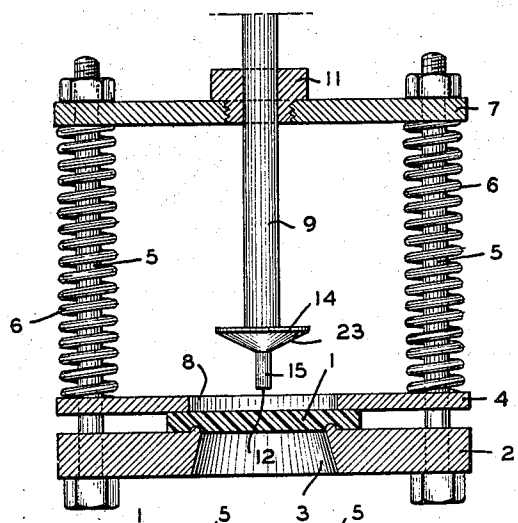
March 24, 1959 C. E. SLAUGHTER 2,878,513

COLLAPSIBLE TUBE MANUFACTURE

Filed Oct. 22, 1953 3 Sheets-Sheet 1

FIG. 1



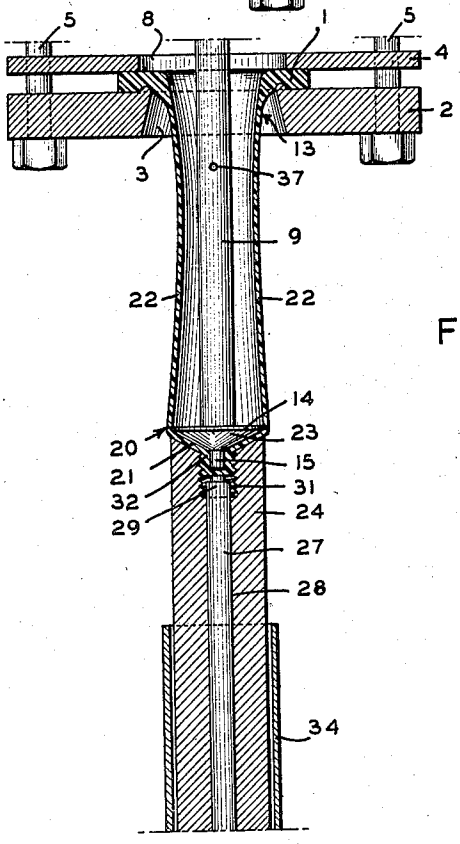


FIG. 7

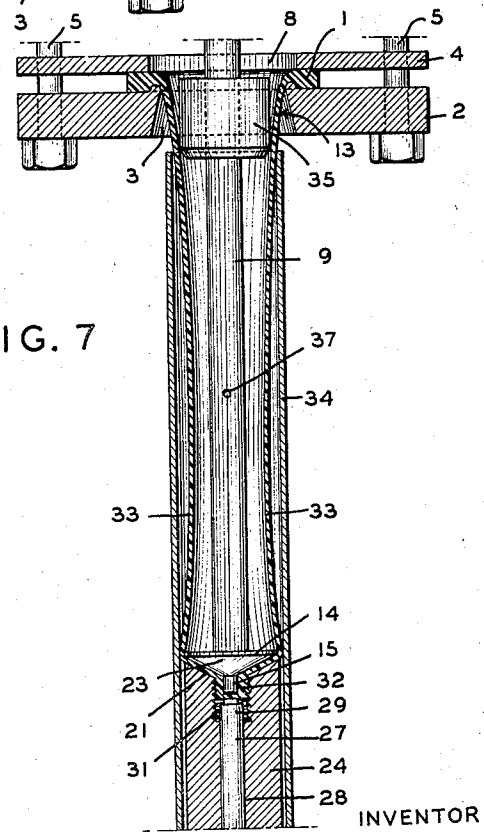


FIG. 2

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COLLAPSIBLE TUBE MANUFACTURE

