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(54) **METHOD FOR PRODUCING A VEHICLE INTERIOR COMPONENT**

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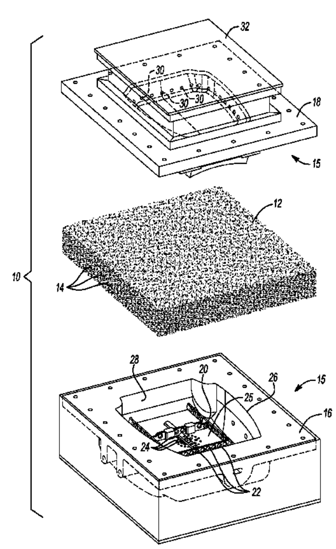
(57) **ABSTRACT**

A method for producing a vehicle interior component includes placing a polymeric cushion blank in a mold having a plurality of apertures and a mold cavity. The method may include the step of passing a first fluid having a first predetermined temperature through at least some of the apertures and through the cushion blank to heat the cushion blank to a compliant, non-liquid state. The method may also include passing a second fluid having a second predetermined temperature lower than the first predetermined temperature through the mold and through the cushion blank to cool cushion blank to a non-compliant state.

20 Claims, 5 Drawing Sheets



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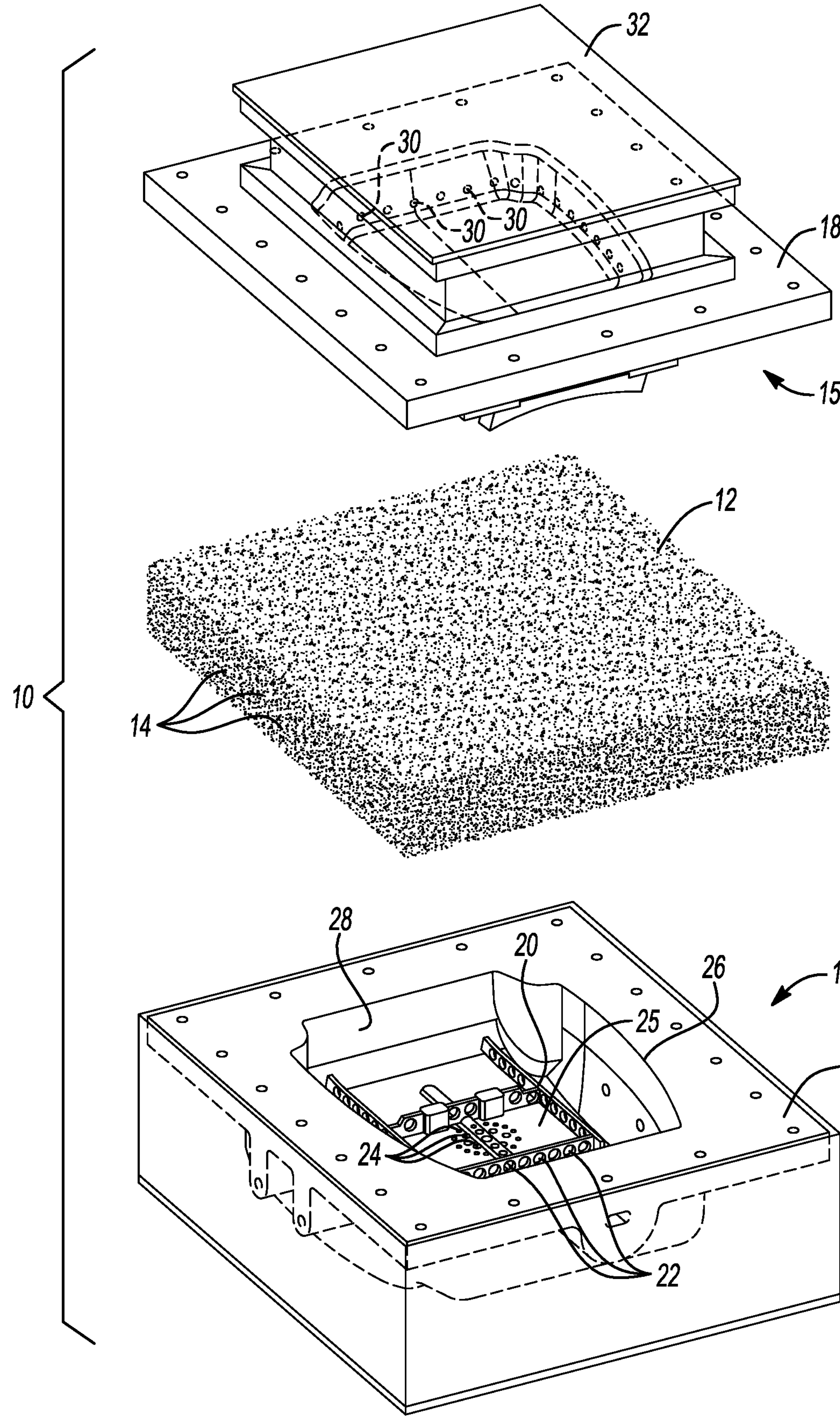

