March 21, 1950 E. H. MYERS 2,501,348

UNIPOLAR GENERATOR ARMATURE

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Fig. 1.

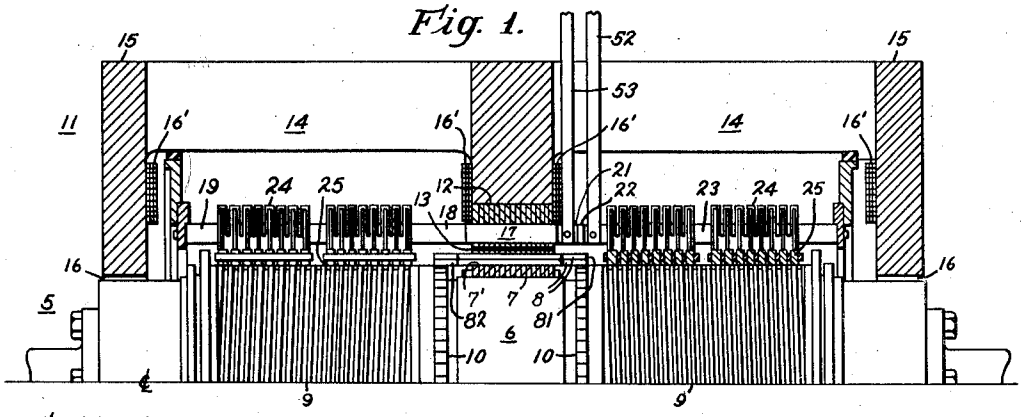


Fig. 2.

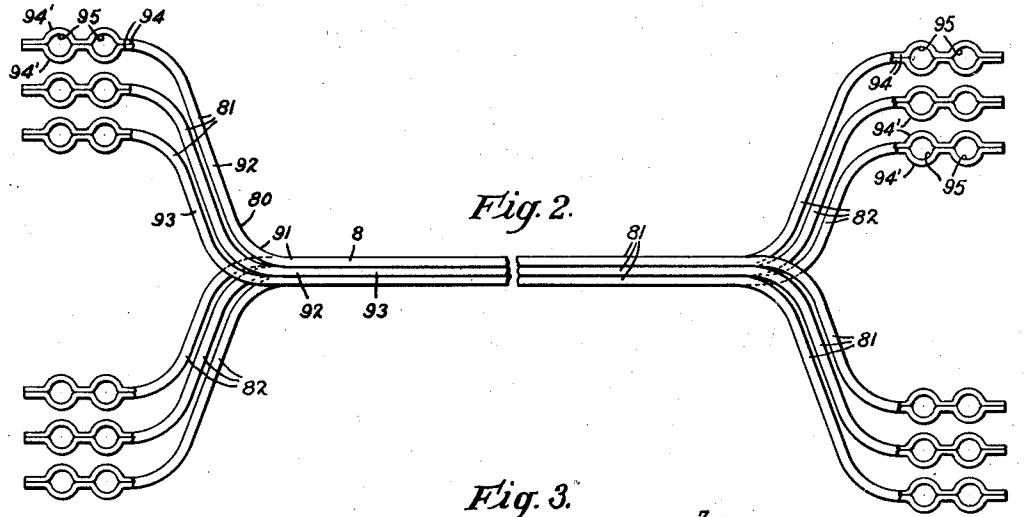
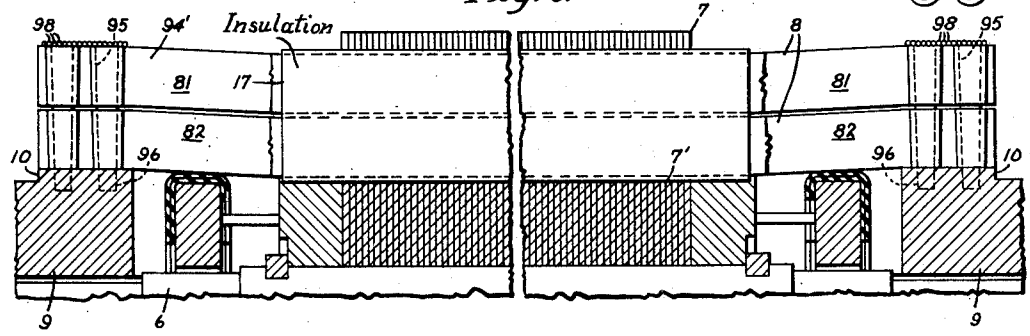


Fig. 3.