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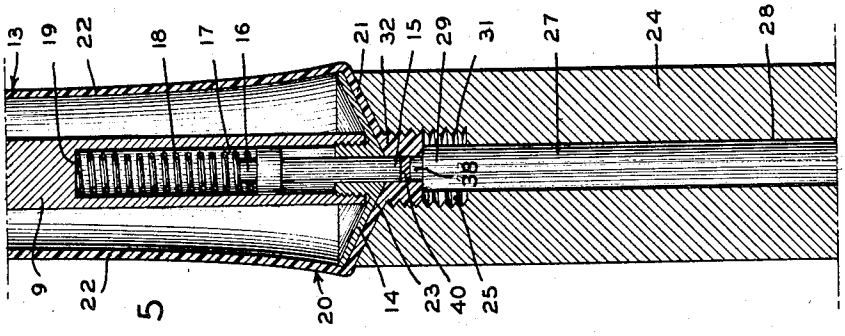


FIG. 5

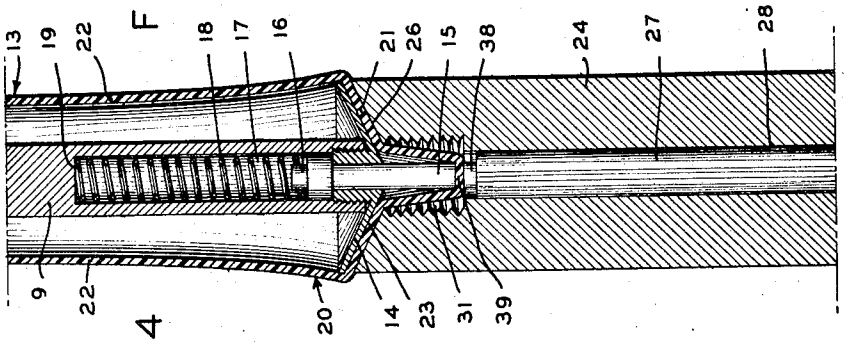


FIG. 4

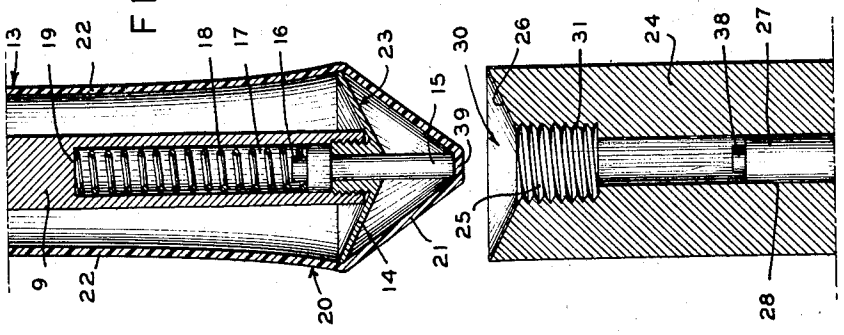


FIG. 3

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COLLAPSIBLE TUBE MANUFACTURE

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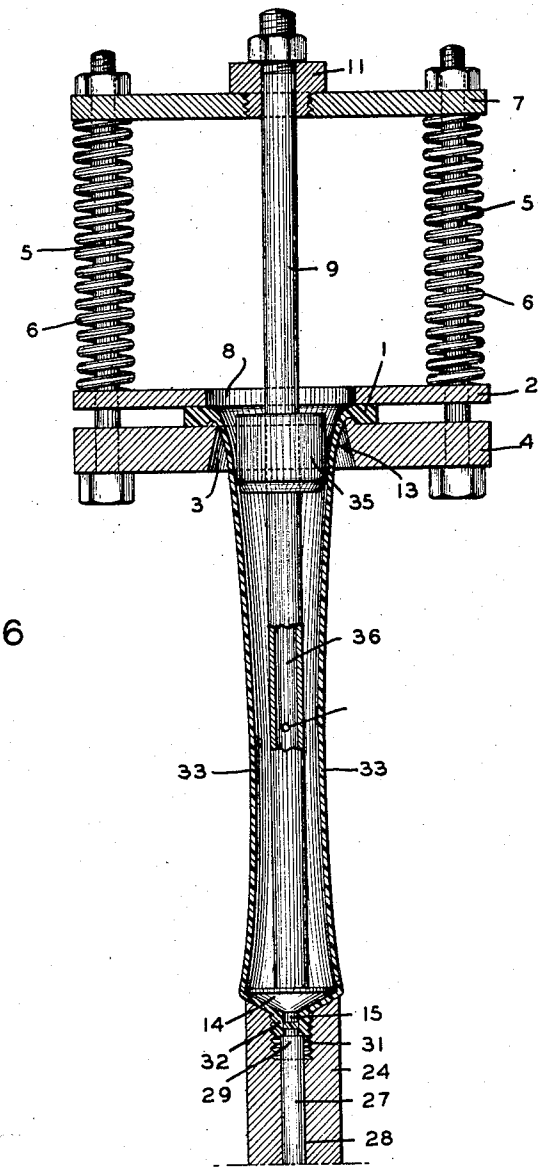
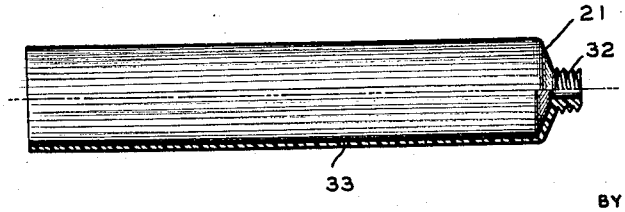


