United States Patent [19]

Holmes et al.

[11] **3,804,131**

[45] **Apr. 16, 1974**

[54] **WIRE SKEINING APPARATUS**

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[73] Assignee: **Essex International Inc.,** Fort Wayne, Ind.

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **140/92.2,** 242/53

[51] **Int. Cl.** **B21f 3/00**

[58] **Field of Search** 140/9.2, 102; 242/53, 127; 28/21

[56] **References Cited**

UNITED STATES PATENTS

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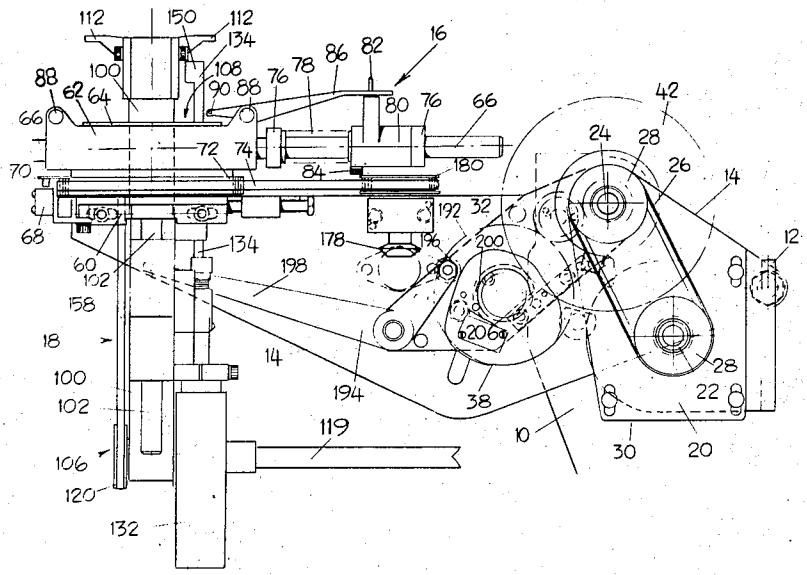
Primary Examiner—Lowell A. Larson

Attorney, Agent, or Firm—Larson, Taylor & Hinds

[57] **ABSTRACT**

Skein winding apparatus for wire coil winding machines has a rotatable arrangement of spaced projections for initially folding wire and has associated with it a device for twisting the folded wire intermediate the spaced elements. The apparatus forms interlocked wire skeins quickly.

11 Claims, 12 Drawing Figures



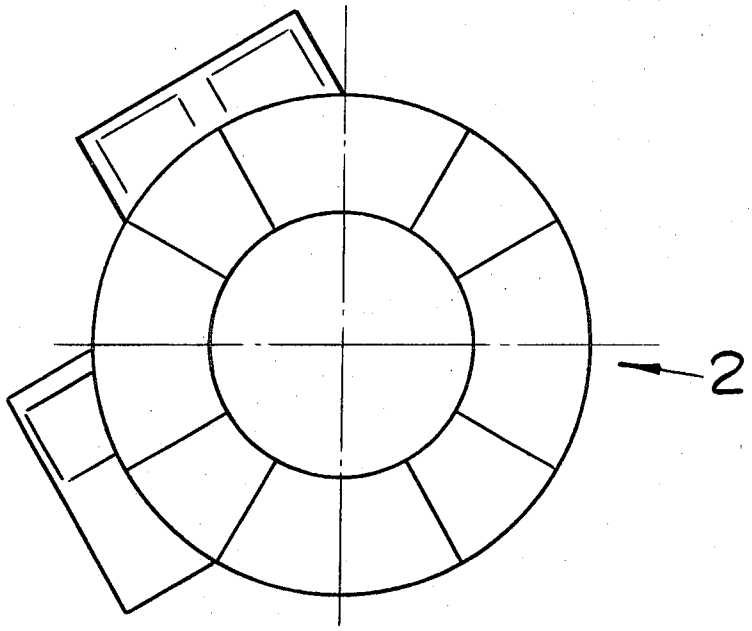
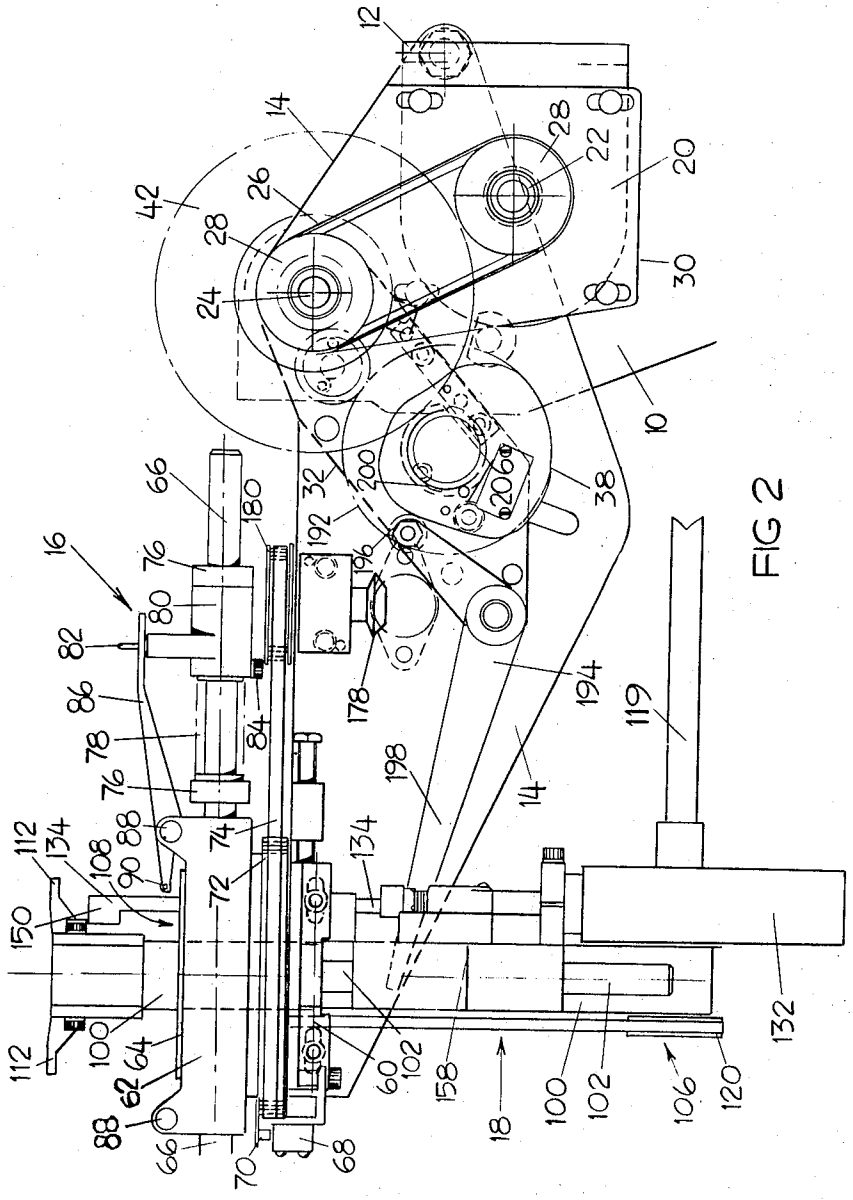


