No. 693,579. Patented Feb. 18, 1902.

H. H. WAIT.

WINDING FOR DYNAMO ELECTRIC MACHINES.

(Application filed Jan. 12, 1901.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

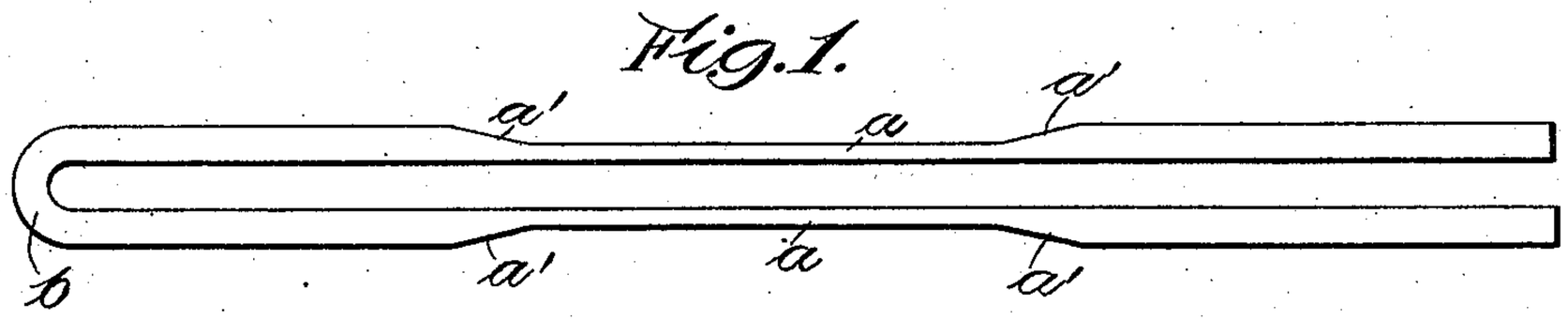
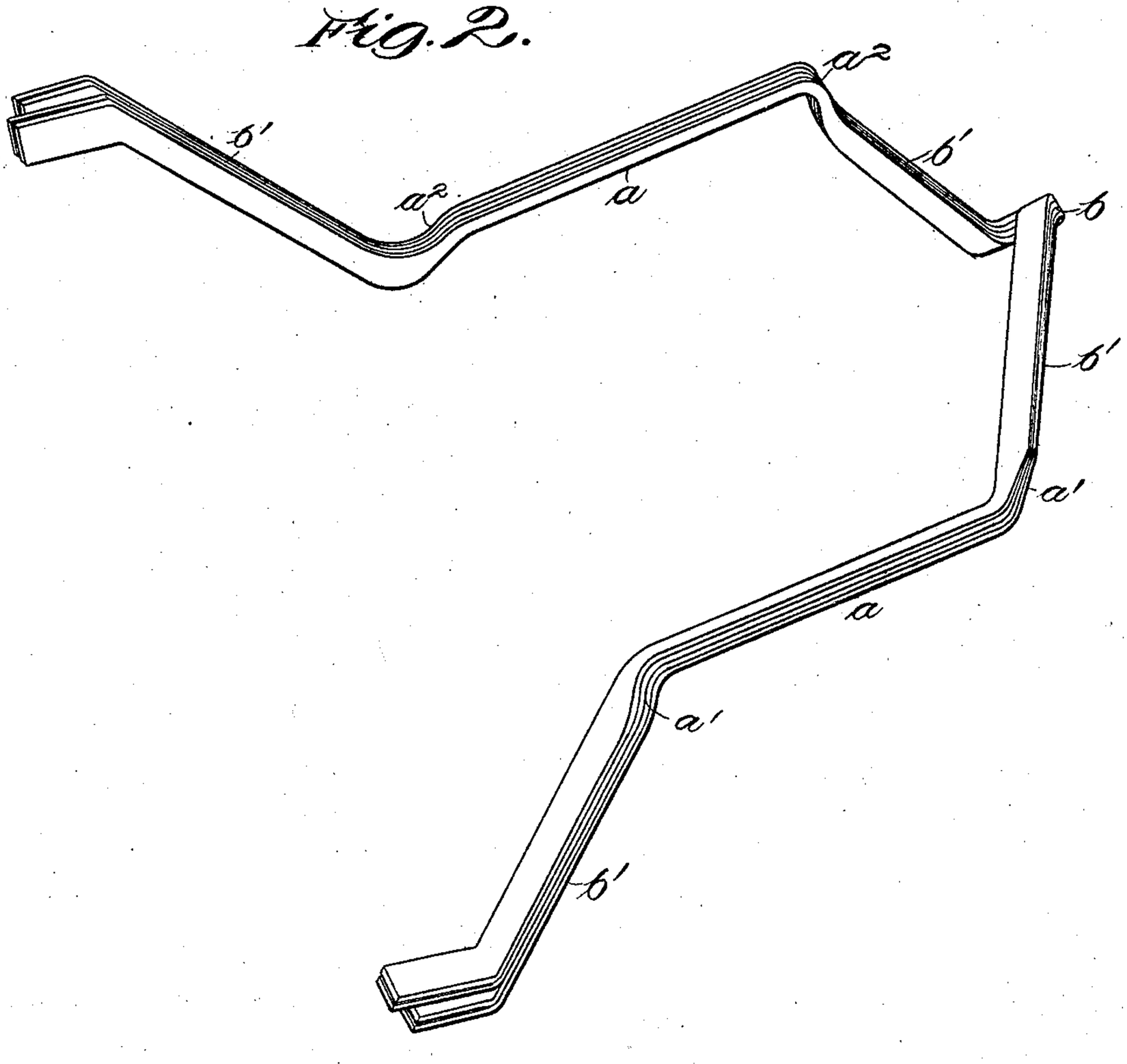


