

[54] TOROIDAL COIL WINDING MACHINE

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[51] Int. Cl. H01f 41/08

[58] Field of Search 242/4, 5, 6, 4 B, 4 BE

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[57]

ABSTRACT

A toroidal coil winding machine comprising a head assembly constructed to support and rotate about its own axis a ring-shaped, wire-carrying shuttle interlinked with a core, which can readily be adjusted to accommodate a large range of shuttle diameters and which provides for rapid removal and replacement of shuttles. The ring-shaped, wire-carrying shuttle is driven by means of three supporting sheaves, two of said sheaves having variable axis positions relative to the third, resulting in coarse and fine position adjustments and providing for the accommodation of variable shuttle sizes. Core removal and replacement are effected by simultaneous upward and lateral movement of one of the supporting sheaves so as to effectively open and twist the shuttle for easy core removal, actuated by a convenient handle readily moved by a single stroke of the operator's hand.

11 Claims, 12 Drawing Figures

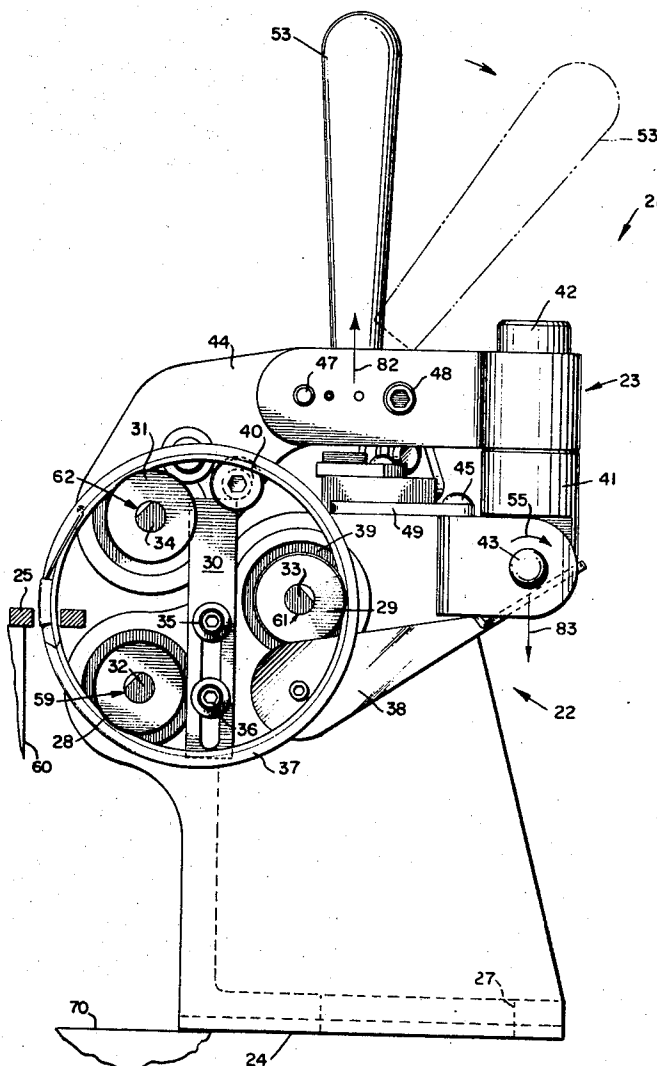
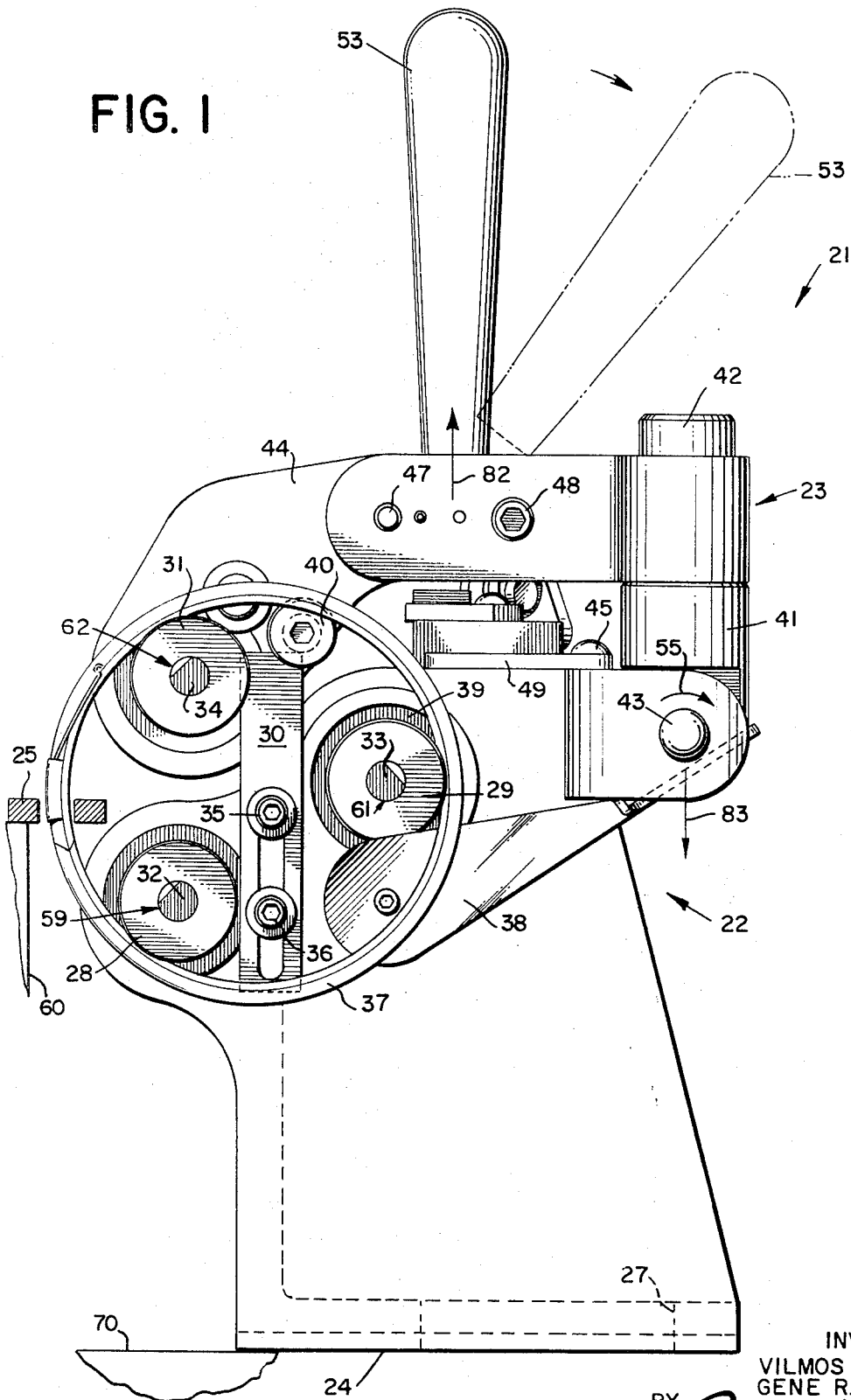


