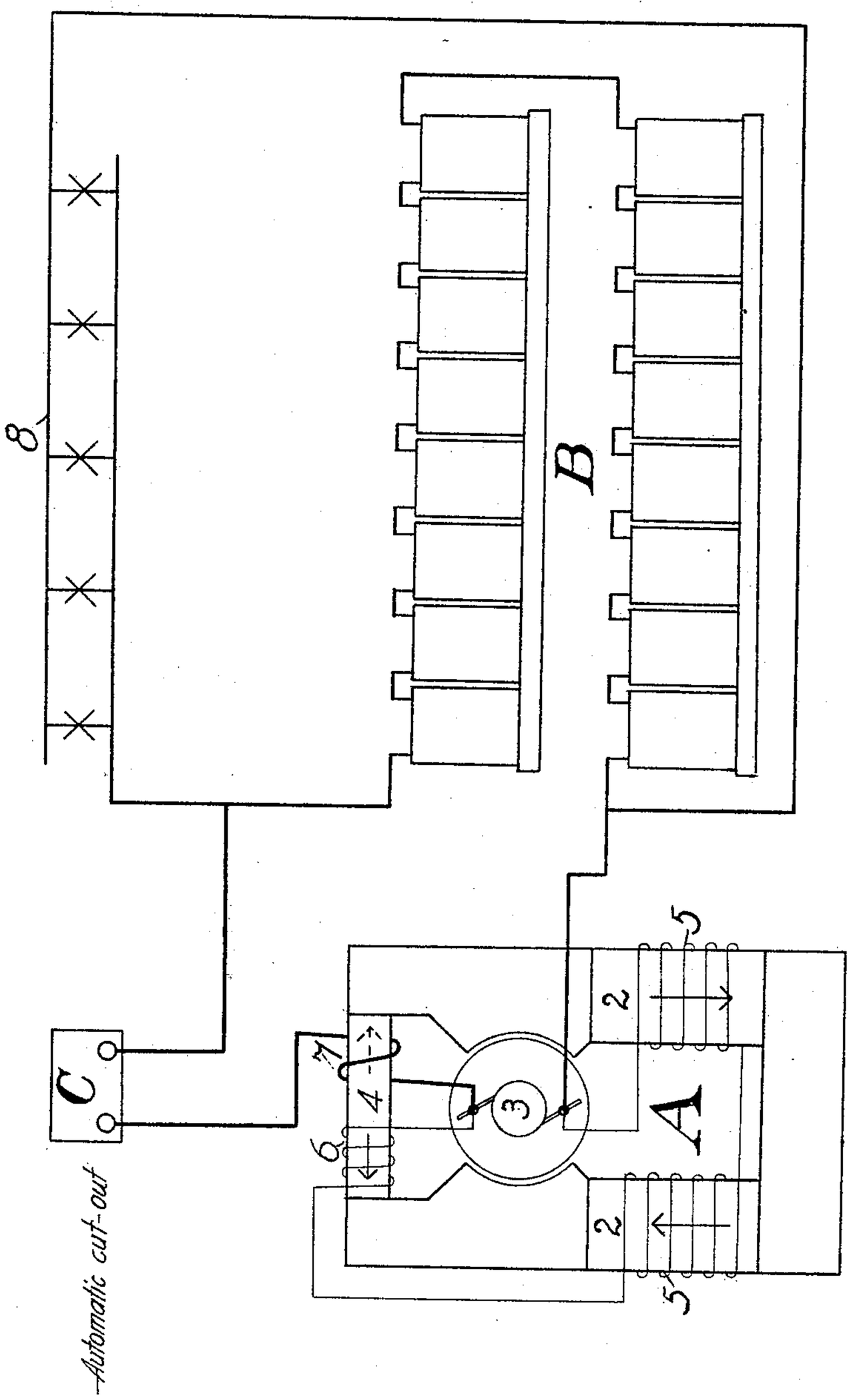
No. 607,125. Patented July 12, 1898.

W. L. NEGBAUR & J. J. FEELY.

METHOD OF AND APPARATUS FOR GENERATING ELECTRICITY.