FIG 1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72
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88
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70
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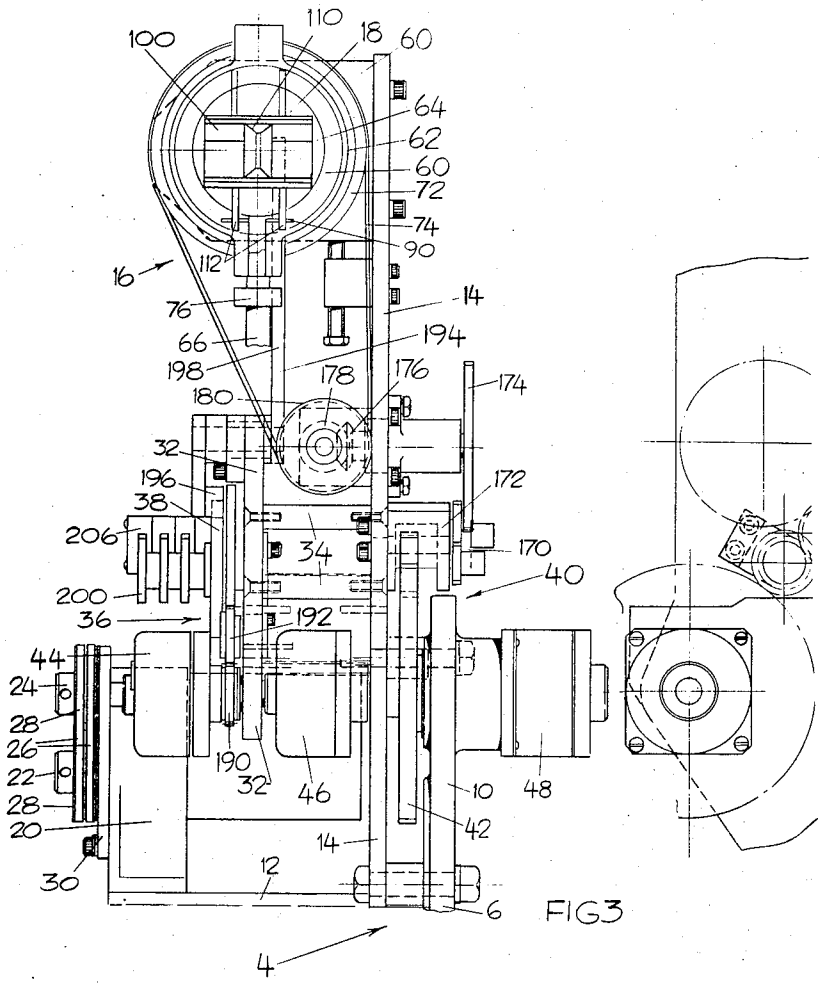
FIG 2


100
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60
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62
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90
112
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FIG3

