

- [54] **TAPERED POLE MADE OF VARIABLE WIDTH METAL STRIPS**
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- [52] **U.S. Cl.** ..... 138/150; 138/130; 138/154; 29/477.3
- [51] **Int. Cl.** ..... **F16I 9/16**
- [58] **Field of Search** ..... 138/150, 154, 130, 144, 138/DIG. 11; 29/477.3; 156/189, 190, 195

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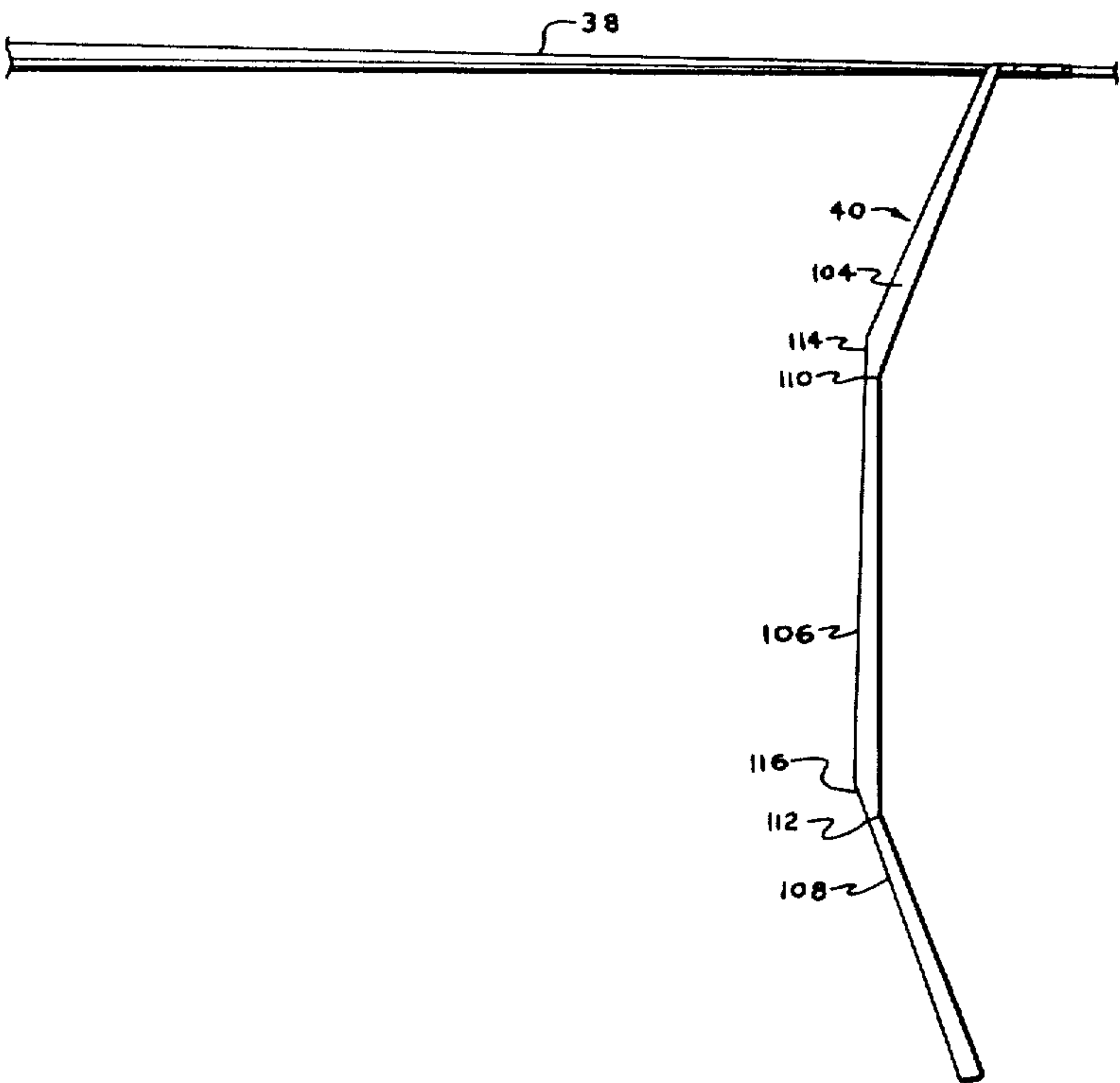
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[57] **ABSTRACT**

A tapered pole design and a method and apparatus for producing tapered poles are provided. The apparatus includes a tapered mandrel, means for rotating the mandrel, means for directing a tapered strip onto the mandrel, and means for placing the strip in tension as it is wound on the mandrel in a pseudo-helical manner. The tapered strip is preferably curved or formed in several segments attached together in end-to-end relationship at angles formed between the first strip segment and subsequent ones. Longitudinally-extending edge portions of the tapered strip preferably slant downwardly to the plane of the strip prior to being wound on the mandrel. This counteracts a tendency for the edges of the strip to curl up when wound under tension. The pole can be removed from the tapered mandrel by a spinning technique or by employing a collapsible mandrel. The pole itself can be made from two separate tapered strips which are wound in opposite directions to provide a double wall tapered pole of maximum strength and stiffness.