FIG. 1



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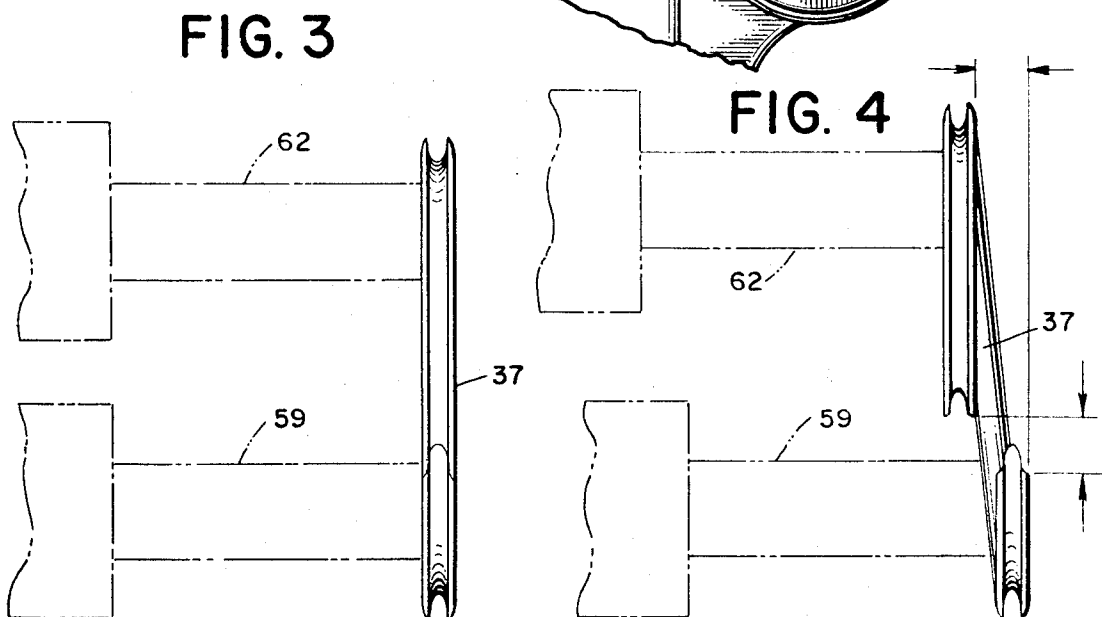
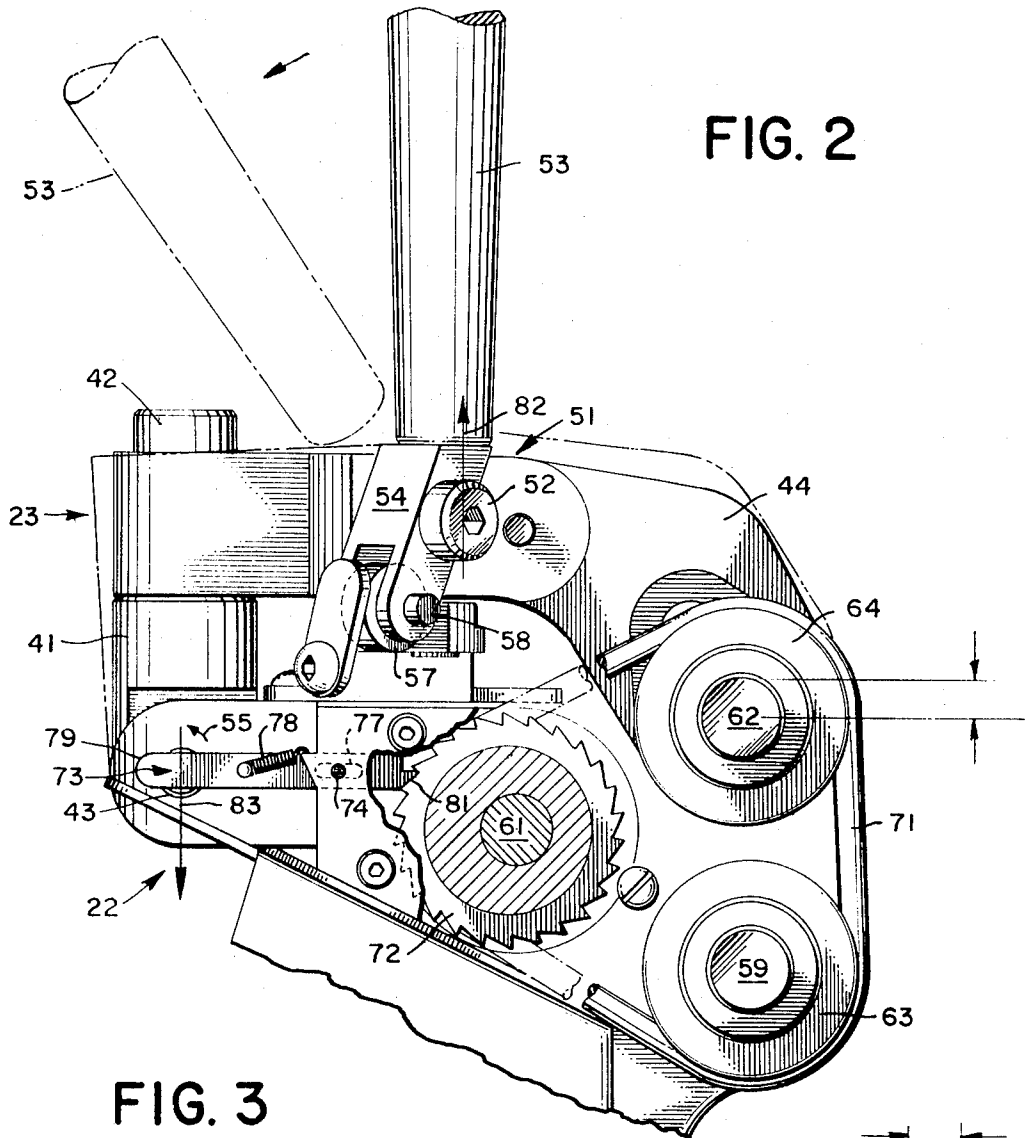


