May 31, 1955 K. C. BUGG 2,709,400

TUBE WINDING MACHINE

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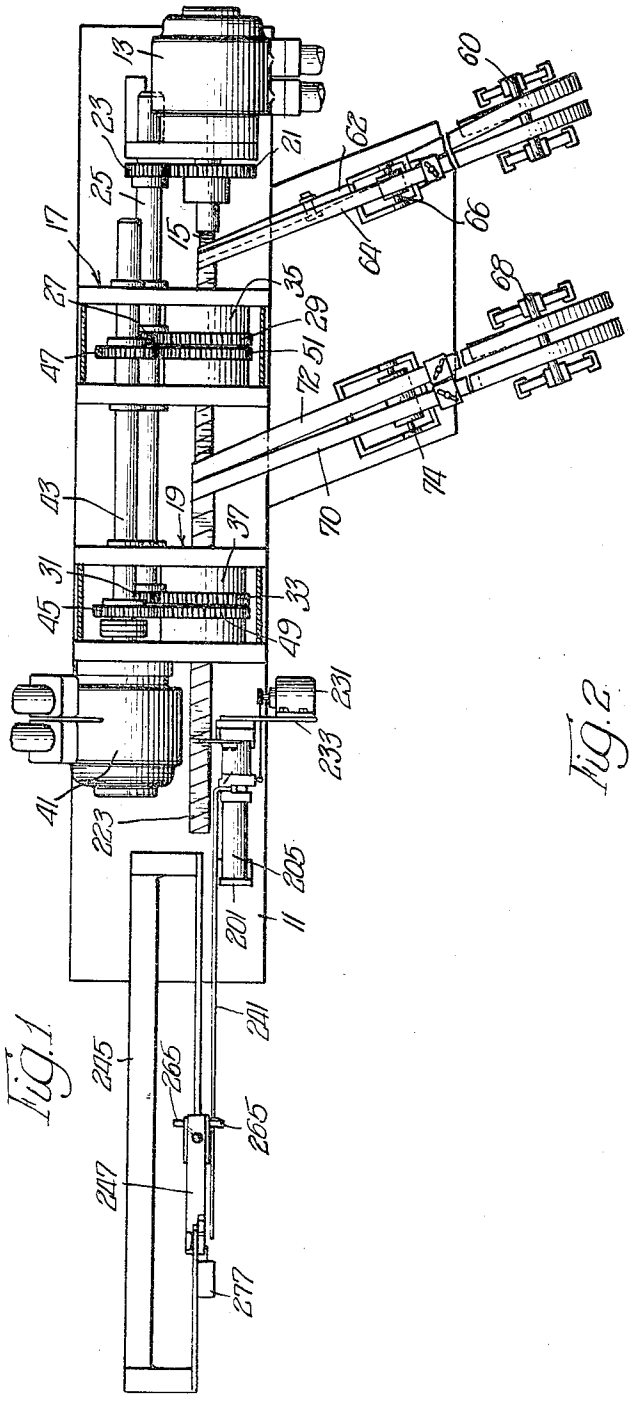