2 Claims, 16 Drawing Figures



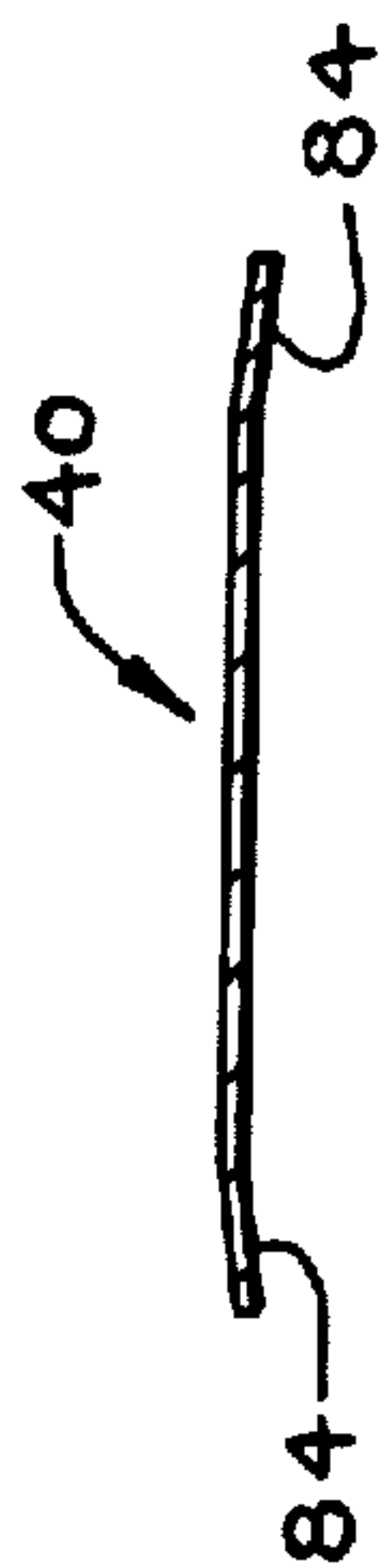


FIG. 5

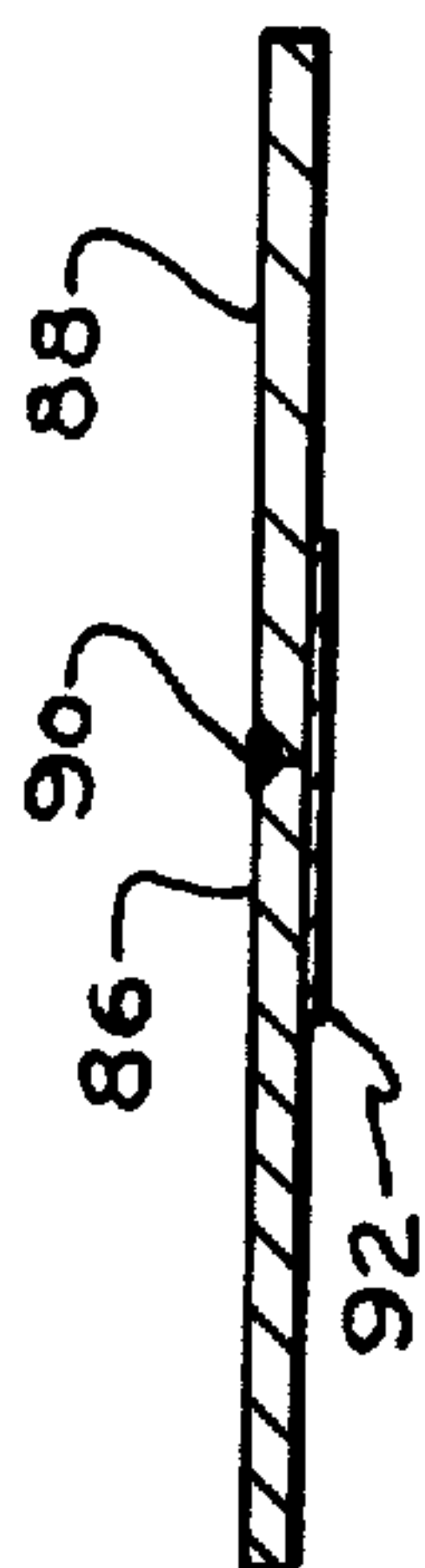


FIG. 6

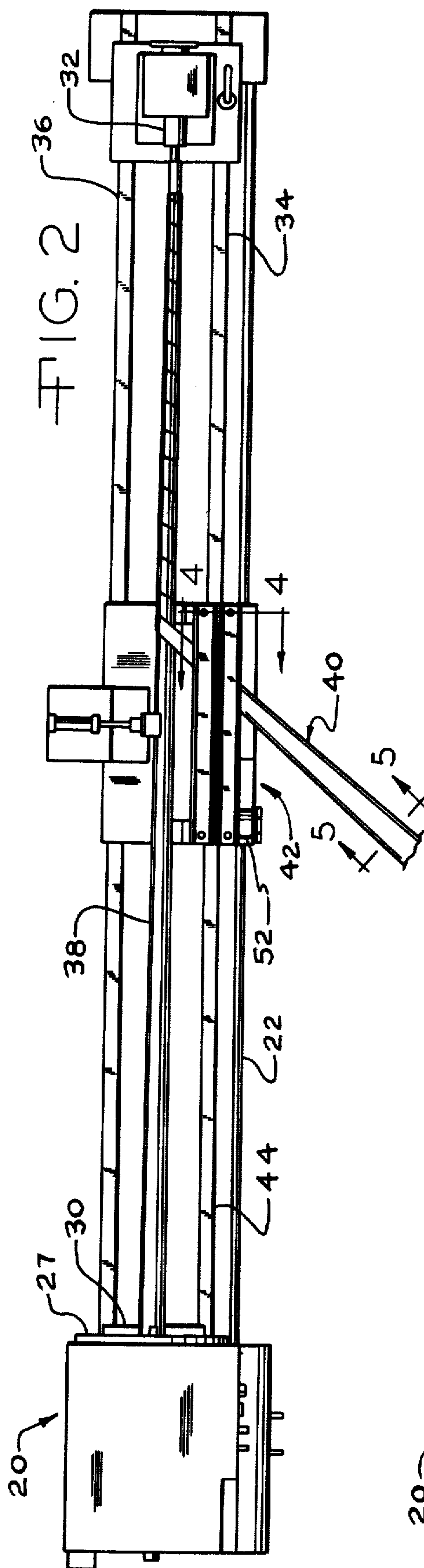


FIG. 2

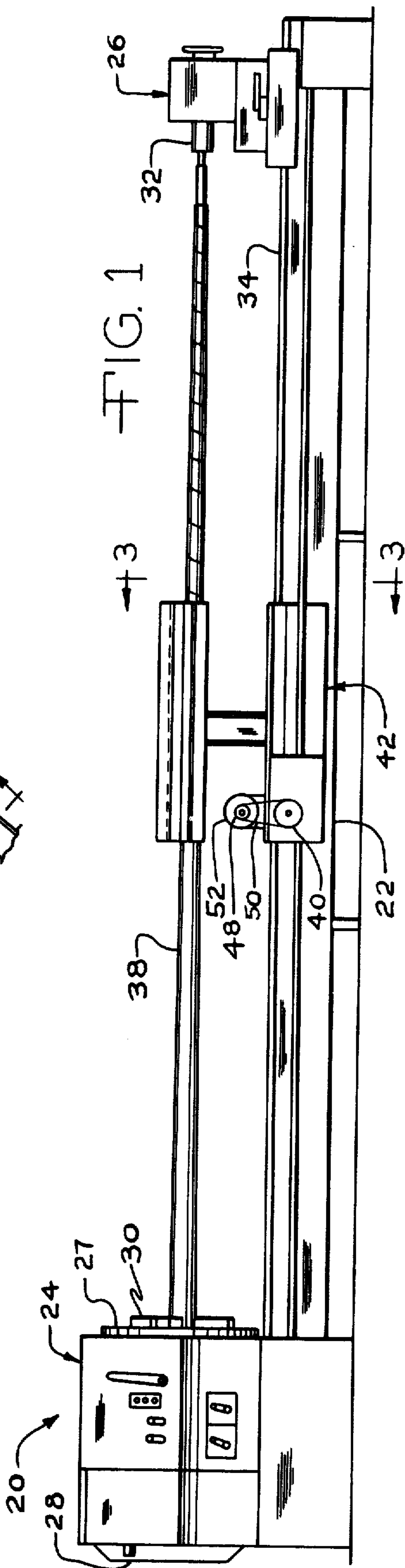


FIG. 1

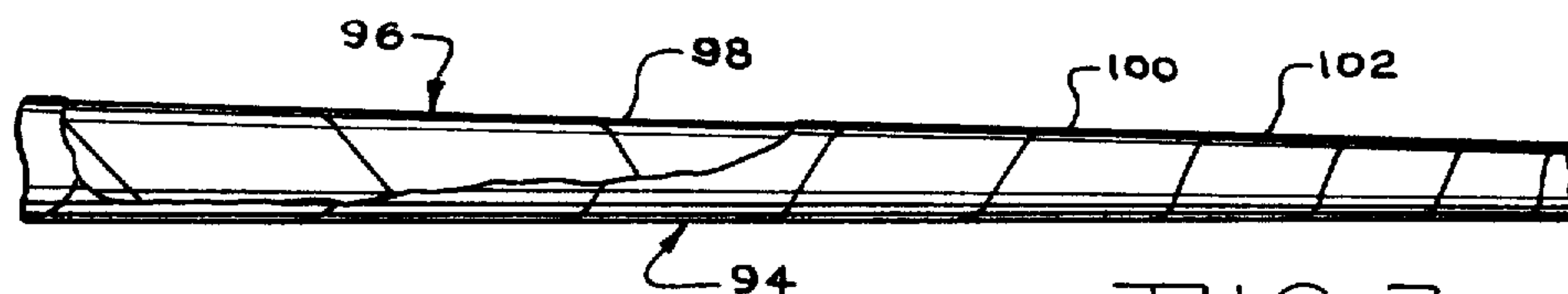


FIG. 7

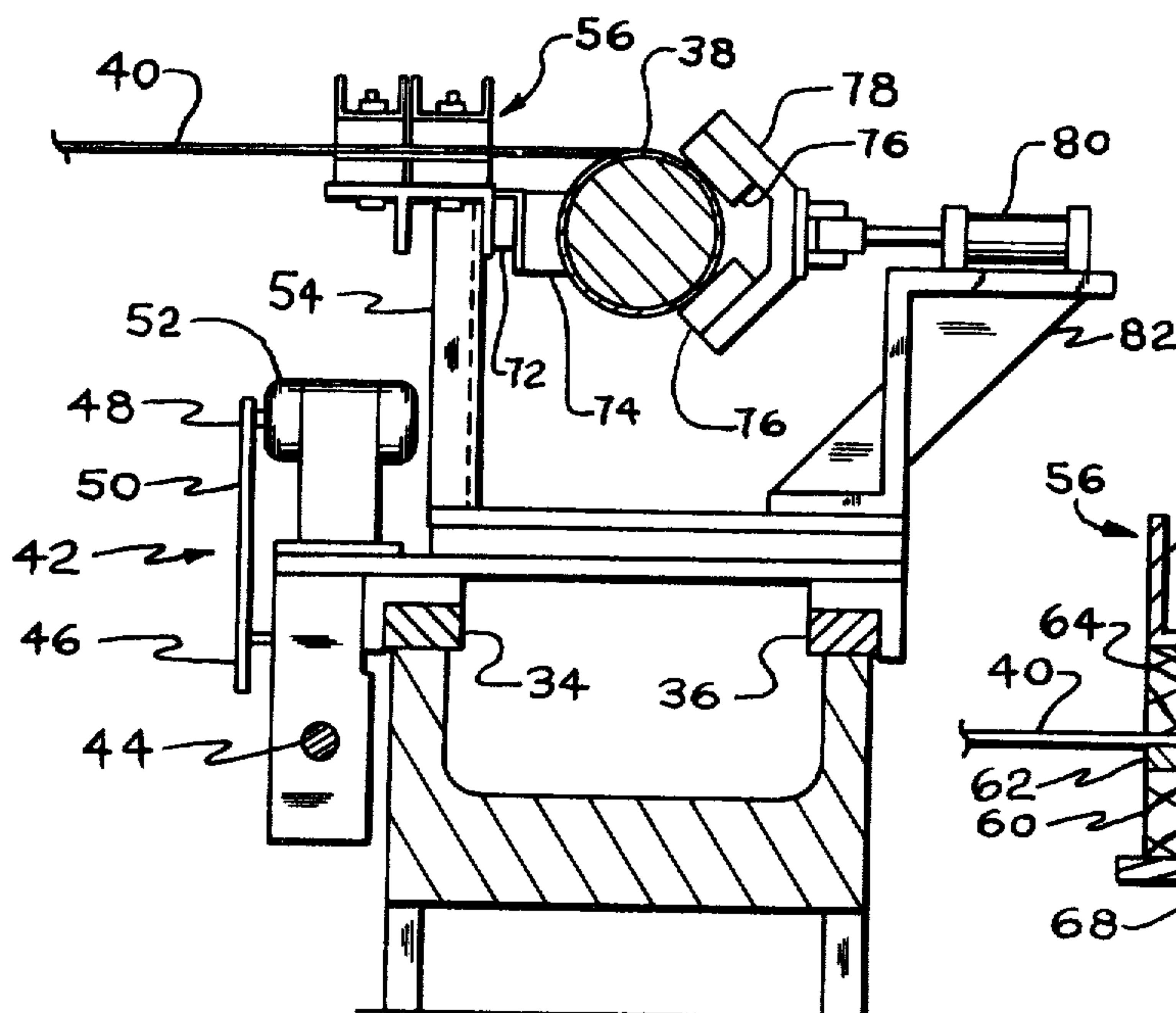


FIG. 3

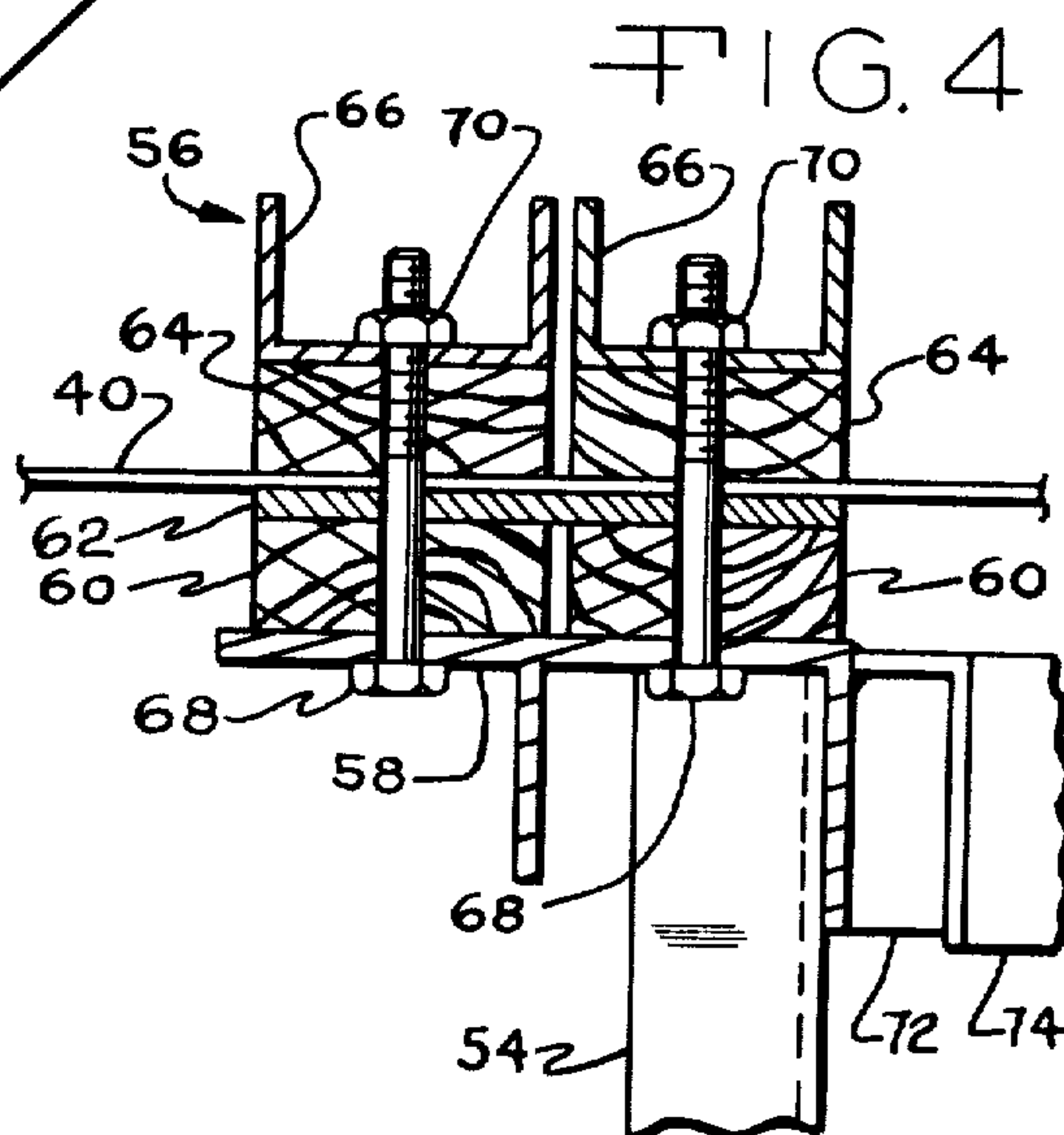


FIG. 4

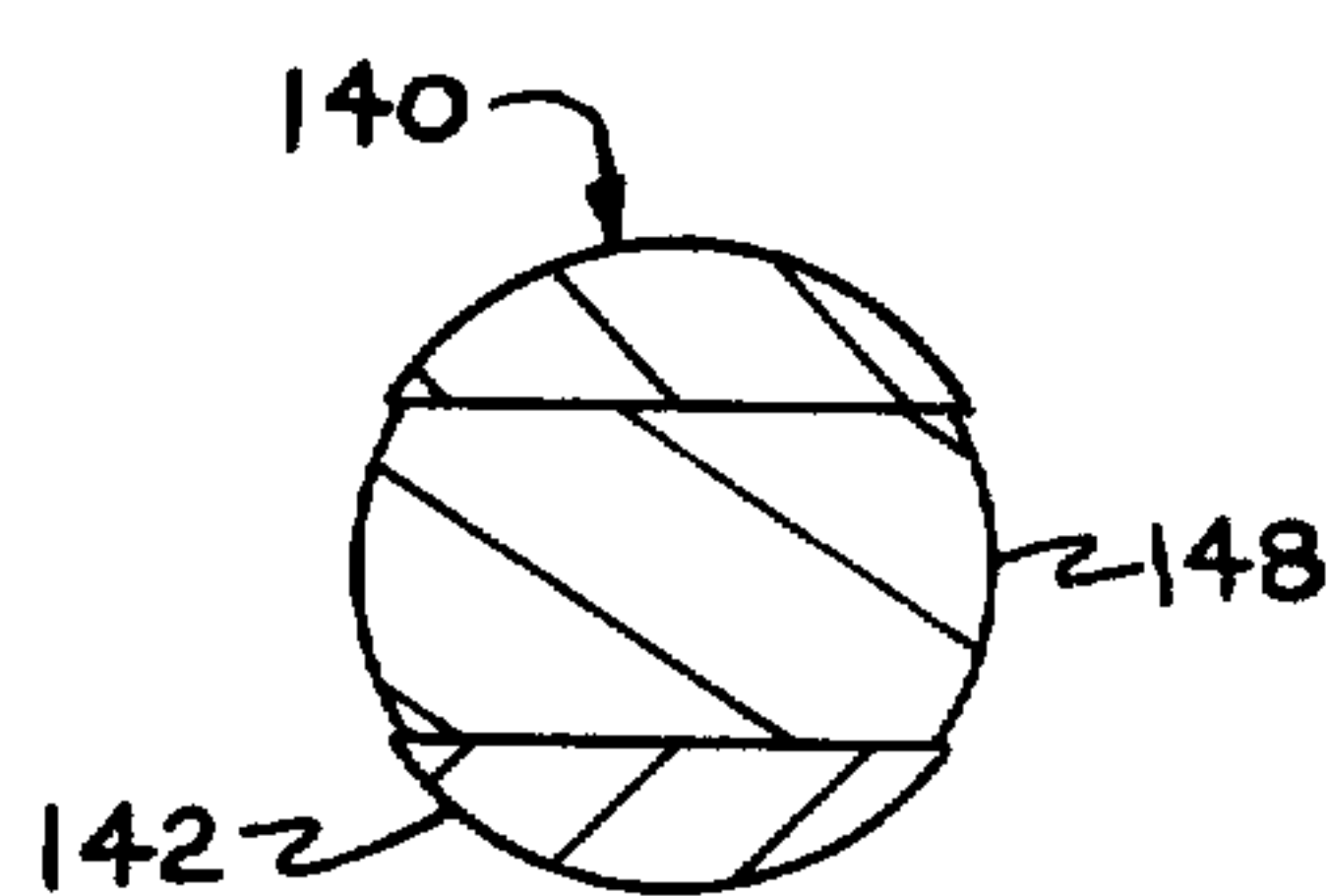


FIG. 14

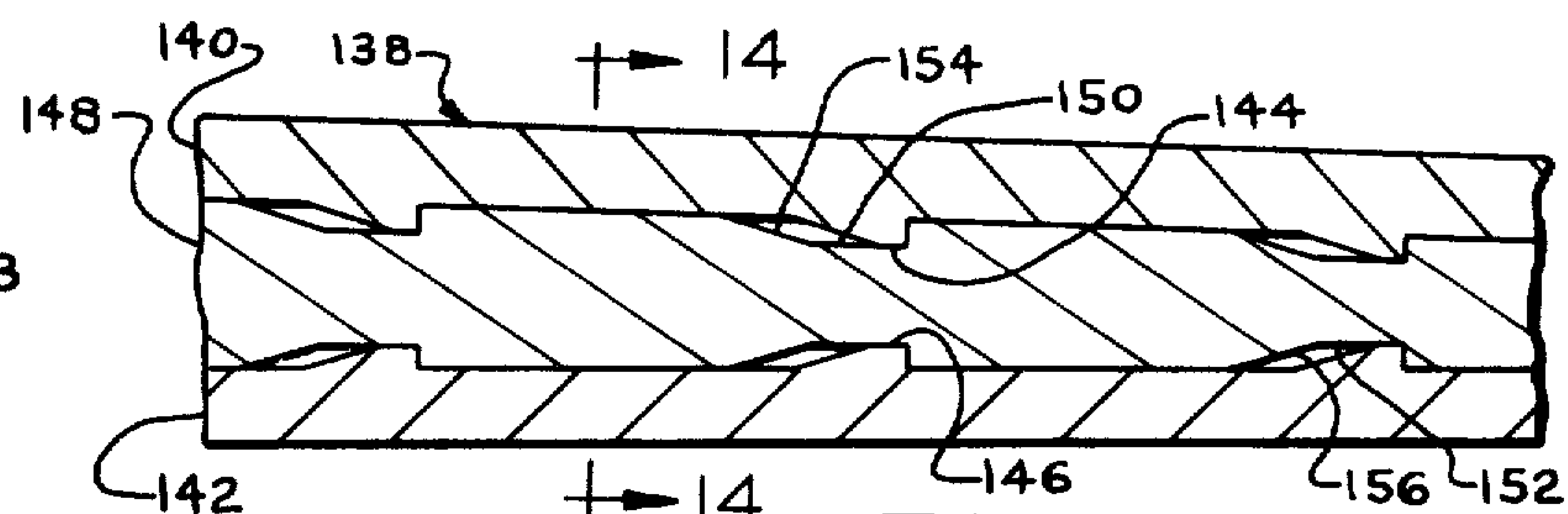


FIG. 13

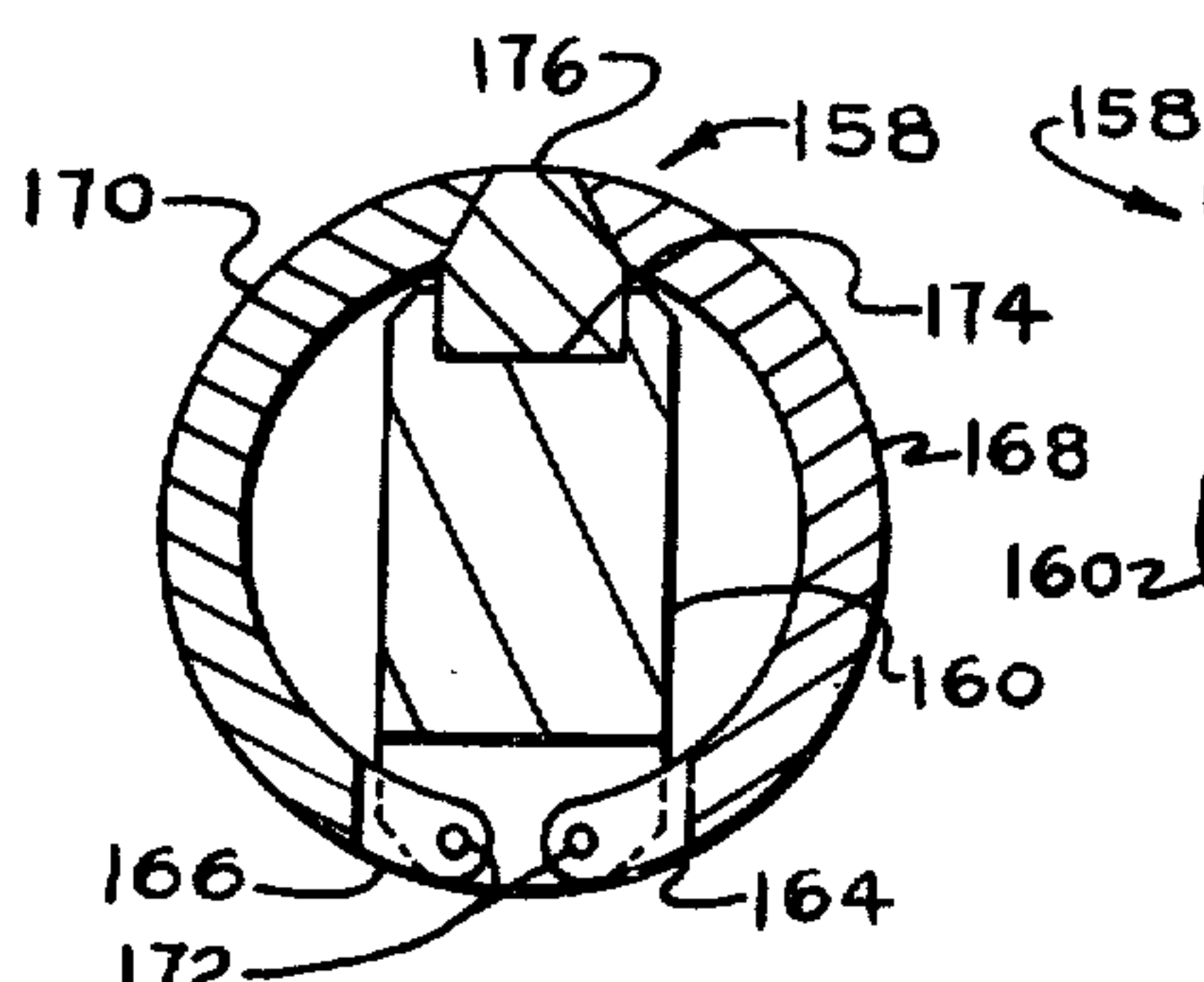


FIG. 16

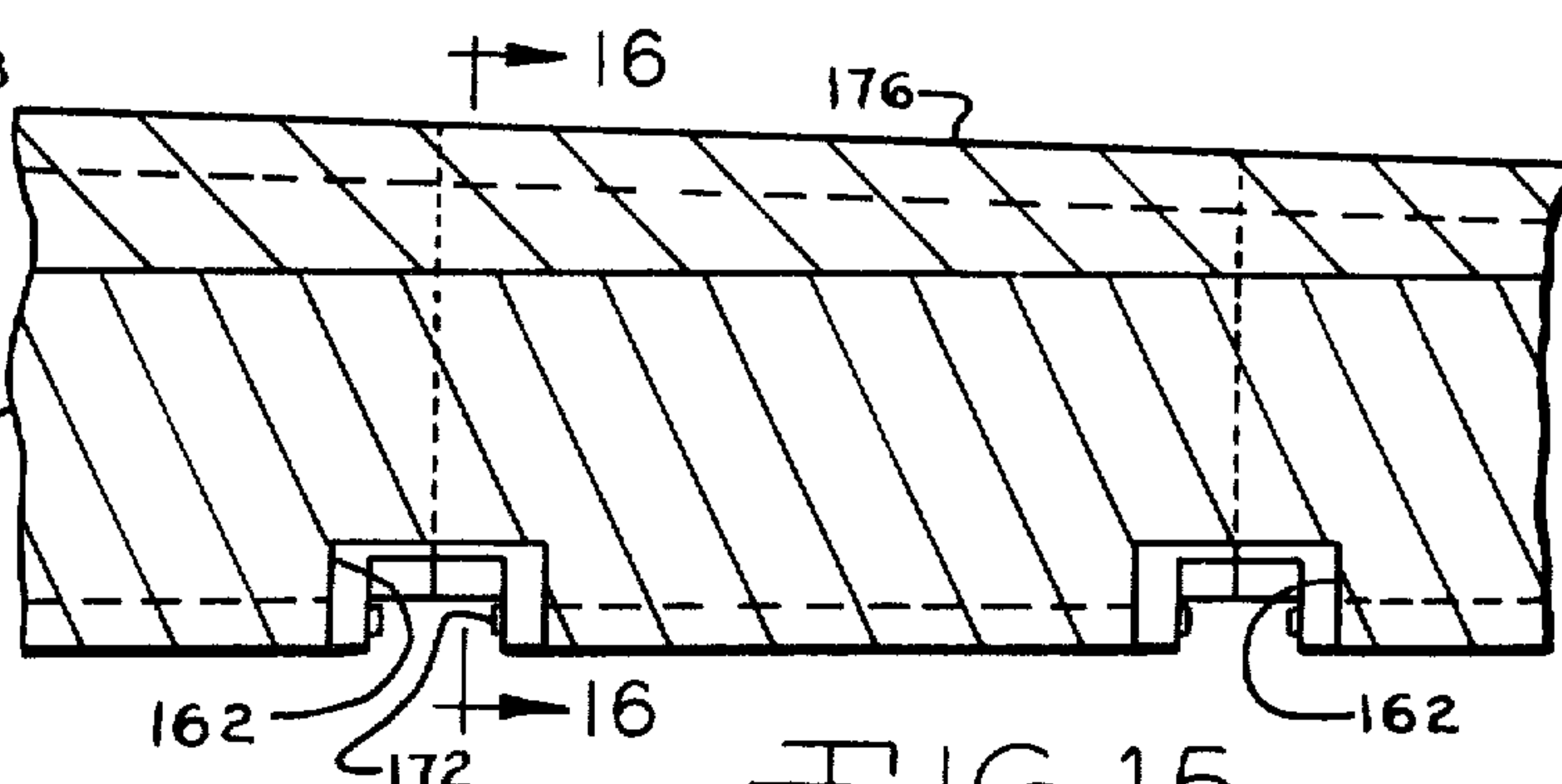
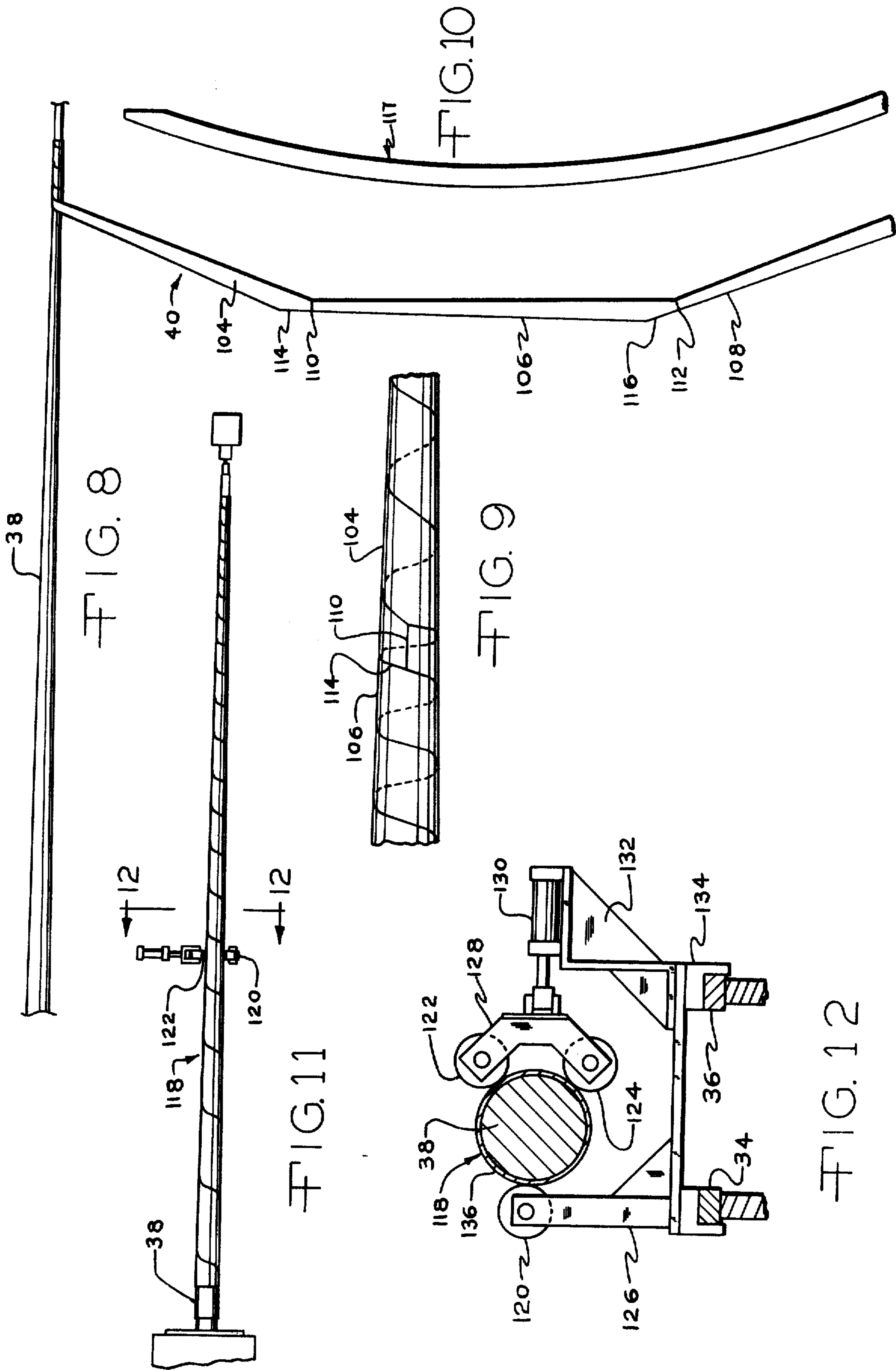


FIG. 15







## TAPERED POLE MADE OF VARIABLE WIDTH METAL STRIPS

This is a division, of application Ser. No. 212,228 filed Dec. 27, 1971, now U.S. Pat. No. 3,771,978.