FIG. 8

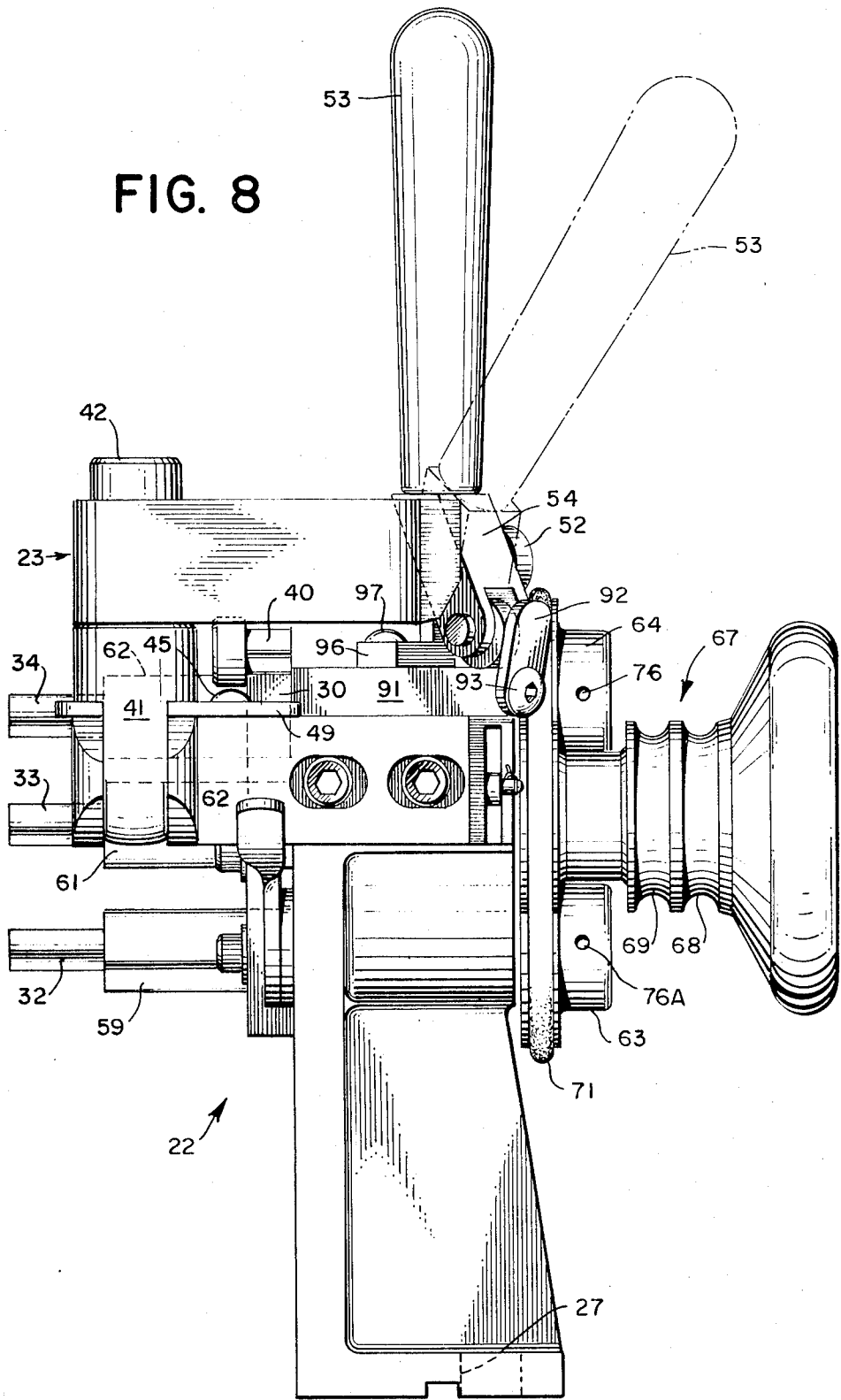


FIG. 9

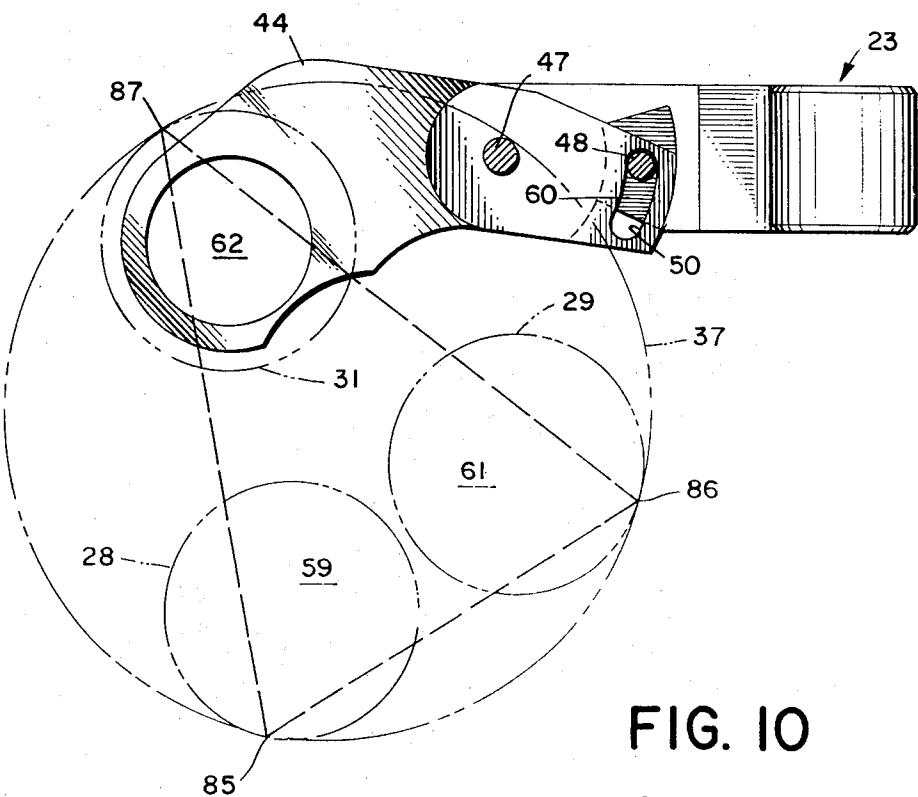


FIG. 10

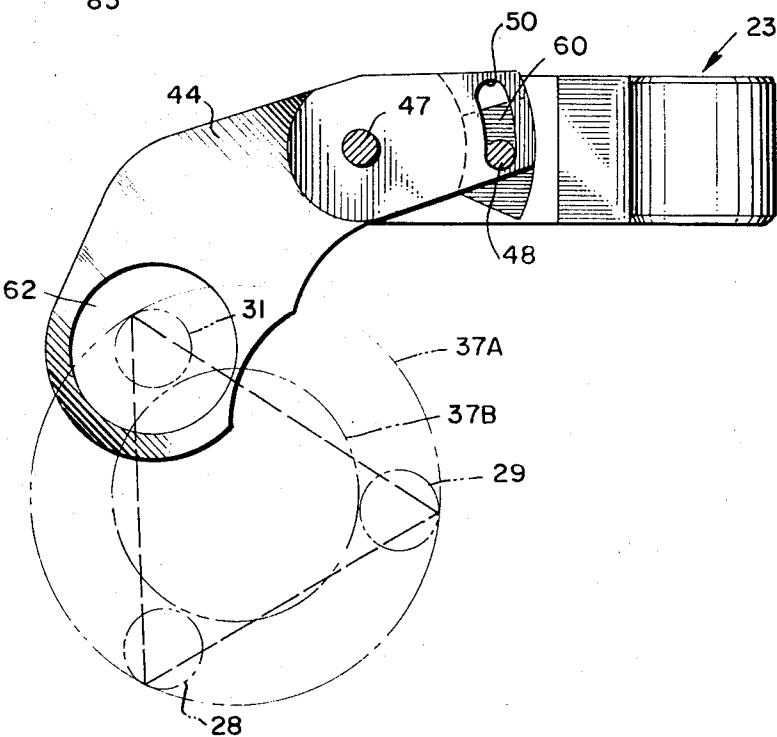


FIG. 11

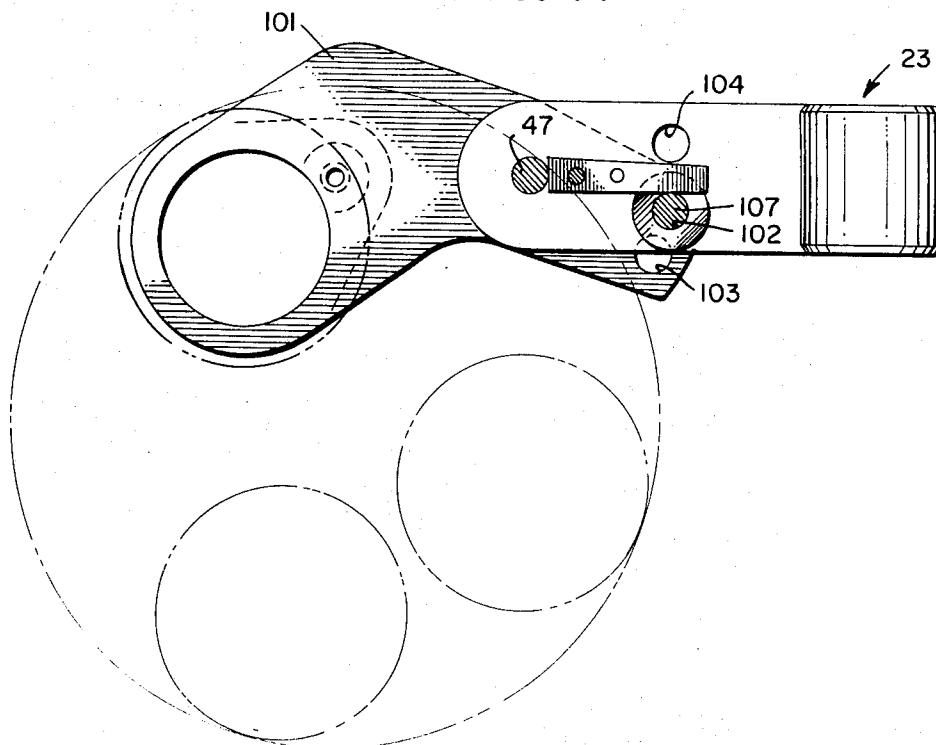
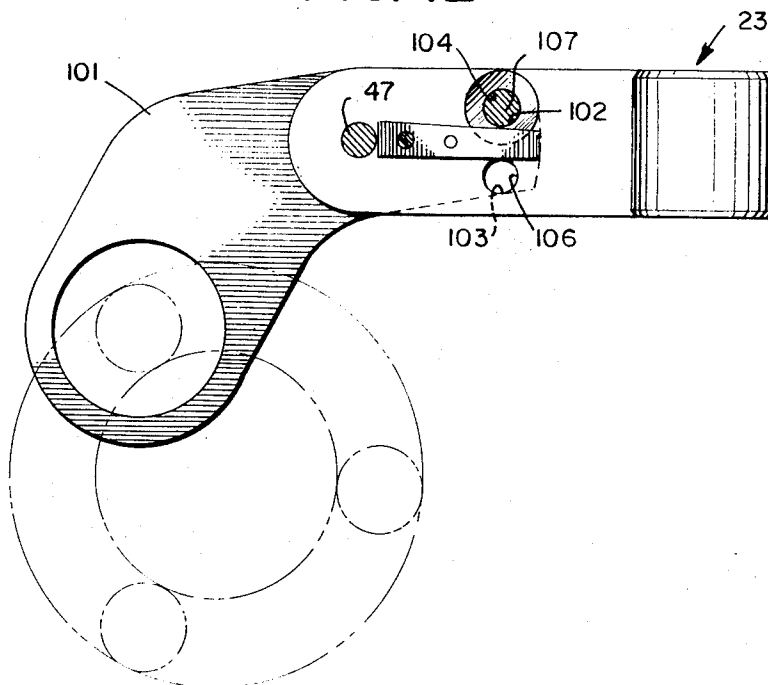


FIG. 12



TOROIDAL COIL WINDING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to coil winding machines and is directed more particularly to advantageous novel structural features of shuttle supporting and driving heads.

Various power driven machines for winding toroidal coils have long been available. The basic toroidal coil winding machine consists essentially of a base plate on which a shuttle supporting and driving head is mounted to cooperate with a toroidal core holder. The toroidal core is firmly supported by the holder which is also capable of slowly rotating the core. The shuttle supporting and driving head is positioned on the base plate so that the shuttle will be able to pass and revolve through the center of the toroidal core during the winding operation.

The coil is wound by driving shuttle supporting sheaves that are journaled in the head so that the wire-carrying shuttle will wind successive turns of the wire upon the core in the conventional manner while the core is slowly rotated.

Although the coil winding process is well known, versatile apparatus is not available that can efficiently employ many varying shuttle sizes. Furthermore, available coil winding machines that do provide for some limited variation in shuttle sizes are not capable of quick and easy resetting for use with different size shuttles.

Accordingly, it is a principal object of the present invention to provide toroidal coil winding machines which will readily accommodate shuttles of many varying sizes.

Another object of the invention is to provide toroidal coil winding machines in which the necessary changes for varying the shuttle size can be made quickly and easily.

A further object of this invention is to provide toroidal coil winding machines in which the ring-shaped shuttles of different sizes are easily and rapidly removed and replaced on the driving supports, which provide firm driving traction and effective control of high speed shuttle rotation.

Another object of this invention is to provide toroidal coil winding machines in which the ring-shaped shuttles can be quickly and easily opened for removal and replacement of toroidal cores and then quickly closed for the winding operation, with movement between both positions being actuated by a single stroke of an operating handle.

Other and more specific objects will be apparent from the features, elements, combinations and operating procedures disclosed in the following detailed description and shown in the drawings.

SUMMARY OF THE INVENTION

