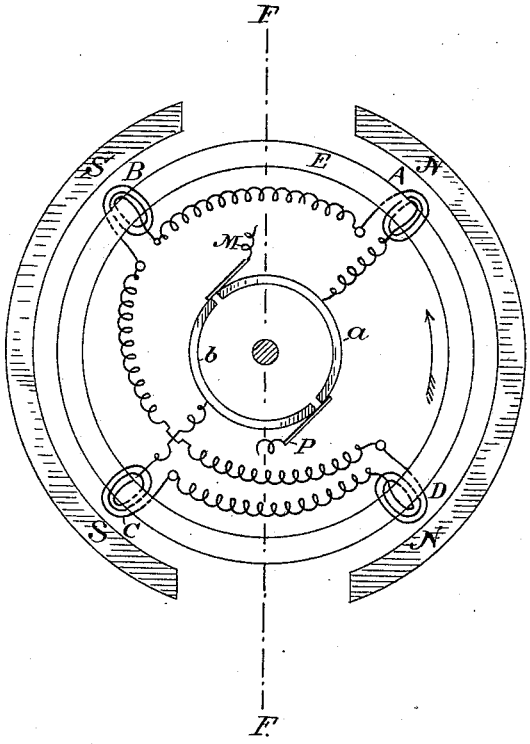
(No Model.)

A. G. WATERHOUSE.

DYNAMO ELECTRIC MACHINE.

No. 304,383. Patented Sept. 2, 1884.



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DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 304,383, dated September 2, 1884.

Application filed February 7, 1883. Renewed February 12, 1884. (No model.)

To all whom it may concern:

Be it known that I, ADDISON G. WATERHOUSE, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a specification.

My invention relates to the manner of connecting the armature bobbins or sections to one another and to the commutator; and it consists in such a disposition of the commutator-brushes with relation to the neutral point of an armature section or bobbin, and such a connection of the several bobbins making up a set to one another and to the commutator, that the change of the commutator-brushes from one segment to another shall take place, not when the armature sections or bobbins are passing the neutral line, or line of reversal of current in the magnetic field, but when said bobbins are to either side of said neutral line and are generating current, said bobbins being, however, so connected to one another that the currents generated in the several bobbins of the set will oppose one another at the time the brushes change, and thus prevent any injurious effects upon the commutator. According to my arrangement, no bobbin is cut out at its neutral point; but when any bobbin of the set is at such point other bobbins of the set are generating useful current, and an effective current from the bobbins is conveyed to the commutator-brushes. It will further be seen from the subjoined description that even at the time of change of current in the whole system or set of coils connected to the commutator the system is not disconnected from the brushes, but is short-circuited for an instant as the brushes pass the commutator-slot and change from one segment of the commutator. Owing to the peculiar connections, no injurious effects follow the short-circuiting of the set, and when several sets are connected in series—that is, when the brushes of one set are connected for tension to the brushes of another occupying a different position on the armature, so as to generate a strong current while the current supplied by the first set is weak—the duration of the short-circuiting may be considerably prolonged.

The drawing is a diagram of the connections of the armature sections or bobbins and the commutator, and illustrates the principles of the invention, which may be applied to any ordinary form of dynamo-machine, but is here shown as applied to what is known as a "ring-armature."

E indicates a ring-armature of ordinary construction, that is supposed to revolve between north and south curved field-of-force poles, N S, in the ordinary way.

A B C D indicate four armature sections or bobbins applied to the armature in the usual way, and forming together an armature set of bobbins, which may embrace all of the armature-coils, or a portion only of the same, the remaining coils comprising, in the latter case, one or more other sets similarly disposed with relation to one another and a commutator, but having an angular or circumferential displacement with relation to the first set, the amount of which would obviously depend upon the number of sets. If but one other set were employed, alternating with the first, the displacement of the sets and of the line of change on the commutator would obviously be forty-five degrees.

The bobbins A B C D are placed at equal distances apart around the armature, and are connected to one another and to the two equal segments *a b* of the commutator in the following manner: Let it be supposed, for the sake of simplicity, that the bobbins are similarly wound, or wound in the same direction, proceeding entirely around the armature; then the inner end of A is connected to a commutator-plate, *a*, and its outer end to the inner end of B, the outer end of the latter to the outer end of D, and the inner end of D to the outer end of C, the inner end of C being connected to the plate *b* of the commutator. Under such arrangement the inner end of every bobbin, in passing the one pole, will be of one polarity, say, positive, and its outer end negative, while, in passing the opposite pole, its inner end will be negative and its outer positive, so that, as will be obvious, the currents generated in A and B will oppose one another when said

bobbins are in opposite fields, and under similar conditions the currents in bobbins C D will oppose one another. If said bobbins occupy analogous or similar positions, the current generated by the system and supplied to the commutator-brushes will be *nil;* but if the armature be revolved and the tension of B and D rises, while that of A C decreases, current will be supplied to the brushes; while, further, if A and B are passing in the same field, and, similarly, C and D are passing through an opposite field, the currents of A and B will assist one another and be combined, for tension, with the currents in C D.

