METHOD OF FORMING PARTLY FOAMED PLASTIC ARTICLES

Original Filed Oct. 19, 1959 5 Sheets-Sheet 1

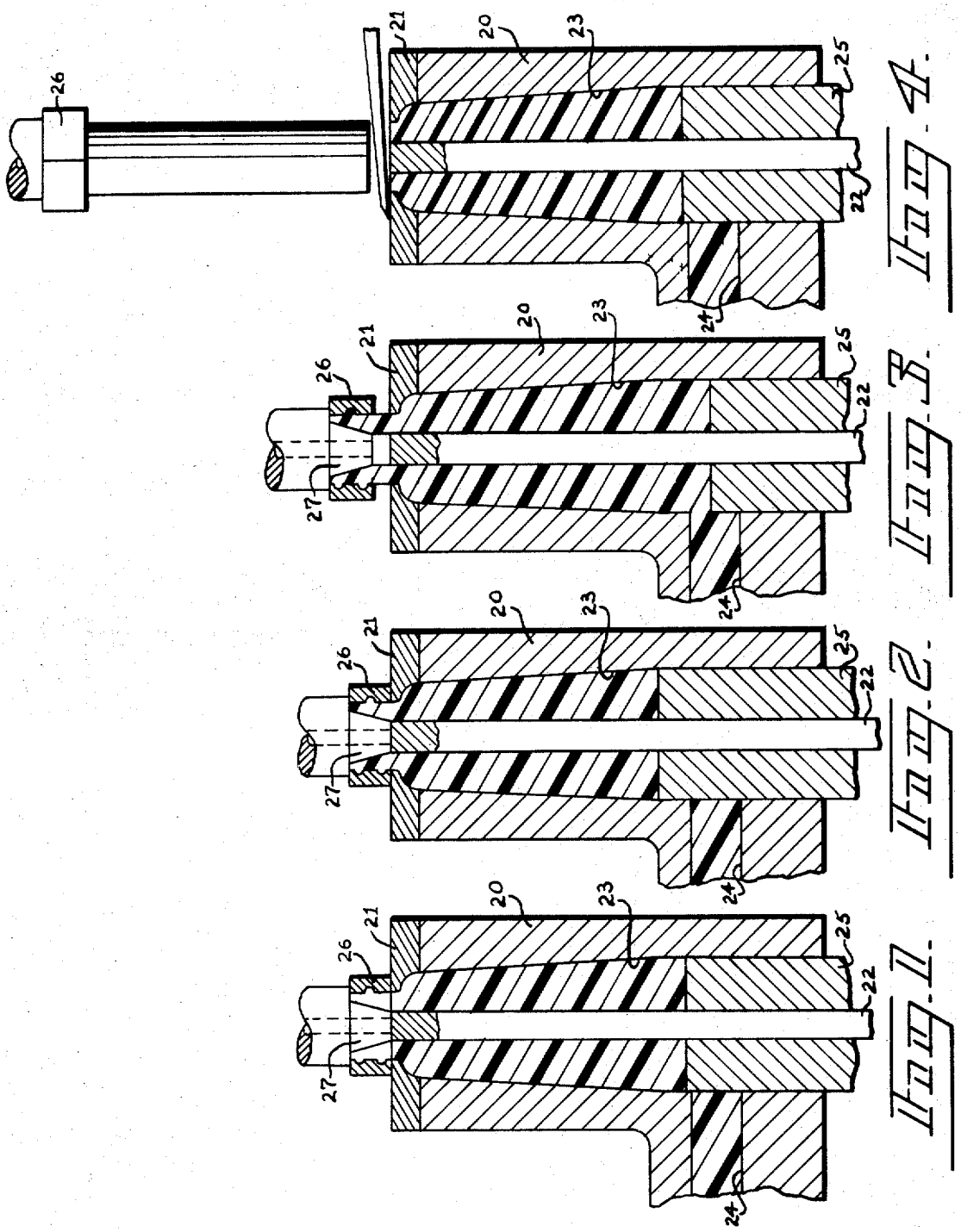
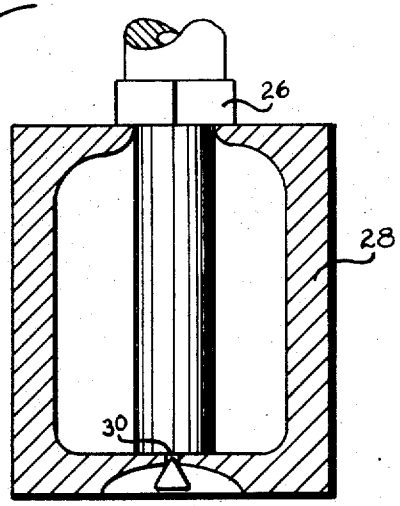


Fig. 4.
Fig. 3.
Fig. 2.
Fig. 1.