This invention provides a toroidal coil winding machine which has a head assembly consisting of essentially two portions. The lower portion of the head assembly is permanently mounted to a base plate and rotatably supports two shafts. One shaft is supported in a fixed position, while the other shaft can be eccentrically rotated by driving circular ratchet teeth that are mounted at one end of the shaft. The lower portion is also provided with a friction brake that maintains the eccentrically rotating shaft in its set position.

The upper portion of the head assembly is connected to the lower portion by means of two perpendicularly related fastening pins. The use of such fastening means allows the upper portion to simultaneously move both vertically and laterally. A third shaft is rotatably supported in a fixed position on a supporting arm which is pivotally connected to the upper portion. By pivoting the shaft supporting arm through its allowable arc, supporting and driving means for varying sized shuttles are provided. The three shafts are used as mounting posts for sheaves upon which the ring-shaped wire-carrying shuttle will be mounted. When the shaft supporting arm is pivoted a plurality of isosceles triangles is created, the tips of which define the frictional contact points for the varying sized shuttles.

Firm shuttle driving traction and high speed rotational control is assured by proper adjustment of the two variable position shafts. Once the sheaves and shuttle are mounted in place, the shaft supporting pivotable arm is rotated and locked in the desired position with the sheave and shuttle in frictional contact. Complete frictional contact can then be assured by operating the ratchet arrangement so that the eccentrically mounted shaft will rotate until it comes into perfect frictional contact with the shuttle. The eccentrically rotated shaft is then locked in place by applying a friction brake. This procedure, which allows both a coarse and fine adjustment, assures that the shuttle will have firm driving traction and thereby allow effective control of high speed shuttle rotation.

A movable handle is angularly attached to the upper portion of the head assembly so as to be capable of motion in one plane. A fingerlike roller supporting member is angularly journaled in the handle and provides a second supporting point for the upper portion. When the handle is moved through its plane, by a single stroke of the operator's hand, the upper portion will simultaneously move both vertically and laterally and result in separating and twisting the shuttle. This provides for simplicity and speed in the removal and replacement of toroidal cores for winding. Once a new core has been mounted in place, the handle need merely be moved back to its original position and this will automatically twist and close the shuttle in place.

