(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
04 January 2024 (04.01.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/006134 A1

(51) International Patent Classification:
D04H 3/037 (2012.01) *B68G 7/02* (2006.01)
A47C 27/12 (2006.01)

(21) International Application Number:
PCT/US2023/025923

(22) International Filing Date:
22 June 2023 (22.06.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

63/355,809	27 June 2022 (27.06.2022)	US
63/356,549	29 June 2022 (29.06.2022)	US
63/503,292	19 May 2023 (19.05.2023)	US
PA202370255	26 May 2023 (26.05.2023)	DK

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM,

(54) Title: METHOD AND APPARATUS FOR PRODUCING A VEHICLE INTERIOR COMPONENT

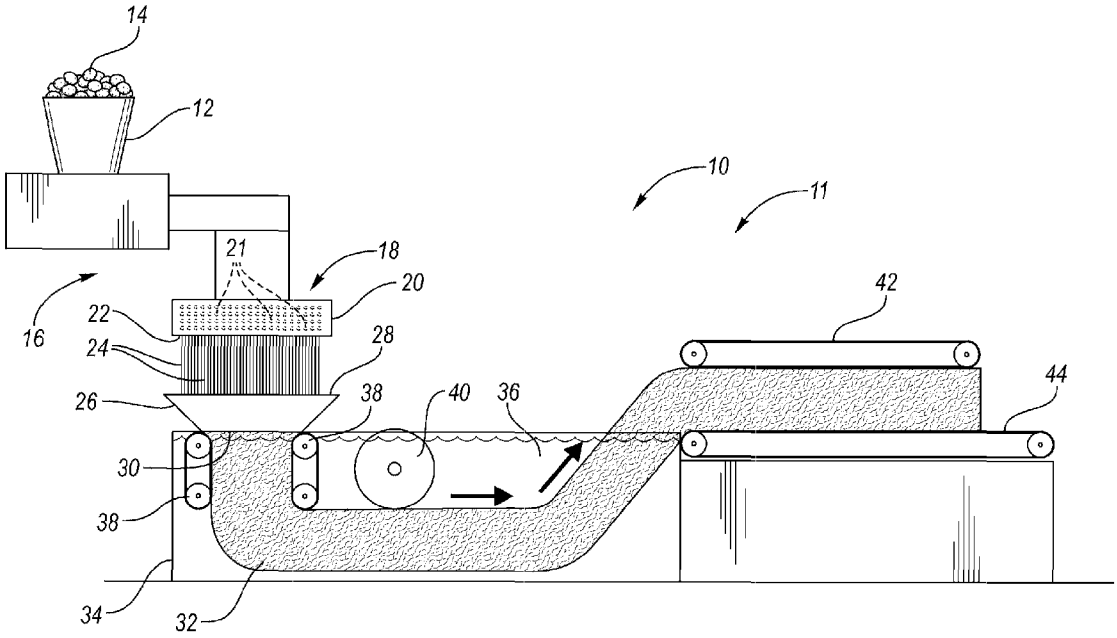


FIG. 1

(57) Abstract: An apparatus and method for producing a vehicle interior component may include creating a plurality of molten polymeric filaments, and applying a fluid stream to the molten filaments to impart the desired shape while in a bath to cool them to form a consolidated filament structure. An assembly, system, and method are provided for shaping a plurality of strands of a molten thermoplastic resin as a contoured unitary mesh product via at least one shaping conveyor. Another assembly, system, and method are provided for shaping a plurality of strands of a molten thermoplastic resin as a contoured unitary mesh product via an actuator assembly having one or more actuators.

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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

METHOD AND APPARATUS FOR PRODUCING A VEHICLE INTERIOR COMPONENT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Danish (DK) patent application no. PA202370255 filed May 26, 2023, U.S. provisional application Serial No. 63/355,809 filed June 27, 2022, U.S. provisional application Serial No. 63/356,549 filed June 29, 2022, and U.S. provisional application Serial No. 63/503,292 filed May 19, 2023, the disclosures of which are hereby incorporated in their entirety by reference herein.

TECHNICAL FIELD

[0002] Various embodiments of the present disclosure relate to a method and apparatus for producing a vehicle interior component, seat cushions, and assemblies, systems, and methods for manufacturing or forming seat cushions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] FIGURE 1 shows a schematic illustration of a system and method in accordance with embodiments described herein;

[0004] FIGURE 2 shows a schematic illustration of a system and method in accordance with embodiments described herein;

[0005] FIGURE 3 shows a consolidated filament structure used as a cushion blank for a vehicle seat with side bolsters formed in accordance with embodiments described herein;

[0006] FIGURE 4 shows a consolidated filament structure used as a cushion blank for a vehicle seat with a concave central portion formed in accordance with embodiments described herein;

[0007] FIGURE 5 shows a consolidated filament structure used as a cushion blank for a vehicle seat with a channel formed in accordance with embodiments described herein;

[0008] FIGURE 6 is a front perspective view of a seat assembly according to some embodiments;

[0009] FIGURE 7 is a front partial perspective view of a cushion of the seat assembly of Figure 6,, according to some embodiments;

[0010] FIGURE 8 is a front elevation schematic view of a system to manufacture the seat cushion of Figure 7;

[0011] FIGURE 9 is a front elevation schematic view of a conveyor assembly of the system of Figure 8, according to some embodiments;

[0012] FIGURE 10 is a front perspective schematic view of a conveyor assembly of the system of Figure 8, according to some embodiments;

[0013] FIGURE 11 is a front elevation view of a cushion manufactured with the conveyor assembly of Figure 9;

[0014] FIGURE 12 is a front elevation schematic view of a conveyor assembly of the system of Figure 8, according to some embodiments;

[0015] FIGURE 13 is a front elevation view of a cushion manufactured with the conveyor assembly of Figure 12;

[0016] FIGURE 14 is a side elevation schematic view of an actuator assembly for use with the system of Figure 8, according to some embodiments;

[0017] FIGURE 15 is a top perspective schematic view of the actuator assembly of Figure 14;

[0018] FIGURE 16 shows a schematic view of a system with an assembly and one or more sub-assemblies according to some embodiments;

[0019] FIGURE 17 shows a method for forming and shaping a product with an assembly and one or more sub-assemblies according to some embodiments; and

[0020] FIGURE 18 shows a method for forming and shaping a product according to some embodiments.

DETAILED DESCRIPTION

[0021] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the various described embodiments. However, it will be apparent to one of ordinary skill in the art that the various described embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

[0022] It is to be understood that the disclosed embodiments are merely exemplary and that various and alternative forms are possible. 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 embodiments according to the disclosure.

[0023] "One or more" includes a function being performed by one element, a function being performed by more than one element, *e.g.*, in a distributed fashion, several functions being performed by one element, several functions being performed by several elements, or any combination of the above.

[0024] It will also be understood that, although the terms first, second, etc. are, in some instances, used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first contact could be termed a second contact, and, similarly, a second contact could be termed a first contact, without departing from the scope of the various described embodiments. The first contact and the second contact are both contacts, but they are not the same contact.

[0025] The terminology used in the description of the various described embodiments herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description of the various described embodiments and the appended claims, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms "includes," "including," "comprises," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0026] As used herein, the term "if" is, optionally, construed to mean "when" or "upon" or "in response to determining" or "in response to detecting," depending on the context. Similarly, the phrase "if it is determined" or "if [a stated condition or event] is detected" is, optionally, construed to mean "upon determining" or "in response to determining" or "upon detecting [the stated condition or event]" or "in response to detecting [the stated condition or event]," depending on the context.

[0027] The terminology controller may be provided as one or more controllers or control modules for the various components and systems. The controller and control system may include any number of controllers, and may be integrated into a single controller, or have various modules. Some or all of the controllers may be connected by a controller area network (CAN) or other system. It is recognized that any controller, circuit, or other electrical device disclosed herein may include any number of microprocessors, integrated circuits, memory devices (e.g., FLASH, random access memory (RAM), read only memory (ROM), electrically programmable read only memory (EPROM), electrically erasable programmable read only memory (EEPROM), or other suitable variants thereof) and software which co-act with one another to perform operation(s) disclosed herein. In addition, any one or more of the electrical devices as disclosed herein may be configured to execute a computer-program that is embodied in a non-transitory computer readable medium that is programmed to perform any number of the functions as disclosed herein.

[0028] Referring to Figure 1, a schematic illustration of a system 10 usable with a method 11 in accordance with embodiments described herein is shown. A hopper 12 holds solid granules of a polymeric material 14 that is to be extruded. In some embodiments, the material 14 is linear low-density polyethylene (LLDPE), although methods described herein may use different types of polymers as desirable and effective to produce the finished product. The material 14 is fed from the hopper 12 to an extruder 16. The extruder 16 melts and transports the material 14 to a die-plate arrangement 18, which includes a die plate 20. The extruder 16 may be, for example, a conventional extruder that includes a barrel that receives a rotatable screw. Rotation of the screw forces the material 14 to move through the barrel and helps heat the material because of the friction generated as the screw rotates. Heating elements may be disposed on the barrel and heat the polymeric material 14 inside the barrel.

[0029] The material 14 exits the extruder 16 at location 22 under pressure and in a molten state. Unless otherwise stated, the term "molten" as used herein means that the material is at least partially melted. It does not mean that the material is necessarily in a fully liquid state; rather, it means that the material is not completely solid and is still able to flow through elements of the system 10. For example, the molten material is still able to flow through the die plate 20, but it may be very viscous and starting to solidify. Once the solid granules of the polymeric material 14 are melted in the extruder 16, the material will begin to cool as it ceases to be agitated by the extruder screw and gets farther from any heaters. At different points in the process 11, the material may have a higher or lower viscosity, but if it is still partially melted and able to flow—even slowly—the term "molten" is applied herein.

[0030] The die plate 20 extrudes the material 14 into filaments 24. More specifically, the die plate 20 has multiple holes 21 disposed therethrough—only some of which are labeled in Figure 1 for clarity—through which the molten material 14 passes. A single filament 24 is extruded from each die-plate hole. The filaments 24 fall downward from the die plate 20 under system pressure and the force of gravity to a funnel 26. The funnel 26 helps consolidate or group the filaments 24 into a more compact arrangement in which the filaments 24 bend or loop, and each filament 24 contacts and bonds to at least one other filament 24. In some embodiments, the funnel 26 has a funnel inlet 28 and a funnel outlet 30 that is smaller than the funnel inlet 28. More specifically, the funnel 26 is narrower at the funnel outlet 30 than at the funnel inlet 28.

Individual separated filaments 24 enter the funnel inlet 28, the filaments 24 then bend or loop and move into contact with each other as they accumulate and slide down the funnel 26 toward the funnel outlet 30, and the consolidated filament structure 32 exits the funnel outlet 30 and enters a water tank 34. When the filaments 24 reach the funnel 26, those filaments near the outer part of the funnel 26—approximately 2–3 rows—slide down an angled surface of the funnel 26, which creates a skin on the consolidated filament structure 32.

[0031] The water tank 34 holds water 36 and receives the consolidated filament structure 32 from the funnel 26. The water 36 performs at least two functions. First, it helps to temporarily support the consolidated filament structure 32 to prevent it from collapsing or condensing into a less open or less porous arrangement. As such, the water 36 provides some resistance that causes the additional bending and looping of the filaments 24 to further build the consolidated filament structure 32. Second, the water 36 cools the polymeric filaments 24 from the outside to solidify them. The temperature of the water 36 may be much less than the temperature of the filaments 24 as they leave the die plate 20, for example, it may be at the temperature of the ambient environment surrounding the tank 34. Although the fluid used in this embodiment is liquid water 36, in other embodiments, other types of fluids may be used.

[0032] The water tank 34 includes various rollers and conveyors that help move the consolidated filament structure 32 through and out of the water 36. A tractor conveyor 38 is submerged in the water 36 and engages opposing lateral sides of the consolidated filament structure 32 to move it away from the funnel 26 at approximately the same speed as the consolidated filament structure 32 exits the funnel 26. The gap between the opposing portions of the tractor conveyor 38 is slightly narrower than the width of the consolidated filament structure 32 to allow the tractor conveyor 38 to better grip the consolidated filament structure 32. As previously noted, Figure 1 is a schematic representation and has been simplified for illustration purposes. For example, a conveyor, such as the tractor conveyor 38, may be located toward the front and back of the system 10 as it is oriented in Figure 1, rather on the left and right sides as shown.

[0033] Another roller 40 helps keep the consolidated filament structure 32 submerged and helps guide it through the water 36 toward a conveyor belt 42 and a shaker table 44 that are

positioned outside of the water tank 34. The shaker table 44 shakes the consolidated filament structure 32 while it is on the conveyor belt 42 to remove at least some of the water 36. Pressurized air may also be blown toward the consolidated filament structure 32, which may also be squeezed to remove more of the water 36. Finally, the consolidated filament structure 32 may be cut to a desired size and shape.

[0034] Figure 2 shows a portion of a system 46 similar to the system 10 shown in Figure 1. This portion of the system 46 can be used to perform a method 48 in accordance with embodiments described herein. The system 46 includes a die plate 50 having a plurality of holes disposed therethrough, which may be positioned at the end of an extruder, such as the extruder 16 shown in Figure 1. Similar to the method 11 described in conjunction with Figure 1, a plurality of molten polymeric filaments 52—only some of which are labeled in Figure 2 for clarity—are formed as a molten polymer moves through the holes in the die plate 50. The molten polymeric filaments 52 move downward from the die plate 50 into a funnel 54, which helps to consolidate them and guide them into a fluid bath 56, which, as described above, may be used for cooling the molten polymer. In this embodiment, the bath 56 is a tank filled with water 58, but in other embodiments, a fluid bath, such as the fluid bath 56, may be filled with fluids other than water, depending on the particular application.

[0035] As the molten polymeric filaments 52 enter the fluid 58, they begin to cool and form a consolidated filament structure 59. At this stage, the filaments 52 are just beginning to form a more solid structure, but are still in a compliant state. More specifically, the filaments 52 forming the beginning of the consolidated filament structure 59 can be moved and arranged into different shapes that will remain when the filaments 52 are completely solidified. A tractor conveyor 60 engages the consolidated filament structure 59 to move it away from the funnel 54. Similar to the system 10 shown in Figure 1, the system 46 may include additional rollers, conveyors, etc. to guide the filament structure 59 through the remainder of the system 46. As shown in Figure 2, the system 46 also includes a conduit arrangement 62 having several conduits 64. The conduits 64 may be configured, for example, as tubes for applying a fluid stream to the molten polymeric filaments 52 as they begin to cool in the fluid bath 56. On the opposite side of the consolidated filament structure 59 is another conduit or tube 66, which is also configured to apply a fluid stream to the filaments 52 as they begin to cool in the water bath 56.

[0036] In accordance with a method described herein, the tubes 64, 66 may be used to apply a fluid stream to the molten polymeric filaments 52 such that the filaments 52 are imparted with the desired shape so that a consolidated filament structure having the desired shape is formed. In the embodiment shown in Figure 2, there are three of the tubes 64 on one side of the filaments 52 and one of the tubes 66 on the other side of the filaments 52. In other embodiments, different conduit arrangements having different numbers of tubes may be used. For example, a conduit arrangement as used with embodiments described herein may have a "stacked" arrangement as the tubes 64 are shown in Figure 2, they could be placed in a row horizontally, or they could be positioned in an array pattern to achieve a desired shape. As described above, the tubes 64, 66 are configured to apply a fluid stream to the filaments 52.

[0037] In the embodiment shown in Figure 2, the fluid used for the fluid stream is the water 58 taken from the water tank. A pump or other device may be used to force the fluid through the tubes 64, 66 and toward the filaments 52. In other embodiments, other fluids may be used, including liquids other than the one filling the tank 56, or the fluid could be mostly or completely gaseous so that air or some other gas is streamed toward the filaments 52. Also as shown in Figure 2, the tubes 64 and the tube 66 are positioned to apply fluid streams in two different directions—i.e., the tubes 64 apply fluid streams directly opposite the fluid stream applied by the tube 66. In other embodiments, a tube or tubes may apply a fluid stream in a single direction, or in different directions that are not opposite each other.

[0038] Each of the tubes 64 includes a nozzle 68 positioned at its end closest to the filaments 52. Similarly, the tube 66 has a nozzle 70 positioned at its end closest to the filaments 52. These nozzles 68, 70 may be convergent—i.e., having an exit opening that is smaller than the inside diameter of the tubes 64, 66. Alternatively, the nozzles 68, 70 may be divergent—i.e., they may act as a diffuser having an exit opening that is larger than the inside diameter of the tube 64, 66. In some embodiments, a different combination of convergent and divergent nozzles may be used to achieve a desired shape of the consolidated filament structure 59. In the embodiment shown in Figure 2, the nozzles 68, 70 are positioned approximately 10–15 millimeters (mm) from a surface of the filaments 52, although in other embodiments they may be positioned closer to or farther away from the filaments depending on the desired effect. Although the tubes 64, 66 are shown on opposite sides of the filaments 52, in other embodiments, a tube or tubes may be

placed at different positions around the outside of the filaments 52, again based on a desired final shape for the consolidated filament structure 59.

[0039] As the molten polymeric filaments 52 begin to cool and form the consolidated filament structure 59, they will become increasingly solid—this is shown at a lower portion 72 of the consolidated filament structure 59, which is positioned near the end of the tractor conveyor 60. As shown in Figure 2, the fluid flowing through the nozzles 68 contacts the polymeric filaments 52 and forms an indentation or channel 74 in the consolidated filament structure 59. Similarly, the fluid flowing through the nozzle 70 on the side opposite the conduit arrangement 62 forms indentations or channels 76 to 78 in the other side of the consolidated filament structure 59. Depending on the size, shape, and array of tubes and associated nozzles, various shapes can be imparted to a consolidated filament structure, such as the consolidated filament structure 59.

[0040] This flexibility may be particularly convenient when the consolidated filament structure is intended for use as a vehicle interior component. For example, the consolidated filament structure 59 may be used as a cushion blank for part of a vehicle seat. To reduce time and cost—particularly in postprocessing operations—the consolidated filament structure 59 may be formed with systems and methods described herein to create a net- or near-net-shaped structure. For example, the channels formed by the fluid streams may be positioned on either side of a seat cushion to help form bolsters or other desirable features. Figure 3 shows a consolidated filament structure forming a cushion blank 80, created using embodiments such as described above.

