

Sept. 8, 1970

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3,527,077

METHOD AND APPARATUS FOR COILING ROD

Filed Nov. 22, 1967

4 Sheets-Sheet 1

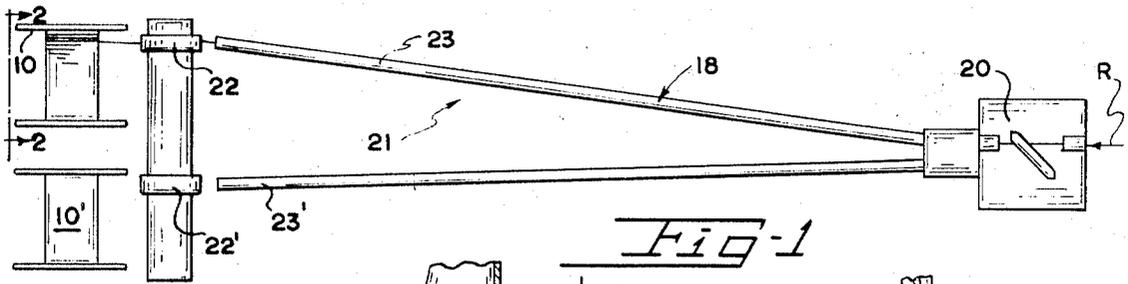


Fig-1

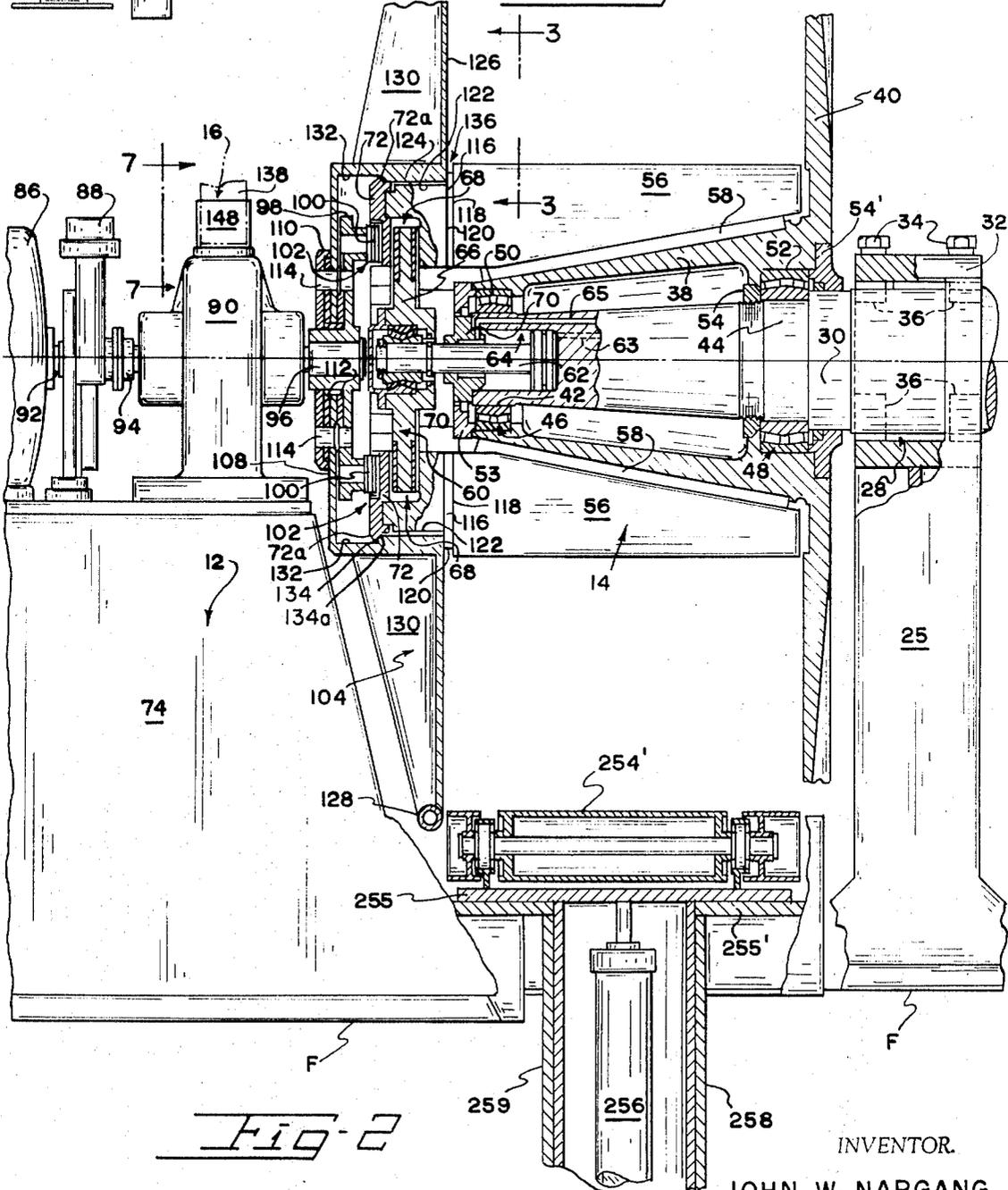


Fig-2

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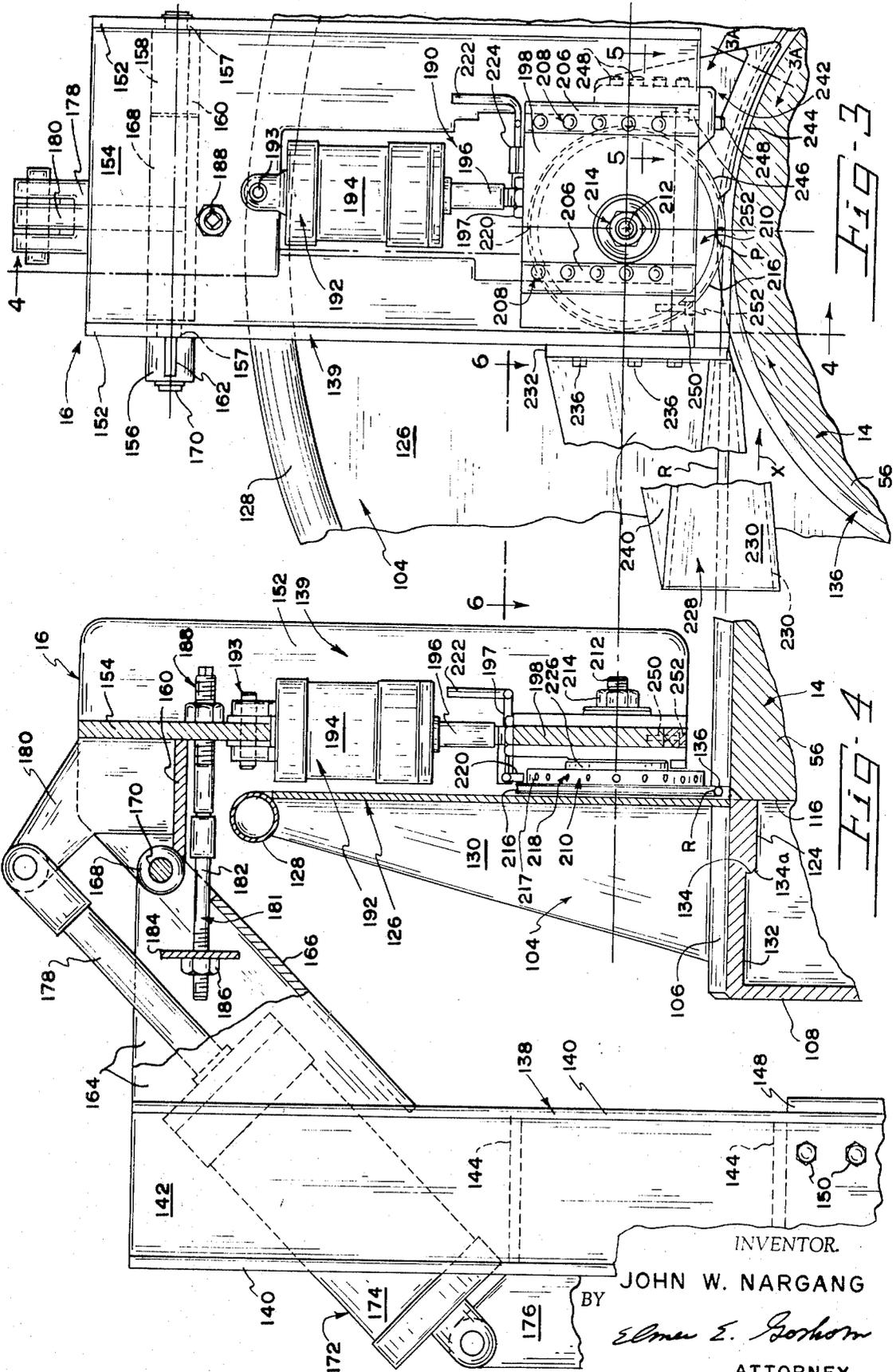
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4 Sheets-Sheet 3