Fig-1

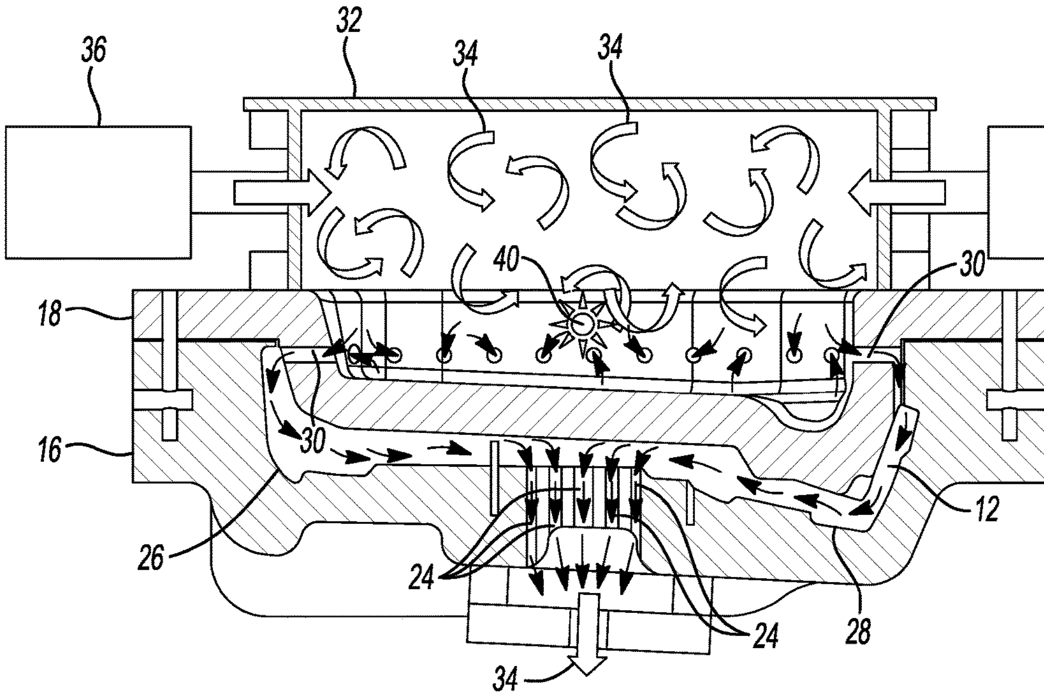
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Fig-2

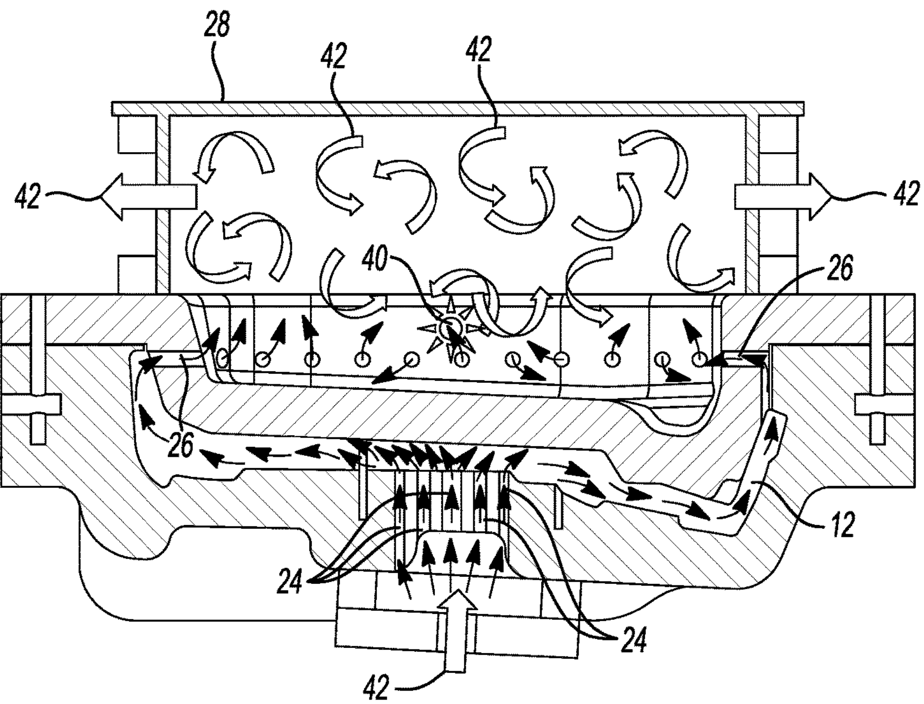
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Fig-3

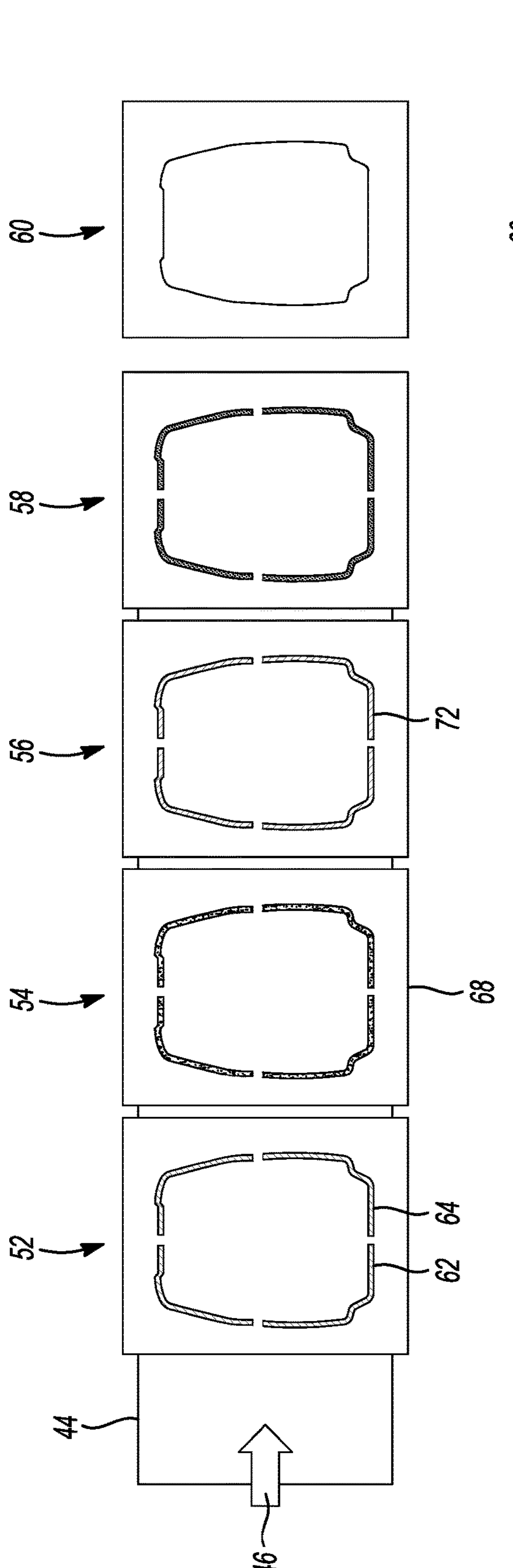
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Fig-4A