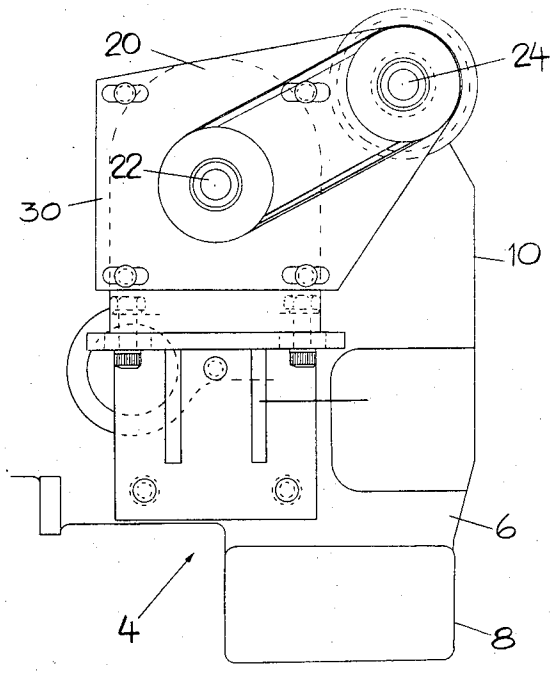


FIG4

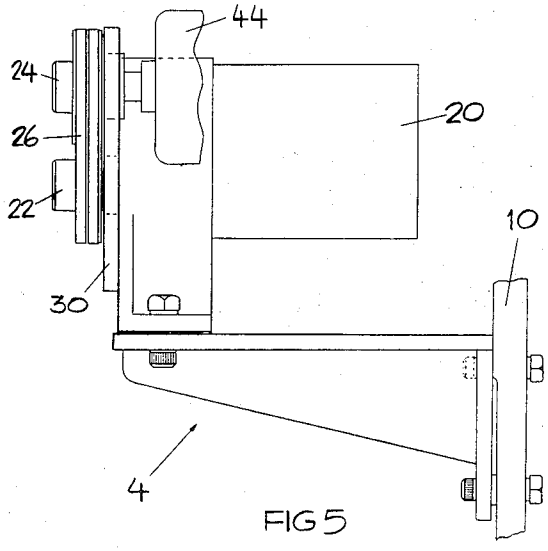


FIG5

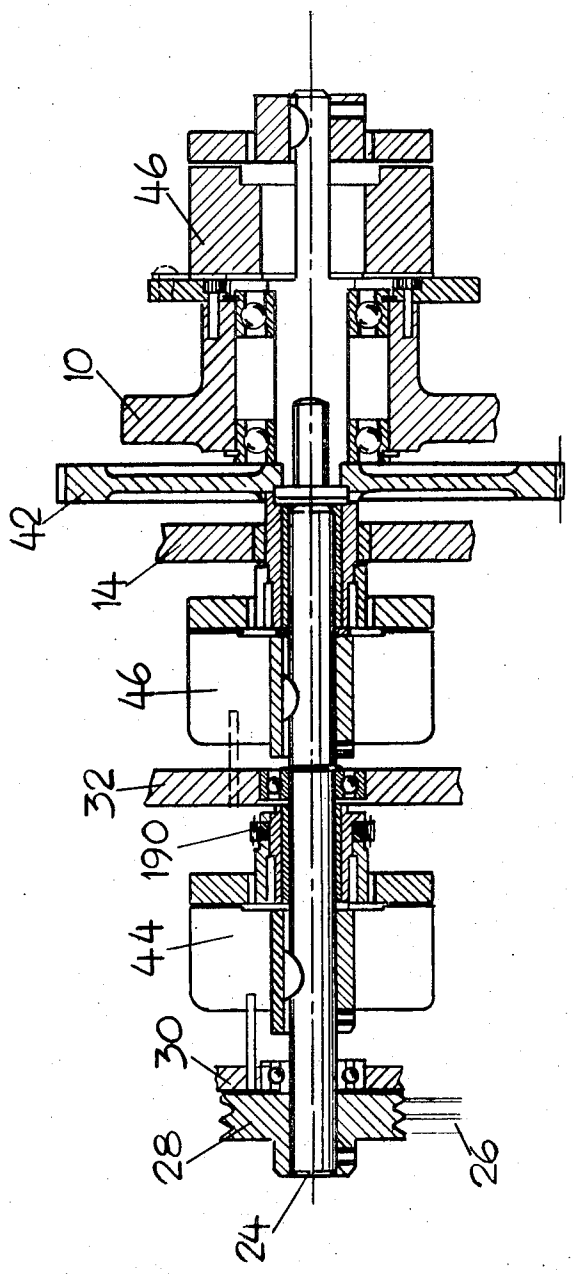
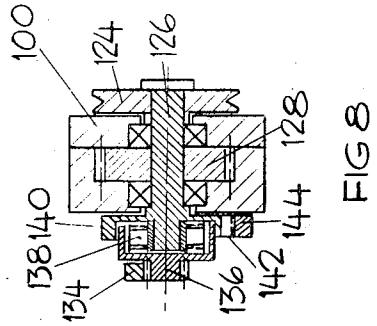


FIG 6


100
124
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140
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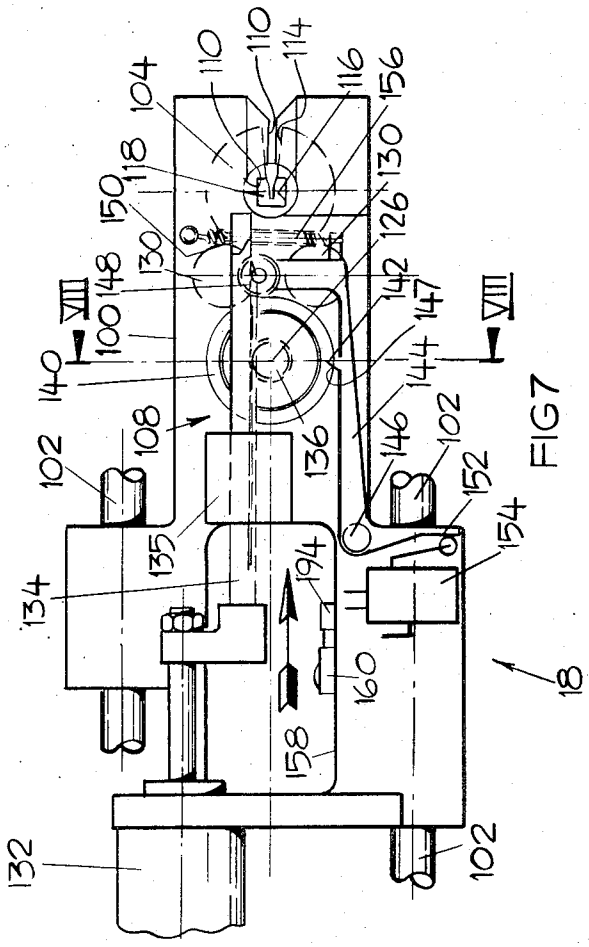
144
134
136
142

FIG 8


104
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142
147
VIII
VIII
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194
160
18
158
132
102

