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B. G. LAMME.
WINDING FOR ELECTRIC MACHINES.

(Application filed Apr. 17, 1901.)

(No Model.)

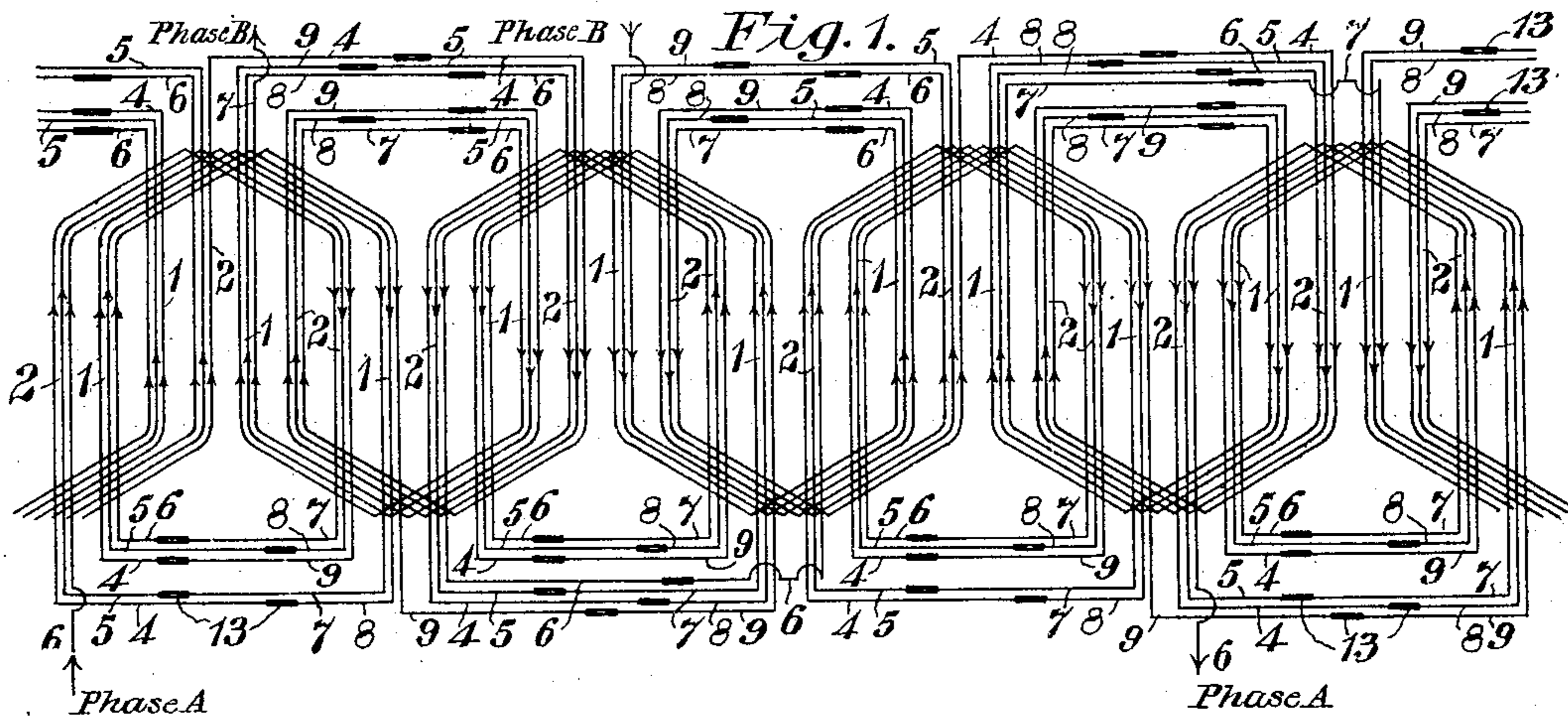


Fig. 2.

