(No Model.)

W. COOPER.

DYNAMO ELECTRIC MACHINE.

No. 563,911. Patented July 14, 1896.

FIG. 1.

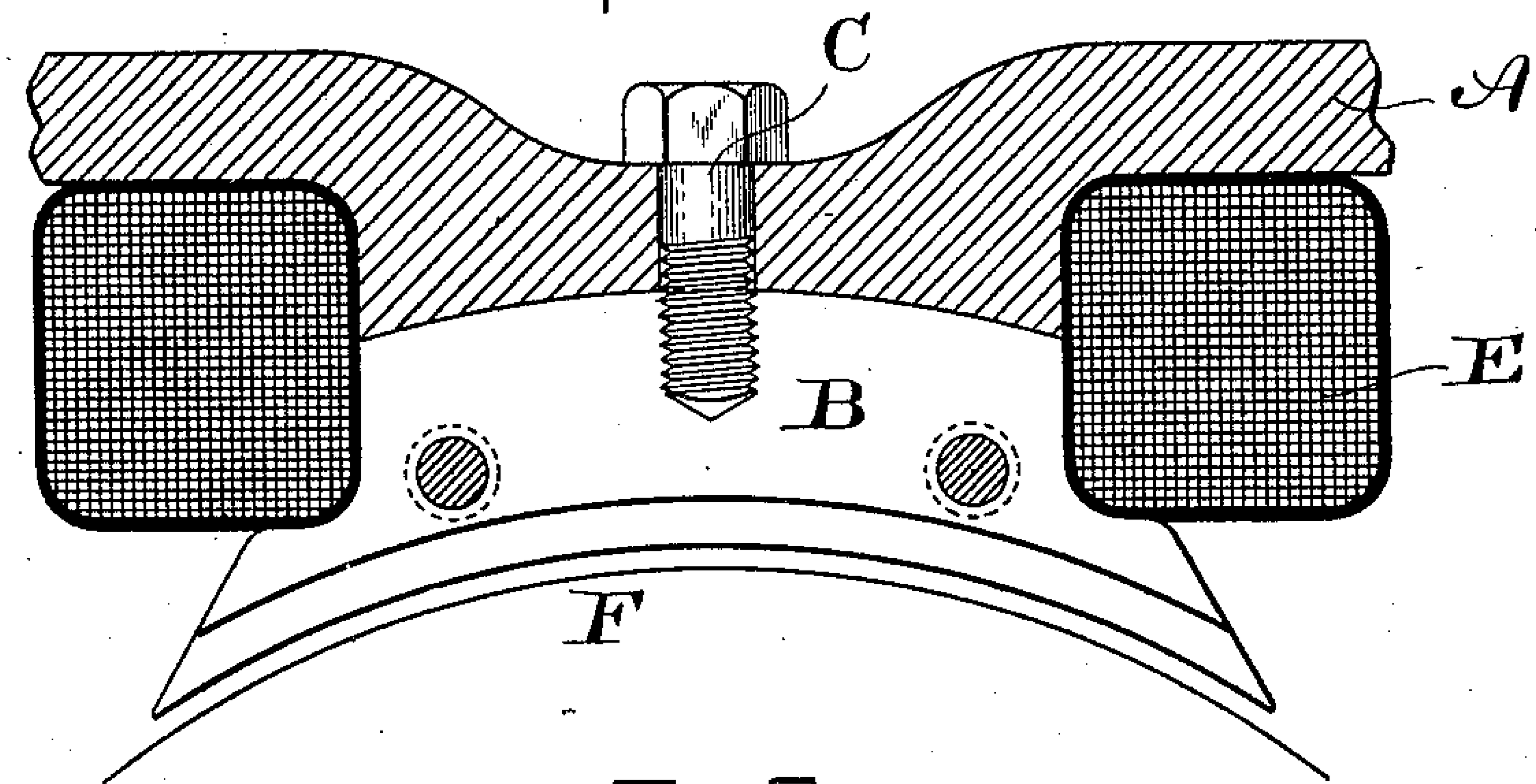


FIG. 2.

