United States Patent

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[54] **TAPER-EXPANDING MANDREL**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **72/370,** 72/393, 72/399, 72/452

[51] **Int. Cl.** **B21d 41/02**

[58] **Field of Search**.....72/393, 399, 452, 355, 370, 72/482; 29/DIG. 41; 18/DIG. 5, DIG. 14, DIG. 53, DIG. 58, 19 TM, 19 TE; 25/128 K

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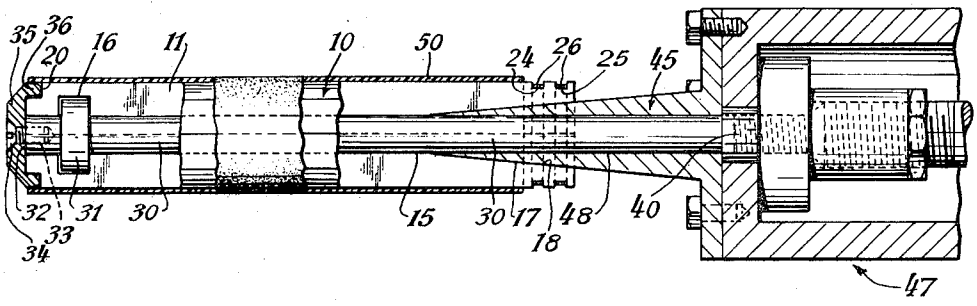
[57] **ABSTRACT**

The present disclosure relates to taper-expanding mandrels and in particular taper-expanding mandrels suitable for flaring or tapering collapsible tubes to permit stacking of one tube within another. The mandrel includes a plurality of discrete longitudinal segments defining a generally cylindrical mandrel surface with hinge means at one end. Expansion means urges the segments outwardly about the hinge means to define a taper to shape a tubular workpiece placed over the mandrel.

6 Claims, 4 Drawing Figures



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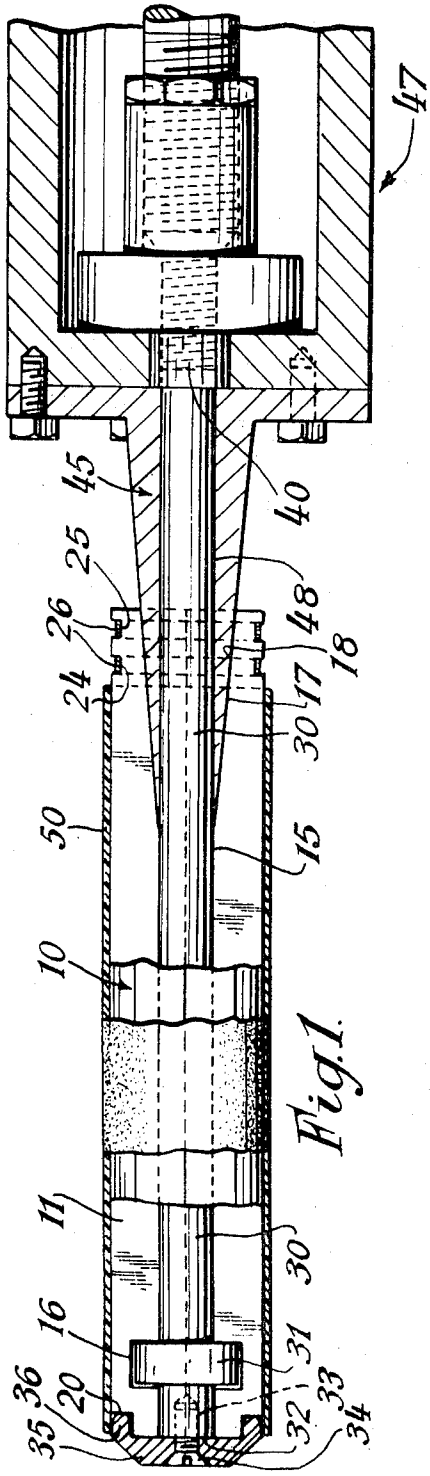

Fig. 1.