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METHOD OF FORMING PARTLY FOAMED PLASTIC ARTICLES

Original Filed Oct. 19, 1959 5 Sheets-Sheet 2



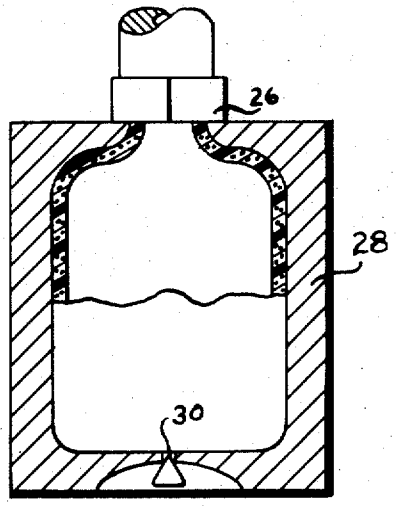


FIG. 6.

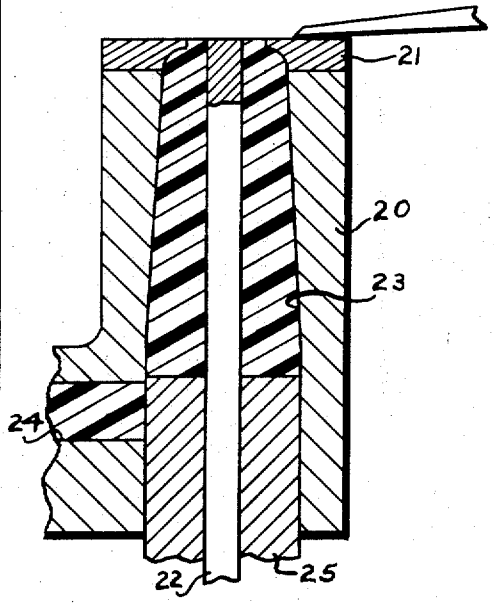


FIG. 5.

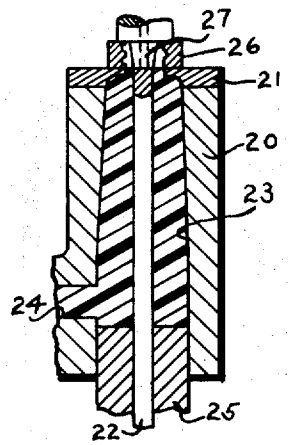
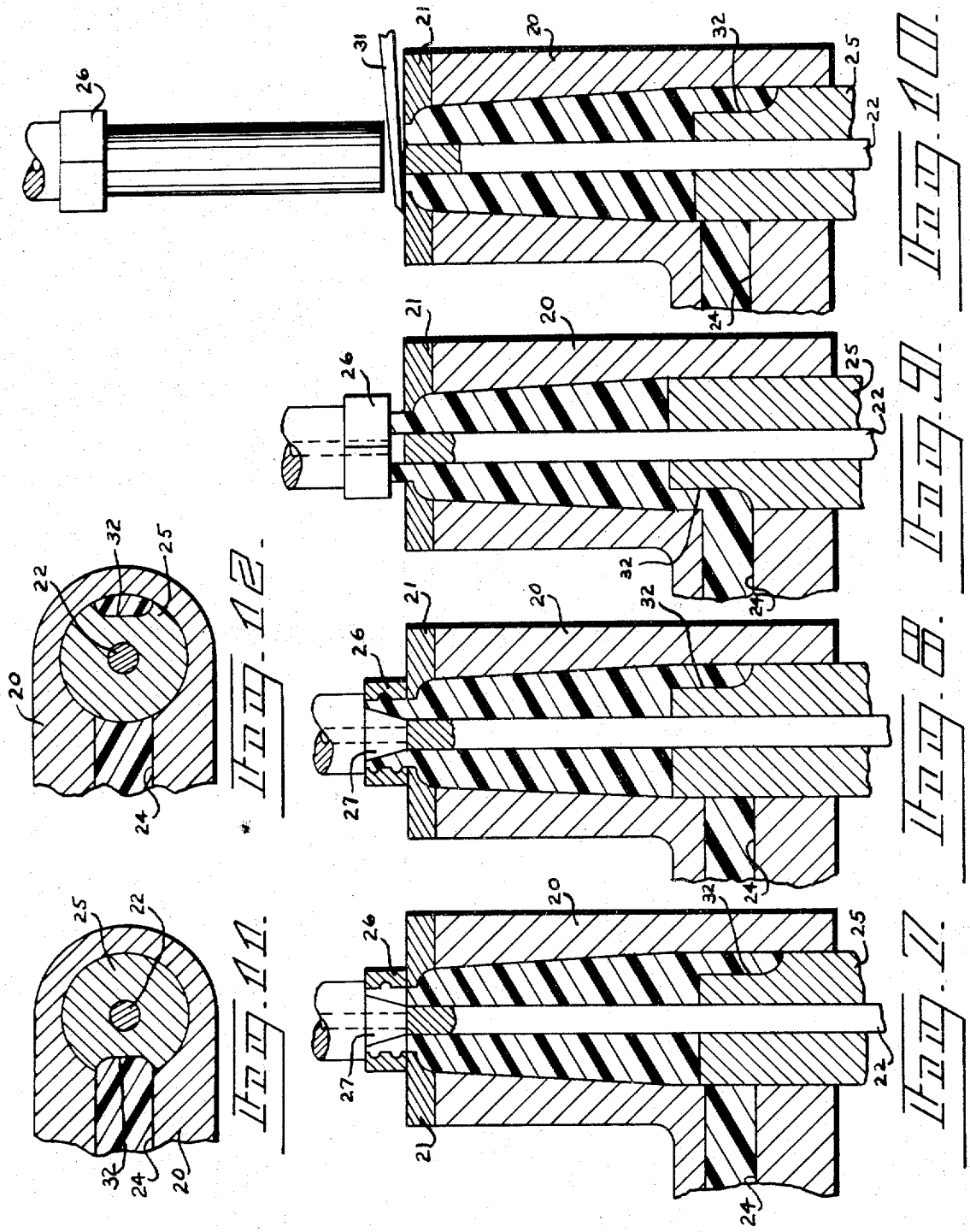