[0041] Specifically, embodiments described herein were used to form two channels 82, 84 on either side of the cushion blank 80, by applying a fluid stream to the molten polymeric filaments in a fluid tank such as illustrated in Figure 2. Two bolsters 86, 88 are positioned on opposite sides of the cushion blank 80, adjacent to respective channels 82, 84. The bolsters 86, 88 can be formed by applying fluid streams on the opposite side of the cushion blank 80 from the channels 82, 84, to push the bolster portions 86, 88 upward as shown in Figure 3. Alternatively, a central portion 90 of the cushion blank 80 may be subject to an array of fluid streams to push it downward so the bolster portions 86, 88 rise above a surface 92 of the central portion 90. Some combination of these two techniques may also be used. In this way, the use of fluid streams, such

as described in conjunction with Figure 2, are used to create a consolidated filament structure having a desired shape.

[0042] Embodiments of systems and methods described herein may also be used to form different types of shapes useful for different applications. For example, Figure 4 shows a consolidated filament structure 94, that is also intended for use as a cushion blank for a vehicle interior component, such as a vehicle seat. The filament structure 94 includes a somewhat concave central portion 96 formed by an array of fluid streams contacting that side of the molten polymeric filaments as they move through the fluid bath. In this embodiment, the side portions of the cushion blank 94 are not so pronounced as to be bolsters, but the central portion 96 is somewhat lower than the sides, which forms a desirable shape for a seated occupant. In Figure 5, another consolidated filament structure 98 is shown. The filament structure 98 is also configured for use as a cushion blank, and in this embodiment, a channel 100 is formed in a surface of the cushion blank 98. The channel 100 may form a convenient location for a sewing seam on a trim cover, which are typically pulled into channels or other indentations in the cushion material to provide a more aesthetically pleasing finished product.

[0043] Figure 6 illustrates a seat assembly 120 as a vehicle seat assembly 120 according to some embodiments. Although the vehicle seat assembly 120 is illustrated and described, any seat assembly 120 may be employed. The seat assembly 120 may be utilized in a land vehicle, aircraft, watercraft, or the like. The seat assembly 120 may also be utilized as an office chair, comfort chair, or the like.

[0044] The depicted seat assembly 120 includes a seat bottom cushion 122 to support a pelvis and thighs of a seated occupant. The seat assembly 120 also includes a seat back cushion 124 to support a back and shoulders of the seated occupant. A trim cover 126 is provided over the seat cushions 122, 124 to conceal the cushions 122, 124 and provide a uniform and smooth contact surface for the occupant.

[0045] Referring now to Figure 7, one of the seat cushions 122 is partially illustrated disassembled from the seat assembly 120. The seat cushion 122 is formed from a plurality of strands 128 of an extruded, expanded thermoplastic resin. The seat cushion 122 is also formed with a base layer 130 bonded to, and/or formed unitarily with, the plurality of strands 128.

[0046] Referring now to Figure 8, the seat cushions 122, 124 are manufactured from a system 132 and a process of extruded thermoplastic resin mesh. In the depicted embodiment, an extruder 134 provides a pressurized molten thermoplastic resin to an extrusion die 136. The extrusion die 136 is arranged with a plurality of outlet ports or nozzles 138 to dispense the plurality of strands 128 of the molten thermoplastic resin. The strands 128 are dispensed through a funnel plate 140 and into a fluid chamber 142. The funnel plate 140 guides the strands 128 into the fluid chamber 142. The fluid chamber 142 retains a fluid, such as water, to resist and cool the strands 128. The fluid chamber 142 resists a flow of the strands 128, thereby causing the strands 128 to buckle, loop, and intersect with adjacent strands 128 within a profile defined by the funnel plate 140. The strands 128 may also expand and float within the fluid chamber 142. The strands 128 are cooled in the fluid chamber 142 by the fluid to form a unitary non-woven thermoplastic cushion 122. According to this process the non-woven thermoplastic cushion 122 is resisted, cooled, and solidified by the fluid.

[0047] The system 132 includes a conveyor assembly 144 in the fluid chamber 142. The conveyor assembly 144 conveys the plurality of strands 128 through the fluid chamber 142. The conveyor assembly also provides an outer boundary to the strands 128 to shape the strands 128 with a contour as the cushion 122. Regular conveyors would otherwise produce a cushion with a rectangular cross-section. However, the seat cushion 122 is contoured for occupant support and comfort. The conveyor assembly 144 is a shaping conveyor for forming a contour into the cushion 122.

[0048] The conveyor assembly 144 is illustrated in Figure 9. The conveyor assembly 144 includes a pair of conveyors 146, 148. The conveyors 146, 148 are employed to form shapes or features on the mesh cushion 122. The conveyors 146 148 press a shape into the mesh cushion 122 within the fluid chamber 142 before the mesh cushion 122 has cured and set into its final shape. The preliminary shaping is formed into the mesh cushion 122 at an initial region as the strands 128 enter the fluid. For example, the conveyors 146, 148 may engage the strands 128 within the first inch of the fluid, based on one example of the funnel plate 140 and the die plate 136. The conveyors 146, 148 maintain contact with the cushion 122 until the mesh 122 cures, such as about six inches into the fluid.

[0049] Each of the conveyors 146, 148 include a track 150, 152 for travelling about the conveyors 146, 148 for conveying the mesh 122 between the tracks 150, 152. In the embodiment of Figure 9, the track 150 travels clockwise; and the track 152 travels counterclockwise. As illustrated in Figure 10, each of the tracks 150, 152 includes a plurality of links 154 pivotally interconnected as a chain link track 150, 152. According to one example, each track 150, 152 includes 96 links 154 with flat or contact surfaces. Alternatively, the tracks 150, 152 may be formed from a belt or the like.

[0050] Referring again to Figure 9, a plurality of shaping tools 156 are attached to the track 150 to form shapes, features, and/or contours 158 in the mesh cushion 122. The shaping tools 156 are modular and are attached to the track 150. For automation flexibility, the shaping tools 156 are interchangeable so that the shaping tools 156 can be interchanged so that various cushion 122 designs are manufactured between the tracks 150, 152. Alternatively, the tracks 150, 152 may be configured to form multiple cushion 122 designs to manufacture various seat cushions 122 on one system 132.

[0051] Figure 9 illustrates that the conveyors 146, 148 are oriented parallel, spaced apart, and facing each other. Figure 10 illustrates that a third conveyor 160 may also be employed to bound a third side of the cushion 122 during the forming and cooling process. The third conveyor 160 is oriented adjacent to the conveyors 146, 148 and is perpendicular to the conveyors 146, 148. A fourth conveyor (not shown) may also be utilized and oriented spaced apart, and parallel to the third conveyor 160 to bound and form all sides of the cushion 122. Of course, any number of conveyors 146, 148, 160 may be utilized.

[0052] As illustrated in Figure 11, the mesh cushion 122 is illustrated as a final cured shape 122 with a plurality of recessed features 158 formed therein from the shaping tools 156. The recessed features 158 may create shape, contour, test markers, location markers, contact surface features, trenches or features for attachment of the cushion 122 to a seat frame, seat trim, actuators, heat transfer devices, or the like. By forming the recessed features 158 concurrently with the forming of the mesh cushion 122, secondary forming operations can be minimized or omitted. Instead of forming the cushion 122 with a rectangular cross section as depicted in Figure 7, the cushion 122 in Figure 11 is formed with a contour that requires less secondary

forming or cutting operations. The shaping tools 156 may be provided on any of the conveyors 146, 148, 160.

[0053] Figure 12 illustrates a conveyor assembly 162 according to another embodiment. The conveyor assembly 162 includes a pair of spaced apart and parallel conveyors 164, 166. Similar to the prior embodiment, the conveyor assembly 162 is oriented with the fluid chamber 142 to receive, shape, and convey the molten thermoplastic strands 128. A linear actuator 168 cooperates with the conveyors 164, 166 to vary the spacing between the conveyors 164, 166 for shaping of the mesh 122. The conveyors 164, 166 are actuated as the mesh 122 is shaped, cooled, and translated through the conveyors 164, 166.

[0054] Figure 13 illustrates a cushion 170 formed by the conveyor assembly 162 of Figure 12. The cushion 170 includes contours 172 that were formed during the shaping and conveying of the mesh 122 by the conveyor assembly 162. Referring again to Figure 12, the linear actuator 168 is in communication with a controller 174 for controlling the linear actuator 168 to actuate one or more of the conveyors 164, 166. Various mesh cushions 170 with various contours 172 are manufactured by the conveyor assembly 162 without changing tooling of the conveyor assembly 162. The various cushions 170 are manufactured by operating various programs with the controller 174.

[0055] The fluid chamber 142 in Figure 8 is utilized as a heat transfer chamber 142. The fluid chamber 142 is employed to cool the mesh 122 to solidify and bond the strands 128. The fluid chamber 142 may also be utilized to heat the mesh 122. For example, an entrance region of the fluid may be heated, while a subsequent region of the fluid may be cooled to assist in the shaping and forming of the cushion 122. For example, the fluid may be heated to 130 degrees Fahrenheit at the ingress region of the fluid chamber 142. The heating and cooling settings may be varied for various seat cushion 122 designs.

[0056] Figures 14-15 illustrate side and top views, respectively, of an actuator assembly 200 according to some embodiments. According to one non-limiting example, the actuator assembly 200 may be used with the system 132 in place of the conveyor assembly 144 in Figure 8, or in addition to conveyors that assist in moving the strands 128 through the fluid chamber 142. The actuator assembly 200 may be positioned at least partially within or submerged in the fluid

chamber 142. The actuator assembly 200 is moved and controlled to provide an outer boundary to the strands 128 to shape the strands 128 with a contour, for example, as the cushion 122, and provide a non-rectangular cross-section for the cushion 122. However, the seat cushion 122 is contoured for occupant support and comfort. The actuator assembly shapes and forms a contour into the cushion 122 by exerting a force on the strands 128 to locally displace or compress the strands and form a feature 158.

[0057] The actuator assembly 200 includes one or more actuators 202, such as electro-mechanical actuators, pneumatic actuators, hydraulic actuators, or the like. In one non-limiting example, the actuators 202 are provided as linear actuators.

[0058] A controller 204 is provided for use in controlling the positions of each of the actuators 202. The controller may be similar to that described above with respect to controller 174.

[0059] The actuators 202 may be arranged in one or more arrays 206. In the example shown, there are two arrays 206 of actuators 202, with the arrays on opposite sides of the strands 128 from one another in the assembly 200 to apply force or pressure to one or both sides of the strands 128.

[0060] In other examples, only a single array may be provided, or more than two arrays may be provided. In one example, only a single array 206 is provided on one side of the strands 128, with a non-moving backing support provided opposite to the array 206 for forming the strands 128.

[0061] In another example, there may be arrays 206 provided on all four sides of assembly 200 to shape all four sides of the strands 128 as they move through the assembly.

[0062] Each actuator array 206 may include a row 207 containing a plurality of actuators. Each array 206 may additionally include one or more layers of rows of actuators.

[0063] In the example shown, there are three layers 208 in each array 206 as can be seen in Figure 14, although arrays 206 with fewer than three layers or more than three layers are also contemplated. Figure 15 illustrates one layer 208 in each of the arrays 206, or the top layer, as it

is a top view of the assembly 200. As shown, the layers 208 of rows may be positioned to be stacked in a direction of travel for the product.

[0064] Although the arrays 206 of actuators illustrate the actuators 202 arranged in a linear row 207 within each layer, and with movement in a common direction, it is also contemplated that the actuators 202 may be arranged along a curved or otherwise shaped row or path, and may additionally or alternatively move in different directions relative to one another. For example, an actuator 202 in one array 206 may be oriented to move at an angle, such as an acute angle, relative to another actuator 202 in the same array 206, which may allow for further profiles or shapes of the strands 128 and resulting cushion 122.

[0065] The assembly 200 provides for a computer controlled forming assembly, or forming ring, for the strands 128 using the actuators 202 in the arrays 206. By providing multiple layers 208, the overall contour surface may be increased to contact and shape the strands. The actuators 202 of the assembly 200 may be at least partially submerged within the fluid chamber 142, to produce the desired forms and profiles for the cushion 122. The assembly 200 may provide for continuously forming or shaping strands 128 using the arrays 206 of actuators 202. By controlling the positions of the actuators 202 in each array 206 as the strands 128 move through the assembly 200 via the controller 204, the profile or shape of the resulting cushion 122 may be dynamically controlled.

[0066] Each of the actuators is provided with a head 210 at a distal end of the moving actuator arm or member. The head 210 may be provided in various shapes and sizes, and may have a curved, planar, or otherwise shaped surface that interacts with the stranded members 128. In one example, the head 210 is coated or formed from a rubber material such as a natural or synthetic rubber, e.g. to provide added compression to the stranded material 128.

[0067] In one example, the heads 210 of the actuators 202 directly contact and interface with the strands 128 within the assembly 200. In another example, one or more flexible and/or elastic layers 212 may be provided between the heads 210 of the actuators and the strands 128 within the assembly, such that the heads 210 of the actuators 202 contact the layer 212, which in turn, contacts the strands 128.

[0068] The controller 204 may control the actuators 202 independently or individually, and may further actuate one or more actuators 202 (e.g. as a group) to provide various contours, shapes, and profiles for the cushion 122 by shaping the outer surface of the bundle of strands 128 within the assembly 200. In one example, opposing actuators 202 are actuated to compress the stranded material 128. The various heads 210 of the actuators 202 cooperate to compress the outer perimeter surface of the stranded material 128 to create an integrated contour shape. For example, the controller 204 may control the actuators 202 based on the desired cushion 122 shape, and the actuator 202 control may be based on the cushion 122 being segmented or sliced to correspond to the layers 208 in the arrays 206.

[0069] The controller 204 may further control the actuation distance of each of the actuators 202, or the stroke, to control the resulting profile and shape of the cushion 122. Furthermore, the controller 204 may control the actuation time, or time that the actuator 202 is at a deployed position or in contact with the stranded material 128 to control the resulting profile and shape of the cushion 122. In one example, the stroke may be controlled by controlling the air pressure to that actuator.

[0070] The controller may receive a signal indicative of the speed of the strands 128 through the assembly 200, or the feed rate of the strands, in order to control the actuators 202 to provide the desired profile and shape of the cushion. The controller 204 may further provide a signal to the extruder 134 to control the flow rate, or run rate, of the strands 128 therefrom.

[0071] After the strands 128 exit the assembly, e.g. through the bottom of the assembly 200 as shown in Figure 14, the strands 128 may be cut in order to form an individual cushion 122.

[0072] The actuators 202 are employed to form shapes or features on the mesh cushion 122 by pressing a shape into the mesh cushion 122 within the fluid chamber 142 before the mesh cushion 122 has cured and set into its final shape.

[0073] The actuators 202 may be controlled and selectively actuated to form a mesh cushion 122 with contours, recesses, or features 158 as described above, or other shapes. By forming the contours and recessed features 158 concurrently with the forming of the mesh cushion 122, secondary forming operations can be minimized or omitted. Instead of forming the cushion 122

with a rectangular cross section as depicted in Figure 7, the cushion 122 in Figure 11 is formed with a contour that requires fewer secondary forming or cutting operations.

[0074] Figure 16 is a schematic view illustrating a system 250 for use in shaping a product 253, for example, a product formed from a plurality of strands of thermoplastic resin, e.g. as a consolidated filament structure. A dispenser 252 is provided to dispense a plurality of strands of molten thermoplastic resin. The dispenser 252 may be provided with an extruder and a die as described above according to one example. The strands or product may be shaped by an assembly 254. The assembly 254 may be provided with one or more sub-assemblies. In one example, the assembly 254 is provided with a single sub-assembly as described above. In another example, the assembly 254 is provided with two, three, four, or more sub-assemblies as described above, and in any combination of sub-assemblies. Each sub-assembly may be provided as: (i) a first sub-assembly 256 with a conveyor to convey a product, and a plurality of shaping tools attached to the conveyor to shape the product as the product is conveyed along the conveyor, (ii) a second sub-assembly 258 with a pair of spaced apart conveyors to convey the product therebetween, and an actuator in cooperation with the pair of conveyors to vary the spacing between the pair of conveyors to shape the product as the product conveyed, (iii) a third sub-assembly 260 with an actuator array comprising one or more actuators, each actuator deployable to contact the product, and a controller configured to control a position of each actuator to contact and shape the product as the product is moved past the actuator array, or (iv) a fourth sub-assembly 262 comprising one or more nozzles positioned to direct fluid towards the product to shape the product as the product is moved past the one or more nozzles. The sub-assemblies may be arranged in sequential order in relation to the product, and/or may be positioned to simultaneously act on the product. Figure 16 illustrates a representative and non-limiting schematic arrangement of sub-assemblies 256, 258, 260, 262, and other arrangements of sub-assemblies are also contemplated as described herein. As shown, and according to one non-limiting example, one or more of the sub-assemblies may be at least partially submerged in a fluid bath 264 to act on and shape the product. Other elements, such as a funnel, and additional rollers or tractor conveyors may be further provided for use with the system 250, similar to that described above, and are not shown in the schematic view of Figure 16 for simplicity.

[0075] Figure 17 illustrates a method 300 for forming a product, such as a contoured consolidated filament structure. In various examples, various steps in the method 300 may be omitted, added, rearranged into another order, or performed sequentially or simultaneously. At step 302, a plurality of strands of a molten polymeric material are dispensed, e.g. from a die. At step 304, a force is applied onto the plurality of strands via one or more shaping assemblies thereby shaping the plurality of strands as a contoured consolidated filament structure. The shaping assemblies may be provided by one or more nozzles, one or more shaping conveyors, and/or one or more actuator assemblies. The shaping assemblies 304 are shown as having a first shaping assembly 304a first shaping the product, followed by two shaping assemblies 304b, 304c simultaneously acting on and shaping the product. In other examples, the shaping assemblies 304 may be arranged to act on and shape the product in other orders, including sequentially, in parallel, or in any combination thereof. The shaping assembl(ies) 304 shape the product by directing one or more fluid jets from the one or more nozzles thereby applying the force on the plurality of strands, conveying the plurality of strands along the one or more shaping conveyors thereby applying the force on the plurality of strands, or actuating one or more actuators to contact the plurality of strands thereby applying the force on the plurality of strands. The product is cooled within a fluid bath at step 306. Note that steps 304 and 306 may occur simultaneously as shown such that the product is shaped within the fluid bath while it is being cooled, with the assembl(ies) 304 at least partially submerged within the fluid bath. Or the cooling at step 306 may occur simultaneously with only some of the shaping steps 304, or subsequent thereto. At step 308, the contoured filament structure is cut to form a member. The member may then be subsequently used, for example, as a cushion, and installed onto a seat assembly frame.

