United States Patent

Geber

[15] **3,685,119**

[45] **Aug. 22, 1972**

[54] **AUTOMATIC TOOLING FOR IN-SLOT WINDER**

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[73] Assignee: **Industra Products, Inc.,** Fort Wayne, Ind.

[22] Filed: **Sept. 30, 1970**

[21] Appl. No.: **76,862**

[52] **U.S. Cl.** .....**29/205 D,** 242/1.1 R

[51] **Int. Cl.**.....**H02k 15/06**

[58] **Field of Search**.....29/205 D, 205 R, 205 C; 242/1.1 R

[56] **References Cited**

UNITED STATES PATENTS

3,025,008 3/1962 Nill et al. .....242/1.1 R

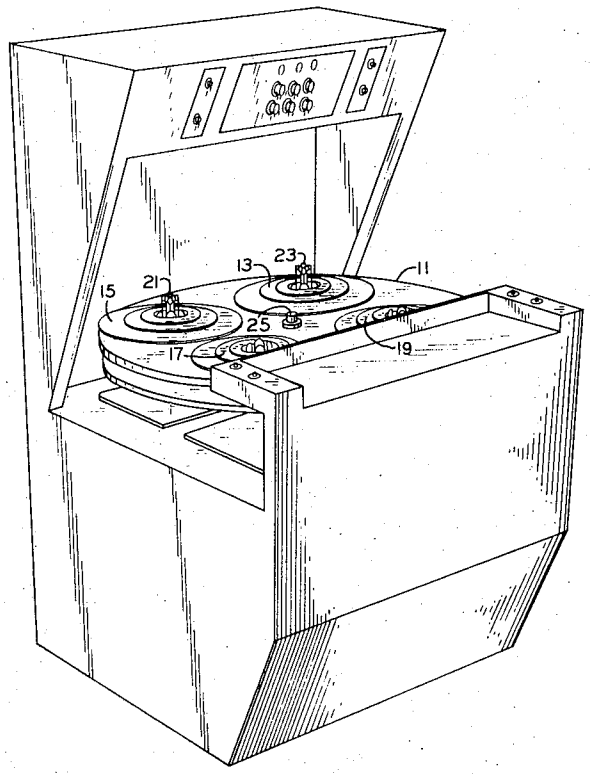
Primary Examiner—Thomas H. Eager

Attorney—Jeffers and Rickert

[57] **ABSTRACT**

An improved multistation automatic bulb inserting in-slot coil winding machine is disclosed having four stator supporting positions each of which is adapted to releasably hold the appropriate number of tooling bulbs in conjunction with a stator. Two stations insert and remove these tooling bulbs and actuate the mechanism within the turn table for securing the bulbs while the other two stations having unique tooling bulb supports which have winding needles for performing the in-slot winding operation.