Fig. 2.



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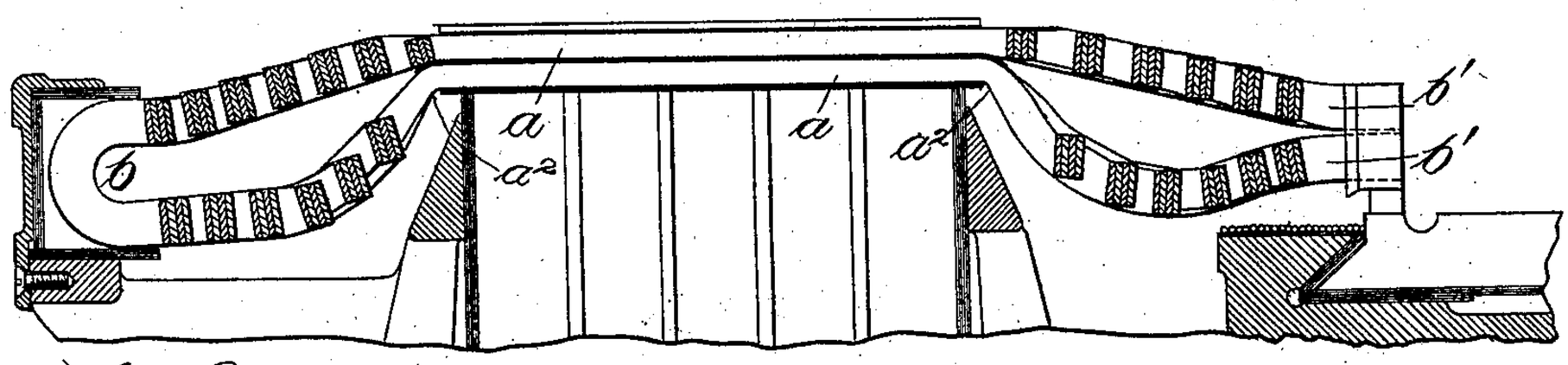


Fig. 3.