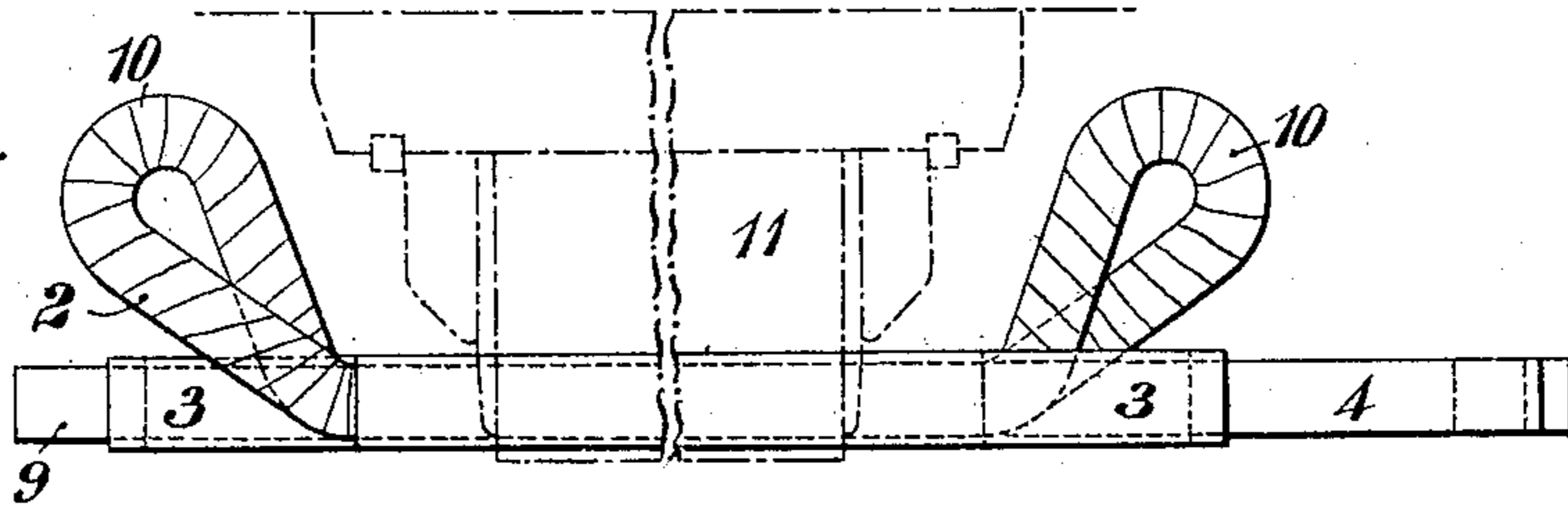


Fig. 3.