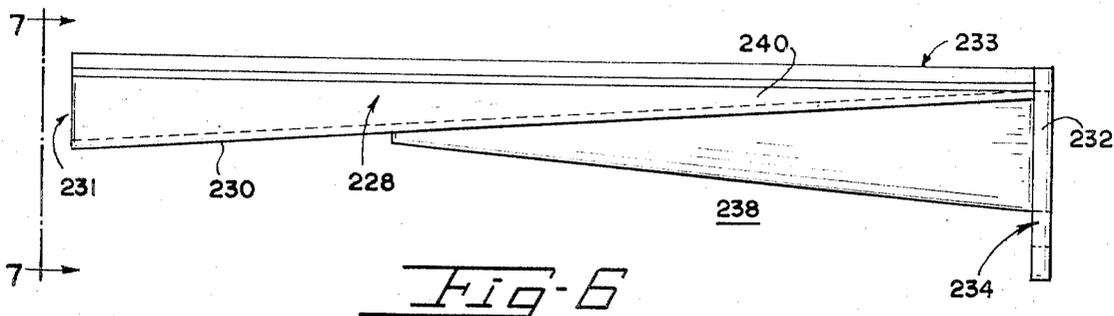


Fig-6

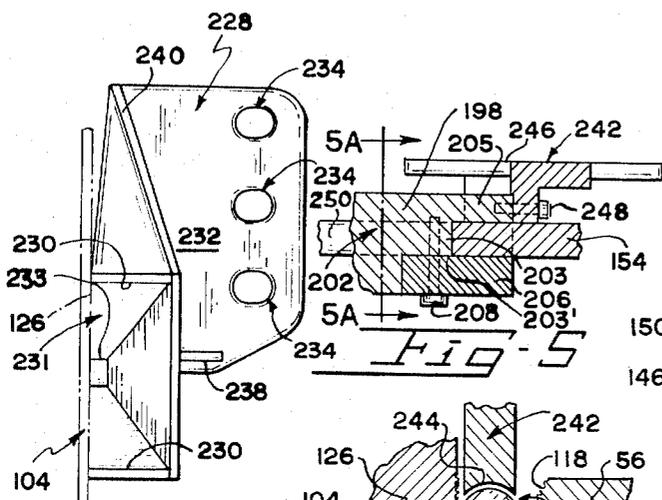


Fig-7

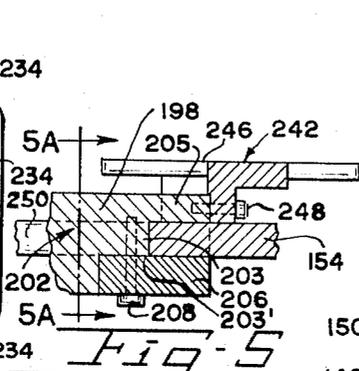


Fig-5

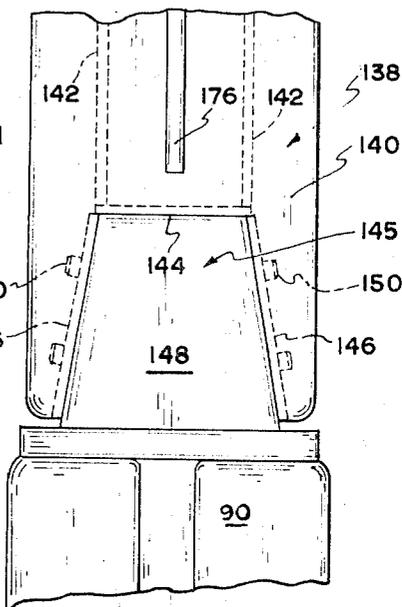


Fig-8

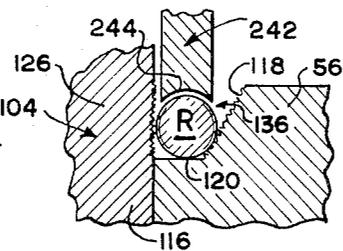


Fig-3A

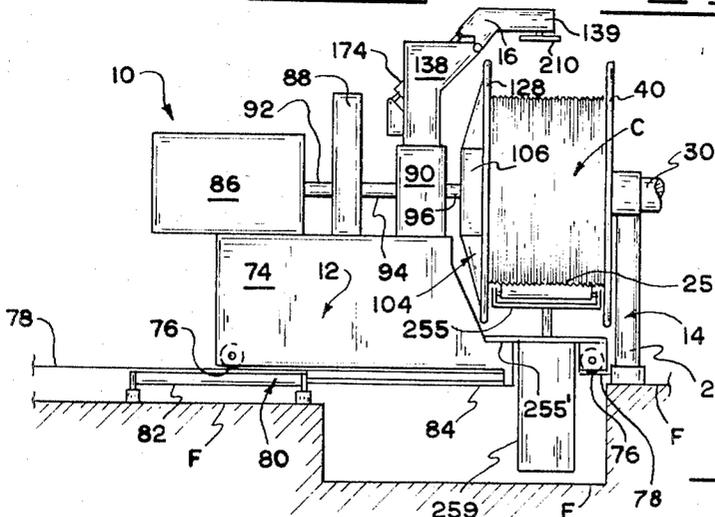


Fig-9

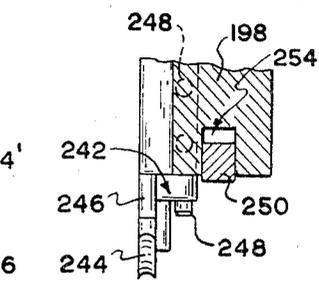


Fig-5A

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3,527,077

**METHOD AND APPARATUS FOR COILING ROD**  
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U.S. Cl. 72-142

22 Claims

## ABSTRACT OF THE DISCLOSURE

A method and apparatus for holdably engaging a leading edge of a rod to enable the leading portion of the rod to be bent into a convolution and for tightly wrapping the rod into a coil. A rotatable coiling apparatus is provided with a surface of revolution and at a preselected area thereof includes a circumferential groove for holdably engaging the leading edge of the rod. The coiling apparatus further includes a force applying mechanism alignable with the groove during the rotation thereof for directing the leading edge of the rod toward the groove and for forceably pressing the same into holding engagement with the groove so as to induce the tight wrapping of the rod about the surface of revolution. After the rod is tightly wrapped about the apparatus to form a coil, the apparatus is also operable to dilate the groove for releasing the coil, including the previously tightly held leading edge of the rod, in order that the apparatus can be recycled for wrapping another rod thereabout.

## BACKGROUND OF THE INVENTION

This invention relates to a method and apparatus for tightly wrapping a rod about the coiling apparatus and for releasing the tight wrapping or coil of rod from the coiling apparatus. More particularly, it relates to such method and apparatus which includes means for directing and pressing the leading edge of the rod into holding engagement with the apparatus to effect coiling of the rod thereabout and then for releasing the previously held leading edge to effect removal of the coiled rod therefrom.

Various methods and apparatus have been designed in the past for wrapping a length of rod into a coil, as illustrated in U.S. Pat. 2,546,637 to Robson granted Mar. 27, 1951, and U.S. Pat. 2,674,414 to Hicks et al. granted Apr. 6, 1954. However, none of the prior art methods and apparatus have proven satisfactory for one or more reasons. One of the principal deficiencies of prior art coiling apparatus is that, even though the leading edge of a fed length of rod is holdably engaged in some manner for the purpose of inducing wrappings of the rod into a coil, the leading edge is subject to being released from the coiling apparatus whereby the rod is not properly coiled.

In contrast, embodiments of the instant invention not only assure positive holding of the leading edge of the rod to initiate tight wrapping of the rod about the coiling surface, but also enable effective release of the tight wrapping of the rod, including the leading edge thereof, in order that the coiling apparatus can subsequently coil another length of rod.

## SUMMARY OF THE INVENTION

It is the primary purpose of the instant invention to provide a method and apparatus for coiling rod and rod-like members including improved means for directing the leading edge of a length of rod to a force applying means and a rotatable drum-like means wherein the force applying means directs the leading edge toward and forceably presses same into holding engagement with a preselected portion provided on the drum-like means so

as to induce tight convolutions of the rod about the drum-like means as well as for releasing and removing coils therefrom.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is an overall plan view on a reduced scale of a multistation production line provided with a pair of axially aligned coilers at the exit station thereof, each coiler incorporating an embodiment of the instant invention for effecting wrapping of a length of rod thereabout;

FIG. 2 is an enlarged elevational end view as seen from a position at line 2-2 of FIG. 1 with parts broken away and other parts shown in section and illustrates details of the improved coiler of the instant invention disposed at one of the stations of the production line;

FIG. 3 is an enlarged transverse vertical section taken along line 3-3 of FIG. 2 and with parts broken away and other parts added and illustrates details of the improved coiler of the instant invention;

FIG. 3A is an enlarged longitudinal section taken along line 3A-3A of FIG. 3;

FIG. 4 is a longitudinal vertical section taken along line 4-4 of FIG. 3 and with certain parts broken away and other parts removed;

FIG. 5 is a horizontal section taken along line 5-5 of FIG. 3 and illustrates further details of the subject device;

FIG. 5A is a cross-sectional detail taken at a position indicated by line 5A-5A of FIG. 5;

FIG. 6 is an enlarged top plan view as seen from a position at line 6-6 of FIG. 3 and illustrates one element for forming part of a chute of the subject device;

FIG. 7 is an end elevation of the chute formed from cooperatively disposed elements of the coiler with certain parts added in dotted lines, as viewed from line 7-7 of FIG. 6;

FIG. 8 is an enlarged elevational view as viewed along line 8-8 of FIG. 2 and illustrates the details for mounting the force applying device on the coiling apparatus;

FIG. 9 is a diagrammatic elevational view of the improved coiling apparatus and illustrates a coiled length of rod wrapped thereabout and the force applying device pivoted to an out-of-the-way position; and

FIG. 10 is an enlarged schematic elevational view of the coiling apparatus provided with the force applying device and illustrates the coiling apparatus in an operative position with certain parts broken away and other parts in dotted lines after release and removal of a length of coiled rod therefrom.

