June 13, 1967 D. E. HILL 3,324,536

COIL ASSEMBLING APPARATUS

Filed May 3, 1965 4 Sheets-Sheet 1

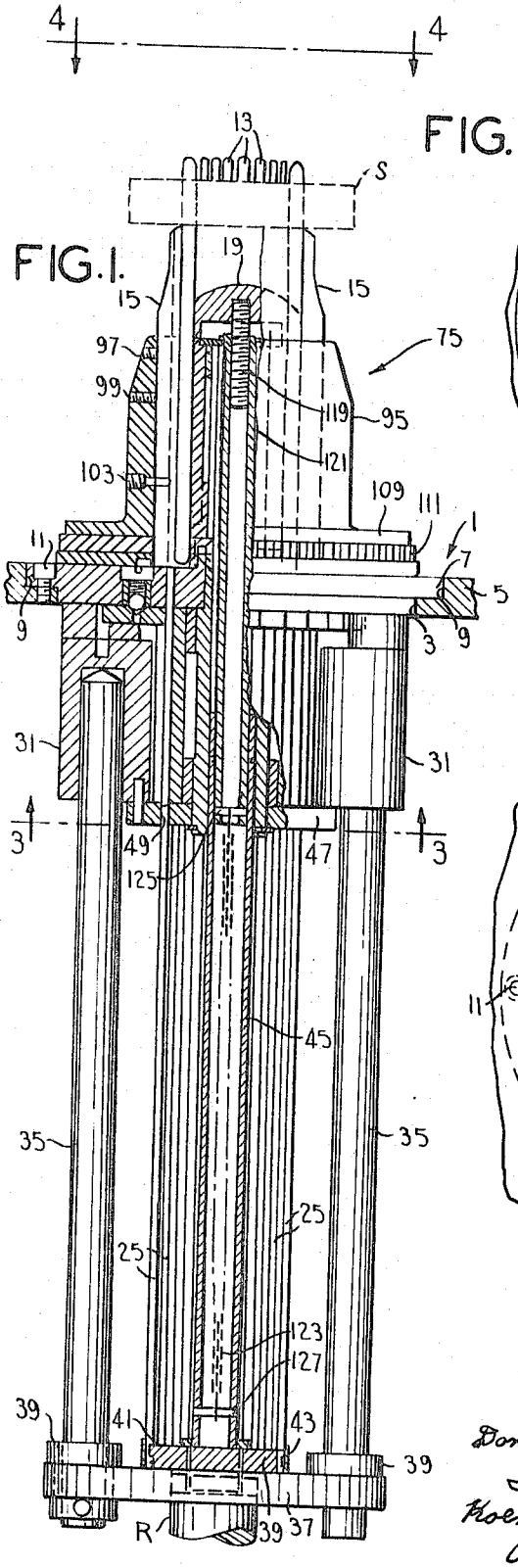


FIG. 1.

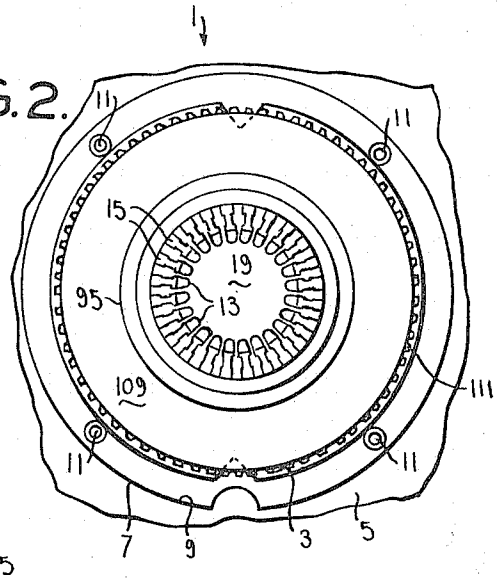


FIG. 2.