Fig. 1

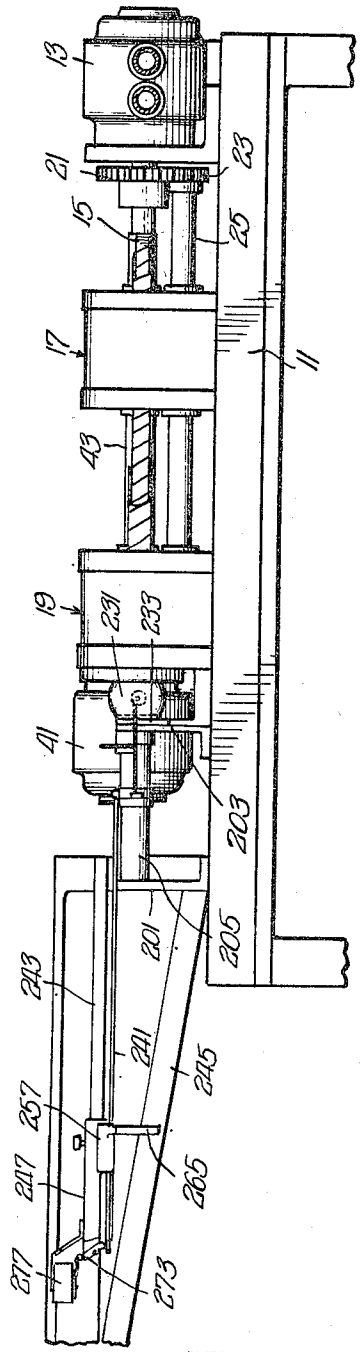


Fig. 2

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TUBE WINDING MACHINE

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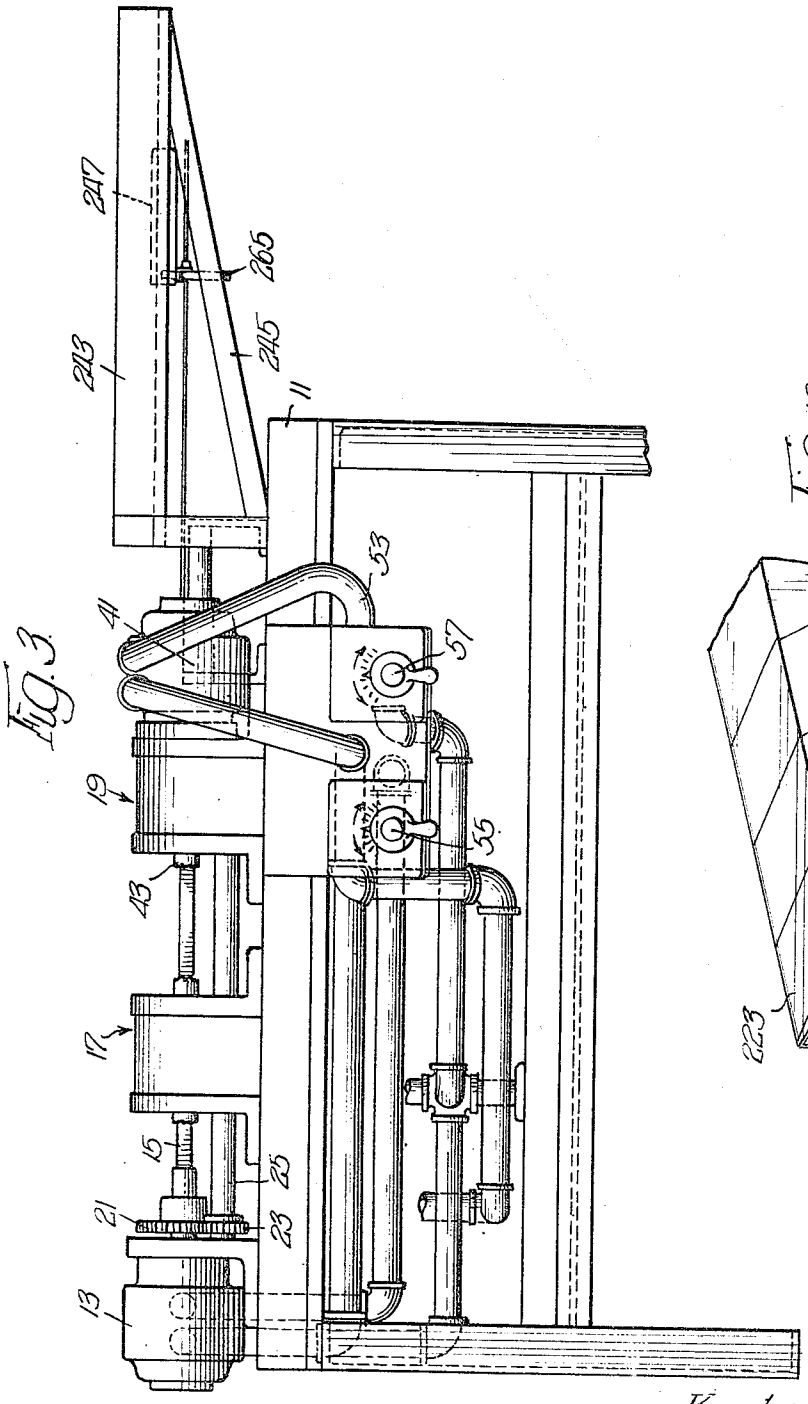


Fig. 3.

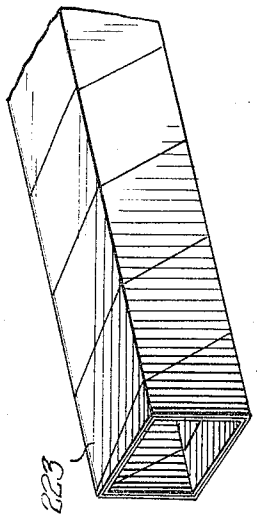


Fig. 13.