FIG. 5A

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METHOD OF FORMING PARTLY FOAMED PLASTIC ARTICLES

Original Filed Oct. 19, 1959 5 Sheets-Sheet 3



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METHOD OF FORMING PARTLY FOAMED PLASTIC ARTICLES

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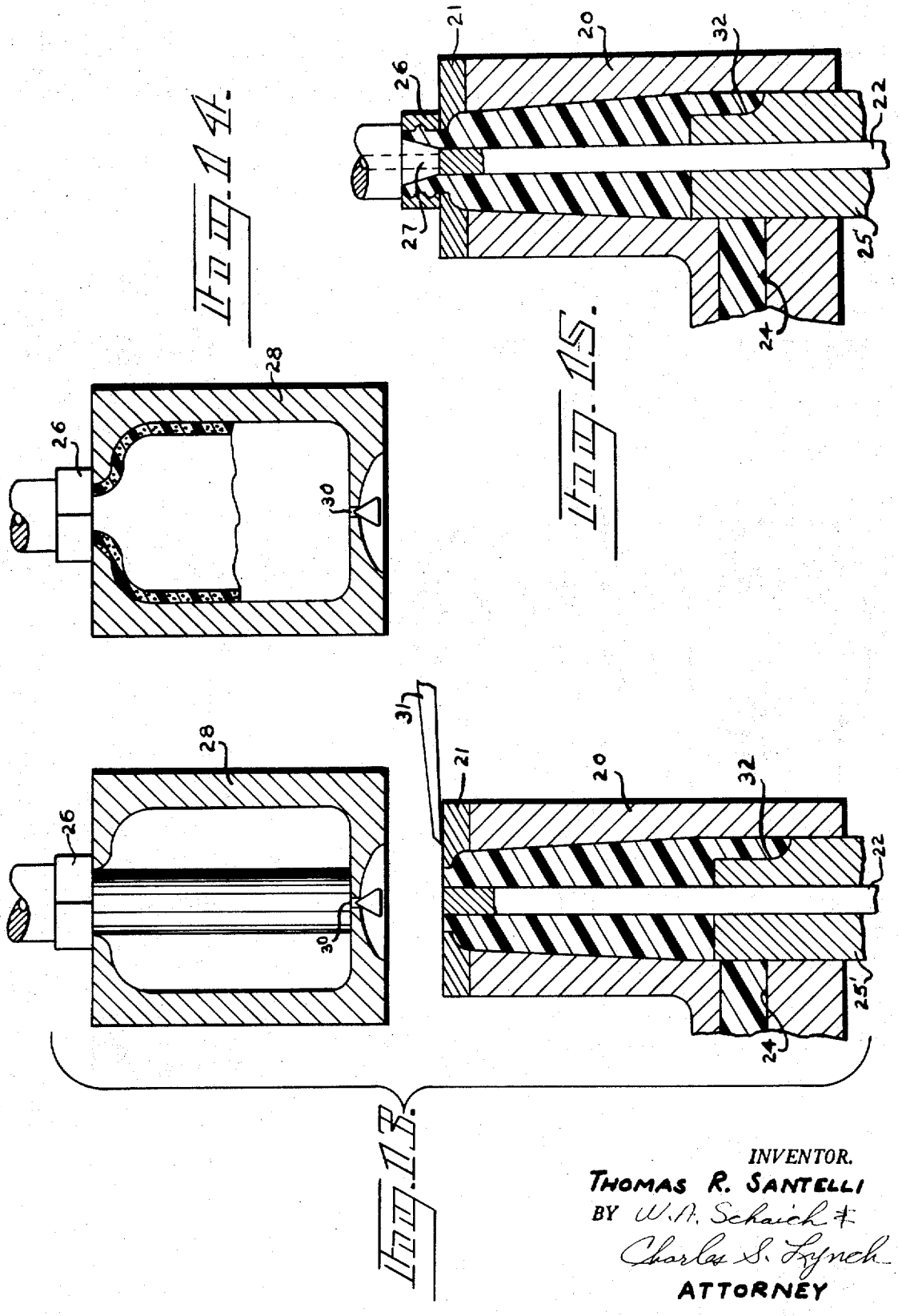


Fig. 14.

Fig. 15.

Fig. 13.