18 Claims, 5 Drawing Figures



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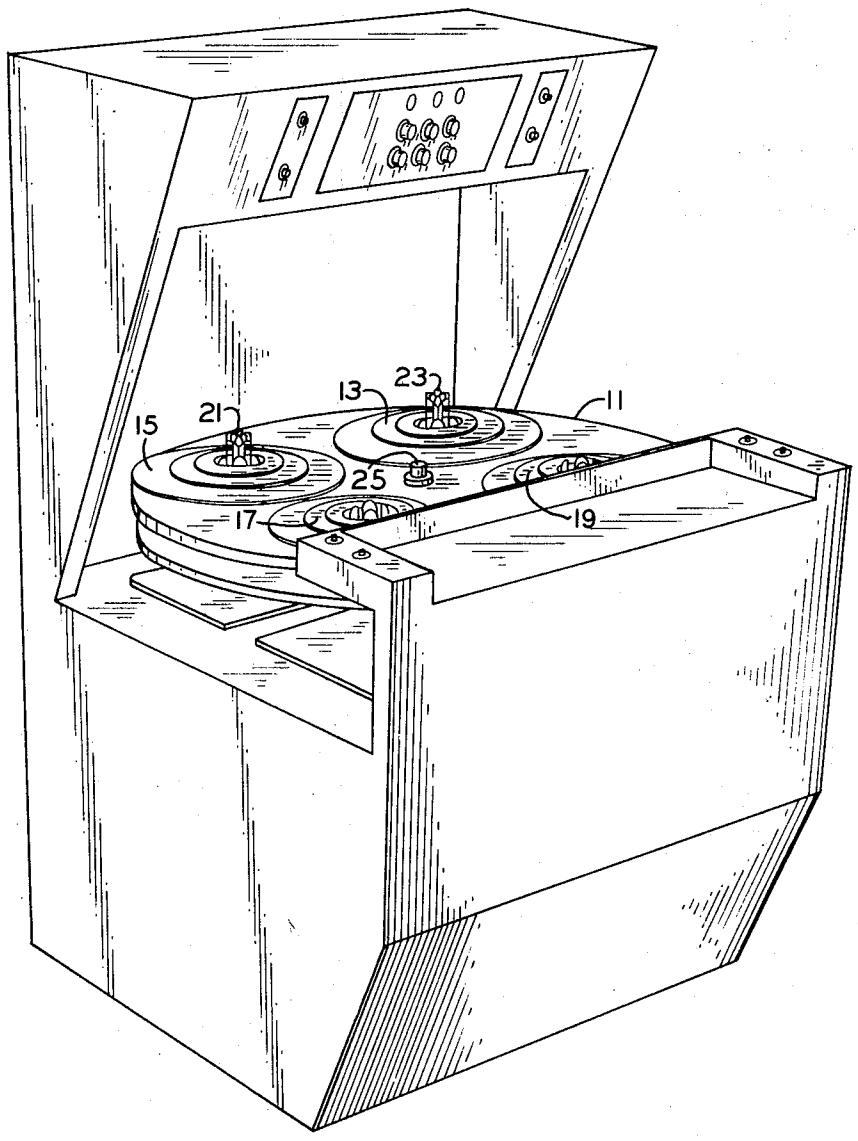

FIG 1

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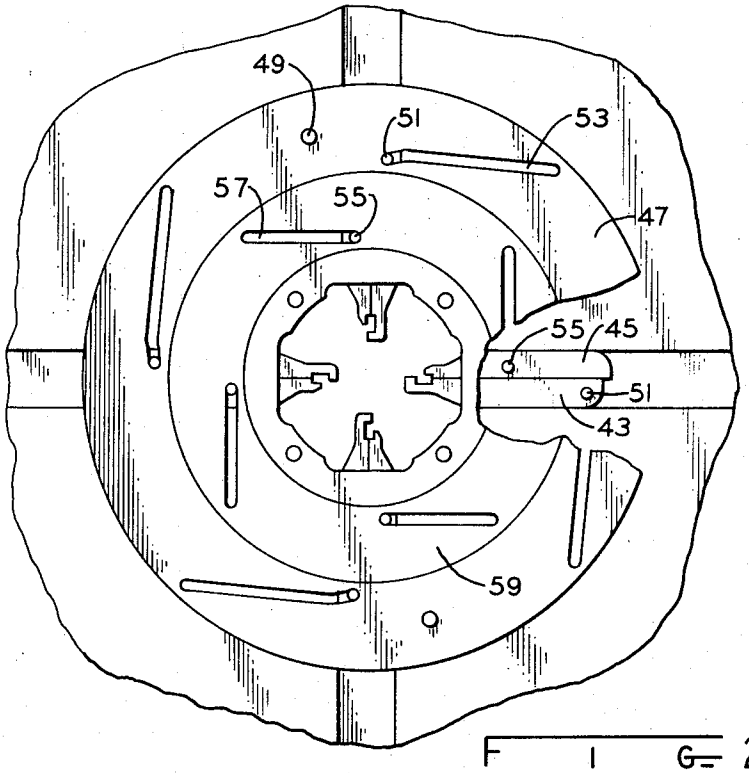

