E. M. TORMIN.

DYNAMO.

APPLICATION FILED JAN. 27, 1912.

1,108,087.

Patented Aug. 18, 1914.

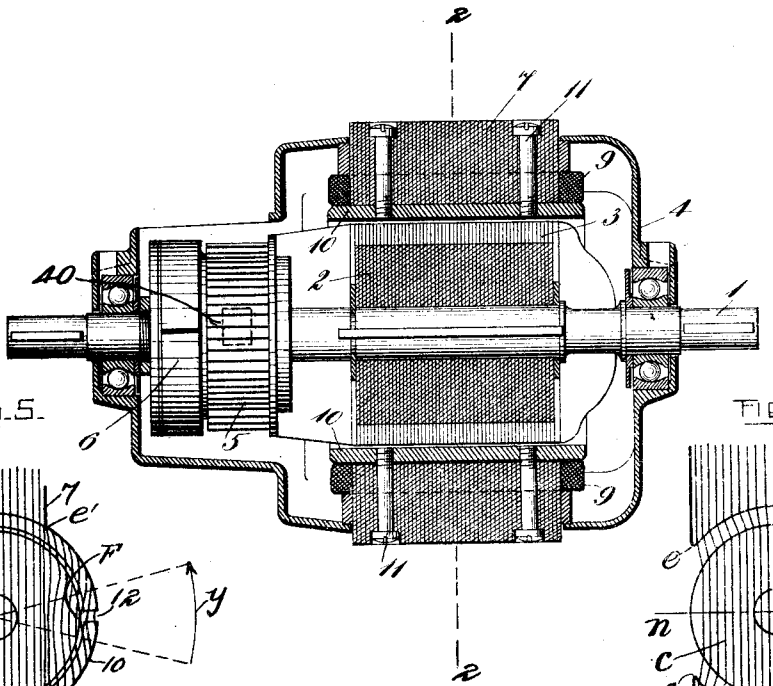


Fig. 1.

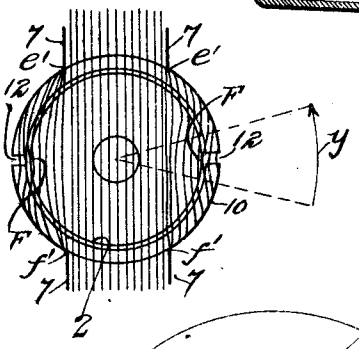


Fig. 5.

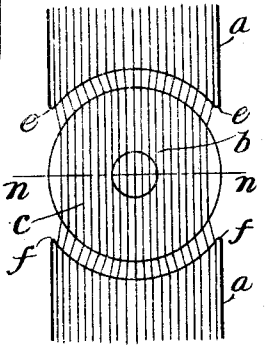


Fig. 4.

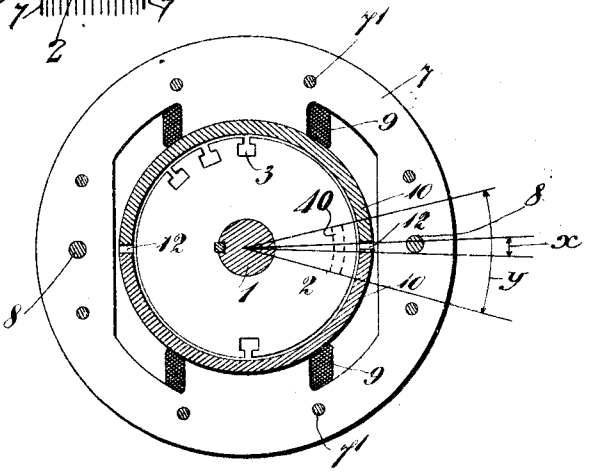


Fig. 2.

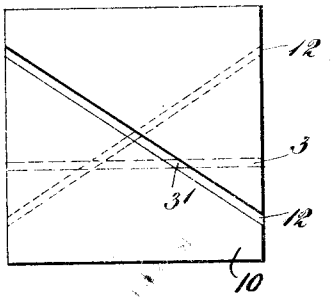


Fig. 3.

