Feb. 14, 1933.

V. G. APPLE

1,897,544

ARMATURE

Filed Nov. 21, 1928

4 Sheets-Sheet 1

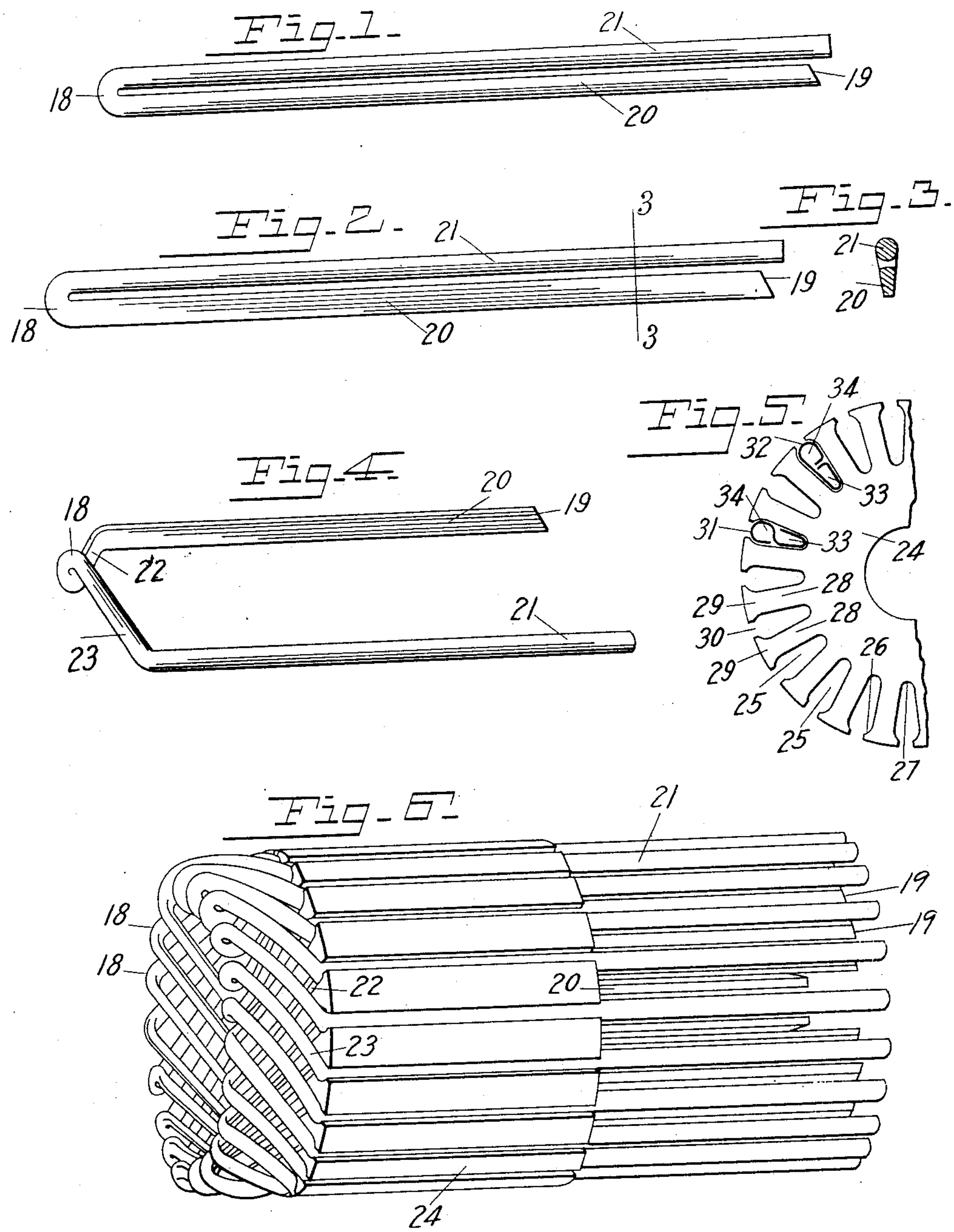

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Fig. 7.