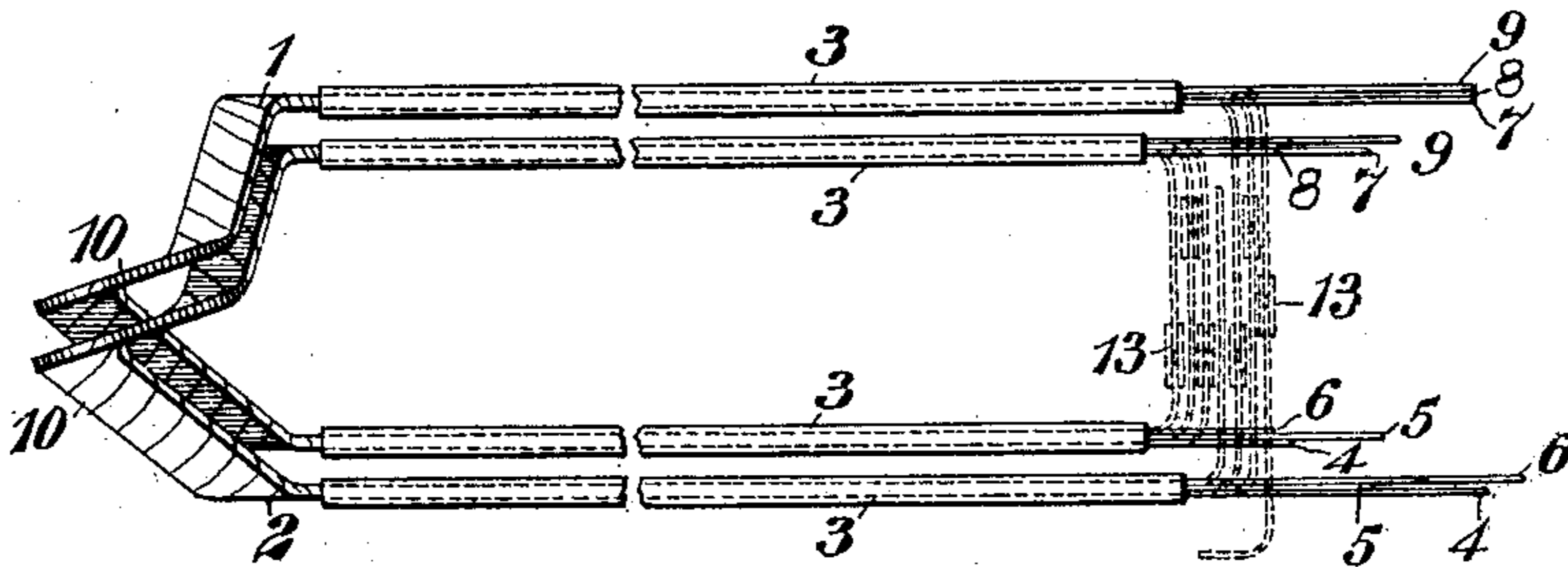


Fig. 4.

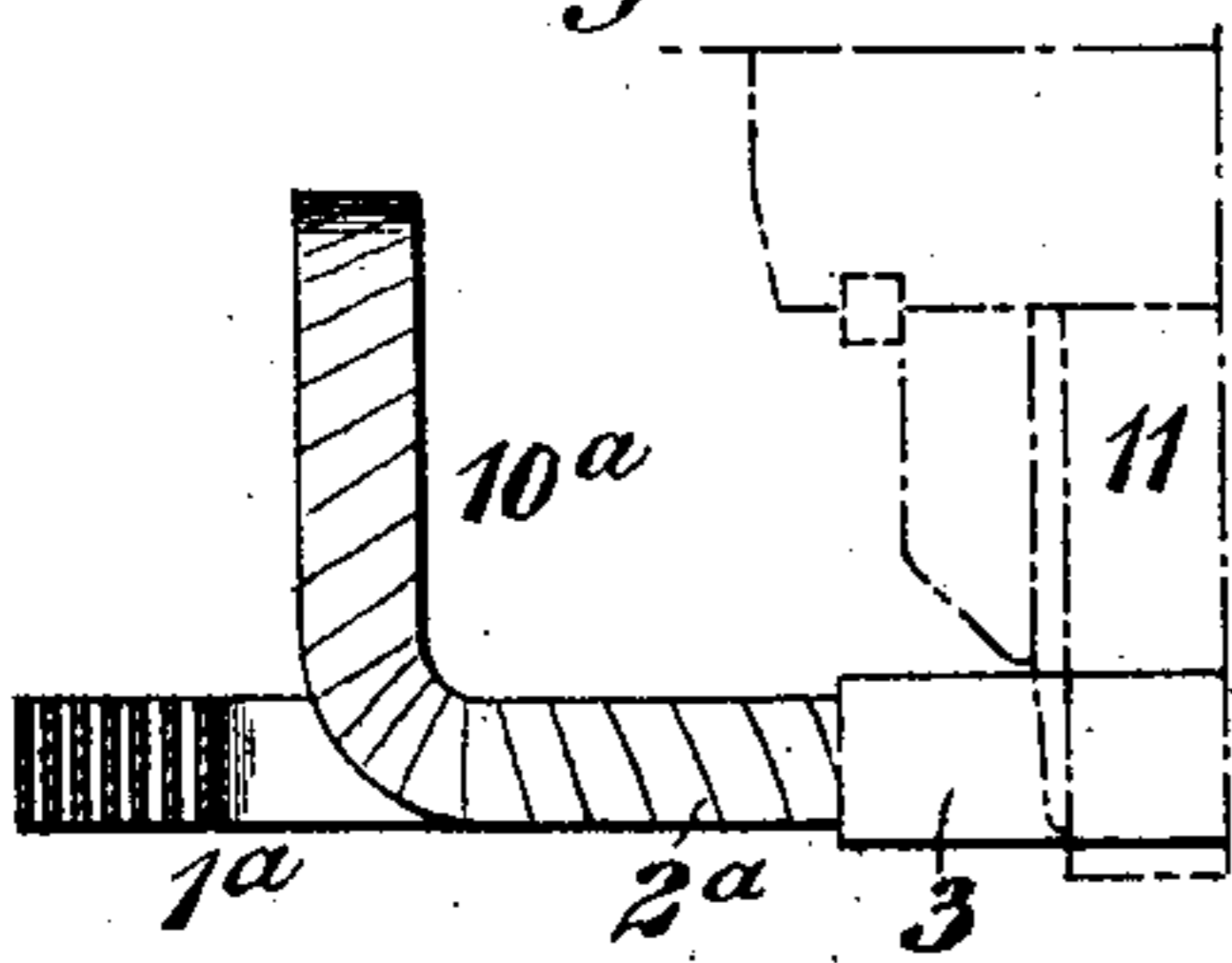


Fig. 5.

