EXPANDIBLE MANDREL ASSEMBLY

Inventors: John Gross; Arthur L. Lind, both of Salem, Ohio

Assignee: Gulf & Western Industrial Products Company, Grand Rapids, Mich.

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Primary Examiner—Stanley N. Gilreath
Assistant Examiner—Gregory A. Walters
Attorney—Meyer, Tilberry and Body

ABSTRACT

An expandible and contractible mandrel assembly of the type used for coiling metal strip. The disclosed assembly includes means permitting both lubricant and cooling fluid to be supplied internally of the mandrel during mandrel rotation.

8 Claims, 4 Drawing Figures
EXPANDIBLE MANDREL ASSEMBLY

The present invention is directed toward the winding and reeling art and, more particularly, to an improved expandible mandrel of the type used for winding metal strip.

The invention is especially suited for use as a hot strip downcoiler mandrel and will be described with particular reference thereto; however, as will be appreciated, the invention is capable of broader application and can be used in winding and reeling of many types of materials under widely varying operating conditions.

During the manufacture of hot rolled metal strip, the strip is normally coiled on a mandrel after it leaves the last mill stand. Typically, the mandrel is cantileverly mounted and arranged to be expanded and contracted so that the coiled strip can be easily removed.

Generally, means are provided for supplying lubricant to the internal parts of the mandrel while the mandrel is at rest. Additionally, since the mandrel is subjected to intense heat, means must be provided for cooling it. Normally, cooling is accomplished by water cooling applied externally to the outer surfaces of the mandrel. Since the outer surfaces of the mandrels are subjected to extreme heat following by sudden cooling, this method of cooling has caused the surfaces to become heat checked and cracked.

Although mandrels have been designed with provision for lubrication of the internal parts during mandrel rotation, the typical design has permitted lubrication only while the mandrel is stationary. Likewise, some mandrels have been designed so that cooling water can be circulated internally of the mandrel during rotation; however, it has not been possible to supply both cooling water and lubricant internally of the mandrels.

The subject invention provides an expandible mandrel assembly wherein both lubricant and a cooling fluid can be simultaneously supplied to the interior of the mandrel during mandrel rotation. According to the invention, the mandrel includes a main, horizontally extending shaft having outer segment members carried therein. Means are provided for shifting the segment members radially of the shaft. The shaft is rotatably mounted in cantilever fashion means are provided for supplying both cooling fluid and lubricant centrally of the shaft during mandrel rotation.

Accordingly, the primary object of the invention is the provision of a mandrel wherein both lubricant and cooling water can be simultaneously supplied to the mandrel during mandrel operation.

Another object is the provision of a cooling mandrel wherein cooling water can be supplied centrally through the mandrel for distribution against the undersides of the members which form the winding surface of the mandrel.

Yet another object is the provision of an expandible mandrel wherein grease or other lubricant can be continually supplied to the mandrel during mandrel operation.

Still another object is the provision of an expandible mandrel of the type described which is simple to manufacture and reliable in operation.

These and other objects and advantages will become apparent from the following description when read in conjunction with the accompanying drawings wherein:

FIGS. 1, 1a, & 1b are a longitudinal cross-sectional view through an expandible mandrel in accordance with the preferred embodiment of the invention; and,

FIG. 2 is a cross-sectional view taken on line 2—2 of FIG. 1.

Referring now to the drawings wherein showings are for the purpose of illustrating a preferred embodiment of the invention only, and not for the purpose of limiting same, FIGS. 1, 1a and 1b show the overall arrangement of the expandible mandrel assembly comprising the cantilever supported mandrel section A the support and drive section B and the fluid and lubricant supply section C.

The actual details of the mandrel section A are not of particular importance to the invention; however, in the preferred embodiment shown the mandrel includes a main, elongated central support shaft 10 which is mounted for rotation about a horizontal axis. Carried on the shaft 10 and extending longitudinally thereof are segments 12 which define the mandrels winding or support surfaces. The particular number of segments provided could be varied but as shown in FIG. 2, the described embodiment includes four of the sections 12 each having an outer arcuate extent of approximately 90°. Additionally, the segments have finger-like portions 13 along their mating edges.