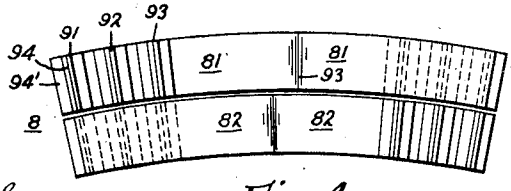


Fig. 4.

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UNIPOLAR GENERATOR ARMATURE

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My invention relates to unipolar generators, and to the armature end-turns thereof and their connections. My invention has more particular relation to large compensated unipolar generators, in which a compensating winding provides the necessary compensation for the armature-reaction, as set forth in the Hague et al. Patent 2,134,511, granted October 25, 1938.

For more than ten years, such large compensated unipolar generators have behaved poorly and erratically, acting either as a cumulatively compounded machine or as a differentially compounded machine, depending upon the direction of rotation, and requiring very considerable care and skill, on the part of the operator, in order to avoid an excessive amount of rejects in the pipes which were welded by the unidirectional currents supplied by the machine. For a great many years, the cause of this objectionable operation escaped the best minds of the industry. Attempts were erroneously made to ascribe the compounding action to the axial flow of the current in the collector-cylinders at the two ends of the machine, or to ascribe the difficulty to even less plausible causes.

In accordance with an important feature of my present invention, I have at last discovered the cause, and the cure, for the trouble. The cause stems from the use of armature conductors, which lie in slots of the armature-core, and which, because of the large size of the machine, were subject to so much thermal expansion and contraction as to necessitate bends in the end-portions of the conductors, between the armature-core and the necks of the respective collector-cylinders at the two ends of the armature, as set forth in the Matthews Patent 2,094,365, granted September 28, 1937. It just so happened, as shown in the Matthews patent, (the designers recognizing no significance in the direction in which the end-windings were bent), that both ends of the armature-conductors were bent in the same direction. In the previous construction, as shown in the Matthews patent, the commutator necks were provided with conductor-receiving slots which were parallel to the portions of the bent conductors which were lying in the conductor-receiving slots of the armature-core, thus avoiding the necessity for twisting the terminals of the bent ends of the armature conductors; and this construction necessitated the bending of the ends of all of the conductors of any one slot in the same direction, notwithstanding the fact that the armature-conductors in any slot were subdivided into upper and lower conductors, after the manner of a double-layer winding, but with the end-throws of both the upper and lower layers extending in the same circumferential direction.

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I have discovered that the compounding trouble which has been heretofore experienced, notwithstanding all efforts to compensate the machine, and which has been heretofore put up with, for lack of any known means for avoiding it, arises from a phenomenon which is no more mysterious than the fact that each bent end-turn of each armature-conductor constituted a fraction of a turn of a magnetizing-coil extending around that end of the armature, so that the accumulation of all of the fractional turns of all of the bent conductor-ends resulted in a considerable ampere-turn effect, at each end of the machine, tending either to increase or decrease the magnitude of the unidirectional magnetizing flux of the machine, which flows axially in the two shaft-ends which extend under the two collector-cylinders. Since the armature-current is entering the armature at one end of the machine, and leaving the armature at the other end of the machine, and since the conductor-ends at both ends of the machine happened to be bent in the same circumferential direction, the compounding effects of the cumulative fractional turns of the bent conductor-ends at the two ends of the armature tended to produce flux-flow in opposite axial directions, in the shaft-ends under the respective current-collectors, so that the magnetizing effects were either both cumulative or both differential, with respect to the directions of the main machine-flux in these two shaft-ends. The cure of the trouble is more or less obvious, once its cause has been analyzed or detected.

