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APPARATUS FOR COILING CABLE AND THE LIKE

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Fig. 1

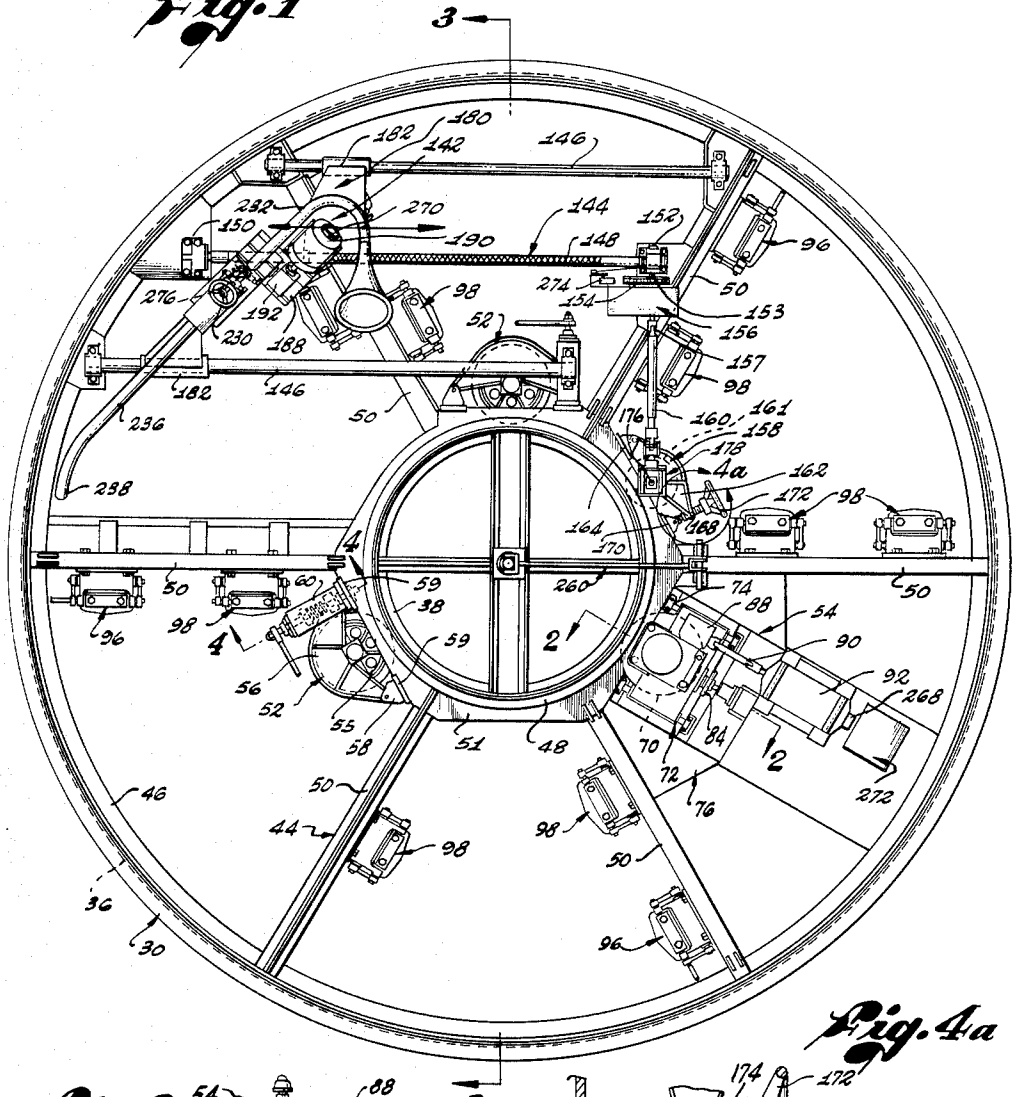


Fig. 4a

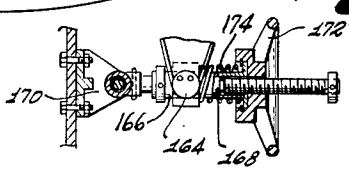
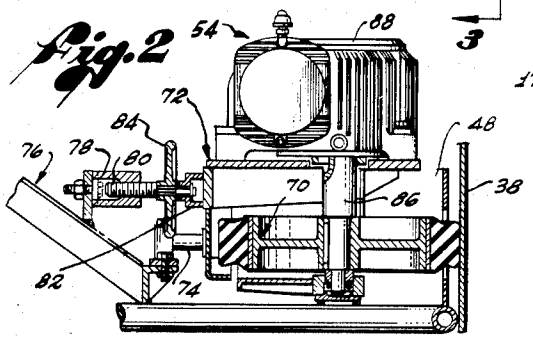


Fig. 2



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Fig. 3a

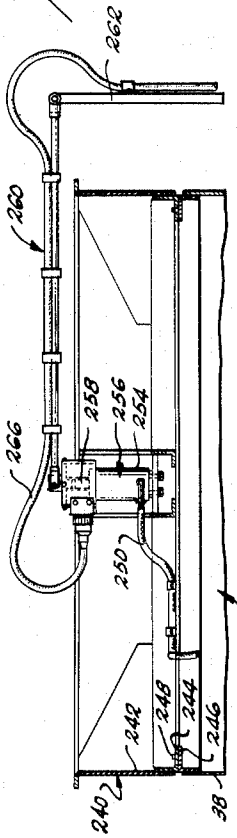


Fig. 3

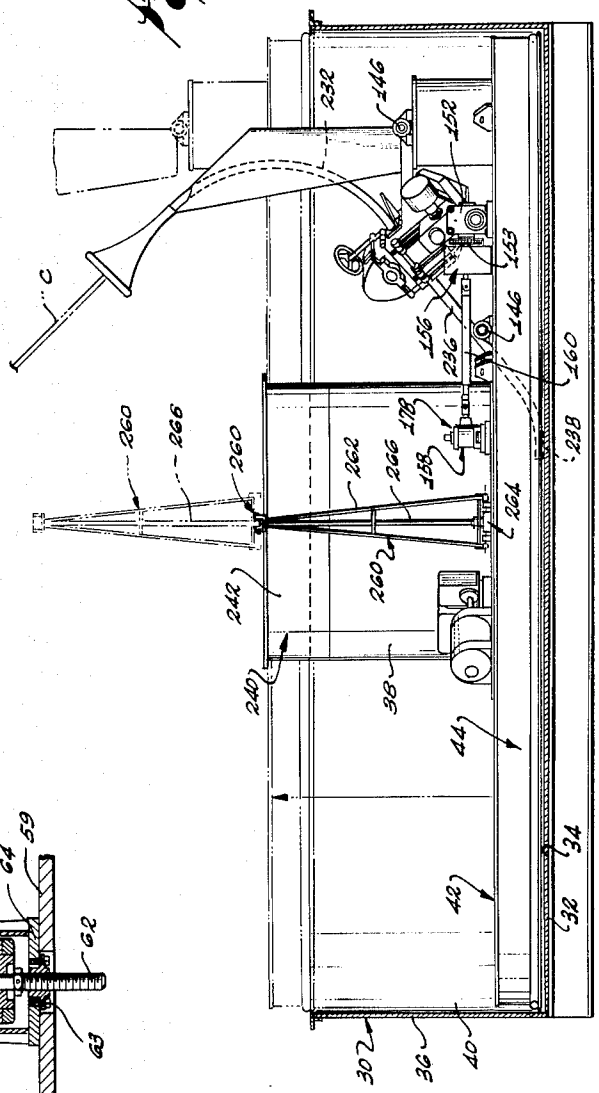
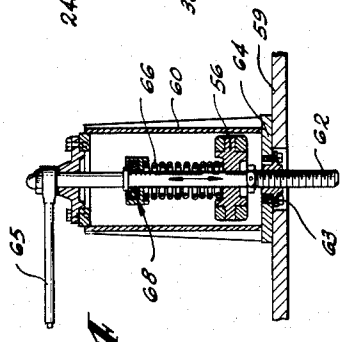