## DETAILED DESCRIPTION

With further reference to the drawings, a coiling apparatus 10, 10' embodying the instant invention is incorporated at the exit station of a multi-station production line 18, schematically illustrated in FIG. 1, for feeding a rod R alternately to either apparatus 10 or 10'. Inasmuch as the apparatus 10 or 10' are of identical construction, description of the apparatus 10 will suffice for both. The apparatus 10, as best shown in FIGS. 2-4, generally comprises a driving mechanism 12, a diametrically adjustable mandrel 14 disposed in operative relation to the driving mechanism 12, and a force applying device 16 mounted on the driving mechanism 12 and disposed in operative relation both to the mandrel 14 and the driving mechanism 12. The driving mechanism 12 and mandrel 14 are mounted on a support such as floor F in cooperative relation whereby the driving mechanism 12 in an advanced position relative to the mandrel 14 effects rotation thereof during holding engagement of the rod R and winding thereof about the mandrel 14. It is noted here that when the drive mechanism 12 and mandrel

14 are in cooperative relation for effecting rotation of the mandrel 14, a rotatable drum-like means is formed. Furthermore, the driving mechanism 12, when in a retracted position relative to the mandrel 14, enables release and removal of the fed length of rod material R wrapped about the mandrel 14.

The force applying device 16, during the rotation of the mandrel 14 and the introduction of the leading edge of the fed length of rod material R thereto, directs the leading edge toward and forceably presses same into holding engagement with a uniquely formed groove 136 provided on the mandrel 14 as will be subsequently set forth. Once the leading edge of the rod-like material R is holdably engaged by the groove 136 of the mandrel 14, the device 16 is pivoted to an out-of-the-way position relative to the mandrel 14, as depicted in FIG. 9, during wrapping of the fed length of rod material R about the rotating mandrel 14.

The multi-station production line 18 in incorporating the apparatus 10 of the instant invention at the exit station thereof as shown in FIG. 1 further includes a switching and cutting apparatus 20 at the inlet end thereof such as disclosed in the U.S. Pat. 3,261,287 to Nargang et al. granted on July 19, 1966 and an appropriate level wind distributing apparatus 21 operatively interposed between the apparatus 20 and the apparatus 10 or 10' of the instant invention. Since the production line 18 is only illustrated as a useful environment for the apparatus 10 or 10' of the instant invention, such line will only be briefly set forth as follows. The level wind distributing apparatus 21 includes reciprocal blocks 22 and 22' and swingable delivery chutes 23 and 23', wherein movements of one block and one chute are correlated in being associated with each apparatus 10 or 10' of the instant invention. The leading edge of the fed length of rod R is directed from a prior processing station, such as rod drawing equipment (not shown), to the switching and cutting apparatus 20 at the inlet station of the production line 18. When the rod R has been levelly wrapped about the apparatus 10 by the correlated movements of the reciprocal distributor block 22 and the swingable delivery chute 23, the switching and cutting apparatus 20 is operated by a control circuit, not shown, for severing the length of rod R and directing the leading edge of the trailing sectional length thereof through the block 22' and chute 23' for holdable engagement of the leading edge of the rod R and subsequent winding thereof about the apparatus 10' of the instant invention. Thus, the production line 18, in conjunction with the apparatus 10 or 10' of the instant invention, advantageously enables a continuously fed length of rod R to be periodically severed into sectional lengths and alternately wrapped into coils by the apparatus 10 and 10' of the instant invention. It is observed here that the rod R can be a ferrous metal, or nonferrous metal such as aluminum or an alloy thereof; can be of any suitable cross-sectional configuration, such as circular, triangular, rectangular; and can be of various suitable cross-sectional areas or sizes.

The mandrel 14 of the coiling apparatus 10 is mounted at one end on an upright pier-like stand 25 having a lower end which includes an enlarged base portion fixed to the floor F and an upper end which includes a transverse opening 28 receiving an inner portion of a shaft 30 for rotatably supporting the mandrel 14 at one end thereof. The upper end of the opening 28 is closed off by a removable retainer plate 32 affixed to the support 26 in a known manner by a series of cap screw assemblies 34, only two of which are shown. A series of four laterally spaced and opposed lugs 36 are formed in the plate 32 and in the stand 26 adjacent the lower end of the opening 28. These lugs 36, after proper disposition of the shaft 30 within the opening 28, project into their associated lug recesses formed in the shaft 30 whereby the inner portion of the shaft 30 is securely anchored against rotation relative to the stand 26. As viewed on the right in FIG. 2,

the shaft 30 is broken away but it is to be understood that it extends axially to form the other end of the shaft 30 rotatably supporting in a corresponding manner the mandrel (not shown) of the other coiling apparatus 10'.

A generally conically shaped hub 38 is rotatably mounted on the outer end of the shaft 30 whereby the truncated end of the hub 38 is radially coplanar with the outer end face of the shaft 30, while the enlarged end thereof includes an integral outwardly directed radial flange 40. As is shown in FIG. 2, the outer end of the shaft 30 includes axially spaced step portions 42 and 44 interconnected by a tapered portion. On the other hand, hub 38 includes corresponding axially spaced annular recessed portions 50 and 52. Suitable bearings 46 and 48 are mounted on the axially alignable stepped and recessed portions 42, 50, 44 and 52 of the shaft 30 and hub 38 whereby the hub 38 is rotatably mounted on the shaft 30. An apertured seal and retainer element 53 connected to the outer end of the hub 38 precisely locates the bearing 46 relative to the recessed portion 50 of the hub 38 and the stepped portion 42 of the shaft 30 while the nut 54 connected to the shaft 30 in conjunction with the apertured seal and retainer element 54' connected to the hub 38 precisely locate the bearing 48 relative to recessed portion 52 of the hub 38 and stepped portion 44 of the shaft 30.

In order to effect expansion and contraction of the mandrel 14, a series of radially and axially adjustable jaw elements 56 are slidably anchored to the outer conical surface of the hub 38. Preferably, four jaw elements 56 of corresponding arcuate configuration are disposed about the hub in circumferential interdigitated relation to each other, whereby the jaw elements 56 can be simultaneously adjusted together in an axial direction along the conical surface of the hub to effect expansion and contraction of the mandrel 14, as will now be described. An elongated track element 58 is associated with each jaw element 56, only two of which are partially shown in FIG. 2, and is affixed to an outer surface portion of the hub 38. It is to be understood that the track element 58 is slidably connected in a conventional fashion to a longitudinally extending groove, not shown, formed in the base portion of the jaw element 56 whereby each jaw element 56 can be moved relative to its associated track element 58 in a direction axially of the hub in order to effect expansion and contraction of the mandrel 14.

As indicated in FIG. 2, an actuating mechanism 60 is connected to the outer enlarged end of the series of jaw elements 56 and to the outer end of the shaft 30 for axially advancing the jaw elements together relative to the hub 38. The mechanism 60 includes a piston rod subassembly 62 slidably disposed within a closed end cylindrical recess 64 extending axially inward from the outer end face of the shaft 30. The free end of the piston rod subassembly 62 has rotatably mounted thereon a disc-shaped drive element 66, the outer periphery of which is disposed within a series of circumferentially aligned arcuate recesses 68. Each one of the recesses 68 extends radially outward from the bottom of the outer enlarged end of each jaw element 56. The left side of each arcuate recess 68, as viewed in FIG. 2, is closed off by a plate segment 72 of arcuate extent corresponding to the enlarged outer end of the jaw element 56. The flat plate 72 associated with the outer end of each jaw 56 is affixed thereto in a suitable manner. A retainer and seal element 70 disposed within the aperture of the aforescribed outer retainer and seal element 53 closes off the opening of the recess 64 whereby fluid under pressure can be controllably directed from an appropriate source, not shown, to opposite sides of the piston through the fluid lines 63 and 65 illustrated as dotted and solid lines at the outer end of the shaft 30 in FIG. 2. It is further noted here that the radial depth and axial extent of the arcuate recess 68 for each jaw element 56 is sufficient to allow free interfitting between the surfaces defining the arcu-

ate recess 68 of each jaw element 56 and the outer peripheral portion of the drive element 66 associated therewith, whether the jaw elements 56 are expanded or contracted relative to the hub 38. Thus, when the actuating mechanism 60 is in its completely retracted position relative to the associated outer end of the shaft 30, the jaw elements 56 are in their radially expanded position relative to the flange 40 of the hub 38, wherein the mandrel 14 is in its fully expanded condition, as indicated by the solid lines in FIG. 2. Conversely, when the actuating mechanism 60 is in a completely extended position relative to the associated outer end of the shaft 30, the jaw elements 60 are in their radially retracted position relative to the flange 40 of the hub 38, wherein the mandrel 14 is in its fully collapsed condition as shown in FIG. 10.