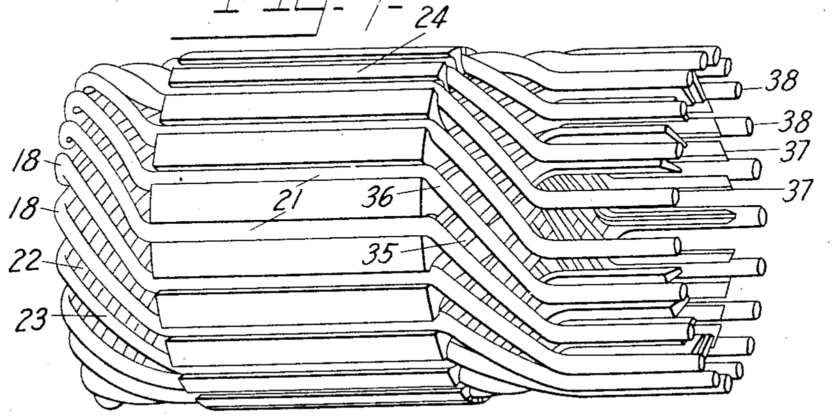

Fig. 8.

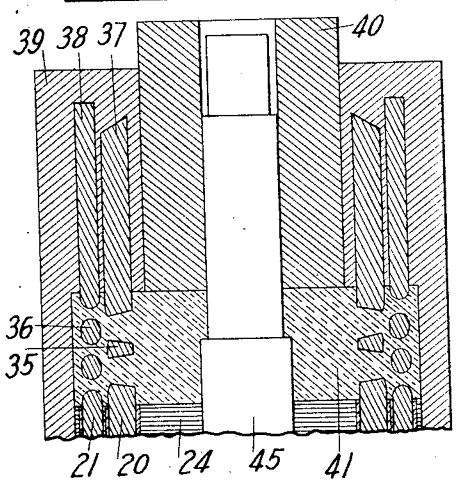

Fig. 9.

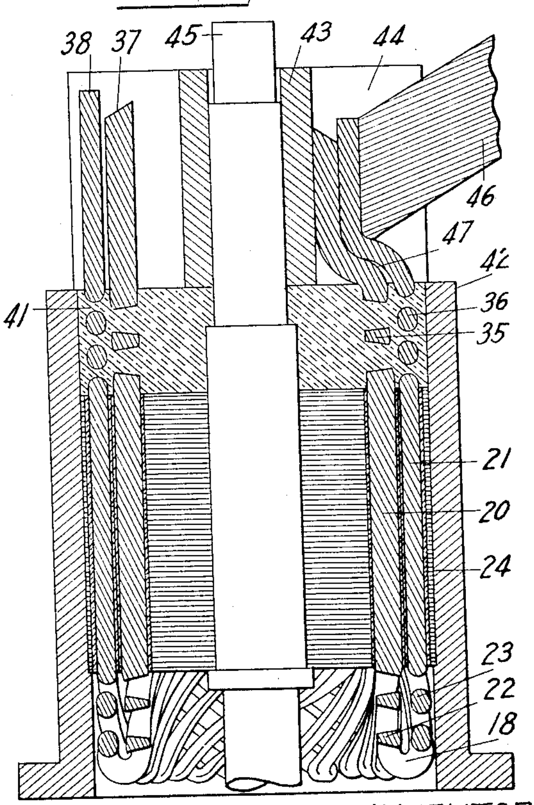

Fig. 10.

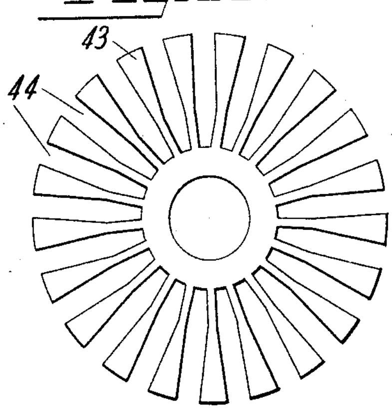

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Fig. 11.