The invention accordingly comprises the features of the construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a right side elevation view of the apparatus according to this invention;

FIG. 2 is a left side elevation view partially cut away of the apparatus according to this invention;

FIG. 3 is a front edge view of a ring-shaped shuttle in the closed position with the supporting and driving shafts shown in phantom;

FIG. 4 is a view similar to that of FIG. 3, showing the shuttle in the open position;

FIG. 5 is a top plan view of the apparatus of this invention with the shuttle-open position shown in phantom;

FIG. 6 is a fragmentary side elevation view of the lower portion of the handle assembly shown in the shuttle-closed position;

FIG. 7 is a view similar to that of FIG. 6, showing the lower portion of the handle assembly in the shuttle-open position;

FIG. 8 is a rear elevation view of the apparatus of this invention with the handle being shown in shuttle-closed position in solid lines and in the shuttle-open position in phantom;

FIG. 9 is a right side elevation view of the upper portion of the head assembly with the pivotable shaft-supporting arm in its outermost position, with the supporting sheaves and shuttle shown in phantom;

FIG. 10 is a right side elevation view of the upper portion of the head assembly with the pivotable shaft-supporting arm shown in its innermost position and with the sheaves and shuttle shown in phantom;

FIG. 11 is a right side elevation view of an alternate design for the upper portion of the head assembly with a two-position pivotable shaft supporting arm in its outermost position, with the supporting sheaves and shuttle shown in phantom; and

FIG. 12 is a view similar to that of FIG. 11 showing the two-position pivotable shaft supporting arm in its innermost position.

MANEUVERABLE HEAD ASSEMBLY

Head assembly 21 of the present invention is shown in FIG. 1 comprising a lower portion 22 and an upper portion 23. Lower portion 22 contains a bottom plate 24 which is secured to a base plate 70 by passing bolts through hole 27. Sheaves 28, 29, and 31 are mounted on driving posts 32, 33, and 34, and ring-shaped wire-carrying shuttle 37 is mounted in frictional contact with the rims of sheaves 28, 29, and 31. Brake 38, comprising a helical-shaped camming surface as its left side, comes into frictional contact with the exposed facing end bushing 39 when the brake lever is pushed downward, and is used to maintain eccentrically rotating bushing 39 in its set position. The height of lower head portion 22 provides for sufficient clearance between the mounting base plate and large-sized shuttles.

Upper head portion 23 is pivotally connected to an upstanding mounting post 41 by being rotatably journaled on its terminal stud 42, and mounting post 41 is pivotally connected to lower portion 22 by means of a pin 43 having a substantially horizontal lateral axis. This connection arrangement, also shown in the top view of FIG. 5 and the rear view of FIG. 8, allows upper portion 23 to pivot angularly around upstanding stud 42, which is free to pivot angularly around horizontal pin 43. Consequently, upper portion 23 is free to pivot simultaneously both vertically and laterally.

Shaft supporting arm 44 is pivotally connected to upper head portion 23 by means of a pivot pin 47, and is maintained in the desired set position by means of a bolt 48. Since driving post 34 terminating shaft 62 is rotatably supported by arm 44, varying driving positions can be easily established by angularly moving arm 44 around pin 47. This simple adjustment provides great versatility, allowing many different size shuttles to be efficiently used on head assembly 21.

Cooperating with arm 44 is a clamping plate 60, shown in FIGS. 5, 9 and 10, which takes the form of a radial sector subtended by two arcs of different diameters. Bolt 48, extending through a bore in arm 44, is threaded through a tapped hole in clamping plate 60, and protrudes into a recess in wall 65 of upper portion 23. By rotating bolt 48 clockwise, clamping plate 60 is drawn into frictional contact with support arm 44. By tightening bolt 48, arm 44 can be secured in any desired position within the arc of rotation of arm 44 since plate 60 will be secured in frictional contact with arm 44 and will maintain arm 44 in this position by preventing any rotation about pin 47.

Support block 30 is slotted for adjustable connection to lower portion 22 by means of bolts 35 and 36. After arm 44 has been rotated into the desired position, support block 30 is adjusted by being moved upward into supporting contact with an overlying bolt 40 projecting from arm 44, and block 30 is secured in that adjusted position by tightening bolts 35 and 36. This assembly supplements bolt 48 and provides additional support preventing arm 44 from pivoting downward out of the desired position, thereby assuring that all the sheaves will be in firm driving traction with the shuttle, providing effective control of high speed shuttle rotation.

Support block 30 thus limits the vertical arc through which arm 44 may pivot about pin 47, and also determines the forward or driving mode position of the entire upper head portion 23. As shown in FIGS. 1 and 5, the arc of lateral rotation of portion 23 about stud 42 is limited by its arrival in lateral contact with support block 30. The use of support block 30 as an arc determining point and a supporting contact point for overlying bolt 40 provides assurance that driving post 34 will be parallel to driving posts 32 and 33, since support arm 44 of upper head portion 23 is precluded from having any unwanted lateral movement.

HANDLE ACTUATION

In FIGS. 2, 5 and 8, it can be seen that handle assembly 51 is angularly, pivotally secured to the left face of the arm 44 on

upper portion 23 by means of a bolt 52, whose axis is substantially horizontal and angularly skewed, extending through arm 44 toward stud 42. Handle assembly 51 comprises an upstanding handle section 53 and a depending roller support section 54, joined together at an obtuse angle to form a single integral handle unit. Roller support section 54 terminates in a roller 57 rotatably mounted on a pin 58. Handle 53 normally stands vertical in the driving or winding mode of the device, as seen in solid lines in FIGS. 1, 2, 3, 5, 6 and 8. Handle 53 is easily pushed by the operator to its rear or loading mode position, shown in dash lines in FIGS. 1, 2, 5 and 8, raising portion 23 to open and twist shuttle 37 as shown in FIG. 4.

Roller 57 provides a supporting contact point upon which upper portion 23 rests on lower portion 22. Handle assembly 51 is angular in construction and capable of rotating about the angularly skewed axis of bolt 52, and upper portion 23 simultaneously moves both vertically and laterally rearward when handle assembly 51 is pushed through its arc of rotation about bolt 52 because the perpendicular distance between bolt 52 and lower portion 22 is progressively and continually increased by this advancing handle rotation. The rotated or open position of the assembly is represented in FIGS. 1, 2, 5 and 8 by the lines in phantom.

SHUTTLE DRIVING MECHANISM

As shown in FIGS. 2, 5 and 8, lower front shaft 59 and rear shaft 61 are rotatably journaled in lower portion 22, and upper front shaft 62 is rotatably journaled in arm 44 of upper portion 23. Belt drive sheave or pulley 63 is mounted on the left end of lower front shaft 59, aligned with a similar belt drive sheave or pulley 64 mounted on the left end of upper front shaft 62. Both drive sheaves or pulleys 63 and 64 are fixed in position by means of set screws 76 and 76A. Rotatable handwheel 67 is mounted on the left end of rear shaft 61 and maintained in position by set screw 80.

Drive belt grooves 68, 69 and 70 are formed in the hub of handwheel 67. Belt groove 70 of handwheel 67 is aligned with pulleys 63 and 64 and accommodates a drive belt 71, preferably an endless elastomer belt, which is also engaged in the grooves of pulleys 63 and 64. Consequently, drive belt 71 encircles all three shafts, as shown in FIG. 2. Separate drive belts are engaged in grooves 68 and 69 of handwheel 67 and are driven by a motor, not shown. As the motor driven belts rotate handwheel 67, drive belt 71 is also forced to rotate and in turn drives pulleys 63 and 64. The resulting effect is the simultaneous rotation of rear shaft 61, upper front shaft 62 and lower front shaft 59, all in the same direction.

As shown in the rear view of FIG. 8, driving post 32 is the right end extremity of lower front shaft 59, driving post 33 is the right end extremity of rear shaft 61, and driving post 34 is the right end extremity of upper front shaft 62. Since the shuttle sheaves are mounted on driving posts 32, 33 and 34 and the shuttle is in frictional contact with the shuttle sheaves, the simultaneous unidirectional rotation of shafts 59, 61 and 62 causes the shuttle to rotate. Since the drive motor is capable of clockwise and counterclockwise rotation and all three shafts are also capable of similar rotation, the shuttle can be rotatably driven either clockwise or counterclockwise.