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TUBE WINDING MACHINE

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Fig. 4

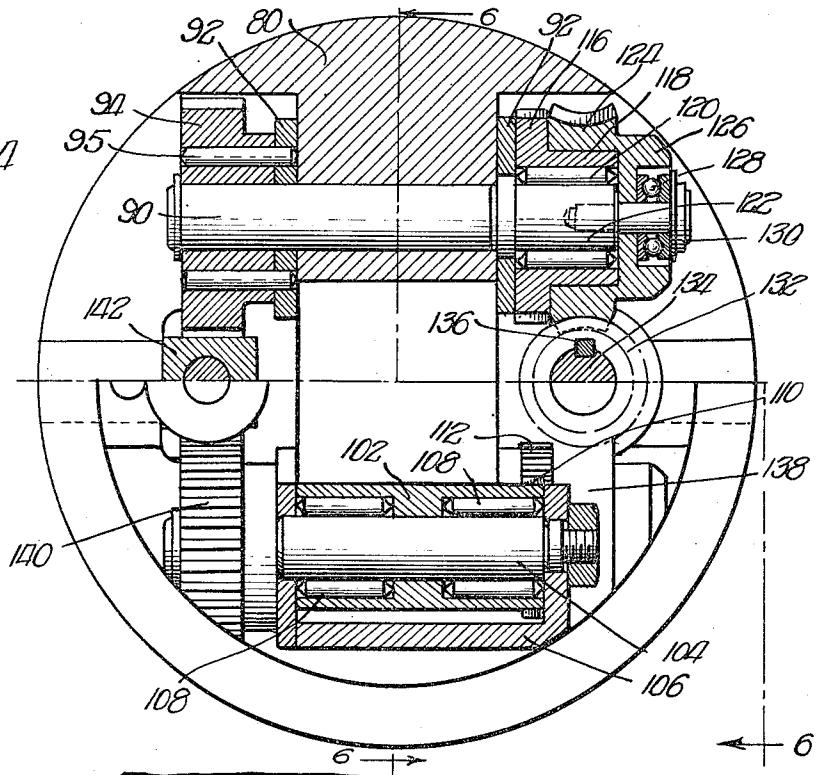
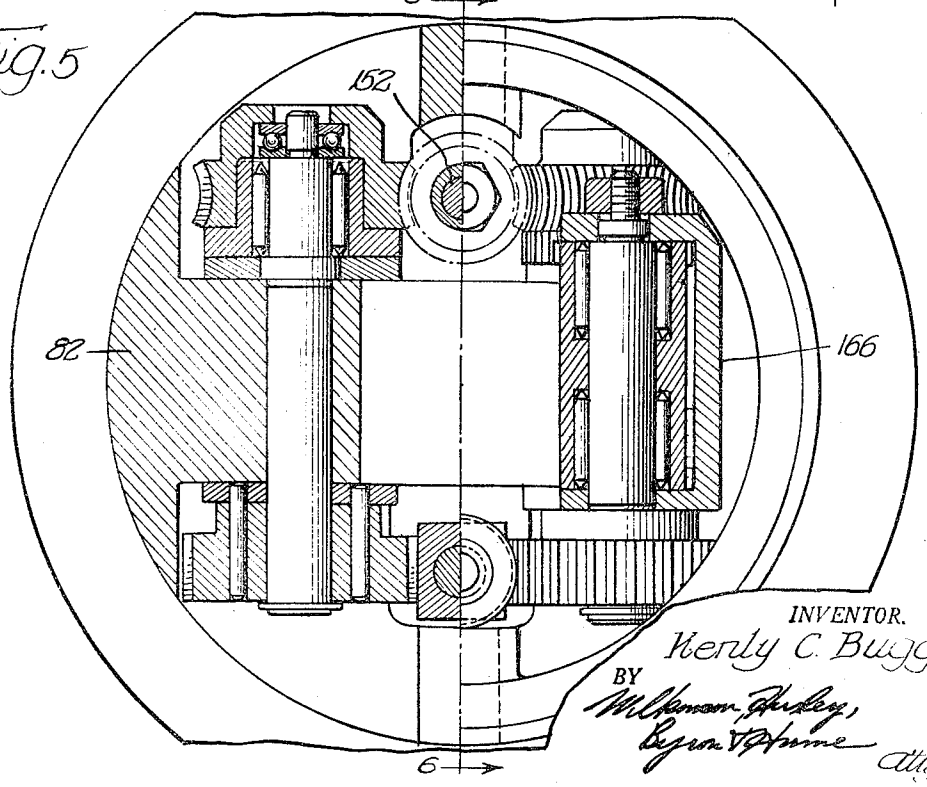


Fig. 5



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TUBE WINDING MACHINE

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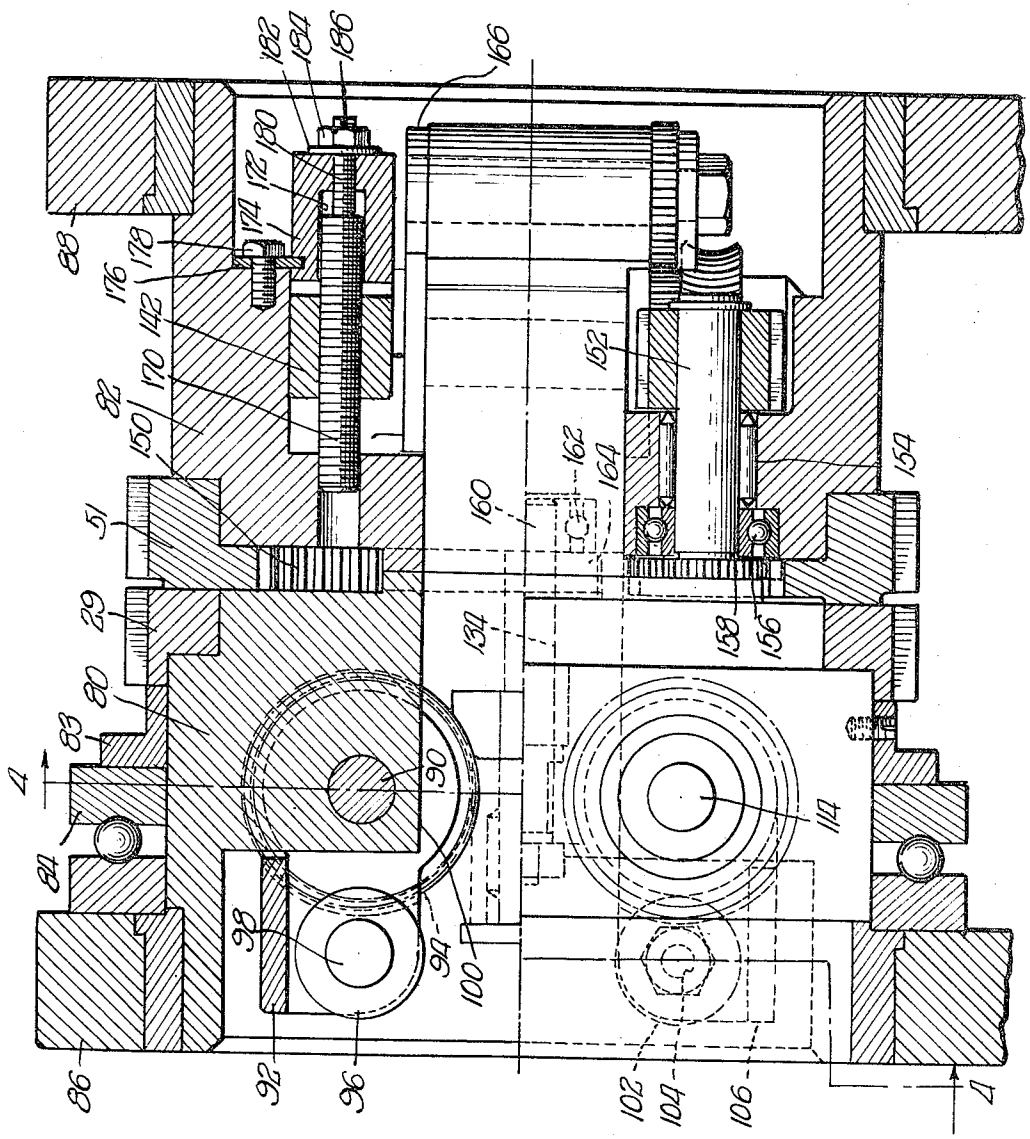