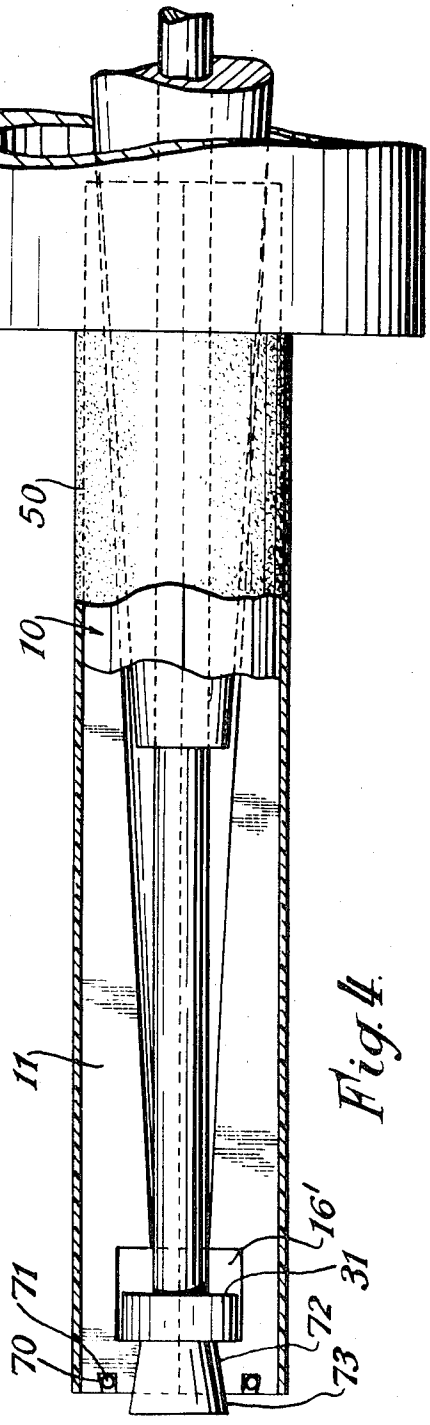

Fig. 4.

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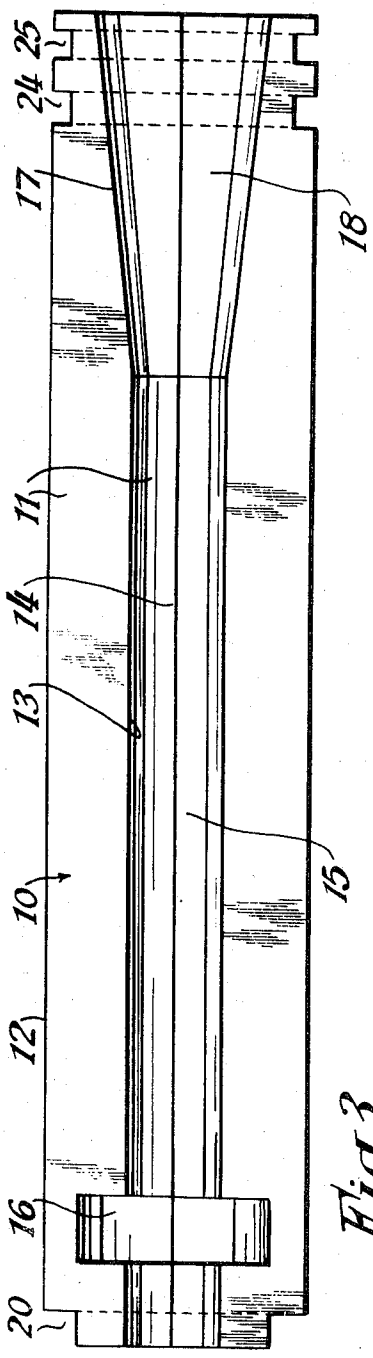

Fig. 3.

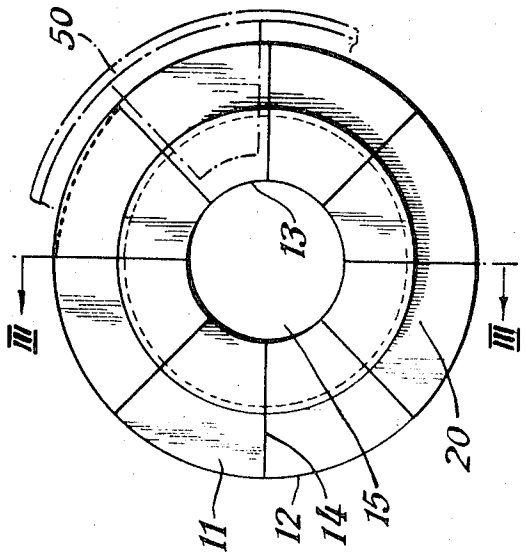

Fig. 2.

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TAPER-EXPANDING MANDREL

The present invention relates to taper-expanding mandrels and the method of using such a mandrel for improving the economics of packing unfilled collapsible tubes.