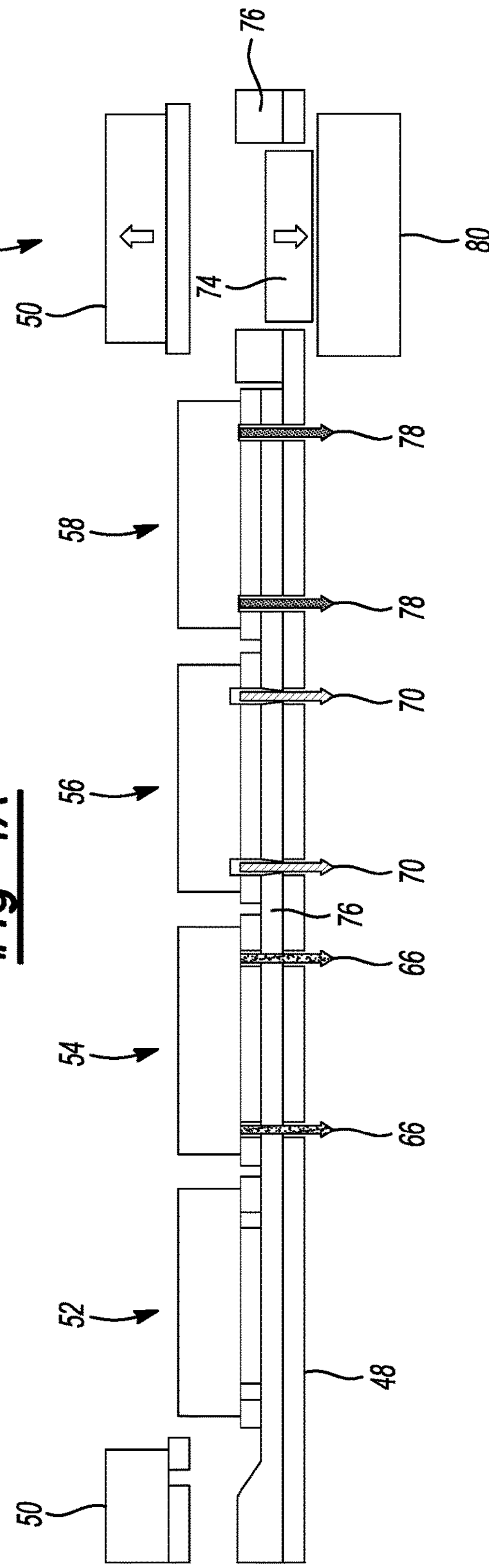
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Fig-4B