FIG. 6

FIG. 8



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2,878,513

COLLAPSIBLE TUBE MANUFACTURE

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Application October 22, 1953, Serial No. 387,691

32 Claims. (Cl. 18—19)

This invention relates to the manufacture of thin walled, one piece collapsible tubes from tractile plastic material, to methods of making collapsible tubes, to apparatus and devices for production of collapsible tubes, and to novel collapsible tubes themselves.

There have been repeated efforts in the prior art to make collapsible tubes from thermoplastic materials. The prior art methods have been unsatisfactory as an industrial operation for many reasons. Many have been complex and expensive. The resulting products have not been uniform. The tube walls in many cases have lacked the necessary strength with desired flexibility. In many cases, the plastic has been subjected to such distortion that internally it is under strain and is, as a result, permeable to essential oils and other components of materials normally contained in products packaged in collapsible tubes.

Among the objects of the present invention is the manufacture of collapsible tubes by relatively simple and economic methods.

Other objects include the production of collapsible tubes that are substantially uniform although made by high speed methods of manufacture.

Further objects of this invention are collapsible tubes of desired strength and flexibility, but free from internal plastic strain.

Still further objects of this invention will appear from the more detailed description set forth below, it being understood that such more detailed description is given by way of illustration and explanation only, and not by way of limitation since various changes therein may be made by those skilled in the art without departing from the scope and spirit of the present invention.

In connection with that more detailed disclosure, the accompanying drawings illustrate one form of the invention.

Figure 1 shows in front elevation, partly in section, a device for drawing plastic to produce a collapsible tube preform.

Figure 2 shows the first stage of the drawing operation.

Figure 3 shows a front elevation partly in section of a preferred form of apparatus elements at the end of the first stage of the drawing operation.

Figure 4 shows a similar view at the beginning of the neck and shoulder forming operations.

Figure 5 shows a similar view at the completion of the neck and shoulder forming operations.

Figure 6 shows the completion of the drawing operation.

Figure 7 shows the final shaping for the tube preform.

Figure 8 shows the collapsible tube preform produced in accordance with this invention.

In accordance with the present invention, it has been discovered that collapsible tubes can be manufactured satisfactorily from plastic or thermoplastic material which tubes possess all necessary characteristics to satisfy industrial and commercial usage and, by methods that are feasible, relatively simple, economical, and rapid, the

body portion of the tube being produced by a drawing operation that yields a one-piece thin walled tube of substantially uniform dimension throughout its length, the plastic being free of internal strain.

Exemplary plastic material that is satisfactory for utilization includes polyethylene, nylon type resins, and polyvinylidene chloride such as "Saran." Such plastics will hereinafter be referred to as tractile plastic. Polyethylene will be used to illustrate the invention. For example, it has been found that plastic such as polyethylene may, under proper conditions, be drawn to give a collapsible tube preform of wall dimension that may be controlled as desired with respect to wall-depth of plastic without internal strain whereby the desired strength may be developed while acquiring the flexibility necessary for collapsible tube use. For some uses, thermoplastics that exhibit a definite melting point and are capable of orientation may be desirable.

In carrying out the present invention, the collapsible tube preform is drawn from a preheated slug of tractile plastic. The slug may be in disc form, its diameter and thickness determining the amount of plastic which is available for the preform.

Of course, the method in which such slug is processed, including manner of operation and temperature, will determine the degree to which the plastic is oriented, the final shape obtained, and the distribution of the plastic in the preform and in the ultimate collapsible tube.

