EXPANDING MANDREL ASSEMBLY

Anatol Michelson, Morton, Pa., assignor to E. W. Bliss Company, Canton, Ohio, a corporation of Delaware
Filed Dec. 15, 1967, Ser. No. 699,943

Int. Cl. B65h 75/24

U.S. Cl. 242—72.1

5 Claims

ABSTRACT OF THE DISCLOSURE

An improved expandable and contractible mandrel assembly which includes an elongated mandrel shaft cantileveredly mounted for horizontal rotation about its longitudinal axis. A plurality of elongated arcuate segment members are carried by the shaft and define the outer mandrel surface. Cam means positioned between the segments and the shaft function to produce radial movement of the segments relative to said shaft when relative movement takes place between the segments and the shaft in a direction along its axis. Additionally, power means are provided for selectively moving the shaft and segments simultaneously an equal amount in opposite directions along the axis so that expansion and contraction of the mandrel takes place without longitudinal movement of the segments relative to the foundation.

The present invention is directed toward the winding and rolling art, and, more particularly, to an improved expandable mandrel assembly.

The invention is especially suited for use as a pay-off reel assembly for paying-off coils of metal strip in rolling mills and will be described with particular reference thereto; however, it will be appreciated the invention is capable of broader application and could be used for winding-in or paying-off a variety of types of material in winding installations.

During the process of cold rolling metal strip, the strip, in the form of a wound coil, is positioned on a pay-off reel or mandrel which holds the coil aligned with the mill center line. The mandrel is mounted for horizontal rotation and is provided with means, such as a D.C. drag generator, for rotating and/or applying a braking force to the mandrel and, consequently, the coil.

Normally, the mandrels are radially expandable and contractible so that they can be contracted for easy insertion in the coil's center opening, and then expanded to firmly hold the coil and transmit the braking force required during the pay-off operation. A wide variety of different expanding mandrel assemblies have been utilized. One of the most commonly used comprises an elongated main mandrel shaft provided with a plurality of longitudinally extending arcuate segments which define the outer surface of the mandrel. Cam or wedge members are positioned between the segments and the main shaft. These members are arranged so that as the segments are selectively moved longitudinally of the main shaft, they are given a radial component of motion, i.e. the mandrel is expanded or contracted.

Generally, the segments are driven longitudinally of the main shaft by a rotary hydraulic cylinder connected with the segments by a rod which extends through an axial bore in the main shaft.

Although this arrangement has been generally satisfac-
FIGURE 6 is a view similar to FIGURE 3, but showing the mandrel in the expanded condition; FIGURE 7 is an end view of the mandrel taken on line 7-7 of FIGURE 3; FIGURE 8 is a cross-sectional view taken on line 8-8 of FIGURE 3; and, FIGURE 9 is a cross-sectional view taken on line 9-9 of FIGURE 6.

Referring now specifically to the drawings wherein the showings are for the purpose of illustrating the preferred embodiment of the invention only and not for the pur-
pose of limiting the invention, FIGURE 1 shows the overall ar-
rangement of the improved expandable and contractible mandrel assembly A which includes the mandrel 10 sup-
ported in cantilever arrangement from a frame and drive housing unit 12. Additionally, the assembly includes power means 14 for expanding and contracting the mandrel 10 and, for reasons which will hereafter become apparent, shifting the frame 12 in directions along the axis of rotation of the mandrel.

Referring specifically to FIGURES 1 and 3, it is seen that mandrel 10 comprises a main central mandrel shaft 16 which is cantileverly mounted in frame 12 for rotatory movement about the longitudinal axis 18. Shaft 16 is mounted in suitable bearings 20 and 22 which are respectively carried in the side plates 24 and 26 of frame 12. Positioned about the outer end 30 of shaft 16 are a plurality of elongated segments of arcuate cross-section. In the preferred embodiment four of the segments 32 are provided, each of which is substantially identical; how-
ever, it is apparent that a fewer or greater number of the segments could be provided and that the segments could differ in detail from one another. Because the segments are shown as being identical, only one will be described in detail and its description is to be considered as equally applicable to the other 3 segments. Additionally, like reference numerals have been utilized to indicate the com-
mon elements in each segment. Specifically, referring to FIGURE 3, it is seen that the arcuate segment 32 includes a first arcuate member 34 which has a cross-sectional extent of approximately 90° and has an inner surface adapted to generally conform with the outer surface of the outer end portion 30 of shaft 16. Connected to the outer surface of member 34 is a second arcuate member 38 which is of an arcuate extent of greater than 90°. The members 38 are positively connected to their res-
pective member 34 in any convenient manner, such as for example, by the use of a plurality of machine screws 40. The limiting extent of each of members 38 is provided with a plurality of alternate recesses 42 and tab portions 44 which are arranged so that when the segments 34 are contracted radially inward, as shown in FIGURE 8, the tabs 44 and the recess 42 of the adjacent edges of the respective segments 32 interfitt to define a relatively con-
tinuous outer mandrel surface.