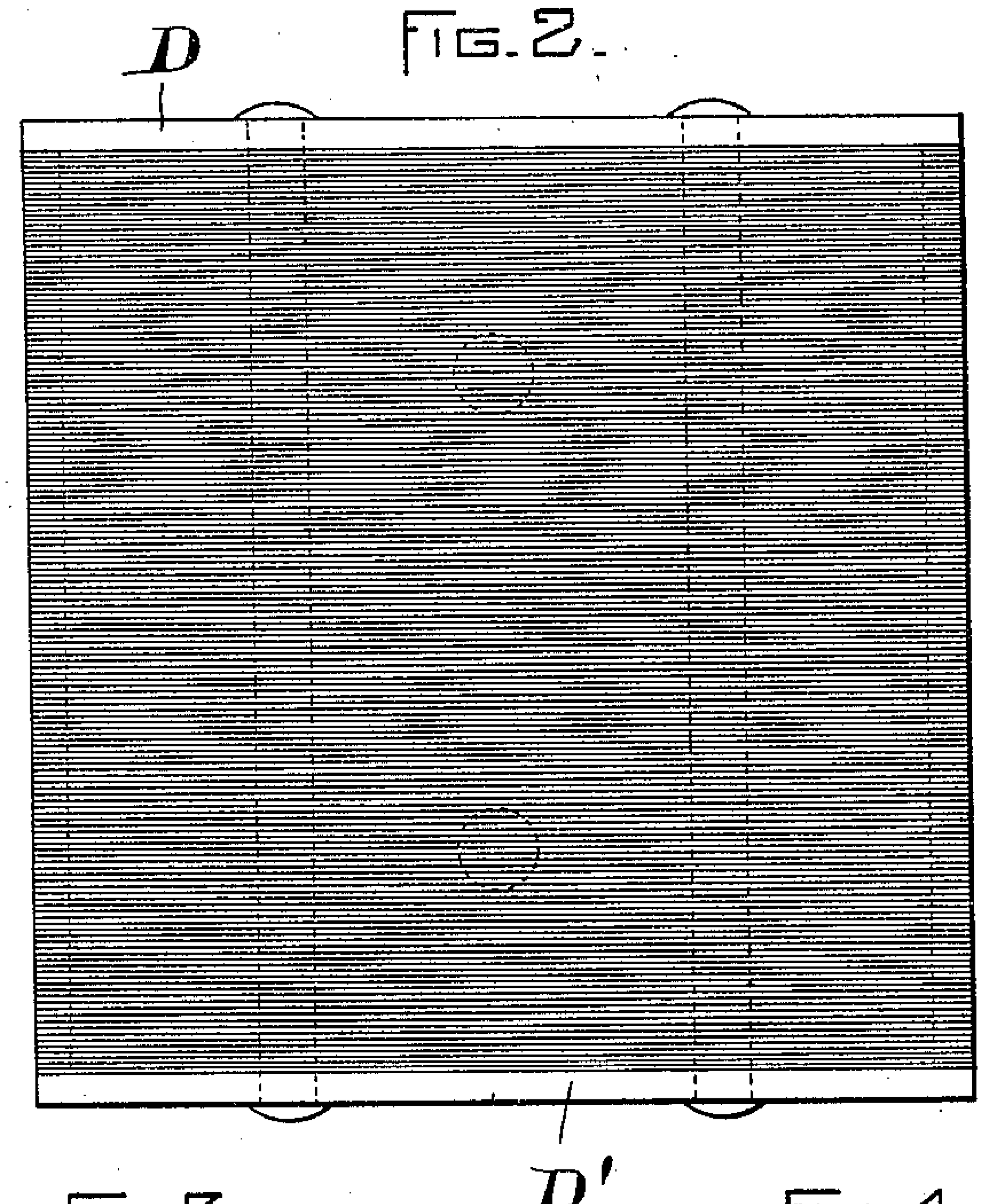


FIG. 3.

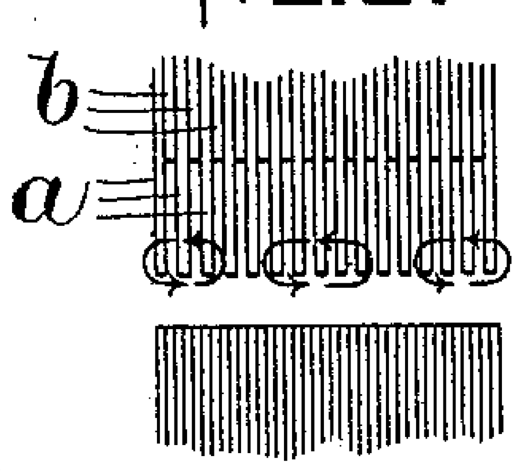


FIG. 4.

