United States Patent

Adair

[15] **3,658,274**

[45] **Apr. 25, 1972**

[54] ROTATABLE MANDREL

[72] Inventor: **James Richard Adair**, Pittsburgh, Pa.

[73] Assignee: **United Engineering and Fenndry Company**, Pittsburgh, Pa.

[22] Filed: **Jan. 19, 1970**

[21] Appl. No.: **3,740**

[52] **U.S. Cl.** **242/72.1**

[51] **Int. Cl.** **B65h 75/18**

[58] **Field of Search** 242/72, 72.1, 46.2, 46.4, 78.1; 279/57, 2

[56] **References Cited**

UNITED STATES PATENTS

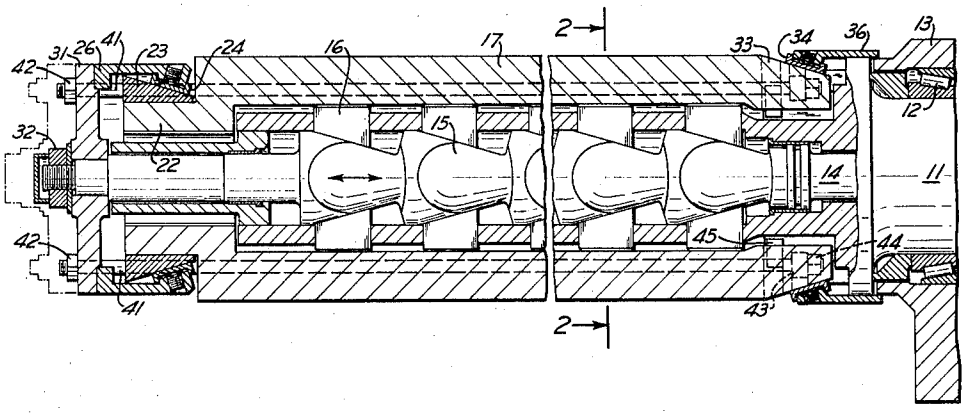
3,443,770	5/1969	O'Brien	242/72.1
2,941,745	6/1960	Perrine	242/72.1
3,379,389	4/1968	O'Keefe	242/72.1
3,456,893	7/1969	Michelson	242/72.1
3,489,363	1/1970	Diolot	242/72.1
3,552,673	1/1971	Evers	242/72.1

Primary Examiner—Stanley N. Gilreath
Assistant Examiner—Milton Gerstein
Attorney—Henry C. Westin

[57] **ABSTRACT**

This disclosure relates to a mandrel for coiling strip as produced by a hot rolling mill. The mandrel includes a rotatable arbor on which a plurality of outer segments are carried. The segments are moved radially relative to the arbor by an axially movable rod carried by the arbor. A piston cylinder assembly moves the rod and, hence, the segments into three radial positions. In order that the segments may be firmly held and supported in these positions, wedges are arranged at the opposite ends of the segments which are engaged by axially movable rings which carry complementary wedges and which are connected to the rod.