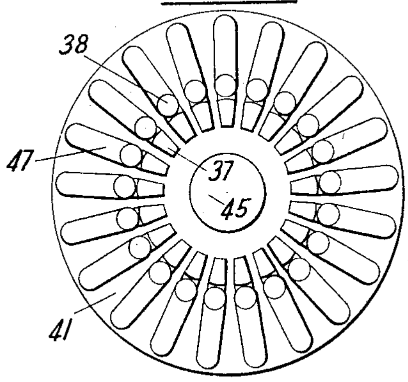

Fig. 12.

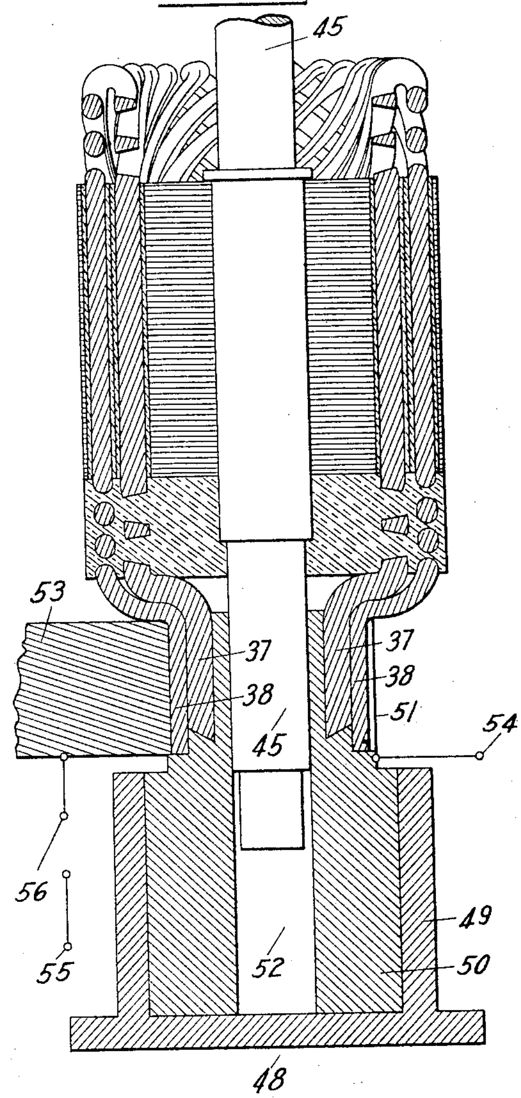

Fig. 13.

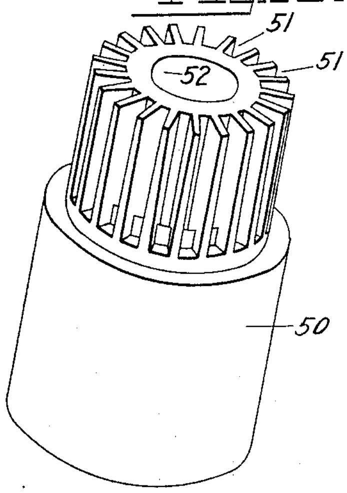

Fig. 14.

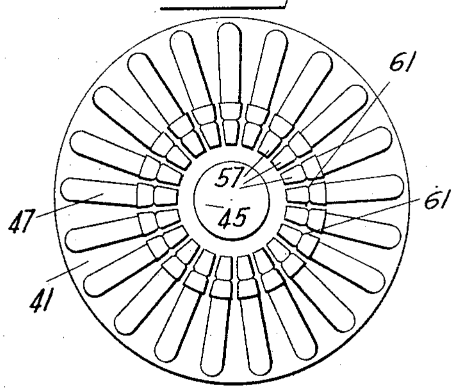

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Fig. 16.

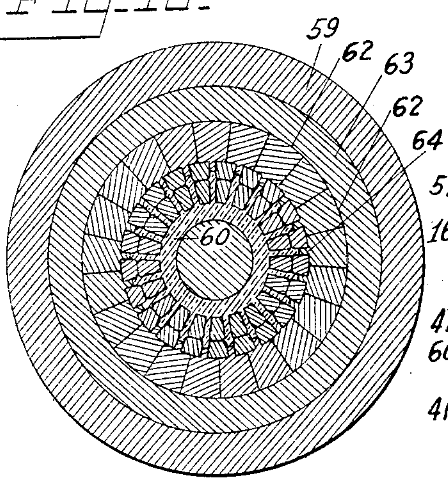


Fig. 15.