FIG 7

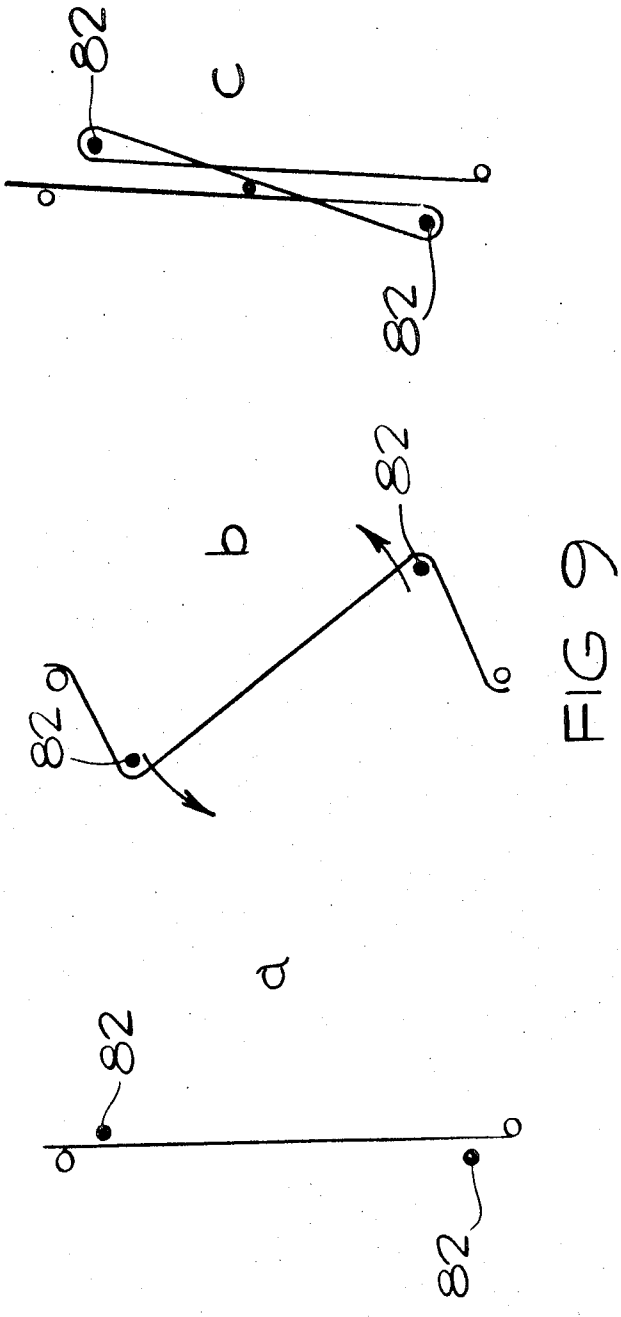


FIG 9

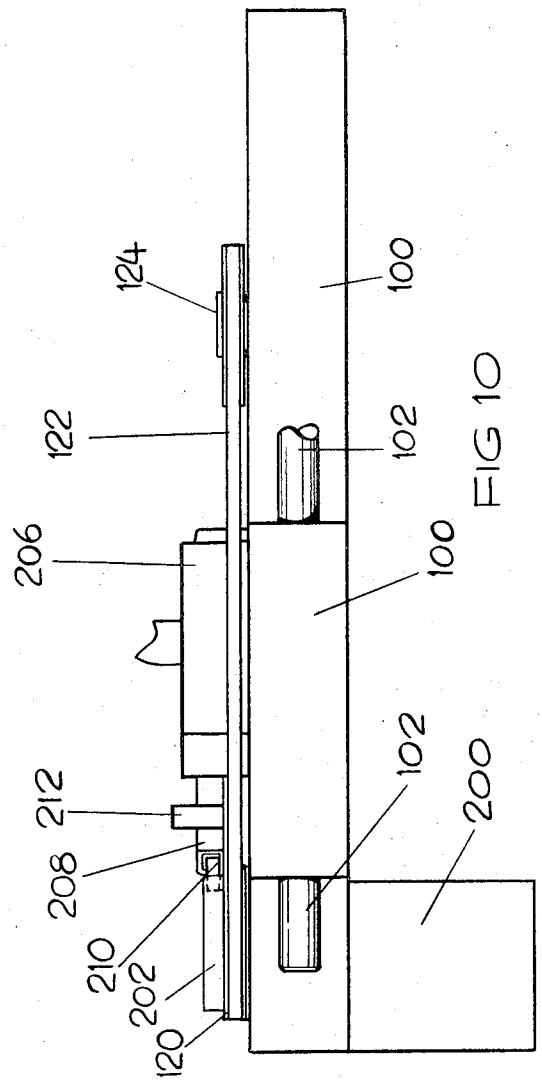
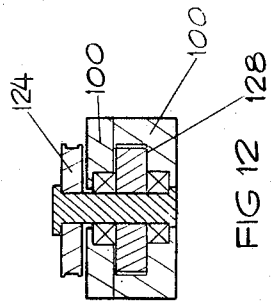


FIG 10


124
100
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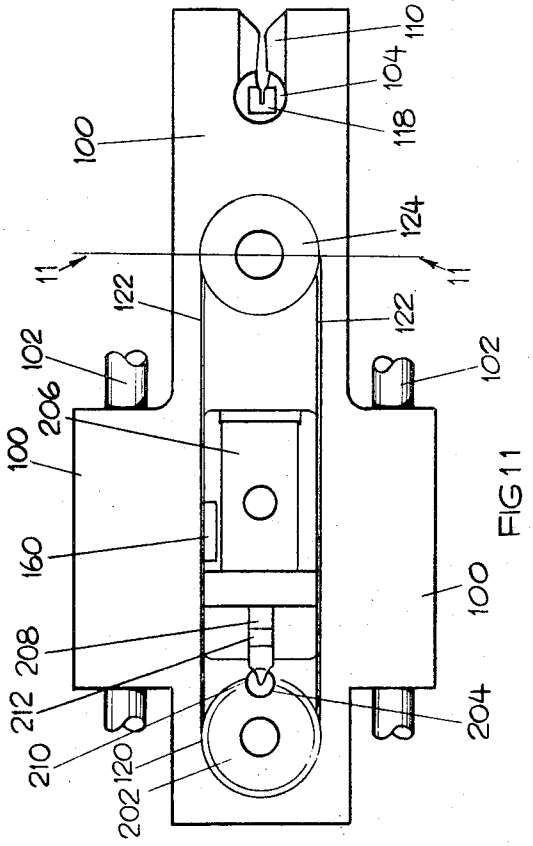
128

FIG 12


110
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118
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102
206
100
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208
212
210
120
202
204
100

FIG 11

WIRE SKEINING APPARATUS

SUMMARY OF INVENTION

The invention relates to wire skeining apparatus for in winding wire onto bobbins to make coils.