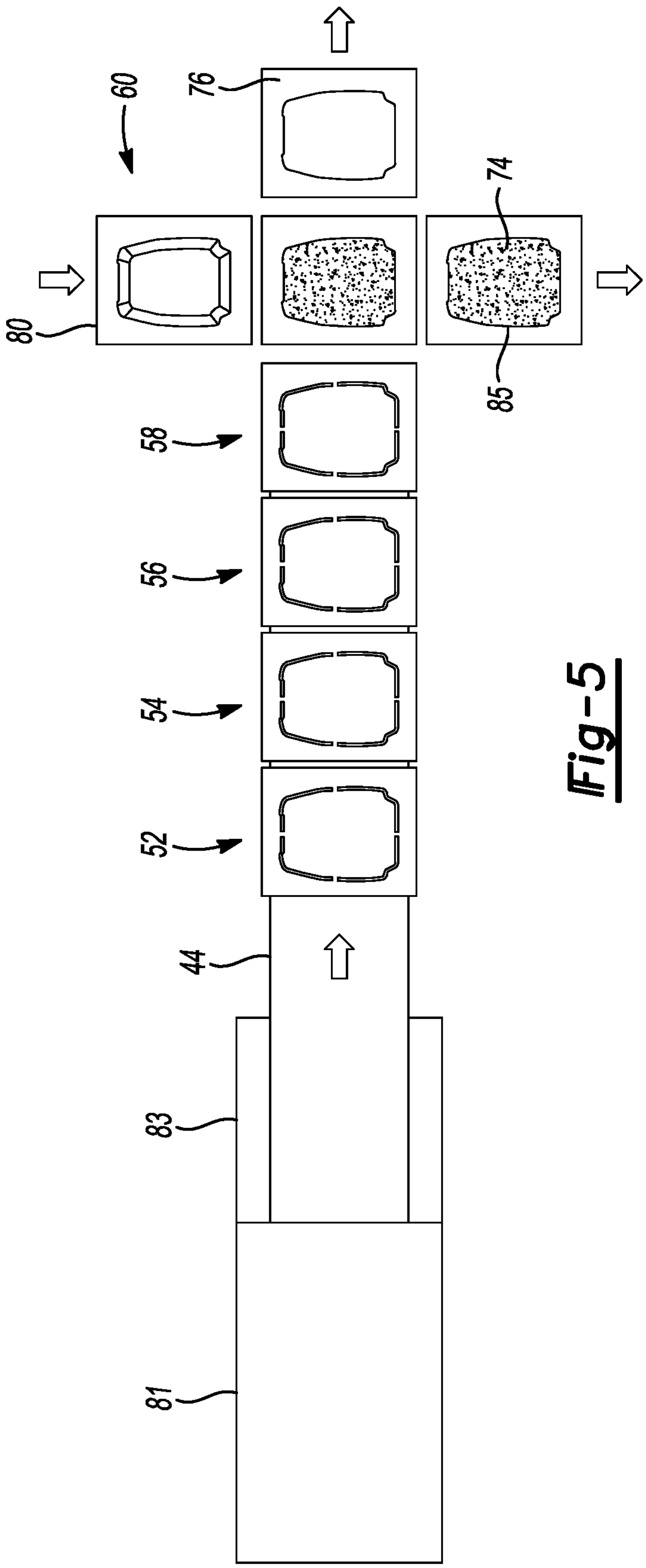

Fig-5

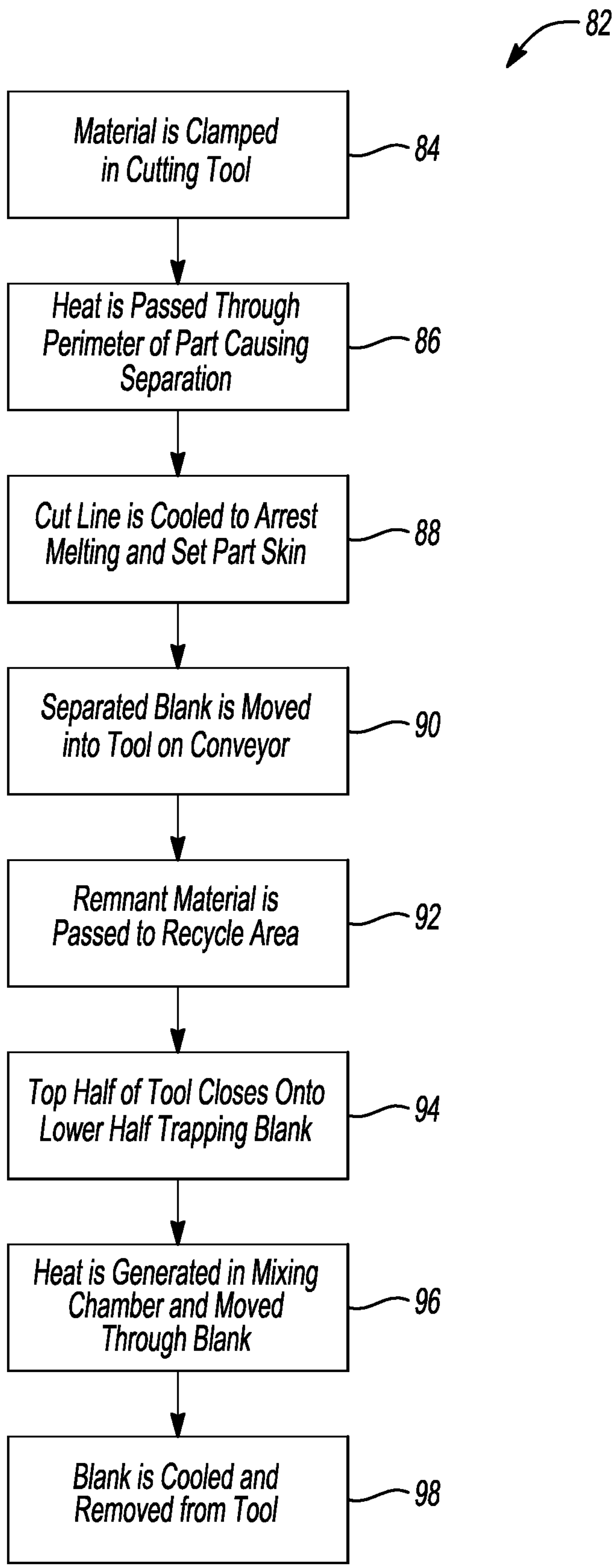
82
Material is Clamped in Cutting Tool
84
Heat is Passed Through Perimeter of Part Causing Separation
86
Cut Line is Cooled to Arrest Melting and Set Part Skin
88
Separated Blank is Moved into Tool on Conveyor
90
Remnant Material is Passed to Recycle Area
92
Top Half of Tool Closes Onto Lower Half Trapping Blank
94
Heat is Generated in Mixing Chamber and Moved Through Blank
96
Blank is Cooled and Removed from Tool
98

Fig-6

METHOD FOR PRODUCING A VEHICLE INTERIOR COMPONENT

TECHNICAL FIELD

The present disclosure relates to a method for producing a vehicle interior component.

BACKGROUND

Vehicle interior components may be relatively simple structures—e.g., an assembly of a frame, one or more cushions, and a cover material. Conversely, they can be extremely complex systems such as a seating system that includes electromechanical or pneumatic back support, occupancy sensors, seatbelt sensors, and myriad different types of sophisticated ventilation systems, just to name a few of the possible features. One component that is common to many of these interior components is a padded portion, for example, a cushion. Many of these cushions are made from a foam material, such as molded urethane. Molded polymeric foams can be configured to accommodate vehicle interior components with different properties. For example, the density of the foam may be engineered to provide a desired amount of durability, and to accommodate various ancillary systems, such as a ventilation system in a seat.