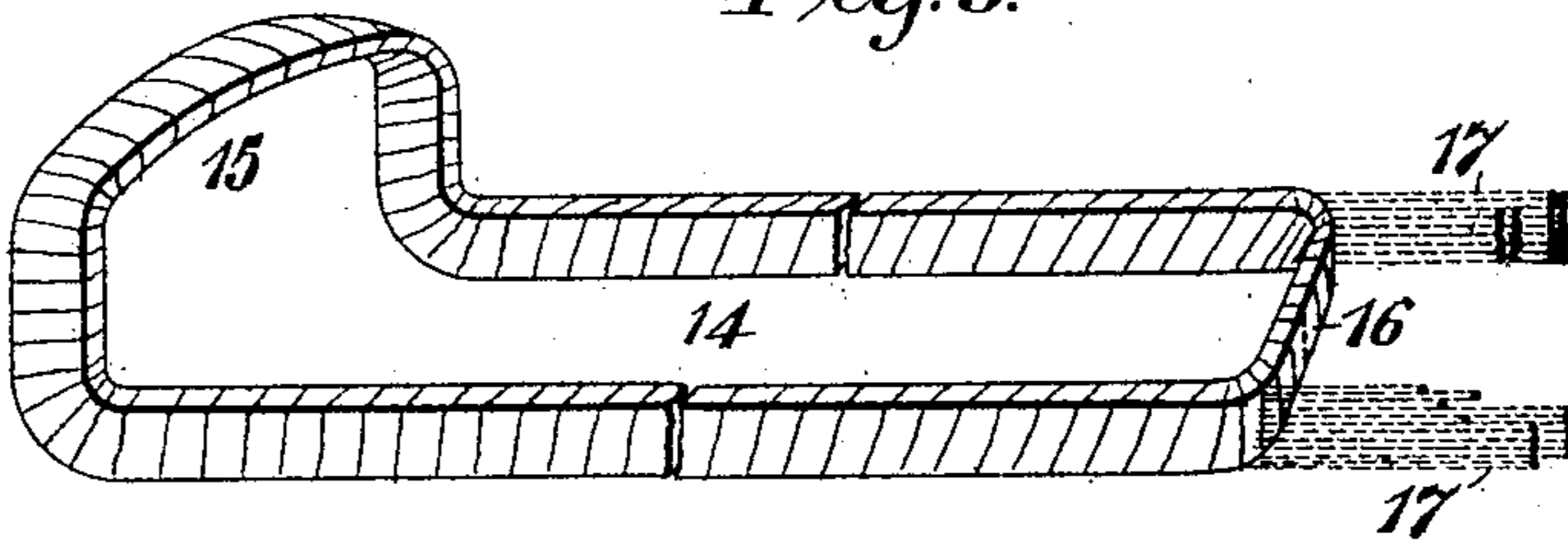
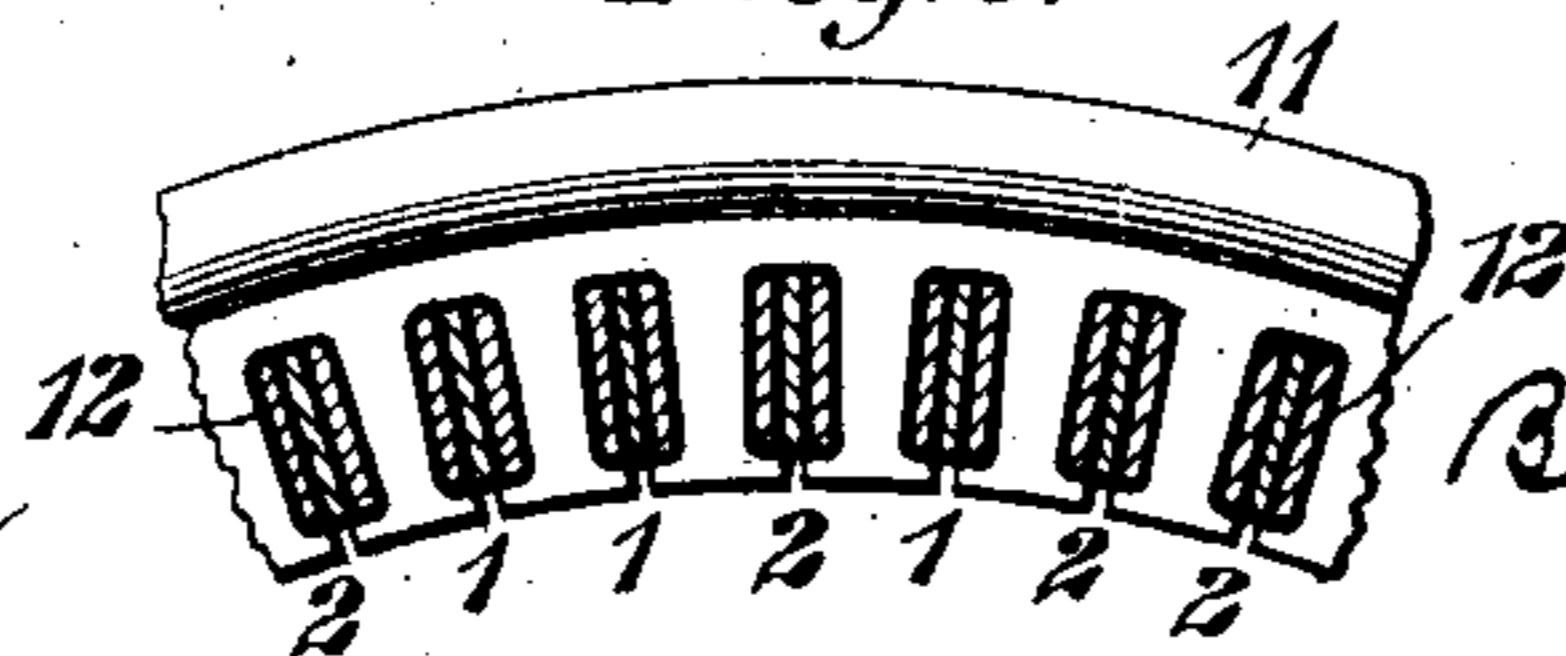