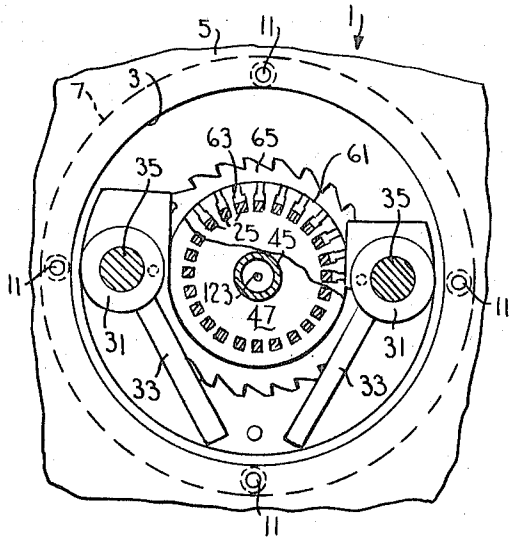


FIG. 3.

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COIL ASSEMBLING APPARATUS

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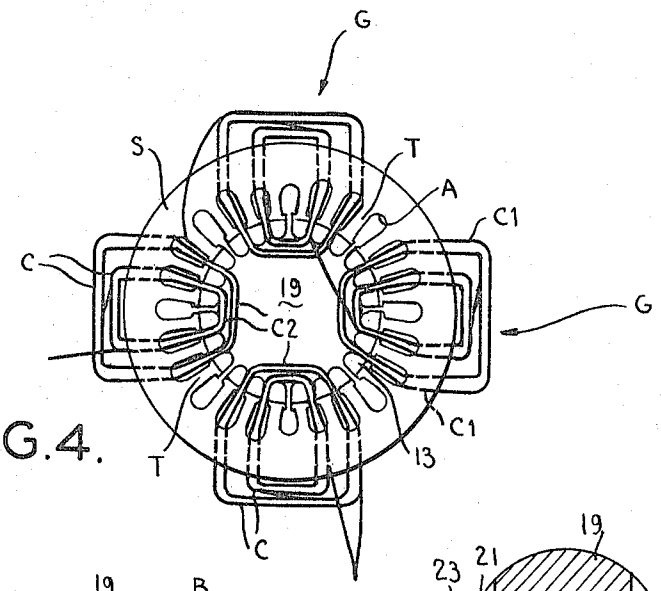


FIG.4.

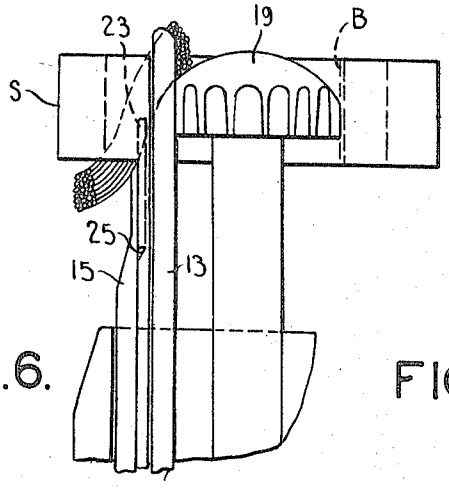


FIG.6.

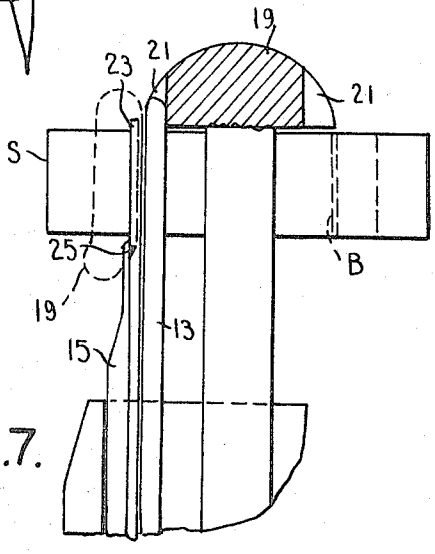


FIG.7.