One limitation of this configuration is that the weight of the cushion may increase significantly when the density of the foam is increased. Another limitation of foam is that an molding process is often used to produce the cushion into a final or near-net shape. Mold tools for this process are expensive and require significant maintenance. These manufacturing processes have several disadvantages—e.g., complexity and cost—and the resulting cushion may add significant weight to the interior component and it may lack the desired durability. A need therefore exists for an alternative method for producing a vehicle interior component that reduces or eliminates at least some of these disadvantages.

SUMMARY

Embodiments described herein may include a method for producing a vehicle interior component that includes the steps of placing a cushion blank in a mold having a cavity with a cavity shape, where the cushion blank comprises a polymeric material in a solid state. A first fluid having a first predetermined temperature may be passed through the mold and through the cushion blank to heat the cushion blank to a compliant, non-liquid state such that the cushion blank assumes the cavity shape. A second fluid having a second predetermined temperature lower than the first predetermined temperature may be passed through the mold and through the cushion blank to cool cushion blank to a non-compliant state.

Embodiments described herein may include a method for producing a vehicle interior component that includes placing a cushion blank in a mold having a plurality of apertures and a mold cavity. The cushion blank may comprise a polymeric material in a solid state. A first fluid having a first predetermined temperature may be passed through at least some of the apertures and through the cushion blank to heat the cushion blank to a compliant, non-liquid state. A second fluid having a second predetermined temperature lower than the first predetermined temperature may be passed through the mold and through the cushion blank to cool cushion blank to a non-compliant state.

Embodiments described herein may include a method for producing a vehicle interior component that includes placing a cushion blank comprising a polymeric material in a solid state in a mold having a cavity. A first fluid flow having a first predetermined temperature may be introduced into the cushion blank a such that the cushion blank is heated to a compliant, non-liquid state in the mold. A second fluid flow having a second predetermined temperature lower than the first predetermined temperature may be introduced into the cushion blank a such that the cushion blank is cooled to a non-compliant state.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a portion of a manufacturing process used in with embodiments of a method described herein;

FIG. **2** shows a cross-sectional view of a material being heated in the mold in accordance with embodiments of a method described herein;

FIG. **3** shows the material from FIG. **2** being cooled in the mold; and

FIGS. **4**A and **4**B show top and front views of a portion of a manufacturing line used with embodiments of method described herein;

FIG. **5** shows additional detail of the manufacturing line shown in FIG. **4**;

FIG. **6** shows a flowchart describing steps of an embodiment of a method described herein.

DETAILED DESCRIPTION

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. The figures are not necessarily to scale; some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

FIG. **1** shows a portion of the manufacturing process **10** in accordance with embodiments of a method described herein. In this embodiment, the manufacturing process **10** performs work on a cushion blank **12**, which may be used, for example, in a vehicle interior component such as a seating system. For a seating system, the cushion blank **12** may be used in a seat bottom, a seat back, bolsters, or other parts of a vehicle seating system such as arm rests. The cushion blank may also be used in other vehicle interior components such as a center console that may or may not be part of a seating system. The cushion blank **12** comprises a polymeric material, and in this embodiment, it is a stranded-mesh material made up of a plurality of integrated polymeric strands **14**—for clarity, only some of the strands **14** are labeled. The strands **14** may be made from, for example, a linear low density polyethylene material, although other polymers and materials effective to provide the desired properties and functionality are contemplated. In other embodiments, a cushion blank, such as the cushion blank **12** may be made from other types of polymeric materials that may or may not be configured as a stranded-mesh material. As used herein, the terms "polymer" and "polymeric" may refer to materials commonly used and identified as polymers—e.g., polyethylene, polyurethane, etc.—or they may refer to "natural" polymers such as plant-based materials like soy foams.

As shown in FIG. **1**, the cushion blank **12** is ready to be placed in a mold **15** that is made up of a bottom portion **16** and a top portion **18**. The bottom portion **16** of the mold **15** includes an interior structure **20** that has a plurality of apertures **22** disposed therein—for clarity, only some of the apertures **22** are labeled in FIG. **1**. The bottom portion **16** of the mold **15** also includes a plurality of apertures **24** in a bottom surface **25**. As explained in more detail in conjunction with FIGS. **2** and **3**, the apertures **22**, **24** facilitate fluid flow through the mold **15**, and through the cushion blank **12** itself. The lower portion **16** of the mold **15** includes a cavity **26** having a cavity shape **28**. As explained in more detail in conjunction with FIG. **2**, the mold cavity **26**—and in particular the cavity shape **28**—is used to shape the cushion blank **12** into a desired near-net or final shape.

The upper portion **18** of the mold **15** also includes a plurality of apertures **30** disposed therethrough. The apertures **30** also facilitate fluid flow through the mold **15** and the cushion blank **12**. Shown in FIG. **1** is a mixing chamber **32** that may be attached to the upper portion **18** of the mold **15** to facilitate mixing of the fluid flowing through the mold **15** and the cushion blank **12**. This is illustrated in more detail in FIG. **2**, which shows a cross-sectional view of the top and bottom portions **16**, **18** of the mold **15**. In FIG. **2**, the cushion blank **12** is captured between the bottom and top portions **16**, **18** of the mold **15**, and has assumed the shape of the cavity **26**.