(No Model.) (Application filed June 17, 1897.)



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METHOD OF AND APPARATUS FOR GENERATING ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 607,125, dated July 12, 1898.

Application filed June 17, 1897. Serial No. 641,131. (No model.)

To all whom it may concern:

Be it known that we, WALTER L. NEGBAUR, of Brookline, and JOSEPH J. FEELY, of Walpole, in the county of Norfolk and State of Massachusetts, citizens of the United States, have invented a certain new and useful Method of and Apparatus for Generating Electricity, of which the following is a specification.

Our invention relates to the generation and utilization of electricity, and more particularly to a method and apparatus for this purpose which will utilize the power derived from a source of motion which is liable to sudden and wide variations, such as wind-power or the power which may be taken from the rotating axle of a car.

For some of the uses of electricity, and especially for electric lighting, a constant pressure on the mains must be maintained, and as the pressure is dependent on the speed produced at the dynamo by the driving power the ordinary methods of electric generation cannot be employed when the source of motion is variable. Special means for regulating the voltage have been tried. Some of them consist in employing compound-wound dynamo having its series winding in opposition to its shunt-winding; but this has been found impracticable, especially as the field-magnets were apt to become demagnetized by the action of such winding.

We have solved the problem of utilizing variable power to generate electricity at constant pressure by providing a system in which a dynamo, in connection with other means, controls the voltage of the whole system automatically without substantial change of its own voltage and without any danger of being itself demagnetized.

In the accompany drawing is shown a diagrammatic representation of a dynamo and connections embodying a preferred form of our invention.

In said drawing, A represents a dynamo which we have devised for our present purpose, having the usual field-magnets 2 2 and armature 3, which parts may be of any preferred design, as they are not peculiar to our machine. The pole-pieces of the field-magnets are connected by an iron core 4, forming a magnetic shunt around the armature.

5 5 are the field-coils, connected in shunt with the armature, and 6 is a coil in series with the field-coils and wound on the iron core 4. All these coils are of high resistance and consist of a large number of turns, as is usual in the case of shunt-wound machines. The sizes of the coils 5 and 6 are such that, neglecting any effects due to the action of the coil 7, hereinafter described, the intensity of magnetization produced in the magnetic shunt 4 by a given current will be the same as that produced in the field-magnets 2 2, and these coils are so wound that the magnetic lines of force produced by all of them will be driven through the armature in the same direction, as indicated in the drawing by the full-line arrows.

7 is a coil of relatively heavy wire and few turns in series with the external circuit and wound on the iron core 4 in such manner that the magnetic lines produced by a current passing through said coil will oppose and cut down those produced by the coil 6.

B is a storage battery into which the current generated by the dynamo A is passed and which with its connections to the dynamo, including the coil 7, may form the entire external or working circuit of the system, although, as will presently appear, a shunt-circuit may be led off from said battery and be used to supply lamps or to perform other useful work. This battery may consist of cells of any approved type.

C is a switch preferably made automatic in its action by being separately connected in the system and so constructed that when the dynamo is running at speeds too low to produce a useful voltage the working circuit will be kept open thereby, but will be closed as soon as the voltage reaches a predetermined point and will remain closed only so long as the voltage is at or above that point. This switch may be of any approved construction, as its details form no part of our present invention. A satisfactory switch for the purpose is shown in Letters Patent of even date herewith, granted to W. L. Negbaur for an electric switch.

In constructing and setting up our system we proceed as follows: Having determined what the working voltage of our dynamo is to

be, we assume a minimum speed, (the best practical rate of which in the case of a particular variable power may be determined by experiment,) and from these data we calculate the size of our armature and field-magnets and the coils therefor in the usual manner, as these parts do not differ from the corresponding parts in an ordinary shunt-wound dynamo. We then determine by calculation or experiment the highest speed which our source of power is to give to the armature when the output of the dynamo is at its maximum and construct the iron core 4 of such cross-section that the sum of the cross-sections of said core and of the field-magnets will be to the difference of said cross-sections (the cross-section of the core always being the lesser of the two) in the same ratio that the maximum speed of the armature is to its minimum speed, as determined in the manner above described. Having thus determined the size of the core 4, the coil 6 is so proportioned, as above stated, that it will tend to magnetize said core to the same intensity that the field-coils magnetize the field-magnets 2 2. Finally the coil 7 is given such size that when the dynamo is running at its highest speed, as above determined, the effect of the current through the coil 7 will just neutralize the effect of the coil 6. What the strength of this current will be will clearly appear from the subjoined description of the operation of the system.