5 Claims, 5 Drawing Figures



PATENTED APR 25 1972

3,658,274

SHEET 1 OF 3

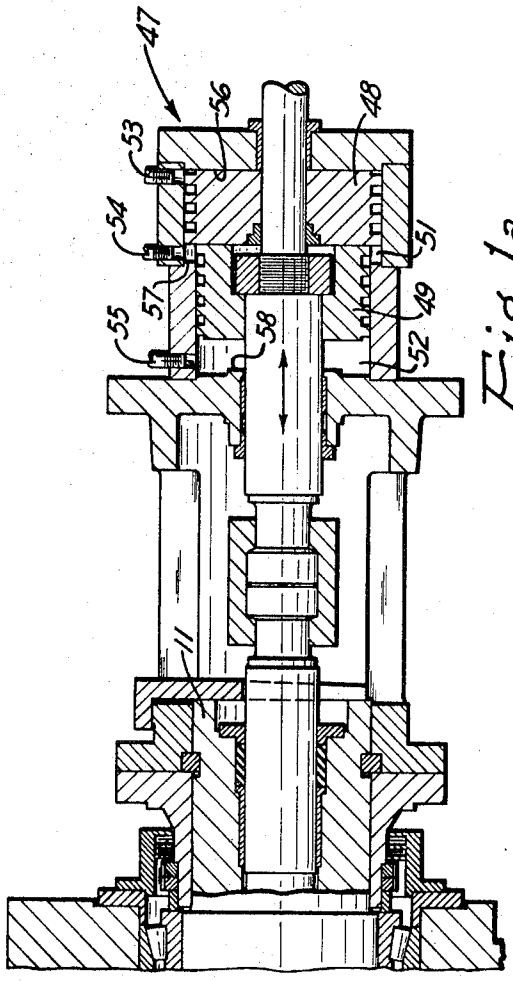


Fig. 1a

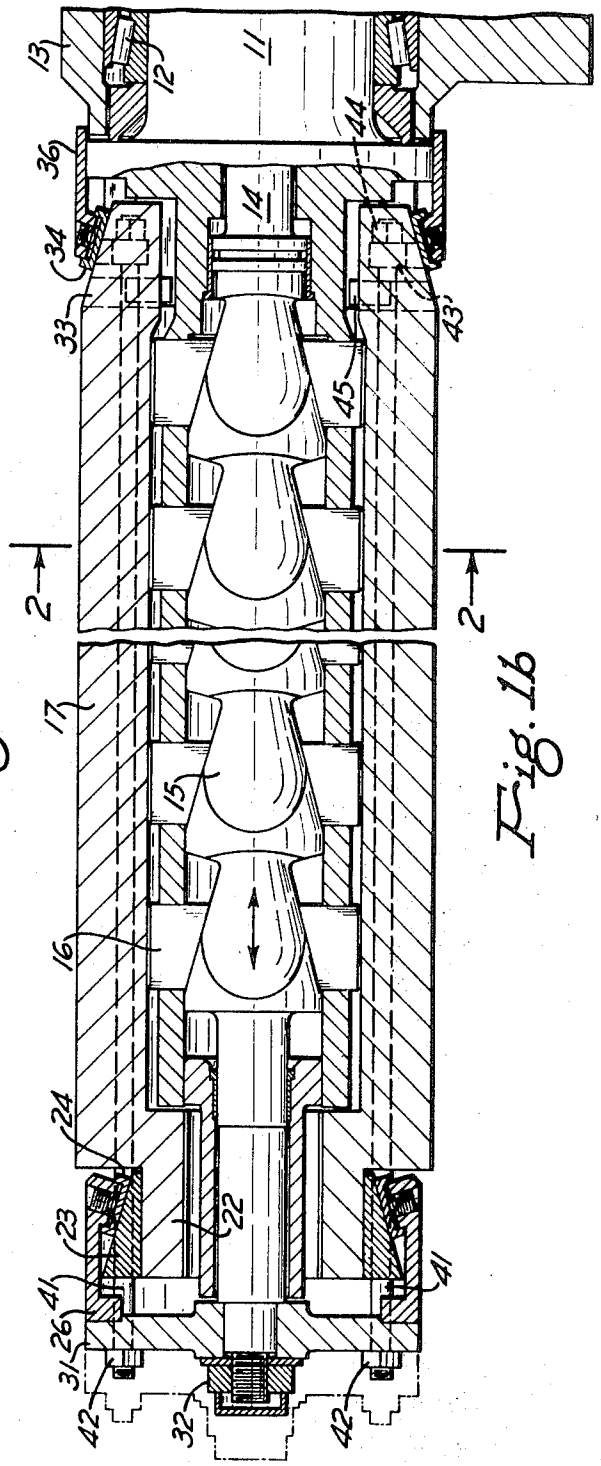


Fig. 1b

INVENTOR.
JAMES R. ADAIR
BY
Henry C. Westin
ATTORNEY.

