United States Patent

[11] 3,596,491

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[54] **METHOD FOR TAPERING TUBES**
21 Claims, 5 Drawing Figs.

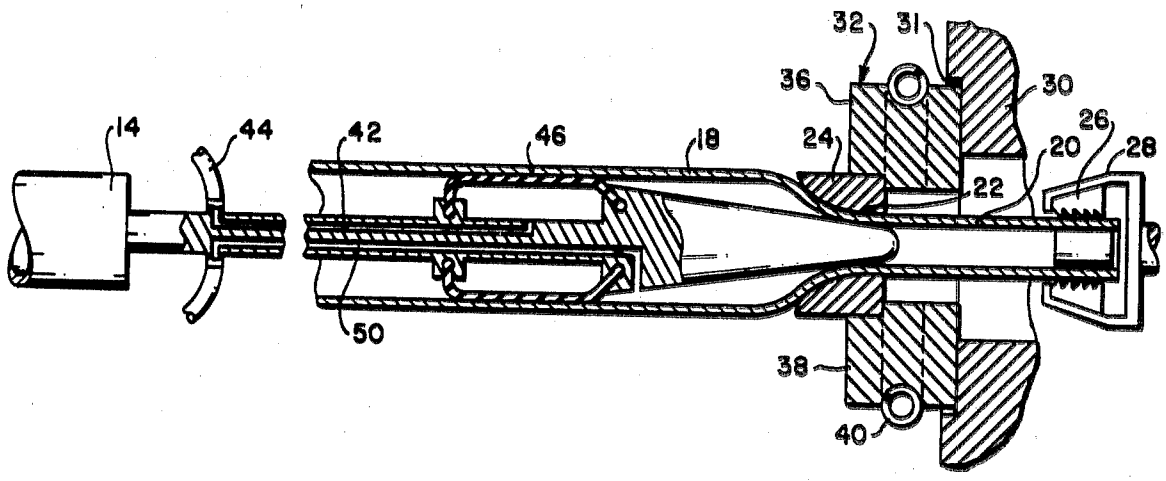
[52] **U.S. Cl.** **72/283, 72/370**
[51] **Int. Cl.** **B21c 1/24**
[50] **Field of Search** ..... 207/18; 72/283, 274, 370; 18/14 V

[56] **References Cited**
UNITED STATES PATENTS

2,240,456	10/1939	Darner	72/283 X
1,967,487	/1934	Waisner	72/283 X
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3,327,513	6/1967	Hinshaw	72/274 X

Primary Examiner—Charles W. Lanham
Assistant Examiner—Michael J. Keenan
Attorney—Gray, Mase & Dunson

ABSTRACT: Tubular shapes are tapered by drawing through a deformable die over a tapered mandrel that is of a length that differs from that of the tapered product by causing relative movement between the mandrel and the tube and die.