The purpose of bearingly mounted the disc-shaped drive element 66 of the mechanism 60 on the free end of the piston-rod subassembly 62 is to enable the drive element 66 to be rotated relative to the piston-rod subassembly 62 during rotation of the mandrel 14 about the axis of the shaft 30 whereby the sealing rings, not shown, on the piston of the piston-rod subassembly 62 are not worn at an excessive rate.

The drive mechanism 12 for rotating the mandrel 14 about the axis of the shaft 30 is supported by a wheeled carriage 74 made up of a series of interconnected plate sections to form a hollow rigid boxlike assembly, as indicated in FIGS. 2 and 9-10. Four freely rotatable wheels 76, only two of which are illustrated in FIGS. 9-10, are mounted on opposite plate sections, only one of which is shown, of the carriage 74 at the longitudinal ends of the lower edges thereof. These wheels 76 rollingly engage the associated track element 78 of a pair of track elements affixed in a known manner to the floor F, the upper edge of one track element 78 being schematically illustrated in FIGS. 9 and 10. The position of the wheeled carriage 74 relative to the outer end of the mandrel 14 is controlled by an extensible fluid actuator 80 comprised of a cylinder 82 and piston-rod subassembly 84. The outer ends of the cylinder 82 are secured to the floor F in a known manner while the free end of the piston-rod subassembly 84 is appropriately connected to the forward lower end of the carriage 74.

The top of the carriage 74 has mounted thereon, as viewed from left to right in FIGS. 2 and 9-10, an electrical drive motor 86, a brake mechanism 88 and a gear speed reducing transmission 90, all of which are connected by the shafts 92 and 94. The hub portion of a drive wheel 98 is connected by conventional key means, not shown, to the output shaft 96 of the speed reducing gear transmission 90. A series of four driving lugs 100 are affixed to the outer periphery of the wheel 98 in equally spaced relation to each other and face in an axial direction toward the outer enlarged ends of the jaw elements 56. The longitudinal extent of the lugs 100 are disposed in radial alignment with the output shaft 96. The lugs 100 are adapted to be inserted into their associated lug receiving recesses 102 formed in the outer end faces of the plate segments 72 of the jaw elements 56, such as illustrated in FIG. 2. Thus, when the lugs 100 are inserted within their associated recesses 102 of the jaw elements 56, the output shaft 96 of the drive mechanism 12 is in driving connection with the mandrel 14 for imparting rotation thereof about the axis of its support shaft 30. As is evident in FIG. 2, the output shaft 96 and support shaft 30 of the mandrel 14 are in axial alignment.

As indicated in FIGS. 2 and 9-10, a flange 104 of corresponding diametrical extent as the aforescribed flange 40 on the mandrel 14 is drivingly connected to the drive wheel 98. The flange 104 includes an annular hub 106, the outer axial end of which is integrally connected to and closed off by an inwardly extending radial end wall 108. A clutch comprised of a disc-shaped cover plate 110

and a pair of friction disc plates 112 frictionally releases the flange 104 from the drive wheel in the event excessive moments of inertia are created in the flange 104, such as, for example, due to sudden stoppage of the output shaft 96. Both friction plates 112, wall 108 of flange 104 and cover plate 110 can be loosely assembled together wherein the wall 108 is interposed of both plates 112. A common opening extends through the axial center of the loose assembly so as to enable emplacement thereof over the outer end of the forwardly extending hub of the wheel 98. After emplacement of the loose assembly of the two plates 112, cover plate 110 and the wall 108 of the flange 104 against the outer radial end face of the wheel 98, the loose assembly can be securely clamped to the wheel 98 by a series of circumferentially spaced pins 114 (only two of which are shown in FIG. 2) passed through aligned openings in the cover plate 110, both friction plates 112, wall 108 and wheel 98. It is to be understood that the openings provided in the wall 108 of the flange 104, for passage of the associated pins 114, are enlarged in an arcuate direction about the axis of the shaft 96 so as to form arcuate-shaped slots, whereby the slots permit a limited degree of rotative movement of the flange 104 about the axis of shaft 96 relative to the wheel 98, plates 112, cover plate 110 and shaft 98. Thus, the arcuate-shaped slots provided in the flange 104 permit a permissive degree of frictional slippage of flange 104 relative to the plates 112 of the clutch so as to prevent injury to the key connection (not shown) between the hub of the wheel 98 and the output shaft 96.

Although not heretofore mentioned, the radial extent of the recesses 102 in each one of the plate segments 72 of the jaw elements 56 is sufficient to freely receive the associated driving lug 100 on the drive wheel 98 when the jaw elements 56 are actuated by the actuating mechanism 60 from an expanded position to a retracted position or vice versa. In order for the driving lugs 100 to be disposed in the associated recesses 102 of the jaw elements 56 to effect driving connection of the jaw elements 56 to the drive wheel 98, the drive mechanism 12 is advanced in correlation with the retraction of the actuating mechanism 60 for effecting expansion of the jaw elements 56. Thus, as the actuator 80 is actuated to extend the rod 84 outwardly of the cylinder 82, the drive wheel 98 is correspondingly axially advanced toward the mandrel 14, as shown in FIG. 10, with the lugs 100 disposed in axial alignment with the associated recesses 102 for insertion therein. When the driving mechanism 12 has been advanced to the position that the lugs 100 are inserted in their associated recesses 102, the actuating mechanism 60 for adjusting the jaw elements 56 is actuated for advancing the jaw elements 56 to their fully expanded position in conjunction with the continued advancement of the driving mechanism 12 toward the mandrel 14. As indicated in FIG. 2, after full advancement of the driving mechanism 12 and complete retraction of the actuating mechanism 60, the jaws 56 are fully expanded with the driving mechanism 12 rotatably connected to the mandrel 14 since the driving lugs 100 are disposed within their associated recesses 102.

At the same time as the jaws 56 are rotatably connected to the drive wheel 98 of the driving mechanism 12, the flange 104 of the driving mechanism is also connected to the mandrel 14 for rotation therewith as will now be described. To this end, an annular surface 132 disposed adjacent the closed end of the hub 106 of the flange 104 is of greater diametrical extent than the annular surface 124 disposed adjacent the open end thereof. A shoulder disposed between and connected to the adjoining ends of annular surfaces 124 and 132 of the hub 106 is comprised of an inner outwardly and downwardly extending frusto-conical surface 134a and an outer radial surface 134, as illustrated in FIGS. 2, 4, and 10. A corresponding outwardly and downwardly extending frusto-conical surface 72a is provided on the outer peripheral

edge of the plate segments 72 of all jaw elements 56 and faces in an axial direction toward the flange 40 of the mandrel 14 as clearly indicated in FIGS. 2 and 10. It is further observed here that the enlarged ends of the jaws 56, as viewed in FIGS. 2 and 10, further includes radially extending shoulders 116 and 118 interconnected by an annular surface 120. The inner radial end of the shoulder 116 of each jaw 56 intersects the inner end of the arcuate surface 122 thereof. The radial extent of the arcuate surface 122 of all the jaws 56 is less than the diametrical extent of the outer annular surface 124 on the hub 106 of the flange 104 whereby there is always sufficient radial clearance between the jaw surfaces 122 and annular surface 124 of the hub 106, especially when the mandrel is in a fully expanded condition, as indicated in FIG. 2.

During the time the driving wheel 98 is being advanced toward the mandrel 14, the flange 104 is correspondingly advanced. With the jaws 56 in a fully retracted position, as indicated in FIG. 10, the outer annular surface 124 of the hub 106 of the flange 104 passes over the arcuate surfaces 122 at the enlarged ends of the jaws 56 until the lugs 100 are inserted in the recesses 102 as afore-described. Then, as the jaws 56 are expanded by actuation of the actuating mechanism 60 in concurrence with the continued advancement of the flange 104 and driving wheel 98 toward the mandrel 14, the plate segments 72 of the jaw elements are expanded radially outward until the frusto-conical surface 72a wedgingly engages the frusto-conical surface 134a of the hub 106 so as to advance the inner periphery of the radial end face of the wall 126 into tight abutting engagement with an outer peripheral extent of the radial shoulder 116 of each jaw element 56. Thus, the wedging action of the frusto-conical surfaces 72a and 134a on the jaws 56 and hub 106 of the flange 104 during expansion of the jaws 56 in conjunction with connection of the drive mechanism 12 to the mandrel 14 assures not only a positive drive connection of the drive wheel 98 to the jaws 56 but also of the flange 104 to the jaws 56. As is evident in FIGS. 2 and 4, the outer radial surface 134 of the shoulder of the hub 106 allows sufficient radial clearance between the inner annular surface 132 of the hub 106 and the frusto-conical surface 134a thereof whereby wedging engagement of surfaces 72a and 134a is assured during expansion of the mandrel 14 in conjunction with connection of the drive mechanism 12 to the mandrel 14.

Conversely, when the drive mechanism 12 is to be disconnected from the mandrel 14 upon the retraction thereof, both actuators 60 and 80 are simultaneously actuated whereby the piston rod 62 of the actuator 60 is extended relative to the shaft 30 while the piston rod 84 is retracted relative to its cylinder 82. Thus, retraction of the jaws 56 withdraws the plate segments 72 radially inward of the hub 106 thereby disengaging frusto-conical surfaces 72a and 134a and enabling separation of the flange 104 from the mandrel 14. After full retraction of the jaw elements 56, continued advancement of the drive mechanism 12 away from the mandrel 14 by the actuator 80 effects complete disconnection of both the flange 104 and drive wheel 98 of the drive mechanism 12 from the mandrel 14, as indicated in FIG. 10.