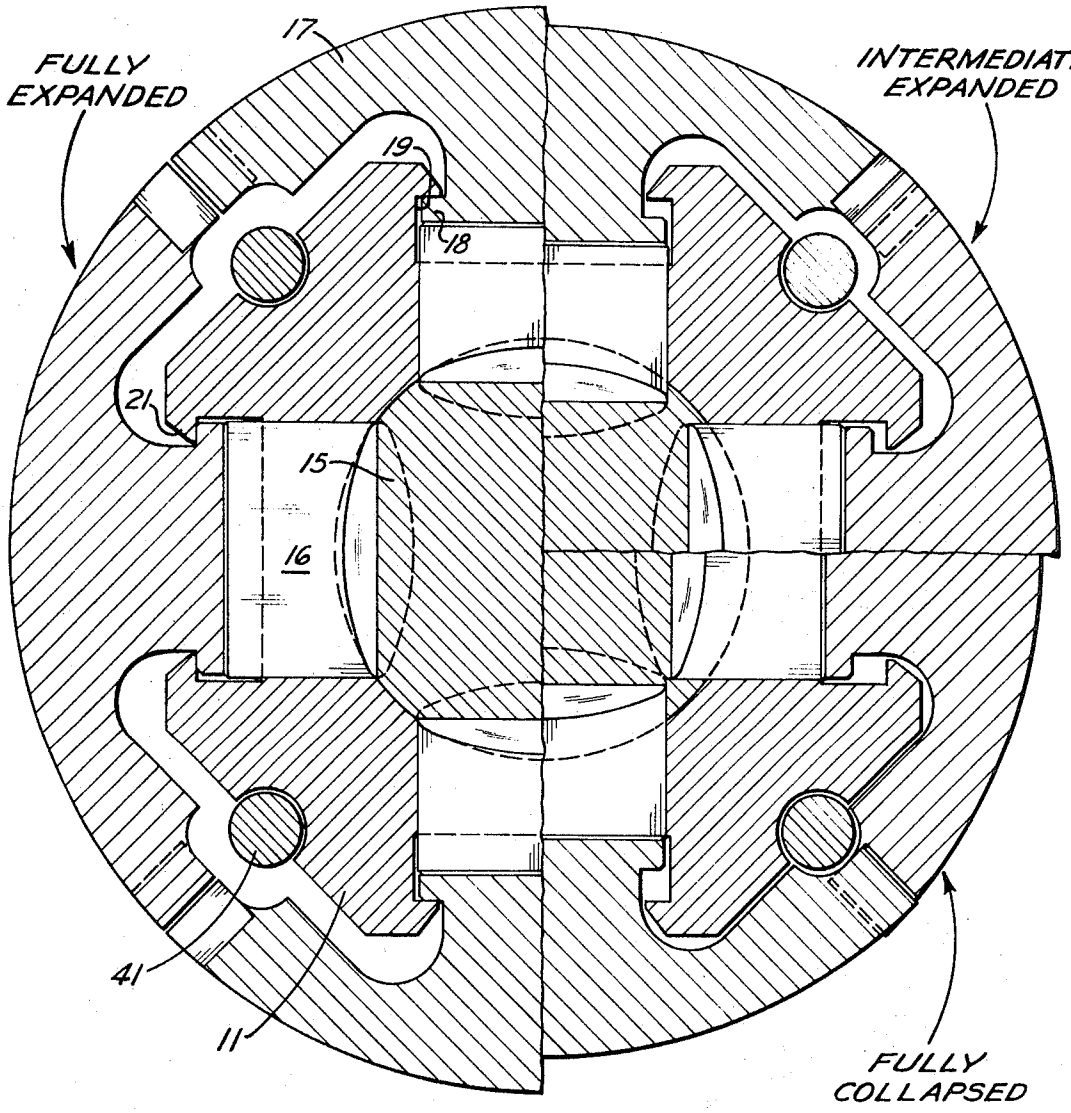


Fig. 2

INVENTOR.
JAMES R. ADAIR
BY
Henry C. Westin
ATTORNEY.