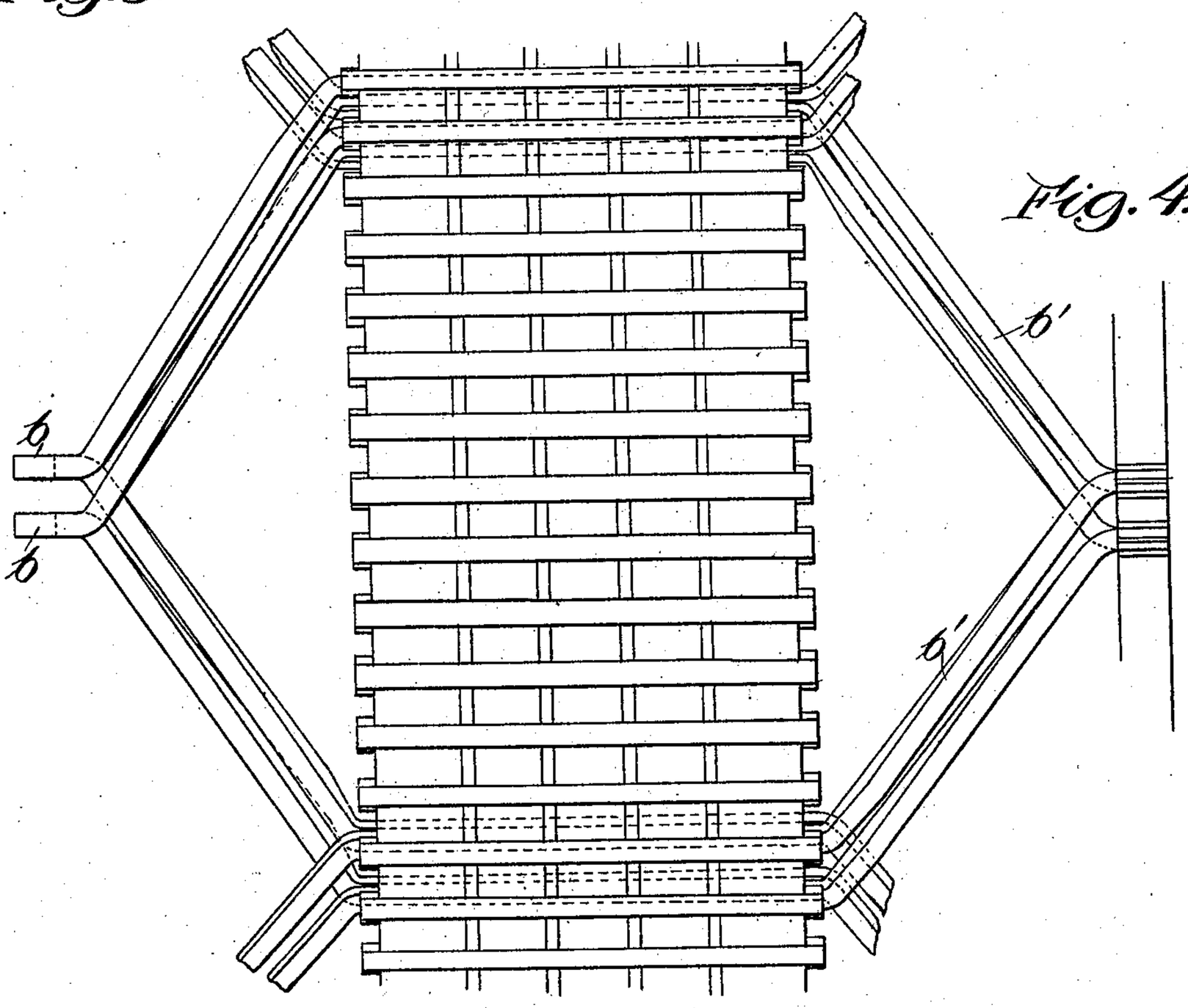
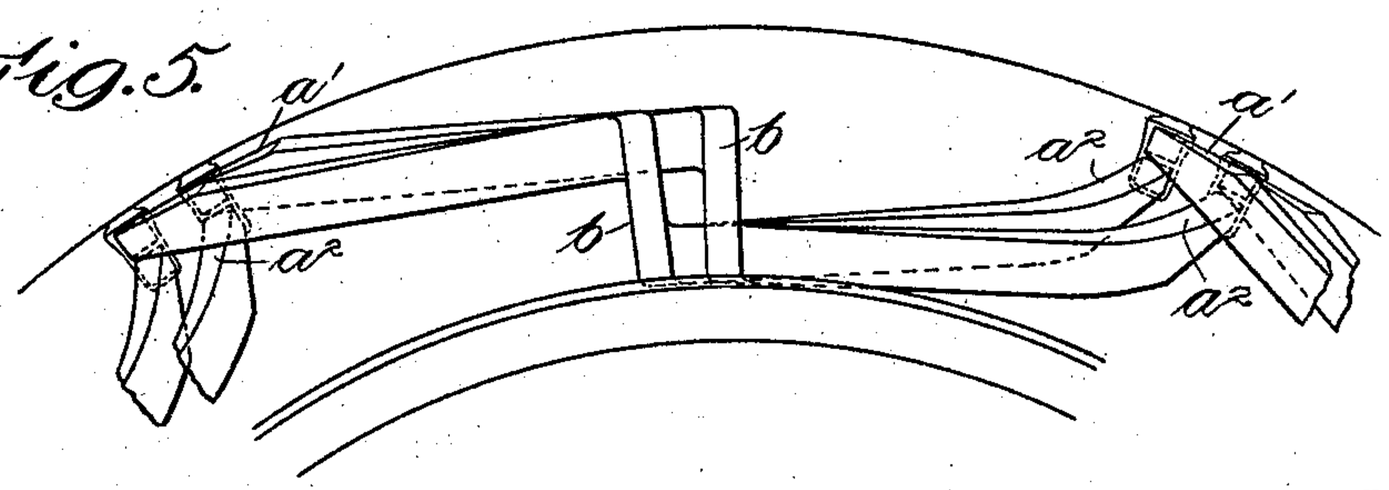