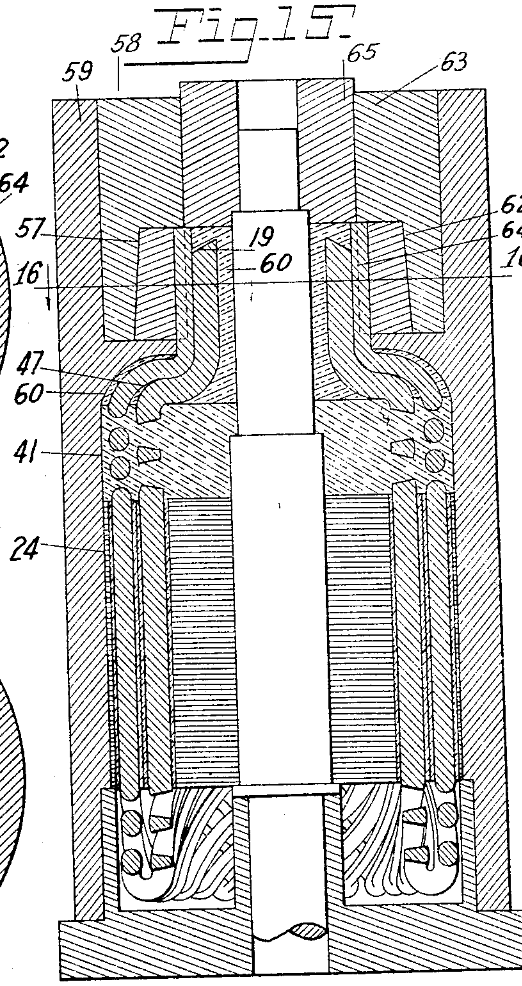


Fig. 17.

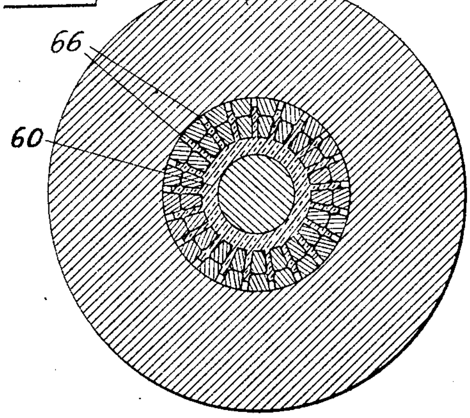
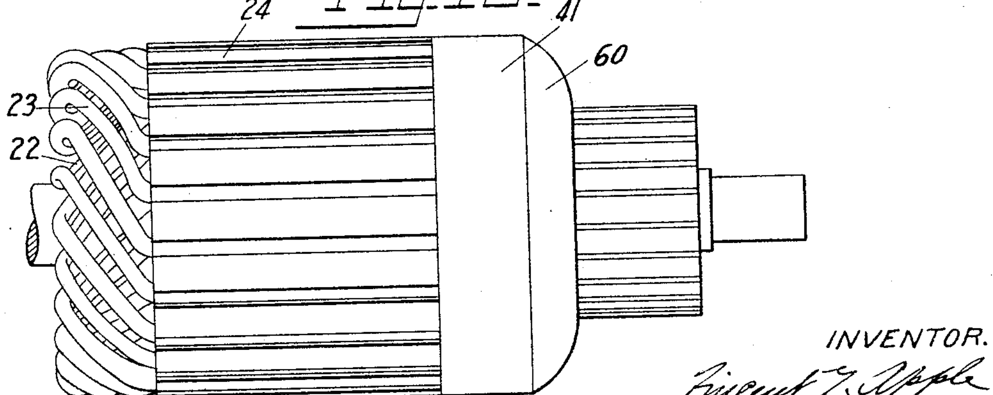


Fig. 18.



INVENTOR.