F F indicate the neutral line, or the line on which, theoretically, the polarity of each armature bobbin or section reverses, though in practice such line is shifted in the direction of the armature, as is well known.

P M are the two ordinary commutator-brushes, which may be termed "positive" and "negative," respectively, and are so applied to the commutator that they will shift from one division to the other, or pass the neutral line of said commutator approximately, when the set of armature bobbins or sections occupy the position shown with relation to the neutral line F F, or the line on which the polarity of each bobbin changes—that is, when the two upper bobbins, A B, are on opposite sides of the neutral line, and similarly placed with relation thereto, while the two lower bobbins have a similar position.

In the position of the parts shown there will be a short-circuit path for the set of armature-bobbins through the brushes, which pass from one segment to the other without breaking contact; but there will be no flash, although said bobbins may be in active magnetic fields and not near the neutral line F F, as will be obvious from a consideration of the polarities of the currents and the connections of the bobbins. Thus, if, as before supposed, the inner ends of bobbins A and D be positive, while the inner ends of B and C are of the opposite polarity, the outer end of A will be negative, so that it will oppose and neutralize the current in B. Similarly, the current in D will neutralize that in C, and, although there is a complete circuit through A B D C, no current will appear at the segments *a b*. Let it be supposed, however, that the armature turns and brings brush M full onto *a*, and brush P full onto *b*. As the bobbins move B and D away from the neutral line and A and C toward it, the electro-motive force of the currents in the two bobbins that are leaving the neutral line F F will begin to rise, and the electro-motive force of the current in the two that are approaching the neutral line to fall; but the currents in B and D will assist one another and will act in opposition to the counter electro-motive force in A and C, and the current or electro-motive force at *a* and *b* will be represented by the difference between that of A C and of B D, and will continue as they approach the neutral line; but when they reach said line their opposing effects will drop to zero, and B and D, which are now supplying current of high tension, will together supply current to the segments unopposed. On line F F, although the current in A and C is *nil*, and they are about to change their polarity, they are nevertheless not cut out, but are retained in circuit, and in connection with the commutator-brushes. When A and C pass said line, their inner ends will respectively become of the same polarity as the inner ends of B and D, so that the currents of all four bobbins will be combined for tension, and will pass in the circuit M, *a*, A, B, D, C, *b*, and P, in obvious manner. A, B, D, and C will continue to assist one another through the next ninety degrees of revolution, or until B and D reach and pass the neutral line F F, on which line said bobbins are not cut out or short-circuited, but are retained in circuit. As B and D pass said line, their polarity reverses, and their inner ends become of the opposite polarity to the inner ends of A and C, so that said bobbins begin to act in opposition to A and C with a gradually-increasing effect as they leave the neutral line, and the current supplied by the set is that due to the difference in electro-motive force between A C and B D, until the armature reaches a position in which the four bobbins are generating current of practically the same electro-motive force, at which time practically no current comes from the system, and the brushes change from one segment to another, ready for the change in the direction of resultant current which comes when B and D overbalance C and A. Said brushes may overlap the break between *a* and *b* for a distance depending upon the time during which the electro-motive force of the bobbins on one side is practically equal to the opposing electro-motive force of the bobbins on the other side. It will thus be observed that during one hundred and eighty degrees, at least, of revolution the four bobbins all work together and assist one another, while, in the other position of revolution succeeding each ninety degrees, during which they assist, the current is due to the difference of electro-motive force between B D and A C, but may even then be quite strong, because while B D or A C, as the case may be, are in a strong field the other two or the opposing bobbins will be generating current of comparatively small electro-motive force. The current of the system will, however, fall as the bobbins A D on one side and B C on the other approach the position in which they are symmetrically disposed with relation to the neutral line F F, and are consequently generating current of practically the same electro-motive force, and the equal effects in A D on the one side are, owing to the peculiar connections, counterbalanced by the equal effects in B C, respectively. The period during which there is a practical neutralization of effects in the bob-

bins on the two halves of the armature will determine the time during which they should be short-circuited, or the distance of overlap of the brushes upon the two halves of the commutator—that is, the time during which they may be kept in simultaneous contact with said halves.

The time of short-circuiting may be instantaneous only, or it may be increased, this being a matter to be governed by the length of the field-poles N S, the nature of the magnetic field, the absence or the presence of another set of bobbins, one of whose commutator-brushes may be connected for tension with A B, a brush, P or M, and which set may therefore, at times, be in circuit with A B C D. If such second set be employed, A B C D should obviously be short-circuited for a longer time, or until their resultant electro-motive force may be such that said bobbins can be placed in series with the other set without sacrifice of efficiency.