Positioned between the segments 32 and the mandrel shaft 16 are cam means which function to produce radial movement of the segments 32 relative to the shaft 16 in response to relative longitudinal movement between the shaft and the segments. These cam means could take a variety of specific forms but are shown as being com-
prised of three cam or wedge units 50, 52 and 54. One set of said cam or wedge units are positioned between each of the respective segments 32 and the mandrel shaft 16. Specifically, cam or wedge unit 50 comprises a plate member 56 which is connected to the inclined outer end portion of shaft 16 by a screw 58. Preferably, plate 56 is formed from a hardened metal to provide a good wear surface for the sliding movement which takes place on it. As best shown in FIGURE 5, the sides of plate 56 flare outwardly and are received in a correspondingly shaped groove 60 formed in the underside of the end of member 34. This maintains the member 34 on the shaft 16 while permitting it to move diagonally relative thereto to produce the required radial component of motion. The specific angle of inclination of the slide surfaces of member 56 and groove 60 are not of particular importance to the invention; however, preferably they are in the range of between 20° and 30° of inclination relative to the axis 18.

The cam or wedge unit 52 includes a first hardened wedge member 62 which has an upper slide surface 64 that is inclined relative to the axis 18 at the same angle as the slide surfaces in cam unit 50. The member 62 is received in an inwardly extending slot or recess 66 formed in the outer surface of reduced end portion 30 of shaft 16. A second generally wedge-shaped member 68 is con-
ected, such as by a screw 70, to the underside of member 34 and is provided with a slide surface 72 arranged to engage the slide surface 64 of member 62.

The cam assembly 54 is generally similar to the cam unit 50 and includes a first cam plate 76 which is con-

ected in a recess 78 formed in the output end of a shaped portion 80 of shaft 16 by machine screw 82. As best shown in FIGURE 4, the sides of plate 76 flare out-
wardly and are received in a similarly shaped groove 84 formed in the underside of the left-hand end of member 34 as viewed in FIGURE 3. The angle of inclination of the slide surfaces of cam plate 76, as shown, is the same as slide surfaces of cam units 52 and 50. Accord-
ingly, as can be readily seen, this arrangement maintains the various arcuate segments 32 on the shaft 16 while producing radial movement of the outer surface of the segments relative to the axis of the shaft 16 when relative movement takes place between the segments and the shaft in a direction along the axis 18 of shaft 16.

In normal operation, the mandrel is moved to its con-
tractions terted position and the coil which is to be unwound is moved into position on the mandrel. The mandrel is then moved to its expanded position and the coil rotated to feed the lead end of the coil to the processing systems such as for example a rolling mill. During the rolling operation, the mandrel is then braked to maintain a tension on the strip as it is unwound from the coil. In the subject embodi-
ment, the means for rotating and/or applying a braking force to the mandrel include a gear train 90 mounted in housing or frame 12. As best shown in FIGURE 1, gear train 90 includes a first large diameter gear 92 which is keyed or otherwise positively connected to the reduced diameter inner end portion 94 of mandrel shaft 16. Gear 92 is in engagement with a second smaller diameter gear 96 which is keyed to a horizontally extending shaft 98 and is rotatedly mounted in bearings 100 and 102 and carried in a side plate 24 and 26 of frame 12, respectively. A third gear 104 is likewise keyed to shaft 98 and is engaged with a fourth gear 106 which is carried on a horizontally extending shaft 108 mounted in suitable bearings 110 and 112 carried in side plates 24 and 26, respectively of the frame 12. The end 114 of shaft 108 is connected through a con-
vention coupling 116 to the output end of a D.C. drag generator 120. As is common practice, by regu-
ulating the functioning of D.C. drag generator 120 either a braking force or a driving force can be applied to the mandrel 10. In order to lock the drive in any selected posi-
tion and to prevent any rotation of the mandrel shaft, a conventional magnetic brake 122 is arranged to engage the left-hand end of the main rotor shaft 124 of the D.C. drag generator 120.

