved. It is necessary, however, that the pressure of steam supplied to the engine should be practically constant, not varying but a few points one way or the other. The maintenance of the steam-pressure at practically a fixed point is easily provided for, as by the use of automatic dampers, &c.

It will be seen that by taking advantage of the constant and variable factors in the construction and operation of steam-engines and constant-current dynamos and by maintain-

ing the steam-pressure at a practically fixed point I am enabled to operate a dynamo having fixed commutator-brushes and without any regulator by a steam-engine having no governor. One contingency must, however, be provided for, and that is the speeding up of the engine beyond a safe limit, due to the breaking of the circuit or an overload on the dynamo, causing the armature-torque to fall to zero or at least dangerously below its normal value. To guard against this contingency I employ a safety device consisting of an automatic steam cut-off which, it must be understood, does not act all of the time after the manner of a governor or controller, but is normally retired and only acts under abnormal conditions, when it acts to entirely cut the steam off from the engine or to such an extent that its action is, so to speak, killed. In other words, when the speed of the engine exceeds a fixed limit, due to the falling of the current below a predetermined value, the engine is stopped by the action of a safety device which entirely or practically cuts off the steam.

The safety device employed by me may assume a great variety of forms and may be either mechanical or electrical in its character, as will hereinafter appear.

The underlying principle on which my improvement is based, so far as the constant-current arc-dynamo is concerned, is that its working or distributing circuits are arranged in series with and between its armature-circuits, so that although the machine remains automatic in its regulation the current produced in the individual coils or individual sets of connected coils of the armature is prevented from accumulating or piling up, so to speak, whereby the maximum voltage produced by the machine will not be found between any two points in the system, at least under any ordinary conditions of its use. It seems unnecessary for me to further explain at this time the character of the connections of a multicircuit constant-current arc-dynamo, but for a more extended explanation of such a machine reference may be had to my pending applications, serially numbered 591,637, filed May 15, 1896, and 621,347, filed February 1, 1897.

Having now set forth the underlying principles on which my invention is based, I will proceed to describe one of the embodiments of it.

In Fig. 1 of the drawings I have shown a high-speed steam-engine of the center-valve type coupled directly to a constant-current arc-dynamo connected up on the so-called "multicircuit" plan, in which the external circuits of the machine are connected in series with and between independent armature-circuits. I do not limit myself, however, to the use of any particular type of steam-engine or to a constant-current arc-dynamo constructed in any particular way or to directly coupling the engine and dynamo, as they may

be belted together, if desired. Thus a slow-speed engine driving a dynamo by means of a belt or other translating device may be employed. As my invention does not call for any change in the construction of the dynamo or engine further than that the dynamo shall be connected up on the multicircuit plan and that the engine shall have a fixed point of cut off I consider it immaterial to describe either, except in the most general way, as all persons familiar with dynamos and engines will fully understand both from a general description.

The engine A is provided with a throttle-valve B and furnished with three cylinders C, D, and E, all of ordinary construction and arrangement. The main shaft of the engine, which is not shown, is directly coupled by means of a coupling F, of any approved construction and not shown in detail, to the armature-shaft of a constant-current arc-dynamo G, which needs no description further than to say that its commutator-brushes H are fixed and not mounted in automatically-shifting brush-holders; nor has it a governor of any kind. As herein shown, four separate circuits I, J, K, and L are connected with the dynamo on the multicircuit plan—that is to say, they are connected in series with and between the independent armature-circuits, whereby the voltage on the external circuits is kept within safe working limits. It will be observed also that the engine is not provided with any governor or controller with which engines as ordinarily used are invariably provided for controlling the amount of steam admitted to their steam-chests.

In Figs. 2 and 3 I have shown two different forms of automatic steam cut-offs for use in connection with my apparatus, although I would have it understood that still other forms may be employed.

In the construction shown by Fig. 2 I employ a valve M, coacting with a valve-seat M', located in a pipe M², which is itself situated in the line of the pipe which conveys the steam from any suitable source of supply to the cylinder of the engine. The valve M, which is normally open, is mounted upon the upper end of a vertically-arranged valve-stem N, the lower end of which is furnished with a weight N', the edge of which normally rests upon the edge of a pivotal trip O, hung upon a horizontal pin o and pivotally connected at its lower end with a collar O', which is mounted upon the engine-shaft P so as to move readily thereupon, but not so as to rotate therewith, the lower end of the trip being pivotally connected with the said collar by means of a pivot o'. The said collar is furnished with an extension O², having an annular flange O³, which is embraced by a flanged collar Q, mounted upon the shaft for rotation therewith, and also movable lengthwise thereupon and connected by means of two short horizontally-arranged parallel links Q' Q' with the inner ends of two bell-crank