Vincent G. Apple

Patented Feb. 14, 1933

1,897,544

UNITED STATES PATENT OFFICE

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ARMATURE

Application filed November 21, 1928. Serial No. 320,902.

This invitation is shown, tho not claimed in my co-pending application Serial Number 235,282, Patented January 7, 1930, No. 1,742,190, and relates to single turn bar wound armature particularly applicable to endwise entry of the winding.

An object of my invention is to reduce the cost yet improve the quality of an armature by eliminating the separately made commutator usually soldered to the terminals of bar windings and instead form a commutator by simultaneously forging and welding pairs of radially adjacent winding terminals into commutator segments and binding the segments together to compose a commutator which is then an integral part of the winding.

Another object is to so proportion the winding apertures and the commutator that bar stock or wire of substantially standard cross section may be adapted to both conductor bars and commutator segments with minimum fabrication.

Further objects will appear from the following detailed description in which reference is made to the drawings wherein—

Fig. 1 shows a length of wire bent back upon itself to hairpin form.

Fig. 2 shows the hairpin Fig. 1 after one of the legs has been flattened to a wedge shape.

Fig. 3 is a cross section taken at 3—3 of Fig. 2.

Fig. 4 shows how the legs of the hairpin Fig. 2 may be spaced apart to form a loop.

Fig. 5 shows a portion of an end view of a core having apertures adapted to be wound with loops Fig. 4.

Fig. 6 shows a core wherein a complete set of loops Fig. 4 have been endwise entered, the open ends of the loops projecting beyond.

Fig. 7 shows the open ends bent to form helically disposed leads leaving axially parallel ends extending from which commutator segments may be formed.

Fig. 8 is a partial cross section taken thru an armature and its mold after insulating material has been molded between and about the diagonal leads leaving the axially parallel ends extending from the insulation.

Fig. 9 shows how the axially parallel pairs of ends are bent to decrease the space between pairs of ends to provide a commutator of relatively small diameter.

Fig. 10 is an end view of the slotted collar used to guide the axially parallel ends as they are being bent as shown in Fig. 9.

Fig. 11 is an end view of the armature after the conductors are bent as shown in Fig. 9.

Fig. 12 is a cross section thru an armature in the fixture used to forge and weld pairs of axially parallel ends to compose commutator segments.

Fig. 13 is a perspective view of the notched electrode used in the fixture shown in Fig. 12.

Fig. 14 is an end view of the armature after the ends have been forged and welded into commutator segments.

Fig. 15 is a cross section thru another mold wherein insulating material has been molded between and about the welded segments to compose a commutator.

Fig. 16 is a cross section taken at 16—16 Fig. 15.

Fig. 17 is a cross section taken thru a mold similar to Fig. 15 but slightly modified.

Fig. 18 shows a complete armature.

Similar numerals refer to similar parts thruout the several views.

As is generally known closed or semi-closed winding apertures in armature cores have many advantages. One advantage is greater magnetization for a given number of winding turns due to the distribution of the armature flux over a greater portion of the air gap thru the resulting widened ends of the core teeth at the outer diameter of the armature. Another is the effective manner in which the conductor bars are held against centrifugal force at high rotative speeds.

A wedge shaped semi-closed winding aperture produces core teeth having widened outer ends and, since one of the objects of my invention is to form wedge shaped commutator segments by joining radially adjacent conductor ends, it follows that winding loops, the two legs of which together fit such a wedge shaped aperture, will also be suitable for making the desired segment. I therefore provide a core having wedge shaped winding apertures, and winding loops having one conductor bar of a cross section which substantially conforms to the wider outer half of an aperture and another conductor bar which substantially conforms to the narrower inner half of the winding aperture, so that the two bars when placed one radially above the other will not only fit the aperture but the ends will form a composite wedge suitable for a commutator segment.

Fig. 1 shows one step in the method of making a loop of my winding and consists of cutting a length of round wire of standard gauge and folding it back upon itself as at 18 to hairpin form, thus providing two round conductor bars 20 and 21 parallel to each other. The end 19 is cut off diagonally for a purpose which will hereinafter appear.