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METHOD OF FORMING PARTLY FOAMED PLASTIC ARTICLES

Original Filed Oct. 19, 1959 5 Sheets-Sheet 5

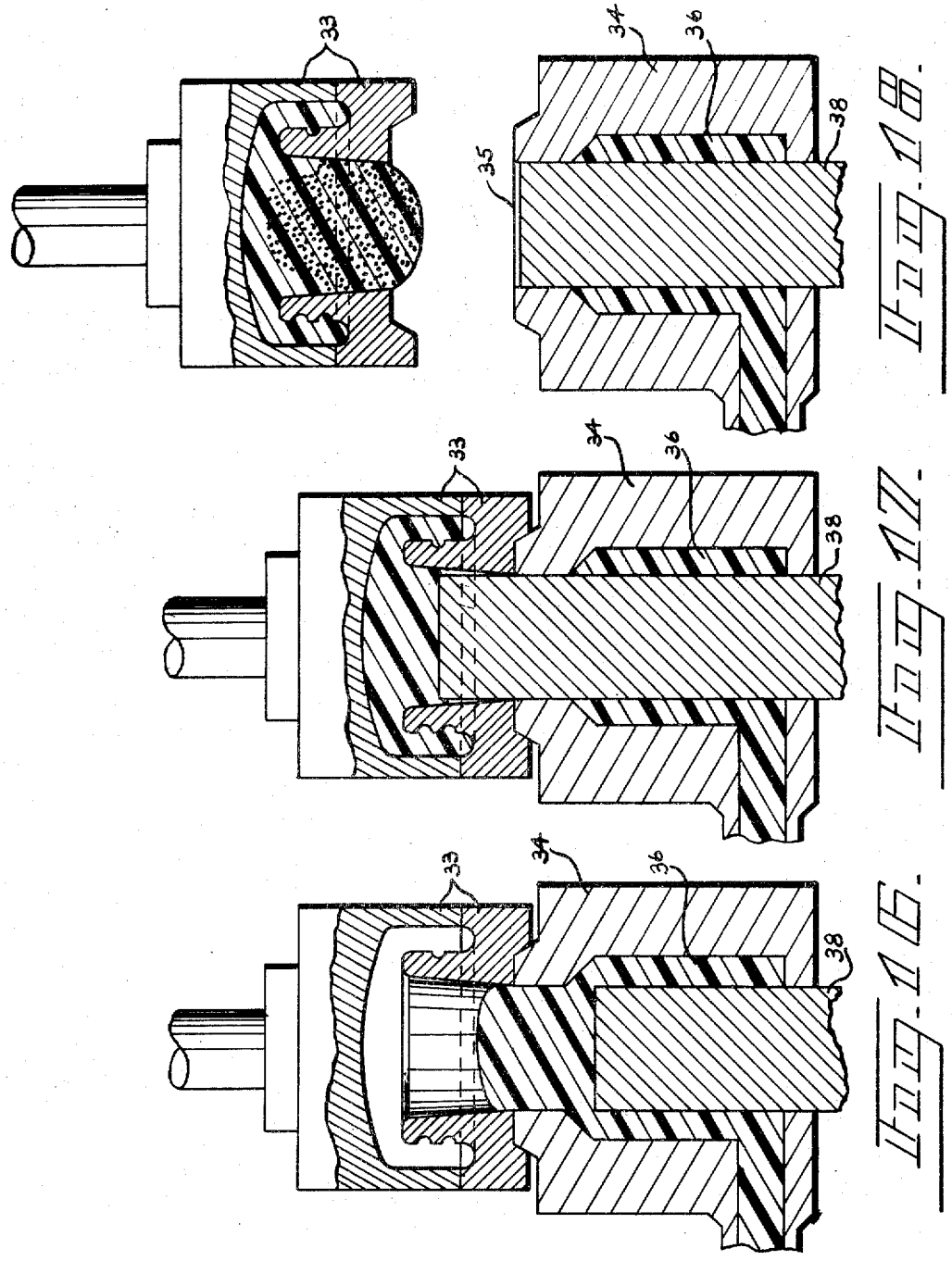


Fig. 18.

Fig. 17.

Fig. 16.

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27,484
METHOD OF FORMING PARTLY FOAMED PLASTIC ARTICLES

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Original No. 3,144,493, dated Aug. 11, 1964, Ser. No. 847,144, Oct. 19, 1959. Application for reissue June 30, 1966, Ser. No. 569,764

Int. Cl. B29c *17/07;* B29d *27/00*

U.S. Cl. 264—45 16 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to plastic articles having an end portion in substantially unexpanded or unfoamed condition with the balance of the article being integral therewith and in expanded or foamed condition. In another aspect the invention relates to a method for forming such an article.

Various articles made of foamed or cellular plastics are desirable because of the various unique properties of foamed plastics, such as cushioning and insulating effects or because of the savings in material which can be realized when producing the article from a plastic in cellular form. However, it has not been desirable to form many objects from cellular plastics in the past because some objects require greater strength or rigidity in certain areas or portions than can be offered by the particular cellular plastic in question.

It is, therefore, an object of the invention to provide a method of forming a cellular plastic article having an end portion which is in a substantially unexpanded condition and integral with the cellular portion of the plastic article.

It is another object of the invention to provide a method for producing such an article.

Other objects and advantages of the invention will become apparent from a consideration of the accompanying disclosure and the drawings.