levers Q^2 Q^3 , furnished at their outer ends with balls Q^3 Q^3 and connected together by means of a short coiled spring Q^4 . The weight of the balls Q^3 and the tension of the spring Q^4 are such that the centrifugal force developed by the rotation of the shaft P will never be sufficient to overcome the spring Q and allow the balls to separate so long as the engine does not acquire a speed in excess of a predetermined fixed speed. In case, however, that the circuit of the dynamo should be overloaded or should be broken, relieving the engine of all of the load imposed upon it by the dynamo or of a greater portion of the said load, then the engine will acquire a speed in excess of its predetermined speed. The balls Q^3 Q^3 will then be thrown apart with the effect of moving the flanged collar Q of the shaft, so as to also move the collar O', which in turn swings the trip on its pinion o, so as to clear the same from the weight N', located at the lower end of the valve-stem. The valve-stem being thus deprived of its support, gravity immediately acts to pull the valve down upon its seat, whereupon the entire supply of steam to the engine is cut off and the engine prevented from getting away, so to speak, and running too fast. It will be seen from the foregoing that the valve J acts not as a controlling device in the sense of constantly controlling the steam admitted to the engine, but that it acts as a safety device under such an abnormal condition as has been indicated.

Instead of normally supporting the valve by means of a mechanical trip, such as O', I may employ in lieu thereof a solenoid R, through which the current passes and which acts through the iron core T, located at the lower end of the valve-stem I, to support the valve J in its elevated position, in which it clears the valve-seat M' of the pipe M². If for any reason the current ceases to pass through the solenoid R on account of a break in the external circuit, or if it falls below a fixed value due to an abnormal increase in the load thereof, the core T falls by gravity into the position in which it is shown by broken lines, thereby allowing the valve J to come to its seat M and entirely cutting off the steam from the engine, which is thus immediately checked or stopped and prevented from running dangerously fast or getting away.

In Fig. 3 I have also shown a resetting-lever S, which is employed for lifting the valve-stem back to its normal position. Some such device might also be used with the valve-stem of the construction shown in Fig. 2. Still other forms of automatic safety steam cut-offs may be employed, as it is obvious that the cut-off may assume a great variety of forms.

It will be seen from the foregoing that by means of my invention I am enabled to construct and advantageously use constant-current dynamos without providing them with regulators or automatically-adjustable brush-holders for shifting the commutator-brushes

in response to variations in the current produced by the machine, and this for the reason that the current produced will be approximately constant in correspondence with the approximately constant pressure of steam admitted to the engine. Furthermore, by means of my invention I am enabled to use a steam-engine without the employment of any governor or steam-controller; yet, again, I am enabled to run the engine with its valve set at the most economical point of cut off, whereby the same efficiency is obtained from the steam at light loads as at heavy loads.

By reducing the speed of the dynamo at light loads the friction losses, the hysteresis losses, and the eddy-current losses are all reduced, and consequently a far higher efficiency of conversion is obtained when running at light loads by reducing the speed than by keeping the speed constant. In fact the efficiency of conversion from steam to the electrical current is almost as high at light loads as at heavy loads, the only losses that are not decreased with decrease of speed being the C² R losses in the dynamo.

Under my invention I am enabled to build large constant-current dynamos at a great reduction of expense in their initial cost, as constant-current dynamos of a given weight can be designed to deliver a far greater output without increase in cost by adapting them to be driven at a slower speed when operating at light loads.

In view of the changes suggested herein and of other changes which may obviously be made I would have it understood that I do not limit myself to the exact construction herein set forth, but hold myself at liberty to make such changes and alterations as fairly fall within the spirit and scope of my invention. I am aware, however, that it is old to generate a constant current by varying the speed of a steam-motor operated under a constant steam-pressure and controlled by an automatic cut-off device which operates a steam-valve when the engine speeds up too high. I do not therefore claim such a construction broadly.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an apparatus for generating a constant electric current, the combination with a steam-engine having a fixed point of cut off; of a constant-current dynamo connected upon the multicircuit plan, that is to say, with its working or distributing circuits connected in series with and between its independent armature-circuits, translating devices located in the said working or distributing circuits and arranged in series, and an automatic steam cut-off constructed and arranged to cut the steam off from the engine when the same exceeds its rated speed.

2. In an apparatus for generating a constant electric current, the combination with a steam-engine having a fixed point of cut off,

of a constant-current dynamo connected up on
the multicircuit plan, that is, with its work-
ing or distributing circuits connected in se-
ries with and between its independent arma-
5 ture-circuits, and an automatic cut-off con-
structed and arranged to cut the steam off
from the engine when the same exceeds its
rated speed, and consisting in a valve located
in a passage which conveys steam to the en-
10 gine, a trip-lever, and a spring-controlled
ball-regulator driven by the engine, and con-

nected with the trip which it actuates to move
and release the valve, and allows the same
to close when the engine exceeds its rated
speed.

In testimony whereof I have signed this
specification in the presence of two subscrib-
ing witnesses.

CHAS. N. BLACK.

Witnesses:

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