At the present time, collapsible tubes are formed by extrusion from a soft metal billet to provide a generally cylindrical body, and a sharply tapering shoulder terminating in an outstanding neck which is usually screw-threaded to receive closure. The cylindrical body is left open at the lower end for subsequent filling and on filling, the open end is then crimped closed to provide a collapsible tube of toothpaste or like material. In use, the closure is removed from the upstanding neck and squeezing the tube produces expulsion of some of the contents from the opening in said neck.

The cylindrical tubes, prior to filling, are manufactured by a tube maker who then transports the tubes to the content manufacturer who fills the tubes and crimps and packs them for dispatch to his customers.

The transport of these tubes is costly since the basic ingredient being transported is the column of air inside each tube.

It has been proposed to overcome this problem by flaring the tube towards its rearward end so that the tubes may be stacked one within the other thereby increasing the tube carrying capacity of a given container, the tubes subsequently being unstacked at the factory for filling, the open flared end of the filled tube being crimped in the normal way.

The present invention seeks to provide a tool for expanding the tubes in an economical and efficient manner to permit the above stacking of the tube.

Hitherto, taper-expanding mandrels have comprised a cylinder one end of which is provided with a plurality of circumferentially slits, longitudinal slits extending over a major portion of the longitudinal extent of the cylinder, expansion taking place by forcing a conical or taper element in said end to force the slits so formed at that end radially outwardly by flexing of the segments with respect to the cylinder. This results in a curved outer surface which is unsatisfactory for the purposes of the present invention.

The present invention, therefore, provides a taper-expanding mandrel comprising a plurality of discrete longitudinal segments which together constitute a segment assembly and define a generally cylindrical mandrel surface, hinge means provided at one end of said segments to permit each of said segments to hinge radially outwardly of the longitudinal axis of said cylindrical surface, expansion means adapted to urge the said segments outwardly and about said hinge means at said one end of the segments so that the outer surfaces of the segments define a taper and operating means for producing relative motion between said segments and said expansion means between an inoperative position in which the segments define a substantially cylindrical mandrel surface and an operative position in which the segments define a tapered surface.

A sheath may be provided about the segments to protect the article disposed about the mandrel and to bias the segments to adopt the generally cylindrical configuration when the expansion means is in the inoperative position. Furthermore, the sheath may serve to bridge the gaps between the segments in the expanded position.

The expansion means may comprise a frusto-conical element which is slidable along the axis of said segment assembly and arranged for the frusto-conical surface of said element to abut said other end of each segment so that it produces relative motion between said segments and said element to urge said element inwardly of said other end of the segment assembly, the segments are caused or allowed to hinge about said hinge means to define said taper mandrel surface. The relative movement between the expansion means and the segments may be effected by means of a hydraulic ram, pneumatic ram or a cam.

The hinge means may permit a limited predetermined expansion of said segments at said one end before expansion of the segments at said other end commences. The magnitude of the expansion may be of the order of 0.030 inch on the diameter of the mandrel before expansion of the main body of the mandrel the arrangement being such as to permit a tube to slide freely over the mandrel and then be gripped by the initial expansion at said one end.

The invention also includes a method of packing unfilled collapsible tubes which method comprises expanding the tube using a mandrel in accordance with the present invention, to flaring the tube in a direction away from the shoulder thereof, thereby permitting the stacking of similarly formed tubes by locating the smaller diameter end of the first within the larger diameter end of the second tube.

The invention also includes tubes when expanded or flared by the method of the present invention.

The following is a description by way of example only and with reference to the accompanying drawings of an expanding mandrel assemblies and the method of using the same in accordance with the present invention.

In the drawings:

FIG. 1 is a section through a mandrel in accordance with the present invention;

FIG. 2 is a forward end view on the segment assembly of the mandrel of FIG. 1;

FIG. 3 is a section on III—III of FIG. 2;

FIG. 4 is a section of an alternative embodiment of a mandrel in accordance with the invention.

The mandrel assembly comprises a generally cylindrical tube **10** defined by eight longitudinal segments **11** each subtending an angle of substantially 45° at the axis of the tube **10**. Each segment **11** is defined by an outer arcuate surface **12** and an inner arcuate surface **13** and a pair of radial surfaces **14**, the arrangement being such that the eight segments **11** together define a substantially cylindrical outer surface and a substantially cylindrical inner bore **15**. Each segment **11** is provided in its inner surface towards its forward end but spaced rearwardly thereof, with a recess **16** so that the eight segments which together constitute a segment assembly define a central bore in which the recesses constitute an expanded portion. The inner surface of each segment **11** is flared at its rearward end at **17** so that the segment assembly defines towards the rearward end an expanding frusto-conical passage **18**.