The slug is fixed in position for the drawing operation by clamping it peripherally and the plastic is drawn from the free or unclamped portion of the disc. The drawing operation may be carried out in any desired way as by means of a mandrel which impinges against a central portion only of the disc and by movement draws the plastic from the slug to the extent desired. During such drawing operation, the walls of the tube preform which are thus being produced in an initial stage should be free and the mandrel therefore does not contact the plastic material at any point except at the central portion of the closed end of the tubular form being drawn. To give the desired diameter and size to the tubular form, the mandrel may carry a disc near the outer end of the mandrel, the diameter of the disc determining the diameter of the tubular preform, and also serving to maintain the drawn walls out of contact with apparatus elements to prevent chilling so that the wall will be free for orientation. The amount of plastic material in the tubular form at this stage and its distribution depends on the nature of the plastic, its temperature, and the character of the drawing operation. It has been found that it is possible to control very accurately the distribution of the plastic in the tubular form and to produce substantially uniform wall dimension in the tube wall, throughout its length. For this purpose, the tubular form is desirably not drawn to the ultimate length desired, in a single continuous drawing operation because the plastic in the outer (closed end) of the tubular form is in plastic deformable condition at this stage. Far superior results and control are obtained if the drawing operation is interrupted when the tubular length produced is only a fraction (as for example one-half inch) of the ultimate desired length. Then, at this stage, the neck and shoulder portions are formed in the outer (closed) end of the tubular form and chilled or frozen so that a rigid neck and shoulder is produced integral with the tubular wall. It will be noted that at this point, the wall of the tubular form does not contact any metal and therefore does not freeze. The drawing operation is then continued to completion of the drawn tubular preform. Finally, since the drawn tubular form will generally show a concavely curved side wall, it is desirably subjected to the pressure of a fluid such as air blown thereinto, to expand the tube

within a metallic tubular form or die to the desired final straight walled tubular pattern, the contact with the metallic die chilling or freezing the thus formed tube at this time. The air pressure is then released, the metallic tubular form or die moved out of position, and the neck forming die removed. Where a threaded tube has been formed the last mentioned die may be removed by unscrewing, or where a split die is used, it is opened and removed.

A number of important advantages are secured by these procedures. The amount of plastic in the neck and shoulder can be maintained to give a rigid structure. The neck can, if desired, be given an external thread of desired strength which thread is formed into the neck at the time of the neck forming operation. At this time, and as part of the operation, the neck may be pierced to form an internal passage connecting with the interior of the tubular form. By forming the neck and shoulder portions in this way and chilling or freezing them, the plastic in the neck and shoulder portion remains set, so that the further drawing operation to final tube length does not remove plastic from the neck and shoulder portions. Instead, the drawing takes place from the drawn tubular portion only which is still at drawing temperature. The tube may be drawn to any length desired and under the conditions given a substantially uniform wall dimension is secured throughout the length of the drawn tube regardless of how thin the tube wall is made. Orientation of the plastic is secured at the same time thus developing strength and flexibility. In this way a plastic collapsible one-piece thin walled tube preform is produced representing a marked advance in the art. The oriented drawn tubular body has the strength and flexibility desired while the heavier neck and shoulder give rigidity and shape retention. Furthermore, the simplicity of operation used in production of such preform not only makes for economy and high speed in production, but enables complete control of the amount of plastic which enters into each portion of the preform and the distribution of the plastic at every point thereof. No such control was possible in any prior art operation nor was it possible to produce such plastic articles in the prior art free from internal strain with resultant loss of strength and life. Tubes produced by the present invention show resistance to penetration even by sulfonated detergents.

The wall dimension of tube can be controlled throughout the length of the tube by the speed of the draw. Fast draw gives a thin wall around the shoulder portion. A very slow draw gives a thin wall around the open end. The correct draw desired can be readily determined for any given set of conditions to maintain substantially uniform wall depth within a couple of thousandths of an inch. In addition, the finished tube can be made of any length within limits, but with retention of substantially uniform wall dimension by the speed of draw. Thus tubes can be made of a diameter such as 1¼" and 5" length to 8" length. The finished tube wall depth also depends of course, on the thickness of the original slug. A typical operation carried out in accordance with the present invention utilized a slug approximately ¼" thick by 1½" diameter at a temperature of 180° C., the slug being made from polyethylene P.M.I. grade (Du Pont). The speed of travel during the drawing operation was 16–18" per minute. The size of the finished collapsible tube was 1¼" in diameter by 7" in length from shoulder to cut off. The thread on the nose was 7/16" long with fourteen threads to the inch. The temperature of the original slug may vary as desired as long as it is at drawing temperature until the final drawing operation and fluid expansion steps are completed. Tubes of any desired diameter, length and wall thickness may thus be produced, and the ultimate configuration of the collapsible tube preform controlled within close tolerance limits as desired.