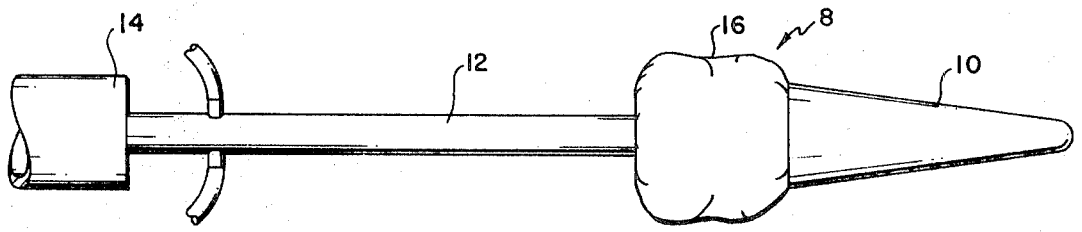


Fig. 1

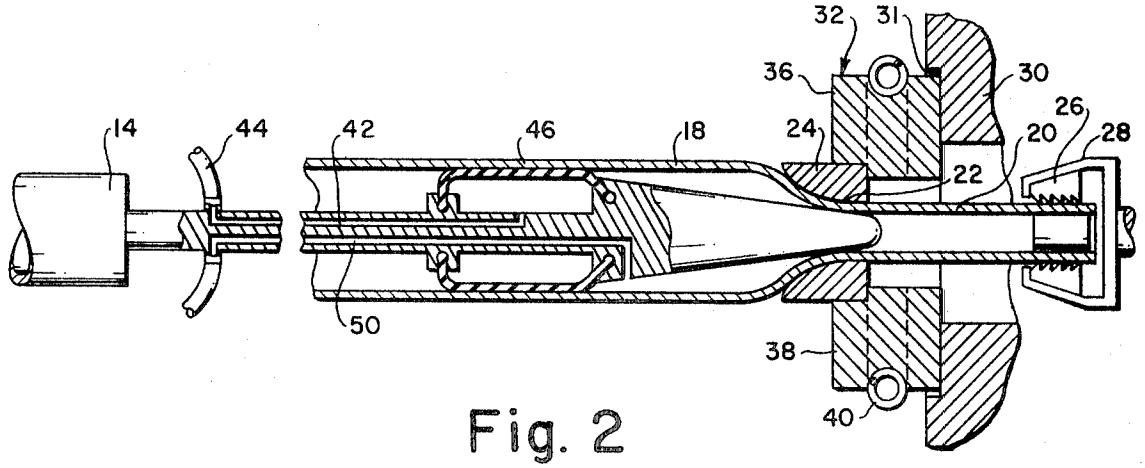


Fig. 2

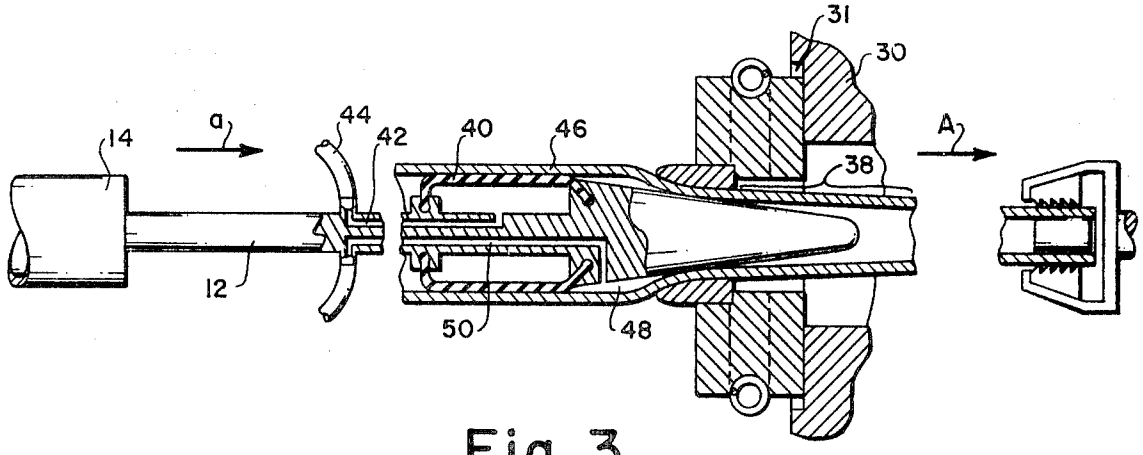


Fig. 3

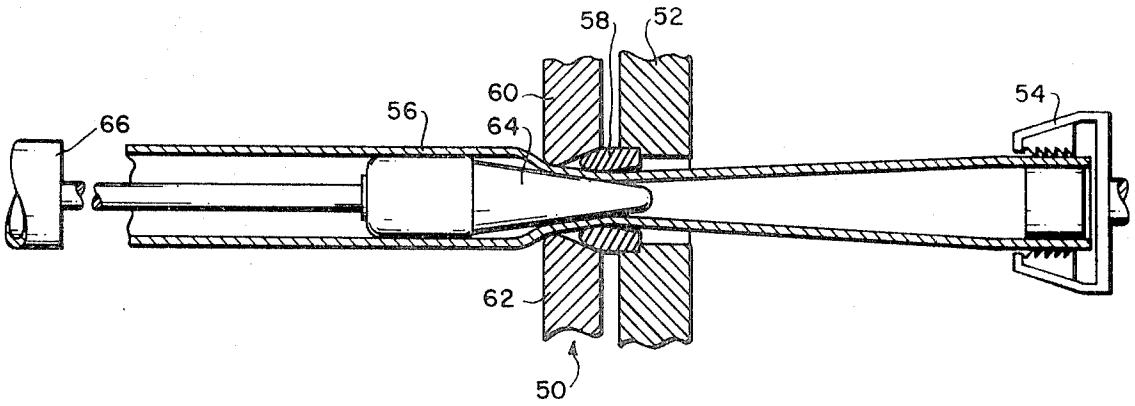


Fig. 4

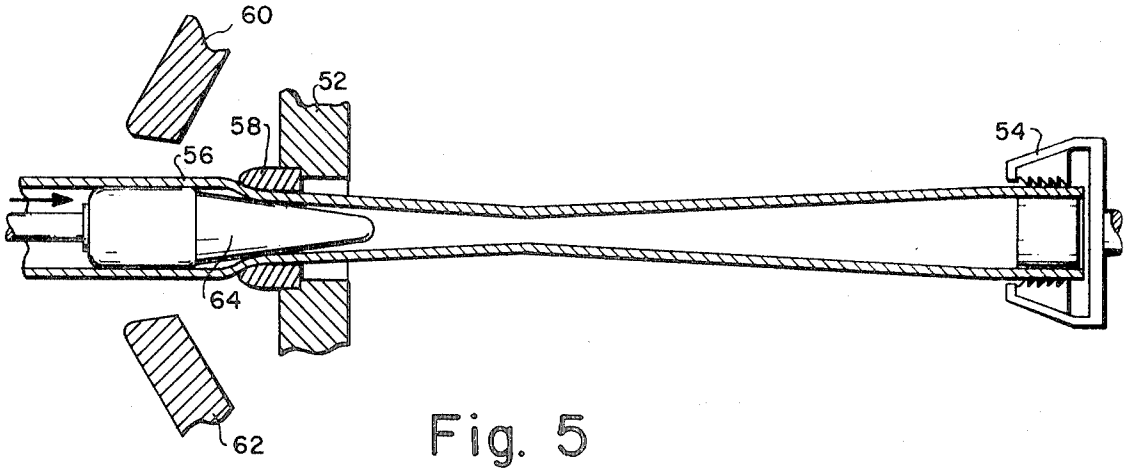


Fig. 5

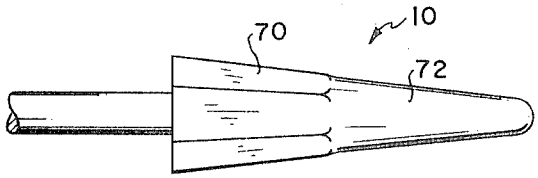


Fig. 6

METHOD FOR TAPERING TUBES

BACKGROUND

This invention relates to improvements in tapering tubes and relates in particular to a novel method for tapering tubes over short mandrels.

In U.S. Pat. No. 3,327,513, Hinshaw, a method and apparatus is disclosed for tapering metal tubes. In accordance with the method of this patent, the tubes are drawn between a tapered mandrel and an expandable or deformable die or ring. In many instances the use of a mandrel of the same length as the drawn tube is undesirable. For example, where drawing large or long tubes such as street-light standards where the tube may be as long as 20 feet and may range in diameter from 2 to 10 inches, the use of such large mandrels becomes a significant deterrent to the use of the process.

Also, it is frequently desirable to vary the length of a product. For example, the length of light poles, flag poles, and sailboat masts, vary, and the use of separate mandrels for each length requires the manufacturer to maintain a prohibitive inventory of mandrels.