The outer surface of each segment **11** is provided with a peripheral recess or rabbet **20** at the forward end extending into the forward face of each segment so that the segment assembly defines an annular peripheral

recess at the forward end of the assembly. The outer surface of each segment is provided in its outer surface at its rearward end with a pair of spaced peripheral grooves **24, 25** which in the segment assembly defines a pair of peripheral grooves each adapted to receive a spring clip **26** which serves to bias the rearward end of the segment assembly to the cylindrical position.

Each segment **11** is machined towards its rearward end in its outer surface so that the arcuate portion of the outer surface defines an arc of radius greater than the radius of the outer arcuate surface of the forward end, the arrangement being such that in the expanded position, the outer surface of the rear end of the segment assembly is substantially circular in section.

The central bore **15** of the segment assembly is adapted to accommodate a longitudinal support rod **30** extending therethrough which has towards its forward end, a radially projecting retention collar **31** integral with said rod, said collar **31** being adapted to be accommodated within recess **16** provided in the inner surface of the segment assembly towards the forward end thereof. The forward end **32** of the support rod **30** terminates flush with the forward end of the segment assembly, and is provided with an axial blind bore **33** which is tapped to receive a threaded screw **34**.

A front plate **35** of substantially frusto-conical form is arranged so that the portion of the largest diameter is contiguous the forward end of the mandrel assembly. The front plate is provided with an axial bore and the face of the front plate is counter-sunk to receive the head of screw **34** for securing the front plate **35** to the support rod **30**. The rearward face of the front plate **35** contiguous the front face of the mandrel assembly is provided with a rearwardly extending annular flange constituting a hinge **36**, said flange **36** being rounded at its rearward end, and adapted to be received within the peripheral recess **20** defined by the rabbet between the arcuate outer surface and the annular front face of the mandrel assembly.

The support rod **30** projects rearward of the mandrel assembly and is threaded at its rearward end **40**. The support rod **30** carries a taper element **45** defined by a frusto-cone terminating at its rearward end in a radial annular flange **46**, the frusto-cone of the taper reducing forwardly of said flange, the walls of the frusto-cone being inclined to the axis of the rod **30** and segment assembly to correspond with the inclination of the walls defining the frusto-conical passage **18** at the rear of segment assembly.

The flange **46** of the taper element **45** is provided with the plurality of circumferentially spaced bolt holes, and is arranged to be secured to the housing **47** of a hydraulic, pneumatic or cam ram assembly. The taper element **45** is provided with a central bore **48** through which the support rod **30** passes and is arranged from the sliding movement of the rod **30** within said central bore **48**. The taper element **45** is typically formed of phosphur bronze or hardened steel and extends into the frusto-conical passage **18** at the rearward end of the segment assembly to abut the same, the abutting portion of each segment **11** being hardened to increase the wear resistance thereof.

The threaded end **40** of the support rod is connected by means of a connecting portion to the operating rod of the ram.

In operation, the ram moves to withdraw support rod **30** rearwardly with respect to the taper element **45** which is maintained stationary on the ram housing **47**. The rearward movement of the support rod **30** produces corresponding rearward movement of the retention collar **31** and of the segment assembly is secured thereto by means of the front plate **35**. The tapered inner surface at the rear of the segment assembly is caused to ride up the taper element **45** with the result that the dimensions of the segmented assembly are increased at the rearward end. Each segment **11** of the assembly is caused, therefore, to hinge outwardly about the hinge flange **36** of the front plate **35**, to define a frusto-conical taper along the length of the segment assembly the extent of which is determined by the distance the support rod **30** is caused to move rearwardly with respect to the taper element **45**. The greater the distance moved, the greater the taper imparted to the expanded segment assembly.

In the expanded position, the segmented assembly at the rearward end is provided with a large number of gaps, and this can be deleterious to certain materials placed thereover for the purpose of expanding or flaring the same. Accordingly, a sheath **50** of a low friction plastics material is provided about the segment assembly, the sheath of material being made of polytetrafluoroethylene, neoprene, polyethylene, or latex, or any other resilient flexible material, the sheath serving to assist in biassing the segment to the generally cylindrical rest, or inoperative position.

On releasing or returning the operating rod of the ram to its normal position, the support rod **30** moves forwardly with respect to the taper, and the rearward end of the segment assembly is withdrawn forwardly from the taper element **45** until the radial sides **14** of the segments **11** each abut the contiguous segments, under the combined action of the spring clips **26** provided in the peripheral recesses **24, 25** in the reduced portion of the rearward end of the segment assembly and by the resilient action of the flexible sheath **50**.