When the flange 104 is connected to the jaws 56 of the mandrel 14, the end face of the radial wall 126 along with the intersecting surfaces 118 and 120 on each of the jaws 56 of the mandrel 14 form a series of arcuate recesses lying in a common radial plane through the axis of the shaft 30. These radially aligned recesses for all practical purposes, particularly when the jaws 56 are in their expanded position adjacent the flange 104, define an endless circumferential groove generally indicated as 136 in FIGS. 2, 3, 3A, 4 and 10.

One of the most important features of the subject apparatus is that this groove 136 is designed to hold and engage the leading edge of a length of rod R when the rod is forceably pressed into the groove 136 during rota-

tion of the mandrel 14 by the force applying device 16 associated therewith, as will now be described below. If desired, as indicated in FIG. 3A, the shoulders 118 on the jaws 56 can be beveled in an upward and outward direction relative to the flange 40 of the hub 30 so as to facilitate insertion and engagement of the leading edge of the rod R. Further, to assist in holding the inserted leading edge of the rod R in the groove 136, serrations can be provided on the shoulder 118 and the inner periphery of the radial end face of the wall 126, as depicted in FIG. 3A.

As viewed in FIGS. 3-4, the device 16 is generally comprised of a support 138 and an arm 139 pivotally connected thereto. Support 138 comprises a pair of outer plates 140 held in parallel spaced relation by another pair of parallel spaced inner plates 142 disposed inwardly of the longitudinal edges of the outer plates 140 and interconnected at their longitudinal edges to opposed inner surface portions thereof. The inner and outer plates 142 and 140 are reinforced by a series of spaced plates 144, two of which are indicated in dotted lines in FIG. 4, extending between and interconnected to opposed inner surface portions of the plates 140 and 142. The lower end of the support 138 is cut away to define a groove of approximately V-shaped configuration, generally indicated at 145 in FIG. 8. The lower reinforcing plate 144 further reinforces the inward edges of the spaced plates 140 defining the bottom of the groove 145 while the downwardly and outwardly inclined edges of the spaced plates 146 defining the side edges of the groove 145 are reinforced by the opposed plates 146 extending therebetween, as shown in FIG. 8. An upstanding boss 148 can be anchored in a suitable fashion to the top of the housing of the gear speed reducing transmission 90 on the wheeled carriage 74, as illustrated in FIGS. 2 and 8. The grooved end of the support 138 is anchored to the boss 148 when the nut-stud-bolt assemblies affixed to the boss 148 are assembled through aligned openings in the plates 146 of the support 138 in a known manner.

The arm 139 of the device 16 includes a pair of plates 152 held in parallel spaced relation by an interconnecting plate 154 so that the interconnected plates 152, 152 and 154 approximate a channel-shaped configuration. The upper ends of the plates 152 include rearwardly extending projections, as viewed in FIG. 4, the outer ends of which have connected thereto tubular spacer elements 156 and 158. The tubular spacer element 156 is affixed to the outwardly facing surface of the left plate 152, while the tubular spacer element 158 of relatively longer length than spacer element 156 is affixed to the inwardly facing surface of the right plate 152, as viewed in FIG. 3. A reinforcing plate 160 extends between and is connected to inside surface portions of the rearward projections of both plates 152 at the upper ends thereof and further plate 160 at its inner edge is also connected to rearwardly facing surface portions of the plate 154, as illustrated in FIGS. 3 and 4. It is to be understood that one end of the outer edge of the reinforcing plate 160 adjacent the inner tubular spacer element 158 can extend and be connected thereto for the purpose of reinforcing same. However, the outer tubular spacer element 156 is reinforced by the triangularly shaped gusset plate 162, disposed between and connected to outer and opposed surface portions of the outer spacer element 156 and the outer plate 152, as indicated in FIG. 3. Openings 157, as shown by dotted lines in FIG. 3, are provided in the rearward projections of the plates 152 of the arm 139 wherein the openings are in axial alignment relative to each other as well as to the bores through the inner and outer tubular spacer elements 156 and 158 affixed to the plates 152, as aforedescribed in order to define an overall opening extending through the openings 157 of the rearward projections of the plates 152 and the bores of the spacer elements 156 and 158.

One of the outer plates 140 on the support 138 of the device 16 at the upper end thereof, facing toward the arm 139 in FIG. 4, includes an upward and outward projection comprised of an affixed pair of parallel spaced plates 164 of corresponding triangular shape and a reinforcing plate 166 extending between and connected to the lower inclined edges of the plates 164. A tubular spacer 168 of a diametrical size, corresponding to the

aforedescribed outer and inner spacers 156 and 158 on the arm 139, extends between and is weldably connected to the outer ends of the plates 164. The upper end of the support 138 is pivotally connected to the upper end of the arm 139 upon interposition and aligning the bore of the tubular element 168 of the support 138 relative to the bores of the inner and outer tubular spacer elements 156 and 158 and openings 157 of both plates 152 of the arm 139, as viewed in FIG. 3, so as to define a common bore extending through the spacer elements 156, 158 and 168. A pin 170 extends through the common bore defined by the aligned tubular elements 156, 158 and 168 and the aligned openings 157 of both plates 152 whereby the upper end of the arm 139 is pivotally connected to the upper end of the support 138.

In order to controllably pivot the arm 139 relative to the support 138 and the flange 104 of the mandrel 14, an extensible fluid actuator 172 extends between and is connected to the arm 139 and the support 138. Accordingly, one end of the cylinder 174 of the fluid actuator 172 is pivotally connected to the upper end of a plate 176 projecting upwardly and outwardly from and affixed to the left outer plate 140 of the support 138, as viewed in FIG. 4. The free end of the piston rod subassembly 178 of the actuator 172 is pivotally connected to the upper end of an upwardly and outwardly projecting plate 180 affixed to the upper end of the arm 139. The intersecting straight edges of the plate 180, as illustrated in FIGS. 3-4, are weldably affixed to the upwardly facing surface portions of the reinforcing plate 160 and to rearwardly facing surface portions at the upper end of the plate 154 above the reinforcing plate 160 between the outer plates 152 of the arm 139.

In order to precisely control the exact location of the lowered position of the arm 139 relative to the support 138 and the flange 104 of the mandrel 14, an adjustable stop 181 is affixed between the spaced plates 164 of the support 138 adjacent the tubular spacer 168. The stop 181 includes a mounting plate 184 extending between and connected to the opposed surfaces of the plates 164 and further includes an adjustable bolt 182, the threaded end of which is passed through the plate 184 for threaded engagement with a nut 186 affixed to the back side of the plate 184. An adjustable set screw and lock nut assembly 188 is threadedly mounted in the plate 154 of the arm 139 so that the set screw and lock nut assembly 188 is aligned with the head end of the bolt 182 on the support 138 whereby the free end of the set screw and lock nut assembly 188 and the head end of the bolt 181 can be adjusted relative to each other to effect abutting engagement at a predetermined point corresponding to the desired lowered position of the arm 139 relative to the support 138 and the associated flange 104 of the mandrel 14. The importance of the predetermined setting of the lowered position of the arm 139 will become more apparent hereinafter. Therefore, by an appropriate control circuit, not shown, the operator can actuate the actuator 172 to an extended position whereby the arm 139 is pivoted to the lowered position relative to the flange 104 and limited by the predetermined setting of the stop 181 and set screw and lock nut assembly 188, as indicated in FIG. 4. If the actuator 172 is fully retracted, the arm 139 is pivoted to a raised and out-of-the-way position relative to the support 138 and above the periphery of the flanges 40 and 104 associated with the mandrel 14, as indicated in FIGS. 9-10.

In order to press the leading edge of the rod R into the recess 136 formed by the jaw elements 56 as aforedescribed, the arm 139 of the device 16 at the outer or lower end thereof comprises a slide 198 and a fluid biased actuator 192 connected thereto. As is evident in FIG. 3, a substantial portion of the plate 154 is cut out from the outer or lower end thereof toward the upper end thereof so as to form a stepped groove 190 approximating the shape of the letter U. The extensible fluid biased actuator 192 provided with a cylinder 194 and piston-rod subassembly 196 is disposed in the reduced bottom portion of the groove 190. One end of the cylinder 194 is pin connected as indicated at 193 to the plate 154 adjacent the bottom of the groove 190. The free end of the piston rod subassembly 196 is threadedly connected to the upper edge of the slide 198 and affixed thereto by lock nut 197. The slide 198 at its longitudinal edges 202 is slidably connected to the inner spaced edges of the plate 154 provided at the outer end of the groove 190. Each of the longitudinal edges 202 on the slide 198 includes a series of three corresponding offset edge portions such that the transversely disposed surface of intermediate offset edge portion 203 thereof is in sliding engagement with the associated inner edge of the plate 154 at the outer end of the groove 190, as illustrated in FIG. 5. To maintain the sliding contact of each transverse surface of the intermediate offset edge portion 203 of the slide 198 with the associated inner edge of the plate 154, a retainer 206 extends lengthwise of the outwardly facing surface 203' of the intermediate offset edge portion 203 of the slide 198, as well as lengthwise of the outwardly facing surface of the plate 154 at the inner edge thereof. Suitable cap screw assemblies, generally indicated at 208 in FIGS. 3 and 5, can be passed through aligned openings in the associated retainer 206 and the outwardly facing surface 203' of the slide 198 for securing the retainer 206 to the slide 198 at each longitudinal edge 202 thereof. Thus, with the retainer plates 206 secured to the intermediate offset edge portions 203 of the slide 198 and with the inner offset edge portions 205 of the slide 198 in overlapped sliding engagement with their associated inner surface portions of the plate 154 at the inner edges thereof, as shown in FIG. 5, the slide 198 is maintained in free sliding engagement with the inner edges of the plate 154 at the forward end of the groove 190.