THE INVENTION

We have now found a method whereby a single relatively short mandrel may be employed in production of relatively long tapered tubes; and a method whereby a single tapered mandrel may be used to draw tapered tubes of various combinations of lengths and diameters.

In accordance with our invention, a tapered mandrel having at least one diameter that corresponds to the minimum desired ID of the tube and at least one diameter that corresponds to the maximum desired ID of the tube is inserted into the tube. Tube and mandrel are then positioned in the drawing ring in the manner described in the aforementioned patent. However, in accordance with the present invention, during drawing the mandrel is caused to move in a manner relative to the tube (in the same direction as the tube when tapering from the small diameter to the large diameter and in a reverse direction to the direction of the tube when tapering from the large diameter to the small diameter) so that the tube tapers to a different length than the length of the mandrel.

The invention is best described in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevation view of a mandrel employed in the method of the present invention;

FIG. 2 is a side elevation view partially in cross section showing a tube mounted on the mandrel of FIG. 1 with an expandable die and supporting apparatus positioned for drawing;

FIG. 3 is a side elevation view similar to FIG. 2 showing the apparatus after drawing has commenced;

FIG. 4 is a side elevation view partially in cross section showing an embodiment of the present invention wherein a tube is tapered downwardly (from large diameter to small diameter);

FIG. 5 is a side elevation view partially in cross section showing the embodiment of FIG. 4 but with the die now tapering upwardly (from small diameter to large diameter) to form a venturi-type tube;

FIG. 6 is a mandrel constructed with zones of differing cross-sectional shape to provide tapered tubes of differing configurations.

The mandrel 8 of FIG. 1 is shown to consist essentially of a conically shaped working head 10 mounted to a supporting rod 12 which is, in this embodiment, the plunger of hydraulic cylinder 14.

The apparatus shown is also provided with a centering means 16 which is described in conjunction with this invention as a preferred embodiment but which is not an essential part of the invention and is claimed only in combination with the present method.

In FIG. 2 the mandrel 8 is shown as projected into a metal tube 18 which has been provided with a pointed end 20 preparatory to drawing. The pointed end 20 of tube 18 extends through the orifice 22 of an expandable die 24 and is gripped with teeth 26 of a conventional gripping mechanism 28. Gripping mechanism 28 is, of course, secured to a power means (not shown) such as a hydraulic cylinder to pull the tube 18 through die 24 over the mandrel 8.

Die 24 is shown to be seated within a segmented dieholder 32 such as that described in conjunction with FIG. 3 of U.S. Pat. No. 3,327,5133. Dieholder 32 is split into two segments 36 and 38 which are held together by a spring 40. Holder 32 abuts a retaining plate 30 which may, for the purposes of the present discussion, be regarded to be stationary. Recession 31 within plate 30 provides for easy centering of die 24 and dieholder 32, but is sufficiently large to permit expansion of segments 36 and 38. It will be understood that any number of segments such as segments 36 and 38 may be employed and that, in fact, more than two segments will be preferred.

The purpose of the segmented dieholder is to permit die or ring 24 to expand freely and "lay" or draw tube 18 onto the surface of the mandrel to provide a tapered tube. In the practice of U.S. Pat. No. 3,327,513, the tube is made to conform to the shape of the mandrel; however, in the practice of the present invention, the mandrel 8 is much shorter than the desired tapered tube length although it possesses the required maximum and minimum diameters for the finished tube ID so that tube 18 cannot be caused to "lay" onto the surface of the mandrel. Instead as is shown by FIG. 3, cylinder 14 is actuated during drawing so that there is relative movement between mandrel 8 and tube 18. By extending rod 12 and thus the mandrel at a controlled speed represented by the arrow (*a*) of (FIG. 3) which will preferably be a slower speed than the speed of drawing which is represented by the arrow (A), it is possible to expand the die 24 gradually and effect an elongated taper of tube 18 as shown at 38.