FIG. 2

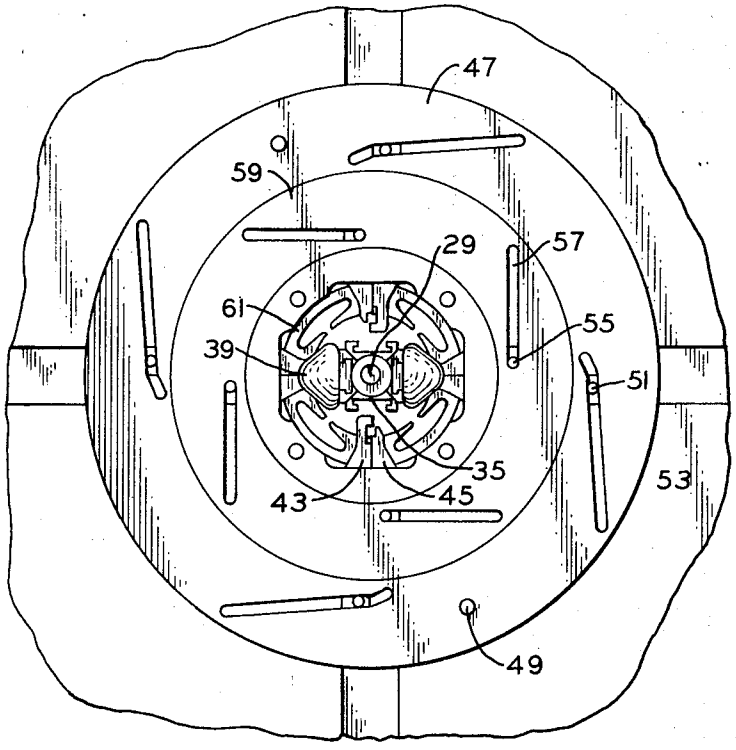

FIG. 3

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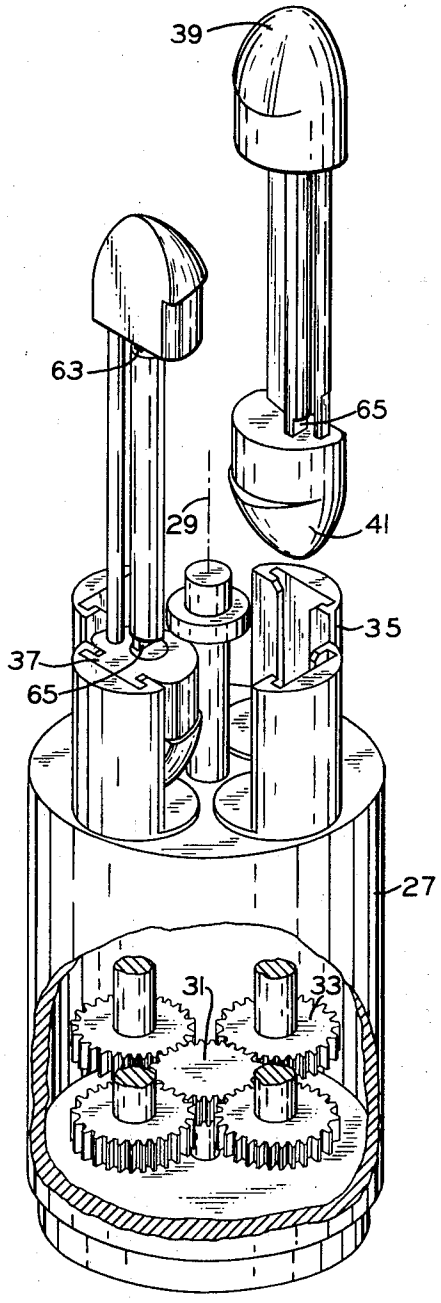