Fig. 4



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Fig. 6

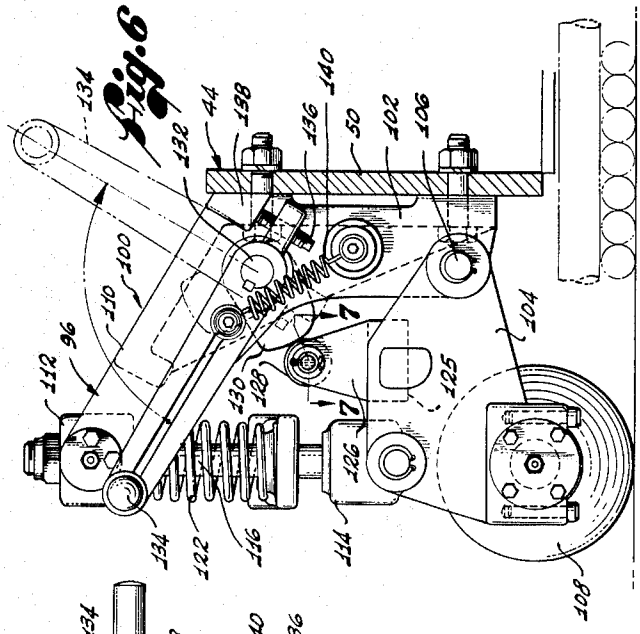


Fig. 7

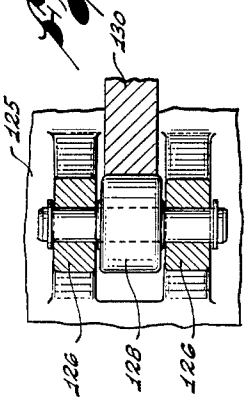


Fig. 5

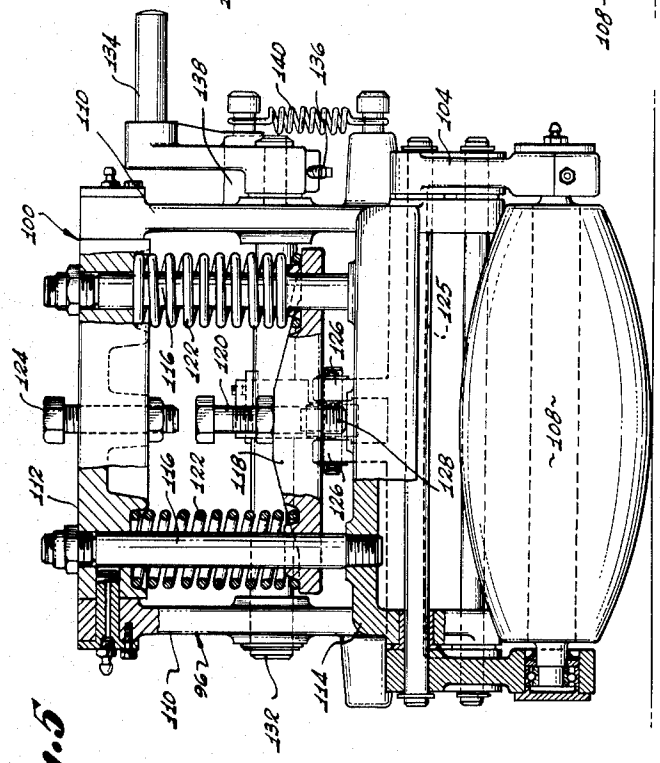
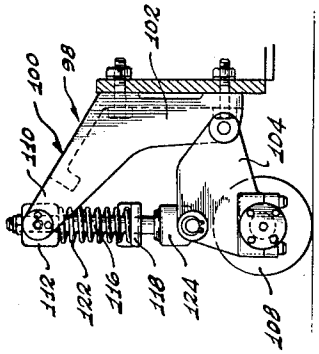


Fig. 8



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Fig. 9

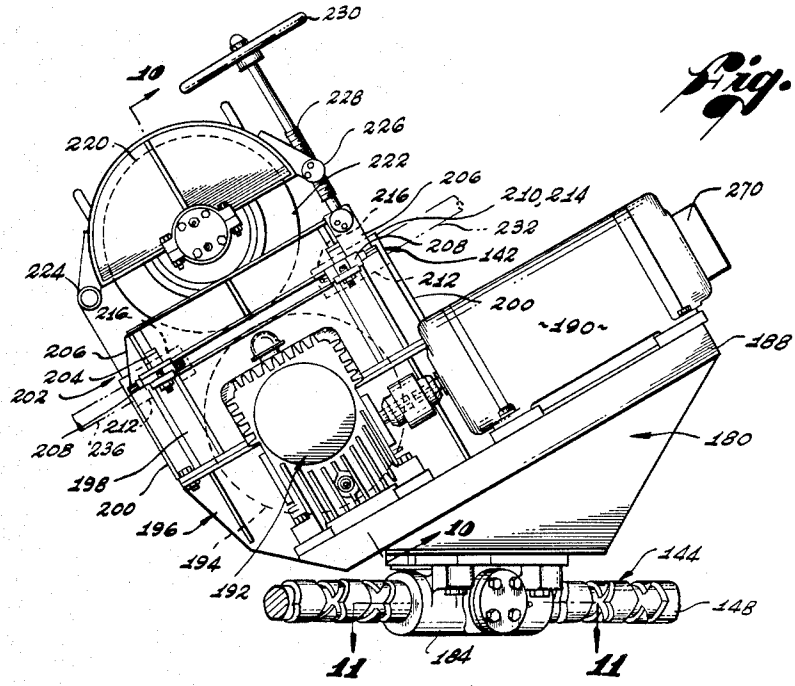


Fig. 10

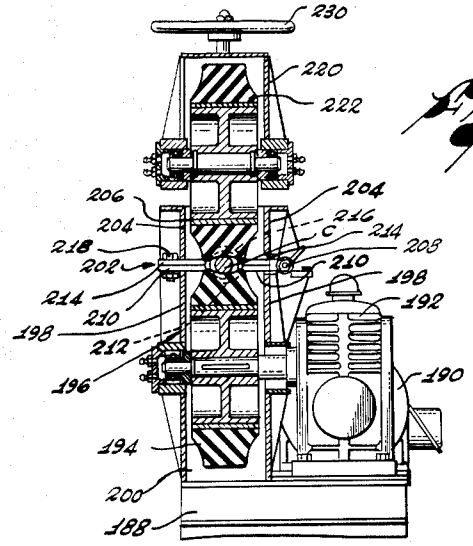
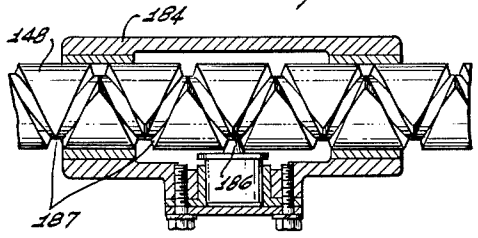


Fig. 11



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APPARATUS FOR COILING CABLE AND THE LIKE

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Filed Mar. 6, 1963, Ser. No. 263,159
17 Claims. (Cl. 242—54)

This invention relates generally to the art of winding cable into coils for convenience of handling, storage, and transportation. The invention relates more particularly to an improved machine for coiling cable.

