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(54) METHOD OF PRODUCING FOAMED PLASTIC CUSHION OR THE LIKE HAVING INTEGRAL SHEET MATERIAL COVER AND APPARATUS THEREFOR

(71) We, THE UPJOHN COMPANY, a corporation of the State of Delaware, United States of America, of 301 Henrietta Street, Kalamazoo, Michigan 49001, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the apparatus by which it is to be performed, to be particularly described in and by the following statement:-

The invention relates to a method of and to apparatus for shaping a fabric or plastic sheet material in a suitable mold under differential pressure so as integrally to incorporate the shaped sheet as the cover or facing of a foamed plastic cushion, protective padding element or similar article. The sheet material may be plastic, fabric, or combination thereof, where in any event the material is naturally, or is made to be, non-pervious to passage of air through it so that it may be shaped in a suitable mold by differential pressure applied across opposite faces. The mold consists of cooperating molding dies of appropriate cavity configuration such that when a cover or facing sheet is supported in and shaped to conform to its respective molding die, two or more of these dies can be brought together to define a mold cavity completely lined by the cover sheets and forming an enclosure shaped to the desired configuration of the finished cushion, vehicle seat, dashboard padding, etc. The fabric or plastic sheet lined mold cavity is then injected with a self-foaming liquid plastic mix which expands in the enclosure to fill the same and provide the internal support for the finished product with its facing sheet integrally attached.

In the production of cushions as for example those for chairs, vehicle seats or the like, a method has been proposed in which a conventional foamed plastic material or rubber is filled into a casing made of rubber or thermoplastic material to form a cushion composition in the casing. The casing or cover is placed in a suitable mold configured to the desired shape of the finished article, and the mold is charged with elastomeric filler material while the casing is supported in the mold, whereby to keep the outline of the cushion. The casing itself consists of two or more three-dimensionally preshaped pieces which in their original condition are simply thin sheets. A disadvantage of this arrangement lies in the fact that a separate operation and apparatus are required to provide the preliminary shaping of the sheets into their desired configured form, something which represents additional labor requirements and increased complexity of production equipment. A further disadvantage of this prior production method resides in the fact that after gelling of the elastomeric material, it is not possible immediately to remove the finished cushion from the mold since subsequent processing is required, particularly as regards connection of the edges of the sheet members and subsequent trimming or finishing operations in respect to the junction at the parting line of the mold.

A similar method is disclosed in British Specification No. 1,239,219, wherein, as shown in Figure 2, a pair of separate flexible laminated covering materials are clamped together between two mold portions, and vacuum is applied through an aperture in one mold section to draw the adjacent laminate into close contact with the mould, before polyurethane foam-forming ingredients are introduced into the cavity. Such use of vacuum is especially recommended for less flexible laminates. The cushion with its integral covering is then removed from the mold portions.

Although this method of production avoids the disadvantage inherent in the previously mentioned method of separately preshaping the cover sheet, there is still a

difficulty in that the production of even, uniform extension or stretch in the facing material of the finished cushion presents practical problems. That is, when the facing sheet is initially subjected to pressure differential to preshape it to be mold cavity, the whole are of the facing sheet is more or less evenly stretched; but only those regions corresponding to the shallower regions of the mold cavity are brought into actual contact with the surface of the mold in this initial stage. However when the fabric contacts the shallower regions of the mold cavity, those regions of the cover sheet become locked by friction against further extension in the mold, even though adjacent regions then undergo further extension or stretching in order to conform them to the deeper regions of the mold cavity. This leads as a result to different degress of extension in different regions of the fabric and therefore to locally different thicknesses of the facing material on the finished cushion. In a finished product such as a cushion, therefore, it is just those parts which are subject to heaviest loading and wear which are covered by the thinnest regions of the facing sheet.