Fig. 6.



WITNESSES:

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WINDING FOR ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 688,317, dated December 10, 1901.

Application filed April 17, 1901. Serial No. 56,330. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN G. LAMME, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented new and useful Improvements in Windings for Electric Machines, of which the following is a specification.

My invention relates to dynamo-electro or electro-dynamic machines, and particularly to the windings of such machines.

The object of my invention is to provide a distributed winding the individual coils of which may be all of substantially the same form and dimensions and well adapted for application to cores having slots that are so nearly closed as to preclude the insertion of the coils except endwise.

In certain classes of machines it is very desirable that the peripheral openings of the core-slots shall be narrow in order to avoid the losses which would accompany the use of machines having open slots. It has been a usual practice to construct machines having core-slots of this character; but heretofore, as far as I have been aware, it has been deemed necessary to either employ bar-conductors provided with end connectors, which are riveted or riveted and soldered to the bars after the latter are inserted in the core-slots, or to wind the coils when individually composed of several turns of wire or strap directly upon the machine.

It is the purpose of my present invention to provide a winding made up of coils, each of which may comprise any desired number of turns of either strap or wire, that are bent or wound into final form, except as to one end, before insertion into the core-slots and are then connected up to form a symmetrical ventilated winding.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram of a two-phase four-pole winding. Fig. 2 is a side elevation of two oppositely-disposed strap-coils constructed in accordance with my invention, a portion of the core to which the coils are applied being indicated by broken lines. Fig. 3 is a plan view of two coils constructed and ar-

ranged in accordance with my invention. Fig. 4 is a side elevation corresponding to one-half of what is shown in Fig. 2, but showing a different form of coil. Fig. 5 is a perspective view of a wire-wound coil constructed in accordance with my invention. Fig. 6 is an end elevation of a portion of an electrical-machine core provided with my winding, the latter being shown in section.