This invention relates to a method and apparatus for producing tapered poles, to a strip from which the pole can be made, and to a specific tapered pole design.

Poles of the type having larger diameters at the base and smaller diameters at the top, as used for street lights, tall signs, etc., are often made from nested cylindrical tubes of varying diameters which nest within one another and are welded together at their junctures. The techniques heretofore known for making tapered poles have been slow and expensive, using more metal than necessary for proper strength, and also requiring machinery which is both costly and space consuming.

The present invention provides a method and apparatus for making a tapered pole from a particular tapered strip which is wound in a pseudo-helical manner on a tapered mandrel. Means are provided for directing and guiding the strip on to the mandrel and means are provided for establishing relative movement between the directing means and the mandrel in a direction such that the strip is wound from the small end of the mandrel toward the large end. Means are also provided for placing the strip under tension when wound on the mandrel, the tensioning means preferably being associated with the directing means. The longitudinal edges of the strip also can be formed downwardly from the plane of the strip. This configuration of the strip helps to counteract the tendency of the edges thereof to curl up when wound under tension on to the mandrel.

The strip according to the invention preferably is shaped in a manner such that the angle between portions of the strip at the narrow end and the axis of the mandrel is smaller than the corresponding angle between portions of the strip at the outer end and the axis of the mandrel, when the strip is in a position to be wound on the mandrel. Stated another way, the strip curves or extends in a direction away from the large end of the mandrel. The strips can be formed in a number of segments which are affixed, as by welding, in end-to-end relationship, with each subsequent segment forming a larger included angle with the first segment than does the preceding segment. However, the strip also can be made with a continuously curved shape from the narrow, first end toward the outer end.

To remove the pole from the mandrel, a spinning technique can be employed in which the pole is spun at a relatively high speed and with pressure rollers or the like then urged against the wall of the pole. The wall thickness is thereby reduced slightly and the diameter of the pole is correspondingly increased so that the pole is thereby easily removed from the mandrel. Rather than the spinning technique, the tapered mandrel can be designed to be collapsible to facilitate removal of the pole.

The invention also includes a double wall pole having an inner wall which is formed by a tapered strip wound in a pseudo-helical manner with a lead angle in one direction. Around this is wound a second tapered strip wound in a pseudo-helical manner with a lead angle extending in the opposite direction. This type of pole has ultimate strength and stiffness not otherwise possible to obtain except with extremely heavy poles.

