United States Patent

Leier et al.

[15] **3,704,978**

[45] **Dec. 5, 1972**

[54] **APPARATUS FOR MANDREL COLLAPSING AND REASSEMBLING IN TUBE WIDENING EQUIPMENT**

[72] Inventors: **Karl Otto Leier**, Mulheim-Ruhr; **Hans Werner Spohr**, Witten-Stockum; **Johannes von Riegen**, Krefeld, all of Germany

[73] Assignee: **Mannesmann Aktiengesellschaft**, Dusseldorf, Germany

[22] Filed: **Nov. 12, 1970**

[21] Appl. No.: **88,720**

[30] **Foreign Application Priority Data**

Nov. 14, 1969 Germany.....P 19 58 838.6

[52] **U.S. Cl.** **425/393**, 425/457, 249/181, 249/178

[51] **Int. Cl.**.....**B29c 17/00**

[58] **Field of Search**.....18/19 BM, 19 BE, 19 TM, 19 TE, 18/45 R; 25/128 RR, 128 R; 249/63, 177, 178, 180, 181, 189, 175

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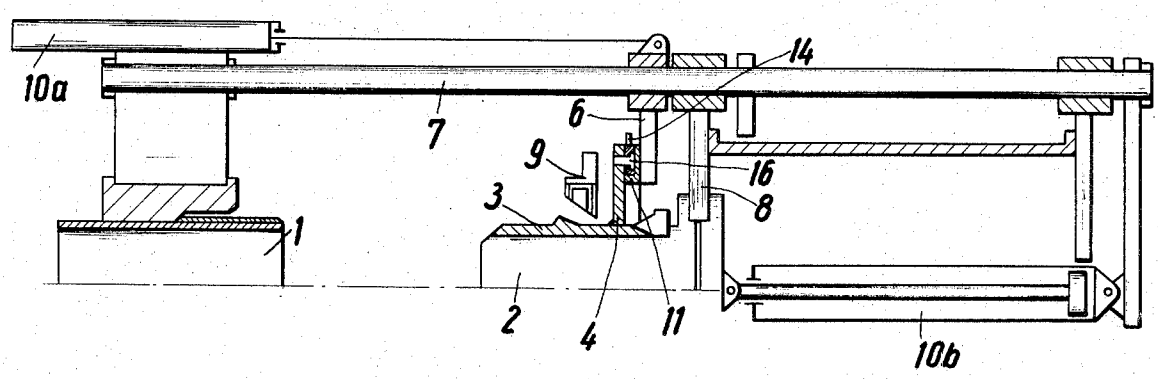
Primary Examiner—J. Howard Flint, Jr.

Attorney—Smyth, Roston, & Pavitt and Ralf H. Siegemund

[57] **ABSTRACT**

A collapsible mandrel, having core and segmented collar, is collapsed and reassembled through rotating positioning means. The collar segments are divided in two groups, whereby the smaller segments have radially outwardly tapering surfaces for engagement with the respectively interspaced, larger segments. The rotating positioning means control radial displacement of the two groups of segments in sequential operation, either through appropriate camming and a single control ring, or through two, independently operated control rings.