In order to more permanently configure the shape of the blank **12** into the cavity shape **28**, the cushion blank **12** is heated to a temperature where the polymeric material from which it is made begins to soften. More specifically, the cushion blank **12** is heated until it reaches a compliant, non-liquid state. That is, it is not heated to the melting point, but just until it begins to become flexible and more readily assume the cavity shape **28**. The control of temperatures and other manufacturing processes may result in some limited, unintentional localized melting of the polymeric material, but if this occurs, it would be negligible, and most of the cushion blank **12** would remain in a non-liquid state. Therefore, the cushion blank **12** begins the molding process in a solid state, and mostly or completely remains in a solid-state throughout the process.

Although the cushion blank **12** could be heated by heating the bottom and top portions **16**, **18** of the mold **15**, this might create localized, undesirably high temperatures near the surface of the blank **12** where it contacts the mold **15**, while at the same time failing to heat the cushion blank **12** adequately near its center. To address this issue, embodiments of methods described herein help to overcome this problem by heating the cushion blank **12** itself—and doing so in a way that provides a generally uniform heat application throughout the part. In the embodiment shown in FIG. **2**, this is achieved by passing a first fluid having a first predetermined temperature through the bottom and top portion **16**, **18** of the mold **15**, and through the cushion blank **12** itself. This introduces a first fluid flow through the cushion blank **12** to bring it to a desired temperature.

The first fluid in the first fluid flow may be a gas, a liquid, or some combination of gas and liquid. For example, the first fluid may be air, steam, super-heated steam, water, etc. The first predetermined temperature will depend on the specific material from which the cushion blank **12** is manufactured. For example, for a stranded-mesh material made from linear low-density polyethylene, such as described above, the first predetermined temperature may be in the range of 85-100 C. Other types of polymeric materials may have different temperature ranges in which they become compliant—e.g., for a high-density polyethylene or a polypropylene, the first predetermined temperature may be 100-130 C.

In the embodiment shown in FIG. **2**, the first fluid is heated air **34**, which is schematically illustrated by the arrows inside the mixing chamber **32**. This means that in this embodiment, the first fluid flow **34** is a first airflow. The air may be at ambient pressure, or it may be compressed or at other pressures different from ambient pressure. As shown in FIG. **2**, the air **34** is introduced into the mixing chamber **32** from two sources **36**, **38**. In practice, the first fluid **34** may be introduced from a single source, or a single source having more than one outlet that leads into the mixing chamber **32**. In other embodiments, a mixing chamber, such as the mixing chamber **32**, may not be used and the first fluid flow **34** may be introduced directly into the top portion **18** of the mold **15**.

In the embodiment shown in FIG. **2**, a temperature sensor **40** is placed in the upper portion **18** of the mold **15** to monitor the temperature of the first fluid **34** as it is introduced into the mold **15** and through the cushion blank **12**. The first fluid **34** flows through the apertures **30** in the upper portion **18** of the mold **15**, and through the cushion blank **12**, before exiting through the apertures **24** in the bottom portion **16** of the mold **15**. In this embodiment, the first fluid **34** also passes through the apertures **22** in the interior structure **20** of the bottom portion **16** of the mold **15**—see also FIG. **1**. Because the cushion blank **12** is made from a stranded-mesh material, the heated air **34** flows generally uniformly throughout the entire thickness of the blank **12**. This helps to ensure uniform heating so that all the material in the cushion blank **12** becomes compliant.

As used herein, the term "compliant" means that the material is in a state—e.g., it is at a temperature—where its shape can be permanently changed. This is in contrast to the movement the material may undergo when a vehicle occupant applies a force to an interior component that includes a cushion made from the cushion blank **12** and causes the cushion to compress. In that situation, the cushion has "memory" and will return to its original shape—or very near to its original shape—shortly after the occupant removes the force from the cushion; more specifically, the cushion made from the cushion blank **12** is in a non-compliant state. For a material, such as the stranded-mesh material described above, the cushion blank **12** becomes compliant when it is heated to a temperature that is high enough to cause the material to soften, but not so high that it reaches the melting temperature of the material. In at least some embodiments, the first fluid flow may be passed through the mold **15** and the cushion blank **12** for a predetermined period of time—i.e., "soaked"—to ensure that the cushion blank **12** is in the desired state.

If the cushion blank **12** was removed from the mold **15** while still in its compliant, softened state, its shape could be inadvertently changed before the material cooled and the desired shape more permanently set. To address this issue, embodiments described herein may use a cooling medium to set the shape of the blank **12**—this is illustrated in FIG. **3**. More specifically, a second fluid **42** may be passed through the mold **15** and the cushion blank **12**, where the second fluid **42** is at a second predetermined temperature that is lower than the first predetermined temperature. Similar to the first fluid **34**, the second fluid **42** may be a gas, a liquid, or some combination of the two. In this embodiment, the second fluid **42** is also air, and so the first and second fluids are the same; alternatively, the first and second fluids may be different materials or even the same material in different states. The second predetermined temperature may be chosen to be any temperature effective to put the cushion blank **12** into a non-compliant state. For example, for a linear low density polyethylene, the second predetermined temperature will be below 85 C, and for high-density polyethylene and polypropylene, it will be below 100 C.

As shown in FIG. **3**, the second fluid **42** enters the bottom portion **16** of the mold **15** and flows through the apertures **24** and into the cushion blank **12**. This introduces a second fluid flow through the cushion blank **12** to cool it to a desired temperature and put the blank **15** in a non-compliant state. After leaving the cushion blank **12**, the second fluid **42** flows through the apertures **26** and enters the top portion **18** of the mold **15**. Here the temperature sensor **40** is used to monitor the temperature of the second fluid **40**. This allows the temperature of the second fluid **42** entering the bottom portion **16** of the mold **15** to be adjusted if the cooling rate is undesirably fast or slow. In the embodiment described above, the first fluid **34** is introduced into the top portion **18** of the mold **15** and the second fluid **42** is introduced into the bottom portion **16** of the mold **15**. In other embodiments, this may be reversed, or the first and second fluids **34**, **42** may both be introduced into the mold **15** through the top portion **18** or the bottom portion **16**.