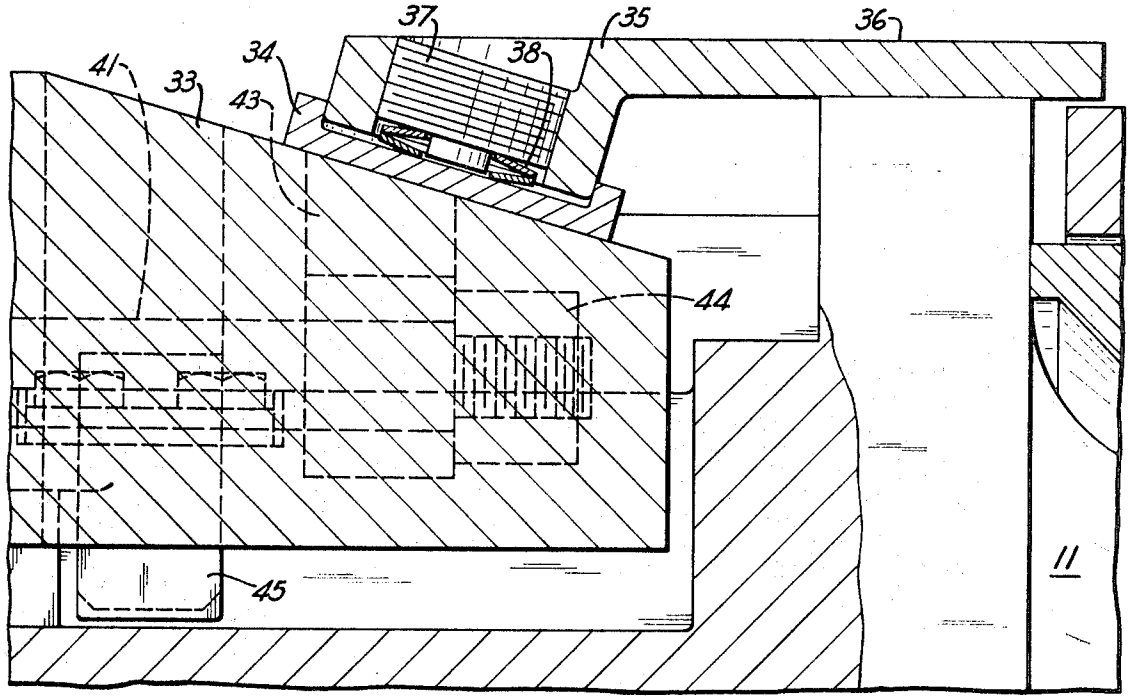


Fig. 3

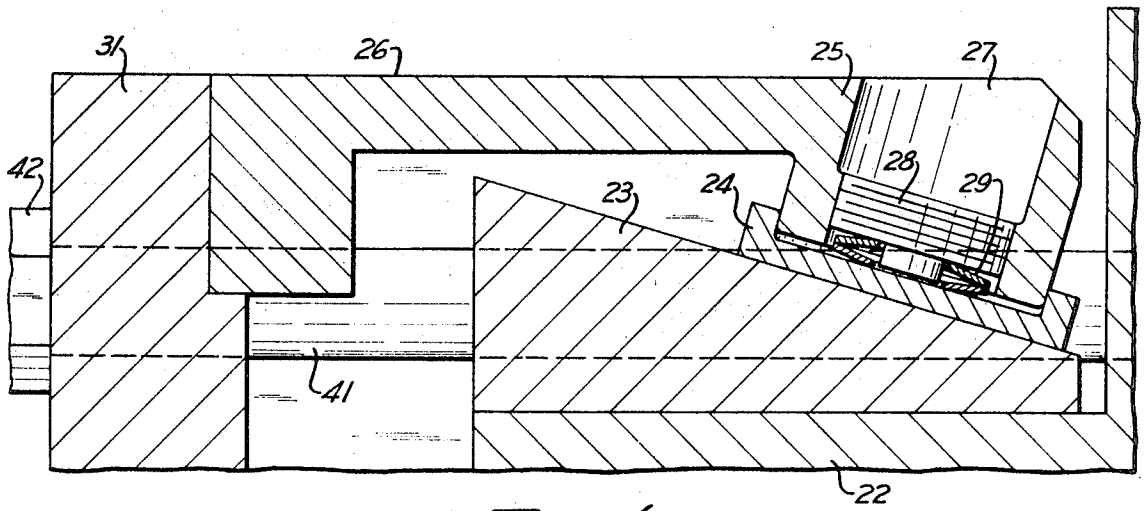


Fig. 4

INVENTOR.
JAMES R. ADAIR
BY
Henry C. Westin
ATTORNEY.