It is common practice in the cable industry to store and transport long continuous lengths of cable in large storage or take-up tanks in which the cable is coiled, layer upon layer, to form a large cable coil contained or enclosed by the tank walls. Submarine telephone and telegraph cable, for example, is frequently stored on board cable-laying ships in this way. During the actual cable-laying operation, the cable is payed out along the ocean floor from the take-up tanks.

A primary application of the present invention is winding or coiling cable into large take-up tanks of the kind discussed above. For this reason, the invention is disclosed herein in connection with this particular application. It will become readily evident to those skilled in the art as the description proceeds, however, that the invention is capable of other uses and applications. Accordingly, it should be understood at the outset that the particular cable-coiling application with respect to which the invention is discussed in the ensuing description is intended to be purely illustrative and not limitative of the possible applications of the invention.

It should be further understood that the term "cable" is used in its broadest sense in the following description and claims. Thtat is to say, the term "cable" as used herein is intended to encompass all forms of cables or cable-like elements, such as hose, rope, wire, flexible pipe, tubing, and so forth.

This invention has as its general object, then, to provide a new and improved machine for coiling flexible cable.

Another object of the invention is to provide a cable-coiling machine in which each successive turn of cable is placed or coiled with great precision alongside the previous turn and with the proper tension or compression to create a very neat, compact, and uniform cable coil.

Yet another object of the invention is to provide a cable-coiling machine which can handle any length of cable within the limits of the cable take-up or storage facility.

A further object of the invention is to provide a cable-coiling machine wherein the cable is coiled by a rotating, vertically floating cable distributor which rides on the uppermost layer of the cable coil and acts as a "hold-down" for the upper turns of the coil.

Other objects, advantages, and features of the invention will present themselves to those skilled in the art as the description proceeds.

Briefly, the objects of the invention are attained by providing a cable-coiling machine equipped with a rotary, power driven cable distributor which turns about and is vertically movable along a vertical rotation axis. In operation of the coiling machine, this distributor is disposed over a horizontal supporting surface on which the cable is to be coiled. According to the illustrative embodiment of the invention, this surface is the bottom annular wall of a cable take-up tank of the kind mentioned earlier. Along the outer and inner circular edges of this bottom wall are the outer and inner cylindrical walls of the take-up tank. In this illustrative embodiment, the cable distributor has an annular frame which fits within the annular take-up tank interior and about the inner cylindrical tank wall and is driven in rotation by friction drive wheels engaging the latter wall. The entire distributor is free to move up and down along this inner tank wall.

Carried on the rotary cable distributor is a cable receiver and feeder including an inclined cable guide with an upper entrance portion above the distributor and a lower exit tip which opens to the underside of the distributor generally tangentially of and in a direction opposing the direction of rotation of the distributor. The cable to be coiled is threaded through the guide until its end protrudes beyond the exit tip of the guide and this end of the cable is secured in some way to the cable take-up facility. Also included in the cable receiver and feeder is a cable feeding mechanism for feeding the cable longitudinally through the cable guide as the distributor rotates.

Supporting the cable receiver and feeder is a reciprocating traverse mechanism on the cable distributor. This traverse mechanism reciprocates the cable receiver and feeder as the distributor rotates, in such manner that the exit tip of the cable guide moves back and forth along a substantially radial direction line of the distributor.

During operation of the coiling machine, the cable feed mechanism and the traverse mechanism are driven in unison with rotation of the cable distributor in such manner that the cable is wound in a series of spiral layers, one on top of the other, on the lower supporting surface of the cable take-up facility or tank. The direction of movement of the traverse mechanism reverses between each layer so that one layer of cable is wound from the outside toward the center of the cable coil and the next layer is wound from the center toward the outside of the coil.

The cable distributor rides on the uppermost layer of the coil, thereby serving as a holddown for the turns of the coil. The distributor thus rises as the number of layers increases. In the case of a take-up tank, a removable drum extension is placed on the top of the inner tank wall to receive the distributor during coiling of the final layers, thereby to permit the tank to be completely filled.

A highly important feature of the invention resides in the fact that the linear speed at which the cable is fed through the cable guide relative to the rotary speed of the distributor is automatically regulated at the end of each radial sroke of the cable guide exit tip to create a compression force in the cable when winding from the outside toward the center of the coil and a tension force when winding from the center toward the outside. In this way, a neat, highly compact, and uniformly wound cable coil is produced.

The invention will now be described in more detail by reference to the attached drawings, wherein:

FIG. 1 is a plan view of the present cable coiling machine, showing the latter in operative position within a cable take-up tank;

FIG. 2 is an enlarged section taken on line 2—2 in FIG. 1;

FIG. 3 is a section taken on line 3—3 in FIG. 1;

FIG. 3*a* is an enlarged vertical section through the upper end of the inner tank structure illustrated in FIG. 3;

FIG. 4 is an enlarged section taken on line 4—4 in FIG. 1;

FIG. 4*a* is an enlargement, partly in section, of the area encircled by the arrow 4*a* in FIG. 1;

FIG. 5 is an enlarged side elevation, partly in section, of one of the cable distributor supporting rollers illustrated in FIG. 1;

FIG. 6 is an end view of the roller structure illustrated in FIG. 5;

FIG. 7 is an enlarged section taken on line 7—7 in FIG. 6;

FIG. 8 is a view, on reduced scale, similar to FIG. 6, illustrating a modified supporting roller structure embodied in the cable distributor;

FIG. 9 is an enlarged side elevation of the cable feeder embodied in the cable distributor of FIG. 1;

FIG. 10 is a section taken on line 10—10 in FIG. 9; and

FIG. 11 is an enlarged section taken on line 11—11 in FIG. 9.

Referring now to these drawings, numeral 30 (FIG. 3) denotes a cable storage or take-up tank of the kind mentioned earlier. This tank includes an annular bottom wall 32 which, in the normal position of the tank, rests on a horizontal supporting surface 34. Joined to and rising from the outer edge of the bottom wall 32 is the outer cylindrical wall 36 of the tank. Joined to and rising from the inner edge of the bottom wall 32 is the inner cylindrical wall 38 of the tank. Take-up tank 30, therefore, has a generally annular configuration defining an annular storage space 40 within the tank.

According to the present invention, a continuous length of cable is coiled in the take-up tank 30, in a series of spiral layers, one on top of the other, by a cable distributor 42. Cable distibutor 42 comprises a generally annular frame 44 (FIG. 1) proportioned to fit within the annular storage space 40 of tank 30 and about the inner tank wall 38. Distributor frame 44 can be made in various ways. This frame has been shown, however, as comprising an outer ring 46, having an outside diameter slightly less than the inside diameter of the take-up tank wall 36, an inner ring 48, having an internal diameter slightly greater than the outside diameter of the inner take-up tank wall 38, and a series of radially extending, circumferentially spaced structural members or spokes 50 joining the outer and inner rings. From this description, it is evident that the distributor frame 44 can fit within the take-up tank 30 in the manner just described.

Secured to and extending about the inner ring 48 of the cable distributor frame 44 are a pair of axially spaced, generally polygonal flanges 51. These flanges, which may be welded to the inner ring 48, for example, have a plurality of straight sides located between the radial structural members 50, as shown.