FIG 4

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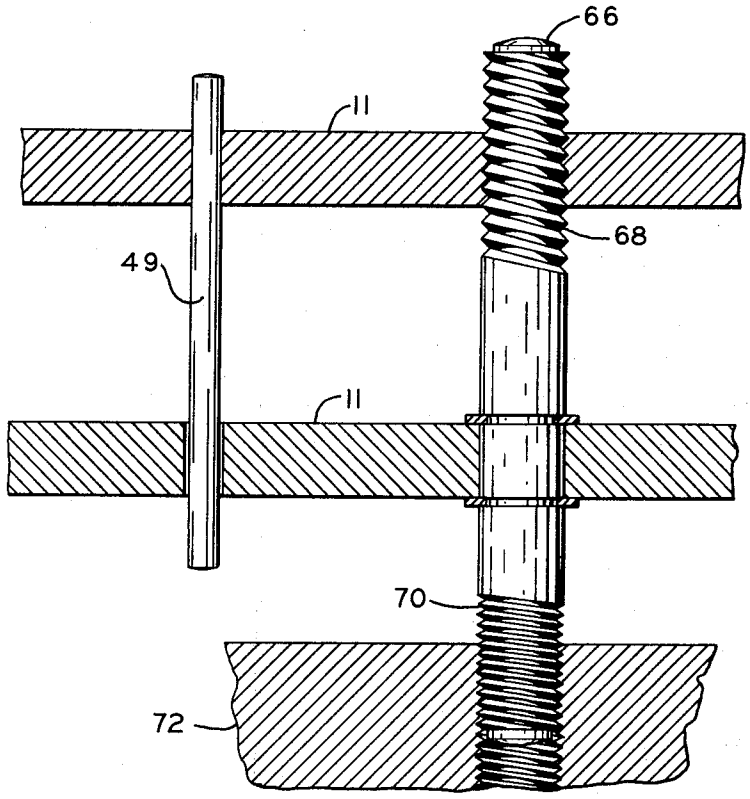

FIG 5

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AUTOMATIC TOOLING FOR IN-SLOT WINDER

CROSS REFERENCE TO RELATED APPLICATIONS

The present application utilizes the mechanical drive linkage disclosed in applicant's copending application entitled "DRIVE FOR IN-SLOT WINDING MACHINE" filed Sept. 30, 1970, Ser. No. 76,697 and assigned to the assignee of the present invention to drive the two winding needles located at the winding stations.

BACKGROUND OF THE INVENTION

The present invention relates to an in-slot winding apparatus for winding coils in stators for dynamoelectric machines and more especially to a multistation in-slot winder having a unique automatic tooling provision which automatically inserts and locks in place tooling bulbs for the winding operation. The prior art patent to Nill et al. U.S. Pat. No. 3,025,008 illustrates the importance of tooling bulbs therein terms "shrouds" but does not however provide any clear system for inserting, gripping and removing these tooling bulbs.

The nature of the in-slot winding operation and the desirability of providing tooling bulbs is well illustrated by the aforementioned Nill et al. patent. A winding head which may have a single wire dispensing needle or several wire dispensing needles, four as shown in Nill being a useful and practical arrangement, execute an axial motion while the needle is dispensing wire in the stator slot and then executes a combined axial and rotary motion so as to form an end turn in the coil and begin dispensing wire in a different stator slot in the opposite direction. The process is repeated for example, the needle passing upwardly in a given stator slot then forming a loop and an end turn of wire and passing downwardly in an adjacent stator slot and hence forming a second or bottom end turn so as to be able to again pass upwardly in the original stator slot. In many stators, the wire at the upper and lower ends of the stator which serves to connect the two stator slots in which wire is being laid will interfere with or partially block the stator bore. Tooling bulbs are provided in the stator to ensure that this wire does not block the stator bore and to properly form these end turns during the winding operation.

It is also known in the prior art to insert the bulb portions which form the end turns below the stator from below the stator and to insert the bulb portions for the upper end turns from above the stator however no prior art scheme provides for the automatic insertion and locking of tooling bulbs having integral upper and lower end turn forming portions.

SUMMARY OF THE INVENTION

The present invention provides an automated scheme for inserting and locking tooling bulbs in winding position in a stator supporting turntable, then revolving that turntable to an in-slot winding location where the stator coils are wound, then returning the thus wound stator and end turn forming bulbs to a location where the bulbs are automatically unlocked and removed such that the only hand operation required is the insertion and removal of the unwound and wound stator respectively.

It is accordingly one object of the present invention to provide an improved in-slot coil winding machine.

It is another object of the present invention to automate the insertion and removal of tooling bulbs.

It is a further object of the present invention to provide a bulb inserting and locking scheme.

Yet another object of the present invention is to provide a multistation winding machine having improved automatic tooling features.

The foregoing features are particularly useful in the winding of shaded pole motors and accordingly it is a salient object of the present invention to provide an improved automated shaded pole stator winding machine.