CORE REMOVAL AND REPLACEMENT

In FIG. 3, wire-carrying ring-shaped shuttle 37 is shown in the closed driving position, and shafts 59 and 62 are shown in phantom. When handle assembly 51 is rotated from the driving position, shown in FIG. 2 by the solid line, to the loading position, shown in FIG. 2 by the lines in phantom, upper portion 23 simultaneously pivots both upward and laterally rearward about the axes of stud 42 and pin 43. This movement causes shuttle 37 to open and twist, distorting elastically as shown in FIG. 4, exposing one side of the shuttle's scarf joint to receive a toroidal core 25 interlinked therewith as shown in FIG. 1. Toroidal core 25 is supported in cooperative juxtaposition by a core holder assembly 60 constructed to support and

revolve the core substantially about its own axis. This process provides a quick, simple and efficient method for loading and removing toroidal cores.

Referring to FIGS. 1, 2, 5 and 8, it can be seen that when handle assembly 51 is pushed through its arc of rotation, upper head portion 23 is governed by three noncoplanar mutually perpendicular axes. The three axes are represented by stud 42, pin 43 and bolt 52. Although upper head portion 23 is capable of pivoting about the mutually perpendicular axes of stud 42 and pin 43, its scope of movement is severely limited by constraints imposed on the actuating handle assembly's pivoting movement, and by having to stretch the elastic drive belt 71. Furthermore, mounting post 41 is pivotally journaled to lower portion 22 by means of pin 43 in a manner that allows only its pivoting motion about the substantially horizontal pin 43. Also, terminal stud portion 42 of post 41 secures upper portion 23 journaled to mounting post 41 in a manner allowing only rotation of upper head portion 23 about the axis of stud 42.

To provide for sufficient shuttle separation at the front of head assembly 21 for easy core removal and replacement, the mutually perpendicular axes of stud 42 and pin 43, about which upper portion 23 pivots, are positioned rearwardly of shuttle 37 on head assembly 21. Furthermore, both bolt 52 and roller 57 have parallel axes which are skewed in the direction of stud 42. This arrangement allows the axes of bolt 52 and roller 57 to be consecutively used as fulcrum points to initiate and control torquing motion about the intersecting axes of stud 42 and pin 43.

Proper shuttle separation is achieved by a two step process. Referring to FIGS. 1 and 2 as handle assembly 51 is pivoted to open shuttle 37, the first forces experienced are vertically oriented, and can be represented by a force 82 acting through bolt 52 vertically upward, and a counteracting force 83 acting through pin 43 vertically downward. Due to the motion constraints of the head assembly, the resulting moment arm between coupled forces 82 and 83 produces a torquing motion 55 of upper head portion 23 about pin 43, which causes the shuttle's scarf-joint to separate.

The second stage forces, shown in FIG. 5, are represented by a force 88 acting diagonally toward the rear through bolt 52 and a counteracting force 89 acting through stud 42. The resulting moment arm of the coupled forces 88 and 89 causes torquing motion 56 of upper head portion 23 about stud 42 and torquing motion 55 (FIGS. 1, 2) about pin 43 simultaneously. This movement causes the separated shuttle to twist, thereby providing sufficient shuttle separation for easy core removal and replacement.

This configuration and resulting motion provides firm, well defined pivoting of upper portion 23 actuated by the simple pivoting movement of a single handle to split and twist the shuttle 37 without any significant slippage or looseness. This results in apparatus that can be used efficiently and quickly by personnel with little or no previous training. All that an operator needs to do is push the handle through its arc of rotation, remove the toroidal coil that has been wound from the shuttle 37, insert a new toroidal core into its proper winding position and pull the handle back to the original position a one-stroke push of handle 53 is the only action required to open shuttle 37 and twist it away to release core 25. Head assembly 21 automatically performs all of the other necessary functions by providing a sheave mounting shaft that is simultaneously pivoted about noncoplanar, mutually perpendicular axes.

To assure proper shuttle separation when handle assembly 51 is rotated to the loading position, an L-shaped plate 49 shown in FIGS. 1 and 5 is provided. Plate 49 is slotted for adjustable attachment to lower head portion 22 by means of bolts 45 and 46. After shuttle 37 has been secured in its driving position, bolts 45 and 46 are loosened and plate 49 is adjusted until edge 50 is in close proximity to shuttle 39. Plate 49 can then be secured by tightening bolts 45 and 46. Plate 49 assures that shuttle 37 will open properly by providing an additional bracing contact point, substantially spaced above the

tangent engagement points of sheaves 28 and 29, maintaining the lower rear sector of shuttle 37 in the same plane as sheaves 28 and 29. Plate 49 thus prevents shuttle 37 from twisting off either sheave 28 or 29 and allows sheave 31 to separate the scarf joint of shuttle 37 and twist its upper front sector aside, so as to provide an opening sufficient for removing and loading toroidal cores.

ONE-STROKE HANDLE OPERATION

In the driving position of handle assembly 51, as shown in FIG. 6, the depending roller support section 54 of handle 51 is in frictional contact with plate 91 and with upstanding contact flange 92, both on lower head portion 22. Flange 92 is mounted on plate 91 by means of screw 93. When handle 53 is rotated rearward to the loading position, as shown in FIG. 7, swinging depending section 54 forward beneath bolt 52, and roller 57 rolls along plate 91 into a shallow groove 94. Continued angular rotation of roller support section 54 is prevented by a restraining block 96. In FIG. 8, it can be seen that restraining block 96 is secured to plate 91 by means of a screw 97, and plate 91 forms a part of lower portion 22.

Since roller support section 54 is integral with handle 53 and the entire handle assembly 51 is capable of rotation about bolt 52, the upper portion 23 of the head assembly is forced to move upwardly as the handle assembly is pushed through its arc of rotation. This upward movement is caused by increasing the perpendicular distance between bolt 52 and plate 91. In FIG. 6 we may represent the minimum perpendicular distance as A from the center of bolt 52 to plate 91, the distance from the center of bolt 52 through pin 58 to the radial contact periphery of roller 57 by C and the angle between C and plate 91 by α . As handle 51 rotates, the vertical height of bolt 52 above plate 91 is equal to C times the cosine of angle α . As handle assembly 51 is rotated from the position in FIG. 6 to the position shown in FIG. 7, angle α is continually being increased until it is equal to 90° . Since C is a constant, the height of bolt 52 will increase as $\cos \alpha$ increases. When angle α is 90° $\cos \alpha$ equals 1 and the height of bolt 58 equals C. At this point, the upper portion of the head assembly has been raised upwardly as far as it can. Thereafter it is lowered slightly as handle assembly 51 is moved "over the top" into the position shown in FIG. 7. Since angle α is greater in this loading position than it is in the driving position, the perpendicular distance from bolt 52 to plate 91 will be greater in the loading position than it is in the driving position. The vertical movement of upper portion 23 provided for by the angular rotation of handle assembly 51 about bolt 52 provides assurance that the head of overlying bolt 40 will clear supporting block 30, and that the shuttle's scarf joint will be properly drawn apart. Flange 92 and block 96 cooperate to limit the rotation of handle 53 about bolt 52 and are positioned so as to assure sufficient vertical movement of the upper head portion 23 to open all shuttle sizes used on the head assembly.