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DYNAMO.

1,108,087. Specification of Letters Patent. Patented Aug. 18, 1914.

Application filed January 27, 1912. Serial No. 673,724.

To all whom it may concern:

Be it known that I, EGMONT M. TORMIN, a subject of the German Emperor, and a resident of Newton Center, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Dynamos, of which the following is a specification.

The present invention relates to dynamo electric machines and more especially to direct-current lighting machines.

The principal object of my invention is to provide a self-regulating variable-speed dynamo, which may be subjected with impunity to excessively high rotational speeds and which is especially adapted to be driven by a motor vehicle such as an automobile for generating current for the lamps and other electrically-actuated devices carried thereby. Preferably a storage battery is "floated on the line", that is, connected across the external circuit, and a speed-controlled cut-out provided, whereby the external circuit is held open until the dynamo attains a certain minimum speed of rotation, such cut-out, however, constituting no part of the present invention and comprising the subject matter of my divisional application Serial No. 712,504, filed July 31, 1912.

Other objects of my invention are to improve and simplify the construction of the machine and increase the efficiency thereof in the manner hereinafter more fully set forth.

My invention comprises a direct current dynamo electric machine so constructed and arranged that the current output will gradually rise as the speed of rotation of the armature or the rate of travel of the motor vehicle increases until a certain critical speed or rate of travel has been reached beyond which the current output will no longer increase and may in fact decrease. This is the essence of my invention. Inasmuch as the armature of a motor-vehicle lighting-dynamo is often subjected to excessively high rotational speeds, it is absolutely necessary that means be provided to prevent the current output from increasing with such armature speed beyond a certain critical point, for otherwise the machine would be burnt out by the excessive current generated.

Heretofore it has been proposed to employ centrifugally-operating devices whereby the speed of the armature was rendered independent of the rate of vehicle travel and was prevented from increasing beyond a certain maximum; but such devices were subject to certain limitations and objections. By means of the present invention they may be eliminated because my dynamo is so arranged that beyond a maximum speed the current output is rendered practically independent of the rate of car travel.

An illustrative embodiment of my invention is shown in the drawings which accompany and form a part of this specification.

In the drawings—Figure 1 is a longitudinal section of a dynamo constructed in accordance with the present invention, Fig. 2 is a transverse section taken on the line 2—2 of Fig. 1, Fig. 3 is an elevation of the pole piece, Fig. 4 is a diagram showing the distribution of the magnetic flux in the usual bi-polar machine, when the armature is stationary and the fields separately excited, and Fig. 5 is a diagram showing the distribution under similar conditions of the magnetic flux in my improved machine.

In the particular drawings selected for more fully disclosing the principle of my invention, 1 is a shaft suitably journaled in the frame 4 and carrying the armature core 2, which is preferably laminated and which may be provided with the slots 3. Secured to the shaft are the commutator 5 and the speed-controlled cut-out 6, such as described in my divisional application above referred to.

The field magnet 7, preferably laminated and consisting as shown in the present instance of soft iron disks held together by the rivet 7′ is secured to the frame in any suitable manner, as for example, by the bolts 8, and it carries the winding 9 which preferably is a shunt winding. Pole-pieces 10, herein shown as solid, are secured to the field-magnet in any suitable manner, as for example by the bolts 11. The two pole-pieces 10, 10 are separated preferably by the narrow gaps 12, 12, the peripheral length of each of which is small with respect to the circumferential length of the pole-pieces themselves. The gaps as shown in Fig. 3

may be inclined with respect to the axis of the machine for the purpose hereinafter more fully set forth. The angle x subtended by the peripheral length of one of the gaps 12 is equal to, or preferably as shown, smaller than the angle of commutation y, *i. e.*, the angle subtended by the peripheral length of a commutator brush (see Fig. 2) so that a plurality of armature coils is short-circuited under the pole-pieces in a strong magnetic field by the brushes, and therefore the back electromotive force developed at their terminals by such short-circuiting is greater than if they were short-circuited in a practically zero field as has heretofore been customary.