These and other objects and advantages of the present invention will appear more clearly from the following detailed disclosure read in conjunction with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a multistation automatic in-slot coil winding machine according to the teachings of the present invention;

FIG. 2 is a top view of one of the four turntable locations of FIG. 1;

FIG. 3 is a top view similar to FIG. 2 showing a stator and a pair of tooling bulbs in position;

FIG. 4 is a perspective view of the bulb inserting head; and

FIG. 5 shows the variable stator height provision in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The perspective view of FIG. 1 illustrates a four station automatic in-slot coil winding machine according to the teachings of the present invention. The machine has a two level turntable **11** which supports four stator supporting locations **13**, **15**, **17** and **19** which are identical in their fundamental structure and each of which is shown in position over a corresponding station of the machine. In the present preferred embodiment, the two locations near the front, that is **17** and **19** are locations at which a stator will be inserted, the tooling bulbs will be inserted and locked in position and from which, after the turntable has indexed twice about its axis **25**, the tooling bulbs will be removed and the completed wound stator removed. The two rearward locations, that is **13**, **15** are over respective winding heads **21** and **23** which, as illustrated, simultaneously in-slot wind four coils in the stators. The structure beneath the two winding heads **21** and **23** is basically that described in my aforementioned application Ser. No. 76,697 entitled "DRIVE FOR IN-SLOT WINDING MACHINE" while the structure beneath the two forward locations will be described in greater detail in reference to FIG. 4.

While the specific step performed at a given station may be modified and varied within the scope of the present invention, the specific preferred embodiment herein disclosed contemplates the two front stations as being identical and the two rear stations as being identical with the turntable being indexed 180° at the end of each cycle of the mechanism. Thus, each of the two front stations would have a bulb inserting head **27** of FIG. 4 and each of these heads would be connected to the primary source of power within the winding machine to be moved axially along its axis **29**, to be rotated slightly about that axis **29**, and to have the cen-

trally located gear **31** turn so as to revolve each of the tooling bulbs substantially 180°. The system must of course be programmed so that each of these motions occurs at the proper time. The bulb inserting head itself is seen to have an internal driving gear **31** and the appropriate number of driven gears **33** so as to rotate each of the same number of bulb supporting rotatable dovetail slot means **35**. It should be clear from FIG. **4** that the axis **29** as well as the four axes about which the rotatable dovetail slot means **35** rotate are parallel. The supports **35** of course mate with corresponding flaring tenon portions **37** on the lower end of each of the tooling bulbs. The tooling bulbs themselves are seen to have a pair of bulb ends **39** and **41** which are for positioning and forming the end turns of a stator winding and the tenon portion **37** is seen to be on the back side of the lower bulb portion so that in operation this tenon portion will not interfere with the end turn forming function. The configuration of the middle portion of these tooling bulbs in arbitrary except as will appear in conjunction with the discussion of FIG. **2** and serves only to connect and maintain the relative position of the two bulb ends.