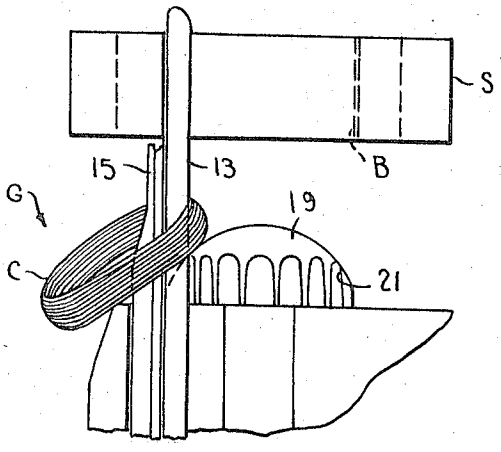


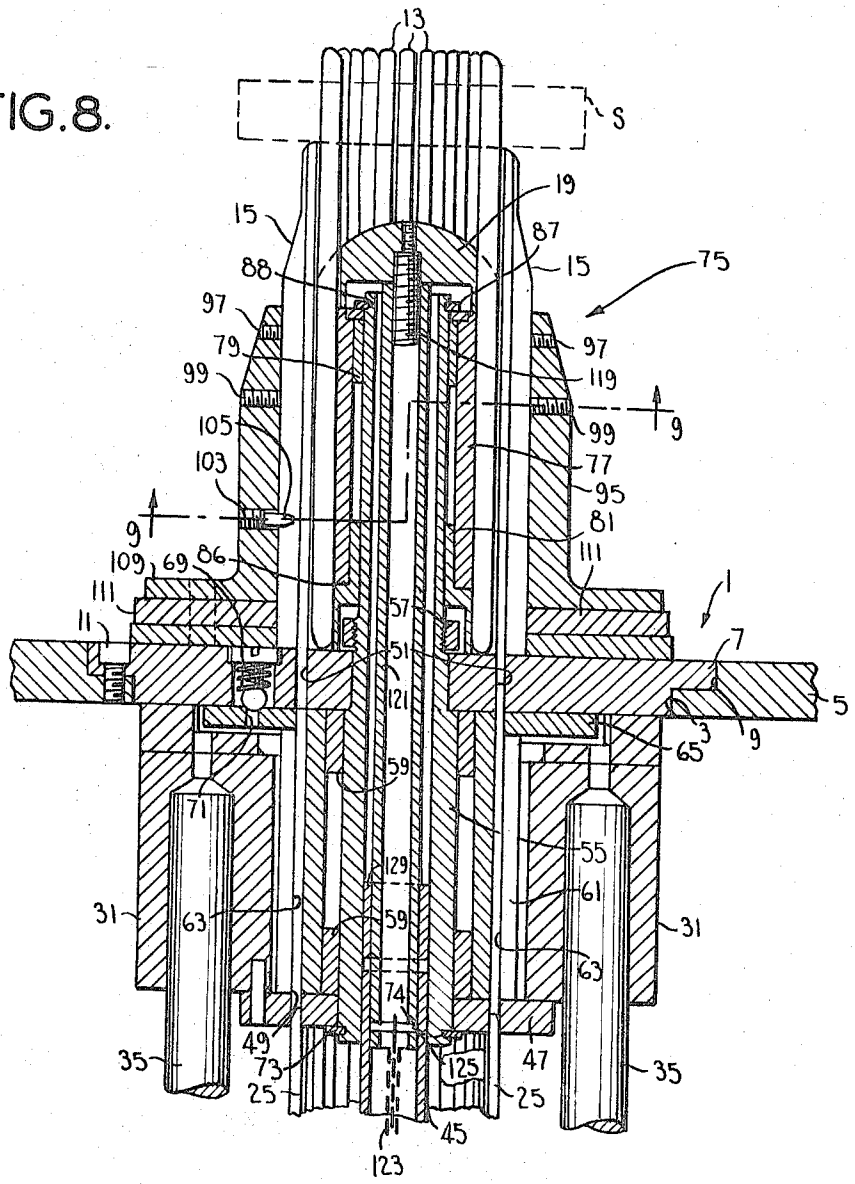
FIG.5.

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FIG.8.