It has been proposed heretofore to overcome this difficulty and obtain an even thickness of the facing sheet throughout its surface by allowing the sheet to slide on the mold wall during the preshaping operation. However this is not readily possible, particularly in cases where the mold is highly contoured to provide substantially different levels in depth of the cavity. Nor is it practical to incorporate liquid or powdered lubrication between the cover sheet and the mold wall to allow slipping to occur more easily, as this causes fouling of the exposed surface of the finished cushion; it may also produce clogging of perforations in the mold wall required to transmit pressure to the undersurface of the facing material.

In order to deal with or at least reduce the abovementioned difficulties, it has heretofore been suggested to use a mold plunger, or a number of such plungers, which preliminarily depress the fabric toward the lower or deeper levels of the mold cavity before application of differential pressure to the cover fabric or facing sheet. By the use of such mold plungers the fabric is subjected initially to a more-or-less even deformation throughout its area while giving it a preliminary shape configured more nearly to the ultimately desired shape. As a result, when the cover fabric is brought into final contact with the total mold surface by differential pressure, there is only a comparatively small further deformation then required, so that undue stretching of the cover fabric is largely eliminated. As will be readily apparent however in the foregoing procedure, additional equipment for premolding or shaping of the cover fabric is required and this is relatively complicated and expensive. Furthermore, use of such preforming plunger equipment does not lend itself to automated, continuous molding operations employed in a production line consisting of a plurality of identical molding dies which continuously travel about an endless conveyor which advances the dies through successive processing stations and operations.

It has also previously been proposed (see British Patent Specification No. 1,456,492) to employ an elastically deformable perforated membrane of varying thickness between the fabric and the mold wall, wherein regions of the membrane corresponding to the deeper levels of the mold contour are thicker than those of the membrane corresponding to shallower levels of the mold contour. Owing to this thickness variation, the membrane has a correspondingly variable stretch capacity in its different regions, and this produces a relatively even stretch or extension of the cover sheet while the latter is frictionally held in engagement with the surface of the membrane so as to prevent lateral movement between them during the shaping and molding operations. A disadvantage with that method, however, is that it does not provide means for producing a totally covered cushion; that it, a cushion having both a front and a rear facing sheet, in one molding operation.

It is a general object of the present invention to provide further improvements in the foregoing methods of manufacture of resilient cushions or similar articles, such that a completely finished product of integral construction is produced in one sequence of operations. According to the invention there is provided a method of forming a cushion or similar product comprising a resilient elastomeric foam and a sheet material facing enclosing said foam and integrally secured thereto, which comprises:

providing a sack composed of two complementary, deformable air-impermeable facing sheets peripherally welded to an annular molded elastomeric frame strip and supporting said sack in complementary partible members of a mold, which members have molding surfaces defining, when the mold is closed, a cavity contoured to the desired shape of the finished product;

closing said partible members with said sack supported therein by its frame strip and applying a differential pressure to said mold to stretch said facing sheets and force them into conformity with said mold cavity;

introducing into said sack while thus conformed a self-foaming liquid polymer mix and allowing said mix to develop and fill said sack with resilient foam;

holding said foam-filled sack in said mold until said foam is sufficiently gelled and said sack walls are secured thereto; and

parting said mold members and removing said foam-filled product in desired configuration completely encased in said sheet material facing.

In this manner, there is produced an integrally constructed cushion or similar product in completely finished double-faced condition in a single apparatus without need for preliminary or subsequent operations.

The sack can be comprised in part of a sheet plastics material, more particularly PVC film, and in part of a textile or textile-like material suitably treated to make it impervious; or it may be formed entirely of the same type of facing material. A method is thus available for producing a cushion product, such as an automobile seat in which the seat and backrest portions are composed of textile sheet material while the side and back surfaces of the structure are formed of PVC film. It is also possible to modify this arrangement so as to make different areas of the seat or back portion of one fabric and surrounding areas of a different materal, which may be desirable for reasons of wear-resistance.

The annular frame strip is pre-formed and is adapted to be welded into and permanently incorporated in the enclosed sack and provides a particularly smooth junction of the cover sheets and attractive appearance of the finished cushion at the weld seam.