According to the invention there is provided a method which comprises providing a quantity of hot plasticized plastic material containing an intimately dispersed foaming or cellulating agent, forming a substantially unexpanded, non-cellular shaped end portion of an article from a portion of said plastic material under shaping conditions which prevent any substantial foaming of said portion by said foaming agent, from another portion of said quantity of plastic material forming the balance of said article integral with said shaped end portion under conditions whereby said second portion of said article is expanded into a cellular structure by the action of said foaming agent.

Further according to the invention there is provided a method for forming a plastic article having a cellular portion integral with an end portion formed from the same plastic composition as said cellular portion, said end portion being in a substantially solid or unexpanded, non-cellular-condition.

Blowing or foaming agents which are dispersed in plastics are of two main general types. In the first type the blowing agent is a chemical blowing agent, that is, one which evolves a gas under the influence of heat by chemical reaction or chemical decomposition. The second type of blowing agent is a physical blowing agent, such as a volatile liquid dispersed in the plastic, such liquid forming a gas or vapor under the influence of elevated temperatures and/or lowered pressures. Such foaming agents are well known and will not be discussed in detail here. Either type of blowing agent is applicable in the present invention.

Chemical foaming agents are usually employed at a concentration of from about 0.5 to 10 weight percent of the plastic composition, including the foaming agent, although higher or lower amounts are applicable.

The nature of the invention will be better understood from a description of the drawings which illustrate several suitable types of apparatus for carrying out the method and producing the article of the invention.

Referring to accompanying drawings:

FIGS. 1 through 6 inclusive are sectional elevational views of one suitable apparatus for performing the method, showing the parts in different positions corresponding to various steps of the method;

FIGS. 7 through 10 and 13, 14 and 15 inclusive are sectional elevational views of another apparatus for performing the method, showing the parts in different positions corresponding to the various steps in the method;

FIG. 11 is a sectional view at the line **11—11** of FIG. 9;

FIG. 12 is a sectional view of the line **12—12** of FIG. 7; and

FIGS. 16, 17 and 18 illustrate sectional views of another apparatus suitable for effecting the method of the invention showing the parts in different positions.

As shown in FIGS. 1 through 6, an apparatus for performing the method includes a body **20** having a vertical opening therethrough and an orifice ring **21** overlying the vertical opening. A mandrel **22** is positioned in the opening thereby forming a tubular cavity **23**. The tubular cavity **23** is in communication with the outlet of a plasticizer and extruder (not shown) through a channel **24**.

A sleeve **25** surrounds the mandrel **22** and is reciprocable by means (not shown) from a position above and overlying the channel **24** to a lower position whereby the tubular cavity **23** can be brought into and out of communication with the channel **24**.

A partible neck mold **26** and a hollow core **27** are mounted above the body **20** for axial movement into and out of alignment with the open end of the cavity **23**. A partible finishing mold **28** (FIGS. 5 and 6) is provided for expanding the plastic tube to finished form, as hereinafter described. The bottom of the mold sections are beveled at **29** and spaced apart at **30** in order to pinch the plastic material and seal the end thereof.

At the beginning of the operation of the apparatus shown in FIGS. 1 through 6, a quantity of hot plastic containing foaming agent material and sufficient to fill the tubular cavity is introduced from the source of plastic through the channel **24** to the cavity. The mass of plastic material in the tubular cavity is isolated from the parent mass of plastic material by movement of the sleeve **25** upwardly across the channel **24**. The apparatus if then in position for the beginning of the cycle and the neck mold **26** is brought into contact with the body **20**, the core **27** contacting the mandrel **22** (FIG. 1).

The sleeve **25** is then moved upwardly under controlled pressure a sufficient distance to force a portion of the plastic material in the tubular cavity upwardly in order to fill the neck mold **26** and form the finish or end portion of the article (FIG. 2). The sleeve **25** is then retracted downwardly to reestablish communication with the plastic material (FIG. 3). Simultaneously the neck mold is moved upwardly and axially away from the end of the cavity. The pressure of plastic material from the parent mass forces plastic material into the tubular cavity, and prevents any substantial expansion by foaming of the plastic in the neck mold. Also, the mold chills the plastic sufficiently that expansion is avoided when the neck mold is later removed. A portion of the plastic material in the cavity **23** is displaced out of the open end of the cavity, thereby forming a length of tubing integral with the neck. As this tubing is formed the foaming agent therein causes expansion into a tube of foamed or cellular plastic as it issues from the cavity. As the

desired length of tubing is formed, the sleeve is again moved upwardly to cut off or resegregate the parent mass from the plastic material in the tubular cavity. A shear blade **31** is then moved across the orifice to sever the length of tubing from the plastic material in the tubular cavity (FIG. 4).

The sections of the hollow mold **28** may then be closed about the plastic material, thereby pinching the lower end of the tubing. The foamed tubing can then be expanded to the confines of the mold by applying fluid under pressure through the hollow core **27** (FIGS. 5 and 6).

After the tubing has been severed from the plastic material in the cavity (FIG. 4), the apparatus is again in position for beginning the cycle by bringing a neck mold into contact with the body **20** and forming the neck finish by moving the sleeve **25** upwardly.