Fig. 4.

Fig. 5.



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UNITED STATES PATENT OFFICE.

HENRY H. WAIT, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

WINDING FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 693,579, dated February 18, 1902.

Application filed January 12, 1901. Serial No. 42,960. (No model.)

To all whom it may concern:

Be it known that I, HENRY H. WAIT, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Windings for Dynamo-Electric Machines, (Case No. 16,) of which the following is a full, clear, concise, and exact description.

This invention concerns the armatures of dynamo-electric machines, and has for its object to improve the structure and form of the inductive winding, more particularly with a view to permit machines of a given power or capacity for work to be constructed with active or working parts smaller than has heretofore been possible—as, for example, in the case of a generator, to provide for a given power with an armature much smaller in circumference than in prior machines.

With armatures as heretofore constructed the limit to the number of conductors, wires, or inductor-bars which may properly be subjected to a given magnetic field with a given expenditure of energy is found in the space upon the periphery of the armature which is available for the reception of such conductors. The slots in the armature-core in which the conductors are placed may not be deepened beyond a given point, since this would too greatly increase the resistance of the magetic circuit and so necessitate a greater number of ampere-turns in the field. The problem, then, is to get the greatest number of conductors of a given resistance in this limited space at the periphery of the armature. With the ordinary conductors heretofore available for winding armatures it has not been practicable to use conductors of less than a given cross-section, because to do so would increase the internal resistance of the armature beyond the proper point for the required output. If the size of the armature be increased in order to provide more space for working conductors, a corresponding increase in size in all parts of the machine and in the amount of energy expended in maintaining the required field strength is necessitated.