Fig. 2 shows another step employed in producing my loop and consists of bringing one of the two like bars to a different cross section from the other. This may be done by striking in a die, by passing the hairpin between suitable rollers, or by any other suitable means which will flatten one bar and leave the other round or which will flatten one bar but slightly and the other considerably to form a composite wedge. In the embodiment shown bar 20 only is flattened as will appear in Fig. 3 which is a cross section taken at 3—3 Fig. 2.

Fig. 4 shows how bars 20 and 21 may be spread to form a winding loop in which bar 20 is joined to bar 21 at 18 by diagonal back lead portions 22 and 23, bar 20 being adapted to occupy the inner half of a core aperture, forming a half turn of the inner layer of the winding, and bar 21 being adapted to occupy the outer half of a core aperture, forming a half turn of the outer layer of the winding.

Fig. 5 is a partial end view of a core 24 having the conventional wedge shaped apertures 25, 25 rounded at the top 26 and bottom 27 leaving teeth 28, 28 having parallel sides and widened ends 29, 29 separated by slots 30. The apertures 25 are preferably lined, or the legs 20 and 21 coated with insulating material.

In the instant case sheet insulation is bent as at 31, or as at 32 and inserted in the core apertures leaving insulated openings 33 adapted to receive bars 20 and insulated openings 34 adapted to receive bars 21.

While the method of procedure hereinbefore illustrated contemplates using round bars or wire in the conventional wedge shaped winding apertures, it is obvious that the use of bars or wire of somewhat modified form in correspondingly modified apertures will come within the scope of the invention, and while I have described succeeding steps by which my winding loop may be produced, these steps need not be taken in the sequence named, but may be taken in a different order, and they may be taken singly as indicated, or several, or all may be combined into a single operation, and while winding loops of the character shown are particularly applicable to cores having closed or semi-closed winding apertures thru which they may be endwise entered they may be used to advantage in cores having open winding slots.

When loops Fig. 4 are to be used in a core Fig. 5 the bars 20 and 21 must be endwise entered thru the core apertures and this is most conveniently done by the process shown in my Patent Number 1,555,931, where an entire winding is first assembled in cylindrical formation then endwise entered into the core until the open ends of the loops extend thru and beyond the core as shown in Fig. 6, after which the projecting ends of the bars are bent as in Fig. 7, bars 21 of the outer layer helically in one direction and bars 20 of the inner layer helically in the other direction forming front lead portions 35 and 36 and leaving axially parallel ends 37 and 38 extending in pairs, one member of each pair radially above the other, from which commutator segments may be formed.

The structure is next placed in a mold Fig. 8, the body portion 39 of which is bored to receive core 24 leaving space around the helical front leads 35 and 36. A plurality of pockets extend upwardly into body 39 to receive the straight ends 37 and 38 of the conductor bars. A plug 40 may close the upper portion of the mold. Insulation 41 is then molded between and about the helical front leads 35 and 36 as shown. Any insulation having the required dielectric and mechanical strength may be used, and it may be poured or pumped into place while fluid, or placed in the mold in granular form, rendered mobile by heat or otherwise, compacted by plunger 40, and hardened by whatever proccess the nature of the insulation requires.

The armature is now placed in fixture 42 (see Fig. 9) then collar 43 having slots 44, said collar being more clearly shown in end view Fig. 10, is placed over shaft 45, so that a pair of straight ends 37 and 38 are contained in each slot of the collar. The fixture comprises means, not shown, whereby a plunger 46 is operated to force pairs of ends 37 and 38 to the bottom of slots 44, bending them as at 47. The armature may be turned in the fixture so that the same plunger 46 may successively bend all of the pairs of straight ends, but it is obviously within the ability of the average mechanic to provide a fixture whereby a plurality of plungers 46 are employed to bend all the pairs of ends simultaneously. An end view of the armature after all of the straight ends 37 and 38 have been bent as at 47 is shown in Fig. 11.