ROTATABLE MANDREL

In the operation of a hot strip rolling mill, it is customary to provide a coiler for coiling the strip as it leaves the mill. The coiler includes a rotatable mandrel which is adapted to be expanded to receive the leading end of the strip and, after a coil is formed, to be collapsed to allow the coil to be removed from the mandrel. In order to form tightly-formed coils, the coils are wound under tension as a result of the differential speed between the last mill stand and the mandrel, in which it is highly desirable to create the tension on the strip as quickly as possible. When rolling and coiling thin strip, this can be done after only a few convolutions have been wrapped around the mandrel. However, in rolling and coiling heavy strip or plate products, the inherent stiffness of the material prevents creating a tension condition until a number of wraps have been formed. In view of this, it has been suggested to provide an intermediate expanded position for the mandrel. In this way, instead of fully expanding the mandrel prior to receiving the material, the mandrel can be brought to an intermediate expanded position and, after the initial wraps are formed on the mandrel, the mandrel can be fully expanded to positively grip the inner wraps and allow a tension to be imposed on the strip issuing to the mandrel. Such a suggestion, however, has not been fully utilized because of the fact that in prior mandrel designs there was no efficient and effective way to hold the segments in a positive way in the intermediate and fully expanded positions, particularly in the intermediate position when subject to the centrifugal force inherent in the operation of the mandrel.

It is, therefore, an object of the present invention to provide a mandrel wherein the segments thereof can be efficiently and effectively held in several different radial positions during the operation of the mandrel.

It is a further object of the present invention to provide a rotatable mandrel having an inner rotatable arbor around which there are positioned a number of outer segments, and a means for moving the segments into at least three different radial positions, wherein there is provided a segment positioning member adapted to engage and support the segments in at least their intermediate radial positions.

It is a still further object of the present invention to provide in a hot coiler mandrel having an inner arbor and a plurality of outer segments which are displaceable in different radial positions relative to the inner arbor, a segment positioning means comprising wedges on the opposite ends of the mandrel in engagement with the segments thereof, wherein one portion of the wedges are automatically movable in a manner to bring the wedges into positive contact with the segments during the various radial positions that the segments may assume.

These objects, as well as other novel features and advantages of the invention, will be better appreciated when the following description is read along with the accompanying drawings, of which:

FIG. 1*a* is a longitudinal sectional view of the drive side of a hot strip coiler mandrel,

FIG. 1*b* is a longitudinal sectional view of the operating side of the mandrel illustrated in FIG. 1*a*,

FIG. 2 is a sectional view taken on lines II—II of FIG. 1*b*,

FIG. 3 is an enlarged sectional view of a portion of the drive side of the mandrel shown in FIG. 1*a* illustrating the adjustable wedge assembly at this side of the mandrel, and

FIG. 4 is an enlarged sectional view of a portion of the operating side of the mandrel shown in FIG. 1*b* illustrating the adjustable wedge assembly at the operating side of the mandrel.

With reference to the drawings and, first, to FIG. 1*b*, there is shown a longitudinally extending arbor 11 which, at the inboard end, is rotatably received in bearings 12 carried in a stationary frame 13 which also houses the gear drive that drives the arbor. The arbor 11 extends towards the left, as one views FIG. 1*b*, and constitutes the inner portion of the mandrel assembly, as can be better seen in referring to FIG. 2. The arbor 11 at its central portion is provided with an axially extending opening in which there is received an actuating rod 14 which,

in the mandrel section, is provided with a number of wedge portions 15 spaced axially along the rod 14, as one views FIG. 1*b*. In engagement with each wedge portion 15 there is a radially extending plunger 16 having, as shown in FIG. 2, a flat surface which complements the flat surface of the wedge portion 15 so that on displacement axially of the rod 14 the plungers, by reason of the wedge action, are displaced radially relative to the arbor 11.