Fig. 6

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TUBE WINDING MACHINE

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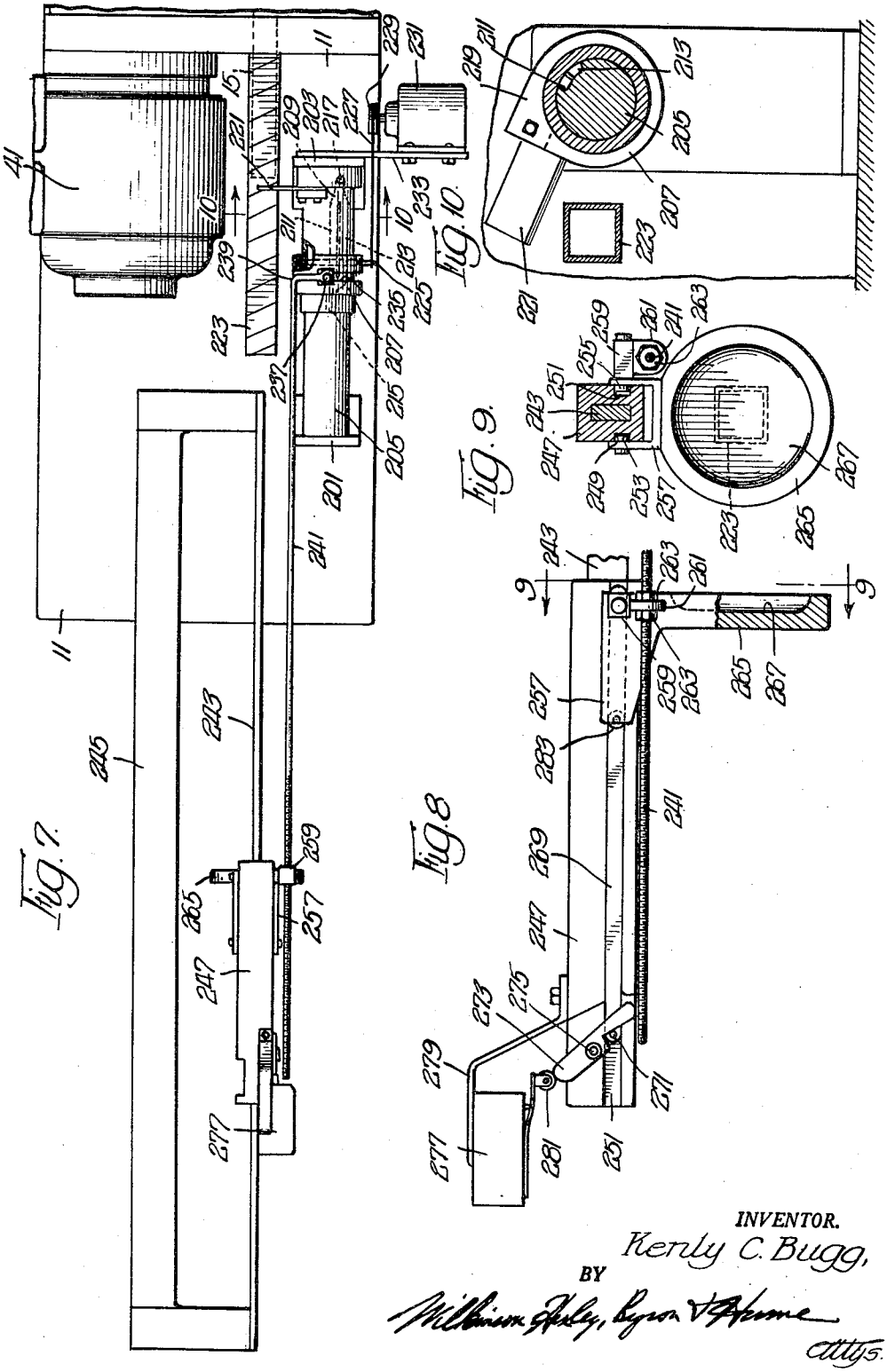


Fig. 7.

Fig. 8

Fig. 9.

Fig. 10.

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TUBE WINDING MACHINE

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Fig. 12.