As has already been indicated, each coil may embody any desired number of layers or turns of either strap or wire; but in Figs. 1, 2, 3, 4, and 6 each coil is shown as comprising three separately-bent straps of the same form and arranged side by side for insertion into the appropriate core-slots.

As illustrated in Figs. 1, 2, 3, and 6, the coils 1 and 2 are arranged in pairs, and the pairs are inserted into the core-slots at opposite ends of the core alternately. Each side of each of the coils 1 and 2 is provided with a sheath 3, of fuller board or other suitable insulating material, and each coil has ends 4, 5, and 6 at one side, that project beyond the sheath 3, and at the other side each of the coils has similar projecting ends 7, 8, and 9. These projecting ends are shown as differing in length; but this is an immaterial feature so far as the formation of the coils prior to insertion in the core is concerned, provided the ends are of sufficient length to be coupled together in proper order after the coils are inserted in the core-slots, so as to make the winding complete. The ends of the coils 1 and 2 that are opposite the free ends 4, 5, 6, 7, 8, and 9 are bent inward toward the core 11 and offset at substantially the middle point of the bent portion, as indicated at 10, so that the corresponding portions of adjacent coils will not interfere with each other and will be spaced apart sufficiently to afford proper ventilation. The ends 10 of the coils are obviously susceptible of variations in shape to suit the amount of available space, the potential between adjacent coils or between the coils and the machine-frame and core or the ideas of the designer respecting either appearance or utility for any given conditions of service. The shape here illustrated is therefore intended to be merely indicative of

any contour that is suitable for practical service. After the coils are bent to shape, as indicated in full lines in Figs. 2 and 3, they are inserted endwise into the core-slots 12, alternate pairs being inserted from opposite ends of the core, as indicated in Figs. 1 and 2. The projecting ends that are to be connected together are then bent so that their extremities are in proximity to each other, and they are then joined by suitable couplings 13, the ends being first cut, however, to the proper length to insure non-interference between the couplings of adjacent turns, provided they are not of proper length when the coils are placed in position. The particular combination of the several ends will obviously depend upon the number of phases of current that the machine is to generate or that is to be supplied to it to operate it as a motor and the number of magnetic poles to be produced, either by current supplied to the winding or by the field-magnet poles of the machine in case the winding here shown is employed as an armature-winding for either a generator or a synchronous motor. As here indicated, the coils are arranged and connected to form a two-phase four-pole winding, the free ends of the coils for phase A projecting in the same direction and being connected as follows: The ends 4, 5, and 6 of coil 1 are respectively connected, by means of suitable couplings 13, to the ends 9, 8, and 7 of coil 2. The end 7 of coil 1 is connected to the end 5 of coil 2, the end 8 of coil 1 is connected to the end 4 of coil 2, and the end 9 of coil 1 is connected to the end 9 of coil 1 of one of the adjacent pairs. The ends 6 of the coils 2 of adjacent pairs are either connected together or left free as leads for attachment to the external circuit either by a suitable binding device or by means of collector rings and brushes, depending upon whether the winding is applied to the stationary or to the rotating member of the machine. The winding for phase B comprises the pairs of coils that are inserted from the opposite end of the core, and they are connected up as follows: As in the winding for phase A, the ends 4, 5, and 6 of each coil 1 are connected, respectively, to the ends 9, 8, and 7 of coil 2. The other ends are connected somewhat differently, however, the end 6 of coil 2 being connected to the end 8 of coil 1 and the end 5 of coil 2 being connected to the end 9 of coil 1. The ends 4 of the coils 2 are connected to the ends 4 of coils 2 of adjacent pairs and the ends 7 of the coils 1 are either connected to the ends 7 of the coils 1 of adjacent pairs or are left free to make connection with the external circuit either by stationary connecting means or through contact rings and brushes, according to whether the winding is on the stationary or the rotatable part of the machine.

The connections of the coils and coil elements shown and described obviously embody only one of many combinations and arrangements of which my invention is sus-

ceptible, and I therefore desire it to be understood that the invention is in no wise limited in this respect. If, for example, the winding were adapted to three-phase currents, the coils would be differently grouped and the coupled conductor ends at each end of the core would not be restricted to currents of a single phase.