Turning now to FIG. **2** which illustrates a top view of one of the four turntable locations without a stator or any of the tooling associated with the station over which this location might be at a particular time. It should be noted that FIG. **3** is an almost identical view, however, a stator, a pair of tooling bulbs and the bulb inserting head are also illustrated in FIG. **3**. It should further be noted that the turntable **11** of FIG. **1** is a two level turntable and each of the levels will have the basic structure of FIG. **2**, that is this structure is repeated both above and below a stator. The structure of FIG. **2** performs the basic function of holding the tooling bulbs in position once they have been inserted by the bulb inserting head of FIG. **4**. This structure has a set of radially sliding hooks **43** and a set of radially sliding retainers **45** which as noted earlier are duplicated on both the upper and lower levels of the turntable. There are as many separate sliding hooks **43** on the upper level of the turntable as there are bulbs to be secured in the turntable and there will be a similar number of sliding retainers in each level of the turntable for a given location, thus, to be specific, the location **17** would have four sliding hooks **43** and four sliding retainers **45** on its upper level and would have four sliding hooks and four sliding retainers on its lower level if the machine were designed to insert and hold four tooling bulbs for the winding of a four pole machine. The hooks **43** are slid radially simultaneously by the revolution of the annular ring **47** and the corresponding lower set of hooks is identically actuated by a corresponding annular ring, the upper and lower annular rings being actuated by a series of pins **49** so that all hooks and all retainers move together. In a preferred embodiment, the upper and lower levels of the turntable may be moved together or apart each moving an equal distance from a center line between them and in opposite directions so as to allow the winding of stators of different lengths by the simple expedient of using tooling bulbs of the appropriate length and adjusting two levels of the turntable accordingly. For this "universal" type of embodiment, the upper and lower annular rings pass over the pins **49** but are slidable on those pins in the direction of the axis of those pins. If the ring **47** were to be rotated counterclockwise from its present position, a pin **51** riding in a slot **53** would follow that slot and thus slide the hook **43** radially outward so as to clear the central portion of the location. In a precisely similar manner, the sliding retainers **45** communicate by means of pins **55** with a slot **57** in an inner annular ring **59** and rotation of that inner annular ring in a clockwise direction as illustrated in FIG. **2** results in the retracting radially outwardly of the retainers **45**. Thus, with the annular ring **47** rotated counterclockwise as far as it may travel and the annular ring **59** rotated clockwise as far as it may travel both the hook **43** and the retainer **45** will be retracted from the central aperture in this location so as to allow the insertion or removal of a stator **61** shown in FIG. **3**.

Referring now to FIG. **3**, the same basic structure of the upper level of the turntable location illustrated in FIG. **2** is shown carrying like reference numerals. To progress from FIG. **2** to FIG. **3** several steps are required. Beginning with FIG. **2** the sliding retainers **45** must be retracted by rotating the annular ring **59** in a clockwise direction. Then the radially sliding hooks **43** must be retracted by sliding the annular ring **47** in a counterclockwise direction. At this time, a stator **61** is placed in this turntable location and supported in a position where the lower level turntable hooks and retainers may slide radially below the stator while the upper level hooks and retainers for that same location will slide radially above that stator. Once the stator is supported in position on the turntable, the bulb inserting head **27** carrying the tooling bulbs and having the slot means **35** and the tooling bulbs in the orientation illustrated in FIG. **4**, that is where the actual surfaces of the bulb portions are turned 180° away from the direction in which they must face for winding, is inserted.

The bulb inserting head travels upwardly carrying the tooling bulbs through the bore of the stator and stopping at a point where the notches **63** are at the same level as the upper retaining and hook means while the notches **65** of FIG. **4** are at the same level as the corresponding sliding retaining and hook means of the lower level of the turntable. At this point, the driving gear **31** is rotated so as to turn each of the driven gears **33** associated with a tooling bulb through 180° so that the bulbs now take on the position shown in FIG. **3**. Assuming the proper angular orientation of the bulb inserting head which would in practice be slightly counterclockwise from that actually illustrated in FIG. **3** the next step is to rotate the annular ring **47** in a clockwise direction so that the hooks **43** slide radially inward. At this point, a slight clockwise rotation of the bulb inserting head **27** about its axis **29** will bring the bulb into hooking engagement with the sliding hooks. The next step is to rotate the annular ring **59** in a counterclockwise direction so as to cause the radially sliding retainers **45** to move toward the center and lock the tooling bulbs in their winding position. At this time, the bulb inserting head may be moved downwardly away from the stator but leaving the bulbs in winding position in the turntable.

Assuming now that the foregoing sequence of events has occurred for both of the forward locations **17** and **19** preferably in a simultaneous fashion, once the bulb

inserting head **27** is clear of the turntable structure this turntable would index 180° so that the two locations **17** and **19** containing a stator and the tooling bulbs locked in position would be presented to the two winding locations at the rear of the machine. The two winding heads **21** and **23** would then perform an in-slot winding operation while at the same time two unwound stators would be inserted in the front locations and tooling bulbs inserted and locked within those stators according to the foregoing sequence. When the winding operation at the rear locations as well as the bulb inserting operation at the front locations is completed and both the forward bulb inserting heads and the rear winding heads are lowered so as to be clear of the turntable that turntable again indexes 180°, a winding operation is begun on the stators at the two rear locations and the completed stators which were wound during the preceding step are removed by reversing the bulb inserting sequence. A new pair of stators are placed in the forward locations and the entire sequence of events repeats itself.