The leads of wound coils are often subject to stresses in use and during their manufacture. Strong leads can be obtained by using a thicker wire for the lead portions than for the remainder of the coil. Alternatively a wire can be formed into a skein of folded and twisted wires to form a lead. The formation of such skeins is only step in the succession of steps necessary to form a wound coil.

It is therefore an object of the invention to provide a compact skein winding apparatus which can be fitted adjacent other equipment on a coil winding machine.

It is a further object of the invention to provide a compact skein winding apparatus capable of operation at speed and without supervision and not limiting the speed of the overall coil winding operation.

The invention provides a wire skeining apparatus which comprises a pair of spaced projections on a rotatable mounting for folding a wire passing between the projections, and an element rotatably mounted on a support reciprocable with respect to the rotatable mounting and having a recess for straddling a portion of the foled wire for forming a skein of interlocked wire by twisting the folded wire. Preferably the projections are mounted diametrically opposite and the support is mounted for sliding to and fro in a central aperture of the mounting. Advantageously the projections are pins and levers are provided on the rotatable mounting straddling the pins for ejecting ends of the skein of interlocked wire from the projections. Suitably the projections are adjustably and resiliently mounted on the mounting. The recess may be formed by a movable insert. Preferably the element is a radially slotted gear disc drivable by a pair of circumferentially spaced gears. Conveniently the element is mounted inside the support which is provided with a converging slot and the element is connected to a drive adapted to stop the element only when the recess and slot are aligned. The apparatus may further comprise a first electric motor for driving a main shaft; a first clutch and a drive train for rotating the mounting which drive train is connected to an index gear for rotating a bobbin; a second clutch and a drive train comprising a reduction gear, a cam shaft, a cam follower and a lever connected to the cam follower for reciprocating the support; and switches to operate the electric motor and clutches as and when required. The element may be connected to a second electric motor operated by time switches to twist the folded wire.

The wire skeining apparatus of the invention may be fitted onto an automatic or semi-automatic bobbin winding machine of the type where a number of winding units are mounted on a continuously rotated table. The skeining apparatus may also be fitted onto a turret bobbin winding machine.

This invention is particularly described with reference to the drawings in which:

FIG. 1 is a schematic plan view of a bobbin winding machine incorporating the skeining attachment according to the invention;

FIGS. 2 and 3 are a side view and a front view respectively of the upper part of the skeining attachment of FIG. 1;

FIGS. 4 and 5 are a side view and a front view respectively of the lower part of the skeining attachment of FIG. 1 and complement FIGS. 2 and 3;

FIG. 6 shows a section through the drive shaft of the skeining attachment of FIGS. 2 to 5;

FIG. 7 shows a bottom view of a twisting mechanism of the skeining attachment of FIGS. 2 to 5;

FIG. 8 shows a section through line A—A of FIG. 7;

FIGS. 9*a* to *c* illustrate various stages of the operation of the attachment of FIG. 1.

FIG. 10 shows a side view of an alternative form of a twisting mechanism of the skeining attachment of FIGS. 2 to 5;

FIG. 11 shows a top view of the twisting mechanism of FIG. 10; and

FIG. 12 shows a section through line 11—11 of FIG. 11.

The bobbin winding machine

With reference to FIG. 1 an automatic continuous bobbin winding machine comprises a rotary table 2 on which a number of winding units are arranged regularly spaced around the circumference of the table. The winding units are each provided with a spindle on which a bobbin frame can be fixed by an operator. Above each of the winding units is also positioned spaced well above the table, a feeder of wire which is rotatable with the table and which supplies insulated wire at an approximately constant tension to the winding unit. While the table moves around beyond the operator load position, the wire fed is wound in coils around the bobbin frame by rotation of the spindles.

When winding is completed the bobbin is finished by subjecting it to a skeining operation; wrapping a tape around the coil; wrapping the skein around a protuberance on the bobbin frame, and cutting the skeined lead of the bobbin at a position approximately half-way down the skeined portion. The bobbin is then removed from the spindle so that a further bobbin frame can be re-loaded on the spindle by the operator.

In order to enable these finishing operations to be performed at successive winding units whilst the table rotates, skeining and subsequent wrapping and cutting attachments are mounted separately from the table on pairs of guide bars mounted radially with respect to the table. The attachments are provided with mountings which can slide on the guide bars and are themselves secured by arms to the table support. By moving the arm radially and the guide bars circumferentially the different attachments can be made to travel along with the rotating table opposite one of the winding units, and on completion of the operation for which the attachment is responsible, can be moved away from the table and back to pick up the next winding unit to repeat the operation. Secured to the spindle is also a gear which meshes with a timing gear on the appropriate attachment when it is in an operative position to control any rotation of the bobbin which may be necessary.

Thus the winding machine produces bobbins continuously at a speed which depends to a large extent on the prompt execution of various operations by the attachments at successive winding units.