As is customary, the segments 12 are arranged to be expanded and contracted relative to the center shaft 10 so as to vary the effective outer diameter of the mandrel. The means for producing the expansion and contraction of the outer segments 12 comprise cooperating wedge surfaces carried on the underside of the segments 12 and the outer surface of the shaft 10. As best shown in FIGS. 1 and 2, the underside of each of the segments 12 includes a plurality of inclined wedge surfaces 14. The wedge surfaces 14 could obviously be formed on separate elements connected to the segments 12; however, in the embodiment under consideration, they are formed integrally with the segment. Carried on the shaft 10 and arranged for cooperation with the wedge surfaces 14 are wedge bar members 16 each having a plurality of outwardly facing inclined wedge surfaces 18. The surfaces 18 are arranged to cooperate with respective ones of the surfaces 14 so that when the segments are moved axially of the central shaft 10 they are caused to have a radial component of motion. The direction of longitudinal movement determines whether the mandrel is expanded or contracted.

The wedge bar members 16 are connected to the inner shaft 10 by being received in longitudinally extending grooves 20 having outwardly extending recesses 22. The wedge bars 16 each include similar outwardly extending portions 24 which are received in the recesses 22. This, in effect, keys the wedge bars to the shaft 10. The wedge bars 16 are maintained in the recesses by a washer 26 which is clamped against the outer end of the wedge shafts by a nut 28 received on a reduced diameter threaded end portion 30 of the shaft 10. The nut 28 is retained on the shaft 10 by a split retainer ring 32 which is received in a groove 34 formed in the shaft 10. At the inner end of the mandrel assembly A, the wedge bars 16 are retained in recesses 36 by retainer members 38 connected to the shaft 10 by machine screws 40. As will be noted, the inner end of the segments 12 have a reduced portion 42 which extends under a recess 44 formed in the respective retainer plate 38.
As can be appreciated, by moving the segments 12 axially of the support shaft 10 they are caused to move in a radial direction. The means for moving the segments longitudinally comprise a push-pull rod member 50 which extends through a central opening 52 formed axially of the support shaft 10. The rod 50 is arranged for free axial movement relative to the support shaft 10 by being carried in sleeve bearings 54 and 55 at opposite ends of support shaft 10.

At its outermost end the rod 50 is drivenly connected to the outer ends of the segments 12 in a manner which permits the segments to move outwardly of the shaft. In the subject embodiment, this is accomplished by a spider member arrangement 54. The spider member assembly includes a threaded inner member 56 which is threadedly received on the threaded end portion 58 of the rod 50. A second generally annularly shaped member 60 is carried on the outer threaded periphery of the member 56. As can best be seen from FIG. 1, the member 60 extends outwardly into grooves or recesses 62 formed at the outer end of each of the segments 12. The members 60 and the corresponding recess 62 include overlapping portions 64, 66 respectively. The member 60 is locked on the member 56 by member 67 and nut 69.

The mandrel assembly A is mounted by a support assembly B so as to extend horizontally for rotation about its longitudinal axis. The support assembly B is best shown in FIGS. 1a and 1b. As shown, the inner end of the support shaft 10 has a reduced diameter portion 65 which is received in a sleeve member 70. The sleeve member 70 is keyed to the support shaft 10 by a key member 72 that extends between grooves formed in members 10 and 70. As can be seen, the sleeve member 70 is tapered at its inner end 74 and engages a corresponding taper 76 formed on the shaft 10. The sleeve 70 is retained on the support shaft 10 by a nut 80 threadedly engaged with the end portion 82 of the shaft 10. The tightening of nut 80 causes the sleeve 70 to be firmly locked into engagement with the shaft 10. As will be noted, the outer sleeve 70 is rotatably mounted in bearings 84, 86. The bearing 84 is in turn supported by any suitable frame structure 88. Bearing 84 is retained on the sleeve 70 by a retainer ring 90 keyed to the sleeve 70 by a key 92. A nut member 94 binds the retaining ring 90 against the inner race of the bearing 84 and forces it against the outwardly extending flange 96 flange 96 formed on the sleeve 70. The bearing 86 is similarly arranged and locked against a flange forming ring 100 by a retainer ring 102 keyed to the sleeve 70 by a key 104. A nut member 106 binds the retainer ring against the bearing.

The mandrel assembly can be driveingly rotated in any convenient manner. In the embodiment under consideration, the mandrel is rotated by a drive assembly (not shown) acting through a gear 108 keyed to the sleeve 70. As shown, the gear 108 is received on the sleeve and positioned between a radially extending flange 110 and member 100.