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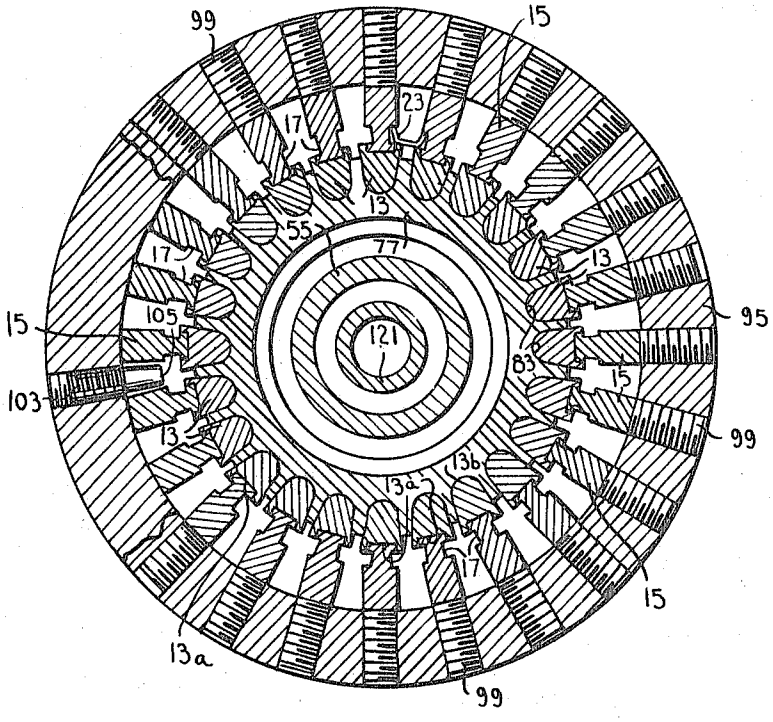


FIG. 9.

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COIL ASSEMBLING APPARATUS

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7 Claims. (Cl. 29—205)

This invention relates to coil placing or assembling apparatus, and more particularly to apparatus for placing or assembling prewound coils and strips of insulation in the slots of a stator.

The invention may be regarded as an improvement upon the apparatus shown in U.S. Patent No. 2,432,267, among the several objects of the invention being noted the provision of improved apparatus of the class described for placing prewound coils and strips of insulation (the latter sometimes being referred to as "bore wedges") in the slots of stators of electric motors, alternators or the like, in efficient and consistent manner; the provision of apparatus of this class adapted for ready adjustment of parts and for easy assembly and disassembly; and the provision of apparatus of this class permitting various wedge assembly patterns. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is a side elevation with parts broken away and shown in section of a coil placing apparatus of this invention adapted for incorporation in a complete coil placing machine;

FIG. 2 is a plan of FIG. 1;

FIG. 3 is a transverse section taken on line 3—3 of FIG. 1, with parts further broken away and shown in section;

FIG. 4 is a view on the line 4—4 of FIG. 1 showing prewound coils and a stator in position ready for placing of the coils by the apparatus in the slots of the stator;

FIGS. 5–7 are diagrammatic illustrations depicting the functioning of the operating members of the apparatus at successive stages in the placing of prewound coils on a stator;

FIG. 8 is an enlarged longitudinal section of part of the apparatus shown in FIG. 1; and

FIG. 9 is a transverse section taken substantially on line 9—9 of FIG. 8.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring first more particularly to FIGS. 1 and 8, a coil placing or assembling apparatus constructed in accordance with this invention is shown to comprise a plate 1 adapted to be removably mounted in position within an opening 3 in a panel 5 of a cabinet which houses certain operating mechanism which may be used in conjunction with the apparatus of this invention. Plate 1 has a peripheral flange 7 which is received in a recess 9 around the opening 3, and is removably secured to the panel 5 as by screws 11. While the panel 5 and plate 1 are shown as horizontal in FIGS. 1 and 5, typically they will be inclined to face the operator of the apparatus. Extending up from the plate 1 are a plurality of fingers 13 adapted for placement thereon of a stator S (see FIG. 4) of an electric motor or the like which is to have a plurality of groups G of prewound coils C placed therein, which coils are to constitute the stator winding. As will be understood, such stators conventionally have a circular bore B and axial slots A located in radial planes extending out from the bore for receiving the side portions (such as indicated at C1) of the coils. The teeth of the stator which

define the slots are designated T. As shown by way of example in FIG. 4, there are twenty-four such stator teeth, and twenty-four stator slots. The inner edges of the teeth are generally flat. In such case, twenty-four fingers are provided, in a circular array corresponding to the circular array of the stator teeth. The radially outer face of each finger is grooved as indicated at 13*a* (see particularly FIG. 9) for reception of the radially inner ends of the stator teeth, with a close sliding fit. The fingers are tapered in cross section and have rounded radially inner faces 13*b*.

