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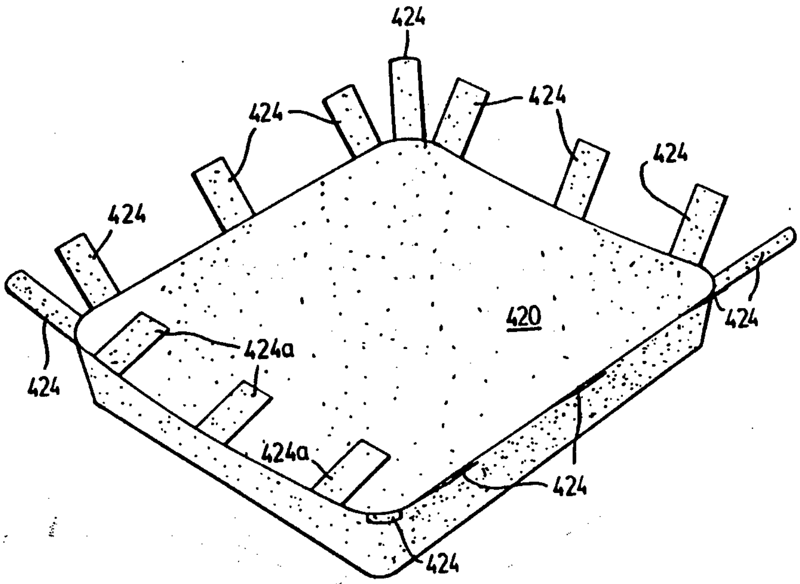

(57) Abstract

A novel method of molding an article includes providing a mould with a vent of a pre-determined size such that, due to the difference in viscosities, gases to be vented from the mold may easily pass through the vent while the material to be molded cannot quickly pass through the vent. In fact, the vent is designed such that the material to be molded which enters the vent; does not exit the end of the vent. In the most preferred embodiment, the vent is in the form of a thin ribbon-like groove so that the material to be molded which does enter the vent forms a thin ribbon of extruded material which need not be removed prior to a finish cover being applied to the molded article.

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VENTED MOLD AND USE THEREOF

TECHNICAL FIELD

The present invention relates to a novel mold for producing foamed articles. Specifically, an aspect of the present invention relates to an improved mold including a vent capable of providing necessary venting of the mold while minimizing extrusion of raw material into the vent, thus reducing wastage. In its most preferred embodiment, the present invention also eliminates the requirement to remove the extruded raw material from the molded article prior to application of a finish (e.g. trim) cover.

The present invention also relates to a novel method of molding articles which reduces wastage resulting from raw material being extruded into the vent during venting of the mold. In its most preferred embodiment, the method reduces or eliminates the requirement to remove the extruded material prior to application of a finish cover.

BACKGROUND ART

Many articles are manufactured by placing a raw material into a cavity in a mold wherein the raw material undergoes a physical change (e.g. it expands or foams) and the article produced thus acquires the shape of the cavity. In particular, this technique is commonly employed for producing foamed articles made from polymeric foams such as polyurethane foam, latex (e.g. natural and styrene-butadiene rubber) foam and the like.

For example, automotive seats are commonly manufactured from polyurethane cushions which are molded to shape and then covered with a vinyl, cloth or leather finish cover. Polyurethane foams are somewhat unique in that foaming and at least a portion of the polymerization process occur simultaneously. Thus, in the production of polyurethane foam using, for example, a conventional cold foam technique, a typical formulation comprises:

1. Polyol
2. Water
3. Tetramethyl ethane diamine
4. Dimethyl ethanol amine
5. Polyisocyanate

The mixture is dispensed into a mold using a suitable mixing head, after which the mold is then closed to permit the expanding mass within it to be molded. Accordingly, it is convenient generally to refer to the mixture initially dispensed into the mold as "a liquid foamable polymeric composition" or, in this case, "a liquid foamable polyurethane composition". As the composition expands in the mold, polymerization occurs and the polymer so formed becomes solidified.

When molding a liquid foamable polymeric composition to form articles such as polyurethane foam articles, it is conventional to use a clam-shell mold comprising a bottom mold and a top mold which, when closed, define a mold cavity. The mold is opened, the liquid foamable polyurethane composition is dispensed into the mold cavity and the mold is closed as a chemical reaction causes the composition to expand. After the mold is closed, the composition expands to fill the interior cavity of the mold. Alternatively, the composition may be dispersed into a closed mold. In either case, as the polymerization reaction is completed, the foam cures and permanently assumes the shape of the mold cavity.

As is known to those of skill in the art, it is essential during this process that the mold be adequately vented to allow the air present in the mold to exit the mold as the foamable composition expands. Further, it is essential to allow a portion of the gases (typically CO_2 in the production of polyurethane) generated during polymerization to exit the mold.

Failure to adequately vent the mold results in defective molded articles exhibiting symptoms of improper foaming such as surface hardening (or foam densification) and/or void formation in the finished article due to trapped gas or air bubbles. At the other extreme, excess venting of the mold will also result in defective molded articles due to collapse of the foam prior to curing; this phenomenon is often referred to as the 'soufflé' effect. Thus, proper venting of molds is an important factor in producing acceptable molded articles.

Typically clam-shell molds are designed with drilled or cut passages in the top mold to provide vents. Locating, sizing and deciding upon the number of these vents is a matter of some skill on the part of mold designer and the production engineers, and is often an iterative procedure with more vents being added to various locations or other vents being blocked-off after test runs have been made.

During molding operations some liquid foamable polymeric composition which moves into the vent is wasted. It is generally desired to minimize the amount of wasted material (also known as "flash", "mushrooms", "buds", "pancakes" and the like) for two reasons, namely (1) the wasted material adds to the overall expense of producing the finished article, and (2) the wasted material must be removed from the molded article prior to the finish cover being applied, thereby necessitating additional labour and the costs associated therewith.

Accordingly, mold designers and production engineers are continually striving to optimize the compromise between providing enough venting at the proper locations while avoiding excess venting and minimizing material wastage during venting.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a novel method of producing a molded article which obviates or mitigates material wastage during venting.

It is another object of the present invention to provide a novel mold which obviates or mitigates at least some of the above-mentioned problems with prior art.

It is yet another object of the present invention to provide a novel method of producing a molded article from which vent-extruded material need not be removed.

According to a first aspect of the present invention, there is provided a method of producing an article in a mold comprising an upper mold and a lower mold defining a mold cavity, the process comprising the steps of:

dispensing a liquid foamable polymeric composition into the mold cavity;

allowing the liquid foamable polymeric composition to expand to substantially fill the mold cavity; and

venting gases in the mold cavity through at least one vent in the mold to allow the gases to exit from the mold, the size of each vent being selected such that movement of the liquid foamable polymeric composition into the vent is restricted to substantially prevent exit thereof from the vent.

Preferably, the at least one vent is located at the part-line of the mold and comprises a thickness in the range from about 0.002 inches to 0.030 inches, more preferably in the range from about 0.005 inches to about 0.020 inches. Also preferably, the at least one vent is rectangular in cross-section and the polymeric material which enters the vent forms a ribbon of material on said article which need not be removed when a finish cover is applied to said article.

