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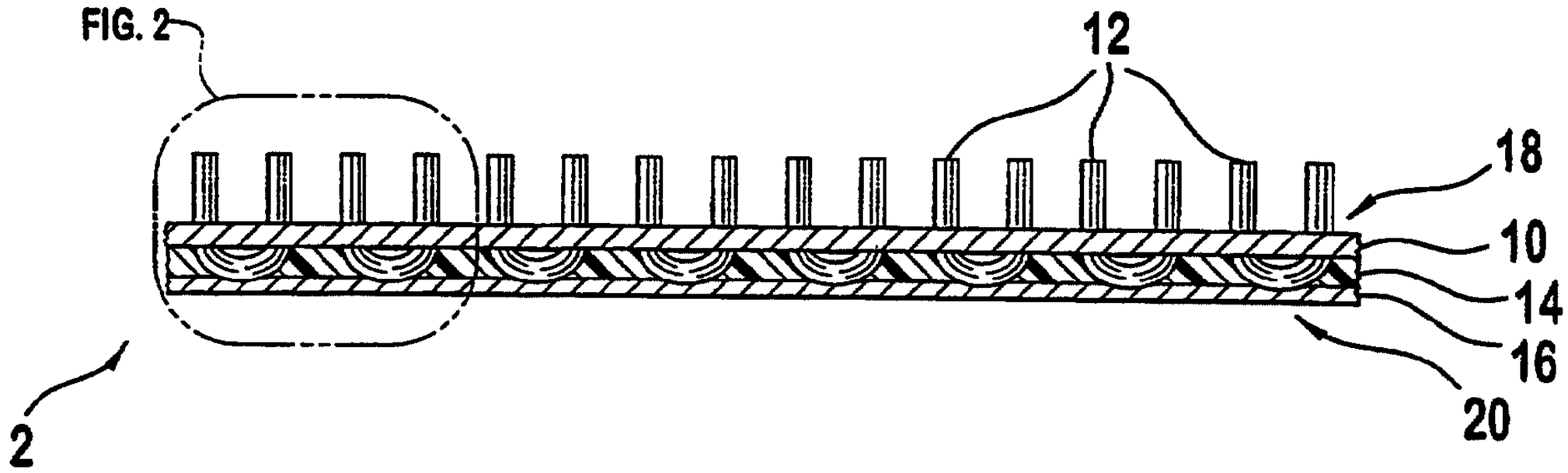
(72) Inventeurs/Inventors:
PRICE, BURTON J., US;
WHITAKER, G. MICHAEL, US;
KNISS, KURT ALAN, US

(73) Propriétaire/Owner:
MAGEE RIETER AUTOMOTIVE SYSTEMS, US

(74) Agent: KIRBY EADES GALE BAKER

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(57) Abrégé/Abstract:
The present invention provides a sound insulating structure cover panel that compliments the sound attenuation material. The method of manufacturing the panel comprises the steps of providing a laminated blank (2) having an interior face which will be observable from the passenger compartment. The side opposite the interior face of the blank has a generally non-permeable polymeric layer (14) adjacent to a primary backing (10) and a secondary backing layer (16) overlying the polymeric layer. In the preferred process, the previously described blank is elevated to a desired temperature and positioned in a closed forming mold (62) such that the perimeter of the blank is retained in a fixed position. The forming mold is closed with a controlled pressure that is sufficient to expand the blank, conform it to the mold and render a panel having a desired permeable.

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(71) Applicant: MAGEE RIETER AUTOMOTIVE SYSTEMS [US/US]; 480 West Fifth Street, Bloomsburg, PA 17815 (US).

(72) Inventors: PRICE, Burton, J.; 6 Blue Jay Drive, Bloomsburg, PA 17815 (US). WHITAKER, Michael, G.; 10 W. 5th Street, Bloomsburg, PA 17815 (US). KNISS, Kurt, Alan; 16 Country Road, Lewisburg, PA 17837 (US).

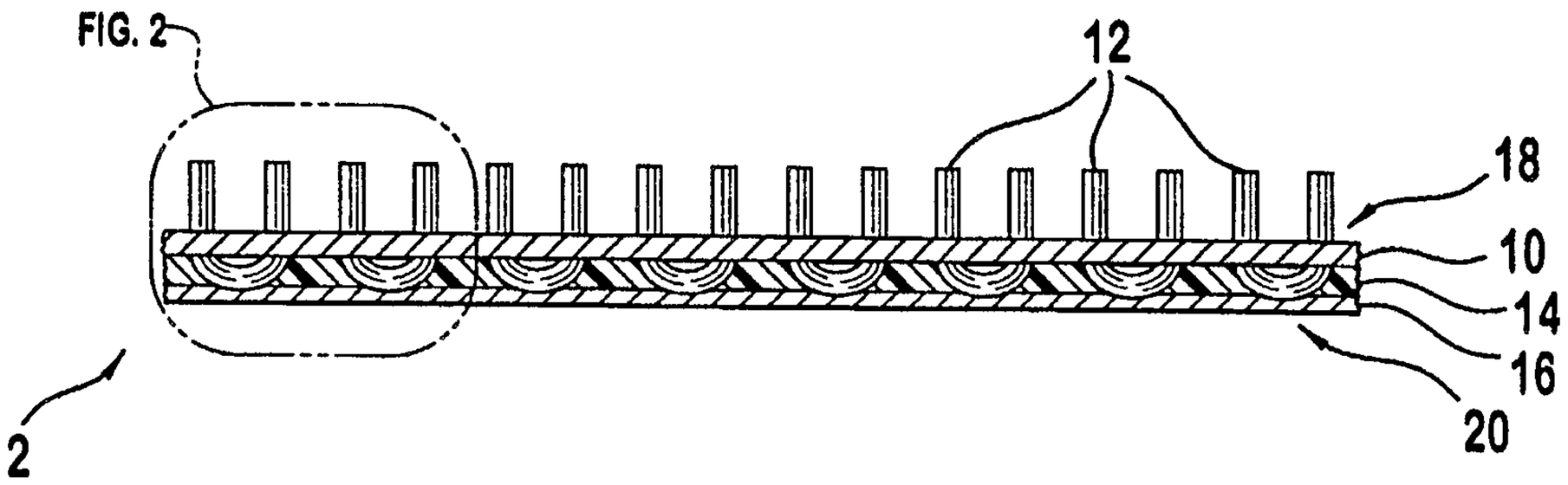
(74) Agents: VOLPE, Anthony, S. et al.; Volpe and Koenig, P.C., Suite 400, One Penn Center, 1617 John F. Kennedy Boulevard, Philadelphia, PA 19103 (US).