The method of the invention is readily adapted to include provision for incorporating a reinforcing structure, such as a metal frame with or without coil springs, directly into the molded cushion so as to integrally incorporate the same therewith.

According to the invention there is also provided an apparatus for forming by the aforesaid method a cushion or similar product, which apparatus comprises:

complementary partible mold members having molding surfaces defining in the closed condition of the mold a cavity contoured to the desired shape of the finished product;

means associated with said partible mold members for supporting the annular frame strip of the cushion, said supporting means comprising a plurality of lugs disposed to extend transversely of the parting plane peripherally about said mold cavity, said lugs being adapted to engage apertures in the priphery of said annular frame strip to support said frame strip intermediate said mold member;

at least one aperture for applying a differential pressure within said mold members to cause the facing sheets of a sack placed in the mold to be stretched into conformation with said molding surfaces; and

an aperture for introducing a self-foaming liquid polymeric mix through said mold members in said closed condition of the mold and between said facing sheets.

The membrane can be of constant or locally varied thickness, and may be either perforate or imperforate.

In order to provide a more detailed explanation, reference is now had to the following embodiments described with reference to the accompanying drawings, in which:

Figure 1 shows diagrammatically a cross-section through a mold half comprising part of a molding die wherein an elastic membrane is employed and a preformed facing sheet is clamped in position in the die ready for shaping.

Figure 2 is a similar view illustrating a subsequent stage in the molding process, wherein radiant heat is supplied together with differential pressure in preshaping the facing sheet.

Figure 3 is a diagrammatic cross-section through a complementary mold half adapted to be mated with that shown in Figures 1 and 2.

Figure 4 is a diagrammatic cross-section through the complete mold, illustrating the two mold halves being held in face-to-face position wherein the respective facing sheets and resilient membranes are in final condition of preshaping in the mold immediately prior to introduction of a self-foaming elastomeric mix.

Figures 1 to 4 only illustrate the invention when they are modified as shown in Figure 5 or Figure 6.

Figures 5 and *6* are fragmentary cross-sectional views of modified mold assemblies in accordance with the invention employing a resilient frame strip interposed in the parting plane of the mold for incorporation into the finished cushion.

Figure 7 is a cross-section of a sack structure of the type for use in the apparatus of Figures 5 or 6.

Figure 8 is a perspective view of a finished seat cushion of the type produced by the apparatus of Figure 5.

In Figure 1 of the drawings, one of the two halves of the mold is represented generally at 1 and comprises a mold box 2 having an internal mold wall 3 apertured to provide exhaust passages 4. The side or face of the mold half opposite to mold wall 3 is delimited by an elastic membrane 6 which is held securely upon edge pieces 8 by means of clamps 8A at the periphery of the mold bix 2; between membrane 6 and the arched mold wall 3 there is a hollow cavity. As here illustrated, membrane 6 is formed with perforations 5 which provide communication between the aforesaid cavity and the

undersurface of a facing sheet 9 placed on the exposed surface of membrane 6; however, the membrane 6 could be formed of suitable open-cell elastomeric material affording suitable porosity such that it is pervious to the pressure obtaining in the aforesaid cavity. The facing sheet 9 is held under a clamping frame 7 at the periphery of the mold; this frame 7 is adapted to be readily clamped in position and removed during the molding process to facilitate rapid application of the facing sheet and removal of the finished cushion, etc. at the completion of the molding operation.

In order to provide a pressure differential across the facing sheet in mold box 2, its interior space or cavity 10 below mold wall 3 is connected by conduit 11 to a suitable differential pressure source, such as a vacuum pump (not shown).

In Figure 3 of the drawings the complementary half of the complete mold is shown, being represented generally at 1'. Apart from the shaping and arching of its mold wall 3', mold half 1' is identical with its complementary mold half 1 and the corresponding parts are accordingly designated by the same number but with a prime appended thereto.