It is an important object of my present invention to provide an armature end-turn or conductor-end bending in such directions that some of the bends produce compounding magnetizing effects which are opposite to the compounding magnetizing effects produced by other bends, so that the magnetizing effects are either exactly and completely neutralized, if such neutralization is desired, in a non-compounded machine, or so that the two opposite compounding effects can be properly controlled and regulated, in the design of the machine, if a small amount of either cumulative or differential compounding should be desired.

A further object of my invention is to provide a novel peg-type neck-construction for the current-collecting cylinders, with the necessary modification of the terminal-ends of the arma-

ture-conductors, necessary to properly cooperate with the pegs which constitute said necks.

An exemplary form of embodiment of my invention is shown in the accompanying drawing, wherein:

Figure 1 is a longitudinal sectional view of the top half of a unipolar generator of the type to which my invention is applicable;

Fig. 2 is a developed plan view showing the armature-conductors which lie in one of the conductor-receiving slots of the armature-core;

Fig. 3 is a fragmentary longitudinal sectional view illustrating the manner in which the conductor-ends of the armature are secured to the pegs which constitute the necks of the respective collector-cylinders at the two ends of the machine; and

Fig. 4 is a fragmentary end-view of the armature-conductors shown in Fig. 2, not attached to the necks of the collector-cylinders.

As shown in Fig. 1, my invention is illustrated as being embodied in a unipolar generator having a rotor member 5 comprising a shaft 6 of magnetizable material, on which is mounted an intermediately disposed armature-core 7 which is provided with a plurality of conductor-receiving slots 7' which are at least partially open, and which receive a plurality of armature-conductors or inductors 8. Mounted on the shaft 6, at each end of the rotor-core 7, is a long, massive, solid collector-cylinder 9, which is a heavy casting made of a highly conducting alloy, and usually spirally grooved on its current-collecting surface. The ends of the armature-conductors 8 are electrically connected to the inner ends, usually in the form of raised necks 10, of the respective collector-cylinders 9.

The unipolar generator further comprises a stator member 11 which is provided with a slotted stator core or yoke 12 surrounding the rotor-core 7 and spaced therefrom by a cylindrical or annular air-gap 13. The outer periphery of the stator-core 12 is connected, at each end, to a stator-frame member consisting of a plurality of frame-arms 14 extending axially towards the respective ends of the machine, and terminating, at each end of the machine, in an end-bracket 15 which completes the magnetic circuit to a point 16 in the shaft 6 outside of the respective collector-cylinders 9. The magnetic circuit just described produces a unidirectional field in the cylindrical air-gap 13, the flux being maintained by field-windings 16'.

Disposed in the slots of the stator-core 12, and preferably slightly insulated therefrom, as by insulation 17, are a plurality of circumferentially spaced, axially extending bars 18 constituting a compensating winding lying in the pole-face of the stator-member. The compensating bars 18 have long ends 19 at their left-hand ends, extending axially, in spaced relation, over the collector-cylinder 9 at the rear end of the machine, to provide brushholder-supporting bars 19 at that end of the machine. The compensating bars 18 have short ends 21, terminating close to the stator-core 12, at the front end of the machine, and these short ends 21 are connected, by insulating joints 22, to a plurality of separate brushholder-supporting bars 23 which comprise, in effect, insulated extensions of the several compensating bars 18, at the front end of the machine. These separate front-end brushholder-supporting bars 23 extend axially, in spaced relation, over the collector-cylinder 9 at their end of the machine.

As set forth in the Hague et al. patent, the brushholder-supporting bars 19 and 23 are used to support a large number of brushholders 24, which are closely spaced, both axially and circumferentially, for supporting a large number of compactly mounted brushes 25 bearing on the respective collector-cylinders 9 at the respective ends of the machine.

Current is conducted to or from the separate or insulated brushholder-supporting bars 23 at the front end of the machine, and from or to the short ends 21 of the compensating bars 18 at the same end of the machine, by means of a large number of generator-leads 52 and 53, respectively, as shown in Fig. 1. A separate lead is connected to each bar, or two leads may be connected to each bar, or any other convenient number of leads may be utilized.