The skeining attachment

With reference to FIGS. 2 to 6, the skeining attachment comprises a base 4 consisting of an index frame 6 provided with tubular openings at 8 for receiving the aforementioned guide bars and with an upstanding carrying arm 10, and a support bracket 12 bolted to the carrying arm 10. Bolted to the carrying arm 10 is an upwardly extending mounting place 14 which supports at its upper end a wire folding unit 16 which in turn supports a twisting unit 18. Mounted on the bracket 12 is a motor 20 having an output shaft 22 which is connected by V-belts 26 and pulleys 28 to a main drive shaft 24. The main drive shaft 24 is supported by a mounting plate 30 bolted to the motor 20 at one end, by the mounting plate 14 and the carrying arm 10 at the other end and at an intermediate position by a mounting plate 32 secured by spacing members 34 to the mounting plate 14. Mounted on the plate 32 is a drive train 36 to drive a programming cam 38 and move the twisting unit 18 to and fro and mounted on the plate 14 is a drive train 40 for rotating the wire folding unit 16 and the aforementioned index gear 42 which is positioned between the carrying arm 10 and mounting plate 14. Each of the drive trains 34 and 40 can be connected by a clutch 44 and 46 respectively to the main drive shaft 24. The drive train 40 can be stopped in a predetermined position by a brake 48 mounted on the carrying arm 10.

The wire folding unit

The wire folding unit 16 comprises a bracket 60 bolted to the mounting plate 14, a hub 62 rotatably retained on the bracket 60, the bracket 60 and hub 62 leaving a central aperture 64 and two arms 66 extending radially from the hub 62 (only one arm is shown in FIGS. 2 and 3). On the bracket 60 are mounted a pair of microswitches 68 at spaced positions and on the hub 62 are mounted a switch actuating plate 70 and a wheel 72 connected to the drive train 40 by a belt 74. Each of the arms 66 serve as a mounting for a pair of spaced rings 76 which can be fixed to the arm 66 in a required position, a spring 78 and a slide block 80 carrying projecting pick-up pins 82 and a bolt 84 for preventing rotation of the block around the arm by engaging in a groove in the arms 66. The spring 78 and the slide block 80 are positioned between the rings 76 with the spring adjacent the hub 62. Also mounted on the hub 62 alongside each arm 66 are a pair of ejector fingers 86 mounted on pivots 88 secured to the hub 62. Each of the ejector fingers 86 on one end of the pivot 88 extends towards the aperture 64 at which position a lateral pin 90 is secured to the ejector fingers and at the other end have a recess to allow the fingers to straddle and extend past the pins 82.

The twisting unit

The twisting unit 18 (see also FIGS. 7 and 8) comprises a housing 100 slidably mounted with respect to the folding unit 16 by a pair of guide bars 102 secured to the bracket 60, a twisting gear 104 at the front of the housing, a drive 106 for the twisting gear and a mechanism 108 for arresting the twisting gear 104 in a particular angular position. An alternative arrangement will be discussed later with reference to FIGS. 10 to 12. The housing 100 is urged into a forward position where it protrudes through the aperture 64 by a pair of springs attached to the housing 100 and the bracket 60. At the front the housing 100 is provided with a recess or slot 110 which provides access to the twisting gear 104 and a pair of ejector finger actuators 112 which are positioned forward of and opposite the lateral pins 90. The twisting gear 104 is a spur gear with a recess 114 which extends to the centre (see FIG. 7). At the centre there is a square cut-out 116 for receiving an insert 118. The insert has a recess which extends radially past the axis of rotation of the gear 112 and which is continuous with the recess 114. The drive 106 for the twisting gear 104 comprises a flexible drive shaft 119 connected to a motor on the table 2, a pulley 120 mounted on top of the housing 100 connected by a V-belt 122 to a pulley 124 adjacent the twisting gear. The pulley 124 is connected by a vertical shaft 126 to a drive gear 128 which through a pair of spaced roller gears 130 drives the twisting gear 104. The drive gear is of the same size as the twisting gear 104. The mechanism 108 comprises an air cylinder 132 mounted on the rear of the housing, a rack 134 operated by the air cylinder 132 and extending underneath the housing through a guide 135 to mesh with a spur gear 136 which is connected through a one-way clutch 138 to a wheel 140 fixed to the vertical shaft 126. The wheel 140 has a cut-out 142 at one particular position. The mechanism 108 further comprises a lever 144 mounted on a pivot 146 which has a protuberance 147 for engaging in the cut-out 142 and a cam follower 148 for engaging a cam piece 150 at the end of the rack 134 on With reference to FIGS. 10 to 12, the alternative twisting unit shown is identical to the one previously discussed except for the manner in which the pulley 124 is driven and brought to a stop in a particular angular position.

Underneath a housing 100 at the rear is mounted a variable speed d.c. motor 200 which is connected through electric cables to a power supply and which is arranged to drive a pulley 120. The pulley 120 is connected to the pulley 124 by a toothed belt 122. On top of the pulley 120 is mounted a cam disc 202 for conjoint rotation which has a recess 204 in that position where the recess 114 is directed towards the front of the housing 100 and aligned with the recess 110. Mounted on the housing 100 is also air cylinder 206 which controls a rod 208 on the tip of which is mounted a roller 210. Actuation of the air cylinder enables the roller 210 to be pressed against the disc 202 and at the appropriate moment into the recess 204. The rod 208 is held against sideways movement and has a trigger 212 to actuate a pair of switches fixed to the housing 100 (not shown) to indicate that the rod 208 has reached either of its extended or the retracted position. one side of the pivot 146 and an extension 152 for operating a microswitch 154 on the other side of the pivot 146. The lever is urged towards the wheel 140 by a spring 156. The housing 100 is formed with a central recess 158 in which is mounted a roller 160.

With reference to FIGS. 10 to 12, the alternative twisting unit shown is identical to the one previously discussed except for the manner in which the pulley 124 is driven and brought to a stop in a particular angular position.