In referring now to FIG. 2, it will be observed that the outer portion of the mandrel is made up of four interfitted segments 17 having inward projections 18 that fit into channels 19 formed in the arbor 11 in such a manner that the segments are displaceable within the channels 19 in radial directions, but are prevented from moving outward beyond the point defined by projecting portions 21 of the arbor. As shown in both FIGS. 1*b* and 2, the plungers 16 engage the inner portion of the projections 18 of the segments, by which means the segments are moved radially relative to the arbor 11.

In referring now to the front of the mandrel, as illustrated in FIG. 1*b*, it will be noted that the segments 17 have stepped portions 22 which, while not shown specifically in the drawing, are indented with respect to the normal width of the segments. On the outer surfaces of the portions 22 of the segments 17 there are secured wedge members 23 having their inclines decreasing in a direction towards the arbor 11. FIG. 4 shows an enlargement of each wedge member 23, in which connection it will be noted that in engagement with each wedge member 23 is a disk 24 arranged at an angle complementary to the incline of the wedge member 23, which angle is defined by the angular adjacent portion 25 of a ring 26. The portions 25 have openings 27 into which there are received threaded lock screws 28 that engage belleville springs 29 which are received between the lower ends of the screws 28 and the inner surfaces of the disks 24. The springs 29 retain the disks 24 in positive engagement with the wedge members 23, yet allow some displacement, such as may be necessary because of thermal expansion and other alignment factors. The ring 26 forms a part of a vertical member 31 located at the extreme outer end of the mandrel. The vertical member of the ring is secured to the actuating rod 14 by a nut 32 so that on movement of the rod the member 31 is displaced, as illustrated in phantom in FIG. 1*b*, which accordingly will displace the wedge disks 24 relative to the wedge members 23.

In referring now to the inward portion of the segments, as illustrated in FIGS. 1*b* and 3, it will be noted that the segments 17 in this region are formed with integral wedge portions 33 and which, as in the case of the portions 22, are of a narrower width than the segments themselves. Each wedge portion 33 is engaged by a wedge disk 34 having a slope complementary to the slope of the wedge 33 as formed by the angle of inclination of portion 35 of a ring 36. The portions 35 receive threaded screws 37, the lower ends of which engage belleville springs 38 arranged between the screws 37 and the inner surfaces of the wedge disks 34. On either side of the portions 22 and 33 and to one side of the wedges 15 and plungers 16, as best shown in FIG. 2, there are arranged four rods 41, the outer ends of which are connected by bolts 42 to the vertical portion 31 of the front ring 26, the opposite end of which is connected to the back ring 36, the connection at the back, as best shown in FIG. 4, being effected through an ear 43 having a nut 44 that connects the end of the rods to the ring 36. Thus, it will be appreciated that upon displacement of the actuating rod 14 and the portion 31 the rods 41 will effect a displacement of the rings 26 and 36 so that the wedges 24 and 34 move relative to the wedges 23 and 33.

With regard to the wedges 15, 23 and 33, it will be observed in FIG. 1*b* that the direction of incline is in the same direction relative to the arbor 11 and that, when the mandrel is expanded, that is, when the actuating rod 14 is moved to the extreme right position as illustrated in FIG. 1*b*, the plungers 16 are at the top of the inclined surfaces of the wedges 15, whereas the wedges 24 and 34 are at the bottom of their mating inclined surfaces. Because of this relationship and the in-

terconnection between the wedges, the wedges **24** and **34** are mechanically synchronized to restrain and hold the segments **17** in their several radial positions in addition to always urging the segments into a collapsed position.

In still referring to the construction of the mandrel itself, it is important to note that at the inboard side, as best shown in FIG. **3**, the segments **17** are connected to the arbor **11** in a manner to hold them against thermal expansion towards the drive side by providing keys **45**. The key construction, however, is such that the segments are free to move radially and are free to expand thermally in a direction towards the operator's side where there is provided sufficient clearance between the portion **22** of the segments and the vertical portion **31** of the ring **26**. This is in view of the fact that the mandrel being discussed is designed to handle hot strip issuing from a rolling mill, which presents the need to consider the thermal expansion of the various parts. Accordingly, the same consideration is given to the rods **41** which are fixedly held by the nuts **42** at the outboard side of the mandrel, but which are allowed to expand in the direction of the drive, in which connection the nut **44** provided at the drive side is allowed to be displaced axially.