My present invention relates to the nature of the armature-conductors 8 and to the connections between said conductors and the respective collector-cylinders 9. The armature-conductors 8 are preferably in the form of preformed half-coils of strap-conductors. In order to have no flux-compounding effect, or to have a reduced flux-compounding effect, as a result of the necessary bends 80 or end-throws in the respective ends of the armature-conductors or half-coils 8, it is necessary to have some of the bends in one circumferential direction, and some in another, as shown in Fig. 2, or in any other manner which results in some bends being in one direction, while the other bends are in the opposite direction, at the ends of the armature-conductors 8. It will be understood, as explained in the previously mentioned Matthews patent, that some sort of end-bends 80, or end-throws of the armature-conductors, must necessarily be provided in order to permit the straight portions of the conductors, which lie in the armature-slots 7', to expand or contract axially, as a result of heating and cooling, without breaking the conductors or the connections between the conductors and the necks of the collector-cylinders 9.

In carrying out my invention, there is a wide latitude in the manner in which some of the end-bends 80 are thrown in one circumferential direction, while other end-bends 80 are thrown in the other circumferential direction.

The armature-conductor 8 which lies in each of the armature-slots 7' could be a solid conductor of considerable cross-section, but preferably, as shown in the Matthews patent, it is stranded in both the circumferential direction and the radial direction, for greater flexibility and convenience in manufacture. It would be possible to make the end-throws in a clockwise direction at one end of the armature-conductor, and in a counterclockwise direction at the other end, but this would result in a cumulatively compounding effect on the axially flowing flux at one end of the machine, and a differentially compounding effect on the axially flowing flux at the other end of the machine, which would result in some flux-loss due to saturation, and would also result in unbalanced magnetic circuits which would usually be avoided by the electrical designer.

In the event of a stranded conductor-formation in which the armature-conductors 8 consist of top coil-sides 81 and bottom coil-sides 82, it woud be possible for the top coil-sides 81 to be made as shown in the Matthews patent, with both end-bends in a clockwise direction, at both ends of the conductors 81, while making the bottom coil-sides 82 with the end-bends reversed,

that is, with both end-bends in a counterclockwise direction, at the two ends of the conductors 82. Such a construction would substantially eliminate all compounding effect, except possibly for the difference between the lengths of the end-turns of the top and bottom conductors 81 and 82, due to the effect of the smaller diameter of the end-throws of the bottom coil-sides, although it is not believed that this effect would be at all noticeable.

My preferred construction, however, is as shown in Fig. 2, in which the directions of the end-throws of the two ends of both the top and bottom conductors 81 and 82 are opposite, one end from the other, and one conductor from the other. In other words, if the left-hand end-throw 80 of the top conductor 81 is clockwise, the right-hand end-throw 80 of the same conductor is counterclockwise, while the left-hand end-throw 80 of the bottom conductor 82 is counterclockwise, and the right-hand end-throw 80 of the bottom conductor 82 is clockwise. This provides a symmetrical design, and a complete and perfect compensation or neutralization of the compounding effects of the bent end-throws, with balanced fluxes at both ends of the machine.

In my present design, it is almost necessary to have the neck-connections disposed in radial directions, at the conductor-terminals where connections are made to the necks 10 of the respective current-collectors 9, instead of using the parallel neck-connections which avoid any twisting of the strap-conductors 81 or 82 as shown in the Matthews patent.

In the particular construction which I have shown, the armature-conductors 8 are stranded into three strands 91, 92 and 93 lying side-by-side in the circumferential direction, and two strands 81 and 82 lying one over the other in a radial direction, in the armature-slots 7'. In addition, each of the strands 91, 92 and 93 is itself composed of a plurality of side-by-side-lying strands 94 in a circumferential direction, which is desirable for greater flexibility in making the circumferential end-bends 80.

Each of the strands 91, 92 and 93 of the conductors which lie in any one of the armature-slots 7' is brought out to a separate connection to the neck of the collector-cylinder 9 at that end of the machine. In a preferred form of embodiment of my invention, the individual subdivided strands are divided into two circumferentially adjacent halves, 94, at the neck-connection terminal, and these two halves are spread apart, at one or more points, in the shape of registering preformed half-loops 94', so as to provide one or more circular radial holes 95, which may be either cylindrical in shape or suitably tapered, to fit over a correspondingly shaped conducting peg 96 which is set down into the adjacent end of the associated collector-cylinder 9, so that the entire assembly of pegs 96, for that collector-cylinder 9, collectively constitute, to all intents and purposes, upstanding extensions of the neck 10 of the collector-cylinder. By this particular peg-construction, I make a very convenient and efficient or serviceable neck-connection between the several conductor-terminals and the collector-cylinder.