According to a second aspect of the present invention, there is provided a mold for producing foamed articles, the mold comprising:

an upper mold and a lower mold which define a mold cavity; and

at least one vent in communication with the mold cavity, the size of each vent being selected to allow relatively free flow of gases therethrough and to restrict movement of a liquid foam polymeric composition therethrough.

Preferably, the vent includes first and second vents, the first vent being located at the part-line between the top and bottom molds. In this embodiment, it is preferred that the first vent comprises a thickness of from about 0.002 inches to about 0.030 inches, more preferably from about 0.005 inches to about 0.020 inches. It is preferred that the second vent is located in the upper mold and comprises a thickness of from about 0.002 inches to about 0.015 inches, more preferably from about 0.003 inches to about 0.010 inches.

BRIEF DESCRIPTION OF THE DRAWING

Embodiments of the present invention will be described with reference to the accompanying drawings, in which:

Figure 1 illustrates a cross-section of a prior art clam-shell mold;

Figure 2 illustrates a sectional view of an article produced in the prior art mold of Figure 1;

Figure 3 illustrates a cross-section of a vent assembly;

Figure 4 illustrates a partial section taken along line 4-4 in Figure 3;

Figure 5 illustrates the vent assembly of Figure 3 in a cleaning position;

Figure 6 illustrates a cross-section of a clam-shell mold employing the vent assemblies shown in Figure 3;

Figure 7 illustrates a perspective view of another clam-shell mold;

Figure 8 illustrates a section taken along line 8-8 when the mold of Figure 7 is closed;

Figure 9 illustrates a molded article made in the mold shown in Figure 7; and

Figure 10 illustrates a cross-section of a mold employing the vent assemblies shown in Figure 3 and the vents shown in Figure 7.

BEST MODE FOR CARRYING OUT THE INVENTION

The most preferred liquid foamable polymeric composition is based upon polyurethane. However, it will be apparent to those of skill in the art that the present invention is applicable to other types of molding operations including, but not limited to, latex foam, neoprene foam, PVC foams and the like.

A prior art mold will first be discussed, with reference to Figures 1 and 2. A typical clam-shell mold, similar to those used for forming an automotive seat cushion from polyurethane foam, is indicated generally at 20 in Figure 1. The mold includes a lower mold 24 and an upper mold 28 which are joined by a conventional hinge means (not shown). Lower mold 24 and upper mold 28, when closed, define a cavity 32 which corresponds to the shape of the automotive seat cushion.

In use, upper mold 28 is released from lower mold 24 and a pre-determined amount of liquid foamable polyurethane composition is dispensed into lower mold 24. Upper mold 28 and lower mold 24 are then sealingly engaged and the liquid foamable polyurethane composition expands, displacing the air within cavity 32. This displaced air exits cavity 32 through a part-line 36 and through one or more vent passages

38 in upper mold 28. Further, as the polyurethane composition expands, polymerization occurs along with the evolution of gaseous CO_2 in cavity 32. This gaseous CO_2 may also exit cavity 32 through part-line 36 and through vent passages 38. As is well known to those of skill in the art (and beyond the scope of this discussion), the liquid foamable polymeric composition eventually completely polymerizes and cures, acquiring the shape of cavity 32.

As is also known to those of skill in the art, the amount of liquid foamable polyurethane composition dispensed in cavity 32 must be selected to ensure that cavity 32 will be substantially completely filled, in order to avoid the occurrence of voids and other foaming defects in the molded article. While the determination of the proper amount of liquid foamable polyurethane composition for a particular mold may generally be calculated, as explained below it has heretofore been required to dispense an excess amount of polymeric composition into the mold to compensate for material which moves through and exits part-line 36 and vent passages 38. This excess, while assisting in ensuring that cavity 32 is filled to avoid the occurrence of voids and other foaming defects in the molded articles, is in fact simply a wastage of valuable raw material.

In prior art molds, during the molding operation, air and the reaction gases produced from the expanding composition exit from cavity 32 through part-line 36 and vent passages 38 until the foam reaches the level of their respective entrances.

At this point, any further expansion of the foam results in movement of the foam into the part-line 36 and/or vent passages 38. In the simplest case of a cavity without irregularities, the foam reaches the level of the part-line and/or the vent passages at approximately the same time, which usually occurs at or near the maximum expansion point of the foam. Thus, provided that the proper amount of liquid foamable polyurethane composition has been dispensed into the cavity, only a small amount of foam enters the part-line and/or the vent passages as cavity 32 is completely filled.

In practice, however, as shown in Figure 1, most molds include irregularities in their cavities for various features required on the molded article. In such a case, the thickness and shape of mold cavity 32 typically varies across the cavity and the entrance to part-line 36 and vent passages 38 in the mold may thus be located at different heights depending upon where they communicate with cavity 32. Further, localized areas of high and low pressure also occur within cavity 32 due to the manner in which the foam and the gases produced collect in and move between the irregularities therein and thus the level of foam in different parts of cavity 32 at different times may vary.

Due to the above-mentioned factors, the foam in the cavity typically reaches the level of the part-line and/or different vent passages at different times while the foam is still expanding. For example, in a region wherein the top of cavity 32 is lower than surrounding regions, such as indicated at 40 in Figure 1, the foam may quickly reach the vent passages 38. As the foam is still rising in the rest of cavity 32 and has not yet cured, a relatively significant amount of foam may enter vent passages 38 in this region.

Again, as the amount of foam which enters the part-line 36 and vent passages 38 reduces the amount of foam remaining in cavity 32 by a like amount, it is necessary that the amount of liquid foamable polyurethane composition placed in cavity 32 include an amount in excess of that required to fill cavity 32 to offset the foam which entered the part-line and vents. This excess amount, while necessary for proper operation of the prior art mold, is essentially wasted material and adds to the cost of forming the article.

Further, as shown in Figure 2, the foam which enters vents 38 forms ‘mushrooms’ 54 (shown in ghosted line) of wasted material on the molded article 50. Further, the material which enters part-line 36 forms ‘pancakes’ 55 of wasted material on the moulded article 50. Typically, mushrooms 54 and pancakes 55 must be disconnected from article 50 and removed from the mold 20 prior to application of a finish cover to ensure a finished covered article which is of acceptable appearance and texture, and to prepare mold 20 for re-use. The necessity of removing mushrooms 54 and pancakes 55 results in an increased labour cost associated with manufacturing the molded product.

In addition to the excess liquid foamable polyurethane composition which is added to offset the material extruded into the vents, excess liquid foamable polyurethane composition is also added to compensate for process variations due to changes in temperature, humidity, ambient pressure and minor changes in the composition of the liquid foamable polyurethane composition. Accordingly, in prior art molds, the wastage of material exiting the vents is inevitable.

Embodiments of the present invention will now be described, with reference to Figure 3 through 10.

The present inventors have determined that it is possible to use the difference in the physical characteristics of the expanding liquid foamable polymeric composition, prior to curing thereof, and the vented gases to design vents which minimize the amount of material which is extruded into the vent passages as wasted material. Specifically, it has been determined that vents may be designed with sizes which provide much different flow rates depending on the viscosity of the fluid flowing therethrough. Thus, gases, which possess a relatively low viscosity, flow relatively easily and quickly through the vent. In contrast, the liquid foamable polymeric composition, which possesses a relatively high viscosity (especially when it reaches the vent as expansion and curing are near completion), flows much more slowly through the vent due to the restriction the thickness of the vent presents to the foam.