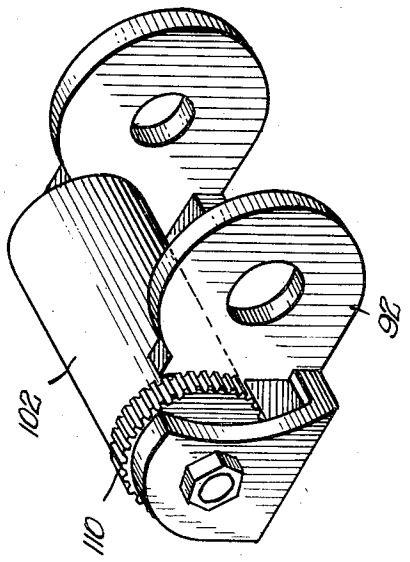
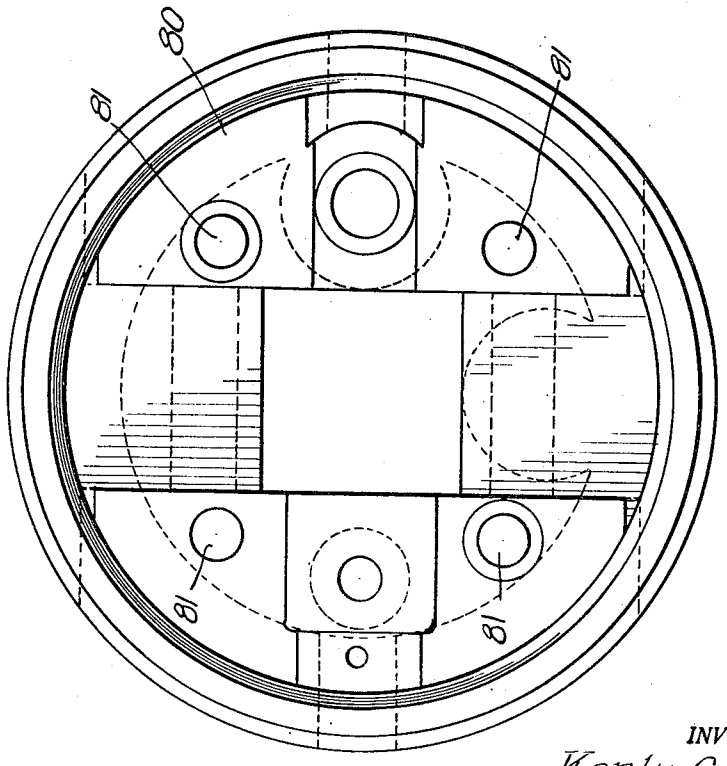


Fig. 11.



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2,709,400

TUBE WINDING MACHINES

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Application October 22, 1952, Serial No. 316,270

2 Claims. (Cl. 93—80)

This invention relates to a new and improved machine for winding tubing in shapes having a plurality of flat sides. The machine has been shown as adapted for winding tubes of rectangular cross section, but it may be modified for use with tubes of different numbers of flat sides or faces. With suitably shaped rollers, it may be used with various shapes of tubes.

The machine is particularly adapted for winding tubes comprising a plurality of layers of paper but it is obvious that it is equally useful for winding tubes from other flexible materials such, for example, as fabric and plastics.

The machine is designed to form continuous tubing which may be cut to desired lengths. Mechanism is provided for cutting the tubing into short lengths automatically without interruption of the formation of the tubing. The tubing may be formed from any desired number of tapes which may be overlapped or superposed to form tube walls of the required thickness or strength. Means are provided for rolling the superposed or overlapped tapes into intimate contact to assure perfect adhesion therebetween and to pull the formed tubing from the mandrel.

It is an object of the present invention to provide a new and improved tube winding machine.

It is a further object to provide a machine adapted to form a tube having uniform and compact walls and accurately sized and shaped.

It is an additional object to provide a machine adapted to operate over a substantial range of tubing size and wall thickness.

It is another object to provide a machine providing continuous tubing with means for automatically cutting the tubing into short tubes of a desired length.

It is also an object to provide a substantial and efficient machine adapted for commercial production and use.

Other and further objects will appear as the description proceeds.

Figure 1 is a plan view of the tube winding machine;

Figure 2 is an elevation of the rear side of the machine, the tape feeding apparatus being omitted;

Figure 3 is a front elevation of the machine;

Figure 4 is a vertical section of the forward portion of a pull-off head taken on line 4—4 of Figure 6;

Figure 5 is a transverse section of the rear portion of a pull-off head taken on a line similar to 4—4 of Figure 6, but on transverse planes;

Figure 6 is a vertical longitudinal section of a complete pull-off head including the forward portion taken on line 6—6 of Figure 4 and the rear portion taken on line 6—6 of Figure 5;

Figure 7 is a plan view of the discharge end of the machine, on an enlarged scale, showing the cut-off and cut-off control mechanism;

Figure 8 is an elevation, on an enlarged scale, of the cut-off control mechanism at the left of Figure 7;

Figure 9 is a section taken on line 9—9 of Figure 8;

Figure 10 is a section taken on line 10—10 of Figure 7;

Figure 11 is an end view of a pull-off head with the rollers and working mechanism omitted;

Figure 12 is a perspective view of a pull-off roller and its supporting bracket; and

Figure 13 is a perspective view of a portion of tube as wound by the machine.