Uniformly spaced about the inner distributor ring 48 are two idler wheel assemblies 52 and a single drive wheel assembly 54. Idler wheel assemblies 52 are identical and each comprises a rubber-tired idler wheel 55 arranged on an axis parallel to the distributor axis. Idler rollers 55 project between the flanges 51 and through openings in the inner distributor ring 48 into engagement with the inner tank wall 38. Each idler wheel 55 is rotatably supported on a wheel cover 56. One end of each wheel cover 56 is pivotally attached to a bracket 58 having a base 59 secured to the outer edges of the inner ring flanges 51. The opposite end of each wheel cover 56 projects into the interior of a cylindrical spring enclosure 60 through a slot in the side wall of the enclosure. One end of this enclosure is attached to the outer edges of the inner ring flanges 51.

Referring to FIG. 4, there is a threaded stem 62 extending axially through the cylindrical spring enclosure 60 and threadedly engaged in a nut 63 fixed in one end wall 64 of the enclosure. On the opposite end of the stem 62, exteriorly of the spring enclosure 60, is a handle 65 by which the stem may be rotated to axially move the latter. The adjacent end of the wheel cover 56 is apertured to receive the stem 62. Encircling the stem is a coil spring 66 which seats at one end against the adjacent end of the wheel cover 56 and at the opposite end against a spring seat 68 fixed on the stem 62.

From this description, it is evident that the idler wheels 55 are spring loaded against the inner tank wall 38 by their respective springs 66. It is further evident that the pressure of the idler rollers against the tank wall may be adjusted by rotating the spring-adjusting handle 65 of the respective idler wheel assemblies.

The drive wheel assembly 54 comprises a rubber-tired wheel 70 (FIG. 2) which projects through the space between the inner ring flanges 51 and an opening in the inner distributor ring 48 into frictional contact with the inner take-up tank wall 38. Drive wheel 70 is rotatably supported on a carriage 72 which, in turn, is slidably supported on rods 74 for movement toward and away from the inner tank wall 38. The ends of these rods are fixed to a supporting structure 76 mounted between two adjacent radical members 50 of the distributor frame 44. Mounted on the supporting structure 76, outwardly of and in axial alignment with the center line of the drive wheel carriage 72, is a flanged nut 78 in which is threaded an adjusting screw 80. The opposite end of the adjusting screw 80 is secured to the drive wheel carriage 72 by means of a bearing 82. Fixed on the adjusting screw 80 is a handwheel 84 by which the adjusting screw may be rotated to advance the drive wheel carriage 72 toward or retract the carriage away from the inner tank wall 38.

Referring to FIG. 2, the drive wheel 70 is keyed on the lower end of a shaft 86 which is rotatably supported at its upper and lower ends in the drive wheel carriage 72, in the manner shown in the latter figure. The upper end of shaft 86 is driven from a speed reducer 88 having a power input shaft 90. This shaft is driven by a motor 92 mounted on the supporting structure 76 (FIG. 1).

From the description thus far, it is evident that the entire cable distributor 42 is driven in rotation about the inner take-up tank wall 38 by the motor 92 through its drive wheel 70. Since the idler wheels 54 and the drive wheel 70 are disposed in simple frictional contact with the tank wall 38, it is obvious that the entire distributor assembly 42 can slide up and down along the tank wall. As discussed earlier, and hereinafter more fully described, this vertical movability of the distributor on the inner tank wall allows the distributor to "float" or ride on the uppermost layer of the cable coil being formed and to rise along the inner tank wall as successive layers are added to the coil.

To the end that the cable distributor 42 may ride smoothly and uniformly over the uppermost layer of the cable coil, the distributor frame 44 mounts a series of spring-loaded rollers 96 and 98. These rollers are attached to the radial structural members 50 of the frame. As shown, there are a number of each of the rollers 96 and 98 spaced about the distributor frame. Rollers 96 and 98 are substantially identical and differ only in the details discussed below.

Referring to FIGS. 5–7 each of the rollers 96 comprises a bracket 100 having a lower, vertical base portion 102 which seats against and is bolted to the respective distributor frame member 50. Pivotally mounted on and disposed at opposite sides of this base are a pair of roller supporting arms 104 which pivot on the base about an axis 106 substantially parallel to and extending radially of the distributor frame 44. Disposed between the outer ends of and rotatably supported on the arms 104 is a roller 108. This roller will be observed to taper toward each end.

The roller bracket 100 includes, further, two spaced, parallel arms 110 which extend upwardly from and at an angle to the bracket base 102 and over the roller 108. Disposed between and pivotally supported on the ends of the bracket arms 110 is a guide bar 112. A cross member 114 extends between and is pivotally attached to the roller supporting arms 104 below the guide bar 112. Extending slidably through the guide bar 112, adjacent its ends, are two shafts 116 which are secured, at their lower ends, to the cross member 114. Slidably positioned on the shaft 116 is a crossbar 118, through the center of which is threaded a bolt 120. The lower end of this bolt seats against the cross member 114. Positioned on the shafts

116, between the guide bar 112 and the crossbar 118, are coil springs 122. Coil springs 122 urge the crossbar 118, and thereby the roller-supporting arms 104 and the roller 108, in the downward direction. It is evident, therefore, that the roller 108 can swing upwardly, about its pivot axis 106, against the bias of springs 122. Upward movement of the roller is limited by engagement of the bolt 120 with a stop screw 124 threaded centrally through the guide bar 112.

The rollers 98 are identical with the rollers 96 thus far described. Rollers 96 differ from rollers 98 in that the former have the following additional structure. Integrally formed on the center of a crosspiece 125 joined at its ends to the roller supporting arms are a pair of upstanding bearing posts 126, between which is rotatably supported a roller 128. Roller 128 is engageable by a cam 130 fixed to a shift 132. Shaft 132 extends through and is journaled in the roller bracket arms 110 adjacent the bracket base 102. Fixed to one end of the shaft 132 is a crank 134 by which the cam 130 may be turned between the solid line position of FIG. 6, wherein the cam 130 engages the roller 128, and the phantom line position of that figure wherein the cam clears the roller. Rotation of the cam 130 toward its solid line extended position is limited by engagement of a stop screw 136 on the crank 134 with one face of an abutment 138 on the roller bracket 100. Rotation of the cam 130 toward its phantom line retracted position is limited by engagement of the crank 134 itself with a second face of the abutment 138. Connected between the crank 134 and the roller bracket 100 is a spring 140 which passes through a dead-center position with respect to the crank pivot axis during swinging of the crank between these two positions of cam 130 and acts to yieldably retain the cam 130 in each of these positions.

When the crank 134 is turned to rotate the cam 130 to its phantom line retracted position, the roller 108 is free to move upwardly, against the action of its biasing springs 122, and the roller 96 functions in precisely the same way as the rollers 98. When the crank 134 is turned to rotate the cam 130 to its solid line extended position, the cam engages the cam roller 128 and thereby locks the roller 108 in its lower position. The purpose of these various elements of the rollers 96 will be explained shortly.

Returning now again to FIGS. 1 and 3, the cable distributor 42 includes a cable receiver and feeder 142 and a reciprocating traverse mechanism 144 for driving the receiver 142 back and forth along the direction lines indicated by the arrows in FIG. 1. The traverse mechanism 144 comprises two spaced, parallel guide rods 146 secured at opposite ends to the cable distributor frame 44 in the manner shown. Midway between and parallel to the guide rods 146 is a so-called diamond lead screw 148. One end of this lead screw is journaled in a bearing 150 mounted on the distributor frame 44. The opposite end of the lead screw 148 is journaled in the housing of a gear reducer 152 mounted on the distributor frame.