Turning to the disclosed drawings, one manner of practicing the invention is as follows. A slug **1** such as of polyethylene, and of the desired size is positioned on the bottom plate **2** over an opening **3** therein, and held in place by holddown plate **4** mounted on standards **5**, **5** carried on plate **2**. Coil springs **6**, **6** are seated against plate **4** at one end and against guide plate **7** at the other end to force the plate **4** against the peripheral area of slug **1** to hold the latter firmly in position during drawing. An opening **8** in plate **4** permits access of draw mandrel **9**. The mandrel **9** is mounted on guide plate **7** and bushing **11**. The outer end **12** of the mandrel **9** is adapted to engage against the central portion of slug **1** and by movement of mandrel **9** to draw the plastic material to tubular form as at **13**. The mandrel **9** carries a disc **14** near its outer end, the disc **14** serving to determine the width of the tubular form and to maintain the walls of the tubular form while being drawn, out of contact with metal so that the plastic is free to orient.

The preferred structure of the outer end of the mandrel is shown in Figure 3. As there indicated, the outer end of the mandrel is formed with a retractable nose **15** which is positioned at its inner end **16** within recess **17** in the mandrel **9**. A spring **18** within recess **17** seats at one end against the inner wall **19** of recess **17** and at the other end against the inner end **16** of nose **15** to force the latter normally in an outward direction into contact with the plastic **20** being drawn into tubular form, the latter having closed end **21** and side walls **22**, the drawn side wall naturally assuming a concave shape. Disc **14** has a circular tangential surface **23** for purposes hereinafter set forth.

A female header **24** is provided having mold cavity **25** formed therein with a circular tangential surface **26** adapted to cooperate with tangential surface **23** on disc **14** of the mandrel **9**. A movable piston **27** reciprocates centrally and longitudinally within a channel **28** in header **24**. The end of piston **27** is adapted to move into cavity **25** for purposes hereinafter set forth.

As shown in Figure 2, when the drawing operation has been conducted for a fraction only of the total drawing movement ultimately contemplated (for example say ½"), the plastic has been drawn into the position shown in the upper part of Figure 3, and formed around the nose and disc. At this point, female header **24** is brought into close contact as shown in Figure 4, and header **24** is held in position. The metal of tangential wall **26** contacts plastic **21** and compresses it against tangential wall **23**. The plastic is thus shaped at this area to form the shoulder desired in the ultimate collapsible tube, and as it is shaped or molded, it is chilled or frozen (set) by the contact with metal wall **26**. It will however be noted that the sheath of plastic around the nose does not at this point contact with any portion of female header **24** and therefore it does not freeze.

As soon as the setting of header **24** and freezing of the shoulder plastic is complete (which may occupy about a ½" of travel) piston **27** in header **24** is raised as shown in Figure 5, so that end **29** of piston **27** enters cavity **25** and contacts the hot plastic exerting a considerable amount of pressure on piston **27** and partly due to spring **18** that is holding retractable nose **15** in place. Sufficient pressure is however applied to the piston to overcome the resistance of spring **18** with the result that nose **15** is gradually forced into the mandrel cavity **17**. The plastic which is still unfrozen has to go somewhere. It compresses, welds into a homogeneous mass, and fills out the space left between nose **15** and the neck forming portion **30** of cavity **25**. If the internal wall of neck forming portion **30** is threaded as shown at **31**, the plastic will be forced into such thread mold to form threaded neck **32** on the plastic in the cavity. At the same time that neck **32** is formed, the chill of the metal immediately freezes the plastic to form a rigid neck integral with a rigid shoulder all molded as an

integral unit on the tubular form. The rapidity of chilling of the shoulder determines the character of the shoulder. The quicker this chilling is brought about, the heavier is this portion of the finished tube. If there is no chilling, then the shoulder and wall have approximately the same thickness.