Turning now to FIG. **5** broken away portions of the two levels of the turntable **11** are illustrated in cross section as being joined by a threaded member **66**. As discussed earlier, the winding machine to be versatile must be capable of handling stators of different heights which may be accomplished by varying the separation between the two levels of the turntable. To be compatible with the winding mechanism, it is desirable when effecting this variation in the separation of the two levels to move the top level of the turntable upward and the lower level of the turntable downward in equal amounts so that the two levels are uniformly distributed above and below a hypothetical fixed center plane. Also as noted earlier, the pins **49** should be made slidable relative to one or preferably both of the turntable levels so that this adjustment may be easily effected. The actual adjustment of the separation between the two turntable levels is effected by the threaded member **66** which has a first threaded portion **68** and a second threaded portion **70** engaging the upper level of the turntable and some support element **72** respectively. If the pitch of the threaded portion **68** is made to be double that of the threaded portion **70** rotation of the member **66** in one direction will result in the lowering of the lower level of the turntable and the corresponding raising of the upper level of the turntable so that their respective distances from a hypothetical center plane remain equal. The specific scheme shown in FIG. **5** requires that the lower level of the turntable be rotatably affixed to the member **66**. It should be clear from this drawing that various combinations of differently pitched left or right hand threads might be used to engage any combination of the upper and lower levels of the turntable and the support member to effect the same result.

While the present invention has been described with respect to a specific embodiment, numerous modifications will suggest themselves to those of ordinary skill in the art. Thus while a four station structure has been disclosed, it is clear that a two station machine having one bulb inserting and removing location and one winding location could easily be constructed in light of the foregoing specification. Similarly, a three station location one of which inserted the bulbs in an unwound stator, one of which performed the winding operation and the third of which removed the bulbs from a completed stator is clearly within the scope of the present invention as is a three station machine where different winding operations occur at each of two of the stations and the third station serves to both insert and remove the bulbs. It would also be desirable to provide the two front stations with a vertically movable stator support structure so that a completed stator would be moved upwardly somewhat after completion of a removal of the tooling bulbs so as to make that stator easily accessible to an operator for removal. Other modifications will suggest themselves to those of ordinary skill in the art and accordingly the scope of the present invention is to be measured only by that of the appended claims.

I claim:

1. A multistation automatic in-slot coil winding machine comprising:

a plurality of tooling bulbs, each having a pair of bulb ends for positioning the end turns of a stator winding;

a turntable adapted to support at least one stator and to revolve so as to sequentially present a stator to each station;

means at a first station for removably supporting the plurality of tooling bulbs and for axially inserting the plurality of tooling bulbs into the stator;

means mounted on said turntable for securing said bulbs in winding position relative to said stator; and

means at a second station for winding one or more coils within said stator.

2. The machine of claim **1** wherein said machine is a two station machine, said bulbs being removed at said first station from a wound stator and reinserted at said first station into a stator to be wound.

3. The machine of claim **1** wherein said machine is an at least three station machine, said bulbs being removed from a wound stator at a third station different from said first and second stations.

4. The machine of claim **2** wherein said first station includes means for actuating said securing means after said bulbs are in winding position, and means for deactuating said securing means prior to the removal of said bulbs from a wound stator.

5. The machine of claim **1** wherein said first station includes means for actuating said securing means after said bulbs are in winding position.

6. The machine of claim **3** wherein said third station includes means for deactuating said securing means prior to said bulbs being removed from a wound stator.

7. The machine of claim **6** wherein said first station includes means for actuating said securing means after said bulbs are in winding position.

8. The machine of claim **1** wherein said means for axially inserting comprises:

a plurality of rotatable dovetail slot means for supporting the tooling bulbs each said rotatable dovetail slot means having an axis of rotation parallel to that of the others;

a flaring tenon portion on one end of each of said tooling bulbs whereby said bulbs may have their tenon portion inserted into and thus be supported by said slot means by relative movement of said

bulb and said slot means in the direction of said axes; and

means for simultaneously moving said plurality of slot means in the direction of said axes whereby said bulbs may be placed in and removed from winding position relative to said stator.