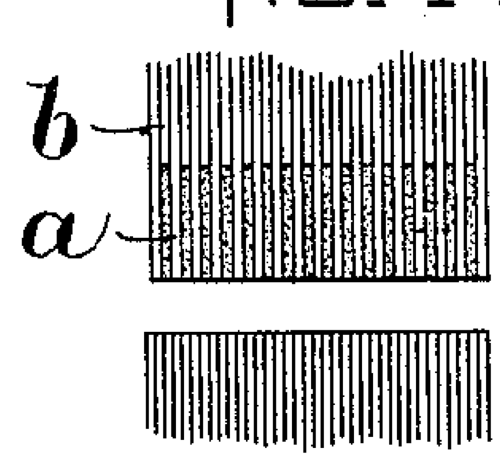
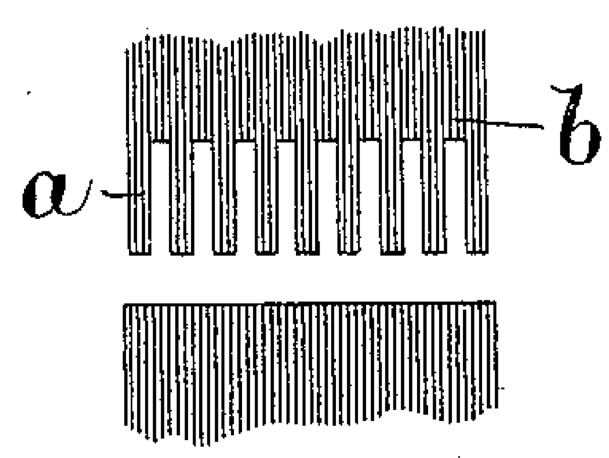


FIG. 5.



WITNESSES.

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DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 563,911, dated July 14, 1896.

Application filed April 18, 1896. Serial No. 588,139. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM COOPER, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Dynamo-Electric Machines, (Case No. 390,) of which the following is a specification.

The present invention relates to field-magnet structures for dynamo-electric machines, and has for its object to increase the capacity and efficiency of the machine, to reduce the eddy-currents in the pole-faces, the sparking of the brushes, and the heating of the machine as a whole.

In machines of the multipolar type the field-magnet poles are placed as near as possible together in order to reduce the size of the machine. The distance between the poles, however, has to be great enough to permit of a sparkless point of commutation, which occurs where the current in the armature-coils is reversed. In order to have a distinct line of commutation, it is necessary to have a high density, otherwise known as a "stiff field," at the pole-faces; otherwise the flux from each field-pole will be distorted and drawn by the armature over toward its adjacent pole-piece, and in consequence there are no points at which the current of the armature can be commuted without excessive sparking. Machines have heretofore been constructed in which a stiff field is maintained at the pole-faces by the expenditure of more or less magneto-motive force, but all of these machines with which I am acquainted are more or less objectionable, because whenever the density is raised at the pole-faces a corresponding rise occurs in the density of the air-gap and armature-teeth; and it is to the maintaining of a stiff field at the pole-face without raising the density of the air-gap and armature-teeth that this invention relates. This is accomplished by slotting the face of the pole-pieces or by making them of laminated iron, the laminations being of different radial length, thus increasing or diminishing the distance between them and the armature-core, the effect being to reduce the cross-section of the iron at the pole-face, the amount being dependent upon the width of the slots or the number of shorter laminations. Although the amount of iron in the pole-face is reduced, it still extends over as many armature-conductors as before, and the flux through the longer laminæ or projections is increased in proportion to the decrease in the iron, the magneto-motive force required to force the lines through the additional resistance due to the slots being practically nothing, amounting in actual practice to less than two per cent. This gives a very stiff field, and the pole-faces may be extended nearer to each other than before. The greater the space covered by the pole-faces the greater will be the number of active armature-conductors, and consequently the output of the machine.

Assume the field-poles to have an excitation of ninety thousand lines per square inch, then the longer laminæ, which have half the total cross-section, must carry twice the number of lines that they would if the laminæ were all equal. This serves to stiffen the field at the pole-face without increasing the density of the air-gap and armature, for the reason that the number of lines per square inch passing through the gap has not been changed, but their force has been increased, due to the restriction of the pole-face in the manner above described.

A further advantage is obtained by the slots in the face of the pole-pieces, for they prevent eddy-currents in a great degree. The laminæ which extend beyond the others, being separated by an air-space or some non-conducting material, offer great resistance to such currents.

In carrying out this invention one way is to provide a cast-metal structure to which are secured laminated pole-tips having laminæ which differ in length. These may be made up into a pole-piece having the desired cross-section, and the laminæ may be so arranged that a short one is placed between two longer ones, or a number of short ones can be placed between a number of longer ones. It is preferred, however, to make the space between the laminæ less than the space between the pole-face and the armature. For mechanical reasons it is desirable to fill the space between the projecting ends of the laminæ with some non-magnetic material, such as paper, fiber, or zinc.