Underneath a housing 100 at the rear is mounted a variable speed d.c. motor 200 which is connected through electric cables to a power supply and which is arranged to drive a pulley 120. The pulley 120 is connected to the pulley 124 by a toothed belt 122. On top

of the pulley **120** is mounted a cam disc **202** for conjoint rotation which has a recess **204** in that position where the recess **114** is directed towards the front of the housing **100** and aligned with the recess **110.** Mounted on the housing **100** is also an air cylinder **206** which controls a rod **208** on the tip of which is mounted a roller **210.** Actuation of the air cylinder enables the roller **210** to be pressed against the disc **202** and at the appropriate moment into the recess **204.** The rod **208** is held against sideways movement and has a trigger **212** to actuate a pair of switches fixed to the housing **100** (not shown) to indicate that the rod **208** has reached either of its extended or the retracted position.

Drive Arrangement

The drive train **40** (see also FIG. **6**) comprises the index gear **42** which can be coupled to the drive shaft **24** by operation of the clutch **46,** a change gear **170** comprising a number of spur gears one of which, **170,** is mounted on a swing block **172,** which mesh with the index gear **42** on one sied and with a drive gear **174** on the other side. The drive gear **174** has a shaft mounted in the plate **14** which is joined to a bevel gear **176** at a position underneath the wire folding unit **16.** The bevel gear **176** meshes with a further bevel gear **178** which has a wheel **180** which drives the belt **74** passing around the wheel **72** of the wire folding unit. The drive train **40** thus can rotate the hub **62.** It is stopped in a predetermined position by the brake **48** which clamps the index gear **42** in position when the arms **66** are substantially vertical.

The drive train **36** comprises a gear **190** which is mounted on the shaft **24** and can be coupled thereto by the clutch **44.** The gear **190** meshes with further gears **192** to rotate the programming cam **38.** On the mounting plate **32** is also fixed a lever **194** which has a cam follower **196** engaging the cam **138** and an arm **198** extending upwards into the central recess **158** of the twisting unit **18** to engage the roller **160.** Rotation of the cam **38** will thus cause the twisting unit **18** to be moved on the guide bars **102** to and fro in conjunction with springs through the aperture **64** in the wire folding unit **16.** Mounted on the cam **38** are a number of microswitch actuators **200** to engage stationary microswitches **206** on rotation of the cam **38.**

Adjustment

Before using the skeining attachment, it is first adapted by selection of an appropriate set of change gears to the sixe of the bobbin concerned and by adjusting the rings **76** to the length of skeined leads desired. Also an insert **118** is selected and is mounted in the cutout **116** which has a recess of a width slightly greater than the diameter of the wire.

Operation

When on the continuous bobbin winding machine described previously it is desired to commence the skeining operation the skeining attachment is moved by the actuating arm and the guide bars supporting the attachment into a position where the index gear **42** meshes with the gear secured to the spindle of the winding unit and is kept in this position while the table continues to rotate. The spindle is then unlocked and the wire from the feeder above the table passes on one side of the upper pick-up pin **82** and on the other side of the lower pick-up pin **82.** The motor **20,** which is permanently switched on, is then caused to rotate the hub **62,** the arms **66** and thereby the pick-up pins **82** (see FIG. **9**) through the drive chain **40** by actuating the clutch **46.** The wire is pulled off the feeder at the top and the index gear **42** causes the spindle to be turned in reverse so as to pay back some of the wire already wound on it. Rotation of the hub **62** is stopped, by engagement of one of the microswitches **68** with the switch actuator plate **70** to release the clutch **46.** The brake **48** is actuated to lock the index gear **42** and thereby the hub **62** shortly afterwards by engagement of the other microswitch **68.** In the locked position the arms **66** are substantially vertical. A timing device enables these switches to become active before **1** rotations has been completed. Thus (see FIG. **9**) the wire is folded to provide **5** strands extending vertically between the pick-up pins **82.** Using an additional set of microswitches or an additional switch actuator plate in combination with a time switch it is possible to control and select the number of rotations of the arms **66** to within one half of a rotation. Thus if the arms **66** are rotated for 180° a skein of three wire strands is obtained. It is also possible to rotate the arms more than once to give skeins with **7** or **9** strands.

As soon as the brake **48** is actuated the clutch **44** is engaged causing the gears **190** and **192** to rotate the cam **38.** The cam **38** and the springs connecting the twisting unit housing **100** and the bracket **60** in conjunction pivot the lever **194** so that the arm **198** is tipped forward allowing the housing **100** to move forward though the aperture **64** to reach the position shown in FIG. **2.** When moving forward the strands of wire enter the recess **110** in the housing and then pass into the recess **114** in the twisting gear **104** to reach the portion of the recess **114** in the insert **118.**

The recesses **110** and **114** are kept aligned in the first construction described during their forward movement to receive the strands of wire by the engagement of the protuberance **147** in the cut-out **142,** whilst the rack **134** is held in a forward position by the air cylinder **132.** The rack **134** is withdrawn which causes the gear **136** to turn idly until the cam piece **150** engages the cam follower **148** on the lever **144** so as to disengage the protuberance **147** from the cut-out **142.** Subsequently the drive **106** for the twisting unit **18** is actuated by operation of one of the microswitches **206.** The flexible drive shaft **119** starts rotating and causes the twisting gear **104** to be turned through the pulley **120,** the V-belt **122,** the pulley **124,** the shaft **126,** the drive gear **128** and the idler gears **130.** The presence of two idler gears ensures that the drive is transmitted constantly in spite of the recess **114** in the twisting gear **104.** This is because when one of the idler gears is opposite the recess **114,** the other is still in meshing engagement. The rotation of the twisting gear **104** causes the wire strands extending between the pick-up pins **82** to be twisted together. After the required amount of twisting the drive **106** is cut off through a time delay switch. The tension which arises on twisting is absorbed by the springs **78** on the arms **66.**

When the drive is cut off the air cylinder **132** is actuated to push the rack **134** forward again rotating the wheel **140** through the gear **136** and one way clutch **138.** The forward movement of the rack **134** also causes the cam follower **148** to be disconnected from the cam piece **150** on the rack allowing the springs **156**

to pull the protuberance **147** against the wheel **140.** Rotation of the wheel **140** causes the twisting gear **104** to be rotated through the one-way clutch **138,** the shaft **126,** drive gear **128** and idler gears **130.** The forward movement of the rack **134** continues until the protuberance **134** engages in the cut-out **142** in the wheel **140.** A pivoting movement of the lever **144** results, which disengages the extension **150** from the microswitch **154** so that the air-cylinder is arrested. Thus the wheel **140** is stopped at a particular position which corresponds to the alignment between the recess **114** in the twisting gear **104** and the recess **110** in the housing **100** necessary to allow the twisted wire strands, hereinafter called the skein, to be released.