In now describing the expanding mechanism for the mandrel which is illustrated in FIG. **1***a*, it consists essentially of the rotating piston cylinder assembly that causes the three movements of the actuating rod **14** and, hence, of the segments **17**. As previously noted, it is a feature of the illustrated mandrel to present the segments **17** in a collapsed position, in an intermediate position and in a fully expanded position, which positions are in legend in FIG. **2**. This is accomplished by providing a double piston cylinder assembly and, as noted previously, the relationship of the mandrel parts is shown in the fully expanded position, in which position the piston cylinder assembly is similarly shown. As illustrated in FIG. **1***a*, connected to the driven arbor **11** and rotatable therewith is a piston cylinder assembly **47** which consists of two relatively movable pistons **48** and **49** received in stepped bores **51** and **52**, respectively. The arrangement is such as to provide pressure chambers, which are best illustrated by referring to their fluid ports, namely, **53**, **54**, and **55**. It is also important to note that the piston cylinder assembly includes a stop surface **56** formed in the inner back wall, a stop surface **57** formed at the center, and a stop surface **58** formed at the front of the cylinder at the inner wall thereof.

When the pistons **48** and **49** of the piston cylinder assembly **47** are in the collapsed position, the piston **48** will be against the surface **57** and the piston **49** will be against the surface **58**. This means that there is a space between the adjacent surfaces of the two pistons and between the piston **48** and the surface **56**. When it is desired to partially expand the mandrel from the collapsed position to the intermediate position for the purpose heretofore described, fluid under pressure is admitted to the port **53**, exhausted at the port **54**, and pressure is admitted to the port **55**. This will keep the piston **48** against the surface **57** and, at the same time, move the piston **49** in a direction towards the piston **48** until it abuts against the piston **48**. This action will move the actuating rod **14** towards the left, as seen in FIG. **1***b*. As long as the two pistons are in this relative position, the mandrel will be held positively in its intermediate position. When it is desirable to bring the mandrel to the fully expanded position, as illustrated in FIG. **1***b*, the pressure is exhausted from the port **53** and the port **54**, but admitted to the port **55**. This will have the effect of forcing the piston **49** against the piston **48** and moving both pistons until the piston **48** contacts the surface **56**. With this movement the actuating rod **14** will also move.

To collapse the mandrel, fluid under pressure is introduced to ports **53** and **54**, and the port **55** is open to exhaust. This will force the pistons **48** and **49** to the left, as one views FIG. **1***a*, causing the piston **48** to abut against the surface **57** and the piston **49** against the surface **58**. This action will, in turn, move the actuating rod **14** to the right, as one views FIG. **1***b*.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof.

I claim:

1. A rotatable mandrel for handling strip-like material comprising:

an inner rotatable arbor,

a plurality of outer segments carried by said arbor in a manner that the segments are movable relative to the arbor in a radial direction incident to the handling of the material by the mandrel,

complementary wedge means for moving said segments to displace them radially,

means arranged on at least one of the ends of said mandrel engageable with said segments for determining the radial positions of said segments,

said segment determining means including wedge means complementary to said wedge means of said means for moving said segments and being mechanically synchronized in relation to said means for moving said segments to provide a positive resistance for the segments in a number of different radial positions.

2. A rotatable mandrel in accordance with claim **1** in which said means for moving said segments includes an axially movable rod,

a wedge assembly having inclined surfaces for each segment arranged between the rod and said segments and intermediate the ends of the segments.

3. A rotatable mandrel in accordance with claim **1** in which said means for moving said segments include a power means adapted to move said segments in unison into a collapsed position, an intermediate position, and a fully expanded position.

4. A rotatable mandrel in accordance with claim **1** including a pair of rings, and wherein said complementary wedge means at the opposite ends of the mandrel are carried by a different one of said separate rings,

means for connecting one of said rings to said means for moving said segments, and

means for connecting said one ring to said other ring so that said rings are displaceable in unison.

5. A rotatable mandrel in accordance with claim **4** including a number of rods in which said rings are connected together by a rod for each segment arranged to pass between said arbor and said segments.

* * * * *