As described hereinafter, the size of the vents is selected such that the gases in the mold may flow through the vents in a relatively unhindered manner while the viscosity of liquid foamable polymeric composition, when it reaches the vent, is such that it flows into and through the vents in a very slow manner, at best. Provided that the vent sizes are properly selected, the liquid foamable polymeric composition will have cured before it has flowed a significant distance into the vent.

As will be apparent to those of skill in the art, vents in accordance with the present invention thus reduce the amount of excess liquid foamable polymeric composition which must be dispensed in the mold to offset the material extruded into the vents.

Figures 3, 4, 5 and 6 illustrate a first embodiment of an improved vent assembly 98 in accordance with the present invention which is preferred for use in an upper mold. The vent assembly comprises a mold sleeve 100 with a guide bushing 125 with a cylindrical bore 104 therethrough. A relief pin 108 is located within and engages the inner surface of bore 104. Relief pin 108 is octagonal in cross-section, as best seen in Figure 4, and when located within guide bushing 125 defines eight vent passages 112 which are segment shaped.

The upstream end 120 of relief pin 108 which communicates with the cavity of a mold is preferably tapered and the downstream end includes a narrowed throat 124. As shown in Figure 3, when relief pin 108 is in the venting position, the downstream end of vent passages 112 are in communication with vent chamber 127 which is in turn in communication with vent outlets 128. Vent outlets 128 exhaust gases to the environment outside the mold. In the operating position shown in Figure 3, gases to be vented from a mold cavity travel along vent passages 112 to vent chamber 127 and then exit through vent outlets 128.

The dimensions of vent passages 112 are selected to allow gases to relatively freely exit cavity 202 and to restrict movement of foam within vent passages 112. Specifically, due to the relatively high viscosity of the foam, the thickness 116 of vent passages 112 present a restriction to the foam while not restricting the gases. Provided that thickness 116 is properly selected, the width 119 of vent passage 112 is not particularly limited, nor is the shape of the passage 112.

As will be apparent to those of skill in the art, the diameter of cylindrical bore 104 and cross-sectional shape of relief pin 108 may be varied to provide different total vent areas while maintaining the desired vent thickness. For example, relief pins with between four and eight sides, defining a like number of vent passages, have been successfully tested.

For polyurethane foams, it has been found that a vent passage thickness of less than about 0.010 inches present a suitable restriction. It will be understood by those of skill in the art that the thickness of the vent passage(s) may be varied according to the particular liquid foamable polymeric composition being used. Thus, if a polymer other than polyurethane is being foamed, the thickness may be suitably determined as would be apparent to those of skill in the art through empirical calculations and/or testing.

While vent assembly 98 has been found to be very successful at limiting foam extrusion from the mold, a small amount of foam does enter vent passages 112. Thus, it is necessary to clean vent passages 112 prior to re-use of the mold. Accordingly, the downstream end of relief pin 108 is connected to a piston 136 in a pneumatic cylinder 140. By varying the pressure on either side of piston 136 through apertures 148 or 152, the end of relief pin 108 may be extended or retracted within bore 104. As relief pin 108 is extended from vent bore 104, the downstream edge of throat 124 sweeps the interior of vent bore 104, removing residual extruded foam. As will be understood by those of skill in the art, guide bushing 125 may be fabricated from Delrin or any other suitable material. Figure 5 illustrates relief pin 108 in its extended position and Figure 3 illustrates relief pin 108 in its operating position.

Figure 6 illustrates a mold 200 which includes several vent assemblies 98. Preferably, vent assemblies 98 are installed in an upper mold 204 of mold 200 in locations strategically selected to provide the desired degree of venting. In use, gases are vented from the vent assemblies 98, as described above, until the foam within cavity 208 reaches the entrance to the vent. At this point, as the foam begins to enter vent passages 112, the restriction presented by vent passages 112 on the foam slows the flow of foam into vent passages 112 such that the foam will have cured before it has entered vent passage to a significant degree, and such that the foam does not exit the vent.

The above-mentioned embodiment provides an advantage over the prior art in that it reduces the amount of excess liquid foamable polymeric composition required to accommodate the foam extruded into the mold vents. Accordingly, the amount of material which enters vent assemblies 98 is reduced when compared to that obtained from conventional mold vents. This results in materials savings and may also results in labour savings since this material need not always be removed from the article or the mold.

Another embodiment of the present invention, will now be described with reference to Figures 7, 8 and 9 which is particularly preferred for use in the part-line between the upper and lower molds. A clam-shell mold is indicated generally at 400 in Figure 7. The mold includes a lower mold 404 and an upper mold 408 which define a mold cavity 412. The mold includes a series of ribbon vents 416 in accordance with the present invention. As shown in Figure 8, when mold 400 is closed, ribbon vents 416 extend between mold cavity 412 and the exterior of mold 400. It has been found that ribbon vents with a thickness indicated at 418, of about 0.005 inches to about 0.015 inches are particularly suited for use when molding polyurethane foams. As with vent passages 112 of the previous embodiment, when used with other polymeric foamable compositions, thickness 418 may be altered as required.

The width, indicated at 417, of ribbon vents 416 is not particularly limited. Widths of up to about 6.0 inches have been found to work in a satisfactory manner. In practice, it is contemplated that the limits to vent width 417 will primarily relate to physical limitations imposed by the shape of the article being molded and the requirement to provide an adequate total venting area to cavity 412.

In use, liquid foamable polyurethane composition is dispensed into mold cavity 412, and upper mold 408 and lower mold 404 are sealingly engaged. The air in mold cavity 412 and the gases produced by the chemical reaction occurring in the expanding composition are vented through ribbon vents 416. The viscosity of these gases are such that they flow relatively easily through ribbon vents 416. Once the level of foam in mold 400 reaches the entrance to ribbon vents 416, the foam enters ribbon vents 416. Due to the above-mentioned restriction, which is presented to the expanding composition by vent 416, the expanding composition can only move slowly through ribbon vents 416. Provided that the thickness of ribbon vents 416 has been properly selected, the liquid foamable polymeric composition will stop moving therein before it travels a significant distance along the vents and certainly before it reaches the end of ribbon vents 416.

Figure 9 illustrates an article 420 fabricated in the mold of Figure 7 employing ribbon vents 416 in accordance with the present invention. As illustrated, article 420 includes a number of ribbons 424 of extruded material from ribbon vents 416.

The advantages provided by ribbon vents 416 are many. First, the amount of material extruded into ribbon vents 416 is limited due to the restriction presented by thickness 418 to the foam, thus the amount of raw material wasted is reduced with a resultant economic saving. Second, ribbon vents 416 are relatively inexpensive to manufacture compared to the prior art vents. Third, ribbon vents 416 may be added readily at regular spaced intervals about mold cavity 412, limited only by the shape of cavity 412, doing away with much of the iterative design effort on behalf of the mold designer and production engineers which was previously required. Fourth, ribbon vents 416 are easy to clean and in many circumstances are self-cleaning with ribbons 424 being removed from vents 416 when the article 420 produced is removed. Fifth, ribbons 424 of extruded material produced by the ribbon vents 424 have a preferred, 'friendly' shape. Specifically, when ribbon vents 416 with relatively small thickness 418 are employed, the resulting ribbons 424 of extruded material may simply be folded back against article 420 when the finish cover is applied to it while maintaining an acceptable appearance and texture. An example of such folded back ribbons is indicated at 424a. This obviates the need to remove the ribbons 424 of extruded material and results in a labour savings.