The proportions just given of the several parts of our dynamo are those which we have found most efficient in practice, but they may be considerably varied without departing from our invention.

The storage battery is composed of sufficient elements to yield the constant voltage of the system, and the switch C is made to operate at that voltage.

As thus constructed the operation of our system is as follows: After the switch C closes the external circuit the storage battery opposes to the voltage of the dynamo a counter electromotive force which is steady and practically constant. When the voltage of the dynamo tends to rise above that of the battery, the current thus generated through the battery passes also through the coil 7 and instantly operates to cut down some of the magnetic lines of force produced by the coil 6, so that the flux through the armature is lessened not only by the number of lines thus neutralized, but also by an additional number produced by the field-coils, which leak or are shunted around the armature through the core 4, its intensity of magnetization having been diminished by the action of the coil 7. This diminution of the flux through the armature reduces the voltage of the dynamo nearly to that of the battery, the excess being just sufficient to maintain such a current through the coil 7 as is necessary to reduce the flux through the armature and establish the requisite balance between the speed and the voltage of the dynamo. Thus, strictly speaking, our dynamo does not act to keep its own voltage constant, but does keep within very narrow limits the difference between its voltage and that of the storage battery, and by keeping the external resistance very small, as is the resistance of a storage battery, this voltage difference will produce a current which will vary sufficiently with varying speeds to keep said voltage difference within practical limits. The storage battery acts as a reservoir for this varying current and converts into stored energy the excess over what is being used by the rest of the system. When the supply of power falls too low to generate the necessary voltage, the switch C opens the external circuit, in which case the voltage of the dynamo for all lower speeds varies with the speed, as the regulating device is for the time being inoperative.

It will be seen that no depolarization or demagnetization of the field-coils of our dynamo can possibly occur, for at the highest calculated speed of the dynamo the coil 7 does no more than completely neutralize the coil 6, and its action cannot reduce the magnetism of the field-magnets at all, even if the speed runs still higher than was designed for, because even if the current in the coil 7 overpowers the coil 6 and generates a magnetic flux in the opposite direction this will not affect the polarity of the field, but will tend to draw the flux produced by the field-coils through the shunt 4 by giving the same a pronounced polarity.

A shunt-circuit 8 may be connected to the terminals of the battery B, which circuit, by virtue of the automatic regulation above described, will have a practically constant difference of potential at its terminals, and thus a number of lamps may be kept burning steadily even while the dynamo is sending a variable current through the battery, as the lamps will consume as much of the current as they require, while the rest will be taken up by the battery. In the same manner this shunt-circuit is of course capable of performing other useful work.

From the foregoing description it will be seen that the method of operation of our invention is briefly this: We design a dynamo which at a given minimum speed shall generate a given voltage. To this voltage we oppose an independent steady voltage of nearly equal amount and automatically keep the difference between these two voltages within relatively narrow limits by means of a varying magnetic leakage around the armature of the dynamo, produced by impressing this small varying difference of voltage on a circuit of low resistance. Finally we provide for the utilization of the current thus produced. If our variable source of power is liable to fall so low at times that it will not generate a sufficient voltage, we then employ a switch whereby the working circuit may be broken when no useful effect is being

produced; but if the source of power is always adequate to produce some useful result, as in the case of water-power, then no switch C need be used.

Our preferred form of switch, being the one shown in the Letters Patent to Negbaur above referred to, operates to close the external circuit when the voltage generated by the dynamo just equals the counter electromotive force of the storage battery, so that the current sent through the external circuit starts from zero and increases from that point as the speed of the armature increases. If the voltage of the dynamo falls below that of the storage battery, then the switch opens the external circuit.