Thus the plastic has been chilled at the neck and shoulder portion and is held securely at the other end between plates 2 and 4. The mandrel 9 then continues with the drawing carrying header 24 in set position, until the drawing movement is complete to the extent shown in Figure 6. At this time the tubular form has the length desired for the finished collapsible tube, the wall 33 of the tubular form being concave as there shown. The second drawing phase is possible because the plastic of the wall is still at drawing temperature. This drawing operation orients the plastic to give it strength and flexibility. It has been found that the drawing of the plastic takes place from the wall of the tubular form only, since the neck and shoulder portions have been frozen. As a result the tubular wall may be drawn to any desired length within reason, and while being so drawn under the conditions set forth, the depth of the tube wall which results is substantially uniform over the entire length of the tube.

When the unit consisting of mandrel 9, female header 24 and piston 27 reaches the bottom or end of the stroke, means are provided as shown in Figures 2 and 7 for expanding the concave wall 33 to form a straight side wall. For this purpose a metallic cylindrical tube 34 (Figure 2) is placed around the concave wall 33 of the tubular form (Figure 7). A plug 35 on mandrel 9 has moved thereon to close the open end of tha tubular form. Air or other fluid under pressure is introduced through a passage 36 and passes into the interior of the tubular form through opening 37, expanding the concave wall into contact with tube 34 which produces the desired shape and freezes the shaped plastic. The air pressure is then released, the tube 34 is dropped or moved out of contact with the shaped collapsible tube preform, the plug 35 withdrawn, and the female header 24 removed. The latter may be rotated to unscrew it from the threaded neck if a thread is present; or if a two part die is used, the latter is opened and the header removed. The collapsible tube preform is now complete and may be severed at its open end from the portion which was clamped between plates 2 and 4.

When desired, a channel in neck 32 communicating with the interior of the tubular form, may be produced by having a pin 38 fitted into the end of piston 27 and in the final closing of the die when the neck 32 is being formed, the pin 38 presses upwardly into the thin end wall 39 of the neck 32 against the nose 15 of the mandrel 9 as shown in Figure 5 so that a very thin disc 40 is punched out into the neck 32 of the collapsible tube. The thin disc 40 is ejected when the piston 27 moves downwardly to permit the nose 15 to act for that purpose, the disc 40 adhering to the pin 38 and can be removed as being blown off when the forming die is opened.

Having thus set forth my invention, I claim:

1. The method of drawing plastic to tubular form which comprises positioning a heated solid slug of tractile plastic material for drawing, confining the peripheral lip of said slug against movement and drawing the material from the unconfined portion of the heated slug to form an elongated one piece thin walled tube having a closed end, the wall of the tube being unconfined during the drawing operation.

2. The method of claim 1 in which the plastic is polyethylene and the slug is heated to drawing temperature.

3. The method of claim 1 in which material of the slug is drawn to a depth several times the width of the slug and approximating that of the length of a collapsible tube.

4. The method of claim 1 in which the drawing operation is carried out by a mandrel, the end only of which is in contact with the plastic and impinges during drawing against the center of the material undergoing drawing, the mandrel carrying a disc near the end of the mandrel, the peripheral edge of which disc impinges against the side walls of the drawn tube.

5. The method of claim 1 in which the plastic is polyvinylidene chloride and the slug is heated to drawing temperature.

6. The method of claim 1 in which the plastic is nylon and the slug is heated to drawing temperature.

7. The method of claim 1 which includes the step of shaping the closed end of the tubular form to produce a threaded neck thereon integral with the tubular form.

8. The method of claim 7 which includes the step of piercing the threaded neck longitudinally to provide a channel therethrough communicating with the interior of the tubular form.

9. The method of claim 1 in which the closed end of the tubular form is shaped to produce a restricted neck thereon integral with the tubular form.

10. The method of claim 1 in which the walls of the tube are blown to desired final shape by fluid under pressure introduced within the tube.

11. The method of claim 10 in which the closed end of the tubular form is shaped to produce a restricted neck thereon integral with the tubular form.

12. The method as set forth in claim 1 including drawing the tube in a first step to an extent approximating a fraction of its final length, then shaping the closed end of the tubular form to produce a restricted neck thereon integral with the tubular form, chilling the formed neck, and completing the tube drawing operation.

13. The method as set forth in claim 12 wherein the neck shaping and chilling operation includes first molding and chilling a shoulder of plastic which joins the neck to the wall of the tube, and then shaping and chilling the neck thereon with a threaded external surface.

