No. 816,511. PATENTED MAR. 27, 1906.

C. P. STEINMETZ.

DYNAMO ELECTRIC MACHINE.

APPLICATION FILED JAN. 28, 1905.

Fig. 1.

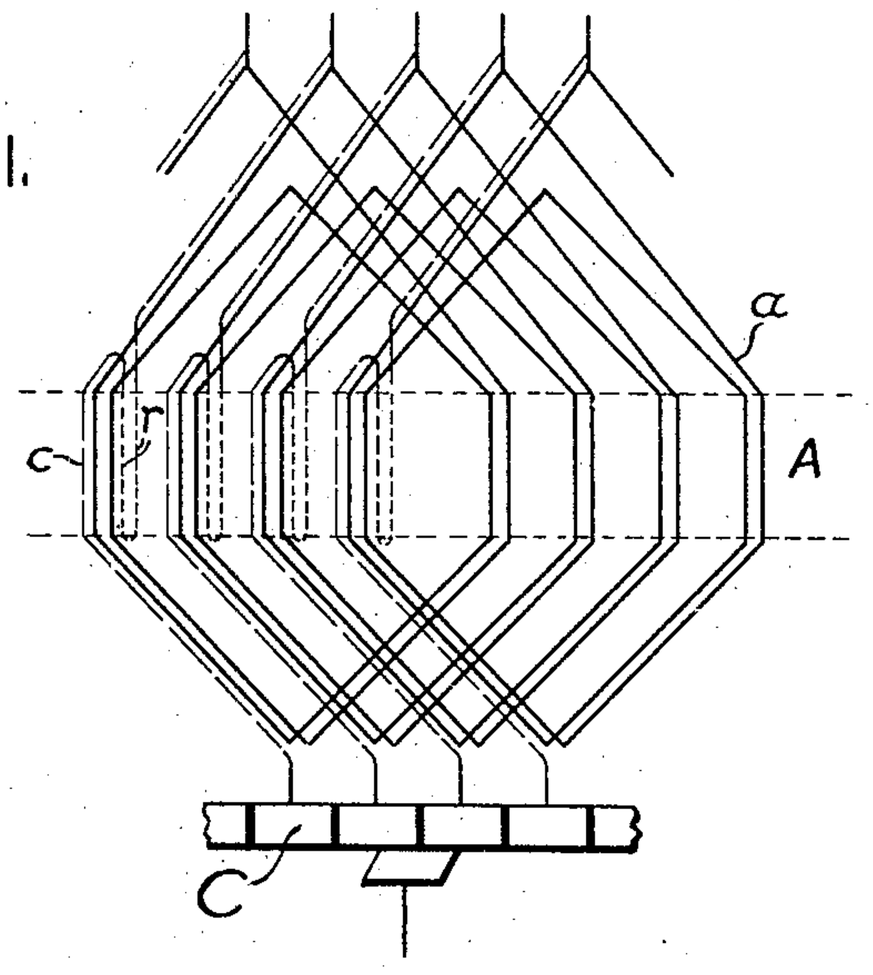


Fig. 2.

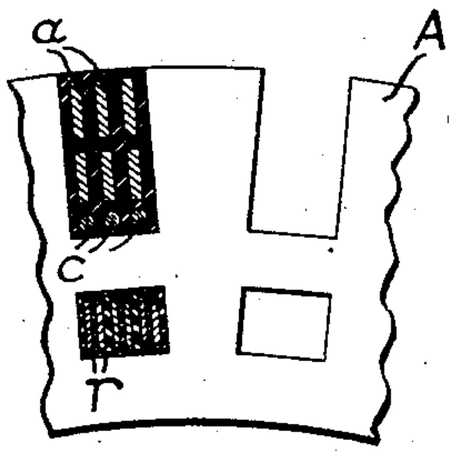


Fig. 4.