The power input shaft 153 of the gear reducer 152 is driven, through a belt drive 154, from the output shaft of an electrically controllable, variable speed drive unit 156. While various types of variable speed drive units may be used on the cable distributor, at this point, a so-called P.I.V. variable speed drive unit has been found to be highly advantageous in the present application. The input shaft 157 of the variable speed drive unit 156 is drivably coupled to a lead screw drive roller assembly 158 by a drive shaft 160.

Referring to FIG. 1, the lead screw drive roller assembly 158 comprises a rubber-tired friction wheel 161 which projects between the flanges 51 of the distributor frame and through an opening in the inner distributor frame ring 48 into frictional contact with the inner take-up tank wall 38. Friction wheel 161 is rotatably supported in a wheel cover 162 which is pivotally attached at one end to a bracket 164. Bracket 164 is attached to the outer edges of the inner frame ring flanges 51. The opposite end of the wheel cover 162 is pivotally attached to a block 164 slidably positioned on a sleeve 166. Extending through the sleeve 166 is a threaded shaft 168, one end of which is pivotally attached to a bracket 170 attached to the outer edges of the inner frame ring flanges 51. A handwheel 172 is rotatably mounted on one end of the sleeve 166 and is threadably engaged with the shaft 168. About the sleeve 166 is a coil spring 174 which seats at one end against a flange on the end of the sleeve and at its opposite end against the slide block 164.

From this description, it is evident that the spring 174 urges the wheel cover 162, and thereby the friction wheel 161, toward the inner take-up tank wall 38. Thus, the frictional contact between the friction wheel 161 and the inner tank wall 38 can be adjusted by rotation of the handwheel 172.

Friction wheel 161 is keyed to a shaft 176 which is journaled at one end in the wheel cover 162 and at its opposite end in the housing of a bevel gear unit 178. Within this unit are bevel gears which drivably couple the wheel shaft 176 to the drive shaft 160.

From the preceding description of the traverse mechanism, it is obvious that when the cable distributor 42 is driven in rotation about the center take-up tank wall 38, by operation of the distributor drive motor 92, the friction drive roller 161 of the lead screw drive roller assembly 158 is driven in rotation in synchronism with rotation of the cable distributor by virtue of the frictional contact between the latter wheel and the inner take-up tank wall 38. This rotation of the friction wheel 161 is transmitted to the lead screw 148 through the gear unit 178, drive shaft 160, variable speed unit 156, and the gear reducer 152. The rotational speed of the lead screw 148 with respect to the rotational speed of the cable distributor is adjustable by control of the variable speed unit 156, in the manner hereinafter described.

Returning now to the cable receiver and feeder 142, the latter comprises a carriage 180 including sleeve bearings 182 which are slidably supported on the guide rods 146. As shown in FIGS. 9 and 11, this carriage is bolted to a cam follower housing 184 slidably received on the diamond lead screw 148. Carried internally of the cam follower housing 184 is a cam follower 186 which engages in the double helix grooves 187 of the lead screw. The operation of a diamond lead screw of this type is well known in the art and is such that during rotation of the lead screw, the cam follower housing 184 is driven back and forth along the lead screw from one end of the screw to the other. Accordingly, during rotation of the lead screw by the lead screw drive roller assembly 158, the cable receiver and feeder carriage 180, and thereby the cable receiver and feeder 142 thereon, are driven or reciprocated back and forth along the guide rods 146.

Referring now to FIGS. 9 and 10, the cable feeder and receiver comprises a frame 188 which is bolted to the carriage 180 and mounts a cable feed motor 190. The shaft of motor 190 is coupled to the input shaft of a gear reducer 192. The output shaft of this reducer mounts a resilient cable feed roller 194. Roller 194 is enclosed within a lower feeder housing 196 secured to the receiver-feeder frame 188. Lower feeder housing 196 comprises upright side walls 198 and end walls 200 joining these side walls. The upper edges of these side and end walls of the lower feeder housing terminate just slightly below the upper edge of the lower feeder roller 194. Above the lower feeder housing 196 is an upper feeder housing 202 having side walls 204 joined by end walls 206. The upper feeder housing 202 is connected to the lower feeder housing by hinges 208. The upper feeder housing 202 can, therefore, be hinged with respect to the lower housing about the pivot axis of the hinges 208.

At each end of the lower feeder housing 202 are pairs of transversely aligned plates 210 which are welded or

otherwise rigidly joined to the upper edges of the side walls 198 and adjacent end wall 200 of the lower housing. The inner, opposing edges of each of these plate pairs are spaced and are welded to a semicylindrical element 212. Above each plate pair 210 is a second pair of plates 214 which are welded or otherwise rigidly joined to the side walls 204 and adjacent end wall 206 of the upper feeder housing 202. The inner, opposing ends of each of these latter plate pairs are spaced and welded to a second semicylindrical element 216.

The semicylindrical elements 212 and 216 are transversely and axially aligned so that when the upper feeder housing 202 is hinged to its closed position of FIG. 10, the cylindrical elements 212 and 216 form two coaxial guide sleeves for the cable to be coiled. These guide sleeves can be opened by hinging the upper feeder housing 202 to its open position and then reclosed by hinging the upper housing to its closed position. The upper feeder housing 202 is retained in its closed position by bolts 218 inserted through holes in the plates 210 and 214, as shown.

The upper feeder housing 202 includes a cover 220 which encloses the upper half of and rotatably supports a resilient idler roller 222. Roller 222 projects through the open top of the upper feeder housing 202 to a position opposite the lower cable feed roller 194. Cover 220 is hinged at one end at 224 to the upper feeder housing 202. The other end of the cover 220 carries a hinged nut 26 which is threaded on a shaft 28. The lower end of shaft 228 is pivotally and rotatably secured to the adjacent end of the lower feeder housing 196. Fixed to the upper end of the shaft 228 is a handwheel 230 by which the shaft may be rotated to move the cover 220, and thereby the idler roller 222, toward and away from the lower cable feed roller 194.

As will be described shortly, the cable C to be coiled passes between the resilient friction rollers 194, 222. The upper roller 222 is adjusted, by means of the handwheel 230, so that the cable is firmly gripped between the opposing peripheries of the rollers, as shown. Accordingly, when the lower roller 194 is driven in rotation by its motor 190, the cable is fed longitudinally through the cable receiving and feeder assembly 142. The direction in which the cable moves is indicated by the arrow in the drawings.

Fixed at one end to the cable receiver and feeder 142, in axial alignment with the cylindrical guide formed by the semicylindrical elements 212 and 216 at the entrance side of the feeder housings 196, 202, is a cable entrance guide 232. The opposite end of this sleeve is flared, as shown, to facilitate entrance of the cable into the sleeve. Fixed to the exit end of the feeder housings 196, 202, in coaxial alignment with the cylindrical cable guide formed by the adjacent semicylindrical elements 212, 216, is an exit cable guide 236. This exit sleeve approaches the plane of the undersurface of the cable distributor 42 generally tangentially and terminates in an exit tip 238 located approximately in or just slightly above the aforementioned plane. The exit tip 238 also opens generally tangentially to and in a direction opposing the direction of rotation of the distributor and terminates approximately on a radius of the distributor frame parallel to the guide rods 146 of the traverse mechanism 144. During reciprocation of the cable receiver-feeder carriage 180, therefore, the exit tip 238 moves back and forth in a general radial direction of the cable distributor.