As before stated, my machine is peculiar, in that the armature-bobbins are not cut out in the neighborhood of the neutral line F F, and also in that the line of change of the commutator-brushes is determined by the peculiar connection of the armature bobbins or sections, which causes an equality of counter electro-motive forces in said bobbins at a certain point in their path, not the point at which the current of said bobbins individually reverses or becomes *nil*.

I have described the bobbins as wound in the same direction. It is obvious that they each might be wound in any direction, provided that that end of each bobbin which is of the same or certain polarity in passing the same portion of the field be connected in a manner corresponding to the connections of the inner ends of the bobbins wound as herein shown, and that the opposite ends of said differently-wound bobbins have connections corresponding to those of the outer ends of A B C D.

What I claim as my invention is—

1. The herein-described improvement in the method of connecting and commutating the bobbins or coils of a dynamo-electric machine, consisting in so connecting the coils or bobbins of an armature system that at one portion of the revolution of the armature the total current supplied by the system will be *nil*, owing to the opposing polarities in such system of the currents coming from the various coils or bobbins, and in applying or setting the commutator so as to change or pass the divisions of the commutator at or near the time that such opposition and neutralization of currents in the system takes place.

2. The combination, in a dynamo-electric machine, of a series or system of armature bobbins or coils, a commutator whose brushes are arranged to overlap the commutator segments or plates at the point of change from one plate or segment to another, so as to short-circuit the system at such point, and connections between those ends of the armature-bobbins that are at such time positive and negative, such that the current supplied by the system will be *nil*, owing to the opposition of the currents of the various bobbins.

3. The combination, with a set or system of armature-bobbins, and the commutator by which the current supplied by such system is collected, of suitable connections between those ends of the armature-bobbins that are positive and negative at the time of change on the commutator, whereby the current will at such time be *nil*, owing to the conflicting polarities of the various bobbins.

4. The combination, with an armature system consisting of four bobbins or coils disposed symmetrically, and having two terminals connected to commutator-segments, of suitable connections between said coils, whereby at one portion of the revolution of the armature the bobbins will work counter to one another in supplying current to the commutator and collecting devices set to change at such portion of the revolution of the armature.

5. In a dynamo-electric machine, the herein-described method of preventing spark at the commutator or heating in an armature system, consisting in suitably connecting the coils of the system so that at the point of change on the commutator the various bobbins will work counter to one another in supplying current to the outside circuit.

6. The combination, with four bobbins or sections on an armature connected in series, and having their free ends connected to the two opposite segments of a commutator-cylinder, of commutator-brushes applied to the same in the manner described, so that the bobbins will remain in circuit as they pass the neutral line, or line in which the polarity of the individual bobbins changes, and the line of change on the commutator will correspond with the arc of revolution in which the armature-bobbins are on opposite sides of said neutral line, and are generating opposing currents in the short circuit formed through the commutator devices, two in one and two in the opposite direction.

7. In a dynamo-electric machine, a series of four armature-bobbins symmetrically disposed, having the outer end of one bobbin connected to the inner end of the next, proceeding in the direction of revolution, the outer end of the third connected to the inner end of the fourth, the outer ends of the second and fourth bobbins connected together, and the inner ends of the first and third free, so that during two arcs of revolution comprising each ninety degrees the currents generated in said bobbins will flow concurrently in series, while in other arcs of revolution the currents in said bobbins will flow in the series two in one and two in the opposite direction, with a resultant electro-motive force depending on the difference in the position of the bobbins with regard

to the line upon which the polarity of the individual bobbins is reversed.

8. The combination, with an armature, of four bobbins, A B C D, having their ends connected in series in the manner described, a commutator, *a b*, and commutator-brushes P M, arranged to short-circuit said bobbins not in the neutral line F F, but when said bobbins are in active magnetic fields and are generating currents that in the two bobbins on one side of said neutral line are opposed to the currents generated in the bobbins on the opposite side of said line.

9. In a dynamo-electric machine, an armature whose bobbins are connected in series, and are so connected as to neutralize one another's effects at the time when they are short-circuited by the commutator.

10. The combination, with a set or system of armature coils or bobbins, of a commutator applied, in the manner described, to change when the coils or bobbins are away from the neutral line and in active positions, and suitable connections between the coils of the system, whereby, owing to conflicting polarities, the commutator plates or segments or the terminals of the set or system will be neutral.

11. In a dynamo-electric machine, a number of armature-bobbins connected in series, in the manner described, so that during one portion of the arc of revolution on each side of a neutral line, F F, said bobbins will assist one another, while in the remaining arcs of revolution the currents in the bobbins on one side of said neutral line will act in opposition to the currents in the bobbins on the opposite side.

Signed at New York, in the county of New York and State of New York, this 1st day of February, A. D. 1883.

ADDISON G. WATERHOUSE.

Witnesses:

THOS. TOOMEY,

WM. H. BLAIN.