As shown in the drawings, the machine for winding tubes is mounted on a table or platform 11. It comprises a drive motor 13 which directly drives a mandrel 15 upon which the tubes are wrapped and formed. This mandrel 15 passes through a pull-off head 17 and on through a second pull-off head 19. The pull-off heads are shown in Figure 1 with their covers cut away. The motor 13 also directly drives a gear 21 which meshes with a smaller gear 23 on a jack shaft 25. This jack shaft carries a gear 27 meshing with a gear 29 in pull-off head 17 and a gear 31 identical with gear 27 meshing with a gear 33 on pull-off head 19. It is to be noted that the gears 27 and 31 are identical with gear 23, while the gears 33 and 29 are identical with gear 21 so that the forward portions 35 and 37, respectively, of pull-off heads 17 and 19 are positively driven in exact synchronism with the mandrel 15.

A second motor 41 is provided with driving shaft 43, which shaft is provided with gears 45 and 47 meshing with gears 49 and 51, respectively, located on the rear portions of pull-off heads 17 and 19.

The drive motors 13 and 41 are shown as hydraulic motors, fluid driven through the piping system indicated generally at 53 on Figure 3. The flow of driving fluid to motor 13 is controlled by a valve indicated at 55, while the valve 57 similarly controls motor 41. Hydraulic drive motors have been chosen for the reason that they are capable of exceedingly accurate control as to speed. Such a speed control is highly important in operation of the apparatus as will be brought out in the description of the pull-off heads and their operation.

As shown in Figure 1, means for holding rolls of tape are indicated at 60, these feeding the tapes 62 and 64 to the mandrel 15 between the motor 13 and the pull-off head 17. The lower tape 62 is fed directly to the mandrel and the tape 64 is wound on tape 62 with the joints between the turns of tapes staggered as shown in the drawing. Adhesive is applied to the underside of the tape 64 by the adhesive applying mechanism 66. Tapes may be used having dry adhesive already applied and the mechanism may be used to moisten such tapes. In the form of construction shown, a second tape roll supporting mechanism 68 is provided feeding tapes 70 and 72 to be wound about tape 64 on mandrel 15 at a point located between pull-off head 17 and pull-off head 19. The undersides of both tapes 70 and 72 are provided with adhesive or moistened by the applicator 74. The particular construction of these tape feeding rolls and adhesive applicators or moisteners forms no part of the present invention.

The construction of the pull-off heads 17 and 19 is shown in detail in Figures 4, 5 and 6. It will be understood that these two heads are identical in construction. Referring first to Figure 6, the pull-off head comprises a forward portion 80 and a rearward portion 82. The construction shown is especially adapted for use in forming rectangular tubes and each of the sections 80 and 82 carries a pair of tube rolling and feeding rollers adapted to engage opposite sides of the rectangle. It will be understood that the construction shown may be used with tubes of any shape having opposed flat faces, as for example, octagonal tubes. In such a case each pull-off head would contact four of the surfaces. It will also be apparent that the construction shown may be readily modified for operation with tubes having a range of flat surfaces and with rollers of suitable shape would operate with cylindrical tubes.

The forward portion 80 carries the gear ring 29 which is secured directly to the body of the portion 80 and rotates therewith. A circular angle flange 83 is secured to the portion 80 and bears against a thrust bearing 84 which engages the bracket 86 supporting the rear end of the rotating part 80. The part 82 rotates in a bracket 88 similar to bracket 86. It will be apparent from the method of operation described hereafter, however, the thrust is toward the bracket 86 and no thrust bearing is needed relative to bracket 88 as there is no axial thrust in that direction. The two parts 80 and 82 are secured together by the pins 81 as shown in Figure 11.

The upper portion of the part 80 carries a support shaft 90 upon which is fitted a roll carrying bracket 92. By reference to Figure 4 it will be apparent that the shaft 90 also carries a bracket adjustment gear 94 which is secured to bracket 92 by means of pins 95. Rotation of gear 94 for an arcuate distance will raise or lower the roller 96 carried on shaft 98, which shaft is also supported in the bracket 92 at a point spaced from the support shaft 90. The upper and lower halves of part 80, as seen in Figure 6, are identical but reversed since they carry identical rollers which engage opposite faces of a tube on the mandrel which passes through the central opening 100 in the part 80.

The section of Figure 4, as indicated by the broken line in Figure 6, is taken in its lower half through the lower roller 102 and the lower shaft 104 which are identical with roller 96 and shaft 98. These are carried in bracket 106 which is similar to bracket 92 but reversed from side to side. From a consideration of the lower portion of Figure 4, it is seen that the pull-off roller 102 is supported upon shaft 104 by means of the roller bearings 108 so that the roller is free to rotate upon the shaft. The roller 102 carries the gear 110 at its right end as seen in Figure 4. This gear 110 meshes with a gear 112 carried on shaft 114, which shaft is shown in Figure 6. The construction at this point is identical with that shown in the upper half of Figure 4 since shaft 114 is identical with shaft 90 and carries the same gear and bearing assembly.