The apparatus thus far described is of a somewhat conventional arrangement; however, of particular importance to the invention, is the arrangement whereby the mandrel can be expanded and contracted while both lubricant and cooling water are supplied to the expandable mandrel section during its rotation. Referring in particular to FIG. 1b, it will be noted that the means for actuating the push-pull rod 50 comprise a double-acting cylinder 112 which is drivenly connected to the push-pull rod 50. The rotating hydraulic cylinder 112 includes a central cylinder forming portion 114 having end plates 116 and 118 releasably connected thereto by machine screws 120. The end plates 116, 118 are sealed, for example, by O-rings 122 received in grooves formed in the end plates.

Positioned within the cylinder forming member 114 is a piston assembly 124. The piston assembly 124 can be of a variety of types but is shown as comprised of a first annularly shaped piston 126 carried on a piston rod 128. The piston rod 128 has an outward extending flange portion 130 which engages one face of the piston member 126. A nut member 132 is received on the threaded portion 134 of the piston rod 128 to lock the piston 126 against the flange 130. A lock nut 134 is provided to hold the nut 132 in position.

The left hand end of the piston rod 128 is connected to the rear end of the push rod 50. In the embodiment under consideration, the piston rod 128 and the rear end of the push-pull rod 50 are connected by a split ring adapter 138. The adapter 138 merely comprises two semi-circular members 140 having internal tongues received in external grooves 142 and 144 formed externally on the push-pull rod 50 and the piston rod 128, respectively. The two halves 140 of the adapter are interconnected by machine screws.

In the embodiment under consideration, the hydraulic cylinder 112 is free to rotate with the mandrel assembly A. The cylinder assembly 112 has its end plate 116 connected through a split adapter 148 with the innermost end of the mandrel shaft 10. The adapter 148 is similar to adapter 138 and comprises two half sections having inwardly extending tongues formed on their inner surfaces which extend into grooves 150 and 152 formed on the outer surfaces of the shaft 10 and the end plate 116, respectively. The two halves of the connector 148 are interconnected in any convenient manner such as through the use of machine screws.

In order to supply hydraulic fluid to the cylinder 112 to produce the desired expansion and contraction of the mandrel during rotation, the apparatus includes a rotatable fluid connection 160. The connection 160 is arranged so that fluid can be supplied to the cylinder 112 during rotation of the mandrel. In the embodiment under consideration, the connection 160 comprises a cylindrical housing member 162 having and end closure plate 164 connected thereto by plurality machine screw 166. An internal distribution member 167 is mounted within the cylinder member 162 and is sealingly carried therein by a plurality of O-ring member 168. The distribution member 167 is provided with three circumferential rows of openings 170, 172 and 174. These openings are aligned with the fluid supply pipes 176, 178 and 180 respectively. The pipes are received in threaded openings formed in the side of the sleeve or cylinder forming member 162. Although not shown the pipes are respectively connected to the required fluid sources. Extending centrally within the distribution member 167 and sealed therein by plurality of O-ring seals 182 is a shaft member 184. The shaft member 184 is connected to the right hand end of the piston rod 128 by a plurality of machine screws 186. The shaft 184 is rotatably carried within the cylinder 162 by a pair of ball bearings 190 and 192. This permits outer housing to remain stationary while the shaft 184 rotates.
The shaft is sealed where it exits from the housing by a plate 194 and a seal 196.

To cause the piston to be moved in the desired direction, hydraulic fluid is supplied through lines 176 and 178. These lines are connected to chambers 200 and 202 of the rotating hydraulic piston assembly 112. It will be noted that openings 170 in the distribution member 167 are connected through a line 206 which extends through the rod or shaft member 184 and the end of piston rod 128 to the chamber 200. The fluid line 178 is similarly connected to a line 208 with the chamber 202. The motion of the piston and, accordingly, the expansion-contraction of the cylinder are controlled by controlling the admission of the hydraulic fluid through lines 176 and 178. Although the valves and other means required for controlling this fluid are not shown, it should be understood that these can be of any conventional type.

Of particular importance to the invention are the means whereby both lubricant and cooling fluid may be supplied to the outer mandrel assembly A during its rotation. In particular, the lubricant is supplied through the fluid line 180 and the distributor member 167 to the line 210 which is formed through the shaft 184 and the end of the piston rod 128. This line connects with a central line 212 formed in the left hand end of piston rod 128 and the right hand end of the push rod 50. The line 212 extends into push rod 50 a short distance and is connected by radially extending lines 214 with the annular gap 216 between the bore 52 and push rod 50. This annular gap provides communication between the lines 212 and a plurality of radially extending openings 218 which are bored through the shaft 10 and the wedge members 16. Each of the lines 218 is connected with a cam surface 18. As can be appreciated, this arrangement permits grease to be continuously supplied to the cam surfaces 18 and 14. The supply can take place without regard to whether the mandrel is stationary or rotating or without regard to the position of the segments 12.