12 Claims, 15 Drawing Figures



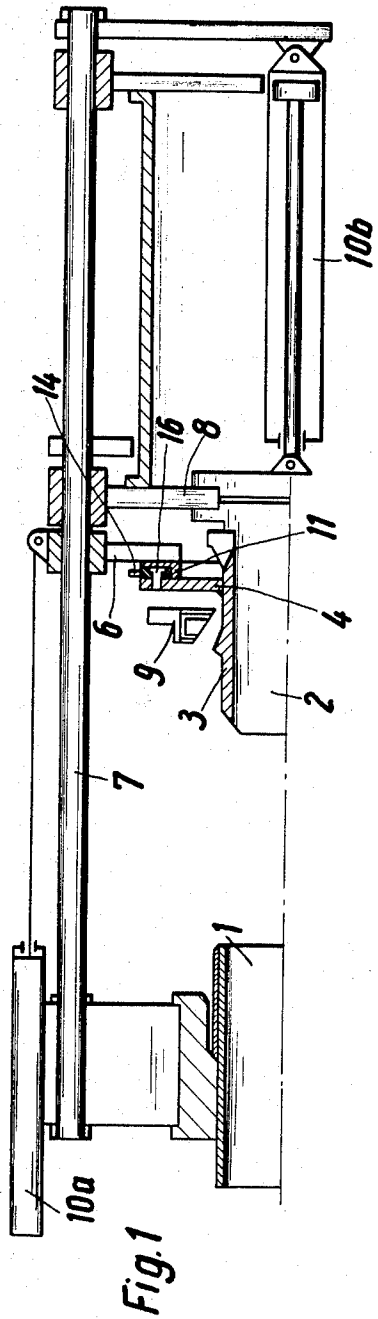


Fig.1

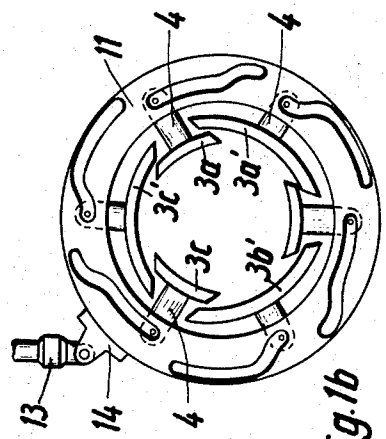


Fig.1b

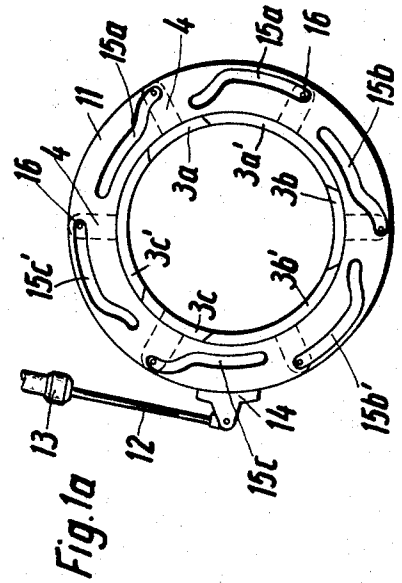


Fig.1a

Fig. 2

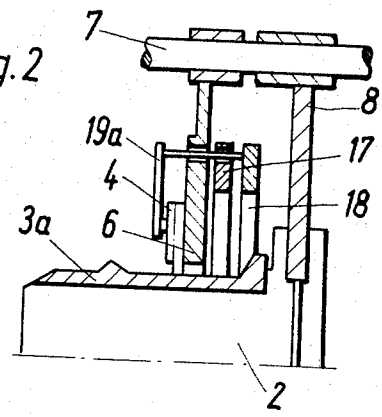


Fig. 2a

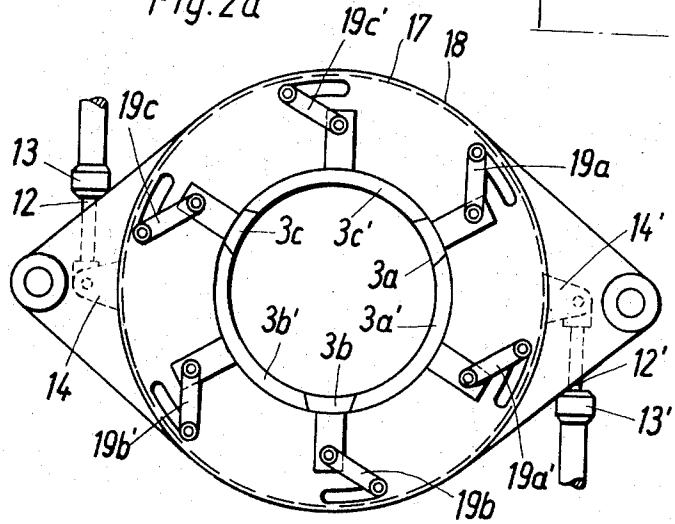
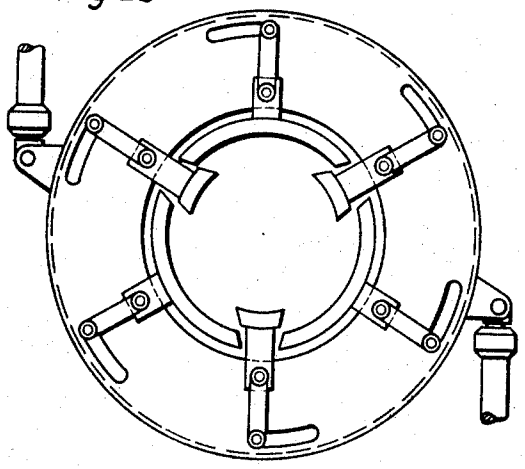


Fig. 2b



Inventors:
Karl Otto Leier
Hans Werner Spohr
Johannes Von Riegen
Smyth, Roston & Pavitt
By Reg. No. Siegesmund
ATTORNEYS

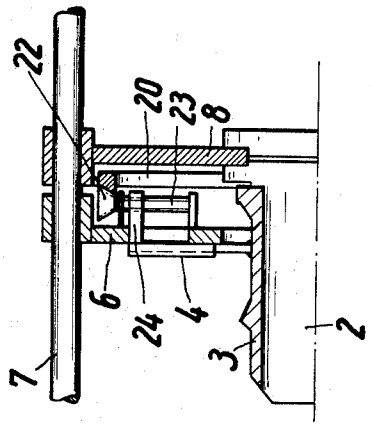


Fig.3

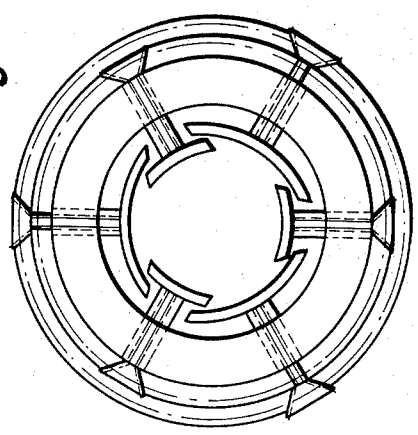


Fig.3b

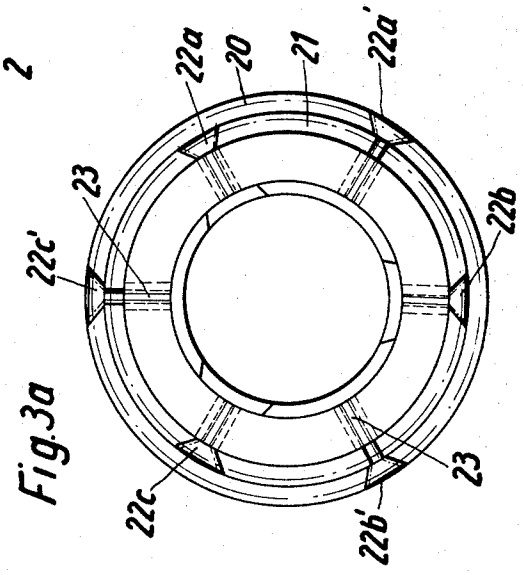


Fig.3a

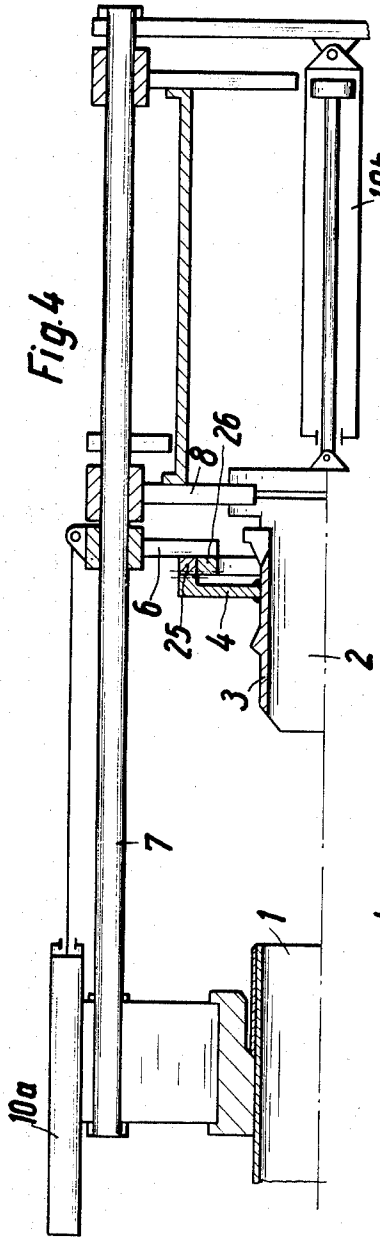


Fig. 4

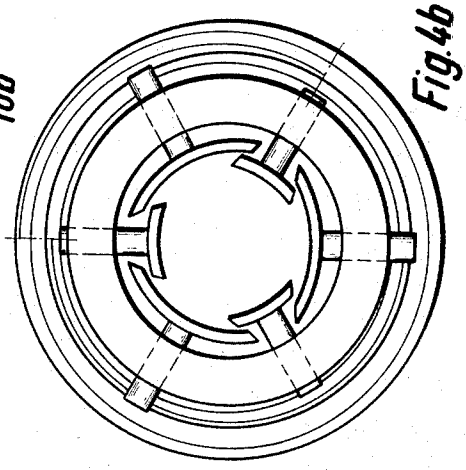


Fig. 4b

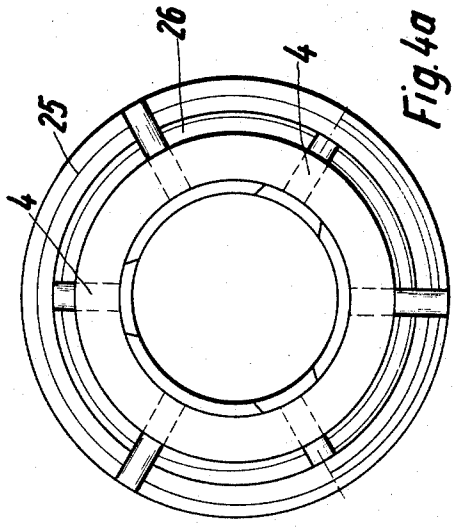
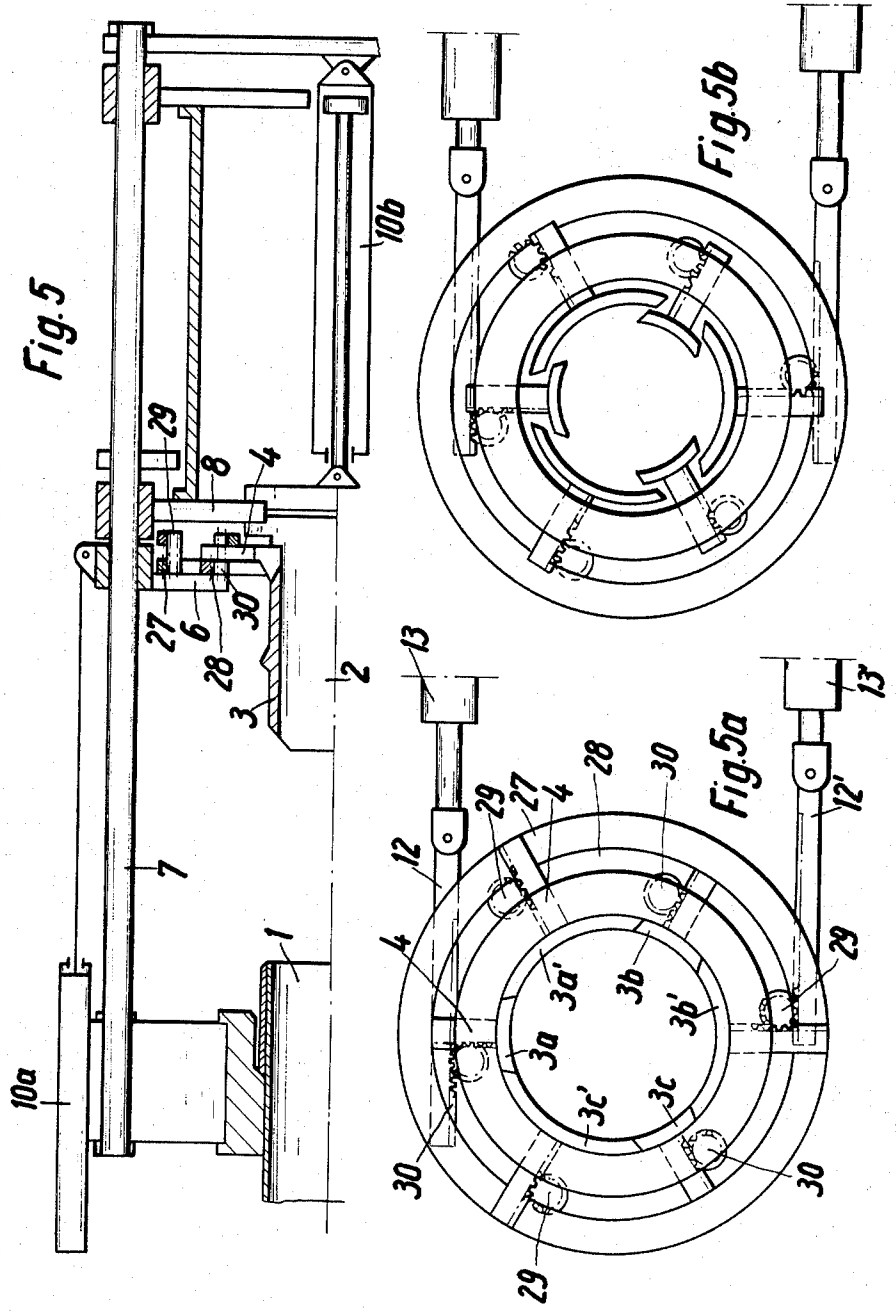


Fig. 4a


Fig.5
10b
29
8
4
27
6
30
28
3
2
7
1
10a
Fig.5b
Fig.5a
13
13'
12
12'
29
27
4
28
30
3a'
3b
3b'
3a
3c'
3c
30
29

APPARATUS FOR MANDREL COLLAPSING AND REASSEMBLING IN TUBE WIDENING EQUIPMENT

The present invention relates to equipment and apparatus for locally widening the end or a portion of the end of a thermoplastic tube. More particularly, the invention relates to equipment of the type in which a mandrel is urged into the heated end of the tube for obtaining local expansion. The mandrel has outer contour corresponding to the resulting internal dimensions of the expanded tube. The mandrel is composed of a mandrel core and of a segmented collar. In the assembled state, the segments together define a tubular collar disposed around and on the core. The thus assembled collar has outer, overall contour corresponding to the inner contour of the widened tube end after completion of widening. The mandrel can be collapsed in that the core is withdrawn axially and separated from the assembled collar segments, so that a hollow space is established into which the individually supported segments can be moved by radially inward displacement, to disengage from the tube after cooling thereof. Now, the segments can likewise be displaced axially.

In accordance with the preferred embodiment of the present invention, it is suggested to define two groups of mandrel collar segments. The segments of one group have dimensions along the periphery of the mandrel larger than the corresponding dimensions of the segments of the other group. Segments of one group alternate with segments of the other group around the periphery of the mandrel. In the assembled state adjacent segments engage in faces oriented so that the segments have wedge like configuration, the smaller segments tapering radially outwardly. The segments are held on actuator rods for position control; the rods extend from the segments, particularly in the rear of the mandrel (considering the front of the mandrel that end that faces the tube to be widened); they remain outside of a tube when the mandrel is inserted for widening. These actuator rods are operatively connected to two coaxially operating position and displacement control means, one control means per segment group, for controlling radial position and displacement of the segments of the respective group to obtain assembling and collapsing of the mandrel. The position and displacement control means include rotatable control means. For collapsing the mandrel, the rotating control means are sequentially effective so that the segments of one group are displaced first into the space previously occupied by the core and having been withdrawn for collapsing; the segments of the other group follow so that all are disengaged from the tube that has been widened. The segments are then removed axially, and subsequently the mandrel segments are reassembled on the core for the next operation step.

The position and displacement control means may include two groups of cam track arrangement. The cam tracks may be arranged on a flat control ring around the center thereof, and the cams are coupled to the mandrel collar segments via the actuator rods. The cam tracks, as associated with the segments of respective one group, are similar among themselves, but differ in contour from those associated with the respective other group to obtain different camming action. Cam tracks, cams and segments are intercoupled so that upon turning of the control ring, the cams for the one group of

segments and the segments of this group themselves are not radially displaced at first but will be radially inwardly displaced near the end of a turning stroke. The latter displacement may be tangentially in relation to the circular inner periphery of the control ring. The cam tracks of the other group have contour to effect immediately a radial inward displacement of the respective cams (and of the mandrel segments connected thereto), while the remainder of the respective cam track of this second group has constant radius.

After a widening operation the mandrel core is axially withdrawn, and the control ring turns to that by camming operation the cams and respective segments of the second group are inwardly displaced first while the cams for the first group are guided for maintaining the segments of the first group in position. Upon continued turning cams and segments of the first group are radially inwardly displaced while the segments of the second group are retained in the inward displaced position. The cam tracks have dimensions along the turning path that the respective constant radius portion is longer for each group than the portion along which the radial distance of the respective cam track from the axis reduced. Due to the differing contour of the cam tracks of the two groups, the segments of the two groups are radially displaced sequentially, inwardly for collapsing, outwardly for reassembling for which operation the control ring turns in the reverse direction, whereby the sequence is likewise reversed. The mandrel is reassembled external to any tube to be widened, whereby the tubular collar as assembled first and the core is inserted thereafter to serve as support.

The preferred embodiment of the invention can be practiced also in different examples. Two flat control rings or disks with central apertures are coaxially disposed, and they are individually and independently turned by means of two respective piston rods. Each control ring is separately coupled to the segments of one group to obtain radial displacement thereof. Sequential displacement of the segments of the two groups is obtained here through sequentially driving the two control rings.

The two control rings may be axially spaced and coupled respectively to the actuator rods of the particular group through lever linkage including, for example, elbow type levers. In another example, the position and control means include two coaxial control rings with spur gears and disposed concentrical or in axial spaced relation. The two groups of segments are coupled to two groups of bevel gears, the gears of the one group meshing with the spur gears of one control ring, the bevel gears of the other group meshing with the spur gear of the other control ring. Each drive is turned on the common axis, individually, e.g., by means of a piston rod or the like, so that the two drives can be turned independently. The bevel gears are coupled to the segments to obtain individual, radial displacement, but also in groups as far as timing is concerned.

In a further example, the two position and displacement means are comprised of two ring-shaped control disks, disposed concentrical or coaxial to each other with axial spacing. Each disk has a planar threading in the form of a planar spiral cam track. Cam pins at the ends of the respective actuator rods for the segments run in that spiral track to obtain radial displacement of

the segments. Again, sequential displacement of the segments of the two groups is obtained through sequential turning of the two control disks.

In a still further example, two concentrically disposed control rings are provided with gear tracks along their respective inner periphery. Pinions mesh with and ride on these tracks. The pinions, in turn, mesh with racks serving as actuator rods for the segments The two piston rods for driving the control rings are likewise constructed as racks and actually drive one pinion per control ring for driving same. Again, the two control rings rotate independently from each other on a common axis, through independent operation of the two piston rods, and the two groups of pinions cause sequentially radial displacement of the two groups of mandrel segments, due to sequential operation of the two piston rods.

In all examples, the piston rods can be driven by any suitable means such as hydraulic, pneumatic or electric motors or the like.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic side elevation of a tube widening apparatus with collapsible, but assembled mandrel with mandrel collar segments position and displacement control improved in accordance with a first example of the present invention;

FIGS. 1*a* and 1*b* are front views of the mandrel segment position control, actuator and displacement mechanism shown in FIG. 1 and respectively for assembled and collapsed mandrel collar;

FIG. 2 is a side elevation of a lever operated mandrel collar segment position control and actuator mechanism;

FIGS. 2*a* and 2*b* show front views of the mechanism of FIG. 2 respectively for assembled and collapsed mandrel collar;

FIG. 3 is a side elevation of a gear and pinion operated mandrel segment position control and actuator mechanism;

FIGS. 3*a* and 3*b* are corresponding front views of the mechanism shown in FIG. 3 respectively for assembled and collapsed mandrel;

FIGS. 4 and 5 are analogous side elevations of two further examples of the invention;

FIGS. 4*a* and 5*a* respectively show front views of assembled mandrels; and

FIGS. 4*b* and 5*b* show respectively front views of collapsed mandrels, including position control mechanism etc., shown otherwise in FIGS. 4 and 5.

Proceeding to the detailed description of the drawings, FIG. 1 shows the end 1 of a plastic tube to be radially expanded, widened or flanged. The particular deformation sought is not important, but it is important that such widening etc. is carried out by means of a collapsible mandrel, inserted into the tube in the assembled state.

The tube expanding mandrel includes a hollow core 2, and segments 3 are arranged around and on that core in form of a tubular collar. For the sake of clarity, only one segment is shown in FIG. 1, but all of the segments are depicted in FIGS. 1*a* and 1*b*. Each segment 3 has a rearwardly arranged rod 4, extending radially away from the segment and connected to a support plate 6 via particular position control means to be described in detail below.

FIG. 1 shows the mandrel in the assembled state, outside of tube 1 but to be inserted thereon. Reference numeral 9 denotes a counter support that becomes active during the tube expanding operation but is of no importance for the present invention.

Support plate 6 is slidably disposed on a transom or rail 7 for axial displacement relative to tube 1 and the mandrel. Drive means 10*a* are provided to obtain the displacement. Mandrel core 2 is connected to another support plate 8, likewise slidably disposed on rail 7 and being displaced by operation of driving means 10*b*.

Turning now to particulars of the position and displacement control means as interposed between mandrel collar segments and support plate, FIGS. 1, 1*a* and 1*b* show a flat control ring 11 provided with two groups of cam tracks, one group including the tracks 15*a*, 15*b* and 15*c*, the other group has tracks 15*a*, 15*b* and 15*c*. Cams collectively denoted 16 connect to the free ends respectively of the segment actuator rods 4 and slide and run in these cam tracks for guidance and positioning.

The segments 3 are likewise divided into two groups, one including the segments 3*a*, 3*b* and 3*c* connected to one cam each of cams 16, via rods, and these cams respectively slide and run in tracks 15*a*, 15*b*, 15*c*. The association of segments of the second group, 3'*a*, 3'*b*, 3'*c* with cam tracks 15'*a*, 15'*b*, 15'*c*, is an analogous one. The flat control ring 11 is connected to a piston rod 15 of drive means 13 via a linking part 14, provided for pivotal connection. The drive means 13 may be a pneumatic or hydraulic motor, or a linear electric motor, solenoid or the like.

FIG. 1*a* illustrates particularly the starting position of the segments, prior to collapsing of the mandrel collar, but after removal of the core. Cams 16 have a first terminal position in one end of the respective cam tracks 15. Upon retraction of piston rod 12, ring 11 turns clockwise so that the cams 16 urge the respectively connecting rods 4 radially inwardly, but in controlled sequence. In particular, segments 3*a*, 3*b*, 3*c* of the first group are displaced immediately into the interior of the tubular space, as the contour of tracks 15*a*, 15*b*, 15*c* of the first group causes the respective cams to move radially inwardly. The cams sliding in the cam tracks 15'*a* etc., of the second group, are not radially displaced at first as the initial portion of these cam tracks has constant radius relative to the center of the assembled mandrel collar. However, upon continued turning, the segments of the second group (3'*a* etc.) are likewise inwardly displaced, due to the particular contour of the end portion of the cam tracks of the second group.

The alternative terminal position is shown in FIG. 1*b*, whereby the segments of the first group necessarily project farther into the interior of tube 1, then the segments of the second group. Now, the collapsed mandrel collar segments can be moved out of a widened tube. Subsequently, the segments are moved radially outwardly through counter-clockwise rotation of the control ring 11 and replaced onto core 2.

Proceeding now to the description of the example shown in FIGS. 2, 2*a* and 2*b*, the position and displacement control for the mandrel segments 3 includes two, axially spaced, flat control rings 17 and 18 of similar diameter. There are three levers 19*a*, 19*b*, 19*c*, pivotally linked to the inner edge of control ring 17, and there are levers 19*a*, 19*b*, 19*c*, pivotally linked to the inner edge of ring 18. These levers are respectively pivotally linked to the actuator rods 4 of the mandrel segments. Each lever is so linked by means of an axially extending pivot shaft. For an disassembled mandrel collar, the levers extend radially outwardly and are pivotally linked to rods 4. Again, for the sake of clarity, but one segment, 3*a*, is illustrated in FIG. 1 as connected to lever 19*a*, the others are analogously connected, as can be deduced from FIGS. 2*a* and 2*b*.

Furthermore, rings 17 and 18 are connected to piston rods 12 and 12′ of drives 13, 13′, respectively. FIG. 2*a* illustrates again the starting position for collapsing the mandrel segments 3*a* etc. At first, ring 17 is turned by operation of piston rod 12 so that levers 19*a*, 19*b* and 19*c* displace the respectively associated segments 3*a*, 3*b*, 3*c*, into the interior of the space formerly occupied by the now retracted mandrel core. Subsequently, ring 18 is rotated, and now segments 3′*a*, 3′*b* and 3′*c* are radially inwardly displaced. The final, collapsed position of the mandrel is shown in FIG. 2*b*.

The arrangement of FIGS. 3, 3*a*, 3*b*, includes two concentrically disposed control rings 20 and 21, each having spur gear for respectively meshing with two groups of bevel gears; the first group includes bevel gears 22*a*, 22*b*, 22*c*, the second group includes bevel gears 22′*a*, 22′*b*, 22′*c*. The bevel gears are connected to the actuator rods 4 for the mandrel segments. For this, the bevel gears are on a worm gear or spindle 23 and threaded guide elements 24 ride on these spindles, for radial displacement upon turning of the spindles. The guide elements 24 are coupled to the actuator rods 4 which, in turn, are connected to the mandrel segments.

The control rings 20 and 21 are sequentially turned through suitable drive motors or the like, which are not shown, but they could be piston rods linked to these rings individually as aforedescribed. Alternatively, a rotary output could be imparted upon these rings through gearing, meshing the respective spur gears in between the bevel gears; not that the latter are not azimuthally displaced. Upon turning of control ring 20, bevel gears 22*a* etc. cause the mandrel segments of the first group (3*a* etc.) to be inwardly displaced, and upon turning of ring 21, bevel gears 22′*a* etc. move the second group of segments 3′*a* etc. into the interior of tube 1. Starting and end position of the collapsing operation are respectively depicted in FIGS. 3*a* and 3*b*.

Turning now to FIGS. 4, 4*a* and 4*b*, the arrangement shown herein has many features similar to these aforedescribed. The drive means in this example includes the two concentrically disposed rings 25 and 26 each provided with a planar threading in form of spiral cam track grooving. The respective ends of actuator rods 4 have corresponding planar threading or camming, meshing with the respectively associated ring for radial displacement upon turning of the particular ring. Otherwise, operation of segment actuation is analogous to operation as has been described with reference to FIG. 3. The starting position corresponding to an assembled configuration of the mandrel collar segments is shown in FIG. 4*a*, the end position for a collapsed mandrel collar is shown in FIG. 4*b*.

The example shown in FIGS. 5, 5*a* and 5*b* has also two concentrically disposed rings 27 and 28 as control means for radially positioning the mandrel segments. The rim along the inner periphery of each ring is provided with a spur gear. The gear of outer ring 27 meshes with axially extended pinions 29, the gear track of the inner ring 28 meshes with similarly extended pinions 30. For this embodiment, actuator rods 4 are provided as racks respectively meshing pinions 29 or 30; the three pinions 30 drive the segments of the first group (3′*a* etc.) and the three pinions 29 drive the segments of the second group (3′*a* etc.) The drive mechanisms 13 and 13′ include piston rods 12 and 12′ which are provided as racks and respectively mesh with one of the pinions 29 and with one of the pinions 30, to obtain rotation of the respective control rings.

For collapsing the mandrel, piston rod 12 is retracted from its extended position, whereby all pinions 30 on inner ring 28 are turned, and the respective racks 4 displace the segments of the first group, 3*a*, 3*b*, 3*c*, in radial inward direction. Subsequently, the outer ring 27 is turned by operation of the advancing rack 12′ so that pinions 29 cause the mandrel segments of the second group, 3′*a*, 3′*b*, 3′*c*, to be displaced also in radial inward direction. FIG. 5*a* illustrates again the begin and FIG. 5b the end of mandrel segment collapsing.

The invention is not limited to the embodiments described above but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be included.

We claim:

1. In an apparatus for locally widening the end of a thermoplastic tube, the apparatus having a mandrel, the mandrel having an axially displaceable core and a segmented collar positionable on the core for support thereon when inserted in the end of the tube to be widened, the collar when assembled and on the core, defining the inner contour of the widened tube end, there being means connected for independently driving the core and the collar axially, a mandrel collar segment positioning device in the apparatus independently from the core and comprising:

the segments of the collar including first segments having relatively small dimensions along the periphery of the mandrel and surfaces tapering in radial outward direction, and second segments alternating with the first segments along the periphery and engaging them at the surfaces for constituting therewith a closed collar on the core to establish an assembled mandrel, each segment axial a first axitl end, leading upon insertion into a tube in which the assembled mandrel is to be inserted, and a second axial trailing end that remains outside of the tube;

a plurality of actuator rods respectively connected to the segments at the respective second axial ends thereof that remain outside of a tube, the rods respectively extending radially outwardly and provided for displacing the segments radially;

first and second coaxially disposed control means rotating on the axis of and being radially displaced from the mandrel collar, the first control means in-

cluding a first rotatable intermediate member with plural drive elements respectively connected to all the actuator rods of the first segments for translating rotation of the intermediate member into radial displacement of the actuator rods for the first segments, the second control means including a second rotatable intermediate member with plural drive elements connected to all the actuator rods for the second segments for translating rotation of the second intermediate member into radial displacement of the actuator rods for the second segments; and

first and second drive means connected respectively to the first and second members for drivingly rotating the first and second members for respectively obtaining the radial displacement of the first and second segments.

2. In an apparatus for locally widening the end of a thermoplastic tube the apparatus having a mandrel, the mandrel having an axially displaceable core and a segmented collar positionable on the core for support thereon when inserted in the end of the tube to be widened, the collar when assembled and on the core, defining the inner contour of the widened tube end, there being means connected for independently driving the core and the collar axially, a mandrel collar segment positioning device in the apparatus independently from the core and comprising:

the segments of the collar including first segments having relatively small dimensions along the periphery of the mandrel and surfaces tapering in radial outward direction, and second segments alternating with the first segments along the periphery and engaging them at the surfaces for constituting therewith a closed collar on the core to establish an assembled mandrel, each segment having a first axial end, leading upon insertion into a tube in which the assembled mandrel is to be inserted, and a second axial trailing end that remains outside of the tube;

a plurality of actuator rods respectively connected to the segments at the respective second axial ends thereof that remains outside of a tube, the rods respectively extending radially outwardly and provided for displacing the segments radially;

a common control member disposed in radially displaced relation to said collar and provided for rotation on the axis;

plural drive elements on the control member and individually coupled to the rods for translating rotational displacement of the single control member into radial displacement of the rods and respectively of the segments thereon; and

a single drive connected to the common control member for drivingly rotating the control member so that the control member causes radial displacement of the rods.

3. In an apparatus as in claim 2, the common control member including a common control ring, having larger diameter than the collar and the core, cams and cam tracks respectively connected between the actuator rods and the control ring, one cam and one cam track per rod and segment, and constructed so that cam action for the rod actuators of the segments of the first group differs from cam action for the segments of the second group upon rotation of the control ring, to obtain sequential radial displacement of the segments of the first and of the second group.

4. In an apparatus as in claim 3, the ends of the rods respectively constructed as cams, the cam tracks provided as a first group of similarly contoured guide ways and a second group of similarly contoured guide ways different from the guide ways of the first group;

the guide ways of the second group each having a section of reducing radius and a section of constant radius so that upon said rotation of the control ring the segments of the second group are immediately displaced radially inwardly.

5. In an apparatus as in claim 1, the first and second intermediate members comprising respectively first and second, independently rotatable, coaxially disposed control rings, having diameter larger than the core and the collar, the drive elements on the control rings being rotational-radial displacement translating elements, the translator elements on the first ring coupled to the actuator rods, the segments of the first group and being drivingly connected to the first control ring therewith, the actuator rods of the segments of the second group drivingly connected to the translator elements on the second control ring; and first and second drive means connected to the first and second control rings for turning them independently on the same axis.

6. In an apparatus as in claim 5, the two control rings provided in axial spaced relation to each other; the translator elements being levers on the rings and respectively linked to the radial outer ends of the actuator rods.

7. In an apparatus as in claim 5, the two control rings each provided with a spiral cam groove, the translator elements being cams on the radially outer ends of the actuator rods, the cams riding in the grooves.

8. In an apparatus as in claim 5, the control rings provided with spur gearing, translator elements being pinions, the actuator rods drivingly coupled to pinions and meshing the spur gearing.

9. In an apparatus as in claim 8, the pinions being bevel gears, there being a worm gear on each bevel gear, the actuator rods geared respectively to the worm gears.

10. In an apparatus as in claim 8, the control rings provided in concentric relation each having spur gearing along its respective inner periphery meshing with the pinions, the actuator rods provided as racks riding on the pinions.

11. In an apparatus as in claim 10, the first and second drive means each including rack, each meshing with one pinion each per control ring for driving same.

12. In an apparatus as in claim 5, the first and second drive means respectively including piston rods, and motor means for linearly moving the piston rods for turning the control rings in one or the opposite direction.

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