The field-coils of our dynamo and the coil 6, being of high resistance, receive a current which varies but little after the dynamo has begun to generate its constant voltage, and of course it would be an obvious modification of our invention to supply these coils with a current from some source external to the system, such as a storage battery.

The voltage of the storage battery of course varies according to the extent to which it is charged. Our system, however, is capable of being operated by wind speeds as low as six to eight miles per hour, which are shown by statistics to be the most frequent in the United States of all wind speeds and to occur nearly every day of the year, so that we are able to use a small battery and to charge it at frequent intervals, and thus keep its voltage from varying to any great extent. So far as we are aware there has been no system prior to our present invention which would generate a current at low wind speeds and also regulate itself at high wind speeds without danger to its working parts, and hence the regulation of these prior systems was defective, because, in addition to other reasons, the storage battery could not be charged often enough to make the system practical, on account of the infrequency of the high wind speeds.

While we have described our invention as more particularly intended for the transforming of wind-power, we do not consider ourselves to be limited to its use for this purpose, as it may be made useful in connection with any variable and sufficient source of power and will successfully transform the same whether its variations be great or small, regular or irregular, sudden or gradual, intermittent or continuous. When the source of power is liable to variations which are sudden rather than gradual, we prefer to drive our dynamo by means of the mechanism shown and described in Letters Patent No. 554,138, granted February 4, 1896.

By disconnecting the source of power and sending a current through our dynamo it may be run as a motor, and will then tend to preserve a constant speed regardless of the load.

We claim as our invention—

1. The herein-described method of generating by a dynamo electricity of practically constant pressure from a source of variable motion which consists in opposing to the generated voltage an independent, steady voltage, and automatically keeping the difference between the two voltages within narrow limits by impressing it on a circuit of low resistance and causing the resulting current to vary the magnetic conductivity of a magnetic shunt around the armature of the dynamo, for the purpose set forth.

2. In a system for generating electricity, a dynamo adapted to be driven at varying speeds and provided with means for keeping its voltage practically constant, comprising a magnetic shunt around its armature and means for varying the magnetic conductivity of said shunt and thereby automatically regulating the magnetic flux through the armature, for the purpose set forth.

3. In a system for generating electricity, a dynamo adapted to be driven at varying speeds and provided with means for keeping its voltage practically constant, said means comprising a magnetic shunt around its armature, a high-resistance coil on said shunt, and a low-resistance coil on said shunt in series with a low external resistance, said coils producing opposite polarities, substantially as described.

4. In a system for generating electricity, the combination with a storage battery of a dynamo adapted to be driven at varying speeds, said dynamo having a magnetic shunt around its armature and means for varying the magnetic conductivity of said shunt and thereby automatically regulating the magnetic flux through the armature, for the purpose set forth.

5. In a system for generating electricity, in combination with a storage battery, a dynamo having a magnetic shunt around its armature, a high-resistance coil on said shunt adapted to be fed with a practically constant current, and a low-resistance coil on said shunt connected in series with the external circuit and producing an opposite polarity to that of the first-mentioned coil, for the purpose set forth.

6. In a system for generating electricity, in combination, a dynamo adapted to be driven at varying speeds, and having a magnetic shunt around its armature and means for varying the magnetic conductivity of said shunt and thereby automatically regulating the magnetic flux through the armature, a storage battery, and an automatic switch arranged to close and open the external circuit, substantially as described.

7. In a system for generating electricity, the combination with a storage battery of a dynamo adapted to be driven at varying speeds, said dynamo having a magnetic shunt around its armature, a high-resistance coil on said shunt, and a low-resistance coil on said shunt connected in series with the external circuit and producing an opposite polarity to that of

the first-mentioned coil, and an automatic switch arranged to close and open the external circuit, substantially as described.

8. In a system for utilizing variable power for generating electricity at a practically constant pressure, the combination with a storage battery of a dynamo the voltage of which is automatically regulated as herein described by means of an electromagnetic shunt around its armature, whereby the voltage of the storage battery may be kept practically constant, substantially as described.

In testimony whereof we have hereunto subscribed our names this 15th day of June, 1897.

WALTER L. NEGBAUR.
JOSEPH J. FEELY.

Witnesses:
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