It is, therefore, a principal object of the invention to provide a method and apparatus for making a tapered

pole on a tapered mandrel from a tapered strip with the strip placed under tension as it is wound on the mandrel.

Another object of the invention is to provide a tapered strip for forming a tapered pole, which strip is made from a plurality of segments attached in end-to-end relationship, with each subsequent segment being at a larger angle to the first segment than is the preceding segment.

Still another object of the invention is to provide a tapered strip for forming a tapered pole, which strip is shaped in a manner to decrease the lead angle of the pseudo-helical position of the strip when wound into a tapered pole form.

Yet another object of the invention is to provide a method and apparatus for producing a tapered pole on a tapered mandrel and removing the pole from the mandrel by reducing the wall thickness of the pole to expand its diameter.

Yet a further object of the invention is to provide apparatus for producing a tapered pole embodying a collapsible tapered mandrel.

Still a further object of the invention is to provide a tapered pole having a double wall, each wall being formed from a tapered strip wound in a pseudo-helical manner, with the strips wound in opposite directions.

Many other objects and advantages of the invention will be apparent from the following detailed description of preferred embodiments thereof, reference being made to the accompanying drawings, in which:

FIG. 1 is a somewhat schematic side view in elevation of overall apparatus for producing a tapered pole on a tapered mandrel;

FIG. 2 is a somewhat schematic top view of the overall apparatus of FIG. 1;

FIG. 3 is a view in transverse cross section taken along the line 3—3 of FIG. 1;

FIG. 4 is an enlarged, fragmentary view in transverse cross section taken along the line 4—4 of FIG. 2;

FIG. 5 is a view in transverse cross section through a tapered strip, taken along the line 5—5 of FIG. 2;

FIG. 6 is an enlarged, fragmentary cross-sectional view taken through two wraps of a tapered strip with a narrow, thinner strip located below the adjacent edges of the tapered strip;

FIG. 7 is a fragmentary view, with parts broken away, of a tapered pole having a double wall, the inner wall constituting a tapered strip wound in a pseudo-helical manner in one direction and the outer wall constituting a tapered strip wound in a pseudo-helical manner in the opposite direction;

FIG. 8 is a somewhat schematic plan view of a tapered mandrel and a segmented tapered strip according to the invention;

FIG. 9 is a fragmentary view of a portion of a tapered pole formed by attached segments of the strip of FIG. 8;

FIG. 10 is a view similar to FIG. 8 of a modified tapered strip;

FIG. 11 is a schematic plan view of apparatus for facilitating removal of a wound tapered pole from a tapered mandrel;

FIG. 12 is an enlarged, schematic view in cross section taken generally along the line 12—12 of FIG. 11;

FIG. 13 is a schematic, fragmentary view in longitudinal cross section of a tapered collapsible mandrel embodying the invention;



FIG. 14 is a view in transverse cross section taken along the line 14—14 of FIG. 13;

FIG. 15 is a view similar to FIG. 13 of a modified collapsible mandrel; and

FIG. 16 is a view in transverse cross section taken along the line 16—16 of FIG. 15.

Referring to the drawings, and particularly to FIGS. 1 and 2, overall apparatus for supporting and rotating a tapered mandrel is indicated at 20. The apparatus 20 can be in the form of a large lathe, including a bed 22, a headstock 24, and a tailstock 26. The headstock 24 has a spindle 27 rotated by a suitable motor 28, with the spindle having jaws 30. The tailstock 26 has an adjustable spindle 32 and is longitudinally movable on ways 34 and 36. A tapered mandrel 38 is engaged by the jaws 30 of the spindle 26 with the opposite end held by the spindle 32. The latter is positioned so that the front surface of the mandrel 38, and specifically a line on the front surface which is tangential to a vertical plane, is parallel to the front way 34. Various other apparatus can be used to support and rotate the mandrel, including the apparatus shown in my copending application, Ser. No. 177,992, now U.S. Pat. No. 3,775,835.

By way of illustration, in a particular example, the mandrel 38 is 35 1/2 feet long with a 3 inch diameter at the small end and a 9 inch diameter at the large end, representing a slope of 0.142 inches per foot of length. However, most commercial tapered poles will require a longer mandrel.

A tapered strip 40 is wound on the mandrel 38, being guided thereon by a directing means or carriage 42. As shown more particularly in FIG. 3, the carriage 42 is slidably mounted on the ways 34 and 36. A threaded rod 44 extends the length of the bed 22 and passes through the carriage 42, engaging a gear (not shown) carried by the carriage 42. The gear is driven through sprockets 46, 48, and a chain 50 by a suitable motor 52 mounted on the carriage. In this manner, the carriage 42 is driven along the ways 34 and 36 and accordingly directs the tapered strip 40.

The carriage 42 has an upstanding frame 54 on which is mounted tensioning means indicated at 56. Referring particularly to FIG. 4, the tensioning means include a structural platform 58 affixed to the top of the frame 54, on which platform are two lower blocks 60. A wear plate 62 is located on top of the blocks 60 with the strip 40 riding on the plate 62. Two additional blocks 64 are in direct contact with the top surface of the strip 40, in this instance. Structural channels 66 are located on top of the blocks 64 and receive bolts 68 which extend completely through the platform 58, the blocks 60 and 64, the wear plate 62, and the structural back-up channels 66 where they receive nuts 70. The degree to which the nuts are tightened on the bolts 68 regulates the amount of drag or friction of the blocks 60 and 64 and the plate 62 on the tapered strip 40, and, hence, the amount of tension on the strip. The upper channels 66 help assure uniformity of the tension on the strip 40 across the width thereof regardless of the location of the strip 40 in the tensioning means 56. In practice, it has been found to be very important to place tension on the strip 40 as it is being wound on the mandrel 38 in order to smoothly and uniformly wrap the strip on the mandrel.

The carriage 42 guides and directs the strip 40 on the mandrel 38, according to the longitudinal position of the carriage, while the tensioning means 56 provide the

tension on the strip, and yet enables the angle of the strip to change as it is wound on the mandrel.

Arms 72 extend from the frame 54 and have contact shoes 74 which engage the mandrel 38 or the newly wound strip 40 on the mandrel. This provides support between the mandrel and the tensioning means 56 to prevent the tension means from being pulled toward the mandrel as tension is applied to the strip 40.

A pair of contact shoes 76 mounted on a yoke 78 are also located on the opposite side of the mandrel 38 and are urged thereagainst by a fluid operated ram 80. These shoes help support the axis of the mandrel in a fixed position as the mandrel rotates, despite the side forces applied thereto as the strip is wound thereon. The ram 80 is affixed to a support 82 which is also part of the carriage 42.

The wear strip 62 is employed on the blocks 60 because edge portions 84 (FIG. 5) of the strip 40 slant downwardly slightly, preferably at an angle of from 1° to 8°. This angular disposition of the strip edges overcomes the tendency of the strip edges to curl upwardly when wound on the mandrel 38 under tension. If the strip is of soft metal or plastic, by way of example, the wear plate 64 is not necessary even if the edge portions of the strip do slant downwardly.