As shown the D.C. drag generator 120 and the mag-
netic brake 122 are mounted on a common welded plate frame 126 which is in turn positively connected, such as by bolting or welding, to a base plate 128. For reasons which will hereafter become apparent, the frame 126 is also connected to the same base plate 128.

As previously discussed, one of the main problems with prior winding reel assemblies was that during ex-
pansion and contraction the outer mandrel segments shifted horizontally relative to the mill or process center line which made alignment of the coil with the mill cen-
ter line difficult. In accordance with the present inven-
tion, this problem is overcome by an arrangement which simultaneously moves the mandrel shaft 16 and the outer segments 32 equal amounts in opposite directions during the mill center line operation. Referring specifically to FIGURES 3 and 6, it is seen that at the inner end portions of the members 34 of the respective segment members 32 there are provided upwardly extending boss or tab portions 130. Tab or boss portions 130 are pivotally connected by the pivot pins 134 to the respective pivot pins 134. The pivot pins are maintained in position in any convenient manner such as through the use of the snap rings 136. The outer ends of the link plates 134 are pivotally connected through pivot pins 137 with upwardly extending tabs or bosses 138 formed on a collar member 140. As shown in FIGURE 4 pins 137 are likewise maintained in position by snap rings 142.

Referring to FIGURES 3 and 6, it is seen that the collar 140 surrounds the somewhat larger diameter portion 146 of shaft 116. The collar is permitted to move longitudinally of the shaft, while prevented from having any circumferential movement relative thereto, by an axially extending key member 148 which is engaged in corresponding grooves formed on the outer surface of shaft portion 146 and the inner surface of collar member 140. As can be seen, by moving collar member 140 in a direction along the axis 18 of shaft 16 the segments 32 can be moved longitudinally in the same direction and, by virtue of the cam units, caused to move radically of the shaft 16.

Although any of a variety of means could be utilized for selectively moving collar member 140, according to the preferred embodiment, the means utilized comprise a rotatable member 150 which is arranged for face rotation in the frame 12 by a pair of conventional thrust bearings 152 and 154, respectively. A bearing retainer plate 156 is connected to frame 12 by screws 158 and functions to maintain member 150 and the bearings from partaking of any axial movement. As shown, the inner diameter of member 150 is threaded, as shown at 159, and engages corresponding threads 160 formed on the outer surface of the inner end of member 140. Accordingly, rotation of member 150 causes the member 140 to be shifted axially of shaft 16.

The means for selectively rotating member 150 include a pinion gear 162 which is rotatably mounted through bearings 164 on the outer end of a shaft 166 which extends horizontally through the frame 12 and is mounted in suitable bearings 168. Pinion gear 162 engages corresponding gear teeth 170 formed on the outer periphery of rotatable member 150. As can be seen, normally rotation of the shaft 166 will cause the rotation of rotatable member 150 and rotation of pinion gear 162; however, because pinion gear 162 is rotatably mounted on shaft 166 no driving rotation will be conducted to shaft 166. However, means are provided to allow pinion gear 162 to be positively connected to shaft 166 so that when the mandrel is not rotated the shaft 166 can be driven to shift the mandrel sections 32. For this reason a conventional clutch, shown in the form of a magnetic clutch 174 has one clutch half keyed to the outer end of shaft 166 and the other half carried on a collar which is connected with pinion gear 162. Accordingly, clutch 174 causes a driving connection to be provided between the pinion gear and the shaft 166.

Any of a variety of power means could be utilized for rotating shaft 166; however, in the preferred embodiment the means utilized comprise a conventional reversible hydraulic motor driven by a right angle reducer drive 182 with shaft 166. As shown, the output shaft 184 of the reducer is connected through a conventional coupling 186 with the left-hand end of shaft 166. As is apparent, depending upon the direction of rotation of motor 180, the mandrel 10 will be either expanded or contracted as desired.