Briefly, during operation of the coiling machine described above, the main cable distributor drive motor 92 is energized to rotate the distributor drive roller 70 and thereby drive the cable distributor 42 in rotation about the inner wall 38 of the cable take-up tank 30. Rotation of the distributor drives the diamond lead screw 148 of the traverse mechanism 144 through the intermediate drive action of the lead screw drive roller assembly 158. Rotation of the lead screw 148 reciprocates the cable feeder assembly 142 along its guide rods 146 in synchronism with rotation of the cable distributor. Simultaneously, the cable feeder drive motor 190 is energized to feed the cable C longitudinally through the exit tip 238 of the feeder assembly into the take-up tank. These component motions of the cable distributor are so timed that the cable is wound or coiled in a series of spiral layers located one on top of the other. The supporting rollers 108 for the cable distributor ride on the turns of cable in the uppermost layer of the coil. As a result, the cable distributor slowly rises as the number of coil layers increases.

In order to permit the take-up tank 30 to be completely filled with cable, it is necessary that the cable distributor 42 rise to a point above the cable take-up tank 30. To this end, the invention provides an auxiliary extension 240 (FIG. 3*a*) for the inner wall 38 of the take-up tank 30. Referring to FIG. 3*a*, extension 240 comprises a cylindrical drum having a cylindrical wall 242 of approximately the same external diameter as the inner take-up tank wall 38. About the lower edge of the extension wall 242 is an internal annular flange 244. When placed in operative position on the take-up tank, the lower flange 244 of the extension rests on an internal flange 246 about the upper edge of the tank wall 38. The extension 240 is retained in coaxial alignment with the tank wall 38 by means of dowel pins 248 fixed in the extension flange 244 and engaging in holes in the tank wall flange 246. Thus, the cable distributor 42 can travel vertically from the inner wall 38 of the take-up tank 30 to the cylindrical wall 242 of the extension 240.

Electrical power for the cable distributor drive motor 92 and the cable feed motor 190 is supplied through an electrical cable 250 carried by the tank wall extension 240 and terminating at its lower end in an electrical plug (not shown) for connection to a source of electrical power. Cable 250 connects to the stationary part 254 of a slip ring assembly 256 coaxially mounted on the extension 240. The rotary part 258 of this slip ring assembly is attached to one end of a boom 260 which extends radially across the top of the extension and beyond one side thereof. Hinged to this extending end of the boom is a depending drive arm 262, the lower end of which is releasably drivably coupled by means 264 to the distributor frame 44. An electrical cable 266 is attached to the boom 260 and the drive arm 262 and is electrically connected to the power input cable 250 through the slip ring assembly 256. Cable 266 is electrically connected to the distributor drive motor 92 and the cable feed motor 190 in the manner described below.

From this description, it is evident that the releasable drive coupling means 264 on the cable distributor 42 drives the boom 260, and thereby the electrical cable 266 and rotary slip ring part 258 attached to the boom, in rotation through the drive arm 262 on the boom. Thus, the boom 260 and electrical cable 266 attached thereto continuously rotate with the cable distributor 42 so as to provide a continuous flow of electrical power to the distributor drive motor and the cable feed motor. As the distributor rises along the inner tank wall 38 and the extension 240, the boom 260 swings upwardly to accommodate such vertical movement of the distributor.

In order to produce a neat, compact, and uniformly wound cable coil with the present cable coiling machine, it is necessary to maintain a light compressive force in the cable when the latter is being wound from the outside of the coil toward the center and a light tension force in the cable when the latter is being wound from the inside of the coil toward the outside. The manner in which this is accomplished in the present coiling machine will now be described with reference to FIG. 1.

The speed of the main distributor drive motor 92 is controlled by a variable speed control circuit including a tachometer 268 for sensing the speed of motor 92, a tachometer 270 for sensing the speed of the cable feed motor 190, and a control unit 272 electrically connected

to these tachometers and to the motor **92** for comparing the speed of the motors **92**, **190** and regulating the speed of motor **92** to drive the cable distributor **42** in rotation at a rate related to the linear speed at which the cable C is fed through the cable guide **236**. Also included in this speed control circuit are means including two limit switches **274** and **276** on the distributor **44** and actuated by the cable feeder **142** at the ends of its stroke, respectively, for changing the relative speed at which the cable distributor **42** is driven in rotation relative to the linear speed of the cable C. These speed change means, which may comprise any means suitable for the purpose, cause the cable distributor to rotate at a tangential speed which is slightly slower than the cable speed during the radially inward strokes of the cable feeder and at a tangential speed which is slightly in excess of the cable speed during the radially outward strokes of the cable feeder. Actuation of the limit switches **274**, **276** by the cable feeder **142** at the ends of its strokes triggers the speed change means between these two states thereof. A suitable memory may be built into the speed control circuitry to cause the latter to resume the proper cable distributor speed in the event the machine is shut down.

The operation of the machine will now be described. Before lowering the cable distributor **42** into the take-up tank **30**, the cable feeder assembly **142** is driven to the limit of its travel toward the outer periphery of the distributor to a position in which the limit switch **276** is tripped. The cable distributor supporting rollers **108** in the roller assemblies **96** are latched in their lower positions. The cable distributor is now placed into the mouth of the take-up tank **30**. Prior to lowering the distributor to the bottom of the tank, however, the extension drum **240** for the inner wall **38** of the take-up tank is placed in position on the upper end of the latter tank wall. After it is properly located by engagement of the dowels **248** in the holes in the tank flange **246**, the extension is secured to the tank wall in any convenient way. The power supply cable **250** is then connected in a suitable receptacle in the floor below the central opening in the take-up tank. Finally, the cable distributor **42** is lowered into the take-up tank until its latched supporting rollers **108** rest on the bottom wall **34** of the tank.

The cable distributor idler rollers **54** and drive roller **70** and the lead screw drive roller **160** are now urged against the inner tank wall **38** by adjustment of the roller adjusting means in their respective wheel assemblies. With the coiling machine thus conditioned for a coiling operation, the cable C to be coiled is threaded through the entrance guide sleeve **232** of the cable feeder assembly **142**, between the friction rollers **194**, **222** of this latter assembly, and through the exit guide sleeve **236** of the feeder assembly until a length of the cable extends beyond the tip **238** of the exit guide sleeve **236**. This extending end of the cable is then attached to the take-up tank **30**, as by inserting the cable end through a hole in the outer wall **36** of the take-up tank **30** and securing said end in place in some convenient way.

Actual operation of the machine is initiated by energizing the cable distributor drive motor **92** and the cable feed motor **190**. The cable distributor **42** is now driven in rotation around the inner wall **38** of the take-up tank **30** and the cable C is fed longitudinally through the cable feeder assembly **142** and out the exit tip **238** of this assembly. Simultaneously, the feeder assembly **142** is driven slowly along its guide rods **146** inwardly of the cable distributor. This inward motion of the cable feeder assembly **142** is adjusted, by the variable speed unit **156**, so that during each revolution of the cable distributor **42**, the cable feeder assembly **142** is advanced one pitch, i.e., one cable diameter. Accordingly, as the cable distributor continues to rotate, the cable is wound inwardly in a first spiral layer on the lower wall **34** of the take-up tank **30**. After a few turns of cable have been laid down, the latched supporting rollers **96** are unlatched to permit the distributor frame **44** to settle down onto the cable to hold the latter in position. Part of the weight of the distributor is now carried through the spring loaded rollers **96**, **98** and part of the distributor weight is carried by the distributor frame resting on the cable turns. The rollers **96** are latched down initially to prevent excess load on the first few turns of cable by the distributor frame.