The slide 198 further includes a wheel 210 rotatably mounted thereon for tangentially engaging the leading edge of the rod R. More specifically, the wheel 210 is provided with a stub shaft 212 integrally connected thereto (not shown) on one side thereof. The outer end of the shaft 212 is passed through a transverse opening (not shown) in the slide 198 and rotatably mounted on the slide at the opening thereof in a suitable manner. A nut and lock washer assembly 214 is threadedly engaged with the outer end of the stub shaft 212, whereby the wheel 210 is assembled to the slide 198, as indicated in FIGS. 3-4. The wheel 210 includes a series of stepped peripheries whereby the largest periphery of the wheel at the left end thereof, as viewed in FIG. 4, includes an outer circumferential groove 216 having a uniform concave configuration axially of the wheel 210 at any point of the circumference thereof. This groove 216 is substantially complementary to the rod R when disposed in tangential engagement with the wheel 210 at lower point P thereof so as to direct the rod R toward and at the same time forceably press it into the underlying and aligned recess 136 of the mandrel 14 during the rotation thereof, as will be further explained hereinafter.

Inasmuch as the rod R is introduced into the device from the left in FIG. 3, as indicated by the arrow X, the engagement of the leading edge of the rod at the lower point P of the groove 216 of the wheel 210 will normally cause rotation of the wheel 210 in a counter-

clockwise direction about the shaft 212, as viewed in FIG. 3. If desired, the wheel 210 can be driven in a counterclockwise direction, as viewed in FIG. 3, to minimize the impact of initial engagement of the rod R at point P. Accordingly, the intermediate and smaller stepped portion 217 of the wheel 210 about the outer periphery thereof includes a series of equally spaced inwardly directed radial recesses generally indicated at 218. These recesses 218 cause rotation of the wheel 210 in a counterclockwise direction about the axis of the shaft 212, as viewed in FIG. 3, when a stream of forced air is directed obliquely against the recesses 218 at the top of the wheel 217. A conduit 222, as partially shown in FIGS. 3-4, is secured by an attachable clamp 224 to the upper edge of the slide 198. The inner end, not shown, of the conduit 222 is connected to a source of forced air, also not shown, while the outer end of the conduit 222 has a nozzle 220 connected thereto for directing a stream of forced air against the recesses 218 at the top of the intermediate stepped portion 217 of the wheel 210 for causing rotation thereof about the shaft 212 in a counterclockwise direction, as viewed in FIG. 3. If the wheel 210 is driven prior to engagement with the leading edge of the rod R, it is preferably rotated at a speed so that the linear velocity of its lower point of engagement P substantially corresponds to or is slightly greater than the linear velocity of the rod R. Other suitable means can also rotatably drive the wheel about the shaft 212 such as an electric or hydraulic motor in an appropriate manner. The smallest periphery 226 of the wheel 210 disposed adjacent the slide 198 acts as a spacer to locate the groove 216 of the wheel 210 in substantially planar alignment with the groove 136 of the mandrel 14 when the arm 139 of the device 16 is in its preset lowered position, as determined by the cooperative stop elements 181 and 188 aforescribed.

Cooperatively disposed portions are provided on the radial end face of the wall 126 of the rotatable flange 104 and the outer end of the arm 139 of the device 16 to direct the leading edge of the rod R for tangential engagement with the grooved periphery 216 of the wheel 210 at lower point P. To this end, a one-piece element 228 is attached to the inlet side of the arm 139 of the device 16, as viewed on the left in FIG. 3. The element 228, as best illustrated in FIGS. 6 and 7, is comprised of a series of three plates 230 weldably interconnected together wherein their adjacent edges are beveled relative to each other in a preselected manner so as to form a necked-down longitudinally extending channel-shaped groove having an enlarged opening 231 at the rod inlet end of the element 228 and a reduced opening 233 at the rod exit end thereof. The interconnected plates 230 at their reduced ends are weldably connected to a flat mounting plate 232 of the element 228. It is observed here that the mounting plate 232 includes a U-shaped opening formed along one edge thereof that is disposed in alignment with the reduced opening 233 of the groove of the element 228 when the mounting plate 232 is connected to the reduced ends of the interconnected plates 230. The series of interconnected plates 230 can be reinforced by spaced plates 238 and 240 of similar triangular shape, wherein the plates 238 and 240 are beveled along certain of their edges in order that the plates 238 and 240 are weldably connected to both the mounting plate 232 and the intermediate plate 230 of the series of interconnected plates 230, as illustrated in FIGS. 6-7.

The mounting plate 232 includes a series of openings 234 for enabling adjustable attachment of the element 228 to the left plate 152 of the arm 139, as viewed in FIG. 3. A series of cap-screw assemblies 236, as depicted in FIGS. 3 and 7, are passed through the openings 234 for threaded connection in a known manner with alignable openings (not shown) in the left plate 152, as viewed in FIG. 3. The element 228 is attached to the left plate

152 of the arm 139 in FIG. 3 by the cap-screw assemblies 236 so that the openings 231 and 233 of the groove of the element 228 are aligned with the groove 216 of the wheel 210 at the lower point P thereof. When the arm 139 is pivoted to its predetermined lowered position, the open side of the groove of the element 228 is closed off by the forwardly disposed free edges of the interconnected plates 230 defining the open side of the groove being slightly spaced from or at most nestingly engaging with the end face of the radial wall 126 of the flange 104, as manifested in FIG. 7, so as to form a chute having a funnel-shaped opening. If the forward free edges of interconnected plates 230 are slightly spaced from the end face of the wall 126 of the flange 104, the spacing is such so as to always be sufficiently less than the cross-sectional size of the rod R. Then, upon rotation of the mandrel 14 by the drive mechanism 12 in conjunction with the introduction of the leading edge of the rod R to the enlarged opening 231 of the grooved element 228, the cooperative relation of the element 228 and the wall 126 of the flange 104 in forming the chute forceably directs the leading edge of the rod into engagement with the wheel 210 at lower point P thereof. When the leading edge of the rod R is holdably engaged by the groove 136 of the mandrel 14 during rotation thereof, the element 228 can be freely released from trailing portions of the held rod R and withdrawn away from cooperative relation with peripheral portions of the wall 126 of the flange 104 upon pivoting the arm 139 of the device 16 to an out-of-the-way position, as indicated in FIGS. 9-10.

Although the grooved element 228 is illustrated in FIG. 7 in cooperative relation with the wall 126 of the flange 104, it is to be understood that the open side of the groove of element 228 could be closed off by other appropriate means, such as another plate (not shown) hingedly connected to the free edge of the upper plate 230, as illustrated in FIG. 7, and spring biased to a closed position wherein the lower end of the other plate, not shown, abuttingly engages the free edge of the lower plate 230 so as to fully cover the open side of the groove. Then, when the device 16 is pivoted to its predetermined lowered position, element 228 acts as a chute for receiving and forceably directing the leading edge of the rod R toward the lower point P of the wheel 210. After the leading edge of the rod R is holdably engaged by the mandrel 14 as aforescribed, the device 16 is pivoted to an out-of-the-way position and the element 228 is released from surrounding trailing portions of the held rod R by virtue of the hinged plate, not shown, being urged against its spring bias by the held rod R to an open position.

A guide element 242 is affixed to the trailing edge of the slide 198, as indicated in FIG. 3. The guide element 242, as best illustrated in FIGS. 3, 3A and 5, includes an arcuate bottom edge 244 having a groove which is also complementary to the rod R. The guide element 242 is adjustably connected to the slide 198 by cap screws 248, as shown in FIGS. 3, 5, and 5A, so that the arcuate edge 244 is not only disposed in alignment with the groove 136 of the mandrel 14 (when the arm 139 is in its lowered position), but is also usually partially inserted therein and spaced from the bottom thereof; this position assures sliding engagement of the rod with the guide element 242 so that the latter can maintain engagement of the rod R with the groove 136. It has been found that without the use of the guide element, 242, the leading edge of the rod R tends to bend upwardly and wind itself about the peripheral groove 216 of the wheel 210. Thus, after the leading edge of the rod R initially engages the wheel 210 at point P, subsequent sliding engagement of the rod with the arcuate edge 244 of the guide element 242 assures retention of the rod in the groove 136. Although the arcuate extent of the groove 244 of the guide 242 is illustrated less than 90° in FIG. 3, the arcuate extent thereof can

be of any suitable amount, such as 90°, so as to assure that the leading edge of the rod is maintained in the groove 136.

To prevent any tendency of the leading edge of the rod R to advance itself between the guide element 242, as illustrated in FIGS. 3 and 5, and the wheel 210, the guide element includes an upwardly extending arcuate surface 246 spaced radially outward of and in alignment with the peripheral groove 216 of the wheel. Such radial outward spacing of the arcuate surface 246 relative to the groove 216 of the wheel 210 is, of course, of less extent than the cross-sectional size of the rod R.