In FIGS. **1-3**, the process starts with the cushion blank **12** already formed. Although FIG. **1** shows the cushion blank **12** as being generally rectangular, in practice, the cushion blank **12** may be formed to a more convenient shape to place in the mold **15**. Embodiments of a method described herein contemplate preparing a cushion blank, such as the cushion blank **12**, prior to its introduction into a mold. FIGS. **4**A and **4**B illustrate several method steps in accordance with such an embodiment. FIGS. **4**A and **4**B are top and front views, respectively, of a cutting process for preparing a cushion blank, such as the cushion blank **12**.

In FIG. **4**A, a polymeric material, and in particular a stranded-mesh material **44**, is being received from an extrusion line where the material **44** is first manufactured. As shown in FIG. **4**A, the stranded-mesh material **44** is moving in the direction indicated by the direction arrow **46**. It moves along a conveyor **48**—see FIG. **4**B—after it is captured by a tool **50**. The tool **50** moves with the material **44** to several stations **52**, **54**, **56**, **58**, **60**. Although it is contemplated that this process will be continuous with different tools capturing the material **44** and moving with it along the conveyor **48**, for convenience, the process illustrated in FIGS. **4**A and **4**B will be described in terms of the single tool **50** as it progresses along the conveyor **48**.

At a first station **52**, a portion of the material **44** is captured by the tool **50**. This may be thought of as "a piece" of the polymeric material **44** being captured by the tool **50**, even though at this stage of the process the material **44** is still part of a continuous sheet. As shown in FIG. **4**A, the tool **50** has an open area **62** having a predetermined shape **64**. In this embodiment, the predetermined shape **64** is a linear shape—i.e., it is generally comprised of rectilinear and curvilinear lines. As described in more detail below, the predetermined shape **64** defines a perimeter of the cushion blank that will be formed. In other embodiments, a tool, such as the tool **50**, may have open areas with different configurations—e.g., linear, nonlinear, or some combination of the two. As the material **44** continues to along the conveyor **48**, it comes to a second station **54**. Here, heat is applied to the tool **50**, as indicated by the arrows **66**. And because of the open area **62**, the heat is also applied directly to the material **44** along the lines defined by the predetermined shape **64**. The remainder of the material **44** that is captured by the tool **50** is shielded from the heat by the closed areas **68** of the tool **50**.

At the next station **56**, the heat continues to be applied, and may be intensified as needed—this is indicated by the arrows **70**. This forms a cut line **72** in the material **44** that has the predetermined shape **64**, and causes separation between the portion **74** of the material **44** inside the open area **62** and the portion **76** of the material **44** outside of the open area **62**—see also FIG. **5**. The heat applied at stations **54**, **56** may be applied at a predetermined temperature—which may be a single value, a range defined by upper and lower limits, or a range defined by a minimum temperature. The heat source may be any convenient source effective to heat the material **44** to the desired temperature—e.g., a heat source with electric or ceramic heating elements, etc. And the heat transfer may rely on conduction, convection, radiation, or some combination of these.

As described below, the portion **74** of the material **44** defines the cushion blank that will be used in a molding process, such as the molding process described above. Next, the material **44** and the tool **50** are moved to the station **58** where cooling is applied to the tool **50** as indicated by the arrows **78**. Adding the cooling at station **58** stops any melting process along the cut line **72**, and may set a skin that may be formed from the adjacent strands of the stranded-mesh material **44** during the heating process. Finally, the material **44** and the tool **50** moved to a station **60**, which is a transfer station where the cushion blank **74** is paired with a bottom portion **80** of a mold, which may be configured the same or similarly to the bottom portion **16** of the mold **15** described above.

FIG. **5** shows the top view of the processes illustrated in FIG. **4**A with additional detail at the beginning and end. Specifically, the material **44** may be manufactured in an extrusion process and is shown in FIG. **5** leaving an extruder **81**. Because the strands of the stranded-mesh material may still be warm and the bonds between them not fully set, the material **44** may be passed through a cooling water bath **83** prior to being captured by the tool **50**—see FIG. **4**B—and moved along the conveyor **48**. As shown in FIG. **5**, the bottom portion **80** of the tool is moved under the material **44** at station **60**. At the same time, the tool **50** is removed from the material **44**—see FIG. **4**B. The portion **74** of the material **44** that will be used for the cushion blank **74** has an outside perimeter **85** defined by the linear shape **64** of the open area **62** of the tool **50**. The blank **74** is then moved away from the conveyor **48** to be molded as described above. The portion **76** of the material **44** that is not part of the cushion blank is moved to another station, where it can be reground or otherwise recycled.

FIG. **6** shows a flowchart **82** illustrating a method in accordance with embodiments described herein. For convenience, the processes illustrated and described in conjunction with FIGS. **1-5** will be used for reference. At step **84**, material is clamped in a cutting tool—see, e.g., the material **44** clamped in the cutting tool **50** shown in FIGS. **4**A and **4**B. At step **86**, heat is passed through a portion of the tool to create a cut line and cause separation between that portion of the material that will be used for a cushion blank and the rest of the material in the tool. This is illustrated, for example, in FIGS. **4**A and **4**B at stations **54** and **56**. Next, the cut line is cooled at step **88**, which may correspond to the station **58** shown in FIGS. **4**A and **4**B. At steps **90** and **92**, the material is separated into the cushion blank and remnant material, respectively—see station **60** in FIGS. **4**A, **4**B and **5**. The remaining steps illustrated in the flowchart **82** are applied to the cushion blank, such as the cushion blank **12** illustrated in FIGS. **1**-**3**. At step **94** the top portion of the tool closes onto a lower portion, which captures the cushion blank between them—see, e.g., FIG. **2**, showing bottom and top portions **16**, **18** of the mold **15** capturing the cushion blank **12**. At step **96**, heat is generated in the mixing chamber attached to the mold and it is moved through the cushion blank. This is also illustrated in FIG. **2**. Finally, at step **98**, the blank is cooled—see FIG. **3**—and it is then removed from the tool and ready to be integrated into a vehicle interior component.

While exemplary embodiments are described above, it is not intended that these embodiments describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention. Additionally, the features of various implementing embodiments may be combined to form further embodiments of the invention.

What is claimed is:

1. A method for producing a vehicle interior component, comprising:
- placing at least a portion of a polymeric material in a tool comprising an open area of a predetermined shape;
- applying heat to the polymeric material through the open area to form a cut line comprising the predetermined shape to form a cushion blank;
- placing the cushion blank in a mold comprising a cavity with a cavity shape, wherein the mold comprises a top portion comprising a first plurality of apertures and a bottom portion comprising a second plurality of apertures;
- passing a first fluid comprising a first predetermined temperature through the first plurality of apertures in the top portion of the mold and through the cushion blank to heat the cushion blank to a compliant, non-liquid state such that the cushion blank assumes the cavity shape; and
- passing a second fluid comprising a second predetermined temperature lower than the first predetermined temperature through the second plurality of apertures in the bottom portion of the mold and through the cushion blank to cool cushion blank to a non-compliant state.

2. The method of claim **1**, wherein:
- the tool further comprises a closed area, and the polymeric material is accessible through the open area for applying heat, and
- a first portion of the polymeric material is separated from a second portion of the polymeric material based on heat applied to the polymeric material through the open area.

3. The method of claim **2**, wherein the first portion of the polymeric material is the cushion blank, and wherein the cushion blank comprising at least the portion of the polymeric material in a solid state.

4. The method of claim **2**, further comprising applying cooling to the polymeric material through the open area along the cut line.

5. The method of claim **1**, wherein the first fluid and the second fluid are the same.

6. The method of claim **1**, wherein the polymeric material is a stranded-mesh material.

7. The method of claim **1**, wherein at least one of the first fluid or the second fluid is air.

8. A method for producing a vehicle interior component, comprising:
- placing at least a portion of a polymeric material in a tool comprising an open area of a predetermined shape;
- applying heat to the polymeric material through the open area to form a cut line comprising the predetermined shape to form a cushion blank;
- placing the cushion blank in a mold comprising a top portion and a bottom portion, wherein the top portion comprises a first plurality of apertures and the bottom portion comprises a second plurality of apertures;
- passing a first fluid having a first predetermined temperature through the first plurality of apertures in the top portion and through the cushion blank to heat the cushion blank to a compliant, non-liquid state; and
- passing a second fluid having a second predetermined temperature lower than the first predetermined temperature through the second plurality of apertures in the bottom portion of the mold and through the cushion blank to cool cushion blank to a non-compliant state.

9. The method of claim **8**, further comprising passing the first fluid through the first plurality of apertures and through the cushion blank for a predetermined period of time before passing the second fluid through the mold and through the cushion blank.

10. The method of claim **8**, wherein the first fluid and the second fluid are different fluids.

11. The method of claim **8**, wherein at least one of the first fluid or the second fluid is a liquid.

12. The method of claim **8**, further comprising:
- cooling the polymeric material through the open area along the cut line, wherein the tool further comprises a closed area and the polymeric material is accessible through the open area to one of cool or heat the polymeric material.

13. The method of claim **12**, further comprising separating a first portion of the polymeric material from a second portion of the polymeric material along the cut line.

14. The method of claim **13**, wherein the cushion blank comprises the first portion of the polymeric material.

15. A method for producing a vehicle interior component, comprising:
- placing at least a portion of a polymeric material in a tool comprising an opening of a linear shape;
- applying heat to the polymeric material through the opening to form a cut line comprising the linear shape to form a cushion blank;
- placing the cushion blank comprising the polymeric material in a solid state in a mold comprising a cavity, wherein the mold comprises a top portion with a first plurality of apertures and a bottom portion with a second plurality of apertures;
- introducing into the cushion blank a first fluid flow comprising a first predetermined temperature through the first plurality of apertures, such that the cushion blank is heated to a compliant, non-liquid state in the mold; and
- introducing into the cushion blank a second fluid flow comprising a second predetermined temperature lower than the first predetermined temperature through the first plurality of apertures, such that the cushion blank is cooled to a non-compliant state.

16. The method of claim **15**, wherein:
- a first portion of the polymeric material inside the opening is separated from a second portion of the polymeric material outside the opening based on the applied heat.

17. The method of claim **16**, wherein the cushion blank comprises the portion of the polymeric material comprising having an outside perimeter defined by the linear shape.

18. The method of claim 15, further comprising maintaining the first fluid flow for a predetermined period of time before introducing into the cushion blank the second fluid flow.

19. The method of claim 15, wherein at least one of the first fluid flow or the second fluid flow is a gas.

20. The method of claim 19, wherein at least one of the first fluid flow or the second fluid flow is an airflow.

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