Extending lengthwise of each finger 13 on the outside thereof is a bar 15 (there being twenty-four such bars, one for each finger). These bars, which terminate short of the upper ends of the fingers, are hereinafter referred to as wedge guide members, having grooves 17 in their side faces providing guides for bore wedges to be inserted in the slots of a stator over the side portions of the coils C, as will appear. The wedge guide members 17 are seated in the grooves 13*a* of the fingers. The apparatus also includes a stripper 19 of cylindrical shape with a rounded nose. The periphery of the stripper is axially fluted for a sliding fit with the fingers 13 internally of the fingers, and includes radially projecting ribs 21 which lie between the fingers (see FIG. 7) for driving the coils into the stator slots.

The operations performed by the apparatus, as distinguished from the means which provide these operations, can be understood with reference to FIGS. 4–7. Initially, the prewound coils C, which may be suitably interconnected, are placed over the fingers 13 in an array corresponding to the desired winding pattern as shown in FIGS. 4 and 5. A stator S is then placed over the fingers with one finger being aligned with each stator tooth. One end of the stator engages the upper ends of the wedge guide members 15 so that the inner ends of the stator slots are in alignment with the wedge guides provided by the members 15. During coil placing, the stator S is held in position by a suitable clamp (not shown).

To place the coils C in the stator S, the stripper 19 is driven upward (forward) as shown in FIGS. 6 and 7 so that the coils are stripped upwards over the fingers 13 and are slid into the respective stator slots. Simultaneously with the lifting of coils C by stripper 19, insulating wedges 23 of generally U-shaped cross section are driven upwardly between the wedge guide members 15 by a respective plurality of wedge push rods 25 into the inner ends of the stator slots. The wedges 23 tend to confine and protect the placed coils 19. Each wedge consists, for example, of a length of dielectric material, such as Mylar, formed to U-shape in cross section.

Referring again to FIG. 1 and also to FIG. 3, the mounting plate 1 has a pair of sockets 31 extending downward (rearward) therefrom. These are braced by webs 33. Mounted in each of the sockets 31 is a guide rod 35 which extends downwardly from plate 1. A carriage 37 is slidable on guide rods 35 toward and from plate 1. Mounted on the upper (forward) face of carriage 37 is a disk 39. Clamped to the periphery of disk 39 in a circular array are the lower ends of the wedge push rods 25 whose operation was briefly described previously. The ends of these rods are keyed to the disk as indicated at 41 are clamped thereto by a band 43. Carriage 37 also carries a tubular ram 45 which extends upwardly (forwardly) toward plate 11.

Carriage 37 is secured to the upper end of piston rod R of a hydraulic cylinder (not shown) by means of which it may be moved up and down on guide rods 35. The wedge push rods 25 slide in a plate 47 at the lower ends of sockets 31 and which has a plurality of openings 49 for guiding the wedge push rods. The plate 1 also has openings 51 through which the push rods 25 can pass to ap-

proach a stator positioned on the upper ends of the fingers 13.

Mounted centrally in plate 1 is a tubular spindle 55 which projects on both sides of plate 1. The spindle 55 has a shoulder engaging the lower face of plate 1 and is secured to plate 1 by a nut 57 threaded on the spindle engaging the upper face of plate 1. Journalled on the lower end of spindle 55 by means of a pair of bearings 59 is a cylindrical wedge magazine 61. This magazine is formed around its periphery with a series of longitudinal slots 63 having narrow entrances 63*a* (see FIG. 3) for receiving and holding wedges 23. As may be seen from FIG. 3, the side of the wedge magazine opposite the webs 33 is open so that wedges can be loaded into the slots 63 from that side. The forming and loading of wedges is preferably carried out automatically by suitable mechanism housed in the aforesaid cabinet, which forms no part of the present invention and hence is not described further herein. It should be noted that, typically, not all of the stator slots will have windings placed therein so that preferably the loading of the magazine is done according to a predetermined program which places wedges only in those magazine slots corresponding to those slots of the stator which are to receive legs of the coils. Attached to the upper end of magazine 61 is a ratchet 65. A suitable indexing mechanism (not shown) operates on ratchet 65 for indexing magazine 61 so that the various wedge receiving slots 63 can be loaded in sequence. Latching of the magazine at the various loading positions is accomplished by a spring-loaded detent ball 69 which operates in cooperation with a plurality of conical depressions 71 distributed around the upper surface of ratchet 65. Plate 47 is removably held on the lower end of spindle 55 by a split ring 73 received in a peripheral groove 74 on the spindle.