In order to limit movement of the wheel 210 toward the groove 136 on the mandrel 14 under the urgency of the bias of the actuator 192, a bar 250, as indicated in FIGS. 3, 5 and 5A, extends across the open end of the groove 190 on the lower or outer end of the arm 139. This bar 250 serves the dual function of not only abuttingly engaging the bottom edge of the slide 198 but also of guiding the bottom edge thereof relative to the groove 136 on the mandrel 14 when the arm 139 is in its predetermined lowered position. The lower edge of the plate 154 adjacent the open end of the groove 190 is further cut away for seating engagement therein of the longitudinal ends of the bar 250 whereby the bar 250 can be anchored flush with the lower edge of the plate 154 of the arm 139 by a series of sunken cap screws 252, as illustrated by dotted and solid lines in FIG. 3. As further shown in FIG. 5A, the lower or bottom edge of the slide 198 between the intermediate offset edge portions 203 thereof includes a longitudinally extending groove 254, the bottom of which abuttingly engages the top of the bar 250 to limit the downward movement of the slide, while opposite sides of the groove 254 are in sliding engagement with opposed sides of the bar 250.

It is to be understood that the bias of the fluid actuator 192 is sufficient, with the arm 139 in its predetermined lowered position, to urge the slide 198 into abutting engagement with the top of the bar 250 until the wheel 210 is forceably engaged at lower point P by the leading edge of the rod R directed through the funnel-shaped chute opening formed by the cooperative relation of rotating flange 104 and element 228, as heretofore discussed. In addition, prior to the introduction of the rod R, the slide 198 in abutting the top of the bar 250 holds the wheel 210 in spaced relation to the groove 136. Then, upon rotation of the mandrel 14, the leading edge of the rod R in being directed through the chute opening formed by element 228 and flange 104 urges the slide 198 upwardly relative to the bar 250 against the bias of the actuator 192. However, this bias is still sufficient to urge the wheel 210 into engagement with the leading edge of the rod at point P so as to direct the engaged leading edge of the rod toward the recess 136 of the mandrel 14, and at the same time, to press the leading edge of the rod into holding engagement with the recess 136 thereof. Throughout the time the leading edge of the rod R is in engagement with the wheel 210 at point P and is being pressed into the groove 136 by said bias, during the rotation of the mandrel 14, the bottom of the groove 254 at the forward end of the slide 198 is not in abutment with the top of the bar 250, such as depicted in FIG. 5A. Once a forward portion of the leading edge of the fed length of rod-like material R is fully held and seated within the full circumferential extent of the groove 136, during rotation of the mandrel 14, a conventional pressure switch (not shown) connected to the actuator 192 senses the build-up of bias within the actuator 192 that is indicative of starting a second winding or wrapping of the rod material R about the mandrel 14 adjacent the groove 136. The conventional pressure switch (not shown) in sensing the build-up of bias becomes operative within the control circuit (not shown) so as to operate the actuator 172 to a retracted position for effecting pivoting of the arm 139 of the device 16 to an out-of-the-way position above the

flanges 40 and 104 of the mandrel 14, as indicated in FIGS. 9-10, whereby the trailing portions of the rod R are tightly wrapped and levelly wound about the mandrel 14 by the action of the aforescribed production line 18 in FIG. 1.

Although lower point P of the wheel 210 is preferably located adjacent the top of the mandrel 14 in FIG. 3, the point P of the wheel 210 can be located at other circumferential locations about the mandrel 14. Whether or not the point P of the wheel 210 of the device 16 is located at the top of the mandrel 14 is, of course, determined to a great extent by the direction of the leading edge of the rod R when it is introduced to the inlet end of the device 16 in order to effect holdable engagement of the leading edge of the rod with the mandrel 14 in accordance with the teachings of the instant invention. An angular adjustment of lower point P of the wheel 210 from zero degrees at the top portion of the jaws 56 of the mandrel 14 up to fifteen degrees in a clockwise direction about the jaws 56 thereof, as viewed in FIG. 3, has been found satisfactory for effecting holdable engagement of the leading edge of the fed length of rod material R in the groove 136 of the mandrel 14, when the rod R is directed to the right along a horizontal path, as illustrated in FIG. 3. To effect angular adjustment of point P of the wheel 210, the device 16 can be mounted in an appropriate fashion on the drive mechanism 12 so as to be tilted an amount corresponding to the angular adjustment of the wheel 210 and point P thereof, such as 15° clockwise from that shown in FIG. 3.

Although not heretofore mentioned, the forward end of the carriage 74 of the driving mechanism 12 adjacent the mandrel 14 is recessed or cut away so as not to be obstructed by the outer periphery of the flanges 40 and 104 on the mandrel 14 during movement of the driving mechanism 12 toward and away therefrom. In addition, the forward end of the carriage 74 has mounted therein a pair of laterally spaced snubber rolls 254', only one of which is shown. The snubber rolls 254' are rotatably affixed at their ends, as illustrated in FIGS. 2, 9 and 10, to an elevatable platform 255 to which is dependently affixed an inner sleeve 258, as shown in FIG. 2. The inner sleeve 258 telescopes within an outer sleeve 259, the upper end of which is affixed to the backside of a plate 255' in alignment with the aperture therethrough. The plate 255' constitutes the top of the carriage 74 at the forward end thereof. An extensible fluid actuator 256 is disposed within the inner sleeve 258 and affixed at its lower end to the carriage 74 in a known manner, not shown. The exposed piston-rod end of the actuator 256 is connected to the platform 255 whereby the snubber rolls 254' can be raised by the actuator into biasing engagement with the outermost level of windings of rod-like material during the coiling thereof about the rotating mandrel 14.

After the rod R has been fully wound about the mandrel 14, as well as severed from the supply of rod R being fed through the switching and cutting apparatus 20 of the production line 18 in FIG. 1, the coil C of rod R in FIG. 9 can be removed from the mandrel 14. Upon deenergizing the drive motor 86 and energizing the brake mechanism 88 in a known fashion, the rotation of the mandrel 14 is stopped. Then, the actuating mechanism 60 of the mandrel 14 and actuator 80 of the carriage 74 are coordinately actuated by a control circuit, not shown, whereby the carriage 74 is moved to a retracted position away from the outer end of the shaft 30, while the jaws 56 of the mandrel 14 are radially retracted toward the outer end of the shaft 30. As indicated in FIG. 10, such relative movement of the flange 104 and jaws 56 effects disconnection of the drive wheel 98 and flange 104 from the outer ends of the jaws 56 while the jaws 56 are adjusted to their fully collapsed condition. Disconnection of the flange 104 from the outer ends of the jaws 56 effects expansion or dilation of

the groove 136 due to separation of the flange wall 126 relative to the shoulder 118 thereof whereby the holdable engagement of the rod R is released. Collapse of the jaws 56 releases grippage of the innermost level of windings of the tightly wrapped windings of the fed length of rod-material R about the mandrel 14. The mandrel 14 then loosely supports the tight wrappings of the coil C of rod. In order to assist removal of coil C from the mandrel 14 during advancement of the carriage 74 away from the mandrel 14, the snubber rolls 254' are held in engagement with the outermost winding of the coil C by the actuator being hydraulically locked in a known manner. When the snubber rolls 254' and flange 104 are advanced beyond the outer end of the shaft 30, as illustrated in FIG. 10, the snubber rolls and flange 104 entirely support the coil C in an upright position until removed such as by forklift truck, not shown.

In summary of the method and operation of the apparatus of the instant invention, a length of rod R is directed toward the force applying device 16 of the apparatus whereby the force applying device 16 directs the leading end of the rod R toward the groove 136 of the mandrel 14, while at the same time forceably pressing the rod R into holdable engagement with the groove 136 during rotation of the mandrel 14. After removal of the device 16 to an out-of-the-way position, as well as after coiling of the length of rod R about the mandrel 14, the coiled rod is removed from the mandrel 14 upon expansion of the groove 136 and collapse of the mandrel 14 so as to release the leading edge of the coiled rod R from the mandrel 14, as well as the innermost level of windings of the coiled rod C therefrom. Such release enables complete removal of the coiled rod C, as shown in FIG. 10.

It is to be understood that any suitable mandrel and associated drive mechanism can be used with the unique force applying device 16 so long as the leading edge of the rod R is holdably engaged within a groove formed by the connection of the drive mechanism 12 to the mandrel 14 for effecting rotation thereof. One of the advantages of the apparatus of the instant invention is that the coils C are formed of relatively tightly wrapped windings of rod R about the mandrel 14 whereby the coil C is not only self-supporting but enables the coil to be of a relatively large size and heavy weight.

In order to assure maximum holding engagement of the rod in the groove for various sizes and cross-sectional shapes of the rod, the shape of the groove 136 can be changed to effectively hold a given shape and size of rod R, such as, for example, by providing readily removable and replaceable arcuate-shaped spacer elements on the enlarged ends of the jaw elements 56 at the reduced end of the mandrel 14. Furthermore, the cooperative relation of the force applying device 16 and the groove 136 of the mandrel 14 for holdably engaging the rod R is capable of handling greater linear feeding speeds of the rod R into the coiling apparatus 10 than heretofore practiced in the art, whereby the mandrel 10 can be rotated at greater speeds in order to form coil bodies at higher production rates. Finally, whether the rod R is in a heated condition or at ambient temperature does not adversely affect the coiling of the rod R about the mandrel 14 or the release and removal of the coiled rod from the apparatus 10 in accordance with the teachings of the instant invention.