After the two facing sheets (e.g. PVC film) 9 and 9' have been clamped firmly on the respective perforated elastic membranes 6 and 6' of mold halves 1 and 1' by clamping frames 7 and 7', the shaping of the facing sheets may be initiated by application of vacuum to the respective molds and by simultaneously subjecting them to softening by radiant heaters 12, as represented diagrammatically in Figure 2. As soon as the desired facing sheet temperature has been reached, the mold halves are pressed together in complementary, closed relation as shown in Figure 4 so that the sheets become welded together at the periphery of the mold cavity, so that the sheets form a closed sack. The shaping of the facing sheets to the configuration of the mold cavity is then completed by further application of vacuum to the respective mold halves, via conduits 11, 11'. As this shaping operation takes place, the facing sheets are constantly held in engagement with respective membranes 6 and 6' by the action of the vacuum transmitted through passages 5 and 5' of the respective membranes, and the interfacial friction thus developed between the membranes and facing sheets prevents any lateral movement between them during the forming operation. As a result the extension of the facing sheets is directly controlled by the extension or stretching of the diaphragms.

After the foregoing preshaping operation is completed, a suitable liquid polymeric self-foaming resin mix, for example a polyurethane mix, is introduced into the cavity 20, as for example by an injection needle (not shown) adapted to enter the enclosure at an aperture in the parting plane of the mold. As the self-foaming reaction takes place, the resilient foam developed completely fills cavity 20 and also forms a secure bond with the respective facing sheets throughout the area of contact.

Upon completion of the foaming reaction, the mold halves are parted and clamping frames 7 and 7' are removed, whereupon the finished cushion can be stripped from the mold. Thus the finished cushion comprises a core of foam material totally enclosed by PVC or other sheet facing material on all surfaces. Apart from trimming off any excess flash resulting from peripheral extension of the facing sheets at the parting plane, no further processing of the cushion is needed.

In the method thus far described, membranes 6 and 6' are represented as having a constant thickness. Where greater degress of deep drawing of the facing sheets is required, it is preferable to employ a membrane having a varied thickness throughout its area, such that the thicker membrane regions are disposed to correspond to those regions where the degree of drawing or cupping is greatest, as disclosed in prior British Patent Specification No. 1,456,492. On the other hand, if the degree of drawing is less than that represented in Figures 1 to 4, it may be possible to dispense with the use of either or both of the membranes, as described in prior British Patent Specification No. 1,466,531. Furthermore, one or both of the resilient membranes may be provided with a low surface profile or embossment on its exposed surface (i.e. the surface contacted by the facing sheet) to simulate in the finished product a leather-like appearance or other desired configuration.

It is also possible, in order to increase the structural strength of the finished cushion, to incorporate a metal frame, with or without spring coils, directly into the cavity of the mold so that this frame assembly becomes fully embedded in the developed plastic foam.

As shown in Figures 5 and 6, in the invention the facing sheets are first formed into a sack together with a frame strip 13 of molded elastomeric (e.g. plastics) material and of annular shape which is previously welded together with facing sheets 9 and 9' in a suitable mold (not shown) to produce the pre-formed sack structure shown in Figure 7. The frame strip 13 gives a particularly smooth and pleasing appearance to the edges of the finished cushion. As here illustrated, the sack incorporates a filling opening 14 through which the self-foaming liquid plastic mix can be introduced.

The sack illustrated in Figure 7 is positioned in one of the two mold halves, which for this purpose is provided with lugs 15 adapted to be engaged in apertures 16 formed in the periphery of frame strip 13. An 0-ring seal 17 is provided for sealing the complementary mold halves 1 and 1', rather than relying on contact odf the elastic membranes 6, 6' with opposite faces of the frame strip 13 for this purpose.

After the sack incorporating the frame strip 13 has been placed in the mold as just described (attached to the mold by the lugs 15 passing through the paertures 16), and the mold closed, vacuum shaping of the facing sheets and insertion and foaming of the resilient foam filler takes place as described hereinabove in connection with Figures 1 to 4.

In Figure 5 the mounting arrangement of the sack is particularly adapted to the situation where the sack (as seen in the cushion of Figure 8) is composed of one facing sheet of one kind of material, such as textile, and another sheet of a different material, such as a thermoplastics sheet such as PVC film. Where the sack structure is composed of thermoplastics sheet on both faces, the mold apparatus is as shown in Figure 6 which includes a metallic frame 18 to which lugs 15' attached; 0-ring seals 17' are provided on each side of the frame 18. Such arrangement utilizing metallic frame 18 is of assistance in heating of the PVC film or other thermoplastics sheet of the sack before the sack is introduced into the mold.

Figure 8 illustrates in perspective a finished cushion produced by apparatus as shown in Figure 5, from which it can be seen that the seat surface or facing consists of textile or textile-like material, while the side, under and back surfaces of the seat (not shown) consist of plastic facing such as PVC film. The cushion represented in Figure 8 is produced in its mold in substantially fully finished condition, apart from trimming off any flash or projection of frame strip 13, on being removed from the mold.

Following previous conventional methods of manufacture for cushion surfacing structures, the sack structure of Figure 7 may also be produced by placing two pieces of fabric or film, formed into U-shapes, one inside the other like complementary box members, welding them together with a frame strip and then fixing them on one of the mold portions. Although this enables deeper cushions to be produced, the local degree of deep drawing is nevertheless extremely low, with the result that it is sometimes possible in this manner to dispense with a requirement for elastic membranes in the mold.

As will be gathered from the above description, the invention makes possible a substantial simplification and reduction in cost in the production of cushions, more particularly in the case of autmotive and aircraft cushions having some degree of contour complexity.

WHAT WE CLAIM IS:-

1. A method of forming a cushion or similar product comprising a resilient elastomeric foam and a sheet material enclosing said foam and integrally secured thereto, which comprises:

providing a sack composed of two complementary, deformable air-impermeable facing sheets peripherally welded to an annular molded elastomeric frame strip and supporting said sack in complementary partible members of a mold, which members have molding surfaces defining, when the mold is closed, a cavity contoured to the desired shape of the finished product;

closing said partible members with said sack supported therein by its frame strip and applying a differential pressure to said mold to stretch said facing sheets and force them into conformity with said mold cavity;

introducing into said sack while thus conformed a self-foaming liquid polymer mix and allowing said mix to develop and fill said sack with resilient foam;

holding said foam-filled sack in said mold until said foam is sufficiently gelled and said sack walls are secured thereto; and

parting said mold members and removing said foam-filled product in desired configuration completely encased in said sheet material facing.

2. A method as claimed in Claim 1, wherein said sack is composed of deformable sheet members of different materials.

3. A method as claimed in Claim 2, wherein the sack is composed of a sheet of a textile and a sheet of a plastics film.

4. A method as claimed in any preceding claim, wherein any thermoplastics sheet forming part of the sack is heated to soften it before the sack is placed in the mold.

5. A method as claimed in any preceding claim, wherein said mold members are each provided with an elastic membrane secured across its face so as to be disposed between the molding surface of the mold cavity and the wall of said sack, and said membranes are deformed elastically of the mold cavity under said differential pressure together with said sack walls during conformation thereof to the mold configuration.

6. A method as claimed in any preceding claim, wherein the frame strip is supported on a mold by means of a frame having lugs which pass through apertures in a peripheral flange of the frame strip.

7. A method of forming a cushion or similar product, substantially as hereinbefore described, with reference to Figures 1

to 7 of the accompanying drawings.

8. A method as claimed in any preceding claim, wherein a preformed reinforcing structure is contained within the sack and becomes embedded in the foam.

9. Apparatus for carrying out the mthod of Claim 1 for forming a cushion or similar product, which comprises:

complementary partible mold members having molding surfaces defining in the closed condition of the mold a cavity contoured to the desired shape of the finished product;

means associated with said partible mold members for supporting the annular frame strip of the cushion, said supporting means comprising a plurality of lugs disposed to extend transversely of the parting plane peripherally about said mold cavity, said lugs being adapted to engage apertures in the periphery of said annular frame strip to support said frame strip intermediate said mold members;

at least one aperture for applying a differential pressure within said mold members to cause the facing sheets of a sack placed in the mold to be stretched into conformation with said molding surfaces; and

an aperture for introducing a self-foaming liquid polymeric mix through said mold members in said closed condition of the mold and between said facing sheets;

10. Apparatus as claimed claim 9, which includes an elastic membrane secured across the face of each of said partible mold members in confronting relation to the respective mold cavity therein, said membranes being adapted and arranged to deform elastically inwardly of their respective mold members upon establishment of a differential pressure in said molding members and to conform to said mold cavity configuration.

11. An apparatus for forming a cushion or similar product, substantially as hereinbefore described with reference to Figures 1 to 4 as modified by Figure 5 and 6 of the accompanying drawings.

12. A cushion or similar product whenever produced by a method, or in an apparatus, as claimed in any preceding claim.

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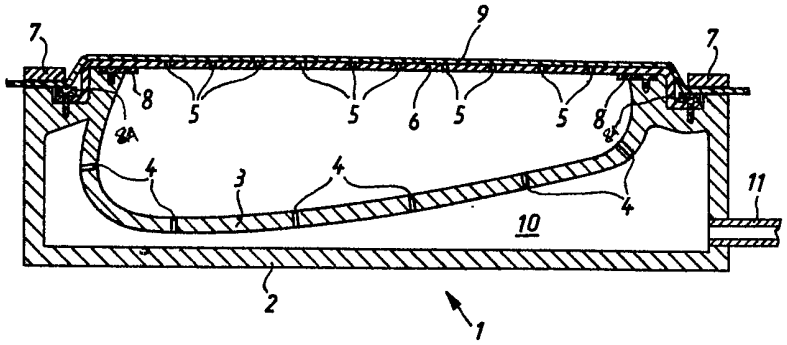
1560565 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig. 1



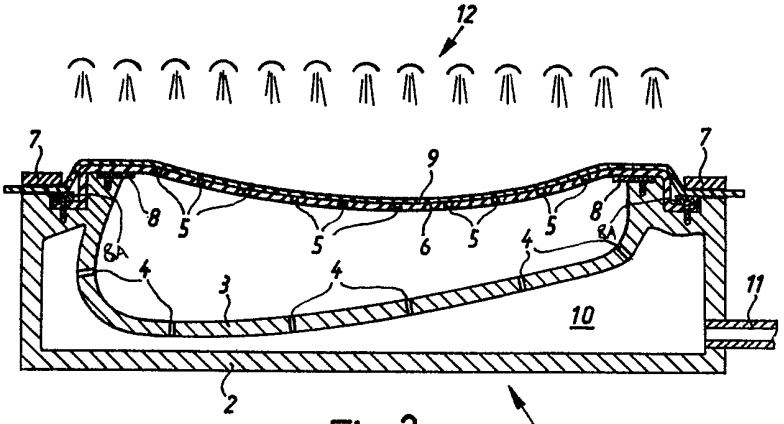


Fig. 2

Fig. 3

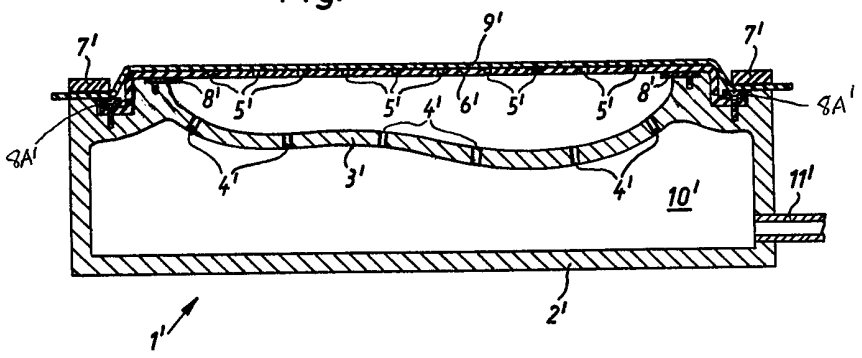

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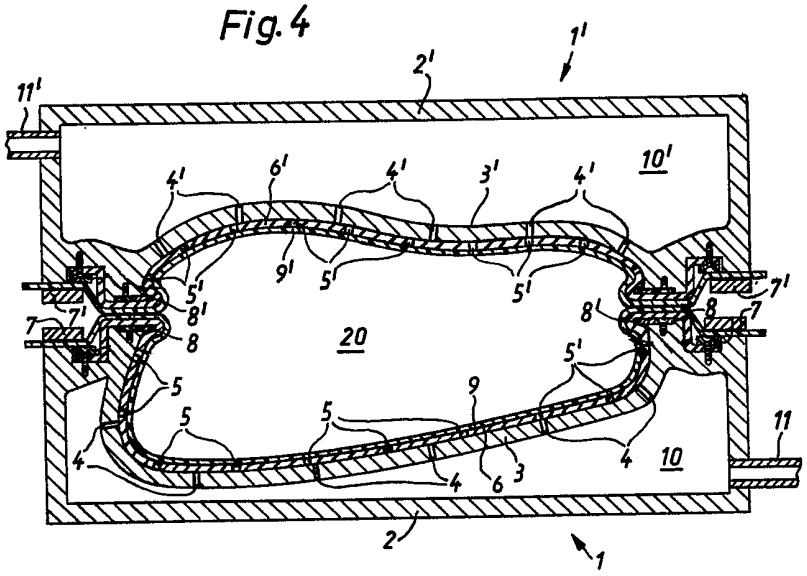
Fig. 4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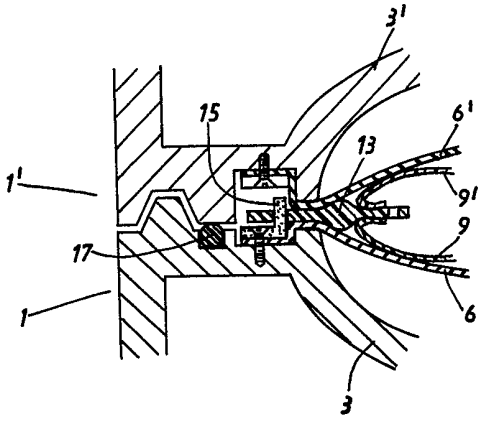

Fig. 5

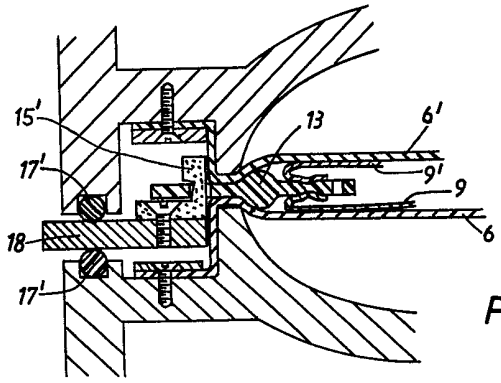

Fig. 6

Fig. 7

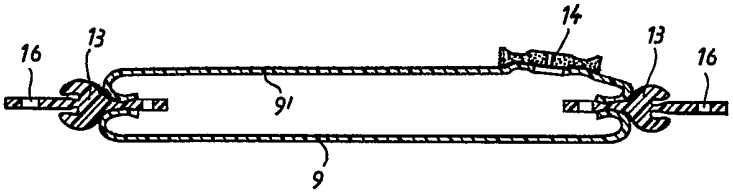

Fig. 8