The upper end of spindle 55 carries an assembly 75 which includes the fingers 13 and wedge guide members 15. At the center of assembly 75 is a cylindrical fluted finger holder 77 which is journalled for rotation around spindle 55 on upper and lower bearings 79 and 81. Finger holder 77, being peripherally fluted, has a plurality of longitudinal grooves 83 in which respective fingers 13 are received extending endwise of the holder. The lower end of the finger holder engages a shoulder 86 on the lower bearing 81, and the finger holder is removably retained on the spindle by a split ring 87 received in a peripheral groove 88 in the spindle adjacent its upper end. As stated previously, the radially inner surfaces of the fingers 13 are rounded at 13*b* to facilitate the sliding of the coils and the grooves 83 are shaped to mate closely with the fingers (FIG. 9).

As above described, the outwardly facing surfaces of the fingers 13 have the longitudinal grooves 13*a* for receiving the respective wedge guide members 15. The side surfaces of the members 15 have the grooves 17 so that, between each pair of adjacent members 15, there is formed a longitudinal guide through which a wedge 23 can be driven. In FIG. 9, one such wedge is shown occupying its position between a pair of members 15. A cylindrical housing 95 surrounds the arrayed fingers and wedge guide members. Threaded in the peripheral wall of housing 95 in alignment with each wedge guide member 15 are two set screws 97 and 99. Tightening of the respective set screws removably clamps each finger guide member pair between finger holder 77 and housing 95 and thus combines these elements into a rigid body.

Also threaded in the peripheral wall of housing 95 at several points around its circumference are taper-end screws 103. The inner ends 105 of the screws 103 are beveled to fit or wedge between adjacent guide members 15 to assure that the housing 95 and the wedge guide members 15 and fingers 13 will rotate as a unit around spindle 55 and that there will be no relative angular displacement.

The lower end of housing 95 is flanged as at 109 (FIG. 8) and a gear 111 is secured to the flange 109. By means of this gear, the assembly 75 can be rotated around spindle 55 to various positions by suitable means (not shown since not a part of the present invention) for facilitating the locating coils C on the fingers 13 preparatory to their being placed in a stator.

As noted previously, the carriage 37 which slides on the post 35 carries tubular ram 45 as well as the array of wedge push rods 25. The wedge push rods 25 are slidable in openings 49 in the disk 47 while the ram 45 slides within the central bore of the tubular spindle 55 (FIG. 8). The stripper 19 is attached by means of a threaded stud 119 to a hollow rod 121 which extends down through the central bore of the spindle and fits slidingly within the central bore of the ram 45. A bead chain 123 is attached to a cross-pin 125 at the lower end rod of 121. The other end of the chain 123 is secured to a cross-pin 127 in the ram 45 near its lower end (FIG. 1). A tubular spacer 129 of cross section substantially the same as that of ram 45, slides on rod 121 between the ram 45 and the stripper 19. Essentially, this arrangement establishes a lost motion connection between the ram 45 and the stripper 19. As ram 45 is driven upwardly (forward) by piston rod R, the stripper 19 will not be moved until the upper end of the ram comes up into engagement with the stripper. On the other hand, if the stripper is in a raised position extending into the bore of a stator as the ram 45 is withdrawn, the stripper will not be pulled down until the slack is taken out of chain 123.

Operation of the above-described coil placing apparatus is as follows:

With the carriage 37 withdrawn so that the wedge push rods 25 are withdrawn clear of the wedge magazine 61 as shown in FIGS. 1 and 8, the wedge magazine is rotated by means of the ratchet wheel 65 for loading of wedges 23 in appropriate wedge holding slots 63 in the magazine. Simultaneously or thereafter, prewound coils C are placed over the fingers 13 in the proper array, the finger and wedge guide assembly 75 being rotated by means of gear 111 to facilitate the laying in of the coils. Then a stator S is telescoped on the upper ends of the fingers 13 with the teeth T of the stator in radial registry with the fingers 13, the stator being held in place by suitable clamp means (not shown).