In some circumstances, it is contemplated that it may be desirable to sandblast or otherwise roughen the inner surfaces of ribbon vents 416 to further decrease the rate at which the liquid foamable polymeric composition moves through the vent. Also, it is contemplated that in some circumstances ribbon vents with a thickness of less than

0.002 inches may be employed and that such vents will inhibit substantially all foam extrusion into the vent. In this manner, the vent acts as a differential vent allowing passage of gas but inhibiting passage of foam. However, care must be taken when using such differential vents to ensure that an adequate total venting area is still provided to avoid defects in the molded article.

It is contemplated that in many circumstances, it will be desired to employ both of the above-described embodiments in a single mold. Specifically, as shown in Figure 10, a mold 600 may include one or more otherwise isolated regions 620 at which vent assemblies 98 may preferably be employed, while ribbon vents 416 are preferably employed at the part-line of the mold. Due to their isolation from ribbon vents 416 at the part-line of the mold, vent assemblies 98 are employed to ensure that gases which would otherwise be trapped in regions 620 are properly vented. The design of such a mold, will be clearly understood by those of skill in the art, in view of the description above.

As will also be understood by those of skill in the art, further variations are possible without departing from the spirit of the invention disclosed herein.

What is claimed is:

1. A method of producing an article in a mold comprising an upper mold and a lower mold defining a mold cavity, the process comprising the steps of:

dispensing a liquid foamable polymeric composition into the mold cavity;

allowing the liquid foamable polymeric composition to expand to substantially fill the mold cavity; and

venting gases in the mold cavity through at least one vent in the mold to allow the gases to exit from the mold, the size of each vent being selected such that movement of the liquid foamable polymeric composition into the vent is restricted to substantially prevent exit thereof from the vent.

2. The method of claim 1 wherein said at least one vent is located at the part-line between said upper mold and said lower mold.

3. The method of claim 2 wherein the size of each vent comprises a thickness of from about 0.002 inches to about 0.030 inches.

4. The method of claim 2 wherein the size of each vent comprises a thickness of from about 0.005 inches to about 0.020 inches.

5. The method of claim 1 wherein said selected size comprises a thickness of less than about 0.002 of an inch to inhibit substantially entry of said liquid foamable polymeric composition into said vent.

6. The method of claim 2 wherein each vent is substantially rectangular in cross-section and said liquid foamable polymeric material entering said vent results in a ribbon of polymeric material attached to said article.

7. The method of claim 6 further comprising the steps of folding back said ribbon of polymeric material against said article and applying a finish cover to said article.

8. The method of claim 3 wherein each vent is substantially rectangular in cross-section and said liquid foamable polymeric material entering said vent results in a ribbon of polymeric material attached to said article.

9. The method of claim 8 further comprising the steps of folding back said ribbon of polymeric material against said article and applying a finish cover to said article.

10. The method of claim 1 wherein said at least one vent is located in said upper mold.

11. The method of claim 10 wherein each vent is segmental in cross-section.

12. The method of claim 10 wherein the size of each vent comprises a thickness of from about 0.002 inches to about 0.015 inches.

13. The method of claim 10 wherein the size of each vent comprises a thickness of from about 0.003 inches to about 0.010 inches.

14. A mold for producing foamed articles, the mold comprising:

an upper mold and a lower mold which define a mold cavity; and

at least one vent in communication with the mold cavity, the size of each vent being selected to allow relatively free flow of gases therethrough and to restrict movement of a liquid foam polymeric composition therethrough.

15. A mold according to claim 14 further including at least first and second vents in communication with said mold cavity, said first vent being located at the part-line between said upper mold and said lower mold.

16. A mold according to claim 15 wherein the size of said first vent comprises a thickness of from about 0.002 inches to about 0.030 inches.

17. A mold according to claim 15 wherein the size of said first vent comprises a thickness of from about 0.005 inches to about 0.020 inches.

18. A mold according to claim 16 wherein said first vent is rectangular in cross-section.

19. A mold according to claim 17 wherein said first vent is rectangular in cross-section.

20. A mold according to claim 15 wherein said second vent is located in said upper mold.

21. A mold according to claim 20 wherein said second vent comprises a thickness of from about 0.002 inches to about 0.015 inches.

22. A mold according to claim 20 wherein said second vent comprises a thickness of from about 0.003 inches to about 0.010 inches.

23. A mold according to claim 21 wherein said second vent is segmental in cross-section.

24. A mold according to claim 21 wherein said first vent comprises a thickness of from about 0.002 inches to about 0.030 inches.

25. A mold according to claim 21 wherein said first vent comprises a thickness of from about 0.005 inches to about 0.020 inches.

26. A mold according to claim 14 wherein said vent comprises a thickness of less than about 0.002 of an inch to inhibit substantially entry of a liquid foamable polymeric composition into said vent.

27. A mold according to claim 14 wherein said vent comprises a substantially constant cross-section.

28. A mold according to claim 18 wherein said first vent has a width in the range from about 0.5 inches to about 6 inches.

29. A mold according to claim 19 wherein said first vent has a width in the range from about 0.5 inches to about 6 inches.

30. A mold according to claim 14 wherein said vent includes walls which have been roughened to increase their surface friction to a liquid polymeric foamable composition.