[0076] Seat assemblies, seats, or chairs may be used herein to refer generally to an assembly which incorporates the teachings of one or more embodiments disclosed herein, which may include any combination of embodiments, or features of embodiments disclosed herein. Similarly, the terms: seat assembly, seat, or chair may refer to the same or similar assemblies. Seat bottoms, backs, bases, head restraints, headrests, or bolsters may be used herein to refer generally to any component, region or portion of a vehicle interior component, a seat assembly, vehicle seat, or chair. Filaments or strands may be used herein to refer to the generally linear

polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure) after being dispensed through one or more orifices of the die plate or extrusion die, which are likewise used to refer to equivalent components. Similarly, the terms: product, a contoured unitary mesh product, consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion may refer to the same or similar components. The term funnel and funnel plate may be used to refer to the same or similar components as well. In yet another example, tank, water tank, fluid bath, and fluid chamber may refer to the same or similar components. In a further example, the term tractor conveyor and conveyor assembly may refer to the same or similar components. The use of different terms to refer to the same or similar components may be used to avoid confusion when describing different preferred embodiments. The terms may be interchangeable as various components of features from various embodiments may be combined in manners not expressly described herein. This does not detract from the fact that certain terms may provide inherent detail not included by other interchangeable term(s) unless expressly stated otherwise (e.g., water tank and fluid chamber refer to similar interchangeable components although in at least one preferred embodiment, the tank is filled with water or arranged to be filled with water as opposed to any liquid when water tank is used).

[0077] A method 1800 is described and illustrated with respect to Figure 18. Method 1800 includes dispensing 1802 a plurality of strands (e.g. 24, 52, 128, and/or 253) of a molten polymeric material (e.g., linear low-density polyethylene (LLDPE)). In some embodiments, filaments or strands may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure).

[0078] Method 1800 includes applying 1804 a force on the plurality of strands (e.g. 24, 52, 128, and/or 253) via one or more shaping assemblies (e.g. 254, 256, 258, 260, 262) to shape the product (e.g. 32, 59, 94, 98, and/or 253) as the product is conveyed. The one or more shaping assemblies may be provided, e.g., by nozzles (e.g. 68 and/or 70), a pair of spaced apart conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166), and/or an actuator (e.g. 200, 202). In some embodiments, the nozzles (e.g. 68 and/or 70) may be nozzles with fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; the nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent

with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid and/or gas. In some embodiments, the conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may be provided with an actuator (e.g. 168 to vary the spacing between the conveyors; the conveyors may be parallel; one or more conveyors may be provided with a track (e.g. 150, 152) on the conveyor, and the tracks may be links or a belt; shaping tools (e.g. 156) may be connected to the tracks and may be interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; and/or there may be four conveyors to surround product. In some embodiments, the actuator (e.g. 202) may be a linear actuator, electro-mechanical actuator, pneumatic actuator, and/or hydraulic actuators, and further may include an array (e.g. 206) of actuators, e.g. a first, second, third, and fourth array to surround the product, with each array at least partially submerged within the fluid bath; an optional elastic layer (e.g. 212) may be positioned between the actuator heads (e.g. 210) and the product; a controller (e.g. 204) may be provided to control the distance that actuator extends to shape the product, the time that the actuator is deployed to contact product, and/or control the actuator based on a feed rate of the product; each actuator (e.g. 202) may be provided with a head (e.g. 210) at a distal end to shape the product; the head may be coated or formed from a rubber material; the head (e.g. 210) may have different shapes including curved or planar; and/or the actuator array (e.g. 206) may have a row (e.g. 207) of actuators that is straight or curved or angled, and contain any number of actuators; and each array may also have multiple layers (e.g. 208) of rows, e.g. rows stacked on one another in the direction of travel such that the product passes multiple layers of actuators. In some embodiments, the one or more shaping assemblies thereby shape the plurality of strands as a contoured consolidated filament structure (e.g., 80, 94, 98, 122, 124, and/or 170; consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, and/or cushion). In some embodiments, a cooling chamber, fluid bath, fluid chamber, and/or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may be provided; with fluid in fluid bath resisting the flow, and/or forming the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion. In some embodiments, the consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253) may be shaped while the fluid in fluid bath resists the

flow, with cooling by the fluid in the fluid bath, and/or while applying the force while the strands are in the fluid bath.

[0079] In some embodiments, and for method 1800, the shaping assembly (e.g. 254, 304) includes at least one of: one or more nozzles (e.g. 68 and/or 70), one or more shaping conveyors (e.g., (e.g., 144, 146, 148, 160, 162, 164, and/or 166), and/or one or more actuator assemblies (e.g. 200). In some embodiments, the nozzles (e.g. 68 and/or 70) may provide fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; the nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas). In some embodiments, the one or more shaping conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may be provided by a pair of spaced apart conveyors; an actuator (e.g. 168) may be provided to vary the spacing between the pair of conveyors to shape the product as the product conveyed; the conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may be parallel, and the actuator (e.g. 168) may be a linear actuator; the one or more conveyors may be provided with a track on the conveyor; the tracks may be links or a belt; the shaping tools (e.g. 156) are connected to the tracks and are interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may be parallel; there may be four conveyors to surround product; and/or there may be a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264), wherein the fluid in fluid bath resists the flow, forms the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, and/or cushion. In some embodiments, the one or more actuators (e.g. 202) may include an array (e.g. 206) of actuators; may include up to a first, second, third, and fourth array to surround the product; each array may be at least partially submerged within the fluid bath (e.g. 34, 56, 142, and/or 264); optional elastic layer (e.g. 212) positioned between the actuator heads (e.g. 210) and the product; the actuators (e.g. 202) may be linear actuators, electro-mechanical actuators, pneumatic actuators, hydraulic actuators; a controller (e.g. 204) may be provided to control a distance that actuator extends to shape the product, a time that the actuator is deployed to contact product, and/or control an actuator based on a feed rate of the

product; each actuator (e.g. 202) may have a head (e.g. 210) at a distal end to shape the product; the head may be coated or formed from a rubber material; the head may have different shapes including curved or planar; the actuator array (e.g. 206) may have a row (e.g. 207) of actuators that is straight or curved or angled, and contain any number of actuators; and/or each array may also have multiple layers (e.g. 208) of rows, e.g. rows stacked on one another in the direction of travel such that the product passes multiple layers of actuators).

[0080] In some embodiments, method 1800 further comprises at least one of: directing one or more fluid jets from the one or more nozzles (e.g. 68 and/or 70) thereby applying the force on the plurality of strands (e.g. 24, 52, 128, and/or 253), conveying the plurality of strands (e.g. 24, 52, 128, and/or 253) along the one or more shaping conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) thereby applying the force on the plurality of strands (e.g. 24, 52, 128, and/or 253), and/or actuating one or more actuators (202) to contact the plurality of strands thereby applying the force on the plurality of strands (e.g. 24, 52, 128, and/or 253). In some embodiments, the nozzles (e.g. 68 and/or 70) may provide fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; the nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas. In some embodiments, the conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may be provided by a pair of spaced apart conveyors and an actuator (e.g. 168) may be provided to vary the spacing between the pair of conveyors to shape the product as the product conveyed; the conveyors may be parallel; the actuator (e.g. 168) may be a linear actuator; one or more conveyors may be provided with a track (e.g. 150 and/or 152) on the conveyor; the tracks may be links or a belt; shaping tools (e.g. 156) may be connected to the tracks and may be interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; and/or it may include a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) where the fluid in fluid bath may resist the flow, and/or form the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, and/or cushion. In some embodiments, the actuators (e.g. 202) may include an array (e.g. 206) of

actuators, with up to a first, second, third, and fourth array to surround product,; each array may be at least partially submerged within the fluid bath (e.g. 34, 56, 142, and/or 264); an optional elastic layer (e.g. 212) may be positioned between the actuator heads (e.g. 210) and the product; the actuators may be linear actuators, electro-mechanical actuators, pneumatic actuators, hydraulic actuators; a controller (e.g. 204) may be provided to control a distance that actuator extends to shape the product, a time that the actuator is deployed to contact product, and/or control an actuator based on a feed rate of the product; each actuator (e.g. 202) may have a head (e.g. 210) at a distal end to shape the product; the head may be coated or formed from a rubber material; the head may have different shapes including curved or planar; the actuator array (e.g. 206) may have a row (e.g. 207) of actuators that is straight or curved or angled, and contain any number of actuators; and/or each array may also have multiple layers (e.g. 208) of rows, e.g. rows stacked on one another in the direction of travel such that the product passes multiple layers of actuators).

[0081] In some embodiments, method 1800 includes moving the plurality of strands (e.g. 24, 52, 128, and/or 253) through a fluid bath (e.g. 34, 56, 142, and/or 264) (e.g., via tractor conveyors and/or rollers, e.g. 38 and/or 40), applying the force on the plurality of strands via the one or more shaping assemblies (e.g. 254, 304) while the plurality of strands is at least partially submerged the fluid bath (e.g., such that shaping occurs within fluid bath).

[0082] In some embodiments, method 1800 includes cooling the plurality of strands (52 and/or 59) within the fluid bath (e.g., 34, 56, 142, and/or 264; a cooling chamber, fluid chamber, and/or heat transfer chamber).

[0083] In some embodiments, method 1800 includes cutting the contoured consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure); and/or the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion may form at least one of a vehicle interior component (e.g., a seat assembly, seat, or chair may refer to the same or similar assemblies; seat bottoms, backs, bases, head restraints, headrests, or bolsters may be used herein

to refer generally to any component, region or portion of a vehicle interior component, a seat assembly, vehicle seat, or chair; and/or a unitary non-woven cushion (e.g., 80, 94, 98, 122, 124, and/or 170) (e.g., a cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion).

[0084] In some embodiments, method 1800 includes heating (e.g., heating in an extruder (e.g. 16, and/or134), rotating screw extruder, and/or optional heating elements) a polymeric material (e.g., linear low-density polyethylene (LLDPE)) to a molten state, such that it becomes the molten polymer. In some embodiments, method 1800 may include introducing the molten polymer into a die plate (e.g., 18, 20, and/or 136) having a plurality of holes disposed therethrough such that the molten polymer moves through the holes and forms the plurality of strands (e.g. 24, 52, 128, and/or 253) as molten polymeric filaments (e.g., from the extruder to the die or die plate). In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure) after being dispensed through one or more orifices of the die plate or extrusion die. In some embodiments, method 1800 includes introducing the molten polymeric filaments into a bath (e.g. 34, 56, 142, and/or 264) (e.g., fluid chamber, cooling chamber, and/or heat transfer chamber) to cool the molten polymeric filaments. In some embodiments, method 1800 includes applying a fluid stream (e.g., via nozzles 68 and/or 70) to the molten polymeric filaments via the one or more shaping assemblies (e.g., 254, 304) to apply the force after the molten polymeric filaments are introduced into the bath such that the molten polymeric filaments are imparted with a desired shape and the consolidated filament structure having the desired shape is formed (e.g., using nozzles (e.g. 68 and/or 70) with fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath or as another fluid / gas).

[0085] In some embodiments, the method 1800 includes a bath (e.g. 34, 56, 142, and/or 264) contains a liquid, and the fluid stream (e.g., via nozzles 68 and/or 70) comprises the liquid. In some embodiments, the nozzles use fluid within the fluid bath.

[0086] In some embodiments, applying the fluid stream to the molten polymeric filaments comprises moving the fluid stream through a nozzle (e.g., 68 and/or 70) before it contacts the molten polymeric filaments (e.g., a pump is used to pump fluid from the bath or another liquid / gas, including air).

[0087] In some embodiments, and for use with the method 1800, the nozzle (e.g., 68 and/or 70) is positioned 10–15 mm from a surface of the molten polymeric filaments.

[0088] In some embodiments, method 1800 includes applying a plurality of the fluid streams (e.g., via nozzles 66 and/or 70) to the molten polymeric filaments after the molten polymeric filaments are introduced into the bath (e.g. 34, 56, 142, and/or 264). In some embodiments, nozzles 66 and/or 70 may provide with fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas.

[0089] In some embodiments, and with the method 1800, the fluid streams (e.g., via nozzles 66 and/or 70) are applied to the molten polymeric filaments (e.g. 24, 52, 128, and/or 253) in a single direction.

[0090] In some embodiments, and with the method 1800, the fluid streams (e.g., 66 and/or 70) are applied to the molten polymeric filaments (e.g. 24, 52, 128, and/or 253) in at least two different directions (e.g., directions that are opposite or not opposite to one another).

[0091] In some embodiments, method 1800 includes heating a polymeric material (e.g., a linear low-density polyethylene (LLDPE)) to a molten state to create the molten polymeric material (e.g., heating in an extruder 16 and/or 134, rotating screw extruder, and/or using optional heating elements). In some embodiments, method 1800 includes extruding the molten polymeric material to form a plurality of molten polymeric filaments as the plurality of strands (e.g. 24, 52, 128, and/or 253). In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure) after being dispensed through one or

more orifices of the die plate or extrusion die, e.g. 18, 20, 50, and/or 136. In some embodiments, method 1800 includes cooling the molten polymeric material in a fluid bath (e.g., 34, 56, 142, and/or 264; a fluid chamber, cooling chamber, and/or heat transfer chamber) to create a consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, method 1800 includes applying a fluid stream (e.g., via nozzles 68 and/or 70) to apply the force to the molten polymeric filaments in the fluid bath via the one or more shaping assemblies such that the consolidated filament structure has a desired shape as the contoured consolidated filament structure (e.g., using nozzles with fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas).

[0092] In some embodiments, the consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253) is a cushion blank (e.g., 80, 94, 98, 122, 124, and/or 170) for a vehicle seat, and the desired shape includes two bolsters (e.g., 86 and/or 88) positioned on opposite sides of the cushion blank.

[0093] In some embodiments, method 1800 includes applying a plurality of the fluid streams (e.g., via nozzles 68 and/or 70) to the molten polymeric filaments (e.g. 24, 52, 128, and/or 253) in the fluid bath (e.g. 34, 56, 142, and/or 264) in at least one direction (e.g., at least two different directions that are opposite or not opposite to one another).

[0094] In some embodiments, at least one of the fluid streams is applied through a nozzle (e.g., 68 and/or 70) (e.g., a convergent or divergent nozzle).

[0095] In some embodiments, the nozzle (e.g., 68 and/or 70) is a divergent nozzle (e.g., where divergent is an exit opening that is larger than the inlet).

[0096] In some embodiments, and for method 1800, each of the fluid streams is applied to the molten polymeric filaments (e.g. 24, 52, 128, and/or 253) through a respective nozzle (e.g., 68 and/or 70) (e.g., a convergent or divergent nozzle).

[0097] In some embodiments, at least one of the nozzles (e.g. 68 and/or 70) is a convergent nozzle (e.g., where convergent is an exit opening that is smaller than the inlet).

[0098] In some embodiments, the fluid bath (e.g. 34, 56, 142, and/or 264) contains a liquid, and the fluid stream comprises the liquid. In some embodiments, the nozzles use fluid within the fluid bath (e.g. 34, 56, 142, and/or 264).

[0099] In some embodiments, method 1800 includes heating a polymeric material (e.g., a linear low-density polyethylene (LLDPE)) to create a molten polymeric material (e.g., by heating in an extruder 16 and/or 134, rotating screw extruder, and/or using optional heating elements). In some embodiments, method 1800 includes forming a plurality of molten polymeric filaments as the plurality of strands (e.g. 24, 52, 128, and/or 253) from the molten polymeric material. In some embodiments, filaments or strands may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure) after being dispensed through one or more orifices of the die plate or extrusion die. In some embodiments, method 1800 includes cooling the molten polymeric material in a fluid bath (e.g., 34, 56, 142, and/or 264; a fluid chamber, and/or heat transfer chamber). In some embodiments, method 1800 includes directing a fluid stream (e.g., via nozzles 68 and/or 70) at the molten polymeric material in the fluid bath to apply the force via the one or more shaping assemblies such that the molten polymer obtains a desired shape (e.g., using nozzles 68 and/or 70 with fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath or as another fluid / gas).

[0100] In some embodiments, method 1800 includes cooling the molten polymer in the fluid bath (e.g., 34, 56, 142, and/or 264) to form a consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253), and directing the fluid stream (e.g., via nozzles 68 and/or 70) at the molten polymer in the fluid bath imparts the desired shape to the consolidated filament structure as the contoured consolidated filament structure. In some embodiments, the technique shapes with fluid streams from nozzles while in the fluid bath.

[0101] In some embodiments, method 1800 includes directing a plurality of the fluid streams (e.g., from nozzles 68 and/or 70 with fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another) at the molten polymeric material in the fluid bath (e.g., 34, 56, 142, and/or 264) in at least one direction.

[0102] In some embodiments, the consolidated filament structure is a cushion blank (e.g., 80, 94, 98, 122, 124, and/or 170) for a vehicle seat, and the desired shape includes two bolsters (e.g., 86 and/or 88) positioned on opposite sides of the cushion blank. In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure); consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253), filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion.

[0103] In some embodiments, the molten polymeric material is a molten thermoplastic resin (e.g., linear low-density polyethylene (LLDPE)), and the contoured consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253) is a contoured unitary mesh product. In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure); consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253), filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion. In some embodiments, method 1800 includes conveying the plurality of strands (e.g. 24, 52, 128, and/or 253) along at least one shaping conveyor (e.g., 144, 146, 148, 160, 162, 164, and/or 166) of the one or more shaping assemblies while applying the force and shaping the plurality of strands as the contoured unitary mesh product. In some embodiments, the method 1800 includes a pair of spaced apart conveyors and an actuator (e.g. 168) to vary the spacing between the pair of conveyors to shape the product as the product conveyed; the conveyors may be parallel, the actuator may be a linear actuator; one or more conveyors may have a track (e.g. 150, 152) on the conveyor; the tracks may be links or a belt; shaping tools (e.g. 156) may be connected to the tracks and are interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; and/or a cooling chamber, fluid bath, fluid chamber, or heat

transfer chamber (e.g. 34, 56, 142, and/or 264) may be provided where fluid in fluid bath may resist the flow, form the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, and/or cushion).

[0104] In some embodiments, method 1800 includes conveying the plurality of strands (e.g. 24, 52, 128, and/or 253) within a plurality of shaping conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) as the contoured unitary mesh product.

[0105] In some embodiments, method 1800 includes translating at least one of the plurality of shaping conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) to vary a spacing between the plurality of shaping conveyors while conveying and shaping the plurality of strands (e.g. 24, 52, 128, and/or 253) (e.g., a pair of spaced apart conveyors and an actuator (e.g. 168) may be used to vary the spacing between the pair of conveyors to shape the product as the product conveyed; the conveyors may be parallel, the actuator may be a linear actuator, and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may be provided).