As shown in Figure 4, the shaft 90 carries the gear 116 identical with gear 112 in the lower portion of Figure 4. This gear 116 has a shouldered sleeve and bearing portion 118 and is supported on the needle bearings 120 which are carried on the projecting end 122 of shaft 90. The worm driven gear 124 has a portion fitting on the shoulder 118 of gear 116 and is keyed to that gear. Gear 124 has a central boss 126 recessed to receive a thrust bearing 128 and is held in place on shaft end 122 by means of the flat-headed screw 130 which engages the outer face of thrust bearing 128. The worm driven gear 124 meshes with a worm drive gear 132 which is secured to shaft 134 by the key 136. As will be apparent from Figure 4, the worm drive gear 132 also meshes with a worm driven gear 138 which is identical with gear 124 and is carried on a projecting end of the lower shaft 114, shown in Figure 6, which is identical with the shaft 90.

Considering the left side of Figure 4, a gear 140 is secured to the bracket 106 in the same manner as the gear 94 is secured to bracket 92. The gears 94 and 140 mesh with identical racks formed on opposite faces of a linearly movable member 142. Movement of the member 142 in either direction serves to rotate the brackets 92 and 106 an identical amount in the same direction. Thus the rollers 96 and 102 may be accurately adjusted to properly engage the tube on the mandrel passing between the rollers. This adjustment is adequate not only to insure proper pressure, but also to adjust the apparatus shown for use over a substantial range of mandrel and tube sizes. For example, one construction, such as shown, may be adjusted over a range adequate to wind tubes running from ½ inch to 1½ inches. It is apparent that an upward or downward movement of two rollers of ½ an inch would be adequate for such a size variation.

The roller and drive construction of the rear parts 82, shown in Figures 5 and 6, is in most respects identical with that described in connection with the forward part 80. The drive of the pull-off rollers of both parts, however, is provided through the part 82. The drive ring 51 is not keyed to the part 82, but is rotatable relative to that part and relative to ring 29. This ring 51 is provided with an internal circular gear 150. The drive shaft 152 for the rollers of the part 82 is carried in needle bearings 154 and ball bearing assembly 156 and carries at its end a gear 158 which meshes with the inner ring gear 150 on the gear ring 51. As shown in broken lines at 160 on Figure 6, the end of the roller drive shaft 134 of the forward end 80, which also appears in Figure 4, is supported in the ball bearing 162 and is provided with a gear 164 meshing with the internal ring gear 150 of the gear ring 51. Thus rotation of the ring gear 51 serves through shaft 160 to rotate rollers 96 and 102 in the forward part 80 and also to rotate the lower roller carried in bracket 166 and the similar upper roller in the part 82. All four rollers are therefore driven at a uniform speed. This speed is determined, however, by the speed of rotation of the ring gear 51 relative to parts 80 and 82 and is independent of the speed of rotation of the mandrel and of the two parts 80 and 82 of the rolling head which must rotate at the same speed as the mandrel.

The cut-off mechanism is shown generally in Figures 1 and 2, but is shown on a larger scale and in greater detail in Figures 7 to 10 inclusive. This mechanism includes a pair of brackets 201 and 203 mounted on the left end of the support table 11. These brackets 201 and 203 fixedly support a guide cylinder 205 on which is movable a slide assembly 207. As shown in Figures 7 and 10, the guide cylinder 205 is provided with a divided cam groove having an entrance end 209, an upper leg 211, a lower leg 213 and a return end 215. The slide 207 is provided with an inwardly extending lug 217 which rides in the cam groove. The slide 207 has a flange 219 to which is secured a cut-off knife 221. The end portion of the formed tube is indicated in these figures by reference character 223.

The slide 207 is provided with a radially extending lug 225 which is connected by the cord 227 to pulley 229 rotated by the motor 231. The motor 231 is shown as supported by an arm 233 secured to the bracket 203. The slide 207 is also provided with an arcuate slot 235 into which is fitted a radially inwardly extending pin 237 carried by an inwardly bent portion 239 of the pull rod 241. The elongated support bar 243 extends to the left from table 11, being provided with a rear diagonal brace 245 connected to its outer end. The guide block 247 is secured to the support bar 243 at any desired position depending upon the length of tube to be cut off.

As best shown in Figure 9, this guide bar 247 is provided with opposed grooves 249 and 251 into which fit rollers 253 and 255 carried by the traveler yoke portion 257. The yoke portion 257 has a laterally extending arm 259 with a depending ear 261 through which the pull rod 241 passes. The lock nuts 263 are threaded on the rod 241 and serve to adjust the spacing between the cut-off knife 221 and the traveler 257. The traveler 257 has a depending disc member 265 with a cup-shaped face 267 adapted to receive the end of the formed tube as indicated in broken lines in Figure 9. A bar 269, shown in Figure 8, extends in groove 251 beyond the traveler yoke 257 and carries a stud 271 adapted to engage the switch operating lever 273 which is pivotally mounted at 275 on the member 247. The switch 277 is carried by bracket 279 extending upwardly from member 247 and is provided with a roller 281 to be contacted by lever 273 in operating the switch. The position shown in Figure 8 is the "Off" position of the switch 277, which switch controls the circuit of the motor 231.

In the operation of the apparatus, the ends of tapes 62 and 64 are wrapped around the mandrel 15 as shown in Figure 1, after which the motors 13 and 41 are started

at slow speed. This rotation of mandrel 15 will continue to wrap the tapes around the mandrel, the initially wound section of tube being forced manually to the left, as seen in Figure 1, until the rollers in the first pull-off head assembly 17 engage the tube at which time the machine takes over and moves the tube rearwardly or to the left. When the initial layers of the formed tube pass the point where tapes 70 and 72 are fed, the machine may be stopped temporarily while the ends of these two tapes are secured to the partly formed tube, thereupon the machine may be put in full operation and the fully formed tube will pass on through the second pull-off head 19.