As is well understood, in the bi-polar dynamo of the prior art, the "neutral line" which is the line joining the "neutral points", or the points at which the brushes must be placed for minimum sparking, is not exactly at right angles to the line joining the centers of the pole-pieces, but is shifted a few degrees from such central line in the direction of rotation on account of the concentration of the field under the leading pole-tip and its weakening under the trailing pole-tip. In such machines each pole-piece does not in general subtend at an angle greater than from ninety to one hundred and twenty degrees, so that the angle subtended by the peripheral length of each gap between the pole-pieces is usually relatively large, the peripheral length of such gap being comparable to the circumferential length of the pole-pieces themselves and the angle subtended by such peripheral length of said gap being of course very much larger than the angle of commutation. An example of this construction is shown diagrammatically in Fig. 4, in which a, a, represent the pole-pieces and b the armature. The distribution of the lines of force when the armature is at rest and the field separately excited is represented by the lines c. It will be seen that the line n—n is the neutral line above referred to and that there is practically no flux in the gaps e—f, e—f, between the leading pole-tip e of one pole of the trailing pole-tip f of the other. Therefore when the brushes are placed at points a few degrees beyond the neutral points in the direction of rotation, practically sparkless commutation may be obtained because there is a practically zero magnetic flux at these points, and hence practically no current flowing in the coils at the moment they are short-circuited by the brushes. For this reason, practically no back electromotive force is developed at the terminals of the short-circuited coils during commutation. In such a machine the current output, *caeteris paribus*, is substantially a linear function of the speed of rotation of the armature, the electromotive force increasing directly with the relative motion between the armature coils and the flux lines, *i. e.*, the "rate of cutting", and such back electromotive force as is developed in the short-circuited coils during commutation correspondingly but not disproportionately increasing. In my improved dynamo, however, I so arrange matters that the coils shall be short-circuited by the brushes in an intense magnetic field, so that there shall be a relatively large current in each coil at the beginning of commutation and a relatively large reverse current therein at the end of commutation, and therefore a relatively large back electromotive force developed at the terminals of such coils during commutation. The back electromotive force in my variable speed machine is produced in the same way as in constant speed machines and other direct current generators, namely, by the closing and opening of the coil circuit every time the segments to which the terminals of such coil are connected make and break contact with a brush and by the inductive effect due to decrease, reversal, and increase of current in the coil during commutation. Inasmuch as this back electromotive force opposes the direct electromotive force, it cuts down the current output of the machine. As the rotational speed of the armature is raised, the current increases but not proportionately with such increase in speed, the current increase being very gradual as the armature speed approaches the critical point, and after the critical point has been passed the back electromotive force increases at a more rapid rate than the direct electromotive force, thereby preventing any further increase in current strength and keeping such strength practically constant or, when excessive speeds are attained, gradually reducing the same.

As above stated, a battery is preferably connected across the line and the voltage across the brushes is therefore nearly constant at all speeds. In such case the back electromotive force alone rises as the velocity of the armature increases and becomes unusually high for high velocities, thereby keeping the current output of the dynamo practically constant, or even causing the same to fall off for excessively high speeds beyond the critical speed above referred to. It will be understood of course that it is by no means necessary to employ a battery connected across the line in order to accomplish the object of my invention.

The manner in which I am enabled to intensify the back electromotive force developed at the terminals of a short-circuited coil during commutation may be more fully explained by reference to Fig. 5. It will be seen that the spaces e—f, e'—f' are almost completely occupied by the pole-pieces 10 and that there exists between said pole-pieces but a narrow gap 12, the peripheral

length of which is very much smaller than the circumferential length of the pole-pieces and that the angle subtended by the peripheral length of each gap is very much smaller than the angle of commutation γ, so that in the commutation zone there exists a strong magnetic flux F which enters the armature by way of one pole-piece and leaves it by way of the other.