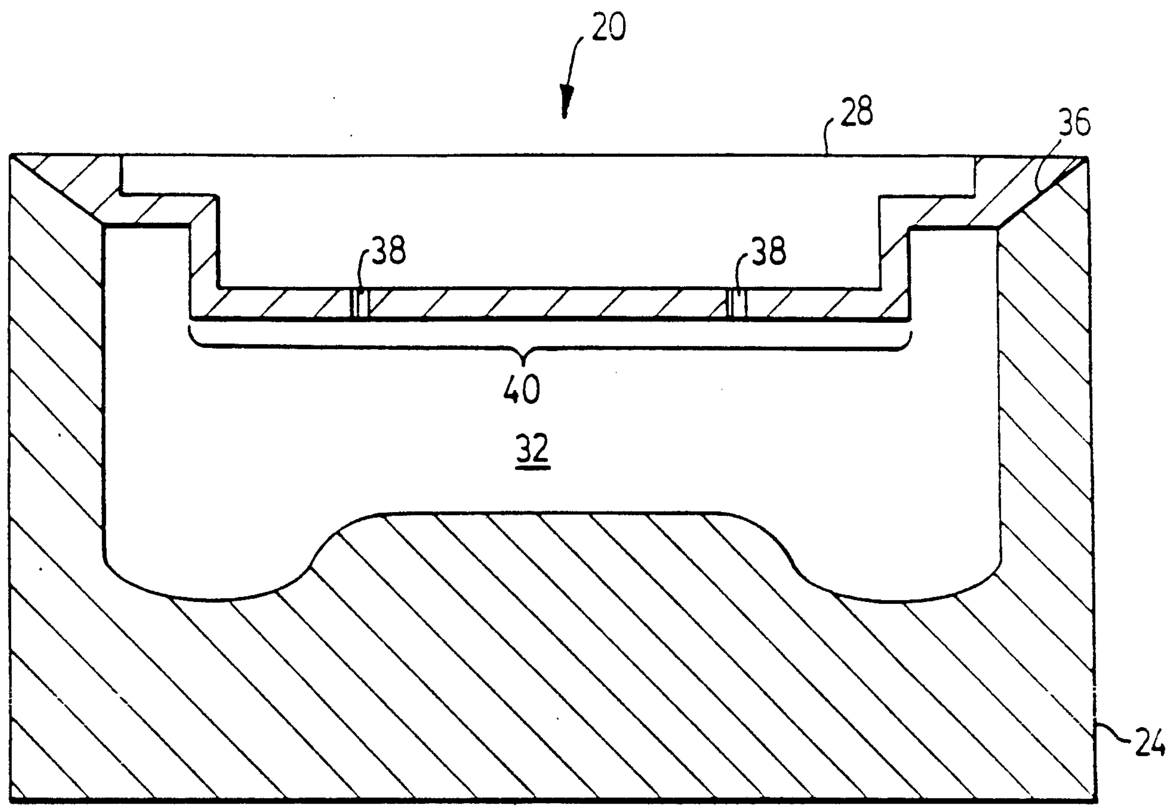

FIG.1

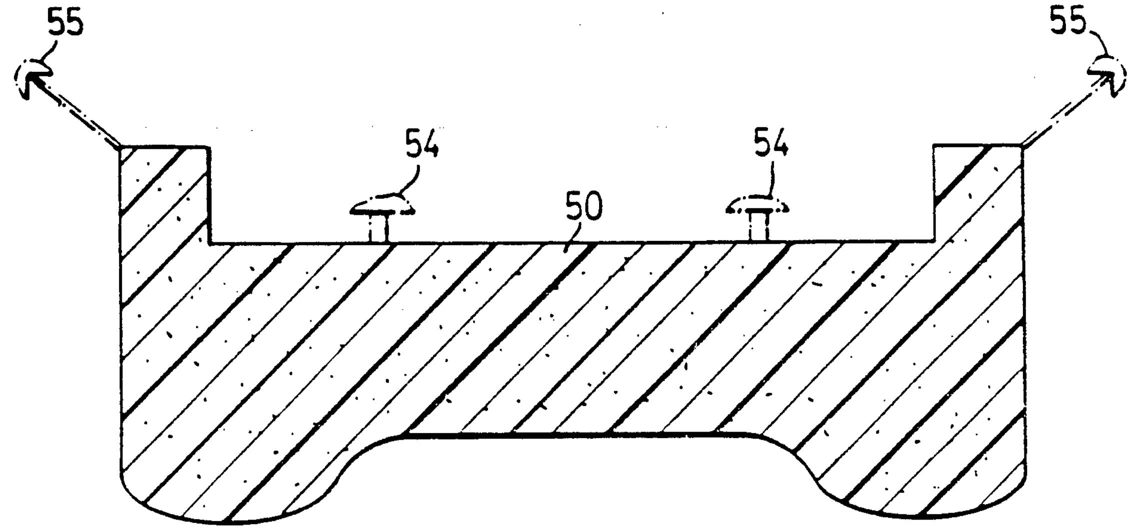

FIG.2

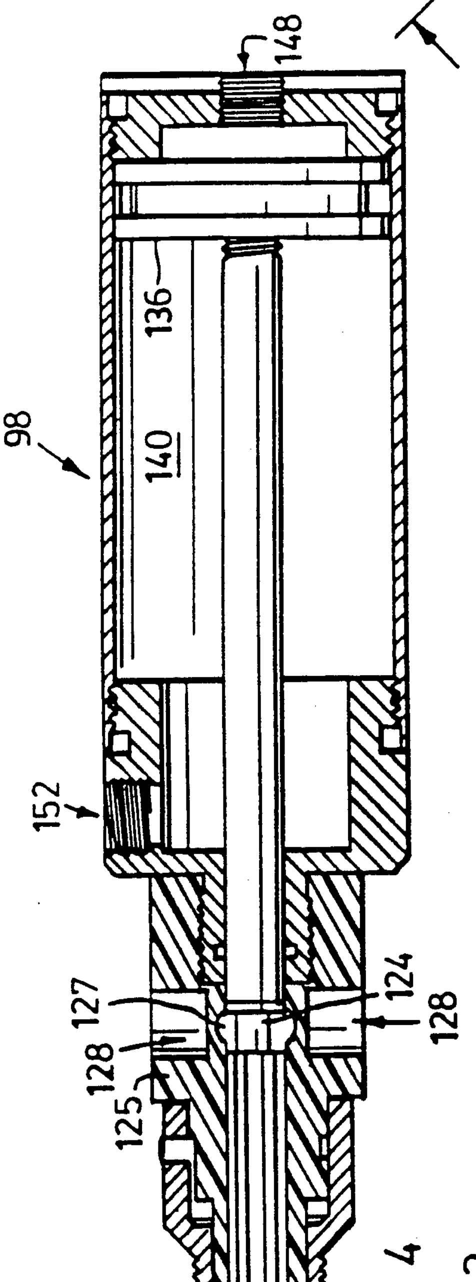

FIG.3

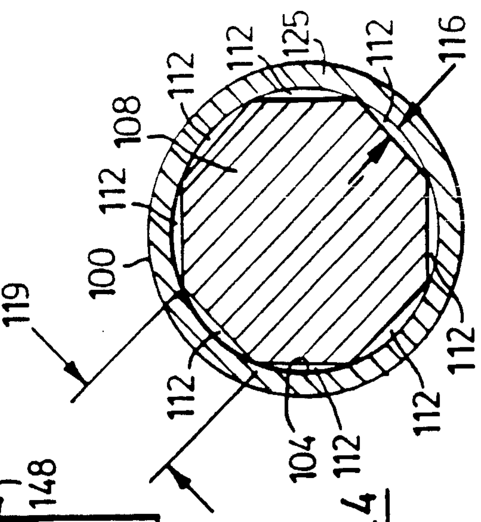

FIG.4

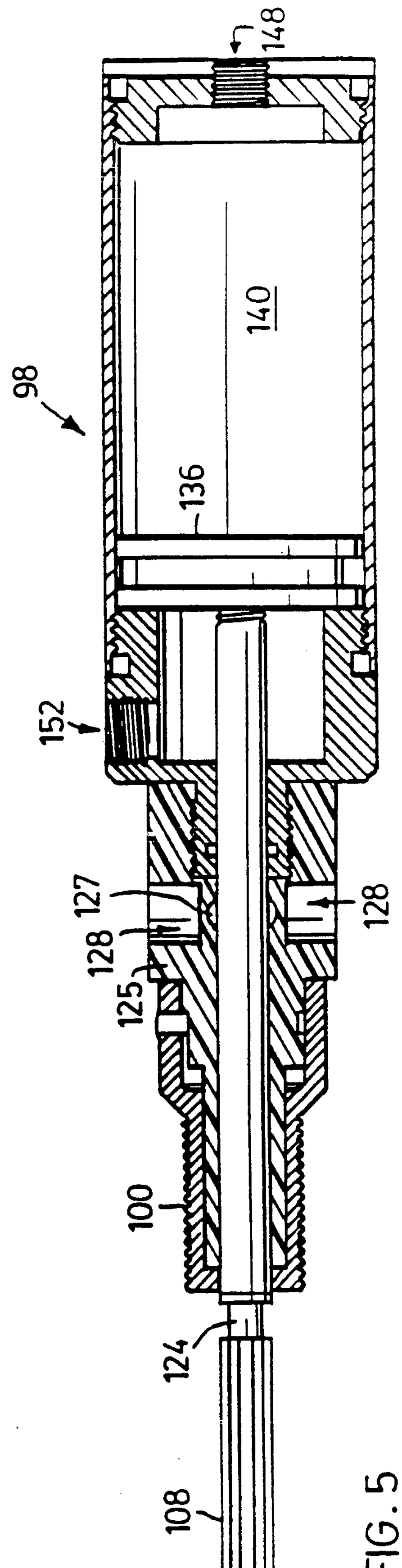

FIG.5

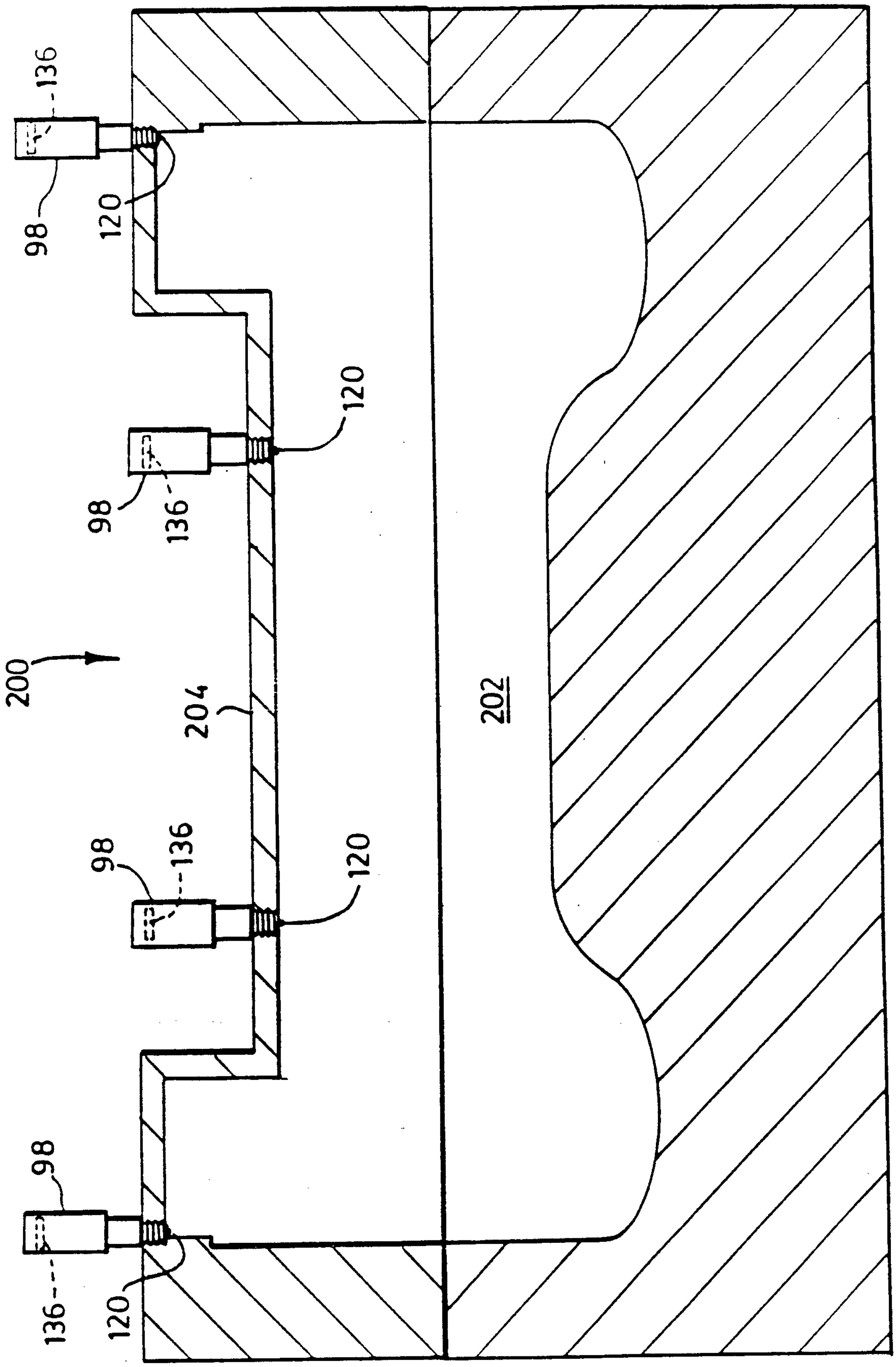

FIG.6

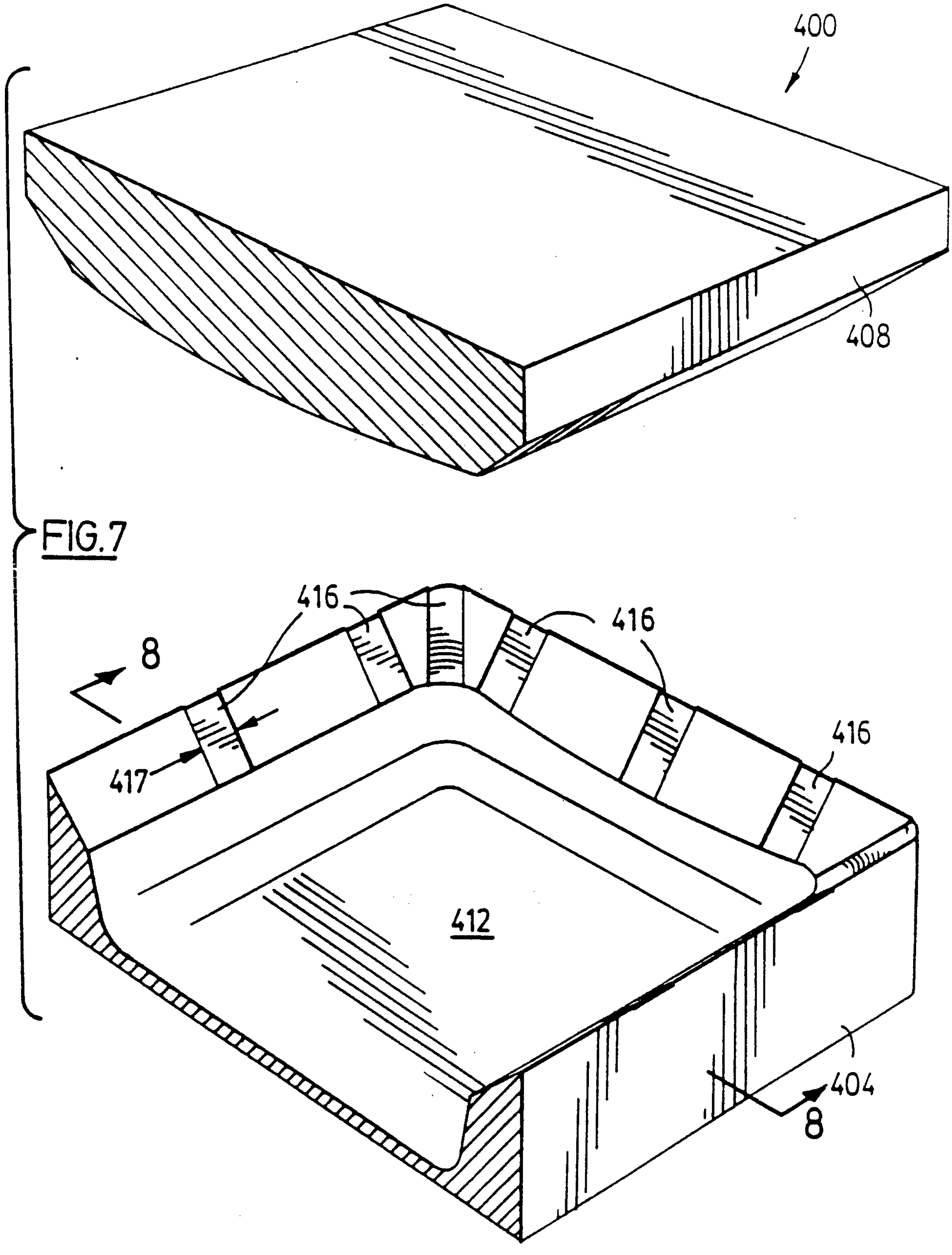

FIG.7

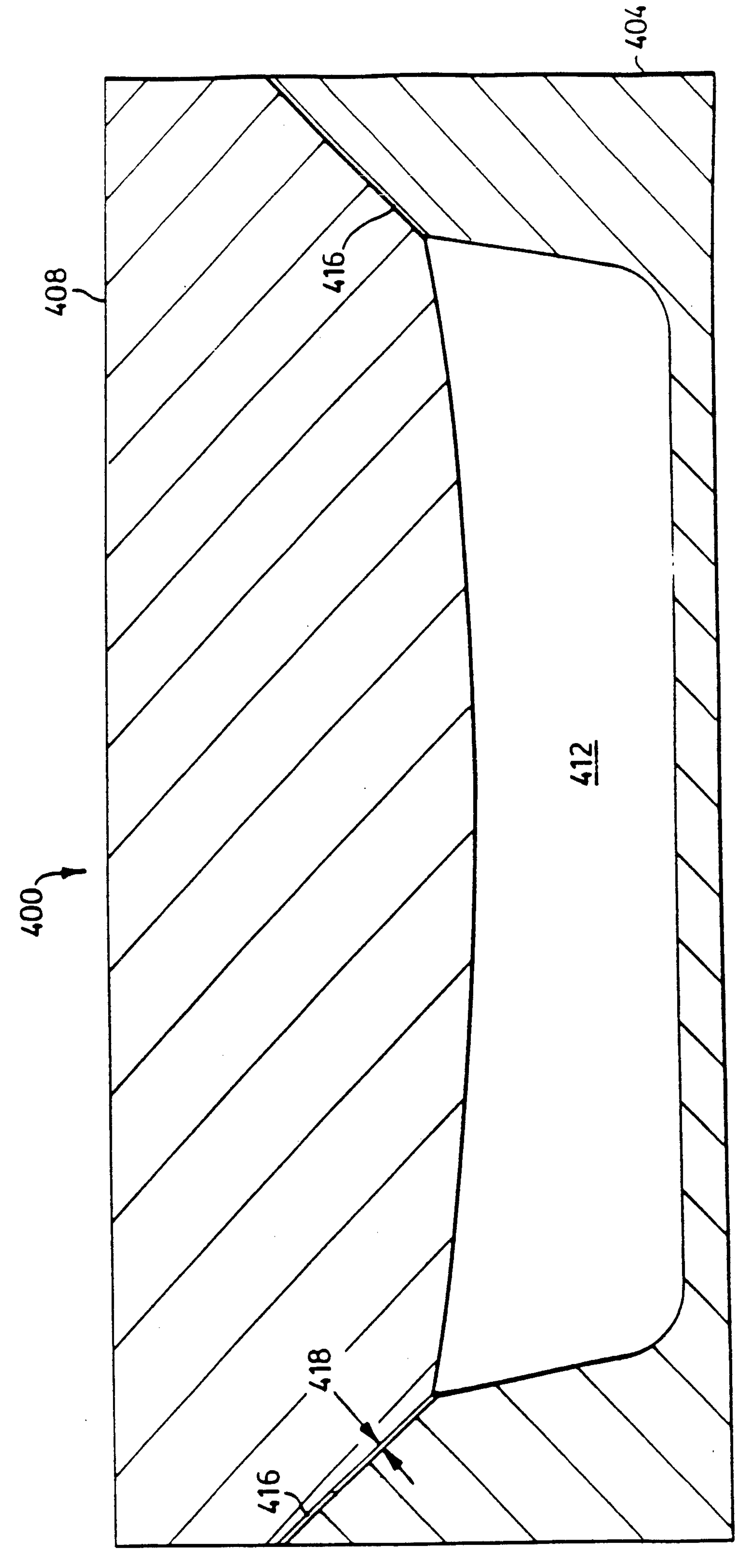

FIG.8

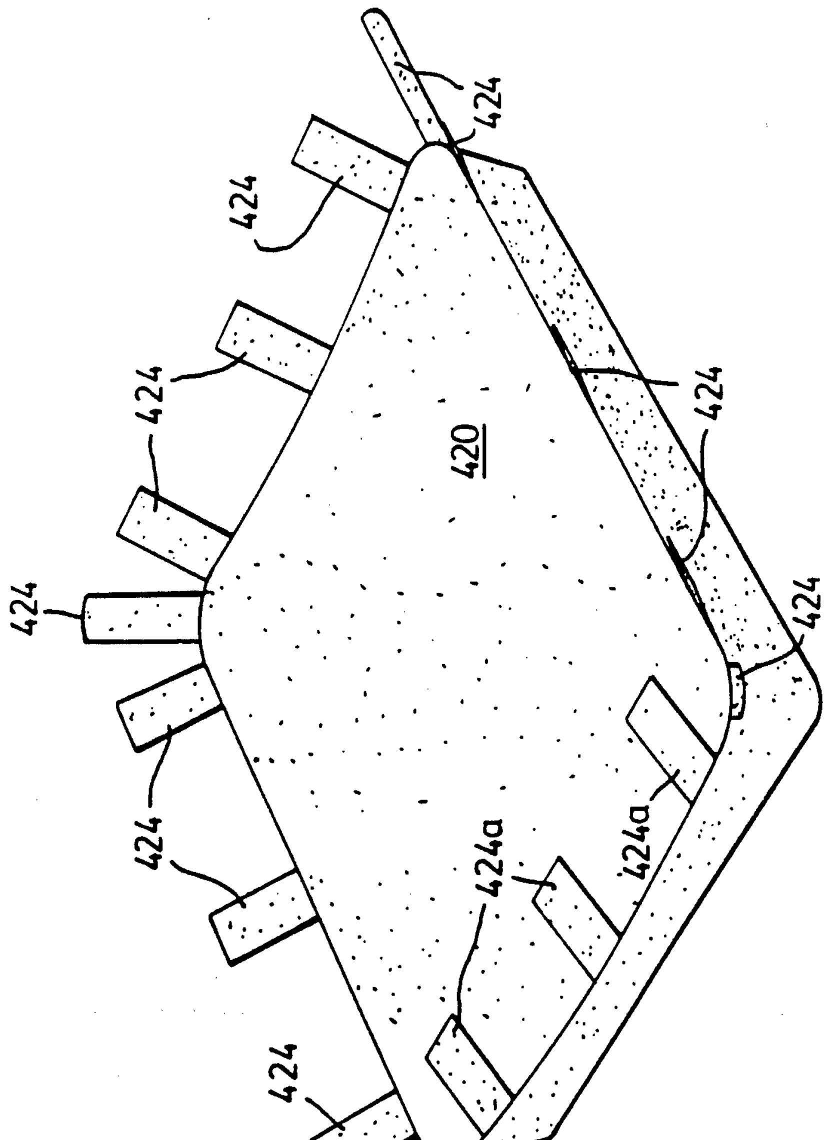

FIG.9

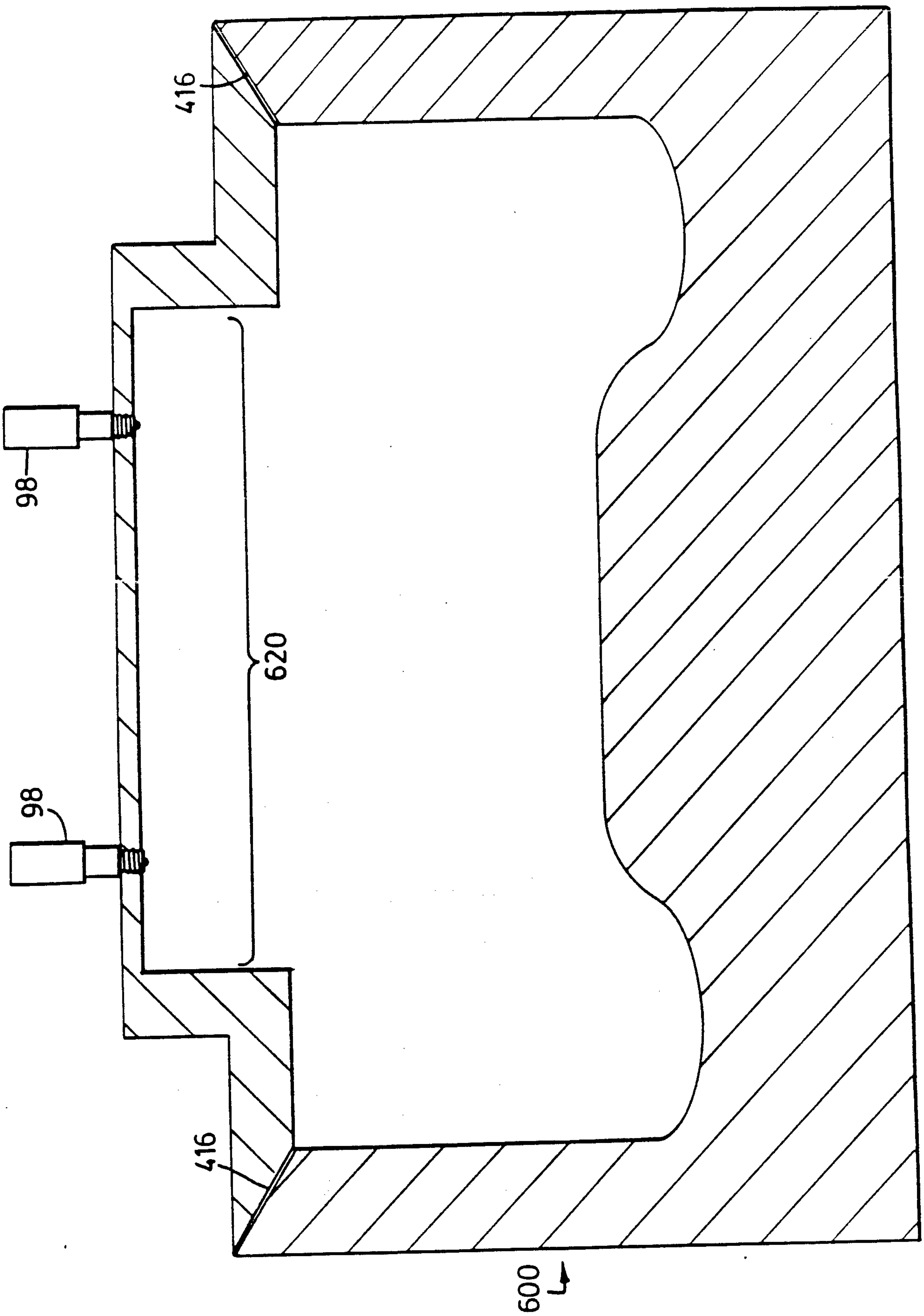

FIG.10

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 93/00360

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^5: B 29 C 67/22,B 29 C 33/42//,B 29 K 105:04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC^5	