A modification of the method can be performed by retracting the sleeve **25** at the beginning of the cycle as shown in FIG. 5a to permit a limited quantity of plastic to enter the tubular cavity and then moving the sleeve upwardly, simultaneously isolating the quantity of plastic in the tubular cavity and forcing plastic into the neck mold positioned over the cavity as shown by FIGS. 2 and 8. The sleeve is then retracted and the neck mold moved axially away from the cavity to form a length of tubing integral with the neck, in the same manner as heretofore described. As the desired length of tubing is formed the sleeve is again moved upwardly as in FIG. 4, or rotated as in FIG. 10 to isolate or resegregate the plastic material in the cavity and the length of tubing is severed. The cycle of operations can then again be started by the retraction of the sleeve.

Another apparatus for performing the method is shown in FIGS. 7 through 15, inclusive. In this apparatus the sleeve **25'** is provided with a slot or groove **32** extending longitudinally along the outer surface of the sleeve to the upper end thereof. In the operation of this apparatus the tubular cavity is initially filled with plastic material containing foaming agent as in the form of the apparatus shown in FIGS. 1 through 6. The sleeve **25'** is in the position shown in FIG. 7 wherein the plastic material in the tubular cavity is isolated or segregated from communication with the parent mass and the groove **32** is in a position out of communication with the channel **24** (FIG. 12.) The sleeve **25'** is then moved upwardly to force plastic material into the neck mold, thereby forming the neck finish (FIG. 8). The sleeve is then rotated to bring the groove **32** into communication with the channel **24**, thereby permitting plastic material to flow from the parent mass to the tubular cavity (FIGS. 9, 11). Simultaneously with this action, the neck mold is moved axially away from the cavity, thereby forming a length of tubing integral with the neck finish by the flow of plastic material out of the tubular cavity. During the forming of the tubing the sleeve is retracted into its lower position. As the desired length of tubing is formed, the sleeve is again rotated to bring the groove **32** out of register with the channel **24** isolating or resegregating the plastic material in the cavity from the parent mass (FIG. 10).

The neck finish and integral tubing can then be severed (FIG. 10) and sealed and expanded, as shown in FIGS. 13 and 14, by closing the mold sections and supplying fluid under pressure through the core.

At the severing of the tube from the material in the tubular cavity, the various parts are again in position for application of pressure to the mass of plastic in the tubular cavity to force plastic out of the tubular cavity and once again begin the cycle of forming a hollow plastic container.

In FIGS. 16, 17 and 18 there is illustrated another method for making a somewhat different article according to the invention. This specific article illustrated is a solid, substantially unfoamed bottle cap having a central plug portion in foamed condition. The illustrated

apparatus includes a body **34** having a vertical opening therethrough and an orifice **35** overlying the vertical opening. The vertical opening **36** is in communication with the outlet of a plasticizer and extruder (not shown) through a channel **37**. A plunger **38** is positioned in opening **36** and is reciprocable by means (not shown) from a position well above opening **35**, such as the position shown in FIG. 17 to a lower position, such as shown in FIG. 16, whereby the opening **36** can be brought in and out of communication with orifice **35**.

A particle mold **33** is mounted above the body **34** for axial movement into and out of alignment with the orifice **35**.

At the beginning of the operation of the apparatus shown in FIGS. 16 through 18, the respective parts of the apparatus are as shown in FIG. 18, except that the mold **33** contains no plastic. A quantity of plastic containing foaming agent has already been introduced into opening **36** through the channel **37** as shown in FIG. 18. The mold is moved into alignment with orifice **35** so as to close the apparatus and the plunger **38** is reciprocated downwardly to a position shown in FIG. 16, allowing a measured quantity of hot plastic to move into the opening as shown in FIG. 16. The plunger is moved to a position shown in FIG. 17, thus ramming the plastic into the mold. The plunger **38** is held in that position for a short period. Then mold **33** is again moved upwardly to the position shown in FIG. 18, allowing the central portion of the plastic containing a foaming agent to expand downwardly through the channel of the mold to form a foamed core. The plunger **38** is moved to the position shown in FIG. 18 ready for the next cycle. After the molded part has sufficiently hardened the mold **33** is parted and the molded article removed therefrom.

In the foregoing operation the relatively thin sections of the bottle cap illustrated as being made of solid plastic are cooled sufficiently by the mold **33** while under the pressure of the ram in the position shown in FIG. 17 that the plastic is hardened and the foaming agent in that portion of the plastic is not effective to cause any substantial expansion of the plastic, thus causing this portion of the molded piece to be in a solid, substantially unfoamed, unexpanded condition. Indirect cooling means can be provided in the mold around this portion of the molded article, if desired, to assist in the cooling. The central portion of the plastic in the mold, as shown in FIG. 17, does not become sufficiently cooled during the injection molding step to set up or harden, and when the mold is separated from the pluger and the opening **35**, the still hot, plasticized plastic containing foaming agent foams under the influence of the foaming agent, thus forming the cellular plug structure illustrated.

The following examples illustrate the methods and articles made from various thermoplastics, but the examples are illustrative only and are not to be taken as limiting the invention.