The arrangement for permitting cooling water to be supplied to the inner portion of the mandrel includes a rotatable connection 220 which is positioned between the inner end of the sleeve 70 and the rotating hydraulic piston 200. This rotatable connection 220 includes a cylindrical portion 222 closed at its opposite ends by end plates 224. The end plates 224 are connected to the cylindrical member 222 and sealingly engaged with the outer surfaces of the reduced diameter end portion 226 of the shaft 10. Positioned within the cylindrical member 222 and sealingly engaged with the end portion 226 is a distributor member 228. Member 228 is provided with a plurality of radially extending openings 230. The openings 230 provide communication from a fluid supply line 232 and radially extending openings 234. As will be noted, the shaft portion 226 of shaft 210 is mounted so as to be freely rotatable within the sleeve 222. For this reason, the bearings 236 are positioned at opposite sides of the distribution member 228. Additionally, it should be understood that the pipes are connected to the supply sources by flexible lines so that during actuation the housings are free to move in the longitudinal direction.

As can be seen, the radially inwardly extending openings 234 connect with longitudinally formed openings or passageways 240. In the embodiment hereunder consideration, there are four of the openings 240 spaced uniformly about the shaft 10. These openings 240 are communicated with openings 242 which extend through the support portion of the shaft 10 to a point beyond the support bearings 84. At that point, radially extending openings 244 connect the passageways 242 with the longitudinally extending passageways 246 which, as best shown in FIG. 1 and 1A, extend through the length of the mandrel section A at locations between each of the wedge or cam bars 16. Connecting between the outer surface of the support shaft and the passageways 246 are a plurality of small spray or outlet openings 250. Referring to FIG. 2 it will be noted that the passageways 246 and the outlets 250 are arranged so as to direct cooling water generally toward the underside of the segments at a location near the juncture of adjacent segments. This permits cooling water to cool both the interior and exterior surfaces of the segments.

The invention has been described in great detail sufficient to anyone of ordinary skill in the art to make and use the same. Obviously, modifications and alterations of the preferred embodiment will occur to others upon the reading and understanding of the specification. 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 expandible and contractible winding mandrel assembly comprising: a rotatably mounted horizontally extending support shaft; a plurality of segment members extending longitudinally of said shaft and defining the outer surface of said mandrel; means for causing said segment members to move radially of said support shaft; first means for continuously supplying lubricant to a position between said segment members and said means for causing said segment members to move radially; and second means for supplying coolant through said support shaft to said segment members.

2. The assembly as defined in claim 1 including means for directing coolant from said support shaft to the undersurfaces of said segment members.

3. The assembly as defined in claim 1 wherein said first means comprises an opening extending longitudinally through said support shaft.

4. The assembly as defined in claim 1 including means for directing said coolant from the support shaft to the undersurfaces of said segments along the lateral edges of said segment members.

5. The assembly as defined in claim 1 wherein said first means comprises a first opening extending longitudinally through the support shaft and connected with a rotary connecting means, and wherein said second means comprises second openings extending longitudinally through said shaft at positions spaced radially and circumferentially of said first opening.

6. The assembly as defined in claim 1, wherein said segment members include cam means facing said support shaft, said means for causing said segment members to move radially include cooperating cam means associated with said support shaft, and said first means includes opening means extending through said support shaft and said cooperating cam means for supplying lubricant between said cam means and said cooperating cam means.

7. The assembly as defined in claim 6, wherein said cam means includes a plurality of first cam surfaces and said cooperating cam means includes a plurality of sec-
ond cam surfaces cooperatively disposed relative to said first cam surfaces, and wherein said opening means includes a lubricant passageway extending longitudinally through said support shaft and lubricant passageway means leading from said lubricant passageway to the area between each of said cooperatively disposed first and second cam surfaces.

8. The assembly as defined in claim 7, wherein said second means for supplying coolant through said segment members includes first coolant passageway means extending longitudinally through said support shaft and second coolant passageway means leading from said first coolant passageway means and directing coolant to said segment members at longitudinally spaced apart locations along the length thereof.