In the accompanying drawings, attached to and made a part of this specification, Figure 1 is a sectional view of a field-magnet structure with an energizing-coil. Fig. 2 is an inverted plan view of a pole-piece, and Figs. 3, 4, and 5 are enlarged details.

A represents the field-magnet yoke of a multipolar structure, made of steel or other suitable metal. The pole-piece B is secured thereto by bolts C. The pole-pieces B are made of laminated iron with heavy end plates D D′, and extending through the laminæ are bolts or rivets which are secured to the end plates. The particular manner of securing the pole-pieces to the frame is immaterial. That shown in the drawings is a very simple one, the joint between the parts being concentric with the center of the armature. The laminations *a* and *b* are of different lengths, and are shown as alternating with each other. This, however, is not necessary, for they may be made in groups of two or three and the groups alternated. In building up the pole-pieces it is preferable to insert some non-magnetizable material between the ends of the longer laminæ at their face, to prevent them from being injured, both in handling and in machining their surfaces. The field-magnet yoke and the pole-pieces could both be made of laminations, and in that case some of them would be provided with shorter polar projections than the others, and the whole would then be assembled in the same manner as if it were a single pole-piece. The field-coils E for the pole-pieces are wound on forms and suitably insulated, after which the coil is inserted in place and held there by means of the bolts C which hold the pole-pieces. The armature F is indicated by a single line, as the particular style of winding and construction forms no part of the present invention.

In the present case the alternate laminæ are alike, half of them short, the other half somewhat longer. This reduces the cross-section of iron on the face of the pole to one-half what it would be if all the laminations were of the same length. The lines of force threading through the iron are compelled to pass between the longer laminæ and the armature-core, the reluctance of the path through the slot or non-magnetic material being much greater than through the iron. This forces the density at the pole-face up to a much greater degree, the amount depending on the relative areas of the longer laminæ and the slots or spaces. The same number of magnetic lines now threads the iron as if the cross-section of iron at the pole-face was not restricted. Consequently the lines are forced across the air-gap between the pole-face and the armature with much greater force and without any appreciable increase on the magnetomotive force required. Where an armature would tend to sweep the lines of a field-pole having a given cross-section of metal and covering a certain number of conductors over toward an adjacent pole-piece, a similar pole-piece provided with slots so stiffens the field that very little distortion results, and a greater output is obtained from the machine, with no sparking at the brushes. The slots in the pole-faces also limit the eddy-currents which tend to circulate in the face of a pole-piece in the direction indicated by the arrows in Fig. 3. The reluctance due to the spaces is very high, and the length of the path through the main laminated portion of the pole-piece is so great that it practically eliminates all of these currents from the pole-face.

The field-magnet structure could be cast with the pole-pieces secured thereto and made either laminated or solid. In the latter case slots would be sawed in the pole-face and the effect would be the same. This, however, is objectionable, for the reason that the cost of sawing these slots would be very great as compared with a laminated structure.

Tests show the above-described invention to have great advantage over other types of machines. For example, a standard machine provided with ordinary pole-pieces was connected up and run at five hundred volts potential, and the current increased until it reached one hundred and fifty amperes, where it sparked so badly that the load could not be increased without danger to the machine. The machine was then taken down and laminated poles of the character above described inserted, the energizing-coils and armature remaining the same as before. With a potential of five hundred volts the load was increased until it reached two hundred and fifty amperes, an increase of sixty-six and two-thirds per cent., and this with less sparking at the brushes than in the previous case. In the first case the temperature of the commutator was 142.5° at the end of a two hours' run, and in the latter 89.5° for the same length of time.

In my statement of invention I have outlined what I at present believe to be the mode of operation of the improved construction described and claimed. I do not wish, however, to imply that the theoretical statements made are to be construed as limitations, as the improvement is an incident of the construction in whatever way it may hereafter be found to operate.

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

1. In a dynamo-electric machine, a field-magnet structure provided with laminated pole-pieces, certain of the laminæ being of less extent than the others.

2. In a dynamo-electric machine provided with a field-magnet structure, a laminated pole-piece for the structure, the face ends of the laminæ being located at different distances from the armature.

3. A pole-piece for a dynamo-electric machine, made of laminated iron, certain of the

laminæ extending to the face of the pole, the balance extending toward, but not to the face thereof, and heavy end plates for securing the laminæ together.

4. In a dynamo-electric machine provided with a field-magnet structure, a laminated pole-piece for the structure, the face ends of the laminæ being located at different distances from the armature, and a non-magnetic filler between the longer laminæ.

In witness whereof I have hereunto set my hand this 15th day of April, 1896.

WILLIAM COOPER.

Witnesses:
B. B. HULL,
A. F. MACDONALD.