Example I

Low density polyethylene in particle form containing p,p'-oxybis (benzenesulfonyl hydrazide) as a foaming agent was introduced into a molding machine of the type of FIGURES 1 to 6 where it was heated and plasticized to a workable condition. This foaming agent has a decomposition range of about 150 to 160° C. Bottles were molded using the machine as described in the description of FIGS. 1–6. The temperature in channel **24** and tubular cavity **23** was maintained at about 305° F. The pressure during the step shown in FIG. 2 was theoretically about 1800 p.s.i.g., although actual pressure may have been somewhat less due to friction losses. A bottle was molded in the manner described with respect to FIGURES 1–6, and the resulting bottle had a cellular foamed structure while the neck or finish was substantially solid and unexpanded.

In the cycle of operations the time of the total cycle was 31 seconds, while the time from the beginning of

the cycle shown in FIG. 1 to the time the sleeve 25 reached the position shown in FIG. 3 was 2.6 seconds. Sixty bottles were molded in this manner.

Example II

The procedure described in Example I was repeated, but using a high density linear polyethylene having a density of about 0.96 gms./cm. and a melting point of about 260° F. This polyethylene contained 1 percent by weight 1,1'-azobis (formamide) as the foaming agent. The temperature in the channel 24 and the cavity 23 was maintained at about 315° F. The bottle again had a substantially solid unexpanded neck or finish portion integral with a cellular body portion.

Example III

The procedure of Example I was again repeated but using particulate polystyrene containing pentane intimately dispersed therein as a foaming agent.

The temperature in the channel 24 and the cavity 23 was maintained at about 325° F.

The bottle so produced had a substantially solid, unexpanded neck or finish integral with a foamed body portion of very fine-celled foamed structure.

In the embodiment of the method described with respect to FIGURES 1–6 and with respect to FIGURES 7–15, the step of blowing the air as in FIGURES 5 and 6 and FIGURES 13 and 14 can be omitted where the dimensions of the foamed body of the article are not desired to be greater than produced by the step shown in FIGURE 4 or FIGURE 10. The tubular foamed extruded body is merely cooled in place, and can be pinched together at the end, and severed, and removed from the apparatus as a finished article.

The invention has been described as being applied to organic plastic materials. The terms plastic and thermoplastic, as used herein, define any organic material which has the required condition of plasticity to permit expansion and setting in predetermined form.

The terms tubular and tubing, as used herein, are intended to include any hollow shapes in which plastic material can be formed including non-circular and irregular shapes.

As will be evident to those skilled in the art, various modifications of this invention can be made or followed in the light of the foregoing disclosure and discussion without departing from the spirit or scope of the disclosure or from the scope of the claims.

I claim:

1. A method which comprises the steps of (1) providing a single, undivided quantity of hot plasticized plastic material containing an intimately dispersed foaming or cellulating agent, (2) forming a substantially unexpanded, non-cellular shaped end portion of an article from a first portion of said undivided quantity of plastic material under temperature and pressure shaping conditions which prevent any substantial foaming of said end portion by said foaming agent and chilling said end portion to an unplasticized essentially rigid condition preventing foaming even at a lower pressure, (3) from a second portion of said undivided quantity of plastic material forming the balance of said article integral with said shaped end portion at a lower pressure condition and a temperature condition wherein said second portion is still plasticized, whereby said second portion of said article is expanded into a cellular structure by the action of said foaming agent, said single quantity of plastic material remaining undivided and unseparated throughout said method.

2. A method of forming a shaped plastic article having a cellular plastic body portion integral with a substantially unexpanded, non-cellular end portion, said method comprising the steps of (1) providing a single, undivided quantity of hot plasticized plastic material containing a foaming or cellulating agent, (2) moving a first portion of said undivided quantity of plastic material into defined portions of a shaping mold under temperature and pressure conditions preventing any substantial expansion of said first portion by said foaming agent and thereby forming said end portion and chilling said end portion to an unplasticized essentially rigid condition preventing foaming even at a lower pressure, (3) shaping a second portion of said undivided quantity of plastic material integral with said first portion at a lower pressure condition and a temperature condition wherein said second portion is still plasticized, whereby said second portion becomes expanded to a cellular form during said shaping, thereby forming said body portion, said single quantity of plastic material remaining undivided and unseparated throughout said method.

3. A method of forming a shaped plastic article having a cellular plastic body portion integral with a substantially unexpanded, non-cellular end portion, said method comprising the steps of (1) providing a single, undivided quantity of hot plasticized plastic material containing a foaming or cellulating agent, (2) moving a first portion of said undivided quantity of plastic material into defined portions of a shaping mold under temperature and pressure conditions preventing any substantial expansion of said first portion by said foaming agent and chilling said end portion to an unplasticized essentially rigid condition preventing foaming even at a lower pressure, (3) extruding a second portion of said undivided quantity of plastic material integral with said first portion at a lower pressure condition and a temperature condition wherein said second portion is still plasticized, whereby said second portion becomes expanded to a cellular form during said extruding, thereby forming said body portion, said single quantity of plastic material remaining undivided and unseparated throughout said method.