In Fig. 4 I have illustrated a variety of winding that is similar to the one already described in that strap-conductors are employed; but in this modification the coils 1^a and 2^a are provided with closed ends 10^a, that are bent approximately at right angles to the sides of the coils. With this construction it is not feasible to arrange the coils as indicated in the preceding figures; but those of each pair or group which project in the same direction may be so formed as to span a different number of teeth or spaces, and the groups may alternate with each other, both as regards the relative position around the core and also as to the ends of the core from which they are inserted in the core-slots. With this form of winding, as well as in that shown in the other figures, the ends of the coils that are connected after the coils are in place in the core are bent and coupled outside the ends 10^a. By this arrangement the coupling operation is easily effected, since the curved ends do not present any obstacle to such operation.

In Fig. 5 I have illustrated the adaptation of my invention to wire-wound coils. The form of the coil 14 here shown, when completed ready for insertion in the core-slots, is substantially like the form of coil shown in Fig. 4. In constructing this coil, however, it is first wound upon a suitable mold or former until the desired number of turns is secured and so that the end 15 projects approximately at right angles to the plane of the sides of the coil, although this portion 15 may project at any other angle than ninety degrees and be given any other desired shape, provided the angle that it makes with the plane of the sides of the coil is such as not to interfere with the assembling of the winding as a whole and the operation of the machine when completed.

After the coil is wound and covered with suitable tape or other insulation the end 16 opposite the end 15 may be divided and the divided portions bent outward in line with the sides of the coil, as indicated at 17. The coil is then in suitable form for insertion into the core-slots, and the projecting ends 17 may be connected up in any manner that is suitable for providing the character of completed winding desired. This general type of winding enables me to produce any desired number of partially-completed coils by winding, bending, or otherwise forming the strap or wire into a suitable shape for insertion into the closed or partially-closed slots, and after insertion to bend and connect together the projecting ends outside the originally bent ends, so as to form a continuous symmetrical

winding that does not differ materially either in function or durability from a winding composed of coils constructed in the usual manner for application to a core having open slots.

5 I claim as my invention—

1. A winding for electrical machines comprising a plurality of coils one half of which have offset bends at one end of the core and the other half of which have similar offset
10 bends at the other end of the core.

2. A winding for electrical machines comprising a plurality of coils each of which has one end bent at an angle to its sides and its other end approximately straight.

15 3. A winding for electrical machines comprising a plurality of coils each of which has a bent or offset end, one half of the coils being reversed in position with reference to the other half.

20 4. A winding for electrical machines comprising a plurality of coils, one half of which are of integral construction and independent of each other at one end of the core and the other half of which are of integral construction and independent of each other at the
25 other end of the core.

5. A winding for electrical machines comprising a plurality of coils, one half of which have ends bent toward the body of the core at one end of the core-slots and the other half of which have ends that are bent toward the body of the core at the other ends of the core-slots, the other ends of each set of coils being connected to form a continuous winding.

35 6. A winding for electrical machines comprising coils which are individually composed of a plurality of side-by-side turns of strap copper and have unlike ends, the coils being so arranged that both kinds of coil ends are
40 equally represented at the two ends of the core.

7. The combination with the core of an electrical machine, having partially-closed slots, of a two-phase winding therefor, comprising coils for one phase inserted into the slots from
45 one end of the core and coils for the other phase inserted into the slots from the other end of the core.

8. A polyphase winding for electrical machines comprising a plurality of sets of coils,
50 all of which are alike but have ends of different form, the coils of one set being reversed in position with reference to those of the other.

9. In an electrical machine, a plurality of
55 coils having unlike ends and connected to form a plurality of independent circuits.

10. In an electrical machine, a plurality of coils having unlike ends, the ends of one kind being so coupled together outside the ends of
60 the other kind as to form one or more complete circuits.

11. In an electrical machine, a plurality of coils each of which has its sides and one end bent to shape before application to the core,
65 one half of said coils being reversed in position with reference to the other half and the free ends of the coils being coupled together outside of the originally-bent ends.

12. In an electrical machine, a winding consisting of a plurality of coils having unlike
70 ends and so disposed that there are both kinds of coil ends at each of the core ends, and the coil ends of one kind are outside those of the other kind.

In testimony whereof I have hereunto subscribed my name this 13th day of April, 1901.

BENJ. G. LAMME.

Witnesses:

WESLEY G. CARR,
BIRNEY HINES.