In any event, in practicing my invention, even though the radially disposed pegs 96 are not adopted as the particular neck-connection means to be employed, it is usually desirable that the neck-connections be disposed in a radial direction, as distinguished from the parallel directions (with untwisted armature-coils) as described in the Matthews patent.

The entire neck-connection assembly is held in place by banding-means 98, peripherally surrounding the pegs 96.

While I have shown by invention in a preferred form of construction, and have discussed some of the alternative arrangements which could have been adopted, I wish it to be understood that many changes in detail might be made by those skilled in the art, without departing from the essential spirit of my invention. I desire, therefore, that the appended claims shall be accorded the broadest construction consistent with their language.

I claim as my invention:

1. A unipolar dynamo-electric machine characterized by a rotor member having a rotor-core provided with a plurality of conductor-receiving slots which are at least partially open, a solid collector-cylinder at each end of said rotor-core, each collector-cylinder having a neck at the end adjacent to the rotor-core, and armature-conductors having their central portions disposed in said core-slots, and having their ends connected to said collector-necks, the armature-conductors having bends in their end-portions between said rotor-core and at least one of said collectors, some of said bends being clockwise and some counterclockwise, whereby the compounding effects of the clockwise and counterclockwise bends will be opposite to each other.

2. The invention as defined in claim 1, characterized by said armature-conductors being stranded in a radial direction so as to provide top and bottom conductors, the bends at one end of the top conductors being in one circumferential direction, while the bends at the same ends of the bottom conductors are in the other circumferential direction.

3. The invention as defined in claim 1, characterized by said armature-conductors being stranded in a radial direction so as to provide top and bottom conductors, and being bent at both ends, the bends of the top conductors being clockwise at a first end and counterclockwise at the other end, while the bends in the bottom conductors are counterclockwise at said first end and clockwise at said other end.

4. The invention as defined in claim 1, characterized by said armature-conductors being stranded in a radial direction so as to provide top and bottom conductors, and being bent at both ends, the bends of the top conductors, being clockwise at a first end and counterclockwise at the other end, while the bends in the bottom conductors are counterclockwise at said first end and clockwise at said other end, the neck-connections comprising substantially radial pegs set down into the respective collector-cylinders, and conductor-terminal formations including perforate portions fitting over said pegs.

5. The invention as defined in claim 1, characterized by the armature-conductor ends lying over the respective collector-cylinder necks, said conductor-ends having a plurality of portions having approximately radially extending holes therethrough, and each of said neck-connections comprising a plurality of conducting pegs extending through said conductor-end holes and on into the underlying collector-cylinder neck.

6. The invention as defined in claim 1, characterized by the armature-conductor ends lying over the respective collector-cylinder necks, said conductor-ends having a plurality of portions

having approximately radially extending holes therethrough, and said neck-connections comprising a plurality of conducting pegs extending through said conductor-end holes and on into the underlying collector-cylinder neck, and peripheral banding-means extending over said pegs for holding the assembly in place.

7. The invention as defined in claim 1, characterized by the armature-conductors being stranded and having conductor-ends lying over the respective collector-cylinder necks, said conductor-ends being divided into two circumferentially adjacent halves having registering preformed half-loops therein, defining approximately radially extending holes in said conductor-ends, and said neck-connections comprising a plurality of conducting pegs extending through said conductor-end holes and on into the underlying collector-cylinder neck.

8. The invention as defined in claim 1, characterized by the armature-conductors being stranded and having conductor-ends lying over the respective collector-cylinder necks, said conductor-ends being divided into two circumferentially adjacent halves having registering preformed half-loops therein, defining approximately radially extending holes in said conductor-ends, and said neck-connections comprising a plurality of conducting pegs extending through said conductor-end holes and on into the underlying collector-cylinder neck, and peripheral banding-means extending over said pegs for holding the assembly in place.