In another application, Serial No. 42,959, filed January 12, 1901, I have described and claimed, broadly, a varisectional conductor for the windings of electromagnetic inductive apparatus, such as dynamos, said conductor being made integrally in alternate lengths of large and small cross-section, the smaller lengths being intended to form the active or working parts of the conductor and having their increased resistance compensated for by the increased size and decreased resistance of the remaining portions. These latter serve merely as connectors to unite the inductive lengths and may be disposed at the ends of the armature, where their increased bulk is not so objectionable.

The present invention relates more particularly to the windings of armatures where comparatively massive inductor-bars are required upon the face of the armature, and my efforts in the present instance have been directed toward the production of a winding, coil, or inductor unit by which the invention of my said other application may be made available for armatures of this kind. The difficulty is to dispose the bulky connector portions of the winding in such a way that there will be proper clearance between them and so that they will take up the least space.

In accordance with my invention I make up the armature-winding from looped bars of copper, preferably rectangular in cross-section, with a large part of the metal cut away from those portions which are to form the inductor-bars passing across the face of the armature. The space upon the periphery of the armature in which a magnetic flux must be maintained is thus economized, and the resistance of the winding as a whole is kept down by the relatively-increased size of the connector portions passing around the ends of the armature. Each loop when spread out forms a pair of comparatively small inductor-bars united by a massive end connector and having similar heavy leads to the commutator. As the narrowed or cut-down portion leaves the armature-slot and widens out to form the connector portion it is bent down and passes in as direct a path as possible to the other inductor-bar of the pair or to the commutator, but in a diagonal direction. One arm of each loop is provided with sharp downward bends where the connector portion narrows down to form the inductor-bar, in order

that it may clear the connector-bars or other loops which cross over it.

I will describe my invention particularly by reference to the accompanying drawings, wherein—

Figure 1 illustrates a copper bar bent into a loop with certain portions cut away preparatory to its being bent into an inductor unit for a dynamo-armature. Fig. 2 is a perspective view of a completed armature-winding or inductor unit ready to be placed in position upon an armature. Fig. 3 is a vertical sectional view of a portion of an armature provided with the improved winding of my invention. Fig. 4 is a plan view showing a portion of an armature-core with two windings in position. Fig. 5 is an end view of the same, showing how clearance is provided for between the several connector portions of the windings when placed in position upon the armature-core.

The same letters of reference are used to designate the same parts throughout the several figures.

In making an armature-winding in accordance with this invention I take a bar of copper of the requisite length, rectangular in cross-section—say five-eighths of an inch wide and one-sixteenth of an inch thick—and bend it edgewise into a loop. As shown in Fig. 1, the outside edges of the central portions $a\ a$ of the two arms of the loop are then cut away until these parts are only from a third to a half as wide as the end portions. The angles $a'\ a'$ at which the bar is tapered down are such that when it is bent and placed in position on the armature-core there will be no projecting portions. The bar is then bent as shown in Fig. 2, which illustrates a winding or inductor unit made up of four bars side by side. The two arms of the loop are spread apart sidewise, one upon one side of the U-shaped loop b and one upon the other. The narrowed portions $a\ a$, which are to form inductor-bars, are kept parallel with one another and separated far enough to occupy their proper slots in the armature-core, and the arms are twisted slightly to make these parts lie flat in their respective slots. The ends $b'\ b'$ are bent diagonally to lead to the proper commutator-bars. One of the arms of the loop, in addition to the main bends to bring the bar into the required general shape, has sharp downward bends $a^2\ a^2$ on either side of the narrow portion a which is to form an inductor-bar. This is to allow the connector portions of the other arms of other windings to cross over the connector portions of the arms so bent and to provide for proper clearance between them, while making the armature as compact as possible. The connector portions are also twisted, as shown, so that their edges may cross one another in approximately parallel planes and the maximum clearance may be provided for. To repeat briefly, each copper loop forms two inductor-bars $a\ a$ of diminished cross-section. Where these inductor-bars merge into the more massive connecting portions they are bent so that the connectors lead away in a diagonal direction, and one of the arms or bars of each pair has the connector portions on its ends bent downward at $a^2\ a^2$ to provide for clearance between that bar and others which cross it. It will be seen that in this method of construction it is only necessary to make those portions of the bars which lie within the armature-slots of the smaller cross-section, and that immediately upon emerging from the slots the cross-section can be gradually increased and at the same time the bars may be bent in the direction to pass to the other inductor-bar of the pair by the shortest practicable path.