When the strip is wound on the mandrel, adjacent wraps 86 and 88, shown in FIG. 6, are joined by a continuous pseudo-helical bead of weld metal 90. To avoid the possibility of welding the wraps to the mandrel 38 and to avoid possible damage to the mandrel, a narrow, thin strip 92 can be wound around the mandrel along with the strip 40 and positioned to bridge and underlie the contiguous edges of the adjacent wraps 86 and 88.

In instances where a strong, stiff pole is desired, a double-wall pole 94 of FIG. 7 can be made. Accordingly, an inner wall 96 of the pole can be formed by a tapered strip 98 with the edges welded as in FIG. 6, with or without the strip 92. An outer wall 100 is then formed over the inner wall 96 by winding a strip 102 thereon. The lead angle of the inner strip 98 is opposite to the lead angle of the strip 102 so that a strong and stiff pole is achieved. This pole can be made by winding the strip 98 from the side of the mandrel opposite to that shown in FIG. 2. When the strip is wound and welded, the strip 102 can be wound on the inner wall 96 from the side shown in FIG. 2. In the first instance, the mandrel is rotated in a clockwise direction, as viewed from the large end thereof. In the second instance, the mandrel is rotated in a counter-clockwise direction.

The strip 40 is not wound on the mandrel 38 in a truly helical manner but, rather, in a pseudo-helical manner. For example, at the beginning the angle of the strip may be 60° to the axis of the mandrel 38 with the longitudinal edges of the strip forming an included angle of 2° and with the strip being 1 inch wide. By the time a 20 foot length of the mandrel has been wound, the angle of the strip to the axis of the mandrel may have decreased to 15°–30°. At this time, the angle has become so narrow as to make proper winding while still retaining tension on the strip extremely difficult. Consequently, it may be desirable to change the angle of the strip as winding progresses, particularly for longer poles.

Poles of lengths to meet most commercial purposes are sufficiently long that the angle of the tapered strip 40 becomes unduly narrow before the full pole can be



wound. To overcome this problem, the strip 40 is segmented (FIG. 8), with three segments 104, 106, and 108 being shown, with the segments being equal in size and shape in this instance. These are joined in end-to-end relationship by suitable means and preferably by welds 110 and 112. The three strip segments 104, 106 and 108 extend in a direction away from the large end of the mandrel 38. Further, each of the segments forms a larger included angle with the first segment than does the immediately preceding segment. Thus, the third segment 108 forms a larger angle with the first segment 104 than does the second segment 106. While each of the segments 104, 106, and 108 is shaped with a long taper away from the mandrel 38, the wider end of each is also shaped with a short taper in the opposite direction. The short tapers are shown at a portion 114 for the segment 104, and 116 for the segment 106, for example. The larger end portions of the segments thereby are tapered down to the same width as the narrow ends of the next, subsequent strip segments. For the edges of the adjacent wraps of the segments 104 and 106, for example, to meet smoothly and contiguously, the tapered portion 114 of the segment 104 forms a straight continuation of the outer or longer edge of the segment 106 and the same is true for the tapered portion 116 and any subsequent tapered portions. The length of the straight continuation preferably equals the circumference of the mandrel at the location when that portion of the strip is to be wound. This enables that edge to be contiguous with the opposite edge of the subsequent segment.

The strip also can be formed in a continuous curve as indicated at 117 in FIG. 10, rather than the segmented one, as shown in FIG. 8.

Particularly when the tapered pole is to be made of deformable or ductile materials, such as aluminum, the wound pole on the mandrel can be subjected to a spinning technique by means of which the wall thickness of the pole is reduced slightly and the diameter is increased, whereby the pole can then be easily removed from the mandrel. Apparatus for this purpose is schematically shown in FIGS. 11 and 12. In this instance, after a tapered pole 118 is wound, it can be turned at a higher rate of speed and subjected to pressure by rollers 120, 122, and 124. The roller 120 is mounted on a frame 126 while the rollers 122 and 124 are mounted on a yoke 128 which is urged toward the pole 118 by a fluid-operated ram 130. The latter is mounted on a support 132 which is mounted on a carriage 134 along with the frame 126, with the assembly then being moved along the pole by suitable means, the carriage being slidably supported on the ways 34 and 36. The forward surface of the pole 118 again is parallel to the front way 34 so that the stationary roller 120 remains in a fixed relationship to the pole. The pressure exerted by the rollers on the pole reduces the thickness of a wall 136 of the pole 118, thereby causing the diameter of the pole to increase and enable it to be easily removed from the mandrel 38.

The tapered pole can also be more readily removed from the mandrel if a collapsible mandrel is employed. Various types of such mandrels can be used, two representative ones being schematically shown in FIGS. 13, 14, and 15, 16.

Referring to FIGS. 13 and 14, a collapsible mandrel 138 includes two main sections 140 and 142 having outer arcuate configurations and having inner wedges

144 and 146 extending toward one another. An intermediate section 148 has arcuate end portions forming a cylindrical cross section in cooperation with the sections 140 and 142. The section 148 further has upper and lower recesses 150 and 152 terminating in slanted ends 154 and 156. With the sections 140, 142 and 148 being in the longitudinal relative positions shown in FIG. 13, the mandrel 138 is collapsed, as shown in FIG. 14, so that the pole wound thereon can be removed from the small end. When the central section 148 is moved longitudinally toward the right, as viewed in FIG. 13, the outer sections 140 and 142 will be expanded to form a circular cross section with the central section. In such position, the pole can be wound thereon.

Another collapsible mandrel 158 is shown in FIGS. 15 and 16, where, a central core section 160 extends the full length of the mandrel and has spaced lower recesses 162 in which ears 164 and 166 of substantially semi-cylindrical mandrel sections 168 and 170 are pivotally connected by pins 172. The upper edge of the core 160 has a central channel or groove 174 in which is slidably supported a longitudinally-extending edge 176. The wedge 176 moves the sections 168 and 170 in and out as the wedge 176 is forced longitudinally in the channel 174. In the position shown in FIG. 16, the sections 168 and 170 are in outer positions to form a circular cross section for the mandrel 158. After a pole is wound thereon, the wedge 176 is moved toward the left as viewed in FIG. 15, to enable the sections 168 and 170 to move inwardly.

Various modifications of the above described embodiments of the invention will be apparent to those skilled in the art, and it is to be understood that such modifications can be made without departing from the scope of the invention if they are within the spirit and the tenor of the accompanying claims.

I claim:

1. A tapered pole made from a plurality of ductile metal strips, each strip being of increasing width from one end to the other, said strips joined together and being wound in a generally helical manner but with the angles of the strips relative to the axis of the pole narrowing from one end of the strips to the other, the first of said strips being wound with edge portions of each wrap of the strip affixed to edge portions of adjacent wraps, and the second strip being wound over the first strip and having edge portions of each wrap affixed to edge portions of adjacent wraps, the edge portions of the second strip being set off to the side of the edge portions of the first strip at least through a substantial portion of their lengths, the wraps of both of said strips increasing in size from one end to the other.

2. A tapered pole made from a plurality of ductile strips, each strip being of increasing width from one end to the other, said strips joined together being wound in a generally biased helical manner but with the angles of the strips relative to the axis of the pole narrowing from one end of the strips to the other, the first of said strips being wound with edge portions of each wrap of the strip welded to edge portions of adjacent wraps, and the second strip being wound in the opposite direction over said first strip and having edge portions of each wrap welded to edge portions of adjacent wraps, the wraps of each of said strips increasing in size from one end to the other.

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