Then, the carriage 37 is advanced (moved upward) by the piston rod R so that the ram 45 and the wedge push rods 25 are driven upward. The wedge push rods pass through the slots 63 in the wedge magazine 61 and push upward the wedges which have been loaded in the magazine. Due to the lost motion between the ram 45 and the stripper 19, the stripper is not moved until the wedges have moved well up into the finger and wedge guide assembly 75 so that the wedges will be in a position to be driven into the stator slots A just as the coils are slipped up over the fingers 13 and driven into the slots by the stripper 19. The amount of lost motion in the connection between the ram 45 and the stripper 19 can be adjusted by appropriately preselecting the length of the tubular spacer 129. In this way the length of the stroke taken by stripper 19 can be easily adjusted to accommodate stators of different axial lengths. As the stripper moves upward, its nose engages the upper end portions C2 of the coils placed on the fingers 13, and the stripper pushes the coils upward and causes the side portions C1 of each coil to be laid within the respective slots A of the stator. The side portions of the coils laid in the slots become covered by the U-section wedges 23, which are driven into the slots adjacent the radially inner ends of the slots. Following the laying in of the coils, the carriage 37 is retracted (moved downward). This retracts the wedge push rods 25 and, after an interval of lost motion, also retracts the stripper 19.

It will be observed that the fingers 13 and wedge guide members 15 may be readily adjusted up or down to accommodate stators of different stack height simply by

loosening the screws 97 and 99. Also, such fingers and web guide members as may not be needed for operation on a particular coil pattern in a particular stator may be readily extracted simply by loosening the screws. The entire assembly 75 may be readily assembled and disassembled, disassembly simply involving loosening the screws 97 and 99 and removing the fingers 13 and members 15, the housing 95, the stripper 19, and snapping off the split ring 87.

Fingers 13 may be coated with an anti-friction material such as a tetrafluoroethylene polymer sold under the trade name Teflon by E. I. du Pont de Nemours & Co. of Wilmington, Del.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantages results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for placing prewound coils and wedges in the slots of a stator comprising:

a hollow cylindrical finger holder having in its periphery a series of longitudinal grooves;

an annular series of fingers around said holder, each finger being received in one of said grooves, said fingers extending forward out of the grooves and projecting beyond one end of said holder for placement thereon of prewound coils and a stator with the pole faces of the stator engaging the outer faces of the fingers;

a series of wedge guide members, one for each of said fingers, each wedge guide member extending lengthwise over a respective finger on the outside thereof and terminating short of the forward end of the finger leaving room for a stator;

a hollow cylindrical housing surrounding the wedge guide members;

screws threaded in the housing engaging the wedge guide members for clamping the wedge guide members against the fingers and for clamping the fingers in place in the grooves of the finger holder;

stripper means axially slidable within the annular series of fingers where the fingers project beyond said holder for driving coils over said fingers and into the slots of the stator; and

means for driving wedges from between said wedge guide members into stator slots for retaining coils so placed.

2. Apparatus as set forth in claim 1 wherein said fingers are coated with a tetrafluoroethylene polymer.

3. Apparatus for placing prewound coils and wedges in the slots of a stator comprising:

a mounting plate;

a tubular spindle fixedly mounted in said plate extending through a hole in the plate, said spindle having a forward end portion extending forward from one face of the plate and a rearward end portion extending rearward from the other face of the plate;

a wedge magazine rotatable on the rearward end portion of the spindle at the rear of said plate, said magazine having a series of longitudinal slots in its periphery for holding wedges to be driven into the slots of a stator;

a carriage movable away from a retracted position in the direction toward the rearward end of the spindle and back to retracted position;

means extending rearward from the plate for guiding the carriage;

a ram extending forward from the carriage into the spindle;

a series of wedge push rods extending forward from the carriage surrounding the ram and movable endwise through the slots of the wedge magazine for driving wedges forward out of the slots, said plate having openings for passage of the wedges and wedge push rods;

a hollow cylindrical finger holder rotatable on the forward end portion of the spindle at the front of said plate, said finger holder having a series of longitudinal grooves in its periphery;