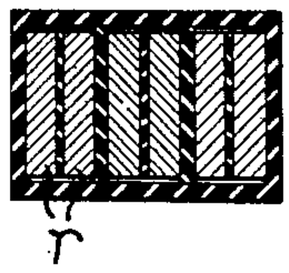
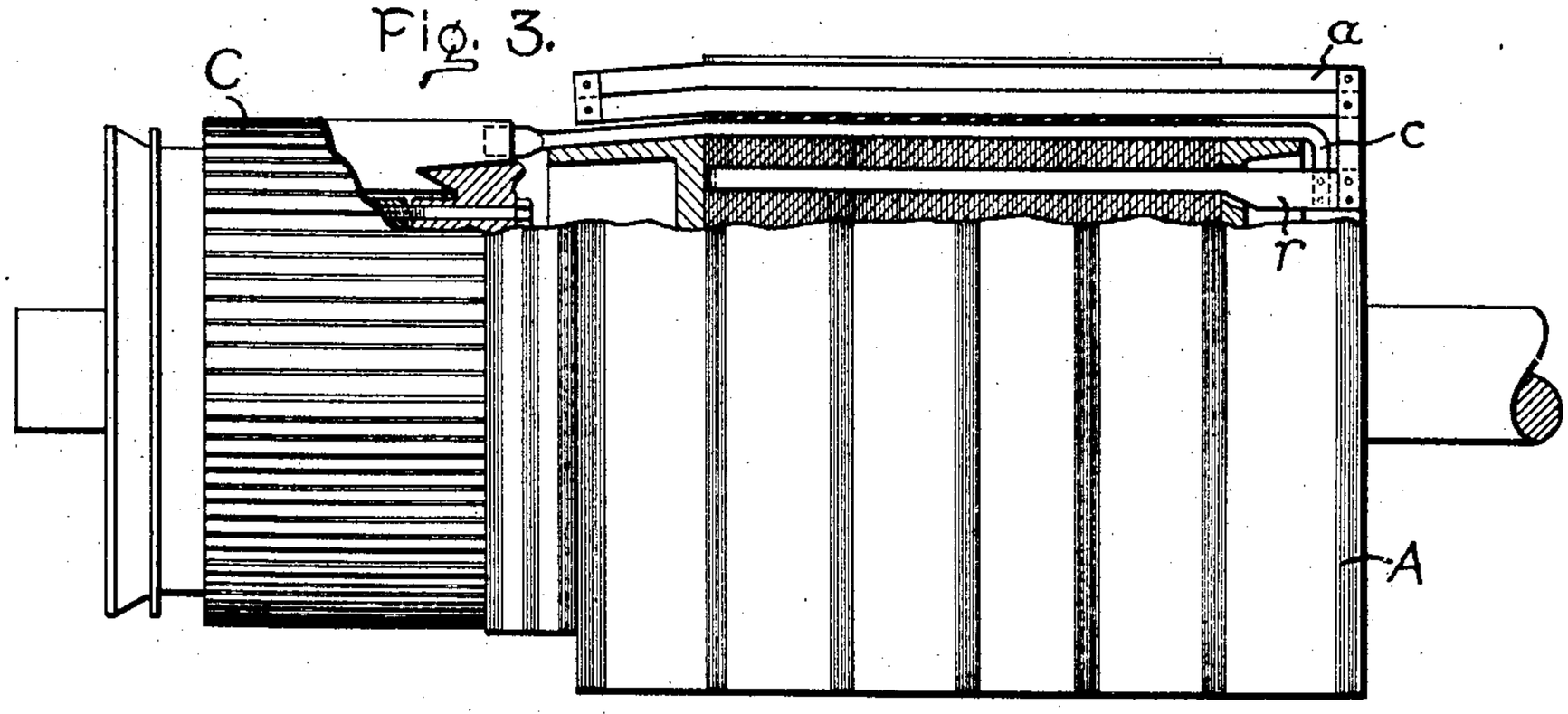


Fig. 3.



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UNITED STATES PATENT OFFICE.

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DYNAMO-ELECTRIC MACHINE.

No. 816,511. Specification of Letters Patent. Patented March 27, 1906.

Application filed January 28, 1905. Serial No. 243,014.

To all whom it may concern:

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, in the county of Schenectady 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 dynamo-electric machines of the commutator type, more particularly to alternating-current machines; and its object is to provide a novel arrangement of high-resistance commutator-leads which is exceedingly compact, durable, and accessible for repairs.