When the exit tip **238** of the cable feeder assembly **142** has been advanced to its inner limiting position, wherein the innermost turn or coil of the first layer is wound adjacent the inner tank wall **38**, the diamond lead screw **148** reverses the direction of the cable feeder assembly **142** and the latter commences its reversed travel toward the outer periphery of the cable distributor. During this outward travel of the feeder assembly, a second spiral layer of cable is wound outwardly over the first cable layer. When the cable feeder assembly **142** again reaches the outer limit of its travel, the diamond lead screw **148** once again reverses the direction of travel of the feeder assembly and the latter commences its inward movement during which a third spiral layer of cable is wound inwardly over the second layer. Thus, successive spiral layers of cable are wound or coiled one over the other, one layer being wound inwardly and the following layer being wound outwardly of the coil.

During the initial stages of coiling the first layer of cable on the lower floor **34** of the take-up tank **30**, all of the cable distributor supporting rollers **108** ride on the lower tank floor. Eventually, the rollers ride up over the layer of cable progressively from the outside toward the inside in the first layer and then from the inside toward the outside in the second layer and so forth. Since the coils or turns of cable, in effect, approach the supporting rollers in the axial direction, the rollers are tapered, as shown and as explained earlier, in order to facilitate movement of the rollers onto each successive layer of cable. The frame **44** of the cable distributor **42** remains substantially at the same elevation during the time that the first few rollers on the distributor ride up over each successive new layer of cable. The biasing springs **122** for the rollers **108**, of course, accommodate the resultant vertical displacement of the rollers with respect to the distributor frame. Eventually, when a given number of supporting rollers are riding on the new layer of cable, the distributor commences to rise as the remaining rollers ride up and over the cable layer. Thus, the cable distributor in effect floats on the top of the coil of cable and rises toward the top of the take-up tank as each successive layer of cable is coiled in the tank. Eventually, the distributor moves from the inner tank wall **38** onto the inner wall extension **240**, the last few layers of cable being coiled in the tank while the distributor rotates on this extension. In this way, the take-up tank **30** can be completely filled with cable.

Returning now to the start of the cable coiling operation, it will be recalled that the cable feeder assembly **142** is initially placed in its outer limiting position wherein the limit switch **276** is tripped. Accordingly, during coiling of the first layer of cable on the lower tank floor **34**, the distributor drive motor **92** rotates the cable distributor **42** at a tangential speed slightly less than the speed at which the cable is being fed through the cable feeder assembly **142**. The cable feed motor **190**, running at constant speed, provides the additional driving force necessary to rotate the cable distributor at the required speed. This additional driving force is, of course, exerted on the cable distributor through the cable itself. As a result, a compressive force is maintained in the cable when the latter is being wound or coiled from the outside toward the center of the coil. This compressive force retains the successive turns of the cable in proper compact relation. The cable distributor supporting rollers **108**, riding as they do on the uppermost turns of the cable, act as holddowns for the cable turns.

When the cable feeder assembly **142** reaches the inner limit of its travel, it trips the limit switch **274**. As discussed earlier, actuation of this limit switch operates the control system of the coiling machine to increase the speed of the distributor drive motor **92** until the cable distributor **42** tends to be driven at a slightly greater tangential velocity than the speed at which the cable is fed through the cable feeder assembly **142**. As a result, a tension force is maintained in the cable as the latter is wound from the inside toward the outside of the cable coil. This tension in the cable, again, maintains the successive turns of the cable in proper compact relation.

Thus, on each successive inward stroke of the cable feeder assembly **142** to wind a layer of cable inwardly over the previous layer, a compressive force is maintained in the cable to retain the successive turns of the cable in compact relation. Similarly, during each outward stroke of the cable feeder assembly to wind a layer of cable outwardly over the previous layer, a tension force is maintained in the cable to retain the successive turns of the cable in proper compact relation. This action results in a very neat, highly compact, and completely uniform cable coil.

At the completion of the coiling operation, the inner wall extension **240** and the cable distributor **42** are removed from the take-up tank.

Clearly, therefore, the invention hereinbefore described and illustrated is fully capable of attaining the several objects and advantages preliminary set forth.

Numerous modifications in the design, arrangement of parts, and instrumentalities of the invention are, of course, possible within the spirit and scope of the following claims.

What is claimed is:

1. A cable coiling machine, comprising:
a rotary frame having a normally vertical axis of rotation and an opening on said axis to receive a cylindrical support for the frame;
a multiplicity of rollers including a friction roller mounted on said frame about said opening with their axes substantially parallel with said rotation axis of said frame and their peripheries protruding into said opening for engagement with said support;
means for driving said friction roller in rotation;
a cable feeder on said frame including a cable guide having an exit end opening to one side of said frame and means for longitudinally feeding a cable through said guide toward said exit end; and
means for reciprocating said exit end of said guide relative to and in synchronism with rotation of said frame in such manner that the relative movement of said exit end of said guide with respect to said frame occurs substantially along a generally radial direction line of said frame and said exit end progressively advances a given uniform distance along said direction line during each revolution of said frame.

2. A cable coiling machine, comprising:
an annular, rotary frame having a central axis of rotation and including inner and outer rings concentric with said axis and struts connecting said rings;
there being an axial opening through said inner ring to receive a cylindrical support for said frame;
a multiplicity of rollers including a friction roller mounted on said inner ring about said opening with their axes substantially parallel to said rotation axis and their peripheries protruding into said opening for engagement with said support;
means for driving said friction roller in rotation;
a cable feeder on said frame including a cable guide having an exit end opening to one side of said frame and means for longitudinally feeding a cable through said guide toward said exit end; and
means for driving said feeder in translation with respect to and in synchronism with rotation of said frame in such manner that the movement of said exit end of said guide with respect to said frame occurs substantially along a radial direction line of said frame and said exit end progressively advances a given uniform distance along said direction line during each revolution of said frame.

3. A cable coiling machine, comprising:
a rotary frame having an axis of rotation;
means for driving said frame in rotation;
a cable feeder on said frame including a cable guide having an exit end opening to one side of said frame and means for longitudinally feeding a cable through said guide toward said exit end;
means slidably supporting said feeder on said frame for movement of said exit end along a generally radial direction line of said frame between a position adjacent the outer extremity of said frame and a position adjacent said axis;
a double helix rotary lead screw on said frame drivably engaged with said feeder for reciprocating the latter between said positions upon rotation of said lead screw in one direction; and
means for driving said lead screw in rotation in synchronism with rotation of said frame.

4. The subject matter of claim **3** including:
means for regulating the rotary speed of said lead screw relative to the rotary speed of said frame.

5. A cable coiling machine, comprising:
a rotary frame having an axis of rotation and an opening on said axis to receive a support for said frame;
a multiplicity of rollers including a friction roller mounted on said frame about said opening with their axes substantially parallel to said rotation axis and their peripheries protruding into said opening for engagement with said support;
means for driving said friction roller in rotation;
a cable feeder on said frame including a cable guide having an exit end opening to one side of said frame and means for longitudinally feeding a cable through said guide toward said exit end;
means slidably supporting said feeder on said frame for movement of said exit tip along a generally radial direction line of said frame between a position adjacent the outer extremity of said frame and a position adjacent said axis;
a double helix rotary lead screw on said frame drivably engaged with said feeder for reciprocating the latter between said positions upon rotation of said lead screw in one direction;
a second friction roller mounted on said frame about said opening with its axis parallel to said rotation axis and its periphery protruding into said opening for engagement with said support, whereby said second roller is driven in rotation in synchronism with rotation of said frame; and
a transmission drivably coupling said second friction roller and said lead screw, whereby the latter is driven by said second roller.

6. The subject matter of claim **5** wherein:
said transmission includes means for regulating the rotary speed of said lead screw relative to the rotary speed of said second friction roller.