Although a preferred embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that various changes may be made therein without departing from the spirit and scope thereof as set forth in the appended claims.

What is claimed is:

1. A device for directing and forcing the leading edge of a rod into tight engagement with a rotatable drum-like means of a coiling apparatus provided with a pair of flanges, said device comprising force-applying means,

means including a stepped grooved portion on said drum-like means and aligned with said force-applying means for receiving and holding the leading edge of the rod when said rod is brought into contact therewith, means for rotating said drum-like means, means for operating said force-applying means at least during the initial rotation of said drum-like means for forceably directing the leading edge of the rod toward and into said grooved portion on said drum-like means and for pressing the leading edge thereof into holding engagement therewith in order to initiate tight wrapping of the rod about said drum-like means and means for disconnecting one of said flanges of said pair of flanges from said rotatable drum-like means in order to effect expansion of the grooved portion and a release of the rod held therein from said drum-like means.

2. A device as set forth in claim 1 including means for guiding and directing the leading edge of a length of the rod into alignment with said force applying means.

3. A device as set forth in claim 1 in which said force-applying means includes a wheel for rollingly engaging the leading edge of the rod.

4. A device as set forth in claim 3 including means for rotatably driving said wheel.

5. A device as set forth in claim 3 in which said force applying means includes a guide element for slidably engaging the rod subsequent to said wheel rollingly engaging said rod.

6. An apparatus for lockably engaging the leading edge of a rod in order to effect coiling of the rod thereabout, said apparatus comprising a rotatable drum-like means provided with a pair of flanges and a grooved portion and a rod-directing device disposed in operative relation to said drum-like means, means for rotating said drum-like means, means including said grooved portion on said drum-like means for receiving and holding the leading edge of the rod when said rod is brought into contact therewith, said rod-directing device including a force-applying means, said force-applying means acting at least upon the initial rotation of said drum-like means to direct the leading edge of the rod toward and into said grooved portion and to forceably press the leading edge thereof into holding engagement therewith in order to initiate tight wrapping of the rod about said drum-like means and means for disconnecting one of said flanges of said pair of flanges from said rotatable drum-like means in order to effect expansion of said grooved portion and a release of the rod held therein from said drum-like means.

7. An apparatus as set forth in claim 6 wherein said rod directing device comprises a support and an arm pivotally connected thereto and said force applying means being connected to the outer end of said arm.

8. An apparatus as set forth in claim 7 in which said force-applying means is provided with a wheel for rollingly engaging the leading edge of the rod.

9. An apparatus as set forth in claim 7 including means connected to said arm and said support and operative to align said arm and said force-applying means relative to the grooved portion of said drum-like means.

10. In a coiling apparatus for rod material and the like, the combination of a coiling mandrel provided with a pair of spaced flanges and an endless rod receiving surface disposed between said flanges, means supporting said mandrel for rotation, means providing a circumferential groove intermediate said flanges, means mounting one of the flanges for movement away from said other flange so as to expand the groove, means for rotating said mandrel, and means for directing the leading edge of the rod to be coiled substantially tangentially into the groove while at the same time forceably pressing the leading edge of the rod substantially radially into the groove whereby portions of the rod will be held in the groove and other portions wrapped about the endless surface of said mandrel upon rotation of said mandrel.

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11. In a coiling apparatus as set forth in claim 10 in which cooperatively disposed means on one of said flanges and said directing and pressing means form an open ended chute for directing and guiding the leading edge of the rod to said directing and pressing means.

12. In a coiling apparatus as set forth in claim 10 in which said directing and pressing means includes a wheel for rollingly engaging the leading edge of the rod in order to direct and forceably press the leading edge of the rod into the groove.

13. In a coiling apparatus as set forth in claim 10 in which said directing and pressing means includes stop means for enabling precise alignment of said directing and pressing means relative to said groove.

14. In a coiling apparatus as set forth in claim 11 including means for moving said directing and pressing means to an out-of-the-way position relative to said mandrel.

15. In a coiling apparatus as set forth in claim 11 in which one of said cooperatively disposed portions has a longitudinally extending groove.

16. A method of coiling rod about a rotatable drum-like means while effecting a tight initial wrap of the rod about said rotatable drum-like means, comprising the steps of directing the leading edge of the rod toward a selected and depressed area on an endless surface of the drum-like means during the rotation thereof, effecting a seating of the leading edge of the rod in said depressed area by forceably pressing the leading edge of the rod into holding engagement with said depressed area on the said surface while continuing the feed of the remainder of the rod toward and about said endless surface without interference from the leading edge of the rod held within the depressed area and thereafter upon completion of the coiling operation expanding said depressed area to permit dislodgment of the rod from said drum-like means.

17. A device for directing and forcing the leading edge of a rod into tight engagement with a rotatable drum-like means of a coiling apparatus, said device comprising force-applying means, engaging means on said drum-like means and aligned with said force-applying means for holding the leading edge of the rod when said rod is brought into contact therewith, means for rotating said drum-like means, means for operating said force-applying means during rotation of said drum-like means for forceably directing the leading edge of the rod toward said engaging means on said drum-like means and for pressing the leading edge thereof into holding engagement therewith in order to initiate tight wrapping of the rod about said drum-like means, said force-applying means including a wheel for rollingly engaging the leading edge of the rod so as to direct and press the leading edge of the rod into engagement with said rod-engaging means, and biasing means for connecting said wheel to said device wherein said last mentioned means biasingly urges said wheel into rolling engagement with the rod.

18. An apparatus for lockably engaging the leading edge of a rod in order to effect coiling of the rod thereabout, said apparatus comprising a rotatable drum-like means and a rod-directing device disposed in operative relation to said drum-like means, means for rotating said drum-like means, rod engaging means on said drum-like means for holding the leading edge of the rod when said rod is brought into contact therewith, said rod-directing device including a force-applying means, said force-applying means acting upon the rotation of said drum-like means to direct the leading edge of the rod toward said rod-engaging means on said drum-like means and to forceably press the leading edge thereof into holding engagement therewith in order to initiate tight wrapping of the rod about said drum-like means, said rod-directing device being comprised of a support and an arm pivotally connected thereto, said force-applying means being connected to the outer end of said arm, and cooperative stop means provided on said arm and said support for enabling pre-

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cise alignment of said force-applying means with said rod-engaging means on said drum-like means.

19. An apparatus for lockably engaging the leading edge of a rod in order to effect coiling of the rod thereabout, said apparatus comprising a rotatable drum-like means and a rod-directing device disposed in operative relation to said drum-like means, means for rotating said drum-like means, rod-engaging means on said drum-like means for holding the leading edge of the rod when said rod is brought into contact therewith, said rod-directing device including a force-applying means, said force-applying means acting upon the rotation of said drum-like means to direct the leading edge of the rod toward said rod-engaging means on said drum-like means and to forceably press the leading edge thereof into holding engagement therewith in order to initiate tight wrapping of the rod about said drum-like means, said rod-directing device being comprised of a support and an arm pivotally connected thereto, said force-applying means being connected to the outer end of said arm, and the outer end of said arm including means for limiting the advancement of said force-applying means beyond the outer end of the arm.

20. An apparatus for lockably engaging the leading edge of a rod in order to effect coiling of the rod thereabout, said apparatus comprising a rotatable drum-like means and a rod-directing device disposed in operative relation to said drum-like means, means for rotating said drum-like means, rod-engaging means on said drum-like means for holding the leading edge of the rod when said rod is brought into contact therewith, said rod-directing device including a force-applying means and said force-applying means acting upon the rotation of said drum-like means to direct the leading edge of the rod toward said rod-engaging means on said drum-like means and to forceably press the leading edge thereof into holding engagement therewith in order to initiate tight wrapping of the rod about said drum-like means, said rod-directing device being comprised of a support and an arm pivotally connected thereto, said force-applying means being connected to the outer end of said arm and being provided with a wheel for rollingly engaging the leading edge of the rod so as to direct and forceably press the leading edge of the rod into holding engagement with said rod-engaging means on said drum-like means, and said force-applying means including a guide element affixed thereto which engages the leading edge of the rod subsequent to said leading rod edge rollingly engaging said wheel.

21. A method of coiling including holding and engaging the leading edge of a rod with a rotatable drum-like means in order to effect a tight initial wrap of a length of rod about an endless surface on said rotatable drum-like means, comprising the steps of directing the leading edge of the rod toward a selected and depressed area on said endless surface during rotation thereof, effecting a seating of the leading edge of the rod in said depressed area by forceably pressing the leading edge of the rod into holding engagement with said depressed area on the said surface while continuing the feed of the remainder of the rod toward and about said endless surface without interference from the leading edge of the rod held within the depressed area, and expanding the depressed area so as to effect a relaxation of the holding engagement between the endless surface and the rod edge.

22. A method of coiling including holding and engaging the leading edge of a rod with a rotatable drum-like means in order to effect a tight initial wrap of a length of rod about an endless surface on said rotatable drum-like means, comprising the steps of directing the leading edge of the rod toward a selected and depressed area on said endless surface during rotation thereof, effecting a seating of the leading edge of the rod in said depressed area by forceably pressing the leading edge of the rod into holding engagement with said depressed area on the said surface while continuing the feed of the remainder

of the rod toward and about said endless surface without interference from the leading edge of the rod held within the depressed area and wrapping said leading edge about the circumference of the depressed area.

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