The shallow groove 94 in plate 91 is bounded by side walls 98 and 99. Since the shuttle's scarf joint must be separated and overlying bolt 40 must clear supporting block 30 before the shuttle can be twisted, groove 94 is positioned away from flange 92 so that the initial movement of upper portion of 23 actuated by the rotation of handle assembly 51 will be vertical movement only, as the head of bolt 40 slides upward beside block 30. Thereafter, roller 57 is free to roll into slot 94, and the interfering contact between roller 57 and the groove's front side 99 maintains the roller in slot 94, making the pin 58 axis of roller 57 the fulcrum for the next stage of pivoting handle movement while upper head portion 23 pivots simultaneously vertically and laterally rearward about the noncoplanar mutually perpendicular axes represented by bolt 42 and pin 43.

The driving impetus for raising upper head portion 23 is supplied by handle assembly 51 and the combination of motions defining the pivoting of upper portion 23 can be explained by considering the rotation of handle assembly 51. As

roller 57 rolls along the flat portion of plate 91, handle assembly 51 rotates about bolt 52. This rotation results in the vertical movement of upper portion 23 already described. Once roller 57 comes into abutting contact with front side 99 of groove 94, the axis of rotation for handle assembly 51 changes from bolt 52 to pin 58, the axis of roller 57. Since bolt 52 pivotally connects handle assembly 51 to upper head portion 23, the handle assembly's rotation about pin 58 urges upper head portion 23 up and back, confined by the surfaces constraining portion 23 to move only in rotation about bolt 42 and pin 43. The simultaneous lateral and vertical movement of upper head portion 23 of head assembly 21 assures the proper opening and twisting of all shuttles mountable on the head assembly. Once the shuttle has been separated and twisted, the convenient removal and replacement of toroidal cores previously described is assured.

After a new toroidal core has been placed in position, rear side 98 of groove 94 comes into abutting contact with roller 57 as handle assembly 51 is rotated forward toward its original position. This interfering contact provides assurance that roller 57 will remain in groove 94 and force handle assembly 51 to rotate about roller pin 58. This allows upper portion 23 to simultaneously rotate both vertically and laterally forward until both parts of the shuttle's scarf joint are in the same plane. Driving posts 32, 33 and 34 are then all parallel. This position is assured, as previously described, by the abutting contact between the left side of support block 30 and the right side of arm 44. Once the shuttle scarf joint is in the same plane, the head of bolt 40 clears block 30, allowing roller 57 to ride up and over rear side 98 of groove 94 until it rolls into contact with flange 92. This rotation produces the vertical lowering of arm 44 carrying shaft 62, thereby closing the shuttle's scarf joint and returning the shuttle to the driving position by means of one quick and simple forward movement of a single handle.

Elastic drive belt 71 and elastic shuttle 37 aid in maintaining upper head portion 23 in either the shuttle closed or shuttle open positions. Since drive belt 71 must be stretched into position in the coplanar grooves of handwheel 67 and pulleys 63 and 64, and further stretched when shuttle 37 is opened, belt 71 and shuttle 37 will tend to return to its nonstretched or unseparated condition and in so doing will draw upper head portion 23 downward. Thus belt 71 and shuttle 37 comprise cooperative or alternative resilient means biasing handle 53 toward either of its two positions. Since handle assembly 51 is pivoted "over the top" of its arcuate path, beyond the point of maximum vertical displacement, the elastic nature of belt 71 and shuttle 37 will attempt to draw upper head portion 23 vertically downward and in so doing will create a positive, slip-free position. When in the shuttle closed position, the elastic nature of belt 71 and shuttle 37 aids in maintaining this position by providing additional forces that must be overcome before upper head portion 23 will move.

SHUTTLE SIZE ADJUSTMENT

As shown in FIG. 2, circular ratchet teeth 72 are eccentrically mounted on rear shaft 61 and are recessed in a suitable cavity formed in the left side of lower head member 22. A ratchet drive lever 73 is supported by pin 74 and is capable of lateral movement in slot 77 and pivoting movement about pin 74. Spring 78 assures that the ratchet driving end 81 of lever 73 is in frictional contact with ratchet teeth 72. By moving the opposite protruding handle end 79 of lever 73 upwardly so that ratchet end 81 is in contact with the lowest tooth 72 possible, the circle of ratchet teeth 72 can be rotated by pushing down on end 79 of lever 73 so that it will rotate about pin 74. By repeating this process, ratchet teeth 72 will revolve about their own axis, and shaft 61 will rotate eccentrically. This configuration provides a fine adjustment to assure that all shuttle sheaves are in firm, driving traction with the shuttle.

In FIG. 9, upper portion 23 is shown with shaft supporting arm 44 positioned for mounting of the largest size shuttle

which can be accommodated by head assembly 21 illustrated. The sheaves 28, 29 and 31 and the shuttle 37 are shown in phantom. On FIG. 10, upper head portion 23 is shown with shaft supporting arm 44 positioned for mounting of the smallest size shuttle which the illustrated head assembly accommodates: either an internally supported shuttle 37A or an externally supported shuttle 37B whose outer rim is internally tangent to the supporting sheaves. These two positions and all intermediate positions of arm 44 are obtainable by loosening bolt 48 to release clamping plate 60, and angularly rotating shaft supporting arm 44 about pivot pin 47 through the arc allowable by slot 50. Shuttle 37 is in tangential traction engagement with sheaves 28, 29 and 31 at points 85, 86 and 87. As arm 44 is pivoted about pin 47 through its allowable arc, traction engagement point 87 changes so as to provide a plurality of isosceles triangles of different sizes having a common base represented by an imaginary line connecting traction engagement points 85 and 86. Tangent point 87 is minutely moved by operation of eccentric ratchet teeth 72 by means of handle 73.

The general procedure for securing the desired size shuttle on the head assembly is to mount the sheaves on the driving posts of shafts 59, 61 and 62, loosen bolt 48 and rotate roller support arm 44 until the shuttle pulley mounted on shaft 62 comes into frictional contact with the juxtaposed shuttle; secure support arm 44 in the desired position by tightening bolt 48, and finally eccentrically rotating shaft 61 by moving lever 73, as discussed above, until sheave 29 mounted on shaft 61 is moved away from the sheaves 28 and 31 to bring all three sheaves into firm frictional driving contact with the ring shaped shuttle. This procedure assures firm driving traction and effective control of high speed shuttle rotation for many different size shuttles.

In FIGS. 11 and 12, an alternate design for upper head portion 23 is represented. Shaft supporting arm 101 is again capable of angular rotation about pin 47, but instead of a slot 50, the shaft supporting arm is provided with two closely spaced holes 102 and 103. Holes 102 and 103 of supporting arm 101 are designed to cooperate with two, more-widely spaced holes 104 and 106 of upper head portion 23. This arrangement provides support arm 101 with four effective positions, two for small shuttles and accompanying sheaves, two others for larger shuttles and accompanying sheaves. Support arm 101 is secured in the desired position by inserting pin 107 through the cooperating holes of support arm 101 and upper portion 23.

As explained above, this invention provides a single head assembly for winding toroidal cores that is capable of being used with many shuttle sizes, provides for easy shuttle separation and core removal and replacement, and is conveniently operable by non-trained personnel. The sheave supporting shafts are positioned sufficiently above the base of the head assembly to provide adequate clearance for mounting large sized shuttles.