7. A cable coiling machine, comprising:
a rotary frame having a normally vertical axis of rotation;
first drive means for driving said frame in rotation;
a cable feeder including a cable guide having an exit end opening to the underside of said frame and second drive means for longitudinally feeding a cable through said guide toward said exit end;
means for reciprocating said exit end of said guide relative to and in synchronism with rotation of the frame in such manner that said exit end of said guide moves along a generally radial direction line of said frame between a position adjacent the outer extremity of the frame and a position adjacent said axis;

means for regulating the speed of one of said drive means, thereby to regulate the ratio of the linear speed of the cable through said cable guide to the rotary speed of said frame; and

frame supporting rollers on the underside of said frame.

8. The subject matter of claim 7 wherein:

said rollers are relatively long in comparison to their diameter and taper to a smaller diameter toward each end.

9. The subject matter of claim 7 wherein:

said rollers are resiliently supported on said frame for vertical movement relative to said frame, and certain of said rollers are uniformly spaced about said frame and comprise means for releasably latching the respective rollers in their lower positions.

10. In combination:

an upright cylindrical support;

a frame mounted for rotation on and axial movement along said support;

a multiplicity of rollers including a friction roller on said frame about and disposed in peripheral contact with said support, and means for driving said friction roller in rotation thereby to drive said frame in rotation, said rollers being slidable along said support;

a cable feeder on said frame including a cable guide having an exit end opening to the underside of said frame and means for longitudinally feeding a cable through said guide toward said exit end;

means mounting said guide on said frame for movement of said exit end of said guide along a generally radial direction line of said frame between a radially outer position and a radially inner position; and

means for reciprocating said guide between said positions in synchronism with rotation of said frame.

11. In combination:

an annular cable tank including vertical, coaxial, inner and outer cylindrical walls and an annular bottom wall joining the lower edges of said cylindrical walls;

a frame mounted for rotation on said inner wall and vertical movement along the latter wall between a position within said tank adjacent said bottom wall and a position adjacent the upper end of said inner wall;

means for driving said frame in rotation;

a cable feeder on said frame including a cable guide having an exit end opening to the underside of said frame and means for longitudinally feeding a cable through said guide toward said exit end;

means mounting said guide on said frame for movement of said exit end of said guide along a generally radial direction line of said frame between a radially outer position and a radially inner position; and

means for reciprocating said guide between said positions in synchronism with rotation of said frame.

12. The subject matter of claim 11 including:

a removable cylindrical extension on the upper end of and of approximately the same diameter as said inner tank wall to which said frame may move axially from said inner tank wall.

13. In combination:

an annular cable tank including normally vertical, coaxial, inner and outer cylindrical walls and an annular bottom wall joining the lower edges of said cylindrical walls;

an annular frame having a central opening receiving said inner tank wall and an outer diameter less than the inner diameter of said outer tank wall;

a multiplicity of rollers including a friction roller mounted on said frame about said opening with their axes parallel to the axis of the frame and their peripheries protruding into said opening into contact with said inner tank wall;

means for driving said friction roller in rotation to rotate said frame;

a cable feeder on said frame including a cable guide having an inlet end opening above said frame and an exit end opening below said frame generally tangentially of and in a direction opposing the direction of rotation of said frame and means for longitudinally feeding a cable through said guide toward said exit end thereof;

guides slidably supporting said feeder on said frame for reciprocation between an outer position wherein said exit end of said guide is located adjacent the periphery of the frame and an inner position wherein said feeder is located adjacent said opening;

a diamond lead screw rotatably supported in said frame and drivably engaged with said feeder to reciprocate the latter between said positions; and

means for driving said lead screw in rotation in synchronism with rotation of said frame.

14. A cable coiling machine, comprising:

a rotary frame having an axis of rotation;

means supporting said frame for rotation on said axis;

means for driving said frame in rotation;

a cable feeder including a carriage, a tubular cable guide on said carriage having an exit end opening to one side of said frame, feed rollers mounted on said carriage and disposed for peripheral driving contact with a cable in said guide, and means on said guide for driving said rollers in rotation, thereby to longitudinally feed the cable through said guide toward said exit end;

means mounting said cable guide on said frame for rotation with said frame and for movement relative to said frame in such manner that the relative movement of said exit end of said guide with respect to said frame occurs along a generally radial direction line of said frame between a position adjacent the outer extremity of said frame and a position adjacent said axis; and

means on said frame for driving said cable guide in said relative movement with respect to and in synchronism with rotation of said frame.

15. A cable coiling machine, comprising:

a rotary frame having an axis of rotation;

means supporting said frame for rotation on said axis;

means including a motor on said frame for driving said frame in rotation;

a cable feeder including a carriage, a cable guide mounted on said carriage and having an exit end opening to one side of said frame, feed rollers mounted on said carriage and disposed for peripheral driving contact with a cable in said guide, and means on said carriage for driving said rollers in rotation, thereby to longitudinally feed the cable through said guide toward said exit end;

means on said frame slidably supporting said carriage on said frame for movement of said carriage relative to said frame in such manner that the relative movement of said exit end of said guide with respect to said frame occurs substantially along a radial direction line of said frame between a position adpacent the outer extremity of said frame and a position adjacent said axis; and

means on said frame for reciprocating said carriage in synchronism with rotation of said frame.

16. In combination:

an upright support;

a frame mounted on said support for rotation relative to and axial movement along said support;

means coacting between said frame and support for driving said frame in rotation while permitting relatively free axial movement of said frame along said support;

a cable feeder on said frame including a cable guide having an exit end opening to the underside of said

frame and means for longitudinally feeding a cable through said guide toward said exit end;

means mounting said guide on said frame for movement of said exit end of said guide along a generally radial direction line of said frame between a radially outer position and a radially inner position; and

means for reciprocating said guide betwen said positions in synchronism with rotation of said frame.

17. A cable coiling machine, comprising:

a cable receiver;

a frame;

means supporting said receiver and frame for relative rotation;

first drive means for driving said receiver and frame in relative rotation on a given axis;

a cable feeder mounted on said frame for movement relative to said frame along a direction line extending generally radially of said axis and including a tubular cable guide having an exit end opening toward said receiver, and second drive means for feeding a cable through said guide toward said exit end thereof;

said cable feeder being radially movable relative to said receiver and frame between a radially outer position and a radially inner position;

one of said drive means comprising a variable speed drive means having a first operating speed relative to a given operating speed of the other drive means at which the linear speed of the cable through said guide is slightly greater than the relative linear speed between said exit end of said guide and said cable receiver when said cable feeder occupies said radially outer position, and said variable speed drive means having a second operating speed relative to said given operating speed of said other drive means at which

the linear speed of the cable through said guide is slightly less than the relative linear speed between said exit end of said guide and said cable receiver when said cable feeder occupies said radially inner position;

means for reciprocating said cable feeder between said positions in synchronism with the relative rotation between said receiver and frame;

means responsive to movement of said cable feeder to said radially outer position for conditioning said variable speed drive means to operate at said first operating speed during subsequent radial inward movement of said cable feeder to said radially inner position; and

means responsive to movement of said cable feeder to said radially inner position for conditioning said variable speed drive means to operate at said second operating speed during subsequent radial outward movement of said cable feeder to said radially outer position.

References Cited by the Examiner

UNITED STATES PATENTS

374,209	12/1887	Sims	242—54
1,992,430	2/1935	Johnson	242—83
2,403,099	7/1946	Lear.	
2,709,553	5/1955	Wellcome	242—54
2,904,273	9/1959	Turner et al.	242—54
2,930,539	3/1960	Bremer	242—54
3,042,336	7/1962	Krafft et al.	242—83

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