My invention permits a reduction in size of the active or working parts of the armature-conductors to allow a greater number to be disposed in a given space upon the periphery of the machine, or, what amounts to nearly the same thing, to allow the armature to be made with smaller circumference or with smaller slots in its periphery. This is accomplished by making up for the increased resistance of the inductor-bars by the decreased resistance of the massive connecting portions $b'\ b'$, which, as shown in the drawings, occupy the space at the end of the armature instead of in the magnetic field. Since the armature-shaft may be as long as desired within reasonable limits, there is no objection to the increased bulk of the connectors when they are formed and disposed as shown in the drawings.

Other advantages besides the obvious one of reducing the bulk of the conductors in the valuable spaces on the armature result from my invention. For example, the armature-teeth between which the inductor-bars are passed can be made shorter, and so of smaller cross-section, without requiring a higher number of ampere-turns for the field-magnet of the dynamo. The result of this is that with the same field ampere-turns the magnetic lines passing through the armature are condensed or crowded together more at the teeth—that is, the teeth are more thoroughly "saturated." The higher the degree of magnetic saturation of the armature-teeth the less will be the change in flux caused by the variation of the reactive ampere-turns on the armature, and consequently the greater may be variation in load without requiring adjustment of the brushes to secure sparkless commutation. Again, since the size of the armature-teeth is the principal factor going to make up the self-induction of an armature-coil, it is evident that by applying my invention the self-induction of the armature, which is the principal cause of sparking in direct-current generators and motors, may be materially reduced.

I claim as my invention—

1. An armature-winding for dynamo-electric machines, comprising looped bars of copper each having the central portions $a\ a$ of

the arms cut down, substantially as shown, and spread apart to form two inductor-bars of diminished cross-section, said inductor-bars being united by the massive connector portions b', substantially as set forth.

2. An armature-winding for dynamo-electric machines, comprising two bars of copper having the central portions $a\ a$ thereof cut down to form two inductor-bars of diminished cross-section, and heavy end connectors formed integrally with said inductor-bars and uniting them, one of said bars having the bends $a^2\ a^2$ where it widens into the connecting portions, whereby clearance is provided for between such connecting portions and the connectors of other loops which cross them, substantially as set forth.

3. An armature-winding for dynamo-electric machines, comprising a looped bar of copper having the central portions $a\ a$ of the arms cut away, substantially as shown, to form inductor-bars of diminished cross-section, the remaining parts being bent diagonally from the inductor-bars, one of the arms of the loop being bent substantially straight and the other arm having double bends $a^2\ a^2$ where the inductor-bar formed by that arm widens out into connector portions, substantially as set forth.

4. An armature-winding for dynamo-electric machines, comprising a looped bar of copper having the central portions $a\ a$ of the arms cut away at angles $a'\ a'$ and spread apart one on either side of the loop b, to form parallel inductor-bars of diminished cross-section, one of the arms of the loop being bent diagonally at the points where the inductor-bar formed thereby widens into the connector portions, and the other arm being also bent diagonally and having additional bends $a^2\ a^2$, substantially as set forth.

In witness whereof I hereunto subscribe my name this 31st day of December, A. D, 1900.

HENRY H. WAIT.

Witnesses:
ELLA EDLER,
ADELL HOCKETT.