14. The method of claim 13 in which the tubular form is finally blown to desired final shape by fluid under pressure introduced within the tube.

15. The method of claim 13 in which the neck is molded with a threaded external surface.

16. The method of claim 15 in which the tubular form is finally blown to desired final shape by fluid under pressure introduced within the tube.

17. In apparatus for drawing tractile plastic to tubular form, means for peripherally gripping a solid slug of tractile plastic material, and means for drawing the material from the unconfined portion of the slug to form an elongated tube having a closed end, the drawing means having no contact with the walls of the tube during drawing.

18. The apparatus of claim 17 in which the drawing means includes a mandrel having an end adapted to engage the center of a slug placed in position for drawing, the mandrel carrying a disc near the end of the mandrel which disc is adapted to engage against the side walls of the tube.

19. The apparatus of claim 18 in which the mandrel has a longitudinal recess, a reciprocable nose member in said recess to form the slug engaging end on the mandrel, the inner end of the nose member reciprocating within the recess, a spring within the recess engaging the inner end of the nose member normally to force it outwardly, the disc carrying a centrally disposed opening through which the nose member moves with respect to said disc.

20. The apparatus of claim 19 which includes a female header having a mold cavity to receive the nose mem-

ber and to cooperate therewith in molding plastic carried by the nose member into the mold cavity.

21. The apparatus of claim 20 in which the female header has shoulder forming walls to cooperate with the disc to produce a shoulder on plastic carried into the mold cavity by the nose member.

22. The apparatus of claim 21 in which the wall forming the mold cavity of the female header has a neck forming portion to cooperate with the nose member to form a restricted neck from plastic carried into the mold cavity by the nose member.

23. The machine of claim 22 in which the female header carries a piston reciprocable thereon into the neck forming portion of the mold cavity to form the neck, whereby the neck may be shaped after the shoulder has been formed.

24. The apparatus of claim 23 which includes a metallic tube movable into position to surround a drawn plastic tube, when formed on the machine, the mandrel having a plug movable thereon to seal the end of a drawn plastic tube when formed on the machine, the mandrel having a passage leading to the interior of the plastic tube to conduct a fluid under pressure within the plastic tube to expand the latter into contact with the metallic tube to shape the plastic tube to final form.

25. The apparatus of claim 17 which includes a metallic tube movable into position to surround a drawn plastic tube when formed on the machine, the mandrel having a plug movable thereon to seal the end of a drawn plastic tube when formed on the machine, the mandrel having a passage leading to the interior of the plastic tube to conduct a fluid under pressure within the plastic tube to expand the latter into contact with the metallic tube to shape the plastic tube to final form.

26. In apparatus for drawing plastic to tubular form, a movable mandrel reciprocable through a distance equal to the length of an elongated tubular form, the mandrel having a longitudinal recess, a reciprocable nose member in said recess to form a plastic engaging end for the mandrel, the inner end of the nose member reciprocating within said recess, a spring within the recess engaging the inner end of the nose member normally to force it outwardly, and a disc carried on the end of the mandrel to close the recess therein, the disc having a centrally disposed opening through which the nose member may move with respect to the disc.

27. In apparatus having a mandrel as set forth in claim 26, a female header having a mold cavity to receive the nose member and to cooperate therewith in molding plastic carried by the nose member into the mold cavity.

28. The apparatus of claim 27 in which the female header has shoulder forming walls to cooperate with the disc to produce a shoulder on plastic carried into the mold cavity by the nose member.

29. The apparatus of claim 28 in which the wall forming the mold cavity of the female header has a neck forming portion to cooperate with the nose member to form a restricted neck from plastic carried into the mold cavity by the nose member.

30. The machine of claim 29 in which the female header carries a piston reciprocable thereon into the neck forming position of the mold cavity to form the neck, whereby the neck may be shaped after the shoulder has been formed.

31. In apparatus for drawing plastic to tubular form, a female header having a mold cavity and a channel connecting therewith, tapering walls extending outwardly from said channel to constitute in part the mold cavity, and a piston reciprocable from within the channel into the mold cavity to force plastic introduced into said cavity into contact with molding surfaces thereof, and a means for operating with the female header to draw the plastic into tubular form and to force it into said mold cavity.

32. Apparatus having a female header as set forth in claim 31 in which the mold cavity has a thread forming portion to mold a threaded external surface on plastic molded therein.

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