an annular series of fingers around said holder, each finger being received in one of said grooves on the finger holder, said fingers extending forward out of the grooves and projecting beyond the forward end of said holder for placement thereon of prewound coils and a stator with the pole faces of the stator engaging the outer faces of the fingers;

a series of wedge guide members, one for each of said fingers, each wedge guide member extending lengthwise of a respective finger on the outside thereof and terminating short of the forward end of the fingers;

a hollow cylindrical housing surrounding the wedge guide members;

screws threaded in the housing engaging the wedge guide members for clamping the wedge guide members against the fingers and for clamping the fingers in place in the grooves of the finger holder; and

a stripper axially slidable within the annular series of fingers where the fingers project beyond said holder driven by said ram for moving coils over said fingers and into the slots of a stator.

4. Apparatus according to claim 3 further comprising means establishing a lost motion connection between said ram and said stripper.

5. Apparatus for placing prewound coils and wedges in the slots of a stator comprising:

a mounting plate;

a tubular spindle fixedly mounted in said plate extending through a hole in the plate, said spindle having a forward end portion extending forward from one face of the plate and a rearward end portion extending rearward from the other face of the plate;

a wedge magazine rotatable on the rearward end portion of the spindle at the rear of said plate, said magazine having a series of longitudinal slots in its periphery for holding wedges to be driven into the slots of a stator;

a carriage movable away from a retracted position in the direction toward the rearward end of the spindle and back to retracted position;

means extending rearward from the plate for guiding the carriage;

a tubular ram extending forward from the carriage into the spindle;

a series of wedge push rods extending forward from the carriage surrounding the ram and movable endwise through the slots of the wedge magazine for driving wedges forward out of the slots;

said plate having openings for passage of the wedges and wedge push rods;

a hollow cylindrical finger holder rotatable on the forward end portion of the spindle at the front of said plate, said finger holder having a series of longitudinal grooves in its periphery;

an annular series of fingers around said holder, each finger being received in one of said grooves on the finger holder, said fingers extending forward out of the grooves and projecting beyond the forward end of said holder for placement thereon of prewound coils and a stator with the pole faces of the stator engaging the outer faces of the fingers;

a series of wedge guide members, one for each of said fingers, each wedge guide member extending lengthwise of a respective finger on the outside thereof and

terminating short of the forward end of the fingers;

a hollow cylindrical housing surrounding the wedge guide members;

screws threaded in the housing engaging the wedge guide members for clamping the wedge guide members against the fingers and for clamping the fingers in place in the grooves of the finger holder;

screws threaded into the housing preventing rotation of the housing relative to the finger holder;

a stripper axially slidable within the annular series of fingers where the fingers project beyond said holder, a rod extending rearward from said stripper and having a sliding fit in said tubular ram; and

a flexible member connecting said rod to said ram whereby a lost motion connection is established between said stripper and said ram.

6. A finger and wedge guide assembly for use in apparatus for placing prewound coils and wedges in the slots of the stator, said assembly comprising:

a hollow cylindrical finger holder having in its periphery a series of longitudinal grooves;

an annular series of fingers around said holder, each finger being received in one of said grooves, said fingers extending forward out of the grooves and projecting beyond the forward end of said holder for placement thereon of prewound coils and a stator

with the pole faces of the stator engaging the outer faces of the fingers;

a series of wedge guide members, one for each of said fingers, each wedge guide member extending lengthwise over a respective finger on the outside thereof and terminating short of the forward end of the finger;

a hollow cylindrical housing surrounding the wedge guide members; and

screws threaded in the housing and engaging the wedge guide members for clamping the wedge guide members against the fingers and for clamping the fingers in place in the grooves of the finger holder.

7. An assembly as set forth in claim **6** further comprising a screw extending from said housing between adjacent wedge guide members for preventing relative rotation between the components of said assembly.

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THOMAS H. EAGER, *Examiner.*

Disclaimer

3,324,536.—*Donald E. Hill*, Fort Wayne, Ind. COIL ASSEMBLING APPARATUS. Patent dated June 13, 1967. Disclaimer filed Jan. 16, 1970, by the inventor.

Hereby enters this disclaimer to claims 1–4 and 6 of said patent.

[*Official Gazette April 14, 1970.*]