In alternating-machines of the commutator type it has been proposed heretofore to insert high resistances in the connections between the commutator-segments and the armature-winding for the purpose of limiting the current flowing in an armature-coil when short-circuited by a brush.

My invention relates to machines employing commutator-leads of this type.

In one aspect my invention consists in providing the armature-body with a second set of slots more remote from the periphery than the slots carrying the main armature-conductors and in placing the high-resistance leads in these inner slots. With this arrangement the heat produced in the leads is conducted away by the armature-core without injury to the main armature-conductors.

In another aspect my invention consists in employing bifilar resistances extending through and supported in the armature-body. This gives an exceedingly compact arrangement and affords firm support for the leads and protects them from external injury. By making the resistances bifilar or double induced electromotive forces in the leads are avoided. Since while the motor is running each lead is in circuit only momentarily, the leads may be made of very high resistance compared to the resistances of the armature-conductors, especially if the leads are so arranged that the heat produced in them is rapidly conducted away; but if the motor fails to start when current is supplied to it the leads connected to the segments which are under the brushes are maintained continuously in circuit and under such conditions are liable to be burned out. Consequently it is important that the leads should be so arranged that they may be readily accessible for repairs.

My invention, more specifically considered, consists in arranging the leads in holes in the armature-body independent of the slots containing the armature-conductors and in connecting the leads to the armature-coils at the end away from the commutator, so that they are readily accessible for repairs. Another feature of my invention consists in arranging the leads with greater cross-section at the portions where they extend beyond the end of the armature-body for connection to the armature-conductors, since the radiation from these parts is less effective in carrying away the heat than the conduction from the portions of the lead within the armature-body.

My invention will best be understood by reference to the accompanying drawings, in which—

Figure 1 shows a diagrammatic development of an armature-winding provided with commutator and commutator-leads arranged and connected in accordance with my invention. Fig. 2 is a detail in cross-section, showing the arrangement of armature-coils and commutator-leads in the armature-body. Fig. 3 shows a side view, partly in cross-section, of an armature arranged in accordance with my invention; and Fig. 4 is an enlarged detail view showing the bifilar leads in cross-section.

In the drawings, A represents the armature, provided with a commutator C and the armature-coils *a*. The commutator is not connected to the armature-coils in the usual manner—that is, by leads directly connecting each commutator-segment with the adjacent end of an armature-coil—but instead each segment is connected to a lead *c*, which extends through the bottom of the coil-slots to the other end of the armature and is there connected to one end of a terminal of a bifilar resistance *r*, the other end of which is connected to the armature-coil at the end away from the commutator. The leads *c* may be of higher resistance per unit of length than the armature-conductors, since each lead is in circuit only a fraction of the time, and conse-

quently these leads are represented as of smaller cross-section than the conductors *a;* but these leads are preferably of lower resistance per unit of length than the bifilar resistances *r*, so that if the motor should refuse to start when the current is turned on the resistances *r* would be burned out rather than the leads *c*. The resistances *r* are shown of large cross-section compared to the leads *c*, since these resistances are preferably made of high-resistance material, such as copper-nickel. The resistances *r* are supported in the armature-body independent of the coil-slot. (Clearly shown in Figs. 2 and 3.) With this arrangement the heat produced in the resistances is efficiently conducted away by the metal of the armature-body and can produce no injury to the insulation of the armature-conductors, as would be the case if the resistances were placed in the same slots with the armature-coils. As clearly appears from Fig. 3, it would be impossible to get at the resistance-strips *r* at the commutator end without breaking several of the commutator connections and removing some of the end connections of the armature-coils. On the other hand, at the other end of the armature there are no obstructions in the way and the connections between those resistances and the coils *a* and leads *c* may be readily made. Furthermore, since the resistances are supported entirely independently of the armature-coils and coil-slots their withdrawal for renewal does not disturb the armature-winding.