In the manufacture of collapsible tubes, the tube is formed by extrusion from a metal billet. The upstanding neck assembly is formed and threaded and the closure cap applied to the tube. The tube is then placed over the mandrel assembly described above with the closure end adjacent the front plate **35**, the ram is then caused to operate to produce expansion of the segment assembly to form a taper thereby stretching and flaring the tube towards its open end. The ram is then released, the segment assembly adopts its normal cylindrical configuration and the flared tube is withdrawn from the segment assembly. A number of tubes may be treated in the same way and the closure portion of the one tube may be inserted in the open end of the second tube and so on, thus producing a stack of tubes so that nine or ten tubes may occupy the linear length of two unflared tubes.

The amount of expansion of the rear end of the segment assembly and thus the amount of taper to each tube may be altered by providing a different spacer between the ram piston and the end of the support rod, or by altering the throw of the ram and/or support rod.

The advertising matter provided on the external surface of the tube treated in this way may be applied either before or after the expanding operation.

In an alternative embodiment of the present invention each segment 11 is provided with an arcuate recess 70 in the forward end thereof which recesses 70 define in the segment assembly an annular groove. The groove accommodates a spring element 71 which serves to contract the segment assembly at its forward end. The inner forward surface 72 of the segment assembly is chamfered or flared towards the forward end and the recess 16' is enlarged to permit axial movement of the retention collar 31 with respect to the segment assembly. The forward end 73 of the support rod 30 is expanded towards the forward end to correspond with chamfer or flare defined by the inner forward surface 72 of the segment assembly, the arrangement being such that in operation rearward movement of the support rod 30 permits rearward movement of retention collar 31 in recess 16' until the collar abuts the rear of said recess. At the same time the rearward movement of the expanded forward end 73 of support rod 30 causes the forward end of the mandrel to be expanded to a limited extent determined by the amount of chamfer or flare on the inner forward surface 72 of the segment assembly and the axial dimension of recess 16' over the axial dimension of retention collar 31.

Thus at the onset of an operating cycle, the forward end of the ram assembly can be caused to expand a predetermined amount, typically 0.030 inches in diameter on the mandrel before expansion of the main body of the mandrel assembly. This allows a tube to slide freely onto the mandrel and then to be gripped by expansion of the forward end.

I claim:

1. A taper expanding mandrel for expanding tubes of relatively low strength material comprising a plurality of discreet longitudinal segments having first and second ends which together constitute a segment assembly and define a generally cylindrical mandrel surface, hinge means provided at the first end of said segments to permit each of said segments to hinge radially outwardly of the longitudinal axis of said cylindrical surface, a sheath of low friction resilient material having a smooth circumference without discontinuities, provided about the segments to protect an article disposed about the mandrel, expansion means adapted to urge said segments outwardly and about said hinge means at said first end of the segments so that the outer surfaces of the segment define a taper and corresponding means for producing relative motion between said segments and said expansion means between an inoperative position in which the segments define a substantially cylindrical mandrel surface and an operative position in which the segments define a tapered surface.

2. A mandrel as claimed in claim 1 wherein the expansion means comprises a frusto-conical element arranged to abut said second end of said segment assembly and a rod means adapted to slide within said frusto-conical element and engage said first end of said segment assembly and operating means for applying axial movement to said rod means to provide relative axial movement with respect to the frusto-conical element so that operation of the operating means will produce relative motion between said segment assembly and said element urging said second end of said segment assembly outwardly, whereby the segments are caused to hinge about the said hinge means to define a taper mandrel surface having a free end at said hinge means.

3. A mandrel as claimed in claim 1 wherein the operating means for producing relative movement between the expansion means and the segment assembly is an hydraulic ram.

4. A mandrel as claimed in claim 1 wherein the hinge means permits a limited predetermined expansion of said segment assembly at said first end before expansion of the main body of the segment assembly commences.

5. A mandrel as claimed in claim 1 wherein the hinge means provided at said first end of the segment assembly secures each of said segments at that end one with respect to the other.

6. A method of forming unfilled collapsible tubes for packing comprising the steps of providing collapsible tubes having cylindrical body portions, expanding the tube using a mandrel as claimed in claim 2 to flare the tube from a smaller diameter end to a larger diameter end and stacking a plurality of similarly formed tubes by locating the smaller diameter end of the first tube within the larger diameter end of the second tube.

* * * * *