Inasmuch as the air-gap or the gap between the armature and pole piece is much smaller than one-half the length of the gap 12 between the pole-pieces, as clearly shown in Fig. 2, the reluctance of the circuit across the gaps 12 is greater than that from one tip to the armature to the other tip, and while there may in fact be a certain small amount of leakage across the tips, such leakage will not materially affect the creation of an intense magnetic field in the commutation zone as distinguished from the practically zero field in such zone as shown in Fig. 4. However, as above pointed out, for sparkless commutation it is necessary to place the brushes at the neutral points of zero or practically zero flux, and inasmuch as the brushes 40 in the present case are located at points where the flux is intense, undue and in fact destructive sparking would take place at said brushes during commutation unless suitable precautions were taken to prevent or minimize the same. In order to reduce such sparking I preferably provide the armature with a relatively large number of coils, for example, fifty, so that by virtue of this large subdivision, a comparatively small counter electromotive force will be developed at the terminals of each coil on short-circuit and a relatively small and practically harmless spark be thereby created between the brushes and the armature segments with which the coil undergoing commutation is connected. If the total electromotive force of the machine as measured across the brushes, be divided among fifty coils, the electromotive force as well as the counter electromotive force per coil will be only half as great as if twenty-five coils were used, only one-fifth as great as if the armature were wound with ten coils, and so on. On account of this high sub-division, a comparatively large number of commutator segments, for example, as many as four, will simultaneously be in electrical contact with each brush. This is rendered necessary because a narrower brush, for example one spanning only two segments, would not have a sufficiently large cross-section to carry the current output. In this case a relatively large number of armature coils, as many as three, are simultaneously short-circuited. By means of this large sub-division of the armature winding, sparking at the brushes is reduced below the danger point, being in fact practically eliminated. Such reduction or elimination of sparking is assisted by the use of the wide brush necessarily employed, which lengthens the time the coil is undergoing commutation, for the amount of sparking produced on commutation is well known to be an inverse function of the time during which a coil remains short-circuited. If the gaps 12 were parallel with the axis of the armature and therefore with the armature slots 3, the sudden passage of each slot with its included coil across the gap 12 would produce a loud humming noise; but by placing the armature slots and said gaps at an angle with each other, as for example by inclining the gap as shown in Fig. 3, a portion only of each winding is under a gap as shown at 3', and thus by the gradual passage of an armature winding across the gap, the humming noise above referred to is eliminated.

It will be understood that I do not limit myself to the particular embodiment of my invention which I have described and illustrated, inasmuch as various modifications may be made by those skilled in the art in the apparatus specifically described without departing from the principle of my invention; but

Having thus described one illustrative embodiment of my invention, without, however, limiting the same thereto, what I claim as new and desire to secure by Letters Patent is—

1. In a direct current dynamo electric machine, a field magnet and pole pieces secured thereto, the pole pieces being separated by narrow gaps of which the peripheral length is very short compared to the circumference of said pole pieces and said gaps being inclined to the axis of the machine.

2. In a variable-speed dynamo electric machine, the combination with a field magnet having pole-pieces and means for directing a portion of the magnetic flux developed by said field-magnet into the commutation zone, of brushes having the minimum cross-sectional area required to carry the current output and an armature having such a relatively large number of coils that a comparatively large number thereof will be simultaneously short-circuited by said brushes, the angle subtended by the peripheral length of the gaps between said pole-pieces being equal to or smaller than the angle of commutation.

3. In a variable-speed dynamo electric machine, comprising means whereby the current output for rotational speeds of the armature beyond a given critical speed is either constant or decreases with such speed of rotation, the combination with brushes having the minimum cross-sectional area required to carry the current output and an armature having such a relatively large

number of coils that a comparatively large number thereof will be simultaneously short-circuited by said brushes, of a field-magnet having pole-pieces, the angle subtended by the peripheral length of the gaps between said pole-pieces being equal to or smaller than the angle of commutation.

In testimony whereof, I have hereunto subscribed my name this 22nd day of January, 1912.

EGMONT MAX TORMIN.

Witnesses:
T. W. NESS,
EDW. C. NEWCOMB.