In the second form of the twisting unit described (see FIGS. **10** to **12**) the recesses **110** and **114** are kept aligned by the engagement of the roller **210** in the recess **204.** The rod **200** is then withdrawn until the trigger **212** actuates the foremost microswitch (not shown) to indicate that the roller **210** is clear of the cam disc **202.** Then the d.c. motor **200** is switched on to rotate the pulley **120** and thereby the twisting gear **104.** The duration of rotation is determined by a time switch which at the end of the period required for twisting, switches the d.c. motor to a slow speed. The air cylinder **206** simultaneously pushes the rod **208** out. When the roller **210** enters the recess **204,** the trigger **212** actuates the rearmost microswitch (not shown) and causes the d.c. motor to stop the pulley **120** in that position.

On completion of the alignment of the recesses **110** and **114,** the the housing **100** is caused to be retracted by further rotation of the cam **38.** When the housing is retracted completely the finger actuators **112** on the housing **100** engage the lateral pins **90** on the ejector fingers **86.** The parts of the ejector fingers **86** with the recess are therefore moved forward. Thus the skein is pushed off the pick-up pins **82.** Continued rotation of the cam **38** moves the housing **100** slightly forward and then a further switch **206** causes the clutch **44** to be disconnected from the drive shaft **24.** In this position the attachment is ready for a subsequent operation.

The attachment is now moved outward by the arm which connects it to the table and is returned by rotation of the guides to pick-up a subsequent winding unit to repeat the operation.

The skein previously prepared is then further processed to complete the manufacture of the bobbin as previously described.

The folding unit enables a folded wire skein to be formed very quickly by a compact arrangement. The associated twisting unit imparts twist simultaneously on the portion of the skein above and below the twisting gear **104,** thus providing a quick twisting action before the skein has been severed from the wire supplied from the feeder.

I claim:

1. Apparatus for forming skeins of interlocked wire comprising:

a pair of projections, a mounting supporting the projections and first drive means for rotating the mounting to fold a wire passing between the projections; and

an element defining a substantially radially extending recess, a housing supporting the element, second drive means mounted on the housing for rotating the element; and

a frame supporting the said mounting and said housing and third drive means mounted on the frame for reciprocating the said housing with respect to the said mounting to enable the element to straddle the folded wire and twist it by rotation.

2. Apparatus as claimed in claim **1** in which the mounting comprises a hub having a central aperture and a pair of arms radiating in opposite directions from the hub to which the projections are secured; the frame comprises a member supporting the hub and at least two guide bars; and the housing is slidably mounted on the guide bars to reciprocate through the central aperture in the hub.

3. Apparatus as claimed in claim **2** which further comprises a pair of levers having one end straddling the projections, the other end extending towards the centre of the mounting and pivoted intermediate the ends on the hub, one lever being associated with each of the projections and means mounted on the housing to engage the centrally extending ends of the levers on withdrawal of the housing to thereby eject the ends of the skein of interlocked wire from the projections.

4. Apparatus as claimed in claim **1** in which the mounting comprises abutments, one abutments on each side of both projections and the projections are urged radially outward towards one of the abutments by springs.

5. Apparatus as claimed in claim **4** in which the abutments are securable in a number of positions with respect to the mounting whereby the length of the skein is adjusted.

6. Apparatus as claimed in claim **1** in which the element comprises a gear disc having a radial slot and a removable insert keyed into the gear disc having a cut-out continuous with the radial slot to define the recess.

7. Apparatus as claimed in claim **6** in which the second drive means comprise a drive gear and a pair of idler gears in meshing engagement with the drive gear and the gear disc and spaced circumferentially.

8. Apparatus as claimed in claim **1** in which the housing is formed with a converging slot and means are provided to arrest the element only when the recess and slot are aligned.

9. Apparatus as claimed in claim **1** in which the first and third drive means comprise a first electric motor mounted on the frame; a main shaft rotatably journalled in the frame and drivable by the first motor, a first drive train for rotating the mounting and a first clutch mounted on the main shaft for selectively interconnecting the main shaft and the first drive train;

a second drive train for rotating a cam, a second clutch mounted on the main shaft for selectively interconnecting the second drive train and the main shaft, and a lever mounted on the frame and engaging at one end the cam and at the other end the housing for reciprocating the housing; and in which the second drive means comprise a second electric motor drivingly connected to the element.

10. Apparatus as claimed in claim **9** in which an index gear is mounted on the frame rotatable independently of the main shaft but controllable by the first clutch to rotate with said main shaft and a brake is provided to arrest the index gear in a predetermined angular position.

11. Coil winding machine comprising a rotatable table and wire feeding and coil winding units rotatable

conjointly with the table; and a wire skeining apparatus having a pair of projections, a mounting supporting the projections and first drive means for rotating the mounting to fold a wire passing between the projections; an element defining a substantially radially extending recess, a housing supporting the element, second drive means mounted on the housing for rotating the element; and a frame supporting the said mounting and said housing and third drive means mounted on the frame for reciprocating the said housing with respect to the said mounting to enable the element to straddle the folded wire and twist it by rotation, movable radially and circumferentially with respect to the table to traverse with the winding units during skeining operations.

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