[0106] In some embodiments, method 1800 includes shaping the plurality of strands (e.g. 24, 52, 128, and/or 253) with at least one shaping tool (e.g., 156) attached to the at least one shaping conveyor (e.g., 144, 146, 148, 160, 162, 164, and/or 166) (e.g., one or more conveyors may be provided with a track (e.g. 150 and/or 152 on the conveyor; the tracks may be links or a belt; the shaping tools may be connected to the tracks and interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may be provided).

[0107] In some embodiments, method 1800 includes resisting a flow of the plurality of strands (e.g. 24, 52, 128, and/or 253), thereby buckling the plurality of strands, the buckled strands intersecting as a unitary non-woven body (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, fluid in fluid bath (e.g. 34, 56, 142, and/or 264) resists the flow and forms the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion.

[0108] In some embodiments, method 1800 includes cooling the plurality of strands (e.g. 24, 52, 128, and/or 253) to bond as the contoured unitary mesh product (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, the cooling may be in a fluid bath, fluid chamber, and/or heat transfer chamber (e.g. 34, 56, 142, and/or 264).

[0109] In some embodiments, method 1800 includes cooling the plurality of strands (e.g. 24, 52, 128, and/or 253) while shaping the plurality of strands (e.g., in a fluid bath, fluid chamber, and/or heat transfer chamber, (e.g. 34, 56, 142, and/or 264)).

[0110] In some embodiments, method 1800 includes cooling the plurality of strands (e.g. 24, 52, 128, and/or 253) in a cooling chamber (e.g., a fluid bath, fluid chamber, and/or heat transfer chamber, (e.g. 34, 56, 142, and/or 264)).

[0111] In some embodiments, the molten polymeric material is a molten thermoplastic resin (e.g., linear low-density polyethylene (LLDPE)), and the contoured consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253) is a contoured unitary mesh product. In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure); consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion). In some embodiments, method 1800 includes actuating one or more actuators (e.g., 202) of the one or more shaping assemblies to contact the plurality of strands thereby applying the force and shaping the plurality of strands as the contoured unitary mesh product. In some embodiments, the array (e.g. 206) of actuators optionally includes up to a first, second, third, and fourth array to surround product, with each array at least partially submerged within the fluid bath (e.g. 34, 56, 142, and/or 264); an optional elastic layer (e.g. 212) may positioned between the actuator heads (e.g. 210) and the product; the actuators may be linear actuators, electro-mechanical actuators, pneumatic actuators, hydraulic actuators; a controller may be provided to control a distance that the actuator extends to shape the product, a time that the actuator is deployed to contact product, and/or control an actuator based on a feed rate of the product; each actuator may have a head (e.g. 210) at a distal end to shape the product; the head may be coated or formed from a rubber material; the head may have different shapes including curved or planar; the actuator array (e.g.

206) may have a row (e.g. 207) of actuators that is straight or curved or angled, and contain any number of actuators; and/or each array may also have multiple layers (e.g. 208) of rows, e.g. rows stacked on one another in the direction of travel such that the product passes multiple layers of actuators.

[0112] In some embodiments, method 1800 includes conveying the plurality of strands (e.g. 24, 52, 128, and/or 253) past the one or more actuators (e.g., 202) as the contoured unitary mesh product (e.g. 32, 59, 94, 98, and/or 253) (e.g. via tractor conveyors 38 and/or 60, and/or rollers 40).

[0113] In some embodiments, method 1800 includes actuating a first actuator of the one or more actuators (e.g., 202) and a second actuator of the one or more actuators (e.g., 202) opposite to the first actuator to vary a spacing therebetween while shaping the plurality of strands (e.g. 24, 52, 128, and/or 253).

[0114] In some embodiments, method 1800 includes resisting a flow of the plurality of strands, (e.g. 24, 52, 128, and/or 253) thereby buckling the plurality of strands, the buckled strands intersecting as a unitary non-woven body (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, fluid in the fluid bath (e.g. 34, 56, 142, and/or 264) may resist the flow, and/or form the consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion.

[0115] In some embodiments, method 1800 includes cooling the plurality of strands (e.g. 24, 52, 128, and/or 253) to bond as the contoured unitary mesh product (e.g. 32, 59, 94, 98, and/or 253) (e.g., cooling in fluid in fluid bath (e.g. 34, 56, 142, and/or 264)).

[0116] In some embodiments, method 1800 includes cooling the plurality of strands (e.g. 24, 52, 128, and/or 253) while shaping the plurality of strands (e.g., by applying the force while the strands are in the fluid bath (e.g. 34, 56, 142, and/or 264)).

[0117] In some embodiments, method 1800 includes cooling the plurality of strands (e.g. 24, 52, 128, and/or 253) in a fluid chamber (e.g., a fluid bath, cooling chamber, and/or a heat transfer chamber; 34, 56, 142, and/or 264).

[0118] In some embodiments, a vehicle interior component (e.g., a seat assembly, seat, or chair may refer to the same or similar assemblies. Seat bottoms, backs, bases, head restraints, headrests, and/or bolsters may be used herein to refer generally to any component, region or portion of a vehicle interior component, a seat assembly, vehicle seat, and/or chair) is formed by any one of the above techniques, including via method 1800.

[0119] In some embodiments, the vehicle interior component is a cushion (e.g., 80, 94, 98, 22, 124, and/or 170) for a vehicle seat and comprises two bolsters positioned on opposite sides of the cushion.

[0120] In some embodiments, a product is manufactured according to the above techniques, e.g. via method 1800.

[0121] In some embodiments, the contoured consolidated filament structure (e.g. 32, 59, 94, 98, and/or 253) forms a product. The method 1800 includes installing the product on a seat frame as a seat cushion.

[0122] In some embodiments, a seat assembly (e.g., seat assembly, seat, and/ or chair) is manufactured according to the techniques described above, including via method 1800.

[0123] A product manufactured according to a method is described. The method includes dispensing a plurality of strands (e.g. 24, 52, 128, and/or 253) of a molten thermoplastic resin. In some embodiments, filaments or strands may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure) after being dispensed through one or more orifices of the die plate or extrusion die (e.g., 18, 20, and/or 136).

[0124] The method includes shaping the plurality of strands as a contoured unitary mesh product (e.g., a consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, and/or cushion) by applying a force onto the plurality of strands via one or more shaping assemblies (e.g. 254, 304), wherein the shaping assembly includes at least one of: one or more nozzles (e.g. 68 and/or 70), one or more shaping conveyors (e.g., 144, 146, and/or 148), and/or one or more actuator assemblies

(e.g. 200, 202). In some embodiments, the nozzles (e.g. 68 and/or 70) may include fluid jets from nozzles in a single direction, or in at least two different directions that are opposite or not opposite to one another; nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas. In some embodiments, the shaping conveyors (e.g., 144, 146, and/or 148) may include one or more conveyors with a track (e.g. 150 and/or 152) on the conveyor; the tracks may be links or a belt; the shaping tools (e.g. 156) may be connected to the tracks and are interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may be provided or a pair of spaced apart conveyors and an actuator (e.g. 168) to vary the spacing between the pair of conveyors to shape the product as the product conveyed, the conveyors may be parallel, the actuator (e.g. 168) may be a linear actuator, and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may be provided.

[0125] In some embodiments, the method includes shaping the plurality of strands by actuating the one or more actuators (e.g., 202) of the one or more shaping assemblies to contact the plurality of strands (e.g. 24, 52, 128, and/or 253) thereby shaping the plurality of strands as a contoured unitary mesh product (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, the actuators (e.g. 202) may include an array (e.g. 206) of actuators, and may include up to a first, second, third, and fourth array to surround the product, with each array at least partially submerged within the fluid bath; an optional elastic layer (e.g. 212) may be positioned between the actuator heads (e.g. 210) and the product; the actuators may be linear actuators, electro-mechanical actuators, pneumatic actuators, hydraulic actuators; a controller (e.g. 204) may be provided to control a distance that the actuator extends to shape the product, a time that the actuator is deployed to contact product, and/or control an actuator based on a feed rate of the product; each actuator may have a head (e.g. 210) at a distal end to shape the product; the head may be coated or formed from a rubber material; the head may have different shapes including curved or planar; the actuator array (e.g. 206) may have a row (e.g. 207) of actuators that is

straight or curved or angled, and may contain any number of actuators; and/or each array may also have multiple layers (e.g. 208) of rows, e.g. rows stacked on one another in the direction of travel such that the product passes multiple layers of actuators.

[0126] In some embodiments, the method includes shaping the plurality of strands (e.g. 24, 52, 128, and/or 253) by conveying the plurality of strands via the one or more shaping conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, the shaping conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may include one or more conveyors with a track (e.g. 150 and/or 152) on the conveyor; the tracks may be links or a belt; the shaping tools (e.g. 156) may be connected to the tracks and interchangeable; the shaping tools form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264); a pair of spaced apart conveyors with an actuator (e.g. 168) to vary the spacing between the pair of conveyors to shape the product as the product conveyed, the conveyors may be parallel, the actuator (e.g. 168) may be a linear actuator, and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264).

[0127] In some embodiments, the method includes shaping the plurality of strands by directing one or more fluid jets towards the plurality of strands (e.g. 24, 52, 128, and/or 253) via the one or more nozzles (e.g., 68 and/or 70) of the one or more shaping assemblies to contact the plurality of strands (e.g., 52) thereby shaping the plurality of strands as a contoured unitary mesh product . In some embodiments, the fluid jets from nozzles may be provided in a single direction, or in at least two different directions that are opposite or not opposite to one another; nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas).

[0128] In some embodiments, the product (e.g. 24, 52, 128, and/or 253) includes a unitary non-woven cushion (e.g., 80, 94, 98, 122, 124, and/or 170; a consolidated filament structure, filament

structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, and/or cushion).

[0129] An assembly is described. The assembly (e.g. 254) includes at least one of: (i) a first sub-assembly (e.g. 256), a (ii) a second sub-assembly (e.g. 258), (iii) a third sub-assembly (e.g. 260), and (iv) a fourth sub-assembly (e.g. 262).

[0130] The (i) first sub-assembly (e.g. 256) comprises a conveyor (e.g., 144, 146, 148, 160, 162, 164, and/or 166) to convey a product (e.g., a consolidated filament structure, filament structure, mesh, extruded material, cushion blank, thermoplastic cushion, mesh cushion, seat cushion, or cushion), and a plurality of shaping tools (e.g., 156) attached to the conveyor (e.g., 144, 146, 148, 160, 162, 164, and/or 166) to shape the product (e.g. 32, 59, 94, 98, and/or 253) as the product is conveyed along the conveyor. In some embodiments, the conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) may be, e.g., one or more conveyors with a track on the conveyor, where the tracks may be links or a belt; the shaping tools (e.g. 156) may be connected to the tracks and are interchangeable; where the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber may be provided.

[0131] The (ii) second sub-assembly (e.g. 258) comprises a pair of spaced apart conveyors (e.g., 164 and/or 166) to convey the product (e.g. 32, 59, 94, 98, and/or 253) therebetween, and an actuator (e.g. 168) in cooperation with the pair of conveyors to vary the spacing between the pair of conveyors to shape the product as the product conveyed. In some embodiments, a pair of spaced apart conveyors and an actuator (e.g. 168) may vary the spacing between the pair of conveyors to shape the product as the product conveyed; the conveyors may be parallel, the actuator (e.g. 168) may be a linear actuator; and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may also be provided.

[0132] The (iii) third sub-assembly (e.g. 200, 260) comprises an actuator array (e.g. 206) comprising one or more actuators (e.g., 202), each actuator deployable to contact the product (e.g. 32, 59, 94, 98, and/or 253), and a controller (e.g. 204) configured to control a position of each actuator to contact and shape the product as the product is moved past the actuator array. In

some embodiments, the third sub-assembly may be an array (e.g. 206) of actuators (e.g. 202), and may include up to a first, second, third, and fourth array to surround product, with each array at least partially submerged within the fluid bath (e.g. 34, 56, 142, and/or 264); an optional elastic layer (e.g. 212) may be positioned between the actuator heads (e.g. 210) and the product; the actuators (e.g. 202) may be linear actuators, electro-mechanical actuators, pneumatic actuators, hydraulic actuators; the controller (e.g. 204) may be provided to control distance that the actuator extends to shape the product, the time that the actuator is deployed to contact product, and/or control an actuator based on a feed rate of the product; each actuator (e.g. 202) may have a head (e.g. 21) at a distal end to shape the product, and the head may be coated or formed from a rubber material; the head (e.g. 210) may have different shapes including curved or planar; the actuator array (e.g. 206) may have a row (e.g. 207) of actuators (e.g. 202) that is straight or curved or angled, and contain any number of actuators; and/or each array (e.g. 206) may also have multiple layers (e.g. 208) of rows (e.g. 207), e.g. rows stacked on one another in the direction of travel such that the product passes multiple layers of actuators.

[0133] The (iv) fourth sub-assembly (e.g. 262) comprises one or more nozzles (e.g. 68 and/or 70) positioned to direct fluid towards the product (e.g. 32, 59, 94, 98, and/or 253) to shape the product as the product is moved past the one or more nozzles. In some embodiments, the nozzles may be used to shape product (e.g. 32, 59, 94, 98, and/or 253) in the fluid bath (e.g. 34, 56, 142, and/or 264), and the nozzles may have fluid streams in a single direction, or in at least two different directions that are opposite or not opposite to one another; the nozzles may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet; and/or a pump may be used to provide fluid to the nozzles from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas.

[0134] In some embodiments, the assembly (e.g. 254) further includes the first sub-assembly (e.g., 256, one or more conveyors (e.g., 144, 146, 148, 160, 162, 164, and/or 166) with a track (e.g. 150, 152) on the conveyor, and where the tracks may be links or a belt; the shaping tools (e.g. 156) may be connected to the tracks and are interchangeable; the shaping tools may form shapes, contour, and recesses (e.g. 158) in the product; the conveyors may be parallel; there may be four conveyors to surround product; and/or a cooling chamber, fluid bath, fluid chamber, or heat transfer chamber (e.g. 34, 56, 142, and/or 264) may be also be provided).

[0135] In some embodiments, the assembly (e.g. 254) further includes a second conveyor (e.g., 144, 146, 148, 160, 162, 164, and/or 166) to convey the product (e.g. 32, 59, 94, 98, and/or 253), the second conveyor spaced apart from the first conveyor to convey the product between the first conveyor and the second conveyor (e.g., two conveyors, each may have shaping tools 156 on tracks 152).

[0136] In some embodiments, the assembly (e.g. 254) further includes a second plurality of shaping tools (e.g., 156) attached to the second conveyor (e.g., 144, 146, 148, 160, 162, 164, and/or 166) to shape the product (e.g. 32, 59, 94, 98, and/or 253) as the product is conveyed along the first conveyor and the second conveyor.

[0137] In some embodiments, the assembly (e.g. 254) further includes a cooling chamber (e.g. 34, 56, 142, and/or 264) to cool the product (e.g. 24, 52, 128, and/or 253) while the product is conveyed and shaped (e.g., a fluid bath, fluid chamber, heat transfer chamber).

[0138] A system is described. The system (e.g. 250) comprises a dispenser (e.g. 252) of a plurality of strands (e.g. 24, 52, 128, and/or 253) of molten thermoplastic resin and the assembly 254 as described above, oriented relative to the dispenser 252 to receive, convey, and shape the plurality of strands.

[0139] In some embodiments, the assembly (e.g. 254) further includes the second sub-assembly (e.g., 258, 164 and/or 166) (e.g., a pair of spaced apart conveyors and an actuator (e.g. 168) to vary the spacing between the pair of conveyors to shape the product (e.g. 24, 52, 128, and/or 253) as the product conveyed, the conveyors may be parallel, and/or the actuator may be a linear actuator).

[0140] In some embodiments, the assembly (e.g. 250) further includes a cooling chamber (e.g. 34, 56, 142, and/or 264) to cool the product (e.g. 32, 59, 94, 98, and/or 253) while the product is conveyed and shaped (e.g., a fluid bath, fluid chamber, and/or heat transfer chamber).

[0141] A system is described. The system (e.g. 250) includes a dispenser (e.g. 252) of a plurality of strands (e.g. 24, 52, 128, and/or 253) of molten thermoplastic resin and an assembly

(e.g. 254), oriented relative to the dispenser (e.g. 252) to receive, convey, and shape the plurality of strands.

[0142] In some embodiments, the assembly (e.g. 250) further includes the third sub-assembly (e.g., 200, 260, and/or an array 206 of actuators 202, which may include up to a first, second, third, and fourth array to surround product (e.g. 32, 59, 94, 98, and/or 253), with each array 106 at least partially submerged within the fluid bath (e.g. 34, 56, 142, and/or 264); and an optional elastic layer 212 may positioned between the actuator heads 210 and the product). In some embodiments, the actuators 202 may be linear actuators, electro-mechanical actuators, pneumatic actuators, hydraulic actuators. In some embodiments, a controller 204 may be provided to control a distance that an actuator 202 extends to shape the product (e.g. 32, 59, 94, 98, and/or 253), the time that the actuator 202 is deployed to contact product (e.g. 32, 59, 94, 98, and/or 253), and/or control an actuator 202 based on a feed rate of the product (e.g. 32, 59, 94, 98, and/or 253). In some embodiments, each actuator 202 may be provided with a head (e.g. 210) at a distal end to shape the product (e.g. 32, 59, 94, 98, and/or 253), where the head 210 may be coated or formed from a rubber material; the head (e.g. 210) may have different shapes including curved or planar. In some embodiments, the actuator array (e.g. 206) may have a row (e.g. 207) of actuators that is straight or curved or angled, and may contain any number of actuators; and/or each array (e.g. 206) may also have multiple layers (e.g. 208) of rows (e.g. 207), e.g. rows stacked on one another in the direction of travel such that the product (e.g. 32, 59, 94, 98, and/or 253) passes multiple layers of actuators (e.g. 202).

[0143] In some embodiments, the assembly (e.g. 250) further includes a second actuator array (e.g., 206) comprising one or more second actuators (e.g. 202), each second actuator deployable to contact the product (e.g. 32, 59, 94, 98, and/or 253), the second actuator array (e.g. 206) spaced apart from the first actuator array (e.g. 206) such that the product is conveyed therebetween. In some embodiments, the controller (e.g. 204) may be further configured to control a position of each second actuator (e.g. 202) to contact and shape the product (e.g. 32, 59, 94, 98, and/or 253) as the product is moved past the second actuator array (e.g., array on second side, may be opposite to the first array).

[0144] In some embodiments, the assembly (e.g. 250) further includes a third actuator array (e.g. 206) comprising one or more third actuators (e.g. 202), each third actuator deployable to contact the product (e.g. 32, 59, 94, 98, and/or 253), the third actuator array spaced apart from the first and second actuator arrays (e.g. 206) such that the product is conveyed therebetween. In some embodiments, the controller 204 may be further configured to control a position of each third actuator 202 to contact and shape the product (e.g. 32, 59, 94, 98, and/or 253) as the product is moved past the third actuator array (e.g., array on third side).

[0145] In some embodiments, the assembly (e.g. 250) further includes a fourth actuator array (e.g. 206) comprising one or more fourth actuators (e.g. 202), each fourth actuator deployable to contact the product (e.g. 32, 59, 94, 98, and/or 253), the fourth actuator array spaced apart from the first, second, and third actuator arrays (e.g. 206) such that the product is conveyed therebetween. In some embodiments, the controller (e.g. 204) may be further configured to control a position of each fourth actuator (e.g. 202) to contact and shape the product (e.g. 32, 59, 94, 98, and/or 253) as the product is moved past the fourth actuator array (e.g., array on fourth side).

[0146] In some embodiments, the first, second, third, and fourth actuator arrays (e.g. 206_ are positioned to surround the product (e.g. 32, 59, 94, 98, and/or 253) (e.g., with actuator arrays on all four sides of the product as it descends into bath).

[0147] In some embodiments, the assembly (e.g. 250) further includes a fluid chamber to cool the product (e.g. 32, 59, 94, 98, and/or 253) while the product is shaped (e.g., fluid bath, with the actuators at least partially submerged within bath to contact product in the bath).

[0148] In some embodiments, the assembly (e.g. 250) further includes a flexible layer (e.g. 212) positioned between at least one of the actuators (e.g., 202) and the product (e.g. 32, 59, 94, 98, and/or 253) (e.g., an elastic layer is positioned between the actuator heads and the product).

[0149] In some embodiments, the controller (e.g. 204) is further configured to control a stroke distance of at least one of the actuators (e.g., 202) to shape the product (e.g., by controlling a distance that the actuator extends to shape the product).

[0150] In some embodiments, the controller (e.g. 204) is further configured to control an actuation time of at least one of the actuators (e.g., 202) to shape the product (e.g. 32, 59, 94, 98, and/or 253) (e.g., by controlling a time that the actuator is deployed to contact product).

[0151] In some embodiments, the controller (e.g. 204) is further configured to receive a signal indicative of a feed rate of the product (e.g. 32, 59, 94, 98, and/or 253), and control at least one of the actuators (e.g., 202) based on the signal.

[0152] In some embodiments, each actuator (e.g., 202) comprises a linear actuator.

[0153] In some embodiments, each actuator (e.g. 202) comprises a head (e.g. 210) (e.g., with the head at a distal end of the actuator to contact product (e.g. 32, 59, 94, 98, and/or 253), and may be coated or formed from a rubber material, different shapes including curved or planar).

[0154] In some embodiments, each head (e.g. 210) of an actuator (e.g. 202) comprises rubber.

[0155] In some embodiments, each actuator array (e.g. 206) comprises a row (e.g. 207) of a plurality of actuators (e.g. 202) (e.g., a row may be straight or curved, and contain any number of actuators).

[0156] In some embodiments, each actuator array (e.g., 206) comprises one or more layers (e.g. 208) of rows (c.g. 207).

[0157] In some embodiments, the layers (e.g. 208) of rows (e.g. 207) are positioned to be stacked in a direction of travel for the product (e.g. 32, 59, 94, 98, and/or 253) (e.g., product passes multiple layers of actuators as it travels).

[0158] A system is described. The system (e.g. 250) includes a dispenser (e.g. 252) of a plurality of strands (e.g. 24, 52, 128, and/or 253) of molten thermoplastic resin and an assembly (e.g. 254), oriented relative to the dispenser (e.g. 252) to receive, and shape the plurality of strands (e.g. 24, 52, 128, and/or 253) as they pass therethrough.

[0159] In some embodiments, the assembly (e.g. 254) includes the fourth sub-assembly (e.g., 262, nozzles (e.g. 68 and/or 70) with fluid streams in a single direction, and/or in at least two different directions that are opposite or not opposite to one another). In some embodiments, the

nozzles (e.g. 68 and/or 70) may be divergent with an exit opening that is larger than the inlet and/or convergent with an exit opening that is smaller than the inlet. In some embodiments, a pump may be used to provide fluid to the nozzles (e.g. 68 and/or 70) from either the fluid bath (e.g. 34, 56, 142, and/or 264) or as another fluid / gas.

[0160] In some embodiments, the nozzles (e.g. 68 and/or 70)are oriented to direct fluid streams towards the product (e.g. 32, 59, 94, 98, and/or 253) in a single direction.

[0161] In some embodiments, the nozzles (e.g. 68 and/or 70)are oriented to direct fluid streams towards the product (e.g. 32, 59, 94, 98, and/or 253) in at least two different directions (e.g., directions that are opposite or not opposite to one another).

[0162] In some embodiments, at least one nozzle (e.g. 68 and/or 70)of the one or more nozzles is a divergent nozzle (e.g., where divergent is an exit opening that is larger than the inlet).

[0163] In some embodiments, at least one nozzle (e.g. 68 and/or 70)of the one or more nozzles is a convergent nozzle (e.g., where convergent is an exit opening that is smaller than the inlet).

[0164] In some embodiments, at least one nozzle (e.g. 68 and/or 70) of the one or more nozzles is a divergent nozzle and at least another nozzle (e.g. 68 and/or 70) of the one or more nozzles is a convergent nozzle.

[0165] In some embodiments, the assembly (e.g. 254) further includes a pump fluidly connected to the one or more nozzles (e.g., 68 and/or 70) (e.g., the pump may be used to pump fluid from the bath (e.g. 34, 56, 142, and/or 264) or pump another liquid / gas, including air).

[0166] In some embodiments, a system (e.g. 250) is described. The system (e.g. 250) includes a dispenser (e.g. 252) of a plurality of strands (e.g. 24, 52, 128, and/or 253) of molten thermoplastic resin and an assembly (e.g. 254) as described above, oriented relative to the dispenser (e.g. 252) to receive, and shape the plurality of strands (e.g. 24, 52, 128, and/or 253) as they pass therethrough.

[0167] In some embodiments, a system (e.g. 250) is described. The system (e.g. 250) includes a dispenser (e.g. 252) of a plurality of strands (e.g. 24, 52, 128, and/or 253) of molten

thermoplastic resin, a fluid bath (e.g. 34, 56, 142, and/or 264), and an assembly (e.g. 254) as described above, wherein the assembly (e.g. 254) is at least partially submerged within the fluid bath. In some embodiments, filaments or strands (e.g. 24, 52, 128, and/or 253) may be used herein to refer to the generally linear polymeric units (although they may be looped, fused or bonded together to form a mesh-like structure) after being dispensed through one or more orifices of the die plate or extrusion die of the extruder (e.g. 16 and/or 134).

[0168] Clause 1. A method, in combination with, or without, any one or more of the successive clauses, comprising dispensing a plurality of strands of a molten polymeric material, and applying a force on the plurality of strands via one or more shaping assemblies thereby shaping the plurality of strands as a contoured consolidated filament structure.

[0169] Clause 1A. A method, in combination with, or without, any one or more of the successive clauses, comprising dispensing a plurality of strands of a molten polymeric material, and applying a force on the plurality of strands via one or more shaping assemblies.

[0170] Clause 2. The method of any of the preceding or successive clauses wherein the shaping assembly comprises at least one of: one or more nozzles, one or more shaping conveyors, or one or more actuator assemblies.

[0171] Clause 3. The method of any of the preceding or successive clauses wherein the method further comprises at least one of: directing one or more fluid jets from the one or more nozzles thereby applying the force on the plurality of strands, conveying the plurality of strands along the one or more shaping conveyors thereby applying the force on the plurality of strands, or actuating one or more actuators to contact the plurality of strands thereby applying the force on the plurality of strands.

[0172] Clause 4. The method of any of the preceding or successive clauses further comprising moving the plurality of strands through a fluid bath; and applying the force on the plurality of strands via the one or more shaping assemblies while the plurality of strands is at least partially submerged in the fluid bath.

[0173] Clause 5. The method of any of the preceding or successive clauses further comprising cooling the plurality of strands within the fluid bath.

[0174] Clause 6. The method of any of the preceding or successive clauses further comprising cutting the contoured consolidated filament structure to form at least one of a vehicle interior component or a unitary non-woven cushion.

[0175] Clause 7. The method of any of the preceding or successive clauses further comprising: heating a polymeric material to a molten state, such that it becomes the molten polymer, and introducing the molten polymer into a die plate having a plurality of holes disposed therethrough such that the molten polymer moves through the holes and forms the plurality of strands as molten polymeric filaments, and introducing the molten polymeric filaments into a bath to cool the molten polymeric filaments, and applying a fluid stream to the molten polymeric filaments via the one or more shaping assemblies to apply the force after the molten polymeric filaments are introduced into the bath such that the molten polymeric filaments are imparted with a desired shape and the consolidated filament structure having the desired shape is formed.

[0176] Clause 8. The method of any of the preceding or successive clauses, wherein the bath contains a liquid, and the fluid stream comprises the liquid.

[0177] Clause 9. The method of any of the preceding or successive clauses, wherein applying the fluid stream to the molten polymeric filaments comprises moving the fluid stream through a nozzle before it contacts the molten polymeric filaments.

[0178] Clause 10. The method of any of the preceding or successive clauses, wherein the nozzle is positioned 10–15 mm from a surface of the molten polymeric filaments.

[0179] Clause 11. The method of any of the preceding or successive clauses, further comprising applying a plurality of the fluid streams to the molten polymeric filaments after the molten polymeric filaments are introduced into the bath.

[0180] Clause 12. The method of any of the preceding or successive clauses, wherein the fluid streams are applied to the molten polymeric filaments in a single direction.

[0181] Clause 13. The method of any of the preceding or successive clauses, wherein the fluid streams are applied to the molten polymeric filaments in at least two different directions.

[0182] Clause 14. The method of any of the preceding or successive clauses further comprising: heating a polymeric material to a molten state to create the molten polymeric material, extruding the molten polymeric material to form a plurality of molten polymeric filaments as the plurality of strands, cooling the molten polymeric material in a fluid bath to create a consolidated filament structure, and applying a fluid stream to apply the force to the molten polymeric filaments in the fluid bath via the one or more shaping assemblies such that the consolidated filament structure has a desired shape as the contoured consolidated filament structure.

[0183] Clause 15. The method of any of the preceding or successive clauses, wherein the consolidated filament structure is a cushion blank for a vehicle seat, and the desired shape includes two bolsters positioned on opposite sides of the cushion blank.

[0184] Clause 16. The method of any of the preceding or successive clauses, further comprising applying a plurality of the fluid streams to the molten polymeric filaments in the fluid bath in at least one direction.

[0185] Clause 17. The method of any of the preceding or successive clauses, wherein at least one of the fluid streams is applied through a nozzle.

[0186] Clause 18. The method of any of the preceding or successive clauses, wherein the nozzle is a divergent nozzle.

[0187] Clause 19. The method of any of the preceding or successive clauses, wherein each of the fluid streams is applied to the molten polymeric filaments through a respective nozzle.

[0188] Clause 20. The method of any of the preceding or successive clauses, wherein at least one of the nozzles is a convergent nozzle.

[0189] Clause 21. The method of any of the preceding or successive clauses, wherein the fluid bath contains a liquid, and the fluid stream comprises the liquid.

[0190] Clause 22. The method of any of the preceding or successive clauses further comprising: heating a polymeric material to create a molten polymeric material; forming a plurality of molten polymeric filaments as the plurality of strands from the molten polymeric material; cooling the molten polymeric material in a fluid bath; and directing a fluid stream at the molten polymeric material in the fluid bath to apply the force via the one or more shaping assemblies such that the molten polymer obtains a desired shape.

[0191] Clause 23. The method of any of the preceding or successive clauses, wherein cooling the molten polymer in the fluid bath forms a consolidated filament structure, and directing the fluid stream at the molten polymer in the fluid bath imparts the desired shape to the consolidated filament structure as the contoured consolidated filament structure.

[0192] Clause 24. The method of any of the preceding or successive clauses, further comprising directing a plurality of the fluid streams at the molten polymeric material in the fluid bath in at least one direction.

[0193] Clause 25. The method of any of the preceding or successive clauses, wherein the consolidated filament structure is a cushion blank for a vehicle seat, and the desired shape includes two bolsters positioned on opposite sides of the cushion blank.

[0194] Clause 26. The method of any of the preceding or successive clauses wherein the molten polymeric material is a molten thermoplastic resin, and the contoured consolidated filament structure is a contoured unitary mesh product; wherein the method further comprises: conveying the plurality of strands along at least one shaping conveyor of the one or more shaping assemblies while applying the force and shaping the plurality of strands as the contoured unitary mesh product.

[0195] Clause 27. The method of any of the preceding or successive clauses, further comprising conveying the plurality of strands within a plurality of shaping conveyors as the contoured unitary mesh product.

[0196] Clause 28. The method of any of the preceding or successive clauses, further comprising translating at least one of the plurality of shaping conveyors to vary a spacing between the plurality of shaping conveyors while conveying and shaping the plurality of strands.

[0197] Clause 29. The method of any of the preceding or successive clauses, further comprising shaping the plurality of strands with at least one shaping tool attached to the at least one shaping conveyor.

[0198] Clause 30. The method of any of the preceding or successive clauses, further comprising resisting a flow of the plurality of strands, thereby buckling the plurality of strands, the buckled strands intersecting as a unitary non-woven body.

[0199] Clause 31. The method of any of the preceding or successive clauses, further comprising cooling the plurality of strands to bond as the contoured unitary mesh product.

[0200] Clause 32. The method of any of the preceding or successive clauses, further comprising cooling the plurality of strands while shaping the plurality of strands.

[0201] Clause 33. The method of any of the preceding or successive clauses, further comprising cooling the plurality of strands in a cooling chamber.

[0202] Clause 34. The method of any of the preceding or successive clauses, wherein the molten polymeric material is a molten thermoplastic resin, and the contoured consolidated filament structure is a contoured unitary mesh product; wherein the method further comprises: actuating one or more actuators of the one or more shaping assemblies to contact the plurality of strands thereby applying the force and shaping the plurality of strands as the contoured unitary mesh product.

[0203] Clause 35. The method of any of the preceding or successive clauses, further comprising conveying the plurality of strands past the one or more actuators as the contoured unitary mesh product.

[0204] Clause 36. The method of any of the preceding or successive clauses, further comprising actuating a first actuator of the one or more actuators and a second actuator of the

one or more actuators opposite to the first actuator to vary a spacing therebetween while shaping the plurality of strands.

[0205] Clause 37. The method of any of the preceding or successive clauses, further comprising resisting a flow of the plurality of strands, thereby buckling the plurality of strands, the buckled strands intersecting as a unitary non-woven body.

[0206] Clause 38. The method of any of the preceding or successive clauses, further comprising cooling the plurality of strands to bond as the contoured unitary mesh product.

[0207] Clause 39. The method of any of the preceding or successive clauses, further comprising cooling the plurality of strands while shaping the plurality of strands.

[0208] Clause 40. The method of any of the preceding or successive clauses, further comprising cooling the plurality of strands in a fluid chamber.

[0209] Clause 41. A vehicle interior component formed by the method of any of the preceding or successive clauses.

[0210] Clause 42. The vehicle interior component of clause 41 wherein the vehicle interior component is a cushion for a vehicle seat and comprises two bolsters positioned on opposite sides of the cushion.

[0211] Clause 43. A product manufactured according to the method of any of the preceding or successive clauses.

[0212] Clause 44. The method of any of the preceding or successive clauses, wherein the contoured consolidated filament structure forms a product; and wherein the method further comprises installing the product on a seat frame as a seat cushion.

[0213] Clause 45. A seat assembly manufactured according to the method of any of the preceding or successive clauses.

[0214] Clause 46. A product manufactured according to a method in combination with, or without, any one or more of the successive clauses, comprising dispensing a plurality of strands

of a molten thermoplastic resin; and shaping the plurality of strands as a contoured unitary mesh product by applying a force onto the plurality of strands via one or more shaping assemblies, wherein the shaping assembly comprises at least one of: one or more nozzles, one or more shaping conveyors, and/or one or more actuator assemblies.

[0215] Clause 47. The product of any of the preceding or successive clauses, wherein the method further comprises shaping the plurality of strands by actuating the one or more actuators of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product.

[0216] Clause 48. The product of any of the preceding or successive clauses, wherein the method further comprises shaping the plurality of strands by conveying the plurality of strands via the one or more shaping conveyors of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product.

[0217] Clause 49. The product of any of the preceding or successive clauses wherein the method further comprises shaping the plurality of strands by directing one or more fluid jets towards the plurality of strands via the one or more nozzles of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product.

[0218] Clause 50. The product of any of the preceding or successive clauses, further comprising a unitary non-woven cushion.

[0219] Clause 51. An assembly in combination with, or without, any one or more of the successive clauses, comprising at least one of: (i) a first sub-assembly comprising: a conveyor to convey a product, and a plurality of shaping tools attached to the conveyor to shape the product as the product is conveyed along the conveyor; (ii) a second sub-assembly comprising: a pair of spaced apart conveyors to convey the product therebetween, and an actuator in cooperation with the pair of conveyors to vary the spacing between the pair of conveyors to shape the product as the product conveyed; (iii) a third sub-assembly comprising: an actuator array comprising one or more actuators, each actuator deployable to contact the product, and a controller configured to control a position of each actuator to contact and shape the product as the product is moved past

the actuator array; and/or (iv) a fourth sub-assembly comprising one or more nozzles positioned to direct fluid towards the product to shape the product as the product is moved past the one or more nozzles.

[0220] Clause 52. The assembly of any of the preceding or successive clauses further comprising the first sub-assembly.

[0221] Clause 53. The assembly of any of the preceding or successive clauses, further comprising a second conveyor to convey the product, the second conveyor spaced apart from the first conveyor to convey the product between the first conveyor and the second conveyor.

[0222] Clause 54. The assembly of any of the preceding or successive clauses, further comprising a second plurality of shaping tools attached to the second conveyor to shape the product as the product is conveyed along the first conveyor and the second conveyor.

[0223] Clause 55. The assembly of any of the preceding or successive clauses, further comprising a cooling chamber to cool the product while the product is conveyed and shaped.

[0224] Clause 56. A system comprising: a dispenser of a plurality of strands of molten thermoplastic resin; and the assembly of any of the preceding or successive clauses, oriented relative to the dispenser to receive, convey, and shape the plurality of strands.

[0225] Clause 57. The assembly of any of the preceding or successive clauses further comprising the second sub-assembly.

[0226] Clause 58. The assembly of any of the preceding or successive clauses, further comprising a cooling chamber to cool the product while the product is conveyed and shaped.

[0227] Clause 59. A system comprising: a dispenser of a plurality of strands of molten thermoplastic resin; and the assembly of any of the preceding or successive clauses, oriented relative to the dispenser to receive, convey, and shape the plurality of strands.

[0228] Clause 60. The assembly of any of the preceding or successive clauses further comprising the third sub-assembly.

[0229] Clause 61. The assembly of any of the preceding or successive clauses further comprising a second actuator array comprising one or more second actuators, each second actuator deployable to contact the product, the second actuator array spaced apart from the first actuator array such that the product is conveyed therebetween; wherein the controller is further configured to control a position of each second actuator to contact and shape the product as the product is moved past the second actuator array.

[0230] Clause 62. The assembly of any of the preceding or successive clauses, further comprising a third actuator array comprising one or more third actuators, each third actuator deployable to contact the product, the third actuator array spaced apart from the first and second actuator arrays such that the product is conveyed therebetween; wherein the controller is further configured to control a position of each third actuator to contact and shape the product as the product is moved past the third actuator array.

[0231] Clause 63. The assembly of any of the preceding or successive clauses, further comprising a fourth actuator array comprising one or more fourth actuators, each fourth actuator deployable to contact the product, the fourth actuator array spaced apart from the first, second, and third actuator arrays such that the product is conveyed therebetween; wherein the controller is further configured to control a position of each fourth actuator to contact and shape the product as the product is moved past the fourth actuator array.

[0232] Clause 64. The assembly of any of the preceding or successive clauses wherein the first, second, third, and fourth actuator arrays are positioned to surround the product.

[0233] Clause 65. The assembly of any of the preceding or successive clauses, further comprising a fluid chamber to cool the product while the product is shaped.

[0234] Clause 66. The assembly of any of the preceding or successive clauses further comprising a flexible layer positioned between at least one of the actuators and the product.

[0235] Clause 67. The assembly of any of the preceding or successive clauses wherein the controller is further configured to control a stroke distance of at least one of the actuators to shape the product.

[0236] Clause 68. The assembly of any of the preceding or successive clauses wherein the controller is further configured to control an actuation time of at least one of the actuators to shape the product.

[0237] Clause 69. The assembly of any of the preceding or successive clauses wherein the controller is further configured to receive a signal indicative of a feed rate of the product, and control at least one of the actuators based on the signal.

[0238] Clause 70. The assembly of any of the preceding or successive clauses wherein each actuator comprises a linear actuator.

[0239] Clause 71. The assembly of any of the preceding or successive clauses wherein each actuator comprises a head.

[0240] Clause 72. The assembly of any of the preceding or successive clauses wherein each head of an actuator comprises rubber.

[0241] Clause 73. The assembly of any of the preceding or successive clauses wherein each actuator array comprises a row of a plurality of actuators.

[0242] Clause 74. The assembly of any of the preceding or successive clauses wherein each actuator array comprises one or more layers of rows.

[0243] Clause 75. The assembly of any of the preceding or successive clauses wherein the layers of rows are positioned to be stacked in a direction of travel for the product.

[0244] Clause 76. A system comprising: a dispenser of a plurality of strands of molten thermoplastic resin; and the assembly of any of the preceding or successive clauses, oriented relative to the dispenser to receive, and shape the plurality of strands as they pass therethrough.

[0245] Clause 77. The assembly of any of the preceding or successive clauses further comprising the fourth sub-assembly.

[0246] Clause 78. The assembly of any of the preceding or successive clauses wherein the nozzles are oriented to direct fluid streams towards the product in a single direction.

[0247] Clause 79. The assembly of any of the preceding or successive clauses wherein the nozzles are oriented to direct fluid streams towards the product in at least two different directions.

[0248] Clause 80. The assembly of any of the preceding or successive clauses wherein at least one nozzle of the one or more nozzles is a divergent nozzle.

[0249] Clause 81. The assembly of any of the preceding or successive clauses wherein at least one nozzle of the one or more nozzles is a convergent nozzle.

[0250] Clause 82. The assembly of any of the preceding or successive clauses wherein at least one nozzle of the one or more nozzles is a divergent nozzles, and at least another nozzle of the one or more nozzles is a convergent nozzle.

[0251] Clause 83. The assembly of any of the preceding or successive clauses further comprising a pump fluidly connected to the one or more nozzles.

[0252] Clause 84. A system comprising: a dispenser of a plurality of strands of molten thermoplastic resin; and the assembly of any of the preceding or successive clauses, oriented relative to the dispenser to receive, and shape the plurality of strands as they pass therethrough.

[0253] Clause 85. A system comprising: a dispenser of a plurality of strands of molten thermoplastic resin; a fluid bath; and the assembly of any of the preceding clauses, wherein the assembly is at least partially submerged within the fluid bath.

[0254] Clause 86. Any one of the preceding clauses 1-85 in any combination.

[0255] While exemplary embodiments are described above, it is not intended that these embodiments describe all possible forms according to the disclosure. In that regard, 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 disclosure. Additionally, the features of various implementing embodiments may be combined to form further embodiments according to the disclosure.

WHAT IS CLAIMED IS:

1. A method comprising:

dispensing a plurality of strands of a molten polymeric material; and

applying a force on the plurality of strands via one or more shaping assemblies.

2. The method of claim 1 wherein the shaping assembly comprises at least one of: one or more nozzles, one or more shaping conveyors, or one or more actuator assemblies.

3. The method of claim 2 wherein the method further comprises at least one of: directing one or more fluid jets from the one or more nozzles thereby applying the force on the plurality of strands, conveying the plurality of strands along the one or more shaping conveyors thereby applying the force on the plurality of strands, or actuating one or more actuators to contact the plurality of strands thereby applying the force on the plurality of strands.

4. The method of any one of claims 1-3 further comprising:

moving the plurality of strands through a fluid bath; and

applying the force on the plurality of strands via the one or more shaping assemblies while the plurality of strands is at least partially submerged in the fluid bath.

5. The method of claim 4 further comprising cooling the plurality of strands within the fluid bath.

6. The method of any one of claims 1-5 further comprising cutting the contoured consolidated filament structure to form at least one of a vehicle interior component or a unitary non-woven cushion.

7. The method of any one of claims 1-3 further comprising:

heating a polymeric material to a molten state, such that it becomes the molten polymer;

introducing the molten polymer into a die plate having a plurality of holes disposed therethrough such that the molten polymer moves through the holes and forms the plurality of strands as molten polymeric filaments; and

introducing the molten polymeric filaments into a bath to cool the molten polymeric filaments; and

applying a fluid stream to the molten polymeric filaments via the one or more shaping assemblies to apply the force after the molten polymeric filaments are introduced into the bath such that the molten polymeric filaments are imparted with a desired shape and the consolidated filament structure having the desired shape is formed.

8. The method of claim 7, wherein the bath contains a liquid, and the fluid stream comprises the liquid.

9. The method of any one of claims 7 and 8, wherein applying the fluid stream to the molten polymeric filaments comprises moving the fluid stream through a nozzle before it contacts the molten polymeric filaments.

10. The method of claim 9, wherein the nozzle is positioned 10–15 mm from a surface of the molten polymeric filaments.

11. The method of any of claims 7-10, further comprising applying a plurality of the fluid streams to the molten polymeric filaments after the molten polymeric filaments are introduced into the bath.

12. The method of claim 11, wherein the fluid streams are applied to the molten polymeric filaments in a single direction.

13. The method of claim 12, wherein the fluid streams are applied to the molten polymeric filaments in at least two different directions.

14. The method of any one of claims 1-3 further comprising:

heating a polymeric material to a molten state to create the molten polymeric material;

extruding the molten polymeric material to form a plurality of molten polymeric filaments as the plurality of strands;

cooling the molten polymeric material in a fluid bath to create a consolidated filament structure; and

applying a fluid stream to apply the force to the molten polymeric filaments in the fluid bath via the one or more shaping assemblies such that the consolidated filament structure has a desired shape as the contoured consolidated filament structure.

15. The method of claim 14, wherein the consolidated filament structure is a cushion blank for a vehicle seat, and the desired shape includes two bolsters positioned on opposite sides of the cushion blank.

16. The method of any one of claims 14 or 15, further comprising applying a plurality of the fluid streams to the molten polymeric filaments in the fluid bath in at least one direction.

17. The method of claim 16, wherein at least one of the fluid streams is applied through a nozzle.

18. The method of claim 17, wherein the nozzle is a divergent nozzle.

19. The method of any one of claims 14 or 15, wherein each of the fluid streams is applied to the molten polymeric filaments through a respective nozzle.

20. The method of claim 19, wherein at least one of the nozzles is a convergent nozzle.

21. The method of any of claims 14-20, wherein the fluid bath contains a liquid, and the fluid stream comprises the liquid.

22. The method of any one of claims 1-3 further comprising:

heating a polymeric material to create a molten polymeric material;

forming a plurality of molten polymeric filaments as the plurality of strands from the molten polymeric material;

cooling the molten polymeric material in a fluid bath; and

directing a fluid stream at the molten polymeric material in the fluid bath to apply the force via the one or more shaping assemblies such that the molten polymer obtains a desired shape.

23. The method of claim 22, wherein cooling the molten polymer in the fluid bath forms a consolidated filament structure, and directing the fluid stream at the molten polymer in the fluid bath imparts the desired shape to the consolidated filament structure as the contoured consolidated filament structure.

24. The method of any one of claims 22 or 23, further comprising directing a plurality of the fluid streams at the molten polymeric material in the fluid bath in at least one direction.

25. The method of claim 24, wherein the consolidated filament structure is a cushion blank for a vehicle seat, and the desired shape includes two bolsters positioned on opposite sides of the cushion blank.

26. The method of any one of claims 1-3 wherein the molten polymeric material is a molten thermoplastic resin, and the contoured consolidated filament structure is a contoured unitary mesh product;

wherein the method further comprises:

conveying the plurality of strands along at least one shaping conveyor of the one or more shaping assemblies while applying the force and shaping the plurality of strands as the contoured unitary mesh product.

27. The method of claim 26, further comprising conveying the plurality of strands within a plurality of shaping conveyors as the contoured unitary mesh product.

28. The method of claim 27, further comprising translating at least one of the plurality of shaping conveyors to vary a spacing between the plurality of shaping conveyors while conveying and shaping the plurality of strands.

29. The method of any of claims 26-28, further comprising shaping the plurality of strands with at least one shaping tool attached to the at least one shaping conveyor.

30. The method of any of claims 26-29, further comprising resisting a flow of the plurality of strands, thereby buckling the plurality of strands, the buckled strands intersecting as a unitary non-woven body.

31. The method of any of claims 26-30, further comprising cooling the plurality of strands to bond as the contoured unitary mesh product.

32. The method of any of claims 26-31, further comprising cooling the plurality of strands while shaping the plurality of strands.

33. The method of any of claims 26-32, further comprising cooling the plurality of strands in a cooling chamber.

34. The method according to any one of claims 1-3, wherein the molten polymeric material is a molten thermoplastic resin, and the contoured consolidated filament structure is a contoured unitary mesh product;

wherein the method further comprises:

actuating one or more actuators of the one or more shaping assemblies to contact the plurality of strands thereby applying the force and shaping the plurality of strands as the contoured unitary mesh product.

35. The method of claim 34, further comprising conveying the plurality of strands past the one or more actuators as the contoured unitary mesh product.

36. The method of claim 35, further comprising actuating a first actuator of the one or more actuators and a second actuator of the one or more actuators opposite to the first actuator to vary a spacing therebetween while shaping the plurality of strands.

37. The method of any of claims 34-36, further comprising resisting a flow of the plurality of strands, thereby buckling the plurality of strands, the buckled strands intersecting as a unitary non-woven body.

38. The method of any of claims 34-37, further comprising cooling the plurality of strands to bond as the contoured unitary mesh product.

39. The method of any of claims 34-38, further comprising cooling the plurality of strands while shaping the plurality of strands.

40. The method of any of claims 34-39, further comprising cooling the plurality of strands in a fluid chamber.

41. A vehicle interior component formed by the method of any of claims 1-40.

42. The vehicle interior component of claim 41 wherein the vehicle interior component is a cushion for a vehicle seat and comprises two bolsters positioned on opposite sides of the cushion.

43. A product manufactured according to the method of any of claims 1-40.

44. The method of any of claims 1-40, wherein the contoured consolidated filament structure forms a product;

wherein the method further comprises installing the product on a seat frame as a seat cushion.

45. A seat assembly manufactured according to the method of claim 44.

46. A product manufactured according to a method comprising:

dispensing a plurality of strands of a molten thermoplastic resin; and

shaping the plurality of strands as a contoured unitary mesh product by applying a force onto the plurality of strands via one or more shaping assemblies, wherein the shaping assembly comprises at least one of: one or more nozzles, one or more shaping conveyors, and/or one or more actuator assemblies.

47. The product of claim 46, wherein the method further comprises shaping the plurality of strands by actuating the one or more actuators of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product.

48. The product of claim 46, wherein the method further comprises shaping the plurality of strands by conveying the plurality of strands via the one or more shaping conveyors of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product.

49. The product wherein the method further comprises shaping the plurality of strands by directing one or more fluid jets towards the plurality of strands via the one or more nozzles of the one or more shaping assemblies to contact the plurality of strands thereby shaping the plurality of strands as a contoured unitary mesh product.

50. The product of any one of claims 46-49, further comprising a unitary non-woven cushion.

51. An assembly comprising at least one of:

(i) a first sub-assembly comprising:

a conveyor to convey a product, and

a plurality of shaping tools attached to the conveyor to shape the product as the product is conveyed along the conveyor;

(ii) a second sub-assembly comprising:

a pair of spaced apart conveyors to convey the product therebetween, and

an actuator in cooperation with the pair of conveyors to vary the spacing between the pair of conveyors to shape the product as the product conveyed;

(iii) a third sub-assembly comprising:

an actuator array comprising one or more actuators, each actuator deployable to contact the product, and

a controller configured to control a position of each actuator to contact and shape the product as the product is moved past the actuator array; and/or

(iv) a fourth sub-assembly comprising one or more nozzles positioned to direct fluid towards the product to shape the product as the product is moved past the one or more nozzles.

52. The assembly of claim 51 further comprising the first sub-assembly.

53. The assembly of claim 52, further comprising a second conveyor to convey the product, the second conveyor spaced apart from the first conveyor to convey the product between the first conveyor and the second conveyor.

54. The assembly of claim 53, further comprising a second plurality of shaping tools attached to the second conveyor to shape the product as the product is conveyed along the first conveyor and the second conveyor.

55. The assembly of any of claims 52-54, further comprising a cooling chamber to cool the product while the product is conveyed and shaped.

56. A system comprising:

a dispenser of a plurality of strands of molten thermoplastic resin; and

the assembly of any of claims 52-55, oriented relative to the dispenser to receive, convey, and shape the plurality of strands.

57. The assembly of claim 51 further comprising the second sub-assembly.

58. The assembly of claim 57, further comprising a cooling chamber to cool the product while the product is conveyed and shaped.

59. A system comprising:

a dispenser of a plurality of strands of molten thermoplastic resin; and

the assembly of any of claims 56-58, oriented relative to the dispenser to receive, convey, and shape the plurality of strands.

60. The assembly of claim 51 further comprising the third sub-assembly.

61. The assembly of claim 60 further comprising a second actuator array comprising one or more second actuators, each second actuator deployable to contact the product, the second actuator array spaced apart from the first actuator array such that the product is conveyed therebetween;

wherein the controller is further configured to control a position of each second actuator to contact and shape the product as the product is moved past the second actuator array.

62. The assembly of claim 61, further comprising a third actuator array comprising one or more third actuators, each third actuator deployable to contact the product, the third actuator array spaced apart from the first and second actuator arrays such that the product is conveyed therebetween;

wherein the controller is further configured to control a position of each third actuator to contact and shape the product as the product is moved past the third actuator array.

63. The assembly of claim 62, further comprising a fourth actuator array comprising one or more fourth actuators, each fourth actuator deployable to contact the product, the fourth actuator array spaced apart from the first, second, and third actuator arrays such that the product is conveyed therebetween;

wherein the controller is further configured to control a position of each fourth actuator to contact and shape the product as the product is moved past the fourth actuator array.

64. The assembly of claim 63 wherein the first, second, third, and fourth actuator arrays are positioned to surround the product.

65. The assembly of any of claims 60-64, further comprising a fluid chamber to cool the product while the product is shaped.

66. The assembly of any of claims 60-65 further comprising a flexible layer positioned between at least one of the actuators and the product.

67. The assembly of any of claims 60-66 wherein the controller is further configured to control a stroke distance of at least one of the actuators to shape the product.

68. The assembly of any of claims 60-67 wherein the controller is further configured to control an actuation time of at least one of the actuators to shape the product.

69. The assembly of any of claims 60-68 wherein the controller is further configured to receive a signal indicative of a feed rate of the product, and control at least one of the actuators based on the signal.

70. The assembly of any of claims 60-69 wherein each actuator comprises a linear actuator.

71. The assembly of any of claims 60-70 wherein each actuator comprises a head.

72. The assembly of any of claim 71 wherein each head of an actuator comprises rubber.

73. The assembly of any of claims 60-72 wherein each actuator array comprises a row of a plurality of actuators.

74. The assembly of any of claims 60-73 wherein each actuator array comprises one or more layers of rows.

75. The assembly of claim 74 wherein the layers of rows are positioned to be stacked in a direction of travel for the product.

76. A system comprising:

a dispenser of a plurality of strands of molten thermoplastic resin; and

the assembly of any of claims 60-75, oriented relative to the dispenser to receive, and shape the plurality of strands as they pass therethrough.

77. The assembly of claim 51 further comprising the fourth sub-assembly.

78. The assembly of claim 77 wherein the nozzles are oriented to direct fluid streams towards the product in a single direction.

79. The assembly of claim 77 wherein the nozzles are oriented to direct fluid streams towards the product in at least two different directions.

80. The assembly of any one of claims 77-79 wherein at least one nozzle of the one or more nozzles is a divergent nozzle.

81. The assembly of any one of claims 77-79 wherein at least one nozzle of the one or more nozzles is a convergent nozzle.

82. The assembly of any one of claims 77-79 wherein at least one nozzle of the one or more nozzles is a divergent nozzles, and at least another nozzle of the one or more nozzles is a convergent nozzle.

83. The assembly of any one of claims 77-81 further comprising a pump fluidly connected to the one or more nozzles.

84. A system comprising:

a dispenser of a plurality of strands of molten thermoplastic resin; and

the assembly of any of claims 77-83, oriented relative to the dispenser to receive, and shape the plurality of strands as they pass therethrough.

85. A system comprising:

a dispenser of a plurality of strands of molten thermoplastic resin;

a fluid bath; and

the assembly of claim 51, wherein the assembly is at least partially submerged within the fluid bath.

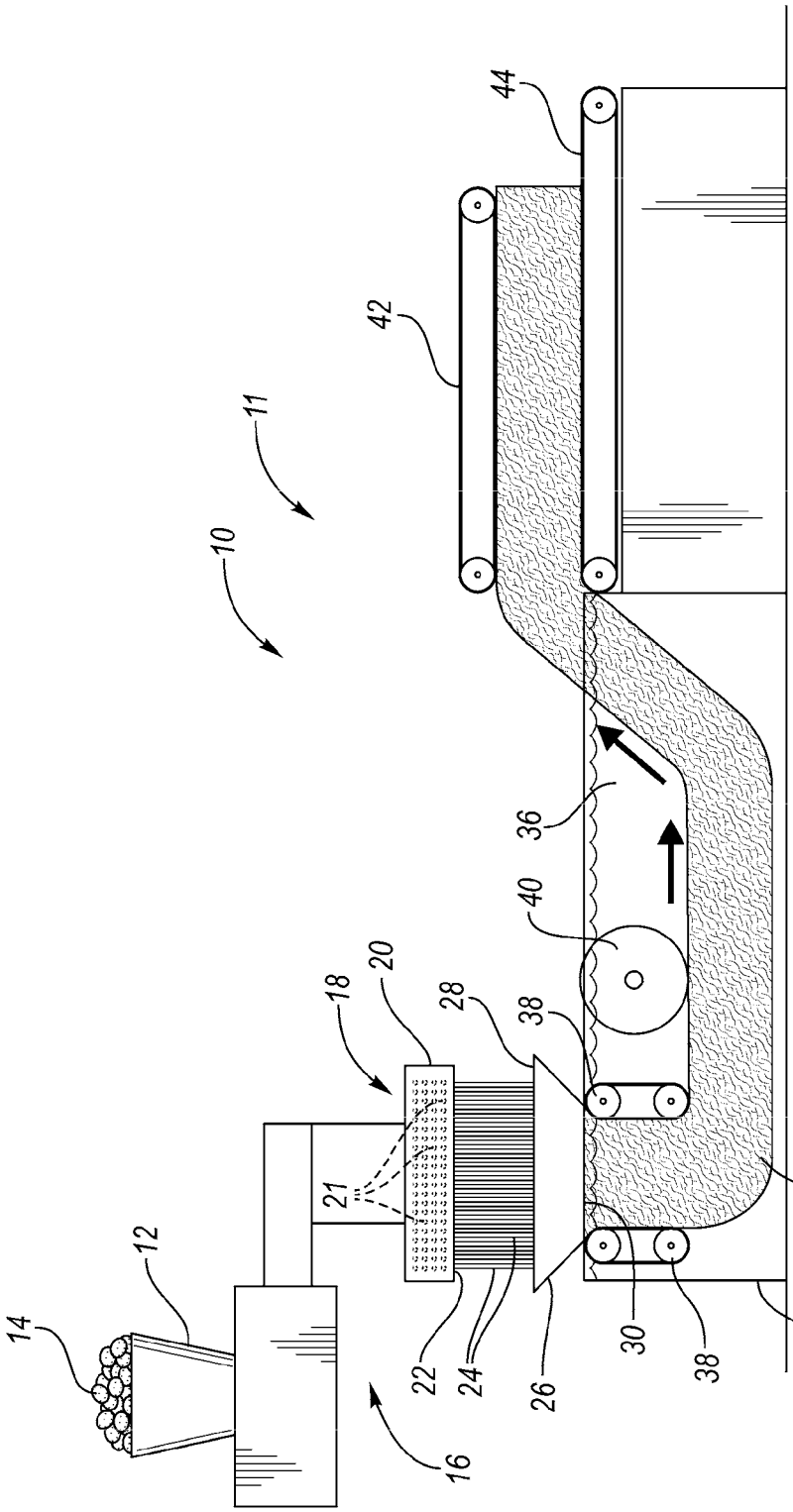


FIG. 1

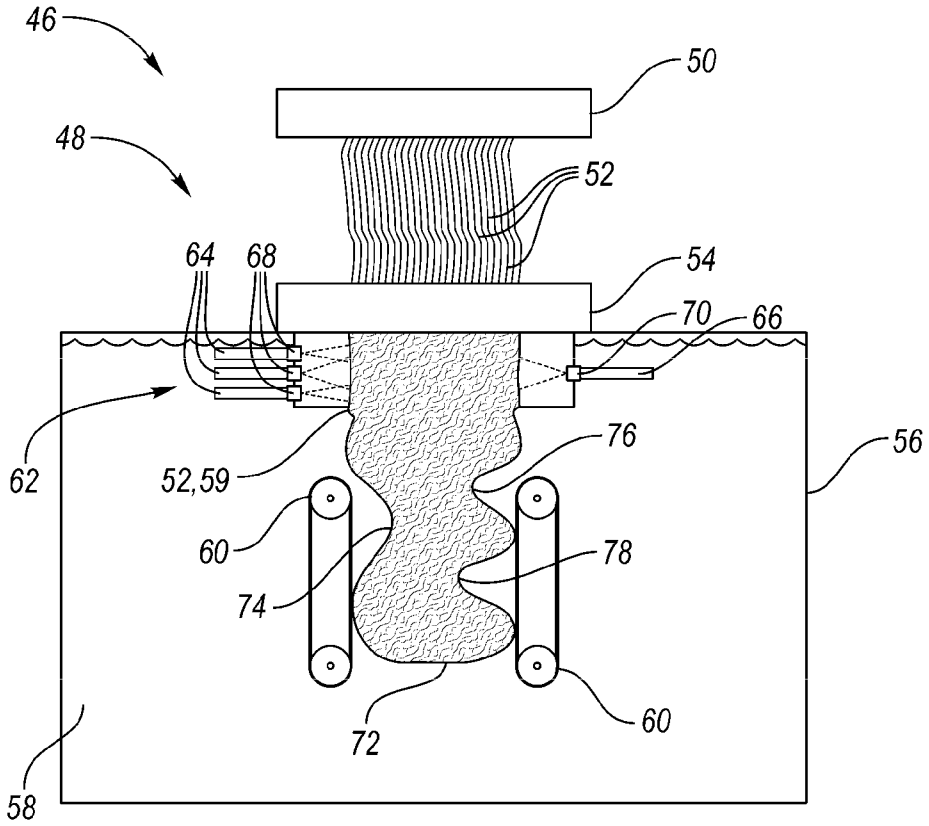

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FIG. 2

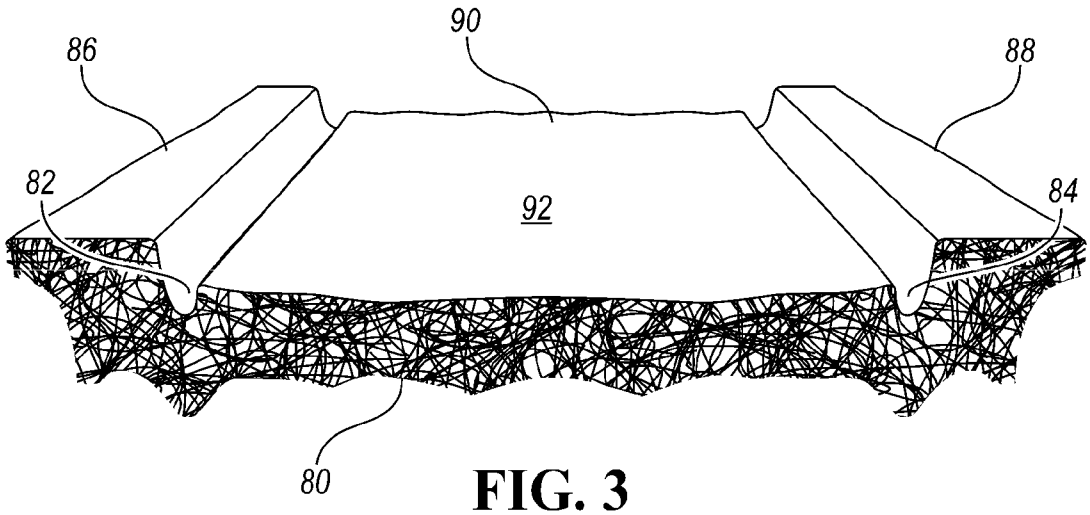

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FIG. 3

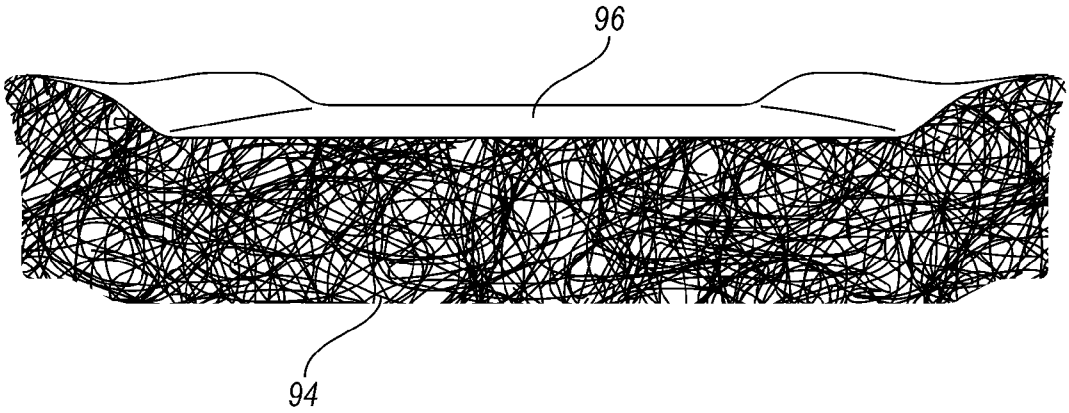


FIG. 4

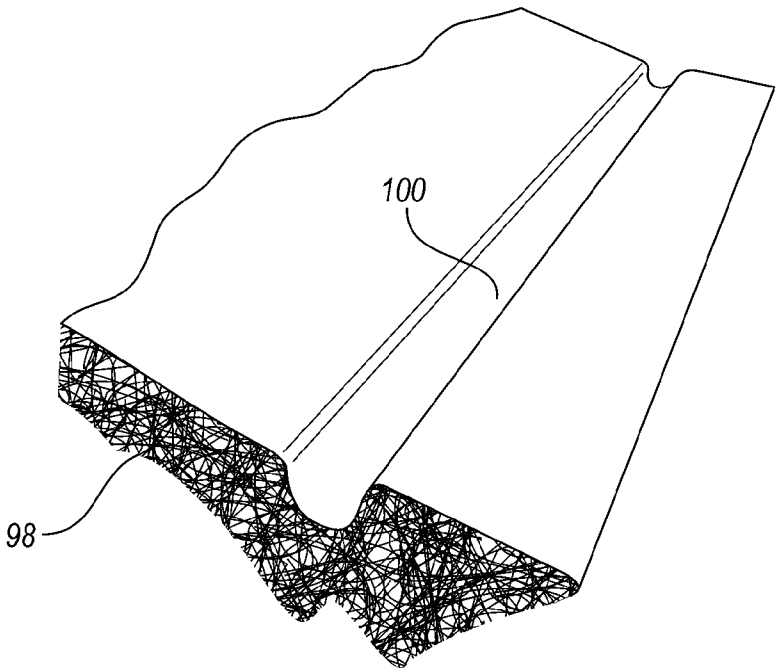


FIG. 5

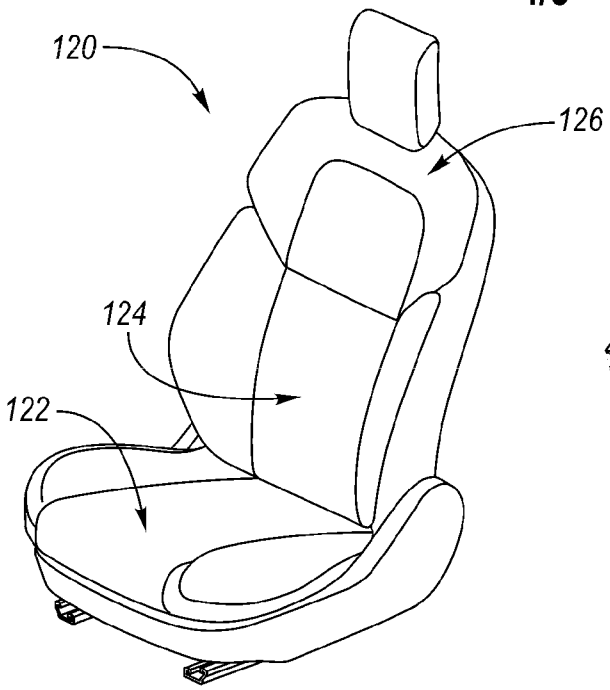


FIG. 6

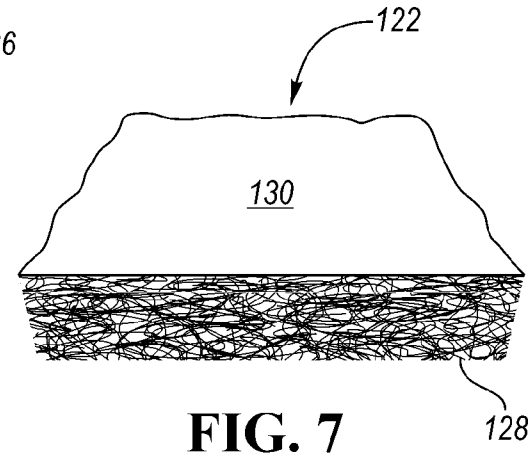


FIG. 7

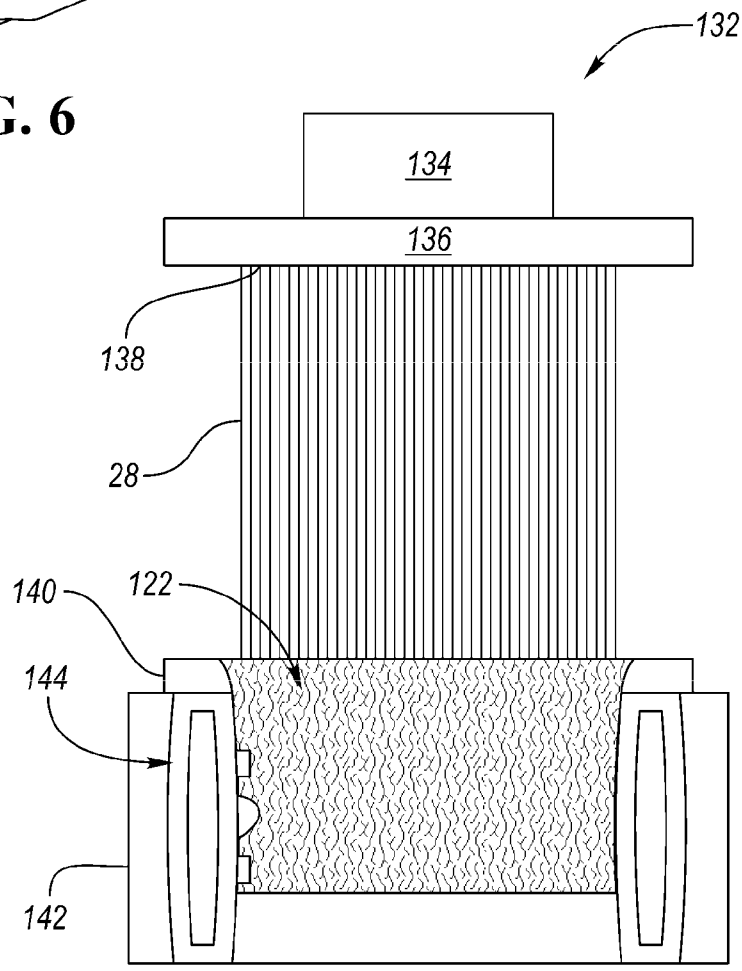


FIG. 8

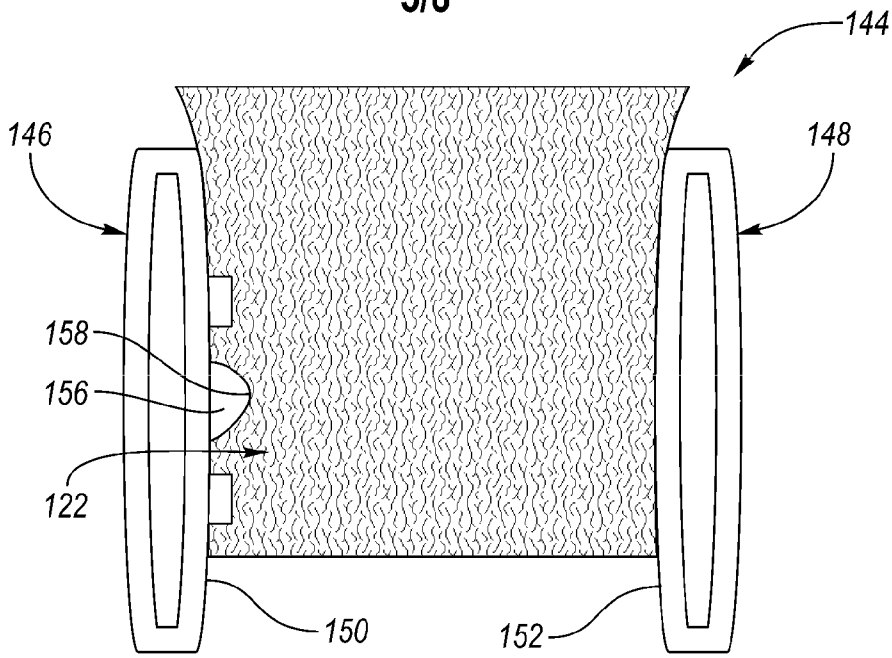


FIG. 9

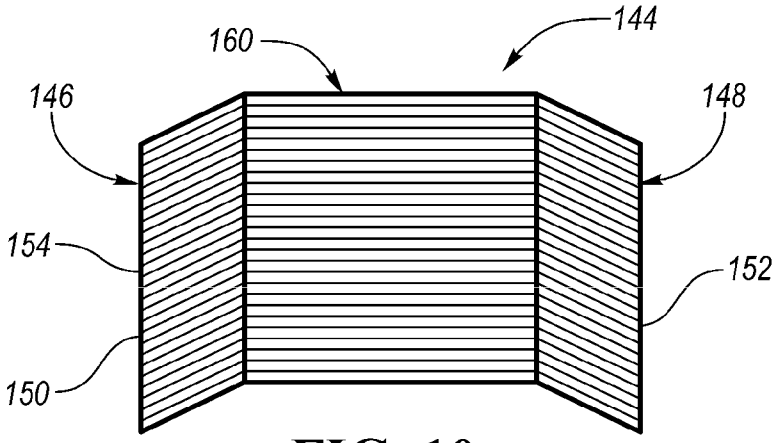


FIG. 10

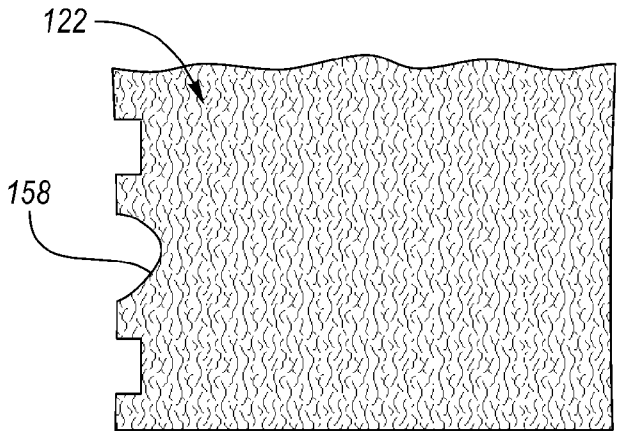


FIG. 11

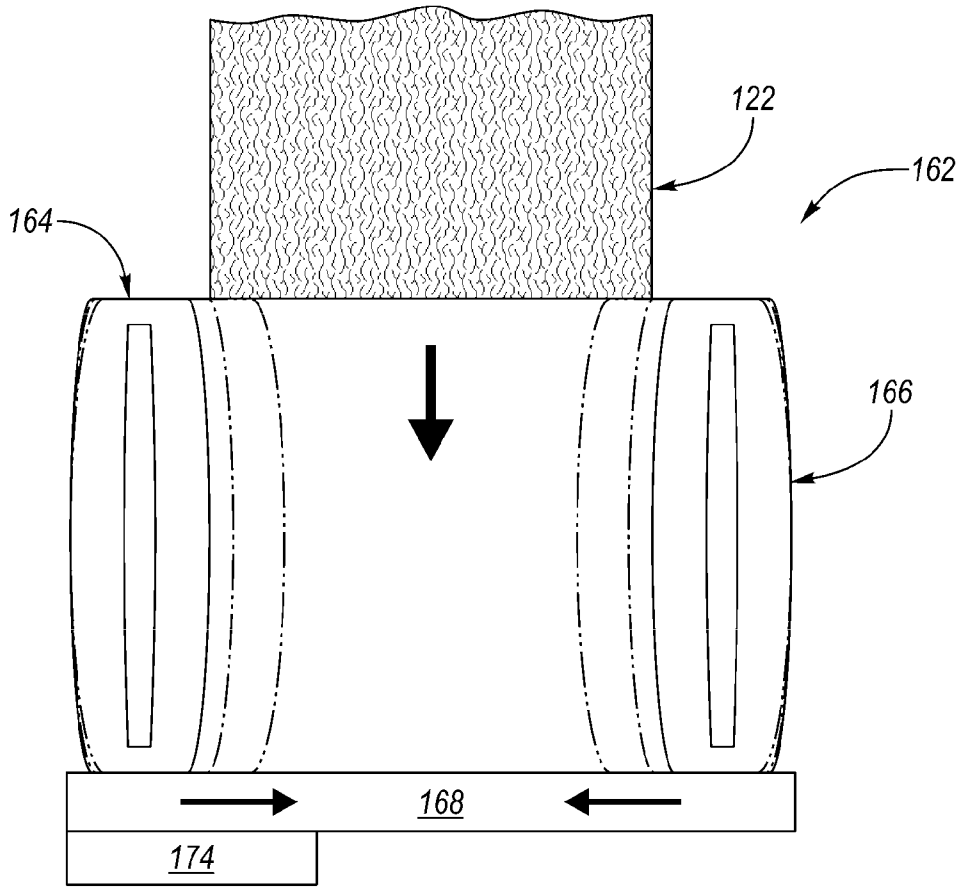


FIG. 12

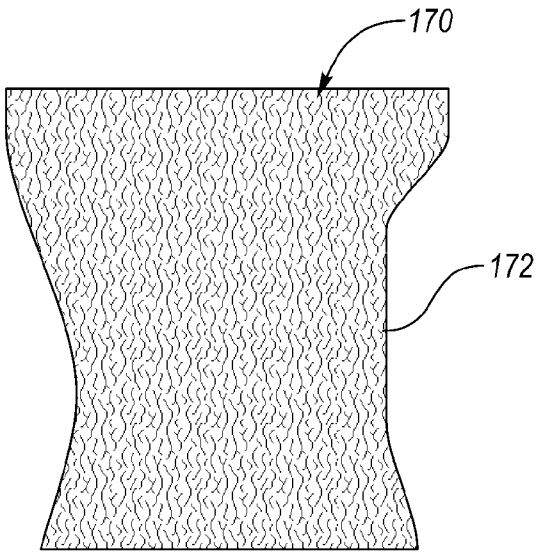


FIG. 13

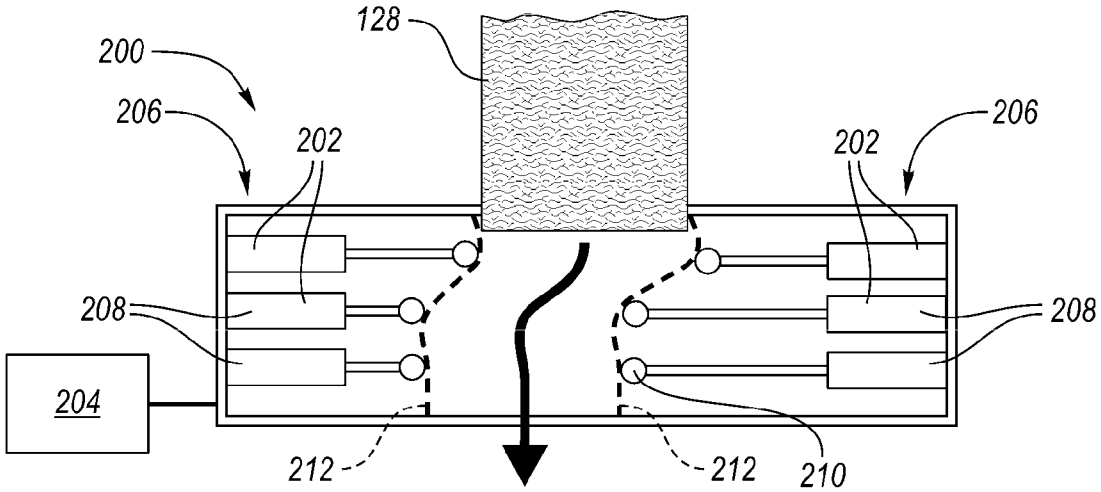

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FIG. 14

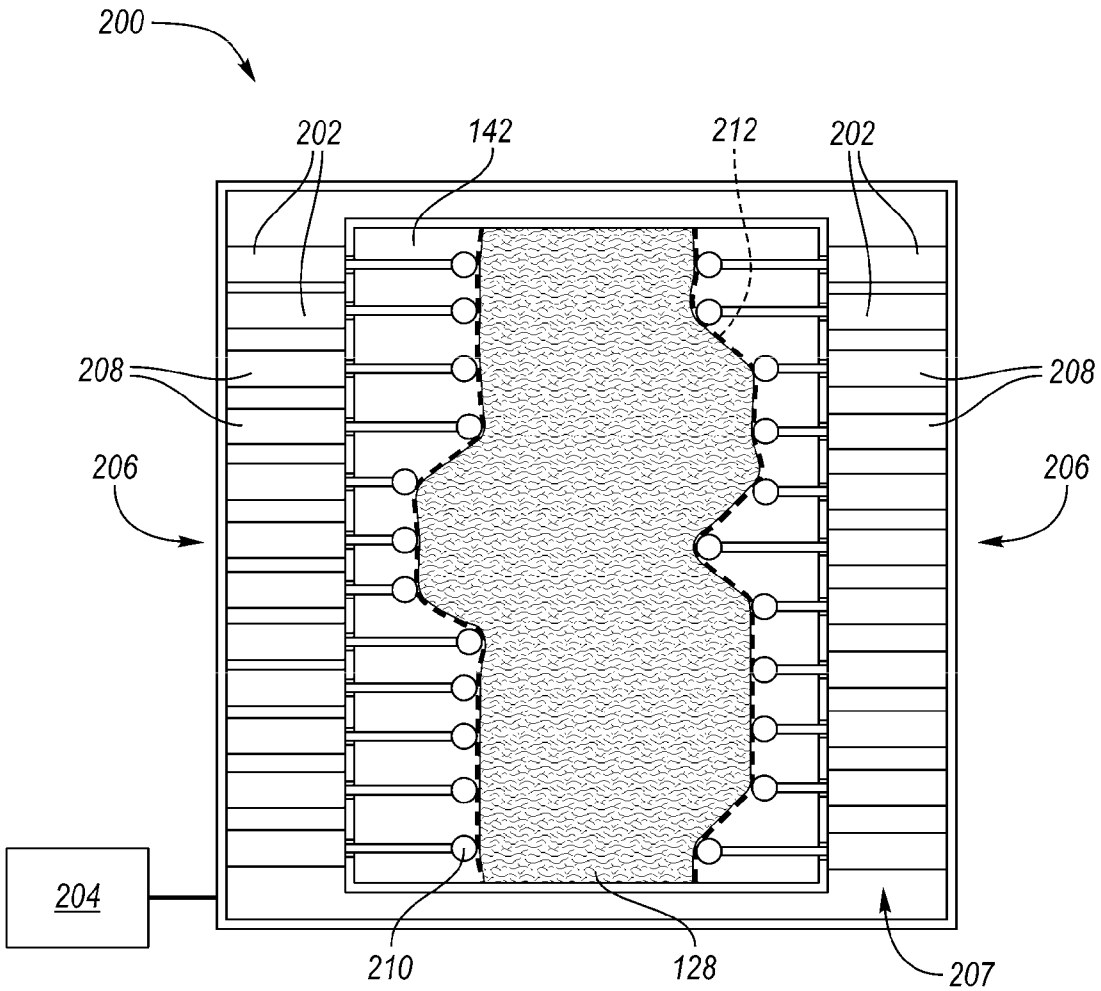

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FIG. 15

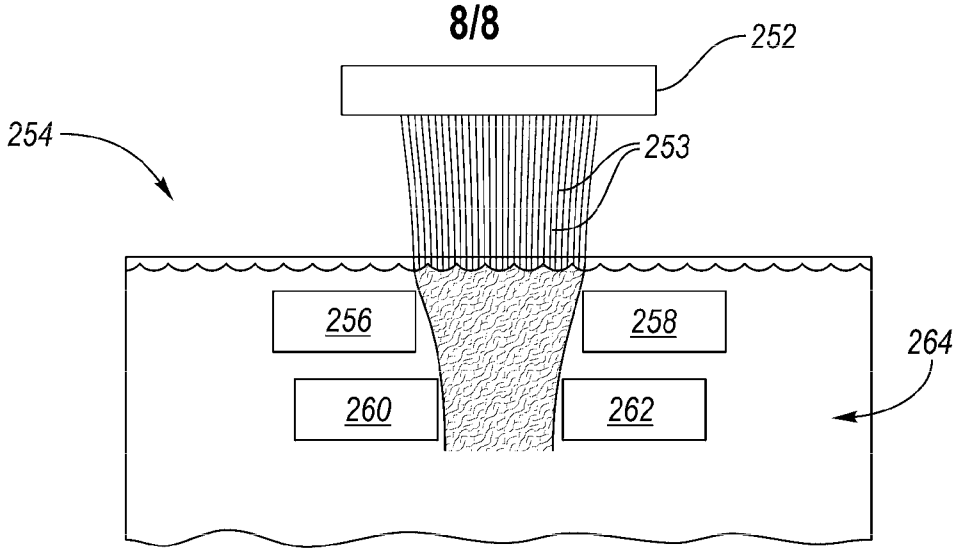


FIG. 16

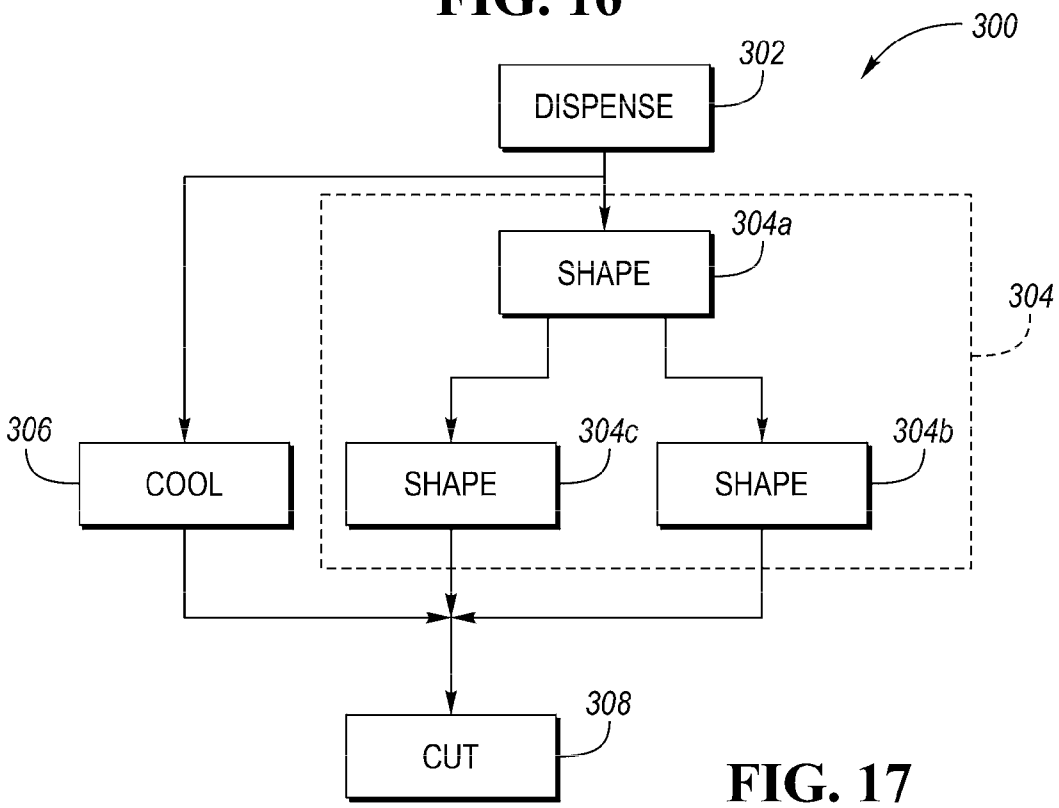


FIG. 17

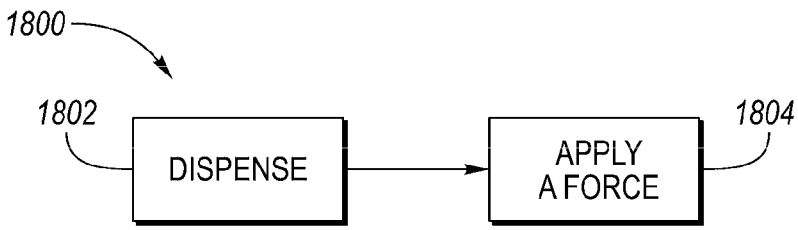


FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/025923

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - INV. - D04H 3/037; A47C 27/12; B68G 7/02 (2023.01)
ADD.

CPC - INV. - D04H 3/037; A47C 27/12; B68G 7/02 (2023.08)
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,378,150 B1 (MINEGISHI et al.) 30 April 2002 (30.04.2002) entire document	1-5, 26-28, 34, 35, 46-51, 57, 58, 85
A	US 2022/0169554 A1 (SAINT-GOBAIN GLASS FRANCE) 02 June 2022 (02.06.2022) entire document	1-5, 7, 8, 14, 15, 22, 23, 26-28, 34-36, 46-55, 57, 58, 60-65, 77-82, 85
A	US 5,639,543 A (ISODA et al.) 17 June 1997 (17.06.1997) entire document	1-5, 7, 8, 14, 15, 22, 23, 26-28, 34-36, 46-55, 57, 58, 60-65, 77-82, 85
A	US 5,464,491 A (YAMANAKA) 07 November 1995 (07.11.1995) entire document	1-5, 7, 8, 14, 15, 22, 23, 26-28, 34-36, 46-55, 57, 58, 60-65, 77-82, 85

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent 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 when the document is taken alone
"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

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 2023	OCT 30 2023
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Taina Matos Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/025923

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 6, 9-13, 16-21, 24, 25, 29-33, 37-45, 56, 59, 66-76, 83, 84
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet(s).

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/025923

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-5, 7, 8, 14, 15, 22, 23, 26-28, 34-36 and 46-50, is drawn to a method comprising: dispensing a plurality of strands of a molten polymeric material.

Group II, claims 51-55, 57, 58, 60-65, 77-82 and 85, is drawn to an assembly comprising at least one of: a first sub-assembly comprising: a conveyor to convey a product, and a plurality of shaping tools attached to the conveyor to shape the product as the product is conveyed along the conveyor.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: dispensing a plurality of strands of a molten polymeric material; and applying a force on the plurality of strands via one or more shaping assemblies as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: a first sub-assembly comprising: a conveyor to convey a product, and a plurality of shaping tools attached to the conveyor to shape the product as the product is conveyed along the conveyor; a second sub-assembly comprising: a pair of spaced apart conveyors to convey the product therebetween, and an actuator in cooperation with the pair of conveyors to vary the spacing between the pair of conveyors to shape the product as the product conveyed; a third sub-assembly comprising: an actuator array comprising one or more actuators, each actuator deployable to contact the product, and a controller configured to control a position of each actuator to contact and shape the product as the product is moved past the actuator array as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a shaping assembly comprises at least one of: one or more nozzles, one or more shaping conveyors, and/or one or more actuator assemblies, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2022/0169554 to SAINT-GOBAIN GLASS FRANCE teaches a shaping assembly comprises at least one of: one or more nozzles, one or more shaping conveyors, and/or one or more actuator assemblies (These nozzles are connected to box structures 70 that supply them with the necessary air. The glass is thus fixed just after it has been bent. The air is blown starting at the first pairs of bending rollers 73. On leaving the shaping and tempering assembly, the sheets of glass tip onto a conveyor 71. The sheets of glass 81 are then evacuated by a flat conveyor 72 that passes through a secondary cooling zone 93, para. 0043).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.