As shown in Fig. 3, the resistances *r* are formed with a larger cross-section at the portions which extend beyond the armature, since the heat is led away by radiation less effectively from these portions than by conduction from the portions within the armature-body.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a dynamo-electric machine, a slotted armature, a winding in the slots, a commutator, and bifilar resistances supported in holes in the armature-body independent of said slots and inserted in the connections between said windings and the commutator-segments.

2. In a dynamo-electric machine, an armature provided with peripheral slots and holes below and independent of said slots, a winding in said slots, a commutator, and bifilar resistances supported in said holes and connected to said winding and to said commutator.

3. In a dynamo-electric machine, an armature provided with peripheral slots and holes below and independent of said slots, coils in said slots, a commutator, bifilar resistances supported in said holes and having their terminals at the end of the armature away from the commutator, a connection from one terminal of each resistance to the adjacent end of an armature-coil, and a connection from the other terminal of each resistance extending across the armature-body to a commutator-segment.

4. In a dynamo-electric machine, an armature provided with peripheral slots and holes below and independent of said slots, coils in said slots, a commutator, bifilar resistances supported in said holes and having their terminals at the end of the armature away from the commutator, a connection from one terminal of each resistance to the adjacent end of an armature-coil, and a connection from the other terminal of each resistance extending through one of said slots to a commutator-segment.

5. In a dynamo-electric machine, an armature provided with peripheral slots and holes below and independent of said slots, armature-coils in said slots, a commutator, leads of higher resistance per unit of length than said coils connected to said commutator and extending through said slots across the armature, and bifilar resistances of higher resistance per unit of length than said leads supported in said holes and having their terminals connected to said coils and to said leads at the end of the armature away from the commutator.

6. In a dynamo-electric machine, a slotted armature, a winding in the slots, a commutator, and high-resistance leads supported in the armature-body independently of said slots and inserted in the connections between said windings and the commutator-segments, the portions of said leads extending beyond the armature-body being of greater cross-section than the portions within said body.

7. In a dynamo-electric machine, an armature provided with peripheral slots and holes below and independent of said slots, a winding in said slots, a commutator, and bifilar resistances supported in said holes connected to said winding and to said commutator, the portions of said leads extending outside of said holes being of lower resistance per unit of length than the portions contained within said holes.

8. A core of an electrical machine having one set of slots adjacent to its surface and another set of slots more remote from such surface, main conductors located in the outer slots, and high-resistance conductors located in the inner slots.

9. In an electrical machine, a core having two concentric sets of slots and two sets of conductors located in said slots and connected together, the inner set being of higher resistance than the outer set.

10. In an electrical machine, a cylindrical, magnetizable core having a set of slots adjacent to its periphery and a second set of slots comparatively remote from its periphery, of relatively low resistance and high resistance

conductors located in said slots and connected in circuit with each other.

11. In an electrical machine, a member having a cylindrical magnetizable core provided with a circumferential set of slots adjacent to its outer surface, a circumferential set of slots between said outer set and the inner surface of the core, relatively low resistance conductors located in said outer slots and relatively high resistance conductors connected thereto and located in said inner slots.

12. In an electrical machine, the combination with a commutator of an armature having core-slots adjacent to the surface of its core for the reception of coils, and a series of slots in said core between the outer slots and the inner surface of the core, and relatively high resistance conductors located in said inner slots and connecting the armature-conductors to the commutator-bars.

13. In an electrical machine, an armature having a laminated core provided with slots adjacent to its outer surface, and slots intermediate its outer and its inner surfaces, armature-coils located in said outer slots, relatively high resistance conductors located in said inner slots, each of said conductors being doubled upon itself and connected at one end to a corresponding armature-coil and at its other end to a commutator-bar.

14. An electrical-machine core having concentric sets of slots, those of one set being adjacent to the surface, and of the proper number, form and dimensions to contain armature-coils and those of the other set being of the proper number, form and dimensions to contain resistance-leads for connection to the armature-coils.

15. An electrical-machine core having concentric sets of slots, in combination with two sets of conductors of different resistance located in the slots of the respective sets and connected together, the slots of each set being adapted, in number, form and dimensions, to its conductors.

In witness whereof I have hereunto set my hand this 26th day of January, 1905.

CHARLES P. STEINMETZ.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.