The armature is next placed in fixture 48 shown in Fig. 12, where frame 49 carries forging die 50 having a plurality of pockets 51, each adapted to receive a pair of superimposed conductor ends 37 and 38, and having a central opening 52 adapted to receive shaft 45. Die 50 is shown in detail in Fig. 13. Fixture 48 comprises also means, not shown, for operating plunger 53 to press a pair of ends 37 and 38 downwardly into a pocket 51. Suitable electric current is applied, one potential at 54 and the other at 55. The fixture may be operated in a manner similar to commercial welding machines wherein pressure is first applied to plunger 53, and when it reaches a sufficient value, switch 56 closes, and the electric current heats ends 37 and 38 until they become mobile, when the plunger will forge the mobile ends substantially to the shape of a pocket 51 and weld them together at the same time. Obviously a plurality of plungers 53 may be made to forge and weld all of the pairs of ends 37 and 38 simultaneously. Fig. 14 is an end view of the armature after all of the welds are made and all of the pairs of ends are forged into commutator segments 57.

The armature is now placed into another mold 58 Fig. 15, the body 59 of which is bored to receive the core 24 and the previously molded portion 41, leaving space between and about the bent portions 47 of the conductors and between and adjacent to the welded segments 57 into which insulating material 60 may be molded. The diagonally cut ends 19 of the inner conductor bars and the slight grooves 61 (see Fig. 14) left at the welded joints provide means which insulation 60 may engage to bind the segments together to compose a commutator.

As more clearly appears in Fig. 16, mold 58 comprises a plurality of jaws 62, held together by ring 63 which fits into the upper portion of body 59. Jaws 62 have tangs 64 at their inner ends, and these tangs extend inwardly a short distance between segments 57 to keep them separated while molding is taking place. Insulation 60 may be forced into place while in a plastic state by plunger 65, or it may be poured or pumped into place. In either event it is hardened by the process most suitable to the nature of the insulation employed.

When the mold is removed the commutator formed will have grooves 66 (see Fig. 17) between the segments where tangs 64 were withdrawn forming what is generally called an undercut commutator, that is, one wherein the insulation which separates the several segments does not extend outwardly between the segments to the brush track, a feature sometimes embodied when the insulation used to separate the segments is unsuitable for a brush track, as when it is harder than the material in the segments so as to wear away unequally with them, or when it is of such a nature that it deteriorates and loses its insulating value under the arcing of the brushes.

In some cases a commutator having undercut bars is not desirable, and in such cases I may construct a mold similar to mold 58 Figs. 15 and 16 but wherein tangs 64 are omitted and hold the commutator segments separated at their outer edges by strips of suitable insulating material corresponding in size to tangs 64, and then place the insulation 60.

I prefer however, when no undercut is desired, to first take the steps shown and described relative to Fig. 15 and thereby first produce an undercut commutator, then place the structure in a third mold which is similar to mold 58 Fig. 15 except that body 59 is bored at the upper end of the commutator diameter, eliminating jaws 62, tangs 64 and ring 63 (see Fig. 17), and therein mold insulation suitable for a brush track into the grooves 66 left by tangs 64 of mold 58.

A complete armature is shown in Fig. 18 when the front leads are covered with insulation 41 and 60. Obviously the back leads 22 and 23 may be similarly covered if desired.

Having illustrated and described my invention, I claim—

1. An armature comprising an apertured core, a plurality of winding loops in the apertures of said core having their open ends which extend from said apertures drawn together to cylindrical formation of relatively small diameter and welded, an outer layer bar radially over an inner layer bar composing a longitudinally grooved commutator segment of each such pair, and molded insulation extending between and about said segments and into said grooves to bind said segments together to compose a commutator.

2. An armature comprising an apertured core, a plurality of winding units, each made from a single piece of rounded wire bent to loop form closed at one end and open at the other, in the apertures of said core, the open ends extending through and beyond the core at one end, being drawn into cylindrical formation of relatively small diameter with the ends of the outer layer bar radially over the ends of the inner layer bars in pairs, the rounded edges of a pair being brought together and welded to compose commutator segments, leaving longitudinal V-shaped grooves in the sides of the segments where the two rounded wires are joined, and molded insulation extending between and about the segments and into said grooves binding the segments together to compose a commutator.

In testimony whereof I hereunto set my hand.

VINCENT G. APPLE.