B 29 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[*]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US, A, 4 191 722 (GOULD) 04 March 1980 (04.03.80), column 6, lines 28-45; fig. 10.	1,5, 10,12-14,26, 27
A		20-22
	--	
X	DE, A, 2 246 948 (HUKLA) 18 April 1974 (18.04.74), page 6, lines 1-21; fig..	1,10, 14,27
A		5,12, 13,20-22,26
	--	
X	DE, A1, 2 540 884 (ZIMMERMANN) 24 March 1977 (24.03.77), the whole document.	1,10, 11,14, 27
A		23
	--	
X	DE, A1, 2 939 314	1,2,14

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26 November 1993	17 -12- 1993
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	MAYER e.h.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	(02.04.81), page 6, lines 5-21; fig. 1,2.	
A		15
	--	
X	DE, C, 866 091 (TALALAY) 05 February 1953 (05.02.53), the whole document.	1,2,14
A		15
	--	
A	US, A, 3 822 857 (TANIE) 09 July 1974 (09.07.74), the whole document.	

ANHANG | ANNEX | ANNEXE

zum internationalen Recherchenbericht über die internationale Patentanmeldung Nr.

to the International Search Report to the International Patent Application No.

au rapport de recherche international relatif à la demande de brevet international n°

PCT/CA 93/00360 SAE 78388

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben. Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The Office is in no way liable for these particulars which are given merely for the purpose of information.

La présente annexe indique les membres de la famille de brevets relatifs aux documents de brevets cités dans le rapport de recherche international visée ci-dessus. Les reseignements fournis sont donnés à titre indicatif et n'engagent pas la responsibilité de l'Office.

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
US A 4191722	04-03-80	US A 4028450	07-06-77
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DE A1 2540884	24-03-77	keine - none - rien	
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DE 866091		keine - none - rien	
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