Centering means 16 consist of a fluidtight inflatable bladder or chamber 40. Fluids such as air or water are supplied to the chamber 40 through a conduit 42 provided in the rod 42 leading from a fluid-pressure source (not shown). When the mandrel has been inserted into the tube as shown by FIG. 2, fluid pressure supplied to conduit 42 through connection 44 causes the bladder to expand, contact the inside walls of the tube, and center the head 10 of mandrel 8.

Bladder 16 also seals head 10 from the balance of the tube at 46 leaving a space 48 in which it is prudent to supply a lubricant to reduce friction between the mandrel head 10 and the inner tube wall since there is relative movement therebetween. This is most effectively accomplished by supplying a lubricant under pressure to the space 48 through a conduit 50 which leads from the surface of mandrel head 10 through rod 12 to such a source of lubricant (not shown).

In the embodiment of FIGS. 4 and 5, it is shown that the method of the present invention may be employed to taper a tube downwardly from its large diameter to its small diameter, and that it is also possible to form a venturi by first tapering down a tube and then up.

The die supporting apparatus of FIGS. 4 and 5 is the same as that disclosed in conjunction with FIGS. 11—13 of U.S. Pat. No. 3,327,513, with the exception that for the purposes of this discussion plate 52 should be regarded to be stationary.

In FIG. 4 a split die 50 is supported relative to the backup plate 52 so as to be movable toward the backup plate at a rate which is correlated to the movement of grippers 54 in drawing tube 56 through the orifice of expandable die or ring 58. The die halves 60 and 62 of split die 50 cause the expandable die to close over tube 56 as the mandrel head 64 is withdrawn from the orifice at a controlled rate (normally slower than the speed of drawing) so that a gradually diminishing mandrel diameter is presented to the die and tube.

When the desired vortex of the tube is reached, the die halves 60 and 62 are withdrawn and the hydraulic cylinder 66 is reversed so that the die now expands over a slowly advanc-

ing mandrel (see arrow) in the manner of FIGS. 2 and 3. Thus tapering up, down, or up and down a tube is illustrated.

FIG. 6 shows a mandrel having a zone or segment 70 which is hexagonal in cross section. By employing an expandable die or ring such as a soft brass die, one may employ this mandrel in conjunction with the above-described apparatus to taper tubes into hexagonal shapes where the tube is tapered over the surface of this mandrel in zone 70 and in round shapes where the tube is tapered over the surface of the mandrel identified at 72. Thus, hexagonal, round, part hexagonal, and part round tubes such as are desired for the production of golf club shafts may be made by the method of the present invention. The exact length of tube or the length of a given shape (i.e., part hexagonal shaft) can be varied and controlled by regulating the speed by which mandrel head 10 is projected into (or withdrawn from) the orifice of the die. For example, a tapered tube may be "stepped" for applications such as golf club shafts by intermittently synchronizing the speed of the mandrel with the speed of drawing.

It will be noted that in most instances it will be desirable to effect axial movement of a mandrel such as mandrel 10 that is slower than the drawing speed so as to effect a tapered tube that is longer than the mandrel. Thus, a single relatively short mandrel can be used to draw varying length tapered tubes which may be many times as long as the mandrel. However, it is also possible to draw tapered tubes that are shorter than the mandrel by employing a relative mandrel speed that is greater than the drawing speed, thus further enhancing the versatility of the use of a tapered mandrel in accordance with the present invention.

It will be understood that the method of the present invention may be employed in the manner of any of the embodiments of U.S. Pat. No. 3,327,513. For example, the expandable dies or rings and/or the tubular workpieces may be caused to rotate to effect a spinning action while drawing and tapering.

It will also be understood that the term "drawing" as it is used in conjunction with the present specification and claims shall include any means for propelling a tube through a die orifice over a mandrel.

For the purpose of the present invention the term "tube" shall include any hollow, elongated body such as pipe, conduit, etc. The term shall also include cross-sectional shapes that are not necessarily round but which may be oblong, square, triangular, hexagonal, octagonal, etc. The mandrel, of course, must conform in shape to the tube or elongated member being drawn.