In order to prevent the expansion and contraction of the mandrel from producing the undesired transverse movement of the outer mandrel shaft 32 relative to the mill center line, or allowing multiple shifting of the shaft 16 in a direction opposite to the axial direction of movement of the segments 32. In the preferred embodiment, this is accomplished by mounting the frame 12 as well as, the D.C. drag generator 120 and the friction brake 122, on common base plate 128 and mounting the base plate in a slide way formed in a main base 190. As shown, base 190 is of welded plate construction and comprises a top plate 192 and a bottom plate 194 interconnected by a plurality of vertically extending plates 196. The outer longitudinal edge of plate 198 is inclined and mates with correspondingly shaped slide way forming members 198 connected to the top of plate 192 by machine screws 200. Accordingly, the entire expanding reel assembly A can be moved in a direction along the axis 18. In order to provide simultaneous movement of the machine A in the direction opposite to the direction of movement of the segments 32, the left-hand end of output shaft 194 of the reducer unit 182 (as viewed in FIGURE 1), is connected through a coupling 202 with a threaded shaft 204. The threaded end portion 206 of shaft 204 is received in a thrust nut 208 which is positioned between upwardly extending portions 210 of a member 212 which is positively connected to the top plate 192 of base 190. A key member 213 prevents rotation of nut 208 relative to member 212 while permitting it to be "floatingly" carried thereby. Accordingly, rotation of motor 180 produces simultaneous movement of the reel assembly A in a direction along axis 18. By proper selection of the lead of the threads 206, and the relative sizes of gear 162 and member 150, as well as threads 159 and 160, it is a simple matter to assure that the rotation of motor 180 produces simultaneous movement of the shaft 16 and the segments 32 equal amounts in opposite directions.

In order to prevent the reaction forces acting through shaft 206 from being conducted back to the right angle gear reducer unit 182, a thrust receiving assembly 211 is attached to the left-hand end of plate 128. This thrust assembly 211 is of conventional design and includes conventional thrust bearings which engage opposite sides of shaft 214 formed on shaft 206. Accordingly, rotation of the shaft causes the actuated directed forces to be carried by thrust unit 212 and conducted to plate 128 for moving the unit.

As can readily be seen, this arrangement provides a simple means for expanding and contracting mandrel 10 while permitting the outer mandrel segments 32 from having any movement in a direction along axis 18 relative to the foundation or center line of the mill.

The invention has been described in great detail sufficient to enable one of ordinary skill in the winding and reeling art to make and use the same. Obviously, modifications and alterations of the preferred embodiment of the invention will occur to others upon a reading and understanding of the specification and it is my intention to include all such modifications and alterations as part of my invention so far as they come within the scope of the appended claims.

Having thus described my invention, I claim:

1. An improved expandable and contractible mandrel assembly comprising: an elongated mandrel shaft cantileverly mounted for horizontal rotation about its longitudinal axis; a plurality of elongated arcuate segments carried by said shaft and defining the outer mandrel surface; a common base plate; a right angle reducer provided on said shaft and said segments and said shaft in a direction along said axis; and, power means for selectively moving said shaft and said segments an equal amount in opposite directions along said axis.
2. The assembly as defined in claim 1 wherein said mandrel shaft is mounted by a frame and wherein said power means moves both said frame and said shaft in a direction opposite to said segments.

3. The assembly as defined in claim 2 wherein said power means includes: a collar member slidably mounted on said shaft and connected with said segments and, a rotatable member threadedly connected with said collar and arranged, when rotated, to move said collar member longitudinally of said shaft.

4. The assembly as defined in claim 3 wherein said power means includes means for simultaneously rotating said rotatable member and moving said frame.

5. The assembly as defined in claim 3 wherein said frame is mounted in a slideway and said power means includes means for moving said frame along said slideway.

References Cited

UNITED STATES PATENTS
2,271,139 1/1942 Holdgate et al. 242—72.1
3,144,996 8/1964 Engel 242—72.1

NATHAN L. MINTZ, Primary Examiner