4. In a method of making a container having a finish portion and a body portion from plasticized plastic material containing intimately dispersed foaming agent capable of liberating a gas in said plasticized material when said material is subjected to a plasticizing temperature and atmospheric pressure the steps of (1) injection molding at least said finish portion of said container in a closed mold of annular cross-section at a superatmospheric pressure sufficient to substantially prevent foaming of said material by said agent, (2) releasing the injection molding pressure after said injection molding step, (3) forming a blowable bubble of said plasticized material in a blow mold, (4) injecting air under pressure into said enclosed tube to inflate the tube to the final configuration of the body portion of said container and (5) accommodating foaming of the plasticized material of said tube during the performance of the steps (2) through (4) above set forth.

5. In a method of making a container having a finish portion and a body portion from plasticized plastic material containing an intimately dispersed foaming agent capable of liberating a gas in said plasticized material when subjected to the temperature of said plasticized material and atmospheric pressure, the steps of injecting plasticized material under pressure into a closed mold conforming to the finish portion of said container, forming additional plasticized material into a blowable bubble integral with said finish portion and at substantially atmospheric pressure and, while said additional material is still plasticized, utilizing said foaming agent to liberate said gas in said additional plasticized material during said forming step to foam the material constituting said bubble, and blowing the foamed bubble to the final configuration of the body portion of said container.

6. In a method of making an article having a first, dense noncellular portion and a second, cellular portion from plasticized plastic material containing intimately dispersed foaming agent capable of liberating a gas in said plasticized material when said material is subjected to a plasticizing temperature and atmospheric pressure, the steps of (1) injection molding said first article portion in a closed mold at a superatmospheric pressure sufficient to substantially

prevent foaming of said material by said agent, (2) chilling said material sufficiently to prevent substantial foaming thereof at atmospheric pressure, (3) releasing the injection molding pressure, (4) forming a tubular parison from additional plasticized material at substantially atmosphere pressure, (5) enclosing the tubular parison in a blow mold, (6) injecting air under pressure into said enclosed parison to inflate the parison to the final configuration of the article second portion and (7) accommodating foaming of the plasticized material during the performance of the steps (4) through (6) above set forth.

7. In a process for the production of blow molded hollow plastic articles wherein a parison of said plastic is formed and then at least a portion of said parison is expanded within a mold to conform to the contour of said mold by a fluid medium, the improvement comprising incorporating a foaming agent into said plastic prior to formation of said parison so that said portion of said parison is foamed before being blow molded, thereby forming an at least partially foamed plastic article as a product of the process.

8. In a process for the production of blow molded hollow plastic articles wherein a parison of said plastic is formed and then said parison is expanded within a mold to conform to the contour of said mold by a fluid medium, the improvement comprising incorporating a foaming agent into said plastic prior to formation of said parison so that said parison is foamed before being molded, thereby forming a foamed plastic article as a product of the process.

9. In a process for the production of blow molded hollow polyolefin articles wherein a parison is extruded around a mandrel and then said parison is expanded within a mold by a fluid medium, the improvement comprising incorporating a foaming agent into said polyolefin prior to extrusion of the parison so that said parison is foamed before being molded, dnd then blow molding said foamed parison, thus forming said foamed polyolefin hollow articles as a product of the process.

10. The process according to claim 9 wherein said polyolefin is polyethylene and said agent is present in the range 0.5 to about 10.0 weight percent based on the total weight of said polyolefin and said agent.

11. A process for producing a foamed plastic hollow article which comprises forming a mixture of a normally solid plastic and a foaming agent of the group consisting of volatile liquids and finely divided solids which decompose

to gaseous products at extrusion temperatures, extruding said mixture through an orifice to form a parison, said parison being foamed due to said agent, and blow molding said foamed parison within a blow mold to form said foamed article as a product of the process.

12. The process of claim 11 wherein the amount of said foaming agent is within the range of from about 0.5 to 10.0 weight percent of said plastic and agent mixture.

13. The process of claim 12 wherein said plastic comprises essentially polyethylene.

14. The process of claim 10 wherein said plastic comprises essentially polyethylene having a density of about 0.96.

15. The process of claim 12 wherein said foaming agent comprises p,p'-oxybis(benzene sulfonyl hydrazide).

16. A method as defined in claim 4 wherein said step (3) is carried out by extruding a tube and pinching the tube shut between the sections of a closable blow mold.

References Cited

The following references, cited by the Examiner, are of record in the patented file of this patent or the original patent.

UNITED STATES PATENTS

Re. 24,784	2/1960	Sherman	264—97 X
2,804,654	9/1957	Sherman	264—97 X
2,964,299	12/1960	Roggi et al.	264—47
2,966,702	1/1961	Soubier	264—97
3,225,127	12/1965	Scott	264—54
2,023,905	12/1935	Schwab.	
2,035,404	3/1936	Quinn.	
2,150,287	3/1939	Minor.	
2,319,042	5/1943	De Wyk.	
2,716,778	9/1955	Beare.	
2,767,436	10/1956	Noland et al.	
2,898,632	8/1959	Irwin et al.	
2,898,634	8/1959	Alderfer.	
2,908,943	10/1959	Miller.	
2,950,505	8/1960	Frank.	

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161—160, 247; 215—1 C; 264—53, 54, 97