We claim:

1. A method for tapering a tube comprising:
   a. axially positioning a tapered mandrel within said tube;
   b. inserting said tube and mandrel axially within the orifice of a deformable die; and
   c. drawing said tube through said die over said mandrel while simultaneously axially moving said mandrel within the die orifice, said motion differing in speed from the speed of drawing, while continuously deforming said deformable die changing the diameter of the orifice of said die to a diameter substantially corresponding to the changing diameter of the mandrel positioned therein.

2. The method of claim 1 wherein said mandrel is formed within preselected minimum and maximum cross-sectional dimensions so as to form a tapered tube of minimum and maximum internal dimensions.

3. The method of claim 2 wherein said die has initial orifice dimensions of a size to conform said tube to the minimum cross-sectional dimensions of said mandrel and said mandrel is positioned during drawing to present cross-sectional dimensions within the die orifice from said minimum to said maximum dimensions so that said die is caused to expand and taper said tube.

4. The method of claim 2 wherein said die has initial orifice dimensions of a size to conform said tube to the maximum cross-sectional dimensions of said mandrel and said mandrel is positioned during drawing to present cross-sectional dimensions within the die orifice from said maximum to said minimum dimensions and external peripheral inward pressures are applied to said deformable die of a magnitude to cause it to close its orifice during drawing and taper said tube.

5. The method of claim 2 wherein said die has initial orifice dimensions of a size to conform said tube to the maximum cross-sectional dimensions of said mandrel and said mandrel is first positioned to present cross-sectional dimensions within the die orifice from said maximum to said minimum dimensions while applying external peripheral inward pressures to said deformable die of a magnitude to cause its orifice to close during drawing and taper said tube downwardly and said mandrel is then positioned to present cross-sectional dimensions within the die orifice from said minimum toward said maximum so that said die is caused to expand and taper said tube outwardly so as to form venturilike shapes.

6. The method of claim 2 wherein said mandrel is continuously positioned at a substantially uniform speed during drawing.

7. The method of claim 2 including the step of using a mandrel with varying cross-sectional shapes between said minimum and maximum diameters.

8. The method of claim 2 wherein said mandrel is continuously positioned during drawing at varying speeds so as to vary the rate of tapering the resultant tapered shape.

99. The method of claim 7 wherein said mandrel is continuously positioned during drawing at speeds that vary with said cross-sectional shapes so as to vary the rate of tapering and resultant tapered shape.

10. The method of claim 2 wherein said mandrel is positioned periodically during drawing so that said tapered shape is stepped.

11. The method of claim 3 wherein said tube is of substantially cylindrical shape and said dimensions are the average diameters.

12. The method of claim 11 wherein said mandrel is continuously positioned at a substantially uniform speed during drawing.

13. The method of claim 11 including the step of using a mandrel with varying cross-sectional shapes between said minimum and maximum diameters.

14. The method of claim 11 wherein said mandrel is continuously positioned during drawing at varying speeds so as to vary the rate of tapering the resultant tapered shape.

15. The method of claim 13 wherein said mandrel is continuously positioned during drawing at speeds that vary with said cross-sectional shapes so as to vary the rate of tapering and resultant tapered shape.

16. The method of claim 11 wherein said mandrel is positioned periodically during drawing so that said tapered shape is stepped.

17. The method of claim 3 wherein the positioning of said mandrel relative to the die is at a slower speed than the drawing speed.

18. The method of claim 4 wherein the positioning of said mandrel relative to the die is at a slower speed than the drawing speed.

19. The method of claim 3 wherein a pressure inflatable chamber is attached to the large dimension end of said mandrel disposed to inflate to a dimension at least as large as the internal tube dimension when subjected to internal fluid pressure and providing said chamber with internal fluid pressure so as to inflate said chamber to contact the internal surface of said tube and center said mandrel.

20. The method of claim 19 wherein a lubricant under pressure is supplied to the surface of said mandrel between said chamber and where the tube wall is drawn onto the mandrel surface.

21. The method of claim 2 wherein said mandrel is continuously positioned during drawing at speeds that vary so as to vary the rate of tapering and resultant tapered shape.