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(54) Title: METHOD FOR MANUFACTURING A SOUND INSULATING STRUCTURE AND THE STRUCTURE PRODUCED THEREBY

FIG. 2



(57) Abstract

The present invention provides a sound insulating structure cover panel that compliments the sound attenuation material. The method of manufacturing the panel comprises the steps of providing a laminated blank (2) having an interior face which will be observable from the passenger compartment. The side opposite the interior face of the blank has a generally non–permeable polymeric layer (14) adjacent to a primary backing (10) and a secondary backing layer (16) overlying the polymeric layer. In the preferred process, the previously described blank is elevated to a desired temperature and positioned in a closed forming mold (62) such that the perimeter of the blank is retained in a fixed position. The forming mold is closed with a controlled pressure that is sufficient to expand the blank, conform it to the mold and render a panel having a desired permeable.

METHOD FOR MANUFACTURING A SOUND INSULATING STRUCTURE AND THE STRUCTURE PRODUCED THEREBY

BACKGROUND OF INVENTION

Field of the Invention

The present invention generally relates to trim panels used to cover the interior surfaces of a vehicle. The invention more particularly relates to panels used to cover the interior surfaces of a passenger vehicle where sound attenuation is desired. The invention most particularly relates to panels which are used in passenger vehicles where appearance and sound attenuation are required. Such panels are employed as the head liners, wall liners and carpets of a vehicle for the purpose of improving appearance, temperature and sound control while enhancing the passengers' driving pleasure.

Description of the Prior Art

The use of trim panels and carpet panels to provide passenger comfort are well known in the art. For example, see U.S. Patents 4,741,945; 4,508,774; and 5,334,338. In addition, the use of these known manufacturing techniques employed by the present invention for producing standard floor covering is also known. See U.S. Patent 5,855,981.

Early efforts at sound attenuation in vehicles generally relied upon heavy, dense materials which would resist the entry of exterior noises into the passenger cabin. However, experience with such materials led to concerns about the

transmission of vehicle vibrations and other sounds based upon the heavy insulating materials. Accordingly, the art has recently considered the use of ultralight, multifunctional, sound-insulating materials. For example, see WO 98/18656 and WO 98/18657.

More recently, it has been determined that ultralight, multifunctional, sound-insulating materials may not achieve their full benefit when used with exterior cover materials that do not compliment their function. Accordingly, the art desired an exterior or decorative cover material which permitted controlled sound transmission to the interior of the vehicle. It has been theorized that permitting transmission of some sound into the cabin will result in sound cancellation and a more pleasing passenger environment. As a result of the more pleasing environment, the use of ultralight materials will be greatly enhanced and a reduction in vehicle weight will be recognized without any decrease in cabin comfort.

SUMMARY OF THE INVENTION

The present invention provides a sound insulating structure cover panel that compliments the sound attenuation material. The method of manufacturing the panel comprises the steps of providing a laminated blank having an interior face which will be observable from the passenger compartment. The side opposite the interior face of the blank has a generally non-permeable polymeric layer adjacent to a primary backing and a secondary backing layer overlying the polymeric layer.

In the preferred process, the previously described blank is elevated to a desired temperature and positioned in a closed forming mold such that the perimeter of the blank is retained in a fixed position. The forming mold is closed with a controlled pressure that is sufficient to expand the blank, conform it to the mold and render a panel having a desired permeable. Preferably, the post formation panel has a permeability of 500 rayls or less as measured on concentric air flow resistance equipment (C.A.R.E. unit) available from Rieter Automotive North America, Inc. 38555 Hills Tech Drive, Farmington Hills, MI 48331.

In accordance with one aspect of the present invention there is provided a process for manufacturing a sound insulating structure comprising: a textile material having interior and exterior sides, a generally non-permeable polymeric layer overlying the exterior side and a backing layer overlying the polymeric layer to form a laminated product; the process characterized by presenting the laminated product to a forming mold such that the perimeter of the product is retained in a fixed position relative to the mold; closing the forming mold under a controlled pressure, heat and time cycle sufficient for expanding the product to conform the product to the mold and to render a permeable sound insulating laminated product; and curing the permeable laminated product.

In accordance with another aspect of the present invention there is provided a laminar assembly comprising: a backing with an exterior surface; a plurality of tufts embedded in the backing; a layer of a polymeric material overlying at least part of the

exterior surface of the backing; a secondary substrate located adjacent the layer of the polymeric material, opposite from the backing; characterized in that at least a portion of the polymeric material is disposed within the plurality of tufts and defines a plurality of voids between the plurality of tufts which results in a permeable laminar assembly.

In accordance with yet another aspect of the present invention there is provided a laminated vehicle sound insulating carpet panel comprising: a backing layer having a plurality of textile tufts embedded therein to establish interior and exterior faces of the backing layer, a layer of a polymeric material disposed on the exterior face of the backing material, the panel characterized by a portion of the polymeric material being disposed in the plurality of textile tufts and defining a plurality of voids, the carpet panel having a permeability of no more than 500 rayls ($N.s/m^3$).

In accordance with still yet another aspect of the present invention there is provided a process for manufacturing a sound insulating structure comprising: a textile panel having interior and exterior faces, a generally non-permeable polymeric layer overlying the exterior face and a backing layer overlying the polymeric layer; characterized by preheating the panel to a controlled temperature; positioning the preheated panel in a forming mold such that the perimeter of the panel is retained in a fixed position relative to the mold; closing the forming mold with controlled pressure

sufficient for expanding the panel to conform it to the mold and to produce a desired permeability through the panel; and allowing the panel to cool.

In accordance with still yet another aspect of the present invention there is provided a laminar textile assembly comprising: a backing layer having a plurality of textile tufts embedded therein to establish interior and exterior faces of the backing layer; and a layer of a polymeric material disposed on the exterior face of the backing material, the assembly characterized by the polymeric material defining a plurality of voids between the plurality of textile tufts and portions thereof being disposed in textile tufts.

In accordance with still yet another aspect of the present invention there is provided a process for manufacturing a sound attenuation panel comprising: providing a textile material having interior and exterior sides, a polymeric layer overlying the exterior side and a backing layer overlying the polymeric layer to form a generally non-permeable laminated product; heating the laminated product to a sufficient temperature to cause the polymeric layer to flow into the textile material; presenting the laminated product to a forming mold such that the perimeter of the laminated product is retained in a fixed position relative to the mold; and closing the forming mold under a controlled pressure, heat and time cycle sufficient to conform the laminated product to the mold and to render an expanded permeable sound attenuation panel

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a known carpet construction which is suitable for use with the present invention.

Figure 2 is an enlargement of the construction within the phantom lines of **Figure 1**.

Figure 3 is an enlargement, similar to **Figure 2**, showing the wicking-in of the polymeric layer in the construction of the present invention as described in the exemplary embodiment of **Figure 1**.

Figure 4 illustrates the wicking-in of **Figure 3** within the tufts of yarn.

Figure 5 illustrates a continuous operation for stretching and molding a panel in accordance with the present invention.

Figure 6 illustrates a heating table for use with a preferred manufacturing process.

Figure 7 illustrates a mold assembly in accordance with the invention.

Figure 8 illustrates a panel in the final molding and cooling stage.

Figure 9 illustrates a molded and cooled panel prior to trimming.

DETAILED DESCRIPTION OF THE INVENTION

The invention will be described with reference to the drawing figures wherein like numbers indicate like elements throughout. It will be appreciated by those skilled in the art that the drawing figures are not to scale and liberties have been taken to permit illustration of the invention.

With reference to **Figure 1**, there is shown a material blank **2** wherein a backing layer **10,** of woven or non-woven construction, is used as a support base for a plurality of yarn tufts **12**. Each of the yarn tufts **12** is comprised of a plurality of yarns in either a spun or filament construction. After the insertion of tufts **12** into the backing **10**, the tufted assembly may be subjected to color and finishing operations before an extrusion coating process which places a polymeric layer **14** on the underside thereof. Finally, a backing layer **16**, generally a porous, non-woven material, is applied to the polymeric layer **14**. This construction will be known to those in the art. As a result of this construction, the resulting laminate will have a face surface **18** which will be the interior surface and a backing surface

20 which will be the exterior surface. For use in the automotive industry, the laminated material is cut into a blank that is subjected to a molding process for producing a post formation panel of a desired geometry in accordance with the vehicle body geometry. Such a construction is known to those skilled in the art and does not form any part of the present invention.

Although the above-described construction of the laminate and the panels are known to those skilled in the art, the present invention differs from the known constructions in the selection of materials for polymeric layer **14** and the post formation process parameters used to form the panels. In keeping with the present invention, the polymeric layer **14** is comprised of a high melt flow polymer which will provide the desired response to the subsequent processing in accordance with the invention. Test materials and panels used to demonstrate the present invention are described below.

The tufted assemblies used for testing were produced by tufting continuous filament yarns of 1400 denier or 1405 denier BCF nylon yarns into non-woven primary backing substrates of 120 g/m^2-140g/m^2 polyester fiber. If desired, spun or other yarn constructions may be used. Tufting machine gauges of 1/8 gauge and 1/10 gauge have been evaluated. It will be recognized by those skilled in the art that machine gauge stitches per inch and stitch pile height combine to determine the overall carpet construction and density. The number of penetrations per square inch is a factor in determining the available porosity and the wicking-in ability of the

construction. The available porosity is an important aspect of the invention because the final product of the preferred embodiment must meet the aesthetic and durability standards set by the vehicle manufacturer. As the construction is altered, the percentage of expansion to achieve the desired post formation product may need to be modified.

The tufted assemblies of the tests were extrusion coated, using known techniques, with a low density polyethylene coating **14** and laminated with a light weight secondary non-woven polyester substrate. A polyethylene coating **14,** of AT 193, available from A. T. Plastic, Inc. of Ontario, Canada, applied between 375-400 g/m^2 has been used successfully with a known 13-17 g/m^2 secondary polyester substrate **16**.

The secondary substrate **16** is laminated directly to the polyethylene **14** using a standard nip roll, in accordance with prior practices. The temperature of the polyethylene extruding from the die is approximately 400°F. The nip pressure, for a laminate of approximately .250 inches, at the rolls was approximately 50 pounds per linear inch and the nip setting was approximately .030 inches. The chill roll temperature was in the range of 55-70°F, and the process line speed varied between 25-40 FPM. At this point, the laminated material was either rolled up or cut into blanks in preparation for the molding operation. Although this laminated material is still non-permeable, it is correctly prepared for the subsequent process which will render it permeable.

In order to form a finished panel, a specific blank size was cut and heated prior to molding. Through reheating of the carpet laminate, the polymeric layer **14** begins wetting out or wicking-in, see **Figures 3** and **4**. This causes the polymeric layer 14 to flow into the primary backing **10** and the tufts **12** and initiates the creation of voids **15** between the tufts **12**. This is the beginning of the transformation from a non-permeable to a permeable laminate. The voids **15** that are formed in the polymeric layer **14** result in the laminate being permeable. The transformation to the desired permeability was achieved by stretching, molding and curing the heated laminate.

Heating of the material **2** for 25-30 seconds under a heat intensity of 10 to 15 watts per square inch of material has been found to provide a satisfactory temperature elevation with the test material. By heating the back surface **20** to a temperature between 325°-350°F, the polymeric layer **14** can be worked without causing melt flow or a loss of adhesion. The heated blank was molded in a chilled molding tool at approximately 1.5 to 4.0 PSI of mold pressure and 45°F. The approximate cool down time in the molding tool was forty-five (45) seconds. In the test material, these conditions produced a controlled stretch of seven to ten percent (7-10%) of the blank size. Upon removal from the mold, a face panel with the desired air permeability had been produced.

With reference to **Figures 5** through **9**, the manufacturing process, as used to produce test samples and as envisioned for production quantities, will be described. As illustrated in **Figure 5**, the material moves from a supply roll to a

heating table **(Figure 6)** through a mold **(Figures 7** and **8)** and is off loaded or further processed as a panel **(Figure 9)**.

In **Figures 5** and **6**, a supply roll **40** of laminated blank material **2** is secured to a tenter frame **46** which has material retaining means **48** spaced in accordance with the desired blank perimeter. The retainer means **48** may be pins, clips or other holding means to grip the material and establish the length and width of the blank. They preferably are adjustable or removable to provide a cutting gap **50** where a transverse cutter **51** can cut the blank from the supply roll **40**. The blank passes over the heating table **52** beneath a plurality of heating elements **54** which are selected in accordance with the construction of the laminated blank material **2** so as to achieve the desired temperature. It is expected that the elements at the entrance **56** will be selected to rapidly elevate the temperature while the elements at the exit **58** will be selected to achieve equalization at a desired temperature.

In **Figure 7**, the heated panel **60** is presented to the refrigerated mold **62** which has a movable, pressure applying half **64** and a stationary refrigerated half **66**. While being held by the retainers **48,** the blank **60** is aligned over the mold as it is closed at the desired pressure to stretch the generally planar blank **60** over the contour of the mold. It will be recognized by those skilled in the art that the mold **62** is configured, in both halves **64** and **66**, to the geometry of the vehicles floor board. When the mold **62** is finally closed, as illustrated in **Figure 8**, the blank **60** might be repositioned in the mold **62**, however, the original perimeter of the blank

will remain substantially unchanged. After the molded panel **70** is released from the mold, **Figure 9,** it may continue to a subsequent processing operation as described hereinafter, or the perimeter may be trimmed to provide a finished and cut to size molded panel.

The test samples produced for this invention were made with the use of piece goods that were presented to the heating table and molded through a hand operation. In this operation, the heated blank was manually placed over a stationary tenter frame adjacent to the mold and the mold was manually emptied when the stretching and molding operation had been completed.

Permeability of the test samples was established by using a C.A.R.E. unit. On average, three readings were taken in four locations on each sample to establish that the panel had achieved the desired permeability. Generally, for automotive purposes, it is preferred to take the test reading in the flat of the foot wells or the base of the panel. In any event, it is preferred that the reading be taken in an area more representative of the mold extension. Thus, a flat portion directly over the tunnel may not be fairly representative. In addition to the above, the use of a well base also provides the practical advantage of being accessible and supportable. It is important to support the sample on a firm but open surface, such as a mesh table, that will not restrict air flow, so the test equipment can be applied firmly.

As noted previously, this invention was motivated by the desire to enhance the use of ultralight material as described in WO98/18656 and WO98/18657. In keeping

with the effort to achieve the maximum benefits of this combination, the assembly of the panel **70** to the ultralight material will be described. Since the combined components must maintain the permeability of the entire sound insulation assembly within a specified range, they must be carefully adhered together. One acceptable adhesive is available from National Starch as item 34-3378 with a melt viscosity of 1500-2125 centapoise at an application temperature of approximately 400°F. An application of hot melt adhesive in the range of 7-9 gm/Ft.^{2} has found to be successful in adhering the components while maintaining the desired permeability.

The adhesive which may be applied to either the carpet or the insulator, preferably, is in a randomized web. This randomized application assures adhesive bonding in all areas without restricting the permeability. The two components should be aligned for accuracy before bonding to prevent multiple positioning attempts which diminish the adhesion and disturb the permeability. The assembly press used to assure physical bonding of the components has preset stops which limit the forces on the components and prevents compression of the sound insulator beyond that needed for adhesion and maintains the assembly's permeability characteristics. Based on the test samples, the assembled components should be compressed with a force that will not compress the ultralight material beyond its specified finished part thickness by more than 2mm. This avoids a compression from which the ultralight material may not rebound.

It will be recognized by those skilled in the art that the automotive industry has specifications and test methods for product performance and durability that must be met by the product in the field. The panels produced in accordance with the present invention have met these product and test specifications.

CLAIMS

1. A process for manufacturing a sound insulating structure comprising:

a textile material having interior and exterior sides, a generally non-permeable polymeric layer overlying the exterior side and a backing layer overlying the polymeric layer to form a laminated product;

the process characterized by presenting the laminated product to a forming mold such that the perimeter of the product is retained in a fixed position relative to the mold;

closing the forming mold under a controlled pressure, heat and time cycle sufficient for expanding the product to conform the product to the mold and to render a permeable sound insulating laminated product; and

curing the permeable laminated product.

2. The process of claim 1 further characterized by the step of closing the forming mold comprises closing the forming mold under a controlled pressure, heat and time cycle sufficient for expanding the product to conform the panel to the mold and to render the laminated product permeable with a permeability of 500 rayls ($N.s/m^3$) or less.

3. A laminar assembly comprising:

a backing with an exterior surface;

a plurality of tufts embedded in the backing;

a layer of a polymeric material overlying at least part of the exterior surface of the backing;

a secondary substrate located adjacent the layer of the polymeric material, opposite from the backing;

characterized in that at least a portion of the polymeric material is disposed within the plurality of tufts and defines a plurality of voids between the plurality of tufts which results in a permeable laminar assembly.

4. A laminated vehicle sound insulating carpet panel comprising:

a backing layer having a plurality of textile tufts embedded therein to establish interior and exterior faces of the backing layer, a layer of a polymeric material disposed on the exterior face of the backing material, the panel characterized by a portion of the polymeric material being disposed in the plurality of textile tufts and defining a plurality of voids, the carpet panel having a permeability of no more than 500 rayls ($N.s/m^3$).

5. A process for manufacturing a sound insulating structure comprising:

a textile panel having interior and exterior faces, a generally non-permeable polymeric layer overlying the exterior face and a backing layer overlying the polymeric layer;

characterized by preheating the panel to a controlled temperature;

positioning the preheated panel in a forming mold such that the perimeter of the panel is retained in a fixed position relative to the mold;

closing the forming mold with controlled pressure sufficient for expanding the panel to conform it to the mold and to produce a desired permeability through the panel; and

allowing the panel to cool.

6. The process of claim 5 further characterized by the step of closing the forming mold being performed with controlled pressure sufficient for expanding the panel to conform it to the mold and to produce a permeability of 500 rayls ($N.s/m^3$) or less as measured by concentric air flow resistance equipment.

7. A laminar textile assembly comprising:

a backing layer having a plurality of textile tufts embedded therein to establish interior and exterior faces of the backing layer; and

a layer of a polymeric material disposed on the exterior face of the backing material, the assembly characterized by the polymeric material defining a plurality of voids between the plurality of textile tufts and portions thereof being disposed in textile tufts.

8. The laminar textile assembly of claim 7 further characterized as an automotive vehicle carpet assembly comprising a secondary substrate disposed adjacent to the polymeric material.

9. The laminar textile assembly of claim 8 further characterized by the laminar textile assembly having a permeability of 500 rayls ($N.s/m^3$) or less.

10. A process for manufacturing a sound attenuation panel comprising:

providing a textile material having interior and exterior sides, a polymeric layer overlying the exterior side and a backing layer overlying the polymeric layer to form a generally non-permeable laminated product;

heating the laminated product to a sufficient temperature to cause the polymeric layer to flow into the textile material;

presenting the laminated product to a forming mold such that the perimeter of the laminated product is retained in a fixed position relative to the mold; and

closing the forming mold under a controlled pressure, heat and time cycle sufficient to conform the laminated product to the mold and to render an expanded permeable sound attenuation panel.

11. The process of claim 10 wherein the textile material comprises an assembly of continuous filament yarns tufted into a backing substrate.

12. The process of claim 10 further comprising the step of cooling the laminated product to 55 - 70 degrees F. before heating the laminated product.

13. The process of claim 10 wherein the step of heating the laminated product comprises heating the laminated product for 25 - 30 seconds under a heat intensity of 10 - 15 watts per square inch of the laminated product.

14. The process of claim 10 wherein the controlled pressure, heat and time cycle comprises 1.5 - 4.0 PSI of pressure at a temperature of about 45 degrees F. for about 45 seconds.

15. The process of claim 10 wherein the sound attenuation panel is expanded by 7 - 10 percent over the laminated product.

16. The process of claim 10 wherein the forming mold is refrigerated.

17. The process of claim 10 wherein heating step causes wicking of the polymeric layer into the textile material.

18. A process for manufacturing a sound attenuation panel comprising:

providing a textile material having interior and exterior sides, a polymeric layer overlying the exterior side and a backing layer overlying the polymeric layer to form a generally non-permeable laminated product;

heating the laminated product for 25 - 30 seconds under a heat intensity of 10 - 15 watts per square inch of laminated product to cause wicking of the polymeric layer into the textile material;

presenting the laminated product to a forming mold such that the perimeter of the laminated product is retained in a fixed position relative to the mold;

refrigerating the forming mold to a temperature of 45 degrees F.; and

closing the forming mold under 1.5 - 4.0 PSI of mold pressure for about 45 seconds to conform the laminated product to the mold and to render a permeable sound attenuation panel that is expanded by 7 - 10 percent over the laminated product.

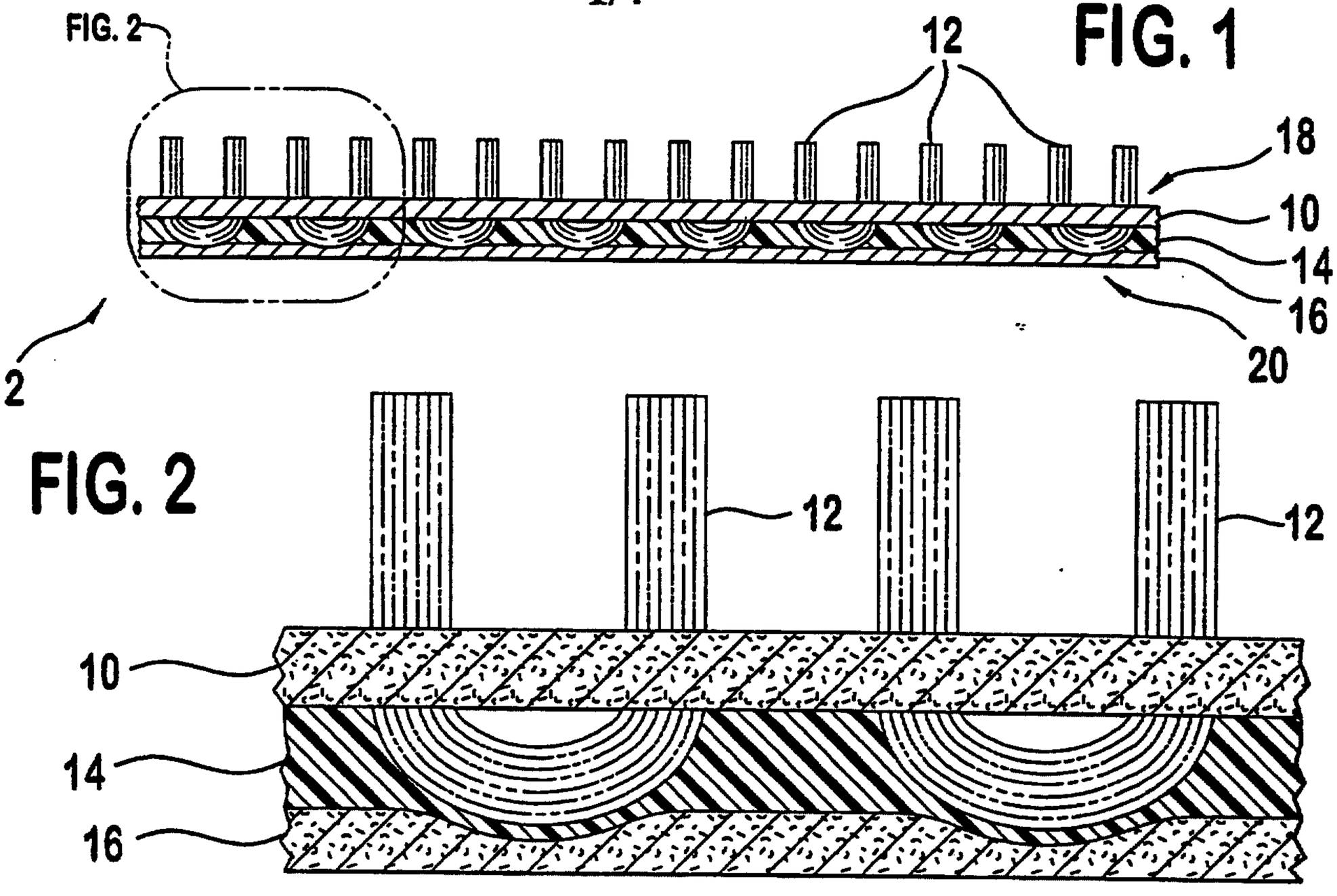


FIG. 1

FIG. 2

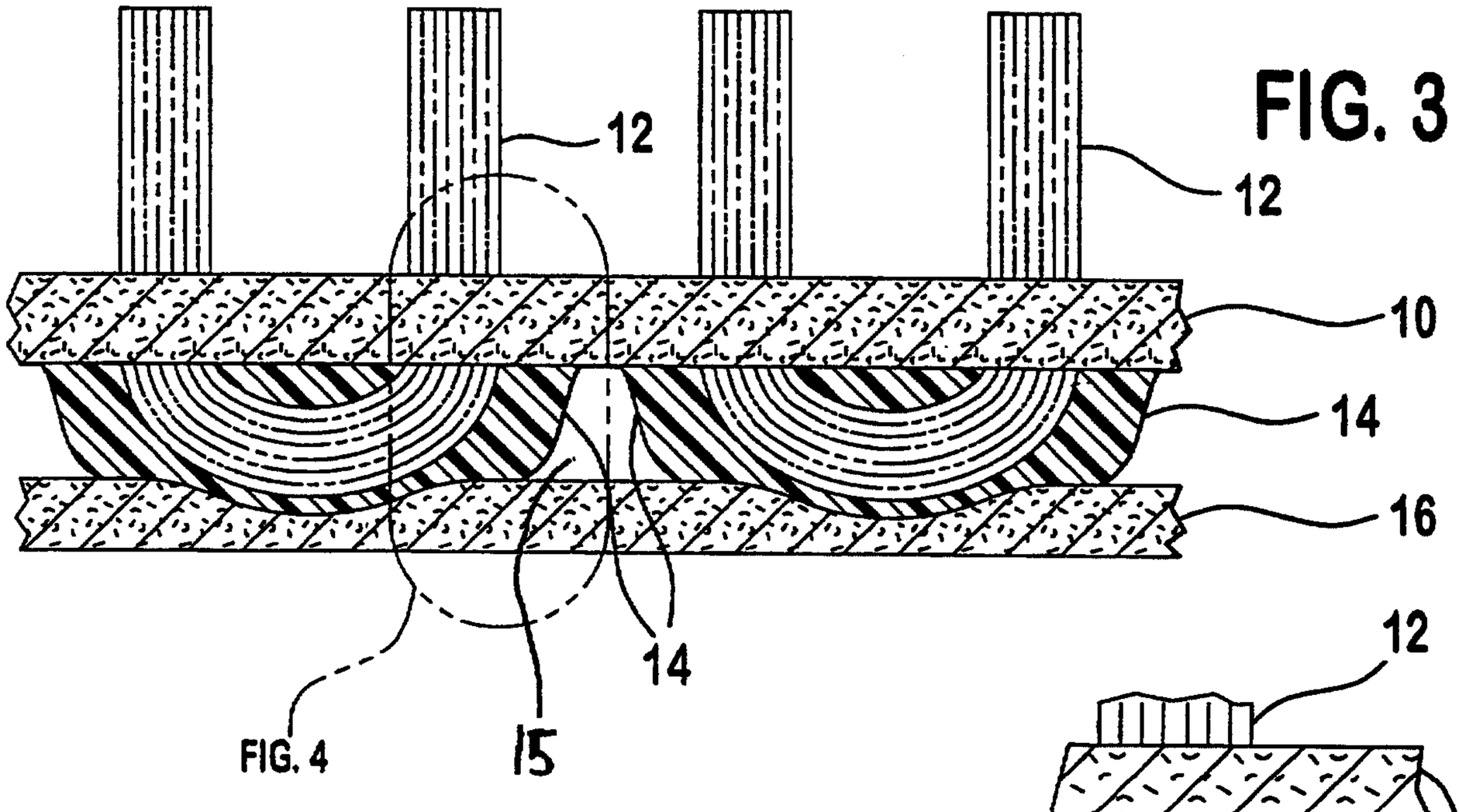


FIG. 3

FIG. 4

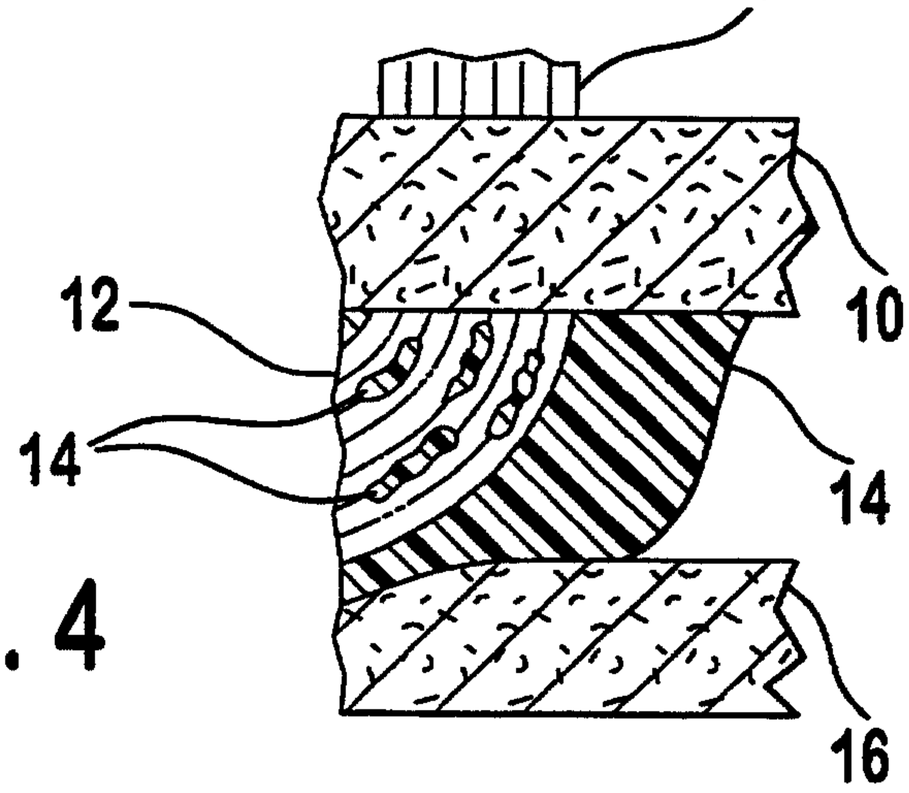


FIG. 4

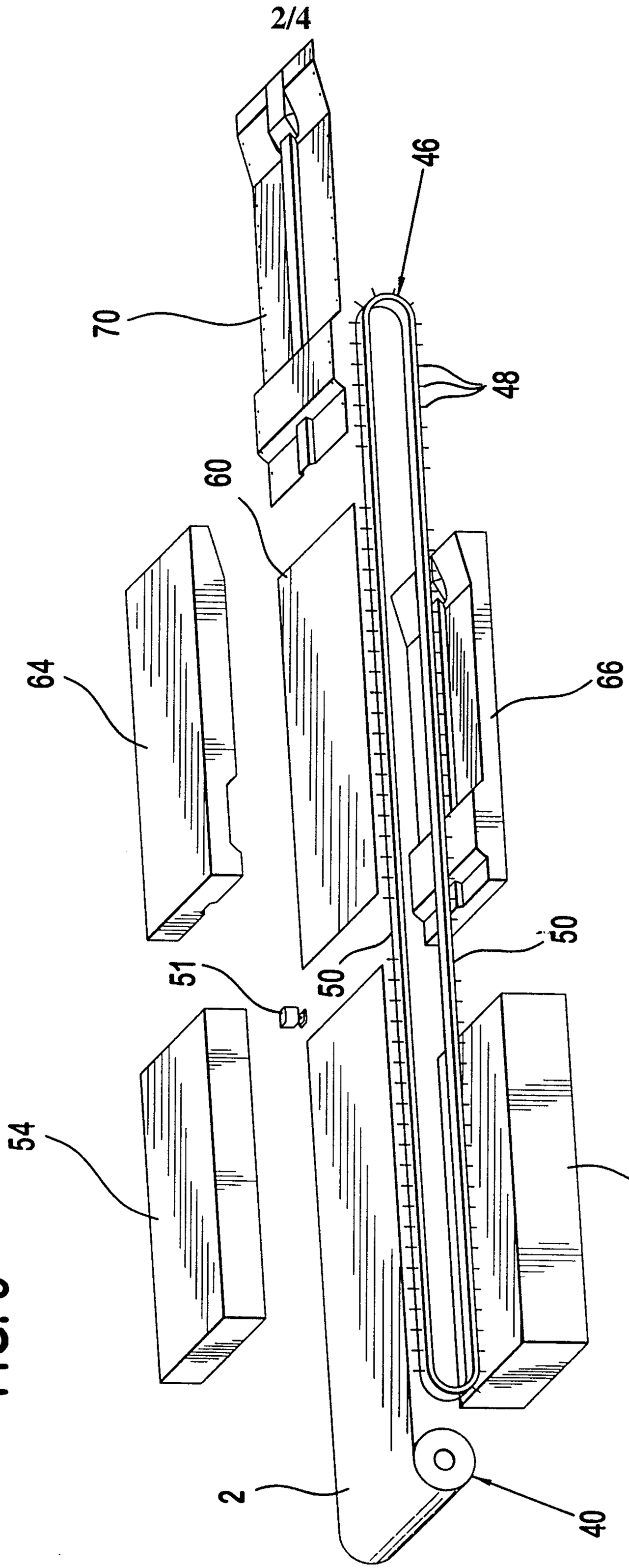


FIG. 5

FIG. 6

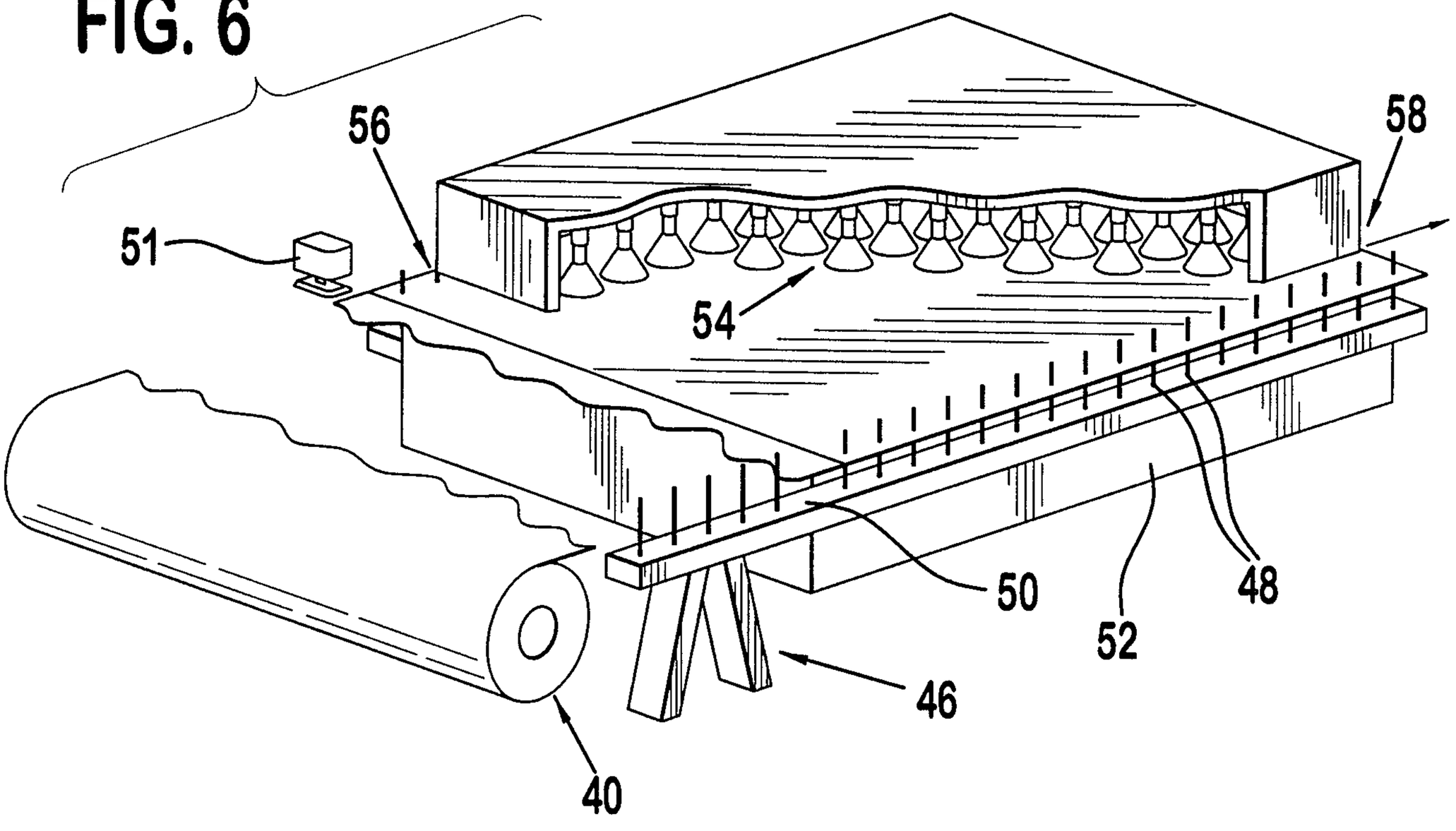


FIG. 7

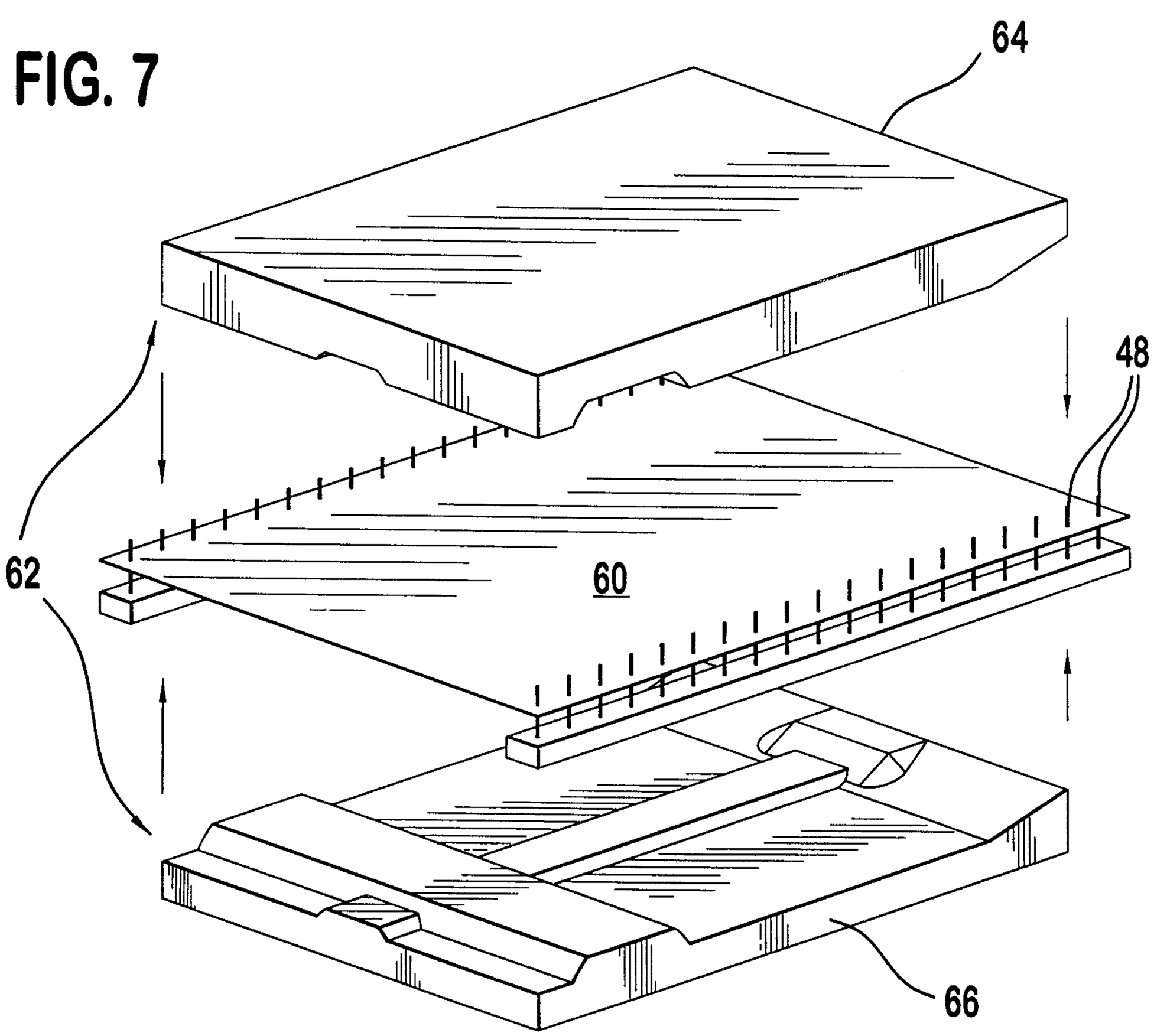


FIG. 8

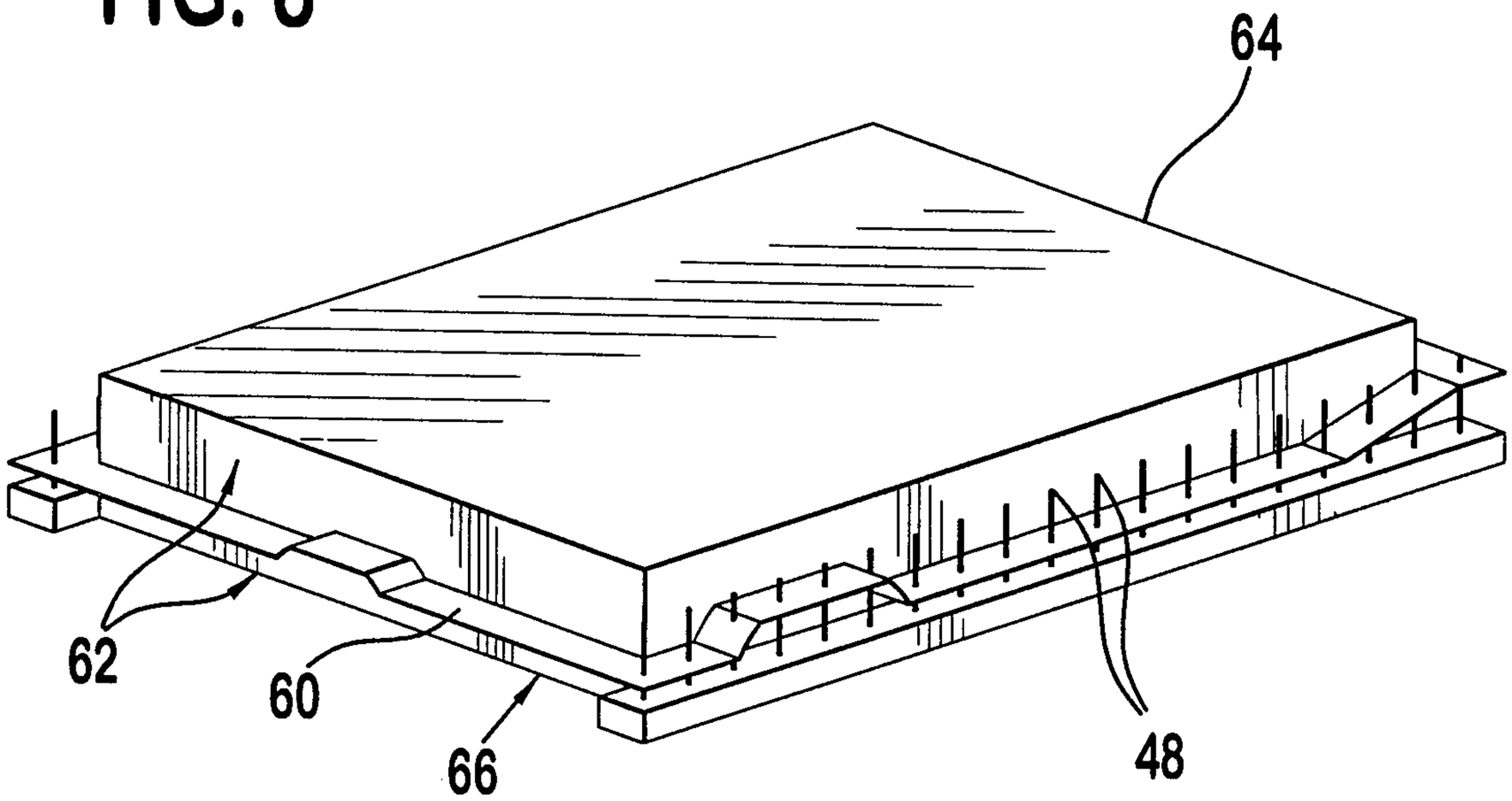


FIG. 9

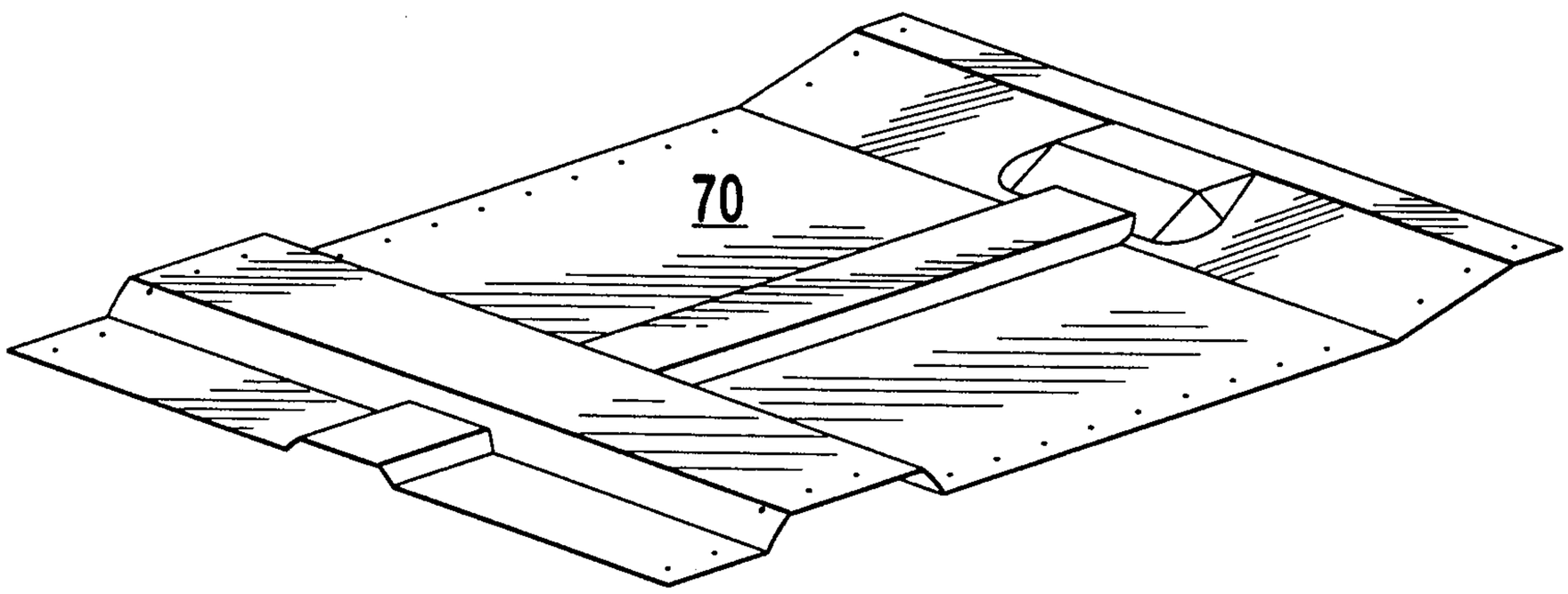


FIG. 2