In the rolling heads, the four pull-off rollers, such as roller 102 of Figure 4, are adjusted to have the desired contact and pressure with the formed tube by moving the racks 142. The rack 142 is threaded on the screw 170 as shown in Figure 6, which screw extends into a recess 172 in the hex member 174. The hex member 174 is held in member 82 and against movement by the lug washer 176 secured in place by screw 178. The screw 170 has a smaller integral extension 180 threaded through the end of hex member 174. The extension 180 carries a washer 182 and lock nut 184 and its end is slotted at 186 so that it may be rotated by a screw driver to move the racks 142 in either direction.

With all the pull-off rollers, such as roller 102, exerting the desired contact pressure on the formed tube, it is further necessary to adjust their speed of rotation in conformity with the speed of rotation of the mandrel 15 and the size of that mandrel as well as the pitch at which the tapes are wound to form the tube. Since all of the rollers are positively driven by means of the inner gear 150 on the ring gear 51 the speed of rotation of the ring gear 51 relative to the pull-off head 80 and 82 serves as a control of the speed of movement of the formed tube along the mandrel. With the hydraulic motor 41 this speed may be very accurately controlled and coordinated with the speed of rotation of the motor 13 by the common control panel shown in Figure 3. It will be apparent that the pull off by rollers 102 is accomplished by rotating ring gear 51 at a speed different from that which the gear 29 is driven to rotate the entire pull-off head assembly.

As the formed end 223 of the tube passes to the left, in Figures 1 and 10, it finally engages the cup-shaped face 267 of member 265, best shown in Figures 8 and 9. The cut-off assembly operates easily and the tube is sufficiently rigid to move the member 265 to the left and to draw the pull rod 241 to the left. This pull rod 241 by means of pin 237 draws the knife slide 207 to the left. As it moves to the left, the lug 217 rides in the upper groove 211 and swings the knife downwardly as the slide 207 is rotated in the counterclockwise direction as seen in Figure 10. Since the tube 223 is being rapidly rotated, it is unnecessary to move the knife 221 across the full cross section of the tube. It need be rocked downwardly sufficiently only to cut through the actual windings of the tube itself as they are rotated against the knife. It will be apparent that during the cutting operation the slide 207 is drawn to the left, as seen in Figure 7, at exactly the same speed at which the tube advances. Consequently, a clean cut is made without any deformation of the cut edges.

During this movement to the left the switch 277 is "Off," as shown in Figure 8, so that motor 231 is not energized. Consequently cord 227 through pulley 229 merely freely rotates the motor armature. It will be understood that if desired, any known type of one way clutch may be interposed between pulley 229 and the armature of motor 231 so that the pulley may rotate freely without rotating the armature. When the traveler yoke 257 has moved to the left until the end 283 of that slide engages and moves the right lower portion

of the switch operating arm 273, the section of tubing will have just been completely severed and will drop downwardly by gravity and no longer thrust against the cup face 267. While the partially severed tube is still exerting pressure, the yoke end 283 thrusts the switch arm 273 to turn it in the clockwise direction as seen in Figure 8 which closes the switch 277.

At this time there will be no further pressure against the member 265 and the motor 231 being energized, the cord 227 will be wound around pulley 229 and will draw the slide 207 back to the right to its starting position. This will, of course, also by means of pull rod 241 restore the traveler yoke 257 and its connected parts to starting position. During the return movement the stud 217 drops down in the lower run 213 of the cam groove which tilts the knife 221 upwardly so that it clears the advancing tube end 223. As the cord 227 draws the slide 257 to its limit of movement to the right the member 271 engages the lower portion of switch operating arm 273 and restores it to the "Off" position shown in Figure 8. This opens the circuit to motor 231 as the stud 217 reaches the right end of the cam groove 209. The operation continues automatically as described to cut off the desired lengths of finished tubing. It will be apparent that by suitable design of the lengths of the support bar 243 and pull rod 241, the cut off lengths of tube may be varied within wide limits.

While certain preferred embodiments of the invention have been shown and described, these are to be understood to be illustrative only as the construction may be modified in accordance with varying conditions and requirements and I contemplate such modifications as come within the spirit and scope of the appended claims.

I claim:

1. In a tube winding machine, a mandrel, means for supplying tube forming tape to the mandrel, a pull-off head encircling the mandrel, a motor for rotating the mandrel and head synchronously, pull-off rollers in the head, a second variable speed motor for rotating the pull-off rollers independently of the rotation of the pull-off head, the pull-off rollers being in opposed pairs on opposite sides of the mandrel axis and an adjustable gear connection for jointly adjusting an opposed pair to vary the spacing between the rollers and the mandrel axis, the two rollers of an opposed pair being moved uniformly toward and away from said axis.

2. In a tube winding machine, a mandrel, means for supplying tube forming tape to the mandrel, a pull-off head encircling the mandrel, a motor for rotating the mandrel and head synchronously, pull-off rollers in the head, a second variable speed motor for rotating the pull-off rollers independently of the rotation of the pull-off head, pivoted brackets in the pull-off head, each bracket carrying a pull-off roller at a point spaced from the pivot axis of the bracket, the brackets and rollers being in opposed pairs on opposite sides of the mandrel axis and a common geared connection for jointly swinging an opposed pair of brackets about their pivots to vary the spacing between the rollers and the mandrel axis.

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