9. The machine of claim **8** further comprising means interconnecting said plurality of rotatable slots for simultaneous rotation thereof whereby said bulbs may be supported in a first orientation for passage through the bore of said stator and then simultaneously rotated into winding position.

10. The machine of claim **1** wherein said means for securing comprises first and second sets of radial sliding hook means and first and second sets of radial sliding retaining means, one of each of said sets radially sliding above said stator and the other of each of said sets radially sliding below said stator, and wherein a hook and a retainer is provided above said stator for each bulb and a corresponding hook and retainer is provided below said stator for each bulb, a hook engaging a portion of a bulb and a retainer preventing the movement of a bulb out of a hook.

11. The machine of claim **9** wherein said means for securing comprises first and second sets of radial sliding hook means and first and second sets of radial sliding retaining means, one of each of said sets radially sliding above said stator and the other of each of said sets radially sliding below said stator, and wherein a hook and a retainer is provided above said stator for each bulb and a corresponding hook and retainer is provided below said stator for each bulb, a hook engaging a portion of a bulb and a retainer preventing the movement of a bulb out of a hook.

12. The machine of claim **10** further comprising:

a first pair of annular rings rotatably mounted above said turntable and concentric with the axis of the bore of said stator;

a second pair of annular rings rotatably mounted below said turntable and concentric with the axis of the bore of said stator;

said first pair of annular rings lying in a plane somewhat above said stator and said second pair of annular rings lying in a plane somewhat below said stator;

means connecting one of said first pair of annular rings and a corresponding one of said second pair of annular rings to said radial sliding hooks;

means connecting the other of said first pair of annular rings and a corresponding one of said second pair of annular rings to said radial sliding retaining means whereby rotary motion of a given annular ring results in radial sliding motion of the corresponding radial sliding element.

13. The machine of claim **1** further comprising a third station identical to said first station and a fourth station identical to said second station, said bulbs being removed at said first and third stations from a wound stator and reinserted at said first and third stations into a stator to be wound.

14. The machine of claim **13** wherein said second and fourth stations comprise a shaft adapted to execute a combined rotary and axial motion and a needle disposed on one end of said shaft and adapted to dispense wire in an in-slot winding operation, said axial motion of said shafts being along the axes of the bores of stators located at said second and fourth stations.

15. The machine of claim **14** further comprising means for indexing said turntable substantially 180° after each winding operation.

16. The machine of claim **1** wherein said machine is an at least three station machine, a separate winding operation being performed at a third station different from said first and second stations.

17. The machine of claim **1** wherein said turntable comprises upper and lower levels further comprising means for varying the separation between said upper level and said lower level whereby stators of different heights may be accommodated.

18. A multistation automatic in-slot coil winding machine comprising:

a plurality of tooling bulbs;

a turntable having upper and lower levels and adapted to support at least one stator and to revolve so as to sequentially present a stator to each station;

means at a first station removably supporting the plurality of tooling bulbs and for axially inserting the plurality of tooling bulbs into the stator;

means mounted on each said turntable level for securing said bulbs in winding position relative to the stator;

means for varying the separation between said turntable levels so as to adapt the machine to a stator of a different height; and

means at a second station for winding one or more coils within said stator.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,685,119 Dated August 22, 1972

Inventor(s) Eugene E. Geber

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title of the Invention, after "Automatic" insert --- Bulb Inserting --- .

Abstract, line 1, after "automatic", omit --- bulb inserting ---

Abstract, line 5, after "stations" insert --- having unique tooling bulb supports which --- .

Abstract, line 8, after "stations" omit --- having unique tooling bulb supports which --- .

Column 1, line 34, "The" should be --- This --- .

Column 3, line 20, "in", first occurrence, should be --- is ---

Column 3, line 64, "the" omitted between "adjusting" and "two" .

Column 4, line 56, "bulb" should be --- bulbs --- .

Column 4, line 62, "downwardly" should be --- downward --- .

Column 6, line 10, "a" should be --- the --- .

Column 8, line 38, after "station" insert --- for --- .

Signed and sealed this 9th day of January 1973.

(SEAL)
Attest

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents