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(54) METHOD AND APPARATUS FOR MAKING A PLASTIC TUBE  
 HAVING A FINISH AND SUPPORT FLANGE

(71) We, OWENS-ILLINOIS INC., a Corporation organised under the laws of the State of Ohio, of Toledo, Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates generally to a method and apparatus for compression forming both a support flange and a finish on a thermoplastic parison. More specifically, the method relates to compressing the opposed ends of the parison while supported within a forming mold to form the finish and the support flange.

15 Over the past several years it has become possible and commercially desirable to form blown plastics bottles of reduced wall thickness due to increased material costs and due to the advent of molecularly orienting the plastics materials. However, in some cases bottles formed of this greatly reduced wall thickness do not have a stacking strength that is comparable either to the previous, thicker bottles, or to glass bottles. This has posed various problems, such as in filling and capping operations when the axial strength of the bottle is critical to prevent collapsing.

20 In an attempt to overcome these specific problems, bottles have been made with an annular neck support flange or ledge which is grasped by various conveying and supporting devices so that the bottle can be pendentially supported during fitting and capping to take the axial load off the bottle during these operations. In fact, this particular arrangement has solved the collapsing problems. However, because of various problems encountered, the molding art has not heretofore provided a method and apparatus for forming both the bottle finish and the support flange in a single operation. (In the art of making bottles that exterior portion of the bottle immediately below the mouth, usually including any means such as a thread for engaging a closure cap, is known as the "finish"). One problem is

25 a resistance of certain plastics materials to flow into both the finish forming cavity and the flange forming cavity in a single operation, thus leaving an incompletely formed bottle. This problem is accentuated with certain plastics materials, such as polyethylene terephthalate which crystallizes at elevated temperatures and thus cannot be heated to improve the flowability of the plastic during the previously tried compression molding operations.

30 The present invention overcomes these and other problems in the art by a method and apparatus that enable the formation of a finish and a neck support ledge on a parison in a single molding operation.

35 According to the invention there is provided a method of making a thermoplastic parison having an integral finish and an integral, annular support ring comprising heating a portion of the parison to a temperature at which it is deformable, positioning the heated parison portion in a mold in general radial alignment with longitudinally-spaced finish and support ring cavities, and moving each end of the parison towards the other end to cause material in the heated parison portion to flow into said longitudinally-spaced cavities.

40 In one of its broad aspects, the method of this invention includes positioning a thermally conditioned deformable parison portion in a mold in substantial radial alignment with longitudinally spaced finish and support ring cavities. Next, one longitudinal end of a parison is supported while the other end is axially compressed to force at least a portion of the thermally conditioned, deformable plastic parison material into at least one of the longitudinally spaced cavities. Then, the previously compressed end of the parison is supported while the previously supported end is compressed to force additional thermally conditioned plastic material into at least the other of the longitudinally spaced cavities to complete the formation of the integral finish and support ring on the parison.

45 In a more limited aspect, the invention

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includes the steps of first positioning an essentially tubular plastic parison in a forming mold so that at least a portion of the parison projects out of the mold. The projecting portion is then placed in heat exchange relationship to a thermal conditioning source, such as a radiant heater, to adjust the temperature of the plastic material in the projecting parison portion to within a range capable of maintaining the essentially tubular configuration yet enabling deformation under compressive forces.

After the projecting portion of the tubular parison has been properly thermally conditioned, that portion is telescopically inserted into generally radial alignment with finish and support ring cavities in the mold in preparation for the compressive molding steps. The telescopic insertion is accomplished in the most preferred embodiment by a spring biased push rod which is a part of an axially movable compressive mandrel, the push rod being telescopically inserted freely into the tubular parison to engage the inner surface of a lower, closed, nondeformable, parison end portion. Further downward displacement of the push rod correspondingly displaces the parison (a) to place the external surface of the parison closed end against an axially movable end abutment and (b) to position the thermally conditioned parison portion in general radial alignment with the finish and support ring cavity.

Next, an internal support cylinder on the compression mandrel is telescopically inserted into the thermally conditioned portion of the parison to prevent internal collapse of the parison during the compression molding steps.

Next, an annular compression ledge on the compression mandrel engages the upper end of the parison and longitudinally compresses that end portion to force a portion of the thermally conditioned parison material into at least the finish cavity of the mold. During this first compression step, the axially movable end abutment is maintained in a fixed position to provide support for the closed end of the parison.

Finally, the end abutment is axially displaced toward the mandrel to force deformable plastic material radially outwardly into at least the support ring cavity to complete the molding operation. Thereafter, the thus-formed parison is removed from the forming mold for additional, optional thermal conditioning in preparation for a subsequent blow molding operation.

This method and apparatus, therefore, solve a previously existing problem in the art, namely the inability to completely and properly form a finish and a neck supporting ledge on a plastics article. This capability of the present invention, along with other meritorious features and advantages, will

become more apparent from the following detailed description of the invention and the appended claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS 70

Figure 1 is a top plan, schematic view illustrating a rotatable turret having four radially arranged molds in four different stations in the finish and neck flange forming operation.

Figure 2 is a vertical sectional view taken along plane 2-2 as indicated in Figure 1, to illustrate a finish forming mold closed upon a parison and positioned at the thermal conditioning station.

Figure 3 is a vertical sectional view taken along plane 3-3 as indicated in Figure 1, to illustrate the thermally conditioned parison as positioned at the compression molding station.

Figures 4-6 are similar to Figure 3, but illustrate various sequential phases of the compression molding operation.

Figure 7 is vertical elevational view of a parison with the integral compression molded finish and neck support ledge.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT 95

Referring now more specifically to the drawings, the primary object of this invention is to form a finish 12 and a neck support ledge or ring 14 on a tubular thermoplastic parison 10 as illustrated in Figure 100, the support ledge 14 being utilized in article handling operations to take vertical loads.

These parison components are formed preferably before a blow molding step by 105 a molding apparatus shown in exemplary form in Figure 1 and including sectional book type molds 20, 22, 24, and 26 that are pivotally secured to the end portions of respective radial arms 28, 30, 32, and 34 110 of a rotatable turret 36. With this arrangement, the molds are sequentially placed at a loading station I, a thermal conditioning station II, a compression molding station III, and an unloading or ejection station IV. 115 As indicated, the rotatable turret 36 is rotated in a counter-clockwise manner by a suitable, conventional power means (not shown).

The individual molds, *per se*, are identical 120 and therefore may be understood by reference to Figure 2, where mold 22 is illustrated at the thermal conditioning station II. Each of the molds include a pair of semi-cylindrical forming molds A, which collectively define annular, longitudinally spaced finish and support ledge cavities, as indicated by letters B and C, respectively. The finish cavity is shown as forming a threaded finish, but may optionally have a configuration to 130

form a lip finish as is known in the art. Additionally, each mold section includes semi-cylindrical upper and lower support members, D and E respectively, which collectively define annular support rings to assist in grasping and stabilizing the parison during the compression molding operations.

Referring back to Figure 1, the molding cycle is initiated by first positioning a parison, as indicated by reference numeral 38, between the opened sections of a mold at the loading station I. The parisons may be formed by conventional free-extrusion or injection molding techniques. As shown in Figure 2, the parison is grasped at an intermediate portion so that at least a portion of the parison projects above the molds for subsequent thermal conditioning. Of course, the length of the projecting portion should be at least equal to approximately the axial length of mold segments A and D, as will become apparent in relationship to later discussions of the compression molding steps. Thereafter, the opened sections of the forming mold are closed by means (not shown) and the turret is rotated in a counter-clockwise manner to sequentially position the parison at subsequent stations.

Turning now more specifically to Figure 2, mold 22 is illustrated at the thermal conditioning station II, where the upper, projecting portion of the parison 40 is thermally conditioned to a deformable temperature. The dwell time at the thermal conditioning station will vary based upon the heat absorption characteristics of the particular material, the heat output of the heating element at the conditioning station, and the temperature that must be reached so that the plastic material is deformable. As an example, polyethylene terephthalate should be heated to within a range from about 90°C to about 115°C so that the material is sufficiently deformable during the compression molding step, yet is still below its crystallization temperature.

In the disclosed embodiment, the thermal conditioning means is in the form of a vertically displaceable heater 42, including an annular heat source 44 suitably secured within a channel 46 of an annular support 48. The heating element 44 is preferably a radiant, infra-red heat source that is capable of heating the projecting end portion of the parison to a substantially uniform temperature throughout the parison wall thickness.

The heater 42 is vertically movable by suitable conventional means (not shown) to position the heater in two primary locations. The first location is as shown in Figure 2 to locally heat the projecting circumferential section of the parison at Station II. The second location for the heater is above the position as shown in Figure 2 so that the

turret 36 may be indexed to sequentially position the radially arranged molds at the various forming stations.

After sufficiently and properly thermally conditioning the projecting end portion of the parisons at Station II, the heater 42 is displaced vertically upwardly and the thermally conditioned parison is displaced to Station III, where mold 24 is illustrated in Figures 1 and 3-6 in axial alignment with a compression molding assembly. That assembly is comprised of an axially movable compression mandrel 50 and an axially movable end abutment 80, both members 50 and 80 being axially movable by appropriate conventional means (not shown).

The compression mandrel 50 is comprised of a head 52 which is suitably secured to an axially movable displacement rod 54, each of these members having a recess 56 and 58, respectively, that collectively form an internal cavity for a purpose which will become apparent hereinafter. The head member 52 also includes an integral, essentially cylindrical internal support nose 60 that is inserted within the heated parison portion for internal support during the compression molding operations. Circumscribing the upper extremity of the support nose 60 is an annular compression ledge 62 which engages and compresses the upper annular open end of the parison. A secondary ledge 64 is vertically spaced from ledge 62 for abutment against the top of the upper support member D when the compression mandrel is at its lowermost position, as illustrated in Figures 5 and 6.

A through-bore 66 extends from recess 56 in head 52 downwardly through the center of internal support 60 to receive a push-rod 68 which is employed to axially displace the parison relative to the forming molds. An enlarged head 70 on the upper end of push-rod 68 limits the axial movement of the push-rod relative to the compression mandrel as will become apparent below. Additionally, a compression spring 74 is interposed between the lower end of internal support 60 and a bushing 72 that is suitably secured on an intermediate portion of the push-rod, the compression spring serving to downwardly bias the push-rod during the axial displacement of the parison relative to the forming mold.

The end abutment 80 includes a conical recess 82 to receive the domed, closed-end of the parison.

The steps of operation at the compression molding Station III are as follows. First, a forming mold, such as 24, is indexed by the rotatable turret into axial alignment with both the compression mandrel 50 and the end abutment 80, the compression mandrel 50, of course, being positioned well above that position shown in Figure 3 to accom-

modate the lateral circumferential indexing movement of the forming molds and the turret.

Next, the compression mandrel 50 is displaced vertically downwardly to first telescopically insert the thermally conditioned parison section into general radial alignment with the finish and neck flange cavities and then to compression mold at least a portion of the thermally conditioned parison material into the finish cavity. This will be understood more readily by reference to Figures 3, 4, and 5.

Figure 3 illustrates the compression mandrel just as the lower end of the push-rod 68 engages the internal surface of the non-deformable, closed parison end. Additionally, it can be seen that the vertical dimension of the compression mandrel 50 is such that a longitudinal portion of the internal support nose 60 has been inserted into the upper, thermally conditioned parison end. Continued downward movement of the compression mandrel correspondingly displaces the parison downwardly until the external surface of the parison closed end bottoms against the conical recess 82 of end abutment 80. Continued downward movement thereafter results in displacing the internal support 60 fully into the opened end of the parison to the position illustrated in Figure 4. During this latter phase of downward movement, the push-rod 68 is stationary and the remaining components of the compression mandrel therefore move relative to the push-rod under the compressive biasing force of compression spring 74.

Figure 4 illustrates the compression mandrel at the moment when (a) the thermally conditioned upper end portion of the parison has been generally radially aligned with the longitudinally spaced finish and neck support ring cavities, (b) the internal support nose 60 has been fully inserted into the upper, thermally conditioned section of the parison, and (c) the annular compression ledge 62 has first engaged the upper annular end of the parison. Further downward movement of the compression mandrel from the position illustrated in Figure 4 displaces the extreme upper end of the parison downwardly and results in at least some degree of compression molding to force deformable plastic parison material radially outwardly into at least the finish cavity B.

Figure 5 illustrates the compression mandrel 50 in its lowermost position where ledge surface 64 engages the top surface of upper support D. Also as shown in this Figure, plastic material has been forced radially outwardly to substantially fill the finish cavity due to surface 62 compressing the upper extremity of the parison downwardly into the forming mold. During the downward movement of the compression

mandrel 50 from the position of Figure 4 to the position of Figure 5, end abutment 80 is maintained in a fixed position to prevent downward movement of the parison during the first phase of compression molding.

When the compression mandrel reaches the position of Figure 5, upward movement of the end abutment 80 is initiated, for example by a suitably positioned limit switch (not shown) that is tripped by mandrel 50. The end abutment is upwardly displaced to the position illustrated in Figure 6 to complete the compression molding by forcing formable plastic material generally radially outwardly to fill the neck support cavity C, thus completing the compression molding operation. Also as shown by Figure 6, the compression mandrel is not moved during the upward movement or end abutment 80 in order to provide support to the upper end portion of the parison during the second compression molding step.

Thereafter, the compression mandrel 50 is raised to retract push rod 68 to a clearance position above the forming mold. Simultaneously, the end abutment 80 is lowered to the position shown in Figure 3. Next, the turret may be rotated to index the compression molded parison to unloading station IV, where the mold sections are opened and the parison is ejected for placement within a hopper or on a conveyor prior to being blow molded.

It is to be understood that the disclosed embodiment is merely exemplary of the overall invention, which is limited only by the following Claims. For example, the invention has been explained in reference to a parison having one closed end. For other types of parisons, an alternative vertical displacement component other than the push rod may be required. Additionally, the operation of the compression mandrel and the end abutment were described in terms of a sequential operation. This is desired only to completely position the thermally conditioned circumferential section of the parison fully within the forming mold prior to compression by the compression mandrel 50. However, this is optional and the two compression steps by the compression mandrel 50 and the end abutment 80 may be simultaneous; for example, the two compression steps may be carried out simultaneously after the uppermost annular end portion of the parison is inserted within mold portion D. Further, the molds have been described in connection with a rotatable turret, but any other suitable arrangement may be utilized.

#### WHAT WE CLAIM IS:—

1. A method of making a thermoplastic parison having an integral finish and an

integral, annular support ring comprising heating a portion of the parison to a temperature at which it is deformable, positioning the heated parison portion in a mold in general radial alignment with longitudinally-spaced finish and support ring cavities, and moving each end of the parison towards the other end to cause material in the heated parison portion to flow into said longitudinally-spaced cavities.

2. A method as claimed in claim 1 wherein material in said heated parison portion is caused to flow into said cavities by supporting one end of the parison while 15 axially displacing the other parison end toward said one end to force at least a portion of the heated plastic material outwardly into at least one of the cavities, and then supporting the other parison end while 20 axially displacing said one parison end toward said other end to force additional heated plastic material into at least the other of the cavities.

3. A method as claimed in claim 2 25 wherein the axial displacement of said other parison end causes a section of the heated parison portion to flow radially outwardly into the finish cavity, and the axial displacement of said one parison end causes a further section of the heated parison portion to flow radially outwardly into the support ring cavity.

4. A method as claimed in any of claims 35 1 to 3 wherein said parison is formed of polyethylene terephthalate, and is heated to a temperature in the range of between about 90°C and about 115°C.

5. A method as claimed in any of claims 40 1 to 4 in which a sectional mold is closed onto a longitudinal portion of the parison intermediate its ends so that an open parison end and a longitudinal parison section adjacent said open end extend out of said mold, thermally conditioning that section of the parison extending out of said mold to a temperature at which it is deformable, engaging the parison at a position where the plastic material is nondeformable and axially displacing the parison to generally radially 45 align at least a portion of the thermally conditioned section with said longitudinally-spaced cavities, and sequentially displacing the two ends of the parison towards each other while interiorly supporting said section to substantially sequentially force plastic 55 material radially outwardly into each of said longitudinally spaced cavities to form said finish and support ring.

6. A method of forming a threaded finish 60 and a neck support ledge on an essentially tubular thermoplastic parison having an open end and a closed end, comprising the sequential steps of:

(1) placing the parison in a mold having 65 a finish forming cavity and an annular neck

support ledge cavity, the open end of said parison and an adjacent longitudinal section of said parison extending above the mold;

(2) substantially uniformly heating that portion of the parison extending above said mold to a temperature at which it is deformable;

(3) axially aligning the mold and the parison with (a) a support surface beneath the closed end of the parison and (b) a compression mandrel above the heated open end of the parison, the compression mandrel including a cylindrical nose insertable within the heated parison portion for internal support thereof, an annular surface circumscribing the upper end of the cylindrical nose for engaging the upper annular openend of the heated parison, and a push rod extending downwardly from the nose for insertion within the parison to engage the internal surface of the closed-end portion thereof, said push rod being yieldably biased downwardly and movable axially relative to said cylindrical nose;

(4) downwardly displacing the compression mandrel and (a) freely inserting the push rod into the parison to engage the internal surface of the closed end parison portion end thereafter displacing the parison axially downwardly with the push rod to radially align the heated parison portion with the finish forming cavity and the support ledge cavity; (b) telescopically inserting the cylindrical support nose within the upper parison open end portion into general radial alignment with the heated parison section, (c) contacting the upper annular end of the parison with the annular mandrel surface, and (d) compressing the heated upper end of the parison by continued downward movement of the mandrel and forcing a portion of the heated parison radially outwardly into the finish forming cavity of the mold;

(5) upwardly displacing the support surface to compress the tubular parison from the closed end thereof to force a portion of the heated parison into the annular neck support ledge cavity; and

(6) removing the thus-formed parison from the finish mold.

7. A molding apparatus for forming a finish and a support flange on a plastics tube, comprising:

a sectional forming mold to receive a plastics tube, said mold including an annular support flange cavity longitudinally spaced from a finish cavity;

a movable compression mandrel axially alignable with said forming mold, said mandrel including (a) an essentially cylindrical portion telescopically insertable within a plastics tube in the mold and radially alignable with the cavities in said mold to internally support the tube and (b) an annular ledge circumscribing an end of said

portion for engaging and axially compressing one end of the tube to force plastic material radially outwardly into at least one of said cavities; and

5 a movable end abutment in alignment with said compression mandrel (a) for engaging and supporting the other end of said tube and (b) for axially compressing said other tube end to force plastic material radially outwardly into the other of said cavities.

10 8. Apparatus as claimed in claim 7 wherein said compression mandrel further includes a spring-biased push rod extending from said cylindrical portion for engaging the internal surface of a closed end on the plastic tube to telescopically insert the plastic tube into the forming mold.

15 9. Apparatus as claimed in claim 7 or 8 wherein said sectional forming mold is laterally displaceable and is closable upon an intermediate portion of said tube so that one end portion of the tube projects out of the mold, said apparatus also including

means for thermally conditioning that portion of the tube that projects out of the mold, and means for axially displacing the tube relative to the forming mold to telescopically insert the thermally conditioned tube portion into the mold in radial alignment with said longitudinally-spaced finish and flange cavities in the mold.

20 10. A method of forming a plastics article, substantially as hereinbefore described with reference to the drawings.

15 11. Apparatus for forming a plastics article, substantially as hereinbefore described with reference to the drawings.

20 12. Plastics articles formed by a method as claimed in any of claims 1 to 6 and 10 or in apparatus as claimed in any of claims 7 to 9 and 11.

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## 1577835 COMPLETE SPECIFICATION

2 SHEETS

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Sheet 1

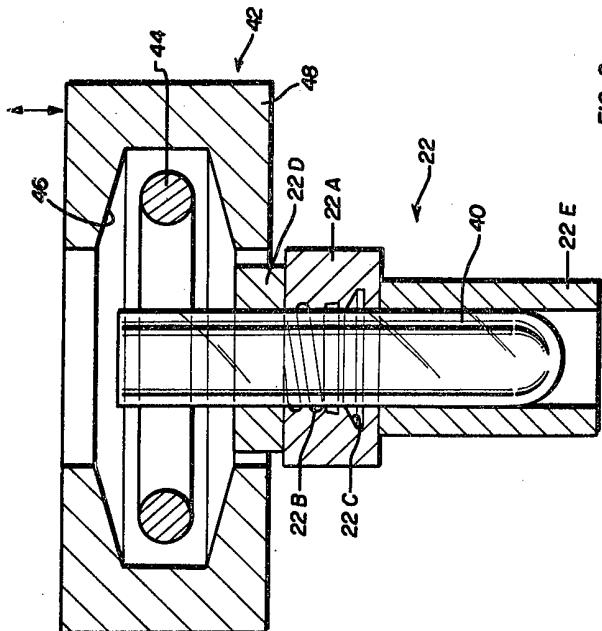


FIG. 2

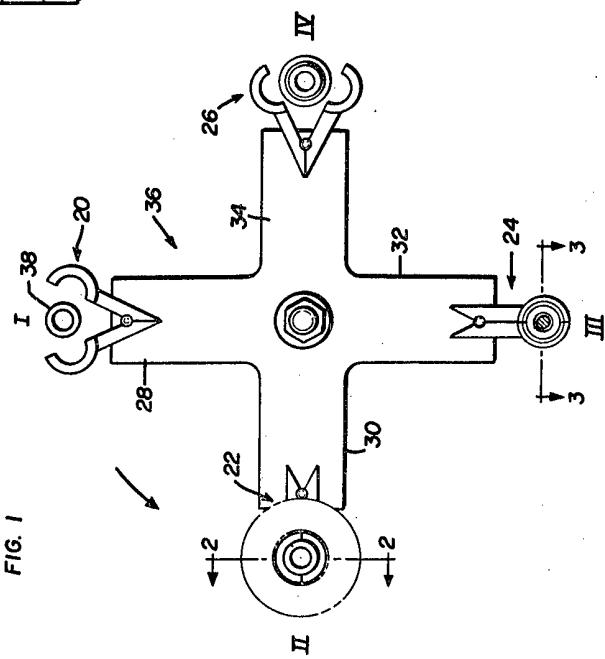


FIG. 1

1577835 COMPLETE SPECIFICATION

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Sheet 2

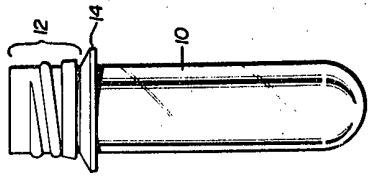


FIG. 7

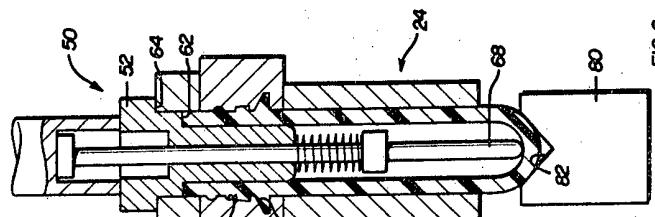


FIG. 6

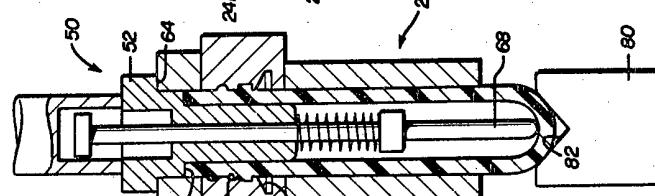


FIG. 5

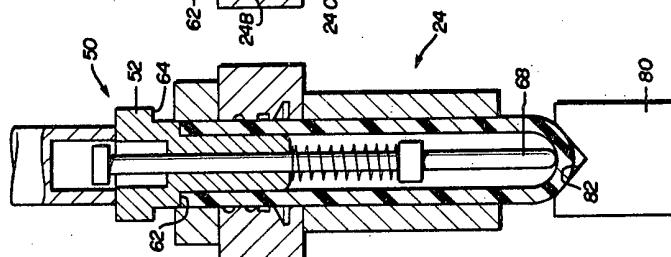


FIG. 4

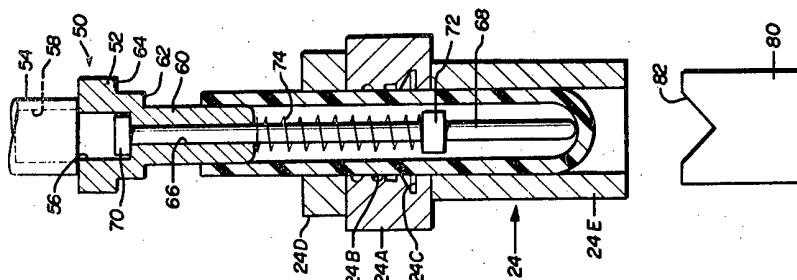


FIG. 3