9. A unipolar dynamo-electric machine characterized by a rotor member having a rotor-core provided with a plurality of conductor-receiving slots which are at least partially open, a solid cylindrical current-collecting member at each end of said rotor-core, said current-collector member having a neck-construction at the end adjacent to the rotor-core, and armature-conductors having their central portions disposed in said core-slots, and having their ends connected to said neck-construction, the armature-conductors having bends in their end-portions between said rotor-core and said current-collector member, some of said bends being clockwise and some counterclockwise, the neck-connections comprising substantially radial pegs set down into the current-collecting member, and conductor-terminal formations including perforate portions fitting over said pegs.

10. A dynamo-electric machine characterized by a rotor member having an armature-core provided with a plurality of conductor-receiving slots, a current-collecting member at at least one end of said armature-core, a stranded-conductor armature-winding carried by said core-slots and having one or more terminal-ends connected to the armature-end of said current-collecting member, said terminal-end connection or each of said terminal-end connections comprising a plurality of substantially radial pegs set down into the current-collecting member, the stranded-conductor construction of said terminal-end being divided into two circumferentially adjacent halves having preformed half-loops fitting over, and secured to a plurality of said pegs.

11. A dynamo-electric machine characterized by a rotor member having a rotor-core provided with a plurality of peripheral conductor-receiving core-slots, a solid cylindrical current-conducting member at at least one end of said rotor-core, a plurality of stranded rotor-winding conductor-bars lying in said core-slots and having ends lying over said cylindrical current-conducting member or members, the stranded bar-construction including bar-ends which are divided into two circumferentially adjacent halves having registering preformed half-loops therein, defining approximately radially extending holes in said bar-ends, and a plurality of conducting pegs extending through said bar-end holes and on into the underlying cylindrical current-conducting member.

12. A dynamo-electric machine characterized by a rotor member having a rotor-core provided with a plurality of peripheral conductor-receiving core-slots, a solid cylindrical current-conducting member at at least one end of said rotor-core, a plurality of stranded rotor-winding conductor-bars lying in said core-slots and having ends lying over said cylindrical current-conducting member or members, the stranded bar-construction including bar-ends which are divided into two circumferentially adjacent halves having registering preformed half-loops therein, defining approximately radially extending holes in said bar-ends, and peripheral banding-means extending over said pegs for holding the assembly in place.

13. A unipolar dynamo-electric machine characterized by a rotor member having an armature-core provided with a plurality of peripheral conductor-receiving core-slots which are at least partially open, a solid cylindrical current-collecting member at each end of said armature-core, preformed half-turn armature-coils having their central portions lying in said core-slots and having their ends lying over the adjacent ends of the respective cylindrical current-collecting members, each of said coil-ends having a plurality of portions having approximately radially extending holes therethrough, and a plurality of conducting pegs extending through said coil-end holes and on into the underlying cylindrical current-collecting member.

14. A unipolar dynamo-electric machine characterized by a rotor member having an armature-core provided with a plurality of peripheral conductor-receiving core-slots which are at least partially open, a solid cylindrical current-collecting member at each end of said armature-core, stranded preformed half-turn armature-coils having their central portions lying in said core slots and having their ends lying over the adjacent ends of the respective cylindrical current-collecting members, said coil-ends being divided into two circumferentially adjacent halves having registering preformed half-loops therein, defining approximately radially extending holes in said coil-ends, and a plurality of conducting pegs extending through said coil-end holes and on into the underlying cylindrical current-collecting member.

15. A unipolar dynamo-electric machine characterized by a rotor member having an armature-core provided with a plurality of peripheral conductor-receiving core-slots which are at least partially open, a solid cylindrical current-collecting member at each end of said armature-core, stranded preformed half-turn armature-coils having their central portions lying in said core-slots and having their ends lying over the adjacent ends of the respective cylindrical current-collecting members, said coil-ends being divided into two circumferentially adjacent halves having registering preformed half-loops therein, defining approximately radially extending holes in

said coil ends, a plurality of conducting pegs extending through said coil-end holes and on into the underlying cylindrical current-collecting member, and peripheral banding-means extending over said pegs for holding the assembly in place.

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