The upper head portion is pivotally connected to the lower head portion by means of two intersecting axes positioned behind the shuttle, and is supported by a handle assembly pivotally secured to the upper head portion on an axis skewed toward the intersecting connecting axes. The single stroke movement of the handle assembly provides two consecutive fulcrum points, the first point causing torque about one of the mounting axes and forcing the upper head portion to move vertically up, thereby opening the shuttle's scarf-joint; and the second point causing torque about both mounting axes and forcing the upper head portion to simultaneously move vertically and laterally, thereby causing the shuttle to twist open. A single stroke of the handle in the opposite direction causes the reverse motion and securely closes the shuttle's scarf-joint.

Precise movement of the upper head portion is assured by means of the supporting block attached to the lower head portion and the overlying bolt attached to the upper head portion. The combination assures initial vertical movement of the upper head portion since the overlying bolt must clear the supporting block. This assembly also provides for parallel orienta-

tion of all sheave supporting shafts, since the upper head portion comes into frictional contact with the block when the shuttle is being closed. This assembly also prevents unwanted slipping movement of the upper head assembly during the winding operation, since the upper head portion cannot move downward because the bolt is supported by the block, and since the upper head portion cannot move laterally since the bolt and the upper head portion are in frictional contact with both sides of the block.

Firm driving traction for many shuttle sizes is assured by providing both coarse and fine shuttle size adjustments. The coarse adjustment is made by pivoting the shaft supporting member of the upper head portion and securing it in place. The fine adjustment is then made by moving the eccentrically rotating shaft on the lower head portion until the desired traction is assured and then securing that shaft in position.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above instructions 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.

We claim

1. A toroidal coil winding machine having a base supporting in cooperative juxtaposition a core-holder assembly constructed to support and revolve a toroidal core substantially about its own axis and a head assembly constructed to support and rotate substantially about its own axis a ring-shaped, scarf-jointed wire-carrying shuttle interlinked with the core, wherein the head assembly comprises:

A. three power-driven shafts rotatably journaled in the head assembly;

B. drive means connected to said shafts for rotation thereof;

C. three shuttle-supporting sheaves mounted to said shafts;

D. an actuating handle;

E. separate angularly related pivot means mounted to said handle and secured to said head assembly for shifting movement between a forward operating position and an alternative rearward load position;

F. means connecting said pivot means and said actuating handle to one of said supporting sheaves for angular pivoting of said one sheave through an arcuate path defined by simultaneous vertical and lateral movement in response to handle shifting movement; and

G. means interposed between said handle and said head assembly resiliently biasing said handle toward each of said two alternative positions,

whereby the shuttle mounted on said supporting sheaves is simultaneously opened and twisted for easy toroidal core removal and replacement by manual rearward pushing movement shifting said handle from said operating position to said load position.

2. The apparatus defined in claim 1, wherein said pivot connecting means comprises means controlling said pivot means wherein said angular pivoting of said one sheave through an arcuate path is about two noncoplanar non-parallel axes, thereby causing the shuttle's closed scarf-joint to separate and the shuttle to distort twistingly for easy toroidal core removal and replacement.

3. The apparatus defined in claim 1, wherein said biasing means comprises a single elastic drive belt adapted for simultaneously rotating said three drive shafts supporting said three shuttle-supporting sheaves and resiliently resisting said actuated shifting movement of said one sheave between its angularly alterable axis positions, normally maintaining the shaft supporting said one sheave in its normal operating position.

4. The apparatus defined in claim 3, wherein one of said shafts is journaled in a pivotably adjustable arm, providing a plurality of groups of three tangent tractive sheave engagement points spaced around the ring-shaped shuttle defining a corresponding plurality of isosceles triangles of different sizes whose apices define various mounting locations on which

shuttles of different sizes can be supported and driven by a single head assembly.

5. Apparatus as defined in claim 1, wherein said head assembly further comprises:

H. a sleeve block rotatably mounted in the head assembly and comprising:

- a. one of said shafts eccentrically journaled therein, and
- b. ratchet teeth encircling said sleeve block; and

I. a pawl actuator movably mounted on the head assembly and cooperating with said ratchet teeth, providing eccentric axis adjustment of said shaft.

6. Apparatus as defined in claim 5, wherein the pawl actuator comprises a finger mounted on the head assembly for both horizontal and vertical motion which cooperates with the encircling ratchet teeth and causes the sleeve to rotate about its own axis and thereby eccentrically rotate the axis of the shaft.

7. A toroidal coil winding head assembly for supporting and rotating a ring shaped shuttle comprising:

A. a stationary lower head portion permanently mounted to a base plate, and comprising

a. a first shaft rotatably journaled in a fixed position,

b. a second shaft eccentrically journaled, and

c. shuttle-supporting sheaves mounted to said first and second shafts;

B. a movable upper head portion comprising a third shaft rotatably journaled therein;

C. means pivotally connecting said upper head portion to said lower head portion;

D. a handle assembly, pivotally connected to the upper head portion by a skew-axised bolt, comprising:

a. an actuating handle,

b. a roller for engagement with a contact plate, and

c. separate angularly related pivot means mounted to said handle for supporting and controllably pivoting the upper head portion;

E. means interposed between the upper head portion and the lower head portion resiliently biasing the handle assembly toward each of two alternative positions, a forward operating position and a rearward load position; and

F. said contact plate supported by said lower head portion and having

a. two terminating contact members which define a limited arc of pivoting movement through which the handle moves, and

b. a roller-arresting groove positioned between said contact members and spaced therefrom by fulcrum lands producing continual elevation of the mounting bolt freely away from the contact plate by providing rolling-fulcrum support for the roller during initial handle-actuating movement, during which the handle pivots about the bolt while the roller rolls across one of said lands,

whereby subsequent descent of said roller into said roller arresting groove blocks rolling traversing movement of the roller, causing continuing handle actuating movement to produce pivoting movement of the handle about the axis of the arrested roller, causing pivotal traversing movement of the bolt and the upper head portion joined thereto and thus skewingly separating the third sheave mounting shaft from the first and second shafts to open and twistingly distort a shuttle supported thereon.

8. Apparatus as defined in claim 7, wherein said upper head portion is further defined as comprising:

d. adjustable pivot means interconnecting a shaft supporting forearm member to said upper head portion for pivoting adjustment of said forearm member about an axis substantially parallel to the axis of the third shaft, said forearm comprising

a. said third shaft rotatably journaled in a sleeve forearm member, and

2. an arc determining slot formed in said forearm member limiting pivoting adjustment thereof.

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9. Apparatus as defined in claim 8, wherein said upper head portion further includes anchoring means maintaining the forearm member in an adjusted position within its limited allowable arc of rotation.

10. Apparatus as defined in claim 4, wherein said upper head portion is rotatably connected to said lower head portion by means of two substantially perpendicularly related connecting pivot pins, respectively oriented vertically and

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horizontally, thereby allowing simultaneous or independent vertical and lateral movement.

11. The apparatus defined in claim 4, wherein a second of said shafts is eccentrically journaled in a sleeve block rotatably mounted in the head assembly, providing fine adjustment of the position of a corresponding apex of each of said isosceles triangles.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,662,965 Dated May 16, 1972

Inventor(s) Vilmos Havasi et al.

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

Insert the following claim:

Apparatus as defined in Claim 6, further comprising a friction brake movably mounted on the head assembly alternatively clamping and releasing the sleeve carrying the eccentrically journalled shaft.

On the cover sheet, following the Abstract, "11 Claims, 12 Drawing Figures" should read -- 12 Claims, 12 Drawing Figures --.

Signed and sealed this 27th day of February 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents