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(21) International Application Number: PCT/US99/15831 (22) International Filing Date: 14 July 1999 (14.07.99) (30) Priority Data: <table border="0"> <tr> <td>09/116,163</td> <td>16 July 1998 (16.07.98)</td> <td>US</td> </tr> <tr> <td>09/116,413</td> <td>16 July 1998 (16.07.98)</td> <td>US</td> </tr> <tr> <td>60/093,099</td> <td>16 July 1998 (16.07.98)</td> <td>US</td> </tr> <tr> <td>09/120,510</td> <td>22 July 1998 (22.07.98)</td> <td>US</td> </tr> <tr> <td>09/127,681</td> <td>31 July 1998 (31.07.98)</td> <td>US</td> </tr> </table> (71) Applicant (for all designated States except US): TEXTRON AUTOMOTIVE COMPAGNY INC. [US/US]; 750 Stephenson Highway, Troy, MI 48083 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): WANDYEZ, Gloria, D. [US/US]; 983 Rivenoak, Birmingham, MI 48009 (US). GRAY, John, D. [US/US]; Box 279, Union, NH 03887 (US). DULETZKE, Scott, J. [US/US]; 39354 Charbeneau Street, Clinton Township, MI 48036 (US). GALLAGHER, Michael, J. [US/US]; 84 Golfview Drive, Manchester, NH 03102 (US). IANNAZZI, Peter, J. [US/US]; 15 Bloody Brook Road, Hampstead, NH 03841 (US). FARRINGTON, Scott, D. [US/US]; 13 King Pine Way, Kingston, NH 03848 (US).		09/116,163	16 July 1998 (16.07.98)	US	09/116,413	16 July 1998 (16.07.98)	US	60/093,099	16 July 1998 (16.07.98)	US	09/120,510	22 July 1998 (22.07.98)	US	09/127,681	31 July 1998 (31.07.98)	US	(74) Agent: SOLOWAY, Norman, P.; Hayes, Soloway, Hennessey, Grossman & Hage, 175 Canal Street, Manchester, NH 03101 (US). (81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>Without international search report and to be republished upon receipt of that report.</i>
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(54) Title: MOTOR VEHICLE INTERIOR COMPONENTS (57) Abstract A method of forming a motor vehicle instrument panel with a flexibly tethered air bag deployment door by molding first and second plastics materials is described. Also described is a vehicle passenger compartment console assembly including a console body having an outer shell and an access opening disposed in the console body outer shell, and having at least two storage modules disposed within the shell and sequentially movably supported between one or more concealed positions displaced from the access opening and a displayed position adjacent the access opening. Also described is an automotive headliner assembly which includes a substrate that is configured to mount to a vehicle in a position generally covering a lower surface of a passenger compartment roof. Cavities are integrally formed into the substrate between the upper substrate surface and the lower substrate surface to provide receptacles for electrical wiring, fiber optic cabling, EA foam and the like or to form a duct for directing air flow. Also described is an inflatable restraint assembly comprising a trim panel, an air bag door positioned spanning an air bag deployment opening in the trim panel, a frangible tear seam defining at least a portion of the air bag door, and a hard plastic collar is attached to the trim panel, wherein the air bag door is integrally formed with the hard plastic collar.																	

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1 **MOTOR VEHICLE INTERIOR COMPONENTS**

2 This invention relates to motor vehicle interior components. In one
3 aspect the invention relates to instrument panels having an integral air bag
4 deployment door defined by a tear seam and more particularly to a tether for
5 a potentially frangible air bag door when it is separated at very low
6 temperatures from the instrument panel and then because of cold
7 embrittlement from a flexible hinge that is integral with the door and
8 normally provides through bending movement for opening swinging
9 movement of the door and its retention to the vehicle structure at higher
10 temperatures.

11 Presently, most passenger side air bag doors are formed in an air bag
12 cover that is separate from the instrument panel because the latter is made of
13 various commercially available thermoplastic materials that are particularly
14 well suited to meeting the requirements of its application but are not well
15 suited to meeting the requirements of an air bag door that is defined by a tear
16 seam formed in a single layer instrument panel. For example, the plastics
17 materials used to make such an instrument panel must have a certain degree
18 of stiffness and high heat resistance to meet the requirements of its
19 application but the materials that are currently available for such an
20 application do not retain ductility and become embrittled at very low or cold
21 temperatures. This lack of low temperature ductility is undesirable for air bag
22 deployment where the air bag is formed integral with and defined by a tear
23 seam that is formed in the instrument panel and is torn to provide an air bag
24 deployment opening in the panel by the force of the inflating air bag acting on
25 the panel in the area of the tear seam. Styrene-maleic anhydride,
26 polypropylene, polycarbonate, polyphenylene oxide and polyurethane are
27 examples of thermoplastic materials that are suitable for such an instrument
28 panel but have not exhibited the required ductility for such a tear-open air
29 bag door at very low temperatures and as a result a portion or portions of the
30 door may fracture and separate from the instrument panel on deployment of

1 the air bag and undesirably enter the space of the passenger compartment. To
2 meet extreme low temperature requirements, many various designs of an air
3 bag deployment door have been proposed wherein the door is made separate
4 from the panel and is installed as a hinged door assembly on the instrument
5 panel so that the door is not prone to fracture from cold embrittlement by the
6 force of the inflating air bag as it freely swings open on its hinge from the
7 force of the air bag.

8 Costs can be reduced, quality can be improved and styling can be
9 enhanced by molding the instrument panel and the air bag cover including an
10 integral air bag deployment door in one piece at the same time out of the
11 same commercially available material. That is provided that the normal
12 material requirements for the instrument panel are not sacrificed while the
13 safe assured operability of the integral air bag deployment door is still
14 somehow retained at reasonable cost even though its plastics material is not
15 well suited thereto.

16 Another aspect of the invention relates to a console for a motor vehicle
17 and, more particularly, to a console having interchangeable storage modules.

18 It is desirable for motor vehicle consoles to include storage
19 compartments for storing loose items and receptacles for housing accessories
20 such as radios, tape decks, CD players, citizens' band radios, and the like.
21 Including such items and accessories within a floor or instrument panel
22 console allows vehicle occupants to easily see and reach the items and
23 accessories while the vehicle is underway.

24 Current consoles include fixed storage compartments for loose items
25 and permanent receptacles and mounting systems for various accessories.
26 For example, U.S. Patent No. 5,106,143 issued April 21, 1992 to Soeters
27 discloses an automotive floor console including a main body 20 with storage
28 compartments 27, 28. The storage compartments 27, 28 are fixed within the

1 console main body 20. The Soeters floor console includes no provision for
2 allowing occupants to interchange storage modules.

3 U.S. Patent No. 3,926,473 issued December 16, 1975 to Hogan discloses
4 an adjustable center armrest unit with "wings" 7 that adjust laterally outward
5 from a main body portion 1 revealing a fixed, non-removable storage
6 compartment 27. As with the Soeters console, and other consoles in the prior
7 art of record, the Hogan console does not provide for the interchange of
8 storage or accessory modules.

9 What is needed is a console system that allows occupants to select
10 various interchangeable storage and accessory modules that the occupants
11 can then have access to while the vehicle is under way.

12 Yet another aspect of the invention relates to an automotive headliner
13 having an integral cavity and a method for making such a headliner.

14 Inside vehicle roof constructions sometimes include laminated
15 headliners. Such headliner are used in many types of vehicles including
16 passenger cars, vans, buses, trucks, trains and airplanes. Headliners are
17 incorporated into vehicle roof constructions for a variety of reasons including
18 aesthetics, sound absorption, energy absorption, and concealment of electrical
19 wiring harnesses and air vents.

20 Materials currently used in headliner construction include
21 particleboard, fiberboard, plastic board, scrim, fabric, plastic, various foams
22 and resin-bonded chopped glass fiber. In some headliners, layers of these
23 materials are joined together into a single laminate structure using lay-up-
24 molding techniques. For example, some headliners are constructed using
25 glass reinforced polyester resin laminated to a rigid urethane foam layer and
26 covered by a soft urethane foam backed fabric. Other headliners are
27 thermoformed laminates that include a polystyrene foam layer sandwiched
28 between layers of kraft paper or polymer film material and covered with soft
29 polyurethane foam-backed fabric. Some constructions eliminate the paper or

1 polymer film covering from such laminates and substitute a non-woven fabric
2 batt adhered to one or both sides of the foam layer. Still other headliners,
3 rather than being layered constructions, are simply molded from a single
4 layer of a composition such as fiberglass reinforced polyester resin.

5 Headliners are typically contoured to conform to the dimensions of the
6 vehicle roof structure they are intended to cover. Their dimensions are also
7 contoured to flow into adjacent interior vehicle trim panels, pillars and other
8 such structures to present a pleasing, finished aesthetic appearance to vehicle
9 occupants.

10 In U.S. Patent No. 5,340,425, issued August 23, 1994 to Strapazzini, the
11 inventor proposes that headliners could be constructed to incorporate
12 molded-in inserts of various kinds to include sound proofing material or
13 decorative carpet-like material.

14 In addition, it is known in the art for headliner assemblies to include
15 one or more electrical wiring harnesses. The harnesses are attached to hidden
16 upper surfaces of such headliner assemblies using fasteners that route the
17 wiring harnesses to a variety of socket for the electrical accessories mounted
18 to the headliners. The headliner assemblies are then mounted to a vehicle
19 roof and an interconnecting wire harness in the vehicle is connected to one or
20 more of the harnesses attached to the headliner assembly.

21 For example, U.S. Patent No. 5,309,634, issued May 10, 1994 to Van
22 Order et al and assigned to Prince Corporation, discloses a headliner or roof
23 panel that includes a variety of clips and mounts for wiring, lamps and the
24 like. The Van Order et al patent describes the roof panel as being formable
25 from any one or more of a number of molded polymeric materials. The
26 patent also discloses that the molded roof panel can be covered by a foam
27 layer and a decorative outer cover. However, neither the Van Order et al
28 patent nor the Strapazzini patent disclose a headliner or a method for making

1 a headliner with structures that can direct airflow in or out of a vehicle
2 interior and/or support energy absorbing materials.

3 British Patent Application No. 1,115,212, published May 29, 1968,
4 discloses an automotive headliner with a lower cushioning layer spaced from
5 an upper roof covering by longitudinal ribs. The cushioning layer, roof
6 covering and ribs define air ducts for supplying air to and removing air from
7 the vehicle interior. According to the British application the ribs may be
8 integrally formed with the cushioning layer but must be assembled to the roof
9 covering in a separate step.

10 It is also known in the art for headliner assemblies to include a duct
11 that is disposed on an upper surface of the headliners. Outlet registers are
12 mounted in holes formed in the headliner at spaced locations. The duct
13 directs airflow from a vehicle heating, ventilation and air conditioning system
14 into a vehicle passenger compartment through the three air outlet registers.
15 In such systems, the duct is formed separately from the headliner and is
16 fastened to the headliner during manufacturing by such means as gluing.

17 It is also known to use blow-molded materials to form certain parts of
18 instrument panels. An example of such a use is shown in U.S. Patent No.
19 5,527,581, issued June 18, 1996 to Sugawara et al and assigned to a Japanese
20 supplier of blow moldable materials. The instrument panel disclosed in the
21 Sugawara et al patent includes a core part having blow-molded sections that
22 are formed from a parison. The parison is fixed in blow mold to form
23 integral cavities in the form of airflow ducts in the instrument panel.

24 What is needed is a headliner configured to support such items as
25 energy absorbing foam, passenger compartment airflow, and electrical wiring
26 while presenting a continuous, unencumbered aesthetic appearance to vehicle
27 occupants. What is also needed is a cost-effective method for making such a
28 headliner.

1 In still another aspect the invention relates to motor vehicle instrument
2 panels having an integral air bag deployment door defined by a tear seam
3 and more particularly to a tether for the air bag door when it is separated at
4 very low temperatures from the instrument panel and then from a flexible
5 hinge that is integral with the door and normally provides for opening
6 swinging movement of the door at its retention to the vehicle structure at
7 higher temperatures.

8 Presently, most passenger-side air bag doors are formed in an air bag
9 cover that is separate from the instrument panel because the latter is made of
10 a commercially available thermoplastic material particularly suited to
11 meeting the requirements of its application but is not well suited to meeting
12 the requirements of an air bag door that is defined by a tear seam formed in
13 the instrument panel. For example, the plastics materials used to make a self-
14 supporting instrument panel must have a certain degree of stiffness and high
15 heat resistance to meet the requirements of its application but the materials
16 that are currently available for such an instrument panel do not retain
17 ductility and become embrittled at very low or cold temperatures which is
18 unsuitable for air bag deployment where the air bag door is formed integral
19 with and defined by a tear seam formed in the instrument panel. Styrene-
20 maleic anhydride, polypropylene, polycarbonate and polyphenylene oxide
21 are examples of thermoplastic materials that are suitable for the instrument
22 panel but do not have the required ductility or flexibility for such an air bag
23 door at very low temperatures. As a result, the air bag cover or door on the
24 passenger side is normally made separate from the instrument panel and of a
25 different commercially available thermoplastic material such as polyurethane
26 elastomer, polyester elastomer, and polyolefin elastomer which are suitable
27 for such application but are not suitable for the requirements of the
28 instrument panel.

1 Costs can be reduced, quality can be improved and styling can be
2 enhanced by molding the instrument panel and the air bag cover including an
3 integral air bag deployment door in one piece at the same time out of the
4 same commercially available material provided, however, that the normal
5 material requirements for the instrument panel are not sacrificed and the safe
6 assured operability of the integral air bag deployment door is retained at
7 reasonable cost, even though the plastics material may not be well suited
8 thereto.

9 Finally in yet another aspect the invention relates to inflatable restraint
10 systems for automotive vehicles. More particularly, the invention relates to
11 such systems that include air bag doors that at least partially tear or otherwise
12 separate from a surrounding structure such as an instrument panel retainer.

13 Current supplemental inflatable restraint systems (SIRs) sometimes
14 include air bag doors that are integrally formed with a portion of a
15 surrounding instrument panel (or instrument panel retainer) as a single
16 unitary panel. Such unitary panels often include weakened areas such as
17 frangible tear seams that define at least a portion of the outline of the air bag
18 door and help to guide tearing and/or breakage under the force of air bag
19 inflating. When a deploying air bag has torn or broken the door open, both
20 the door and the surrounding instrument panel and/or panel retainer must
21 be replaced if the SIR is to be restored to working order.

22 Such unitary panels are sometimes made of materials that remain
23 ductile at very low temperatures to prevent portions of the panel from
24 fragmenting when inflating air bags hit them. Certain more expensive plastic
25 formulations remain elastic or ductile at temperatures substantially below
26 where less expensive "standard" formulations become brittle or inelastic. In
27 other words, standard formulations may be cheaper and very well suited to
28 general instrument panel requirements, but are not as certain as more
29 expensive formulations at extremely low temperatures. There have been

1 various attempts to cost-effectively meet with a single material application.
2 However, it has proven to be especially difficult to cost-effectively design an
3 instrument panel with satisfactory air bag deployment characteristics at
4 extremely low temperatures.

5 What is needed is an air bag door that is integrally formed with a
6 portion of a surrounding automotive instrument panel or instrument panel
7 retainer made of a material that remains ductile at low temperatures but
8 without requirement that the entire instrument panel or panel retainer be
9 constructed of the same material. What is also needed is such an integrally
10 formed door and surrounding panel structure that can more easily be
11 replaced following air bag deployment without requiring replacement of the
12 entire instrument panel or instrument panel retainer.

13 In one aspect of the present invention, a molded motor vehicle
14 instrument panel made of a thermoplastic material well suited for the primary
15 purpose of such a panel has an integral air bag deployment door for a
16 passenger side air bag that is safely retained to the vehicle structure in a very
17 cost effective manner. The air bag door is defined by a tear seam in the panel
18 and is normally retained by an integral flexible mounting/hinge flange to a
19 part of the vehicle structure when the seam is torn by the inflating air bag and
20 wherein this flange which before was integral with both the door and the
21 panel is then separated from the main body of the panel while remaining
22 integral with the door and bends to allow the door to swing open to allow
23 deployment of the air bag through an opening in the instrument panel while
24 retaining same to the vehicle structure as the door is then free of the
25 instrument panel. At very low temperatures, a portion of the air bag door can
26 break away from the mounting/hinge flange where it joins therewith because
27 of plastic embrittlement at these low temperatures and the high bending
28 stresses encountered at this juncture.

1 This separation of the broken door portion from the vehicle structure is
2 prevented by bonding a layer of second plastics material over the juncture
3 zone and an adjoining inside surface of the potentially frangible door portion
4 and an adjoining one side of the mounting/hinge flange. The second plastics
5 material has the physical characteristic of remaining ductile to a substantial
6 degree at low temperatures substantially below the temperature at which the
7 first plastics material becomes brittle. The bonded layer thus forms a tether
8 that tethers the frangible door portion to the mounting/hinge flange in a
9 flexible manner when this door portion breaks away from the flange because
10 of embrittlement of the first plastics material at the low temperatures on
11 tearing of the tear seam and opening movement of the door by the inflating
12 air bag pressing against the inside surface of the frangible door portion. This
13 allows the broken door portion to continue movement in its opening direction
14 to allow continued deployment of the air bag while the broken door portion
15 remains connected by the flexible tether to the mounting/hinge flange and
16 thereby the vehicle structure.

17 The instrument panel and the air bag deployment door tethering layer
18 may be formed in various ways including injection molding the panel and
19 injection molding, spraying or low pressure molding the tethering layer in a
20 second step. Such formation of the tether in place as a bonded layer is
21 particularly advantageous from both a cost and production standpoint as it
22 becomes integral with the instrument panel and there is no need to inventory
23 a separate tether that must then be fastened by some form of fastening means
24 to both the mounting/hinge flange and the door. Furthermore, the bonding
25 of the tethering layer to the inside surface of the door hides its presence from
26 view which is desirable from an appearance or styling standpoint.

27 The present invention provides a method of forming a motor vehicle
28 instrument panel with a tethered air bag deployment door wherein the panel
29 including the door is formed of a plastics material suited to meet the

1 requirements of an instrument panel and the tether is formed of a layer of
2 plastics material that spans a potential fracture zone in the door and remains
3 ductile at low temperatures that cause embrittlement of the door that could
4 result in the fracturing of a portion of the door at thus fracture zone on air bag
5 deployment and loss of its retention to the vehicle structure but for the
6 tethering layer.

7 The invention also provides a method of forming a motor vehicle
8 instrument panel including an air bag deployment door that is defined by a
9 tear seam molded in the panel wherein the panel is formed of a plastics
10 material suited to its requirements and the door is retained to the vehicle
11 structure on breaking away at very cold temperatures by a flexible layer of
12 plastics material that is formed in place over an inside surface of the door and
13 one side of a mounting/hinge flange that is molded integral with the inside
14 surface of the door and normally retains the air bag door to the vehicle
15 structure on opening movement.

16 Another aspect of the present invention includes an automotive air bag
17 cover assembly comprising a hinge panel that is connected, in a layered
18 disposition, to an inside surface of at least one of the integral air bag cover
19 and instrument panel. The instrument panel comprises a first plastics
20 material and is configured to mount in the passenger compartment of the
21 motor vehicle. The air bag door panel also comprises the first plastics
22 material and is formed with the instrument panel as a single integral panel.
23 The door panel is at least partially surrounded by the instrument panel. One
24 object of this second aspect of the present invention is to simplify and
25 accelerate the manufacture of hinged integral panels by providing a hinge
26 panel that is insert molded into an inside surface of at least one of the
27 instrument panel and the door panel.

28 In the present invention a hinge panel acts as a primary hinge between
29 the door panel and the instrument panel during air bag deployment. The

1 hinge panel spans a panel juncture zone between the door panel and the
2 instrument panel.

3 Another feature of the present invention is to aid in bending the first
4 plastics material at the hinge location by providing a panel juncture zone that
5 includes a styling groove separating at least a portion of the door panel and
6 the instrument panel. The styling groove may also function as a tear seam.

7 Another feature of the present invention is to guide tearing around the
8 door panel when the air bag inflates by providing a panel juncture zone that
9 includes a weakened tear seam separating at least a portion of the door panel
10 and the instrument panel.

11 The present invention also provides a hinge that includes a hinge panel
12 edge aligned with at least a portion of the tear seam to act in guiding tearing
13 along the tear seam as the door is forced open during air bag inflation. And
14 the present invention prevents hinge panel fracture at low temperatures by
15 providing a hinge panel comprising metal or a second plastics material that is
16 more ductile and less brittle at low temperatures than the first plastics
17 material.

18 The present invention also provides a means of securing the door panel
19 to a structural member during deployment by providing a hinge flange that
20 extends transversely inward from the inside surface of the door panel. The
21 hinge flange is configured to secure the door panel to a structural member.
22 The hinge panel spans a juncture zone between the hinge flange and door
23 panel in a layered disposition with a portion of the hinge panel being attached
24 to the hinge flange.

25 And, the present invention provides a means for supporting an air bag
26 canister assembly on the instrument panel by providing a collar that extends
27 transversely inward from the inside surface of the instrument panel and from
28 around the door panel. The collar defines a door-collar interface along the
29 region where the collar extends from the panel. The hinge panel spans the

1 door-collar interface, one portion of the hinge panel being attached to the
2 collar and another portion of the hinge panel being attached to the door
3 panel.

4 Additionally, the present invention provides a method for making an
5 air bag cover assembly. The method includes providing a mold having first
6 and second mold portions. The first and second mold portions form a mold
7 cavity when closed together. The mold cavity has a shape that complements
8 the shape of the integral instrument and door panel and the hinge panel.
9 After being formed separately, the hinge panel is placed in the second mold
10 portion. The mold is then closed and the first plastics material is introduced
11 into the mold cavity in molten form. The molten first plastics material is then
12 allowed to conform to the shape of the mold cavity and to solidify in the mold
13 cavity. The mold is then opened and the completed assembly is removed
14 from the mold.

15 The method may also include formation of the hinge panel from the
16 second plastics material and the selection of a second plastic material that is
17 more ductile and less brittle at low temperatures than the first plastics
18 material.

19 The method may alternatively include the provision of a hinge panel
20 comprising metal. In applications where an edge of the hinge panel is aligned
21 with a tear seam to guide tearing along the tear seam, metal is generally
22 preferred over plastic due to increased rigidity which aids in evenly
23 distributing door opening forces along a tear seam to promote more uniform
24 tear seam fracture and subsequent door opening.

25 The method may also include the placement of the hinge panel on the
26 mold cavity surface of the second mold portion in a position spanning a
27 portion of the mold configured to form the panel juncture zone between the
28 instrument panel and door panel portions of the integral panel. The mold
29 cavity surface of the second mold portion may be shaped to form a hinge-

1 flange that protrudes transversely inward from the door panel portion of the
2 integral panel. In this case, the hinge panel is placed on the mold cavity
3 surface of the second mold portion in a position spanning a portion of the
4 mold configured to form a flange juncture zone between the hinge-flange and
5 the door panel.

6 In accordance with another aspect of this invention, a motor vehicle
7 console assembly is provided that includes positioning apparatus configured
8 to support any one of at least two storage modules in a display position while
9 simultaneously supporting at least one of the other storage modules in a
10 concealed position. This allows a passenger compartment occupant to gain
11 physical access to a module and its contents through the access opening while
12 leaving other modules concealed within the shell. The assembly also includes
13 a console body having an outer shell and an access opening disposed in the
14 console body outer shell. A positioning apparatus is movably supported
15 within the console body outer shell. The storage modules are disposed within
16 the shell and are movably supported on the positioning apparatus. The
17 storage modules are sequentially movable between one or more concealed
18 positions displaced from the access opening and a displayed position adjacent
19 the access opening.

20 According to another aspect of the invention, the positioning apparatus
21 comprises an electro-mechanical occupant-actuated drive mechanism. The
22 drive mechanism relieves occupants of the need to physically move the
23 storage modules between the concealed positions and the displayed position.

24 According to another aspect of the invention, the positioning apparatus
25 comprises an occupant-actuated automatic module selection system. The
26 automatic selection system allows occupants to move a selected storage
27 module to the displayed position by actuating the automatic system and
28 designating which storage module they wish to have displayed.

1 According to another aspect of the invention, the modules are
2 sequentially moveable through the displayed position.

3 According to another aspect of the invention, the positioning apparatus
4 comprises a carrousel supported for rotation about a carrousel axis.

5 According to another aspect of the invention, the positioning apparatus
6 comprises a drum-type carrousel supported for rotation about a generally
7 horizontal axis. This horizontal axis disposition provides a configuration that
8 better accommodates the storage and selective display of certain vehicle
9 accessories.

10 According to another aspect of the invention, an access door is
11 movably supported across the module access opening. The door is shaped to
12 cover the access opening in a closed position and movable to an open position
13 uncovering the access opening.

14 According to another aspect of the invention, at least one of the
15 modules comprises an appliance that is incorporated into the design of the
16 module. This gives occupants selective access to any number of different
17 appliances that are so incorporated.

18 According to another aspect of the invention, at least one of the
19 modules comprises a storage space. This allows occupants to store loose
20 items in selectively accessible modules of the console assembly.

21 According to another aspect of the invention the console body is a floor
22 console body supported on a floor of an automobile between a front driver's
23 seat and a front passenger seat of the automobile. Positioning the console
24 assembly in a floor console provides ready access to storage modules for
25 passenger compartment occupants.

26 According to another aspect of the invention, a forward image display
27 panel is supported in a forward end of the console body. This display panel is
28 supported in a position to provide information to front seat occupants.

1 According to another aspect of the invention, an aft image display
2 panel is supported in an aft end of the console body and image-producing
3 electronic circuitry connected to the aft display panel. This display panel is
4 supported in a position to provide information to rear seat occupants.

5 According to another aspect of the invention at least one remote-
6 control unit is included that is communicable with the electronic image-
7 producing circuitry. The remote-control unit allows occupants to control
8 information displayed on the display panel without having to reach forward
9 and manipulate controls on the floor console.

10 According to another aspect of the invention the console body is an
11 instrument panel console body supported in an instrument panel assembly of
12 the automobile. Locating the assembly in the instrument panel console body
13 provides occupants with easy forward access to items stored or mounted in
14 the assembly.

15 According to another aspect of the invention, the positioning apparatus
16 comprises a drum-type carrousel supported in the instrument panel console
17 body for rotation about a generally vertical axis.

18 According to another aspect of the invention, the positioning apparatus
19 comprises a drum-type carrousel supported in the instrument panel console
20 body for rotation about a generally horizontal axis.

21 According to another aspect of the invention, the carrousel is at least
22 partially housed within a central stack portion of the instrument panel
23 assembly.

24 According to another aspect of the invention, the carrousel is rotatable
25 to a closed position and in which the carrousel includes a face panel that
26 covers the access opening in the closed position. The face panel deters theft
27 by denying physical access to the contents of the storage modules in the
28 closed position.

1 According to another aspect of the invention, the positioning apparatus
2 includes a platform having at least two storage regions. The platform is
3 rotatably supported within the console body outer shell. The positioning
4 apparatus is configured to rotate the platform and move a selected one of the
5 storage regions to a display position adjacent the access opening while
6 simultaneously moving the other of the storage regions into a remote position
7 displaced from the access opening. This allows a passenger compartment
8 occupant to gain physical access to an item stored on one storage region of the
9 platform through the access opening while leaving other items stored on the
10 other storage regions in the remote positions within the shell.

11 In accordance with yet another aspect of this invention an automotive
12 headliner assembly is provided that includes a cavity formed into the
13 substrate between upper and lower substrate surfaces to provide a receptacle
14 for wiring, foam and the like or to provide a duct for directing airflow. The
15 headliner assembly is configured to line the roof of the passenger
16 compartment of a vehicle. The headliner assembly comprises a unitary
17 substrate configured to be mounted to a vehicle in a position generally
18 covering a lower surface of a passenger compartment roof. The lower
19 substrate surface is disposed opposite the upper substrate surface. The
20 substrate comprises a moldable material. A decorative cover may be
21 supported on the lower substrate surface.

22 According to another aspect of the invention, the cavity comprises an
23 air duct and the headliner includes an air inlet opening positioned to receive
24 air from a vehicle air handling system. An air outlet opening is spaced from
25 the air inlet opening and disposed in an underside surface of the headliner
26 assembly to direct air from the vehicle air handling system into the passenger
27 compartment. The air duct extends between and connects the air inlet
28 opening and the air outlet opening to provide gaseous communication
29 between the air inlet opening and the air outlet opening. Because the air duct

1 is formed into the headliner substrate, the headliner assembly includes fewer
2 parts and its fabrication is greatly simplified.

3 According to another aspect of the invention a directional air outlet
4 register is disposed in the air outlet opening.

5 According to another aspect of the invention the cavity comprises an
6 elongated conduit and the headliner includes a cable inlet opening disposed
7 adjacent a peripheral edge of the headliner assembly to receive electrical or
8 fiber optic cabling from a vehicle electrical or fiber optic system. A cable
9 outlet opening is spaced from the cable inlet opening and is disposed adjacent
10 a fixture supported on the headliner assembly to allow an end of the cable to
11 be connected to the fixture. The cable conduit extends between and provides
12 a channel between the cable inlet opening and the cable outlet opening.

13 According to another aspect of the invention, foam is disposed within
14 the cavity. The cavity may include an inner wall that envelops the foam. The
15 foam may be energy-absorbing foam to enhance the ability of the cavity to
16 absorb passenger head impact forces. The foam may be an acoustic energy-
17 absorbing foam to reduce noise levels within the passenger compartment.

18 According to another aspect of the invention additional foam-filled
19 cavities are disposed in an array at spaced locations where passenger head
20 impact is likely to occur if passengers are subjected to sudden vertical
21 acceleration components.

22 According to another aspect of the invention the cavity is integrally
23 formed in the substrate.

24 According to another aspect of the invention, a decorative outer cover
25 is disposed on a lower surface of the substrate. A foam layer may be included
26 between the lower surface of the substrate and the decorative outer cover.

27 According to another aspect of the invention, a method is provided for
28 constructing a headliner. According to the method a blow mold is provided,
29 the blow mold having a contoured portion shaped to complement the desired

1 exterior contours of the headliner substrate to be formed. The contoured
2 portion includes an enlarged region corresponding to a desired cavity
3 position in the substrate to be formed. A molten parison is then extruded into
4 the hollow portion of the blow mold and the parison is expanded into
5 conforming contact with the contoured portion of the blow mold by injecting
6 gas into the molten parison. The molten parison is then allowed to harden
7 into the headliner substrate and the substrate is removed from the blow mold.

8 According to another aspect of the inventive method, the molten
9 parison is provided between open halves of a two-piece blow mold. The two
10 blow mold halves are closed together around the molten parison before fully
11 expanding the molten parison.

12 According to another aspect of the inventive method, a layer of foam is
13 provided on a lower surface of the substrate and a layer of cover material is
14 provided on a lower surface of the foam.

15 According to another aspect of the inventive method, foam is provided
16 within the cavity.

17 According to another aspect of the inventive method, foam is provided
18 within the cavity by first inserting one end of an injection nozzle. Foam is
19 then injected into the cavity through the nozzle and the nozzle is withdrawn
20 from the cavity.

21 According to another aspect of the inventive method, the molten
22 parison is extruded:

23 According to another aspect of the inventive method, the molten
24 parison is expanded by inserting a blow pin into the molten parison, injecting
25 the gas into the parison through the blow pin and removing the blow pin
26 from the parison.

27 The present invention also provides a molded instrument panel made
28 of a commercially available thermoplastic material well suited for the primary
29 purpose of such a panel has an integral air bag deployment door for a

1 passenger side air bag that is safely retained to the vehicle structure in a very
2 cost effective manner. The air bag door is defined by a frangible tear seam in
3 the panel and is normally retained by an integral flexible mounting/hinge
4 flange to a part of the vehicle structure when the seam is torn by the inflating
5 air bag and wherein this flange which before was integral with both the door
6 and the panel is then separated from the panel while remaining integral with
7 the door and bends to allow the door to swing open to allow deployment of
8 the air bag through an opening in the instrument panel while retaining same
9 to the vehicle structure as the door is then free of the instrument panel. At
10 very low temperatures, a portion of the air bag door can break away from the
11 mounting/hinge flange where it joins therewith because of plastic
12 embrittlement at these low temperatures and the high bending stresses
13 encountered at this juncture. This separation of the broken door portion from
14 the vehicle structure is prevented by provision of a flexible tethering hinge
15 that is formed separately from the panel of a different material and thereafter
16 fastened to the panel so as to span the critical juncture between the flange and
17 the potential break away door portion. The tethering hinge material is of a
18 strong flexible material that remains flexible or ductile to a significant degree
19 at these very cold temperatures.

20 The flexible tethering hinge is fastened along one margin on one side of
21 the critical juncture zone to a portion of the mounting/hinge flange remote
22 from this potential fracture zone by fastening means such as rivets and is
23 fastened along another margin on the other side of this zone to the inner side
24 of the potential break away door portion by fastening means such as an
25 adhesive or heat staked bosses that cannot be observed at the outer side of the
26 door. The tethering hinge has a portion intermediate its margins that spans
27 the potential fracture zone and flexes when door breakage occurs to permit
28 the broken door portion to continue to swing outward to provide for air bag
29 deployment while retaining the broken door portion to the vehicle structure.

1 According to another embodiment of the invention, the tethering hinge
2 is formed of a second plastics material that is relatively more flexible than the
3 first plastics material of the panel at temperatures below that which the first
4 plastics material becomes unacceptably brittle and susceptible to breakage. In
5 this embodiment, the tethering hinge is welded to the panel by selective
6 application of energy.

7 The present invention also provides a new and improved motor vehicle
8 instrument panel with an integral and tethered air bag deployment door and
9 a method of forming such a panel, and a tethered air bag deployment door at
10 low cost and of high quality and to meet certain styling desires.

11 The invention further provides a motor vehicle instrument panel
12 having an integral air bag deployment door that is defined by a tear seam in
13 the panel and is retained to the vehicle structure by a flexible tethering hinge
14 in the event the door is separated at very low temperatures from an integral
15 mounting/hinge flange that normally fastens the air bag door to the vehicle
16 structure, and the invention provides a motor vehicle instrument panel
17 including an air bag deployment door that is defined by a tear seam in the
18 panel and is retained to the vehicle structure by a flexible tethering hinge
19 formed of flexible sheet material in the event the door is separated at very low
20 temperatures from an integral mounting/hinge flange that normally fastens
21 the air bag door to the vehicle structure.

22 Additionally, the present invention provides a low cost, high quality,
23 motor vehicle instrument panel including an integral and also flexibly
24 tethered air bag deployment door wherein the door is defined by a tear seam
25 in the panel and is retained to the vehicle structure by a flexible tethering
26 hinge formed of flexible sheet material in the event the door is separated at
27 very low temperatures because of cold embrittlement and bending stresses
28 from an integral mounting/hinge flange that normally retains the air bag
29 door to the vehicle structure.

1 In yet still another aspect, the invention provides an inflatable restraint
2 assembly comprising a trim panel, a hard plastic collar attached to the trim
3 panel. An air bag door is integrally formed in the hard plastic collar in a
4 position spanning an air bag deployment opening in the trim panel. A
5 frangible tear seam defines at least a portion of the air bag door.

6 In addition, according to the invention, the air bag door is integrally
7 formed in the hard plastic collar as a single unitary panel.

8 In addition, according to the invention, the integral air bag door and
9 collar comprise a material that remains ductile at low temperatures.

10 To better understand and appreciate the invention, refer to the
11 following detailed description in connection with the accompanying
12 drawings wherein like numerals depict like parts, and wherein:

13 Figure 1 is a perspective view of a motor vehicle instrument panel
14 including integral air bag deployment door with a flexible tether made
15 according to the present invention and as installed in a motor vehicle over an
16 air bag system;

17 Figure 2 is an enlarged view taken along the line 2-2 in Figure 1 when
18 looking in the direction of the arrows;

19 Figure 3 is a view taken along the line 3-3 in Figure 2 when looking in
20 the direction of the arrows;

21 Figure 4 is a view like Figure 2 but showing the air bag door opened
22 and broken during the deployment of the air bag at a very low temperature;

23 Figure 5 is a fragmentary perspective view of mold tools used to hold
24 the flexible tethering layer in Figures 2 and 3 and includes a sectional view of
25 the instrument panel as molded and then located between these tools for the
26 molding of the flexible tethering layer;

27 Figure 6 is a view taken along the line 6-6 in Figure 5 when looking in
28 the direction of the arrows;

1 Figure 7 is a sectional view of the instrument panel as molded without
2 the flexible tethering layer and includes a diagrammatic view of spraying
3 apparatus for forming the flexible tethering layer;

4 Figure 8 is a cross-sectional side view of a motor vehicle instrument
5 panel constructed according to the invention and including an integral air bag
6 deployment door in a closed position, a plastic insert molded hinge and an
7 integral mounting/hinge flange;

8 Figure 9 is a cross-sectional side view of the instrument panel of
9 Figure 8 with the air bag deployment door being moved out of the closed
10 position by an inflating air bag;

11 Figure 10 is a cross-sectional side view of the instrument panel of
12 Figures 8 and 9 with the air bag deployment door being fractured as it is
13 moved out of the closed position by an inflating air bag;

14 Figure 11 is a perspective view of a motor vehicle instrument panel
15 including integral air bag deployment door having a plastic insert molded
16 hinge constructed according to the present invention and as installed in a
17 motor vehicle over an air bag system;

18 Figure 12 is a cross-sectional side view of the instrument panel and air
19 bag system of Figure 11 with the air bag deployment door in a closed
20 position;

21 Figure 13 is a cross-sectional side view of the instrument panel and air
22 bag system of Figure 11 with the air bag deployment door being moved out of
23 the closed position by air bag inflation;

24 Figure 14 is a cross-sectional side view of a motor vehicle instrument
25 panel constructed according to the invention and including an integral air bag
26 deployment door and including a metal insert molded hinge;

27 Figure 15 is a cross-sectional side view of a motor vehicle instrument
28 panel constructed according to the invention and including a collar extending
29 transversely inward from an inside surface of the instrument panel, an

1 integral air bag deployment door in a closed position and a plastic insert
2 molded hinge;

3 Figure 16 is a perspective view of a floor console assembly constructed
4 according to a first embodiment of the present invention and installed in a
5 vehicle interior;

6 Figure 17 is a cut-away perspective view of the floor console assembly
7 of Fig. 16;

8 Figure 18 is a perspective view of an instrument panel assembly
9 constructed according to a second embodiment of the present invention with
10 a carrousel portion of the assembly in an open position;

11 Figure 19 is a perspective view of the instrument panel assembly of Fig.
12 18 with the carrousel portion of the assembly in a closed position;

13 Figure 20 is a partial cross-sectional view of the instrument panel
14 assembly of Fig. 18 taken along line 20-20 of Fig. 18;

15 Figure 21 is a partial cross-sectional view of the instrument panel
16 assembly of Fig. 19 taken along line 21-21 of Fig. 19;

17 Figure 22 is a partially cut-away perspective view of an instrument
18 panel assembly constructed according to a third embodiment of the present
19 invention;

20 Figure 23 is a perspective view of an instrument panel assembly
21 constructed according to a fourth embodiment of the invention;

22 Figure 24 is a perspective view of a headliner assembly constructed
23 according to the present invention;

24 Figure 25 is a top view of the headliner assembly of Fig. 24;

25 Figure 26 is a cross-sectional side view of the headliner assembly of
26 Fig. 24 taken along line 26-26 in Fig. 25;

27 Figure 26A is an enlarged view of the region bounded by circle 26A in
28 Fig. 26;

1 Figure 27 is a cross-sectional side view of a blow-mold with a parison
2 extrusion die injecting a molten parison between halves of the die in
3 accordance with the method of the present invention;

4 Figure 28 is a cross-sectional side view of the blow mold of Fig. 27 with
5 a blow pin injecting gas into the molten parison in accordance with the
6 method of the present invention;

7 Figure 29 is a perspective view of a motor vehicle instrument panel
8 including integral air bag deployment door with a flexible tethering hinge
9 according to the present invention and as installed in a motor vehicle over an
10 air bag system;

11 Figure 30 is an enlarged view taken along the line 30-30 in Figure 29
12 when looking in the direction of the arrows and includes a diagrammatic
13 view of the air bag system;

14 Figure 31 is a view taken along the line 31-31 in Figure 30 when
15 looking in the direction of the arrows;

16 Figure 32 is a view like Figure 31 but of a much smaller cross section
17 area in larger relative scale and illustrates in an exaggerated manner an
18 adhesive used to fasten the flexible tethering hinge to the air bag door instead
19 of the hot staked rivets shown in Figures 30 and 31;

20 Figure 33 is a view like Figure 30 but showing the air bag door opened
21 and broken but retained during the deployment of the air bag at a very low
22 temperature;

23 Figure 34 is a schematic sectional view of a motor vehicle instrument
24 panel constructed according to an alternative embodiment of the invention;

25 Figure 35 is a schematic fragmentary cross-sectional view of the panel
26 and tethering hinge layers held by a clamping fixture in preparation for
27 subsequent welding according to another embodiment of the invention;

28 Figure 36 is a schematic fragmentary cross-sectional view of the panel
29 and tethering hinge layers of Figure 35 shown joined by a weld;

1 Figure 37 is a diagrammatic view showing the process steps for
2 forming, joining together and installing the panel and tethering hinge layers
3 to the vehicle structure in position over the air bag system;

4 Figure 38 is a rear perspective exploded view of an instrument panel
5 including an air bag door integrally formed in a collar and installed in an
6 opening in an instrument panel retainer portion of the instrument panel
7 according to the invention, but omitting a foam layer of the instrument panel
8 for clarity;

9 Figure 39 is a side cross-sectional view of the instrument panel of
10 Figure 38 including the foam layer; and

11 Figure 40 is a side cross-sectional view of a retainer and unitary panel
12 portion of an instrument panel constructed according to the invention and
13 having an alternative fastener arrangement.

14 Referring to Figures 1-4, there is illustrated a molded instrument panel
15 air bag cover assembly 10 for concealing an inflatable air bag system of a
16 motor vehicle. The motor vehicle structure is generally designated as 11.
17 Alternative embodiments of the instrument panel cover assembly 10 are
18 generally shown at 10a in Figures 8-10, 10b in Figures 11-14, and 10c in Figure
19 15. Reference numerals with the suffix "a" in Figures 8-10, the suffix "b" in
20 Figures 11-14 and the suffix "c" in Figure 15 designate the alternative
21 configuration of each element common to the embodiment of Figures 1-4.
22 Unless the description indicates otherwise, where the description uses a
23 reference numeral to refer to an element in Figures 1-4, I intend that portion
24 of the description to apply equally to elements in Figures 8-10, 11-14 and 15;
25 indicated by the same reference numeral with the suffix "a", "b" or "c";
26 respectively.

27 The cover assembly 10 has a contoured section 12 on the driver side for
28 the installation of an instrument cluster (not shown) and an air bag
29 deployment door 14 of rectangular shape on the passenger side that is defined

1 by a tear seam 16 molded in the cover assembly. The tear seam 16 may be
2 formed by a groove either in the face of the panel as shown or by a similar
3 groove in the back side of the panel to hide the tear seam from view as is well
4 known in the art. The cover assembly covers an air bag system 18 that is
5 located behind the cover assembly directly behind the air bag door 14 and is
6 mounted on a sheet metal portion 20 of the vehicle structure at the front of the
7 passenger compartment. The air bag system 18 is of a conventional type that
8 includes an inflatable air bag 22, a gas generator 24 and a controller 26 that
9 includes a vehicle impact sensor and triggers ignition of the gas generator to
10 inflate the air bag for deployment into the passenger space 28 directly in front
11 of a passenger seated on this side.

12 The cover assembly 10 is a molded one-piece part of generally uniform
13 wall thickness and is formed of a suitable thermoplastic material such as
14 styrene-maleic anhydride, polypropylene, polycarbonate, polyphenylene
15 oxide and polyurethane that provides sufficient stiffness so that the panel is
16 self-supporting to maintain the desired shape and has sufficient heat
17 resistance to resist deformation due to heat in its interior vehicle environment
18 where it is located immediately behind the windshield (not shown). The
19 cover assembly may be molded in various conventional ways including
20 injection molding as is well known in the art. The groove forming the tear
21 seam 16 is made deep enough in relation to the wall thickness of the cover
22 assembly and the strength of the plastic material used so as to sufficiently
23 weaken the wall section at the tear seam to the point that it is torn by the force
24 of the inflating air bag acting against the back or inside surface of the air bag
25 door and creates on its separation from the cover assembly an opening 30
26 therein for the deployment of the air bag as illustrated in Figure 4 and
27 described in more detail later.

28 The cover assembly 10 is fastened to portions of the vehicle structure
29 11 at various locations outside the area of the air bag door with one such

1 location being shown in Figure 2 wherein a sheet metal screw 32 fastens the
2 panel at a lower edge thereof beneath the air bag door to a sheet metal portion
3 34 of the vehicle structure. In addition, it will be understood that similar
4 screws or other conventional type fasteners are used at other locations outside
5 the area of the air bag door to securely fasten the cover assembly in place on
6 the vehicle structure.

7 The air bag deployment door 14 in the cover assembly 10 is separately
8 fastened to the vehicle structure by an elongated mounting/hinge flange 36
9 that is molded integral with the back inside surface of the door and extends
10 horizontally along substantially the entire length and adjacent to the upper
11 edge thereof as seen in Figures 1-3. The flange 36 has a flat rectangular
12 portion 38 that extends inwardly of the door a substantial distance and
13 terminates in a flat, rectangular, angled, horizontally extending, distal portion
14 40 that is fastened along its length by bolts 42 to a sheet metal portion 44 of
15 the vehicle structure. The flange 36 is also formed with a controlled thickness
16 and is capable of elastic bending to a significant degree in the rectangular
17 portion 38 in a certain substantial temperature range and down to a certain
18 low temperature (e.g. -20°F) without breaking and thereby act as a cantilever
19 hinge to normally provide for outward swinging opening movement of the
20 door when the door is separated along the tear seam from the cover assembly
21 for air bag deployment. Prior to such air bag door separation, the flange 36
22 acts to fasten the cover assembly to the vehicle structure at the air bag door
23 and also provides support for the latter against a pushing force such as from a
24 passenger which could otherwise push the door inward and separate the door
25 from the cover assembly along the tear seam.

26 The flange 36 is designed to normally hinge and retain the air bag door
27 14 to the vehicle structure during its outward opening movement when the
28 tear seam 16 is torn by the force of the inflating air bag and in doing so is
29 highly stressed at its juncture 48 with the door as the flange portion 38 bends

1 to effect swinging movement of the door. However, at very low or cold
2 temperatures such as -20°F and below, the typical plastic material suitable for
3 the cover assembly in its primary application can become brittle to the point
4 where the lower and major portion 46 of the door, that is forced by the
5 inflating air bag to bend outward about the horizontally extending juncture
6 48 of the door with the flange 36, may fracture or break off at this highly
7 stressed location or zone (see Figure 4) and enter into the passenger space 28.
8 This is prevented in a very cost effective manner by the strategic addition of a
9 flexible door tethering layer 50 of controlled thickness that is formed in place
10 over the one side 52 of the mounting/hinge flange 36 adjoining the potential
11 fracture zone 48, over this zone, and over the inside surface 54 of the
12 potentially frangible door portion 46. The material forming the door
13 tethering layer 50 is a flexible plastics material of a prescribed controlled
14 thickness that is formed in place as described in more detail latter, bonds in its
15 formation without an added adhesive to the material of the cover assembly,
16 and remains flexible or ductile at temperatures substantially below that at
17 which the material of the cover assembly 10 including the integral air bag
18 deployment door 14 becomes brittle. Examples of such material for the
19 tethering layer 50 that will remain flexible or ductile at temperatures as low as
20 -60°F are polyurethane elastomers, polyester elastomers, and polyolefin
21 elastomers. In addition, it will be understood of course that the tethering
22 material while well suited for its application is not suited to meet the stiff
23 requirements of the cover assembly.

24 The flexible tethering layer 50 extends horizontally substantially the
25 entire length of the mounting/hinge flange 36 and is bonded to the side 52 of
26 the flat flange portion 38 at a margin portion 56 of the tethering layer that
27 extends laterally to the distal flange portion 40 so as to maximize the bonding
28 area on this side of the potential fracture zone 48 and thereby maximize the
29 retention of the tethering layer to the flange 36. The tethering layer 50 spans

1 and is bonded to the potential fracture zone 48 at an intermediate portion 58
2 of the tethering layer and is bonded to the inside surface 54 of the potentially
3 frangible air bag door portion 46 at a margin portion 60 that extends laterally
4 to near the lower edge of the door so as to maximize the bonding area of the
5 tethering layer with this door portion and its retention to the flange 36.

6 Referring to Figure 4, the tethering layer 50 at its intermediate portion
7 58 that spans the potential fracture zone flexes when door breakage occurs
8 because of cold plastic embrittlement to permit the broken door portion 46 to
9 continue to swing outward and upward about the line of fracture at the flange
10 36 to provide for continue air bag deployment while retaining the broken
11 door portion safely to the vehicle structure with the tethering layer 50 and
12 flange 36. The bonded retention of the tethering layer over substantially the
13 entire inside surface of the separated door portion 46 and that of the bending
14 portion 38 of the flange 36 maximizes the retention forces available from the
15 tethering layer 50 across the door fracture to retain the broken door portions
16 46 to the flange 36 and thus to the vehicle structure. And the controlled
17 thickness of the tethering layer 50 is determined in relation to the tensile
18 strength of its plastics material so as to not fail in bending tension at its
19 intermediate portion 58 at the greatest anticipated forces acting thereon from
20 the propelled mass of the broken door portion 46. However, it will also be
21 understood that the intermediate bending portion 58 of the tether layer 50
22 could have a greater thickness than the adjoining margin portions 58 and 60
23 for greater tensile strength as necessary in a particular application to conserve
24 material and/or space.

25 The cover assembly 10 including the integral air bag deployment door
26 14 and the mounting/hinge flange 36 is molded in one-piece at one time of
27 the same plastics material such as that previously described which is suitable
28 for the primary purpose of a cover assembly wherein it must be sufficiently
29 stiff for self-support and resistant to heat. The cover assembly 10 is molded in

1 a conventional manner well known in the art and may be formed for example
2 in an injection mold or reaction injection mold whose mold cavity completely
3 defines the surfaces of the cover assembly including the groove defining the
4 tear seam 16 in either the outside or inside surface.

5 Referring to Figures 5 and 6, there is shown the appearance side mold
6 tool 70 of an injection mold used to mold the appearance or front side of cover
7 assembly 10 which is shown in place as molded thereby in these illustrative
8 views and wherein the flexible tethering layer is yet to be formed. And it will
9 be understood that the injection mold for the cover assembly 10 further
10 includes another mold tool (not shown) that defines the back side of the panel
11 and cooperates with the mold tool 70 to form a mold cavity into which the
12 plastics material for the panel is injected in molten form under pressure in a
13 conventional manner. With the molded cover assembly 10 left in place in the
14 mold tool 70 and the back side mold tool moved out of the way, the air bag
15 deployment door tethering layer 50 may then be formed in place with an
16 injection mold tool 72 that seats against the inside surface of the cover
17 assembly over the area in which the tethering layer 50 is to be formed and
18 which includes the side 52 of the mounting/hinge flange 36 and the inside
19 surface 54 of the frangible door portion 46. It will also be understood that the
20 cover assembly could be supported by a dedicated support tool that is much
21 smaller than the cover assembly mold tool 70 and has a similar support
22 surface that just spans the area of the outer side of the molded cover assembly
23 opposite where the tethering layer is to be formed. The injection mold tool 72
24 is formed on its molding side with a tethering layer defining cavity 74 that is
25 closed by the side 52 of the mounting/hinge flange 36 and the inside surface
26 54 of the frangible door portion 46 and defines therewith a closed mold cavity
27 76 that defines the entirety of the tethering layer shape.

28 The mold tools 70 and 72 with the cover assembly 10 located there
29 between are clamped together in a conventional type plastics injection

1 molding machine (not shown) and the tethering plastics material as earlier
2 described is injected in molten form under high pressure in a conventional
3 manner through a passage 78 in the mold tool 72 into the closed mold cavity
4 76 to form the flexible tethering layer 50. It will also be understood that a low
5 pressure mold tool with a tethering layer defining mold cavity like the cavity
6 74 in mold tool 72 but with the low pressure mold tool suitably adapted in a
7 conventional manner for gravity molding, reaction injection molding, or resin
8 transfer molding of the tethering layer with reactive components of the
9 plastics material can also be used to mold the tethering layer in place on the
10 inside surface of the cover assembly. In either case, the plastics material
11 forming the tethering layer bonds without an added adhesive to the inside
12 surface of the cover assembly to form a strong attachment thereto over the
13 entire extensive interface between the tethering layer 50 and both the
14 mounting/hinge flange 36 and the frangible door portion 46.

15 The tethering layer 50 may also be formed in place on the inside
16 surface of the cover assembly by spraying the tether forming plastics material
17 as illustrated in Figure 7. This is preferably accomplished with a mask 80 of
18 controlled thickness that is laid against the side 52 of the mounting/hinge
19 flange 36 and the inside surface 54 of the frangible door portion 46 in
20 interfacing relationship therewith and has an opening 82 that defines the
21 periphery of the tethering layer 50. The mask 80 has the desired thickness of
22 the tethering layer or a slightly greater thickness and may be formed of metal
23 or plastic and either by flexible so as to readily conform to the surface to be
24 masked or be preformed with the required interfacing shape. The mask 80 is
25 held in place by suitable means such as by flanges 84 fixed to a robot arm and
26 the outer surface 86 of the mask is coated with a suitable release agent such as
27 silicone to prevent the tether forming plastics material from adhering thereto.

28 With the mask 80 held in place on the inside surface of the cover
29 assembly, the tether forming plastics material is sprayed through the mask

1 opening 82 onto the unmasked area of the panel to form the tethering layer 50
2 using a conventional type plastics spraying system 88 that includes a suitable
3 mixing head 90 having a spray wand 92. The spraying system 88 operates in
4 a conventional manner to effect spraying on command and wherein reactive
5 components of the plastics material are delivered to the mixing head 90 by
6 separate lines 94 and 96 and these components are mixed in the mixing head
7 just prior to spraying with the wand 92. The mixing head 90 may be
8 manipulated by an operator or a robot and the mixed plastics material is
9 dispensed from the mixing head through the spray wand onto the unmasked
10 area of side 52 of the mounting/hinge flange 36 and the inside surface 54 of
11 the frangible door portion 46 as illustrated in Figure 7 to form the tethering
12 layer to the desired controlled thickness. Then on setting of the sprayed
13 plastics material, the mask is removed leaving the tethering layer in place and
14 bonded without adhesive to the cover assembly.

15 Summarizing examples of the plastics materials that can be used in the
16 above molding processes to form the tethering layer; the gravity molding
17 material can be a thermoset material such as polyurethane, the resin transfer
18 molding material can be a thermoset material such as polyester, the reaction
19 injection molding material can be a thermoset material such as polyurethane,
20 the spray molding material can be a thermoset material such as polyurethane,
21 and the injection molding material can be thermoplastic material such as
22 polyolefin.

23 As shown in Figures 8-10, 11-14 and 15, respectively, the second, third
24 and fourth embodiments 10a-c of the cover assembly 10 each comprise an
25 instrument panel generally indicated at 100a-c. In each of these embodiments
26 the instrument panel 100a-c comprises a first plastics material and is
27 configured to mount in the passenger compartment of the motor vehicle. An
28 air bag door panel shown at 14a-c also comprises the first plastics material
29 and is formed with the instrument panel 100a-c as a single integral and

1 unitary panel 14a-c, 100a-c. The door panel 14a-c is at least partially
2 surrounded by the instrument panel 100a-c.

3 In each of the second through fourth embodiments, a hinge panel,
4 shown at 50a-c, is connected to an inside surface 102a-c of the unitary panel
5 14a-c, 100a-c in a layered disposition. The inside surface 102a-c is disposed
6 opposite an outside or "class A" surface 104a-c of the unitary panel 14a-c,
7 100a-c. The hinge panel 50a-c comprises a second plastics material that is
8 more ductile and less brittle at low temperatures than the first plastics
9 material. The hinge panel 50a-c is insert molded into an inside surface of at
10 least one of the instrument panel 100a-c and the door panel 14a-c. As shown
11 at 50b' in Figure 14, in other embodiments the hinge panel 50 may comprise
12 sheet metal or both sheet metal and plastic. Metal is especially advantageous
13 as a component of an aft edge of the hinge panel aligned with a tear seam due
14 to increased rigidity which aids in distributing door opening forces more
15 evenly along the tear seam to promote more uniform tear seam fracture and
16 subsequent door opening.

17 As shown in Figures 8-15, the hinge panel 50a-c includes a hinge panel
18 aft edge 110a-c aligned with an aft portion of the tear seam 16a relative to the
19 direction of door opening during air bag inflation. The alignment of the aft
20 portion of the tear seam 16a and the hinge panel aft edge 110a-c helps to
21 guide tearing along the tear seam 108.

22 As shown in Figures 8-10, the door panel 14a of the second
23 embodiment includes a hinge flange 36a extending transversely inward from
24 the inside surface 54a. As is described in detail with respect to the first
25 embodiment, above, the hinge flange 36a is configured to secure the door
26 panel 14a to a structural member 44a. The hinge panel 50a spans a flange
27 juncture zone, shown at 112a in Figures 8-10, where the hinge flange 36a
28 integrally extends from the inside surface of the door panel 14a. The hinge
29 panel 50a acts as a secondary hinge and a tether in the event the door panel

1 14a should fracture at the flange juncture zone 112a – or at any other point
2 spanned by the hinged panel 50a. The hinge panel 50a is attached to the
3 hinge flange 36a and door panel 14a in a layered disposition by insert
4 molding.

5 As is also shown in Figure 8-10, a forward tear seam portion 108a of
6 the weakened tear seam 16a runs parallel to and adjacent the panel juncture
7 zone 112a of the second embodiment. The forward tear seam portion 108a
8 delineates a boundary between a forward portion of the door panel 14a and
9 the instrument panel 100a. The forward tear seam portion 108a completes a
10 full 360° tear seam path for the tear seam 16a that defines the entire outline of
11 the air bag door panel 14a. Therefore, upon air bag inflation, the entire door
12 panel 14a is torn free of the instrument panel 100a and is tethered only by the
13 hinge flange 36a. Alternatively the forward tear seam portion 108a may be
14 omitted.

15 As shown in Figures 11-14, the hinge panel 50b of the third
16 embodiment spans a panel juncture zone 106b between the door panel 14b
17 and the instrument panel 100b. The hinge panel 50b acts as a secondary hinge
18 between the door panel 14b and the instrument panel 100b during air bag
19 deployment. The hinge panel 50b may lie flush with the inside surface.
20 However, in other embodiments, the hinge panel 50b may be molded in a
21 raised position to allow for a constant thickness of the first material over the
22 unitary panel 14b, 100b.

23 As shown in Figures 11-14, the panel juncture zone 106b of the third
24 embodiment may include a styling groove 108b separating at least a portion
25 of the door panel 14b and the instrument panel 100b. The styling groove 108b
26 may be formed by methods other than injection molding such as laser scoring,
27 cutting or melting. The styling groove 108b promotes upward bending of the
28 first plastics material at the hinge location by removing material that would
29 otherwise impede such upward bending.

1 As shown in Figure 14, a urethane foam layer 120 may be disposed
2 over the unitary panel 14b and a plastic skin layer 122 may be disposed over
3 the foam layer. While the foam and skin layers 120, 122 are shown on the
4 unitary panel 14b of the embodiment of Figure 14, such layers may also be
5 included in any embodiment of the invention.

6 As shown in Figure 15, the instrument panel 100c of the fourth
7 embodiment includes a collar 114 that integrally extends transversely inward
8 from the inside surface 102c and from around the door panel 14c. The collar
9 114 defines a door-collar interface 116 along a region where the collar 114c
10 extends from the unitary panel 14c, 100c. The collar 114 forms a sleeve for
11 receiving an air bag canister assembly 18c. In other embodiments, the collar
12 114 may serve as a guide chute for a deploying air bag. The hinge panel 50c
13 spans the door-collar interface 116. An inner portion 56c of the hinge panel
14 50c is attached to the collar 114 and an outer portion 60c of the hinge panel
15 50c is attached to the door panel 14. A styling groove 108c may be aligned
16 with the portion of the door-collar interface 116 that the hinge panel 50c
17 spans. The styling groove 108c is formed into the outside or "class A" surface
18 104c to aid upward bending of the door panel 14c.

19 In practice, air bag cover assemblies 10a-c can be made by first
20 providing a mold having first and second mold portions. The first and second
21 mold portions form a mold cavity when closed together. The mold cavity has
22 a shape that complements the shape of whichever unitary panel 14a-c, 100a-c
23 and hinge panel 50a-c is to be formed. A hinge panel 50a-c is formed from
24 the second plastics material, metal or a combination thereof and is placed in
25 the second mold portion. The hinge panel 50 is placed in a portion of the
26 mold cavity in the second mold portion in a position spanning a portion of
27 the mold configured to form the juncture zone 112a, 106b or interface 116
28 between the door panel 14a-c and either the instrument panel 100b of the

1 second embodiment, the hinge flange 36a of the third embodiment or the
2 collar 114 of the fourth embodiment.

3 For example, to form a cover assembly 10a according to the second
4 embodiment, i.e. a hinge-flange version of the invention, the mold cavity
5 surface of the second mold portion is shaped to receive the hinge-flange 36a.
6 The hinge panel 50a is placed on the mold cavity surface of the second mold
7 portion in a position spanning a portion of the mold configured to form the
8 flange juncture zone 112a between the hinge-flange 36a and the door panel
9 14a. In this case, the mold cavity surface of the second mold portion has a
10 shape complementing that of the inside surface 102a of the unitary panel 14a,
11 100a. The mold is then closed by positioning the first mold portion on the
12 lower mold portion. The first mold portion includes a mold cavity surface
13 shaped to complement the shape of the outside or "class A" surface 104a of
14 the unitary panel 14a, 100a. The first plastics material is then introduced into
15 the mold cavity in molten form. The molten first plastics material is allowed
16 to conform to the shape of the mold cavity and to solidify in the mold cavity.
17 The mold is then opened and the completed assembly 10a is removed from
18 the mold with the hinge panel 50a molded into the unitary panel 14a, 100a as
19 shown in Figure 8.

20 A first embodiment of a vehicle passenger compartment console
21 assembly constructed according to the present invention is shown at 210 in
22 Figs. 16 and 17. Alternative embodiments of the console assembly are
23 generally shown at 210a in Figures 18-21 and 210b and 210c in Figures 22 and
24 23, respectively. Reference numerals with the suffix "a" in Figures 12-21, the
25 suffix "b" in Figure 22 and the suffix "c" in Figure 23 designate the alternative
26 configuration of each element common to the embodiment of Figures 16 and
27 17. Unless the description indicates otherwise, where the description uses a
28 reference numeral to refer to an element in Figures 16 or 17, I intend that
29 portion of the description to apply equally to elements in Figures 18-21

1 indicated by the same reference numeral with the suffix "a", the elements in
2 Figure 22 indicated by the same reference numeral with the suffix "b", and
3 the elements in Figure 23 indicated by the same reference numeral with the
4 suffix "c".

5 The floor console assembly 210 includes a console body 212 with an
6 outer shell 214 having a size and shape that allow the console assembly 210 to
7 fit in the area between the front driver seat 216 and the front passenger seat
8 218 of a motor vehicle. As shown in Fig. 16, the outer shell 214 has an
9 elongated box shape with rounded corners and edges sculpted to flow into
10 the interior contours of the automobile the console is installed in.

11 The first embodiment of the floor console assembly 210 includes an
12 access opening 220 disposed in the console body outer shell 214. The access
13 opening 220 is centrally located in an upper surface 222 of the outer shell 214
14 and is generally rectangular. The access opening 220 is defined by a pair of
15 straight side edges 224 and by upwardly curved forward 226 and aft 228
16 edges. The forward 226 and aft 228 edges each include a semi-circular groove
17 230.

18 As is best shown in Fig. 17, the first embodiment also includes a
19 module positioning apparatus 232 that is movably supported within the
20 console body outer shell 214. The positioning apparatus 232 comprises a
21 drum-type carrousel 236 supported for rotation about a horizontal central
22 carrousel axis 238. The carrousel axis 238 is aligned parallel to the direction
23 that the immediately adjacent passenger seats 216, 218 are facing, i.e. the
24 direction of vehicle travel.

25 As shown in Fig. 17, the positioning apparatus 232 may include an
26 electro-mechanical occupant-actuated drive mechanism 240 and may also
27 include an occupant-actuated automatic module selection system 292. To
28 select a module using the electro-mechanical drive mechanism 240 an
29 occupant actuates the drive mechanism and causes it to continue rotating

1 modules past the access opening until a desired module appears in the access
2 opening 220. With the automatic selection system, an occupant momentarily
3 depresses a button or key corresponding to the desired module which causes
4 the drive mechanism 240 to rotate the carrousel until the selected module
5 appears.

6 Three storage modules 234 and/or appliance modules 242 are
7 supported on the positioning apparatus 232 for rotational movement within
8 the console body outer shell 214. In other embodiments the positioning
9 apparatus may carry only two modules or may carry more than three
10 modules. Other embodiments may also move the modules in other than a
11 rotational motion.

12 The shape of each storage module is a cylindrical section
13 approximating an elongated triangular prism with a single elongated arcuate
14 plane as shown at 234 in Fig. 17. Other embodiments may include modules
15 having different sizes and shapes. Storage modules 234 may also include
16 contoured inserts designed to nest one or more loose articles.

17 An appliance module 242 may have any shape so long as that shape
18 allows the appliance module 242 to fit within the confines of its assigned
19 space within the carrousel 236. In the case of a carrousel with three equal-size
20 compartments or sections, as shown in Fig. 17, the appliance module 242 must
21 fit within a space approximating that defined by storage module 234.

22 However, the module compartments or sections need not have the same size
23 and shape. Some modules are larger than others to accommodate larger
24 appliances. Examples of the types of appliances that may be built into the
25 appliance modules 242 include computers, fax machines, modems, cellular
26 telephones and hair-dryers.

27 The storage 234 and appliance 242 modules are sequentially rotatable
28 through a displayed position adjacent the access opening 220. The displayed
29 position is best shown in Fig. 17 as viewed through the access opening 220.

1 The carousel-type positioning apparatus 232 allows passenger compartment
2 occupants to select and retrieve any one of the storage 234 or appliance 242
3 modules and to gain access to its contents through the access opening 220.

4 As shown in Fig. 16, an access door 244 is slidably supported in the
5 semi-circular grooves 230. The access door 244 has an arcuate shape to cover
6 the access opening 220 in a closed position and may be slid to an open
7 position revealing and providing access to the contents of whichever module
8 234, 242 is in the presented position.

9 A forward image display panel 246 in the form of a cathode ray tube
10 (CRT) is supported in a forward end of the console body 212. The forward
11 image display panel 246 is positioned to display images primarily to the
12 occupants of seats 216, 218 positioned on either side of the console assembly
13 210.

14 An aft image display panel 248, also in the form of a CRT, is supported
15 in an aft end of the console body 212. The aft image display panel 248 is
16 positioned to display images primarily to occupants seated behind the
17 console assembly 10. Image-producing electronic circuitry is included in an
18 electronic computer game module 250 connected to the aft display panel 248
19 and, in response to occupant inputs, transmits signals that produce images on
20 the aft display panel 248. In other embodiments, the image-producing
21 electronic circuitry may not be included in a computer game module. Instead,
22 it may be included in a device that, for example, converts broadcast
23 microwave signals or information stored in magnetic media (videotape) into
24 video images.

25 Occupant inputs to the electronic circuitry are passed through signal
26 wires 52 from a remote-control unit 254. Audio signals may be transmitted to
27 occupants via headphones 256. Alternatively, occupant inputs may be passed
28 from the remote control unit 254 to the image-producing electronic circuitry
29 by electromagnetic transmissions instead of wires.

1 This first embodiment 210 of the present invention reduces clutter by
2 providing occupants with selective access to any one of a number of different
3 storage 234 and appliance 242 modules and storing non-selected modules
4 inside the center console 212. The electro-mechanical drive mechanism 240
5 and occupant-actuated automatic module selection system allow a driver to
6 gain access to a module while diverting a minimum amount of attention from
7 the task of operating the vehicle. The image display panels 246, 248 are
8 conveniently located to display information to front and rear seat occupants,
9 respectively.

10 The second embodiment of the vehicle passenger compartment
11 console assembly is shown at 210a in Figs. 18-21. The assembly 210a includes
12 an instrument panel console body 212a rather than a center console body 212
13 as in the first embodiment. The instrument panel console body 212a is
14 supported in an instrument panel assembly 213 of the automobile. The
15 instrument panel assembly 213 may be of any type known in the art to
16 include the panel disclosed in United States Patent No. 5, 556,153 (the '153
17 patent). The '153 patent is assigned to the assignee of the present invention
18 and is incorporated herein by reference.

19 The instrument panel console body 212a includes an outer shell 214a.
20 An access opening 220a is disposed in the outer shell 214a and a positioning
21 apparatus 232a is movably supported within the outer shell 214a. Three
22 storage modules 234a are also disposed within the shell 214a and are movably
23 supported on the positioning apparatus 232a. The storage modules 234a are
24 sequentially movable between one or more concealed positions and displaced
25 from the access opening 220a and a displayed position adjacent the access
26 opening 220a. The concealed positions are shown at 260 in Figs. 20 and 21.
27 The displayed position is shown at 262 in Figs. 18 and 20.

28 The positioning apparatus 232a is configured to support an one of the
29 storage modules 234a in the display position 262 while simultaneously

1 supporting the other two storage modules 234a in a concealed position 260.
2 As with the first embodiment, this allows a passenger compartment occupant
3 to gain physical access to a module 234a and its contents through the access
4 opening 220a while leaving other modules 234a concealed within the shell
5 214a.

6 The positioning apparatus 232a comprises a drum-type carrousel 236a
7 or turnstile supported in the instrument panel console body 212a for rotation
8 about a generally vertical carrousel axis 238a. The storage modules 234a are
9 defined by four vertically oriented rectangular divider panels shown at 264 in
10 Figs. 18, 20 and 21, a semi-circular cap panel shown at 266 in Fig. 18 and a
11 base panel shown at 268 in Figs. 18, 20 and 21. The base panel 238 generally
12 matches the shape of the cap panel 266. The divider panels 264 extend
13 radially and integrally outward from a common point at the vertical axis 238a.
14 Upper and lower ends of the divider panels are connected to or integrally
15 formed with the cap panel 266 and the base panel 268, respectively.

16 Other embodiments may include any suitable divider and cap panel
17 configuration. As with the first embodiment the carrousel 236a of the second
18 embodiment may also incorporate appliance modules 234a and/or contoured
19 inserts designed to nest one or more loose articles.

20 Rotational support may be supplied by any means known in the art to
21 include axle rods 270 extending along the vertical axis 238a upward from the
22 cap panel 266 and downward from the base panel 268 through or into journal
23 bearing assemblies 272. The carrousel 236a may be molded as a single piece
24 from plastic or other suitable materials, or the panels 264, 266, 268 may be
25 connected together by adhesives, fasteners or any other means known in the
26 art.

27 The carrousel 236a is at least partially housed within a central stack
28 portion 274 of the instrument panel console body 212. The central stack
29 portion 274 is described in detail in the '153 patent. The access opening 220a

1 is defined by a rectangular opening in an aft end of the central stack portion
2 274.

3 The carrousel 236a is rotationable to a closed position as shown in Fig.
4 19. The carrousel 236a includes a flat, generally vertical face panel shown at
5 276 in Figs. 19-21. The face panel 276 has the same approximate rectangular
6 shape as the opening in the central stack portion 274 of the instrument panel
7 console body 212 that defines the access opening 220. The face panel 276 is
8 disposed across and generally closes the access opening 220, i.e. the
9 rectangular opening, when the carrousel 236a is in the closed position.

10 The third embodiment of the vehicle passenger compartment console
11 assembly is shown at 210b in Figure 22. According to the third embodiment
12 the positioning apparatus 232b comprises a drum-type carrousel 236b
13 supported "Ferris-wheel" style in the instrument panel console body 212b for
14 rotation about a generally horizontal axis 238b. The carrousel axis 238b is
15 disposed transverse to the vehicle direction of travel to more conveniently
16 present the contents of the storage modules 234b to vehicle occupants. The
17 display position is located at the aft-most portion of the carrousel 236b where
18 the contents of a storage module 234b are visible and/or physically accessible
19 through an access opening 220b defined by a small rectangular window in a
20 front panel 278 covering the center stack opening. The storage modules 234b
21 of the drum-type carrousel 236 include a radio receiver 280, a CD player 282,
22 a cell phone 284, HVAC controls 286, and open compartments for storage
23 234b. Other embodiments may include any number of other such
24 components. All of the components in the storage modules 234b are
25 selectively movable to the display position adjacent the access opening 220b
26 through occupant actuation of a selector switch 288 mounted on the console
27 above the rectangular opening in the central stack portion 274.

1 Actuation may alternatively be accomplished by any other suitable
2 means known in the art. In addition, such actuation means may be mounted
3 on any convenient surface within the vehicle passenger compartment.

4 The fourth embodiment includes a "lazy Susan-type" positioning
5 apparatus 232c that includes a platform 290 having any number of generally
6 pie-shaped storage regions 234c. The platform 290 is rotatably supported
7 within the console body outer shell 214c. The positioning apparatus 232c is
8 configured to rotate the platform 290 and move a selected one of the storage
9 regions 234c to a display position adjacent the access opening 220c while
10 simultaneously moving the other of the storage regions 234c into a remote
11 position displaced from the access opening 220c. This allows a passenger
12 compartment occupant to gain physical access to an item stored on one of the
13 storage regions 234c of the platform 290 through the access opening 220c
14 while leaving other items stored on the other storage regions in positions
15 within the shell 214 that are remote from the access openings 220c.

16 As with the other embodiments, the positioning apparatus 232c
17 includes an electro-mechanical occupant-actuated drive mechanism 240c and
18 an occupant-actuated automatic module selection system 292c. Similar to the
19 first embodiment, the fourth embodiment includes an access door 244c that is
20 slidably supported across the module access opening 220. The door 244c is
21 shaped to cover the access opening 220 when moved to a closed position and
22 uncovers the access opening 220c when moved to an open position as shown
23 in Fig. 23.

24 As with previously described embodiments, the storage spaces 234c on
25 the lazy-Susan type platform 290 of the fourth embodiment are adapted to
26 permanently or semi-permanently accommodate various appliances or to
27 temporarily store various loose items.

28 Unlike the previously described embodiments, the positioning
29 apparatus 232c of the fourth embodiment includes no divider panels 264, no

1 cap panel 266 and only a single axle rod (not shown) extending axially
2 downward from the base panel 268.

3 A headliner assembly for lining the roof of the passenger compartment
4 of a vehicle is generally shown at 310 in Figs. 24-26. The headliner assembly
5 310 includes a unitary substrate, generally indicated at 312 in Figs. 24-26, that
6 is configured to mount to a vehicle in a position generally covering a lower
7 surface of a passenger compartment roof (not shown). The substrate 312
8 includes an upper substrate surface shown at 314 in Figs. 24-26 and a lower
9 substrate surface shown at 316 in Fig. 26. The lower substrate surface 316 is
10 disposed opposite the upper substrate surface 314. The substrate 312 may be
11 made of any suitable moldable material to include various plastics or
12 fiberglass reinforced polyester resin.

13 A decorative cover, shown at 318 in Fig. 26, is supported on the lower
14 substrate surface 316. The decorative cover 318 may be in the form of a fabric
15 or solid layer of any suitable material.

16 Cavities, shown at 320, 322, and 324 in Fig. 26 are formed into the
17 substrate 312 between the upper substrate surface 314 and the lower substrate
18 surface 316. One of the cavities, shown at 320 in Fig. 26 is defined by an
19 elongated receptacle or conduit, shown at 326 in Figs. 24-26. The conduit 326
20 is configured to support electrical wiring or fiber optic cabling.

21 Two of the cavities, shown at 322 in Fig. 26, are defined by generally
22 rectangular pockets, shown at 328 in Figs. 24-26. As best shown in Fig. 26, the
23 pockets 328 are configured to hold energy absorbing foam 334. In other
24 embodiments, the pockets 328 may be filled with acoustic energy or sound
25 absorbing foam or other energy-absorbing materials or structures. In still
26 other embodiments, the pockets 328 may be configured to absorb passenger
27 head impact energy without the aid of foam filling.

1 The largest of the cavities, shown at 324 in Fig. 27, is defined by a
2 contoured duct shown at 330 in Figs. 24-26. The duct 330 is configured to
3 direct airflow into a vehicle passenger compartment.

4 Each of the cavities 320, 322, 324 is preferably integrally formed in the
5 substrate 312. In other words, the conduit 326, compartments 328 and duct
6 330 are integrally formed with the substrate 312 as a single unitary piece.

7 A foam layer, shown at 332 in Fig. 26, is preferably disposed on a lower
8 surface of the substrate 312 and the decorative outer cover 318 is disposed on
9 a lower surface of the foam layer 332. The foam layer 332 and decorative
10 outer cover 318 may be fastened in place by adhesives or any other suitable
11 means.

12 Cavity 324 and air duct 330 protrude upward from the substrate 312
13 and have rounded contours to facilitate airflow. At one end of the air duct
14 330 the headliner assembly 310 includes an air inlet opening shown at 336 in
15 Figs. 24 and 25. The air inlet opening 336 is disposed adjacent a peripheral
16 edge 338 of the headliner assembly 310 and is configured to receive air into
17 the air duct 330 from a vehicle air handling system, e.g. a heating, ventilating
18 and air conditioning (HVAC) system (not shown). Three air outlet openings
19 are shown at 340 in Figs. 25 and 26. The air outlet openings 340 are spaced
20 from each other and are spaced from the air inlet opening 336. The air outlet
21 openings 340 are disposed in a triangular array and extend through a
22 thickness of the headliner assembly 310. The air outlet openings 340 direct air
23 from the vehicle air handling (HVAC) system into the passenger
24 compartment. The air duct 330 extends between and connects the air inlet
25 opening 336 and the air outlet openings 340 to provide gaseous
26 communication between the air inlet opening 336 and the air outlet openings
27 340.

28 A directional air outlet register, shown at 344 in Fig. 26, is rotatably
29 mounted within each air outlet opening 340 and protrudes from an underside

1 surface 342 of the headliner assembly 310. The directional air outlet registers
2 344 allow passengers to direct air to various parts of the passenger
3 compartment.

4 Similar to the air duct 330, the conduit 326 protrudes upward from the
5 substrate 312. The conduit 326 is configured to support wires or cables 346
6 that will conduct electricity, light, or other forms of electromagnetic radiation
7 to various points in the headliner assembly 310. More specifically, the
8 conduit 326 defines an elongated tube. The cross-sectional shape of the
9 conduit 326 may be any suitable shape for holding cables 346. The headliner
10 assembly 310 includes a cable inlet opening 348 at one end of the conduit 326
11 and disposed adjacent the peripheral edge 338 of the headliner assembly 310.
12 The cable inlet opening 348 is positioned to receive cables 346 leading to the
13 vehicle roof from a vehicle electrical or fiber optic system.

14 Two cable outlet openings, shown at 350 in Figs. 24-26 are spaced from
15 the cable inlet opening 348. The cable outlet openings 350s are disposed
16 adjacent respective electrical or fiber-optic light fixtures shown at 352 in Figs.
17 24-26. In the present embodiment, the fixtures 352 are electrical dome lights.
18 However, in other embodiments, each fixture 352 may include, for example, a
19 fiber optic dome or indicator light. Each fixture 352 may also include a roof-
20 mounted electronic accessory such as a radio, television, computer monitor,
21 tape deck or CD-player that is supported on or adjacent the headliner
22 assembly 310. The cable outlet openings 350 are disposed adjacent such
23 fixture 352 to allow the electrical or fiber optic cables to be connected to the
24 fixtures 352. The cable conduit 326 extends between and connects the cable
25 inlet opening 348 and the cable outlet openings 350.

26 The pockets 328 support energy absorbing foam 334 in strategic
27 locations in the substrate 312. Each pocket 328 includes an inner wall 354 that
28 envelops and seals the energy-absorbing foam 334 within the pocket 328. The
29 foam-filled cavities 322 of the pockets 328 are disposed in an array at spaced

1 locations where passenger head impact is likely to occur if passengers are
2 subjected to sudden vertical acceleration components. The two pockets 328 of
3 the present embodiment are disposed directly above the seating locations for
4 the driver and the front seat passenger as shown in Figs. 24-26.

5 The headliner assembly 310 may be constructed according to the
6 present invention by first fabricating a two-piece clamshell-type blow mold as
7 is generally indicated at 356 in Figs. 27 and 28. The mold 356 is fabricated to
8 include a hollow portion, shown at 358 in Figs. 27 and 28, for receiving molten
9 parison 360 and shaping exterior contours of the headliner substrate 312 to be
10 formed. In fabricating the mold 356, the hollow portion 358 of the mold 356 is
11 shaped to complement desired exterior contours of the headliner substrate
12 312 to be formed. As shown in Figs. 27 and 28, the hollow portion 358 is also
13 configured to include enlarged regions 362, 364, 366 corresponding to
14 respective cavities 320, 322, 324 to be formed in the substrate 312. An
15 additional hollow portion forms an air passage, shown at 370 in Figs. 27 and
16 28, at one end of the mold 356 when the two halves are joined together. The
17 air passage is configured to receive an air injector such as a blow pin 374. The
18 air passage 370 branches to the enlarged regions 362, 364, 366 of the hollow
19 portion 358 of the mold 356 to allow air to be injected into each of the
20 enlarged regions 362, 364, 366 from the air injector.

21 Once the mold 356 has been fabricated, a molten parison 360 is
22 extruded downward between the open mold halves and into the hollow
23 portion 358 within the blow mold 356. As shown in Fig. 27, a parison
24 extrusion die 372 extrudes the parison 360 in the form of an oblong, hollow
25 tube. The mold halves are then closed together around the tubular parison
26 360, pinching together opposed walls 363, 365 of parison along outer
27 boundaries of the enlarged regions 362, 364, 366. Pressurized gas is then
28 injected into a hollow center region 367 of the molten tubular parison 360
29 causing the parison 360 to expand within the enlarged regions 362, 364, 366 of

1 the hollow portion 358 of the mold 356. The pressurized gas also causes the
2 parison 360 to expand within the gas passage 370, conforming to the contours
3 of the gas passage 370 as shown at 380 in Figs. 24-26A. After the cavities 320,
4 322, 324 have been formed in the parison 360, the blow pin 374 may be
5 removed from the parison 360.

6 The parison 360 is then allowed to harden into the desired shape of the
7 headliner substrate 312. The blow mold 356 is then opened and the headliner
8 substrate 312 is removed. Following hardening and removal of the headliner
9 substrate 312, the foam layer 332 is adhesively applied to the substrate lower
10 surface 316 and the decorative outer cover 318 or skin is adhesively applied to
11 the lower surface of the foam layer 332. Alternatively, the decorative outer
12 cover 318 and foam layer 332 may be placed in the blow mold 356 before
13 molding and integrally joined during molding. As other alternative, the outer
14 cover 318 and foam layer 332 may be coextruded at the same time as a multi-
15 layered parison.

16 As shown in Fig. 26, foam 334 is provided within the pocket cavities
17 322 by inserting nozzle portions 376 of one or more foaming machines into
18 the pocket cavities 322 and filling the pocket cavities 322 with the foam 334.
19 Preferably, the foam is urethane foam produced via a reaction injection
20 molding process. This may be accomplished either before or after the
21 headliner substrate 312 is removed from the mold 356. Foam injection may
22 also occur instead of gas injection in forming the pocket cavities 322 rather
23 than after gas injection and pocket cavity formation. After foam injection is
24 complete the foam injection nozzles 376 are then withdrawn from the pocket
25 cavities 322 and the foam 334 allowed to cure.

26 Referring to Figures 29 and 30, there is illustrated a molded motor
27 vehicle instrument panel 410 as installed in a motor vehicle structure
28 generally designated as 411. The instrument panel 410 has an opening 412 on
29 the driver side for the installation of an instrument cluster (not shown) and an

1 air bag deployment door 414 of desired shape, in this case rectangular, on the
2 passenger side whose entire or partial perimeter, in this case entire, is defined
3 by a frangible tear seam 416 molded in the instrument panel. The tear seam
4 416 may be formed by a groove either in the face of the panel as shown or by
5 a similar groove in the back side of the panel to hide the tear seam from view
6 as is well known in the art or by other methods known to the art of forming
7 an integral but frangible tear seam. When installed on the vehicle structure
8 411, the instrument panel covers an air bag system 418 that is located behind
9 the instrument panel directly behind the air bag door 414 and is mounted on a
10 sheet metal portion 420 of the vehicle structure. The air bag system 418 is of a
11 conventional type that includes an inflatable air bag 422, an inflator 424 and
12 an impact sensor 426 that on vehicle impact triggers ignition of the inflator to
13 inflate the air bag for deployment into the passenger space 428 directly in
14 front of a passenger seated on this side.

15 The instrument panel 410 is an injection molded one-piece part of
16 generally uniform wall thickness and is formed of a first plastics material and
17 preferably a suitable commercially available thermoplastic material such as
18 polypropylene, polycarbonate, and styrene maleic anhydride that provides
19 sufficient stiffness so that the panel is self-supporting to maintain the desired
20 shape and has sufficient heat resistance to resist deformation due to heat in its
21 interior vehicle environment where it is located immediately behind the
22 windshield (not shown). The groove forming the tear seam 416 is made deep
23 enough in relation to the wall thickness of the instrument panel and the
24 strength of the plastic material so as to sufficiently weaken the wall section at
25 the tear seam to the point that it is torn by the force of the inflating air bag
26 acting against the back side of the air bag door and creates on its separation
27 from the instrument panel an opening 430 therein for the deployment of the
28 air bag as illustrated in Figure 33 and described in more detail later.

1 The instrument panel 410 is fastened to portions of the vehicle
2 structure 411 at various locations outside the area of the air bag door with one
3 such location being shown in Figure 30 wherein a sheet metal screw 432
4 fastens the panel at a lower edge thereof beneath the air bag door to a sheet
5 metal portion 434 of the vehicle structure. And it will be understood that
6 similar screws or other conventional type fasteners are used at other locations
7 outside the area of the air bag door to securely fasten the instrument panel in
8 place on the vehicle structure.

9 The air bag door 414 in the instrument panel 410 is separately fastened
10 to the vehicle structure by an elongated mounting/hinge flange 436 that is
11 molded integral with the back side of the door and extends horizontally along
12 substantially the entire length and adjacent to the upper edge thereof as seen
13 in Figures 29 - 31. The flange 436 has a flat portion 438 that extends
14 transversely inwardly of the door a substantial distance and terminates in a
15 flat, angled, horizontally extending, distal portion 440 that is fastened along
16 its length by bolts 442 to a sheet metal portion 444 of the vehicle structure.
17 The flange 436 is also formed with a uniform thickness and acts as a cantilever
18 hinge to normally provide for outward swinging opening movement of the
19 door when the door is separated along the tear seam from the instrument
20 panel for air bag deployment. Prior to such air bag door separation, the
21 flange 436 acts to fasten the instrument panel to the vehicle structure at the
22 air bag door and also provides support for the latter against a pushing force
23 such as from a passenger which could otherwise push the door inward and
24 separate the door from the instrument panel along the tear seam.

25 The flange 436 is designed to normally hinge and retain the air bag
26 door 414 to the vehicle structure during its outward opening movement when
27 the tear seam 416 is torn by the force of the inflating air bag and as such
28 serves as a primary tether for the door 414 to retain connection with the
29 vehicle structure 411. In doing so, the flange 436 is highly stressed at its

1 juncture 446 with the back side of the door as a portion 438 of the flange
2 bends to effect swinging movement of the door. The material of the panel 410
3 and hence the flange 436 is flexible in a limited temperature range
4 encompassing normal operating temperatures for most vehicle applications
5 (e.g. 0°F and above). However, at very low or cold temperatures such as -20
6 degrees Fahrenheit and below, the typical commercially available plastics
7 material suitable for the instrument panel in its primary application can
8 become brittle to the point where the lower and major portion 448 of the door
9 that is forced by the inflating air bag to bend outward about the horizontally
10 extending juncture 446 of the door with the flange portion 438 may fracture or
11 break off at this highly stressed zone (see Figure 33) and be flung into the
12 passenger compartment. This is prevented in a very cost effective manner by
13 the strategic addition of an elongated flexible supplemental tethering hinge
14 450 that is formed from a sheet of strong flexible material that is efficient and
15 relatively more flexible or ductile than the plastics material of the panel 410 at
16 temperatures substantially below that at which the material of the instrument
17 panel 410 becomes brittle so as to tether the door in the event the highly
18 stressed zone 446 fractures due to embrittlement of the panel material.
19 Examples of such material for the hinge 450 are thermoplastic materials such
20 as polyvinyl chloride, coated nylon and Kevlar, thermosetting materials such
21 as polyurethane and polyester, metal mesh screen, and a woven fabric of
22 fibers formed of such plastic materials or natural fibers such as cotton or
23 hemp.

24 According to the embodiment of Figures 29-33, the flexible tethering
25 hinge 50 extends horizontally substantially the entire length of the
26 mounting/hinge flange 436 (see Figure 31) and is fastened along one
27 horizontal margin 452 of the hinge 450 on one side of the critical juncture zone
28 446 to the flat portion 438 of the mounting/hinge flange at a location remote
29 from this potential fracture zone by fastening means such as rivets 454. The

1 tethering hinge 450 is fastened along another horizontal margin 456 parallel to
2 the margin 452 and on the other side of this potential fracture zone to the
3 inner side of the potentially frangible air bag door portion 448 by fastening
4 means that cannot be observed at the outer side of the door. For example, the
5 latter fastening means can be hot staked bosses 458 that are provided on the
6 inner side of the door as shown in Figures 30, 31 and 33 such as by being
7 molded integral therewith or friction welded thereto or the hidden fastening
8 means may be a suitable adhesive 460 as shown in Figure 32. Examples of
9 suitable adhesives for this purpose are polyurethanes and polyolefins. In the
10 case of where rivets and bosses are used to fasten the tethering hinge at both
11 its margins 452 and 456 respectively and where a woven fabric as above
12 described is employed as the tethering hinge, both of the margins 452 and 456
13 preferably comprise one or more folds to provide increased strength at their
14 points of attachment to the mounting/hinge flange 436 and the potential
15 break away door portion 448. Where an adhesive is used to fasten the woven
16 fabric tethering hinge to the door, only the margin 452 is preferably provided
17 with one or more folds to reinforce its attachment by the rivets 454 or other
18 suitable mechanical fasteners to the mounting/hinge flange 436.

19 The tethering hinge 450 has a portion 462 intermediate its margins 452
20 and 456 that spans the potential fracture Zone 446 and flexes when door
21 breakage occurs as illustrated in Figure 33 to permit the broken door portion
22 448 to continue to swing outward to provide for air bag deployment while
23 retaining the broken door portion to the vehicle structure. The intermediate
24 portion 462 of the flexible tethering hinge 450 is preferably provided with an
25 outward fold 463 in its installed condition as shown in Figure 30 that unfolds
26 as shown in Figure 33 on the fracturing off of the door portion 448 from the
27 mounting/hinge flange 436 to minimize the amount of stretching that is
28 required of the tethering hinge between its attaching means 454 and 458 or 460

1 to allow deployment of the air bag while retaining the broken door portion to
2 the vehicle structure.

3 According to another embodiment of the invention, illustrated in
4 Figures 34-37, the supplemental tethering hinge 450' is molded or otherwise
5 formed separately from the panel 410 from a second plastics material that is
6 different from the plastics material used for the panel. The construction of the
7 panel 410, the vehicle support structure 411, and air bag system 418 may be
8 the same as that described above for the first embodiment of Figures 29-33,
9 and hence the same reference numerals will be used for those components.

10 The second plastics material for the supplemental tether hinge 450' is
11 one that exhibits relatively greater flexibility or ductility than the material
12 used for the panel 410 at temperatures below that which the plastics panel
13 material becomes unacceptably brittle. Suitable plastics materials for the
14 supplemental tethering hinge 450' include polyolefin elastomer, polyurethane
15 elastomer, polyester elastomer, silicon or rubber modified plastic; however,
16 the means and method by which the hinge 450' is attached to the panel is
17 different than that described previously for the first embodiment.

18 As illustrated diagrammatically in Figure 37, the panel 410 and
19 tethering hinge 450' are formed separately from one another (e.g. molded
20 from the aforementioned first and second plastics materials, respectively) and
21 are subsequently brought together and joined in a subsequent welding
22 operation by means of which the panel 410 and tethering hinge 450' become
23 permanently fused to one another.

24 As shown in Figure 34, the hinge 450' is a sheet-like member having a
25 flange portion 452' that overlies a surface of the flange 436 adjacent the door
26 414 of the panel 410 and conforms generally to the size and shape of the
27 flange 436 in its preferred construction. The hinge 450' can be formed from
28 sheet stock; formed by injection molding; or formed by other well known
29 molding techniques such as compression molding, vacuum molding or the

1 like. The hinge 450' also has an integral door portion 456' that extends across
2 the inner side surface of the door 414 at least to the extent that the hinge 450
3 does (as seen in Figure 30) and preferably across the majority of the inner side
4 surface so as to have the same general size and shape as the door 414, as
5 illustrated in Figure 34 to provide uniform flexure of the door 414. When
6 installed, the door portion 456' of the hinge 450' is generally coextensive with
7 the door 414 and extends across and covers the air bag 422, but does not
8 extend across the preformed tear seam 416, as can be seen in Figure 34, in
9 order to retain the designed in frangibility of the tear seam 416. As with the
10 hinge 450 of the first embodiment, the tethering hinge 450' has an integral
11 intermediate portion 462' between the hinge and door portions 452', 456' ,
12 that spans or bridges the highly stressed juncture zone 446 between the flange
13 436 and door 14 of the panel 410 and is provided for the same reason. The
14 fold 463 provided in the embodiment of Figure 30 is not required in this
15 embodiment because the tether is more elastic than that in the first
16 embodiment.

17 The preferred means and method of securing the supplemental
18 tethering hinge 450' in position on the panel 410, according to the second
19 embodiment, is by welding. In which the panel 410 and tethering hinge 450'
20 are heated sufficiently at their interface at selected locations to melt and
21 thereby fuse the two layers together at weld joints 470, illustrated
22 schematically in Figures 34 and 36. One skilled in the art of welding plastics
23 will appreciate that any of a number of known welding techniques could be
24 employed to join the two plastic layers including, for example, welding
25 techniques such as ultrasonic, vibration, induction, hot plate conduction,
26 electromagnetic radiation, microwave radiation, and radio frequency welding
27 to name a few. The selection may depend in part on availability of the
28 equipment, economics, and suitability of the materials for the process.
29 Whatever technique is selected, it should be one that develops a sufficient

1 fusing of the materials strong enough to withstand the load applied to the
2 tethering hinge 450' upon deployment of the air bag 422 so as to maintain
3 connection with both the door 414 and the flange 436.

4 Figure 35 illustrates schematically the general arrangement that may be
5 employed for welding the hinge 450' to the panel 410. As illustrated, the
6 tethering hinge layer 450' is positioned and held by a suitable clamping
7 fixture 472 against the panel layer 410. The fixture 472 may be of the type
8 having a fixed lower platen 474 against which the tethering hinge layer 450'
9 may be placed and an upper movable platen 476 that is movable relative to
10 the lower platen 474 into and out of engagement with the panel layer 410 to
11 clamp and release, respectively, to the door 414 of the panel 410 and tethering
12 hinge 450' layers. The particular configuration of the clamping fixture tooling
13 472 will depend, of course, on the contour and accessibility limitations
14 imposed by the panel 410 and they also differ depending on the welding
15 technique employed. The clamping fixture 472 may also provide access to the
16 weld-forming tooling, shown schematically in Figure 35 at 478 as being
17 accessible through an opening in the lower platen 474 of the fixture 472 and
18 movable into and out of engagement with the tethering hinge layer 450' to
19 develop the weld joints 470. It is contemplated that one skilled in the art of
20 welding plastics will appreciate that the disclosed clamping fixture and
21 welding tooling is merely schematic to illustrate the general arrangement that
22 may be utilized and that the particular configuration and arrangement of the
23 tooling will be dictated, in part, on the configuration of the panel 410 and the
24 welding process utilized.

25 The particular pattern of weld joints 470 will vary according to the
26 requirements of the specific application. For example Figure 34 shows the
27 employment of a plurality of discrete, spaced apart weld joints 470 joining the
28 flange portion 452' of the hinge 450 to the flange 436 of the panel 410, and
29 joining the door portion 456' to the door 414 of the panel 410. More or less

1 welds could be utilized. For instance, all or a substantial portion of the
2 contacting interface could be welded if required. In any case, the application
3 of the welding should be carried out so as to not affect the appearance of the
4 outer exposed, so-called "class A" surface of the panel that is seen by the
5 occupant. In other words, the development of the weld joints 470 should be
6 controlled so that when formed, they are not visibly detectable on the class A
7 surface (e.g. there should be no melting, depressions, or other weld-induced
8 imperfections on the class A surface).

9 By molding the tethering hinge 450' separately from the panel 410, it
10 allows the panel 410 and tethering hinge 450' to be tested individually for
11 performance before being joined and further simplifies the application of the
12 tethering hinge material 450' to the back side of the panel 410 more
13 particularly in applications in which the panel 410 has a complicated contour,
14 including undercut regions which would make it difficult to mold the
15 tethering hinge 450' in place against the panel 410.

16 A cover assembly for an inflatable restraint assembly, generally
17 indicated at 510 in Figures 38 and 39 is generally shown installed in an
18 automotive instrument panel 511. The assembly 510 comprises an air bag
19 door generally indicated at 512 and a hard plastic rectangular frame-shaped
20 collar generally indicated at 514 in Figures 38 and 39. The air bag door 512 is
21 integrally formed in the collar 514 as a single, unitary panel 516. The
22 assembly 510 also includes a retainer portion 518 of the instrument panel 511.
23 The unitary panel 516 is fastened across an opening 520 in the retainer portion
24 518 of the instrument panel 511 as shown in Figures 38 and 39. A layer of
25 foam, shown at 519 in Figure 39, covers the retainer 518 and the unitary panel
26 516. A skin or layer of cover material, shown at 556 in Figure 38, is disposed
27 over the foam layer 519.

28 The retainer 518 includes a depressed rim portion shown at 522 in
29 Figures 38 and 39. The depressed rim portion 522 of the retainer 518 is

1 configured to support the collar 514 of the unitary panel 516. When the collar
2 514 is seated on the depressed rim portion 522 of the retainer 518, respective
3 outer surfaces 524, 526 of the instrument panel retainer 518 and the unitary
4 panel 516 lie flush with one another as is best shown in Figure 39. Along an
5 upper edge 528 of the rectangular opening 520 in the retainer portion 518 of
6 the instrument panel 511, the depressed rim portion 522 forms an elongated
7 trough 530. The elongated trough 530 has a generally U-shaped cross section
8 with sidewalls 532 that angle outwardly as shown in Figure 39. As is also best
9 shown in Figure 39, an upper edge 534 of the collar 514 of the unitary panel
10 516 is shaped to complement the shape of the elongated trough 530 of the
11 depressed rim portion 522 of the retainer 518. The retainer 518 may also
12 include gussets 536 supporting the elongated trough portion 530. The gussets
13 536 help to insure that bending occurs in the unitary panel 516 in a hinge
14 region 538 where the air bag door 512 merges with the collar 514 rather than
15 in the retainer 518 where the elongated trough 530 merges with a surrounding
16 portion 540 of the retainer 518.

17 The thickness of the air bag door portion 512 of the unitary panel 516 is
18 less than that of the collar 514 except where the air bag door 512 includes a
19 generally U-shaped region 542 of increased thickness. The region of increased
20 thickness 542 is formed by an integral elongated extension of material having
21 a trapezoidal cross-section as shown in Figure 39. This region of increased
22 thickness 542 defines one side of a weakened area or frangible tear seam
23 shown at 544 in Figures 38 and 39. The region of increased thickness 542
24 helps to confine tearing and/or breakage to the tear seam 544. The tear seam
25 544 in the unitary panel 516 defines at least a portion of the outline of the air
26 bag door 512. The tear seam 544 is configured to help guide tearing and/or
27 breakage under the force of air bag inflation. In the embodiment of Figures 38
28 and 39, the tear seam 544 is formed in an inner surface of the unitary panel

1 516. However, in other embodiments, the tear seam 544 may alternatively be
2 included on the outer surface 526 of the unitary panel 516.

3 The tear seam 544 partially defines a U shape with rounded corners
4 leaving an integral or "living" hinge region, shown at 538 in Figures 38 and
5 39, between upper ends of the U shape which the air bag door 512 hinges
6 around after being torn and/or broken open by a deploying air bag. In other
7 embodiments the tear seam 544 may have other suitable shapes such as
8 rectangular or circular and may or may not include an integral hinge region.

9 The tear seam 544 is formed during the integral molding of the unitary
10 panel 516. However, in other embodiments the tear seam 544 may instead be
11 formed by other methods such as gas-assisted injecting molding, machining
12 using computer numerical control equipment (CNC), laser scoring or any
13 other suitable method known in the art.

14 The unitary panel 516 includes approximately 520 heat stake bosses 546
15 that integrally extend from a back surface of the collar portion 514 of the
16 unitary panel 516. The heat stake bosses 546 are integrally formed with the
17 unitary panel 516 but may be post-applied by any suitable adhesive method
18 in other embodiments.

19 Surrounding the rectangular opening 520 in the retainer 518 in the
20 depressed rim portion 522 of the retainer 518 is a row of small through-holes
21 548 configured and positioned to receive the approximately 20 heat stake
22 bosses 546. The bosses 546 are heat staked to form heads on an inside surface
23 550 of the depressed rim portion 522 of the retainer 518 as shown in Figure 39.

24 Other embodiments may use other suitable fasteners such as pop rivets
25 in place of heat stake bosses 546 to fasten the collar portion 514 of the unitary
26 panel 516 to the retainer 518. For example, Figure 40 shows fasteners 552 that
27 extend through holes in both the unitary panel 516 and the retainer 518.

28 The unitary panel 516 also includes an elongated ridge 554 that
29 integrally extends from the outer surface 526 of the unitary panel 516. The

1 ridge 554 has a right-triangular cross-section the vertical side of which
2 extends perpendicularly outward from the outer surface of the collar 514
3 opposite the tear seam 544. The ridge 554 is included to reduce foam
4 thickness along a line running parallel to and adjacent the tear seam 544 in the
5 unitary panel 516. The line of reduced foam thickness helps guide foam layer
6 breakage and reduces foam fragmentation when the air bag door is forced
7 open.

8 As is best shown in Figure 39, the foam layer 519 is disposed over and
9 is adhered to the outer surface 524 of the instrument panel retainer 518 and
10 the outer surface 526 of the unitary panel 516. The skin 556 is disposed over
11 and is adhered to an outer surface 525 of the foam layer. Because the
12 respective outer surfaces of the retainer 518 and the unitary panel 516 lie flush
13 with one another, the presence of the unitary panel 516 causes no disruption
14 in the smooth outer class-A surface of the skin. In other embodiments, the
15 skin 556 may be weakened along the same outline as the tear seam 544
16 and/or the ridge 554 on either the inside or outside surface or may include a
17 styling groove or other feature identifying the location of the SIR door to the
18 vehicle occupant.

19 In the present embodiment the trim panel that is configured to support
20 the unitary panel 516 is an instrument panel 511. However, in other
21 embodiments, the unitary panel 516 may be configured to be mounted in
22 other vehicle panels.

23 The unitary panel 516 may comprise any suitable plastics material to
24 include polyurethane (PU), thermoplastic elastomers (TPE), thermoplastic
25 urethanes (TPU), thermoplastic olefins (TPO), or polyesters. The retainer 518
26 may comprise any suitable plastics material to include acrylonitrile-butadiene
27 styrene terpolymer (ABS), styrene maleic anhydride copolymer (SMA),
28 polyphenylene oxide (PPO), polypropylene (PP), polyurethane (PU) or
29 polycarbonate (PC).

1 In practice, the cover assembly 510 is constructed by first forming the
2 instrument panel retainer 518 and the unitary panel 516. The unitary panel
3 516 is formed by injection molding to include the heat stake bosses 546 and
4 the ridge 554. The skin 556 is formed either as a cast shell, by vac forming or
5 by spaying. The foam layer 519 is formed by foaming-in-place, i.e. injecting
6 foam between the retainer 518 and the skin 556.

7 The instrument panel retainer 518 is formed by injection molding or
8 other suitable methods to include the rectangular opening 520 and the
9 openings 548 for receiving the heat stake bosses 546. The unitary panel 516 is
10 then assembled to the instrument panel retainer 518 in a position spanning
11 the rectangular opening 520. The panel 516 is assembled to the instrument
12 panel retainer 518 by first inserting the heat stake bosses 546 into the small
13 through-holes 548 in the depressed rim portion 522 of the retainer 518. When
14 the panel 516 is seated in the depressed rim portion 522, distal ends of the
15 heat stake bosses 546 protrude from the through-holes 548. The protruding
16 distal ends of the heat stake bosses 546 are then heat staked, i.e. melted, to
17 form heads. The skin 556 is then placed in a mold along with the assembled
18 retainer 518 and unitary panel 516, and foam is injected into the mold
19 between them.

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1 1. A method of forming a motor vehicle instrument panel with an
2 integral air bag deployment door comprising the steps of:
3 molding an instrument panel with a first plastics material to a
4 desired shape and with an integral air bag deployment door whose opening is
5 at least partially defined by a tear seam formed by a groove molded in one
6 side of the panel; and forming a flexible bonded door tethering layer of a
7 second plastics material on an inside surface of at least one of the instrument
8 panel and door, and spanning a frangible portion thereof at the inside surface
9 wherein the second plastics material has the characteristics of bonding to the
10 first plastics material and remaining ductile to a substantial degree at low
11 temperatures substantially below the temperature at which the first plastics
12 material becomes brittle to thereby form a flexible tether that retains the
13 frangible portion when the frangible portion breaks away because of
14 embrittlement of the first plastics material at the low temperatures on tearing
15 of the tear seam and opening movement of the door by an inflating air bag
16 pressing against the inside surface of the door and wherein the tethering layer
17 is formed by one of the following steps: (a) by injection molding the second
18 plastics material against the inside surface; or (b) by forming a mask having
19 an opening conforming to a perimeter of a desired tethering layer, laying the
20 mask against the inside surface, and spraying the second plastics material
21 through the opening in the mask and onto the inside surface to form the
22 bonded layer; or (c) by gravity molding the second plastics material on the
23 inside surface; or (d) by reaction injection molding the second plastics
24 material on the inside surface; or (e) by resin transfer molding the second
25 plastics material on the inside surface; or (f) by locating an injection mold
26 tool against the inside surface, and injection molding the second plastics
27 material in the mold tool against the inside surface; or (g) by locating a low
28 pressure mold tool against the inside surface, and molding the second plastics

1 material in the mold tool on the inside surface at a low pressure less than high
2 pressure injection molding.

3 2. A cover assembly for concealing an inflatable air bag system of a
4 motor vehicle, the assembly comprising:

5 an instrument panel comprising a first plastics material and configured
6 to mount in the passenger compartment of the motor vehicle;

7 an air bag door panel comprising the first plastics material and formed
8 with the instrument panel as a single integral panel, the door panel being at
9 least partially surrounded by the instrument panel; and

10 a hinge panel connected to an inside surface of the integral panel in a
11 layered disposition, the hinge panel being insert molded into an inside
12 surface of at least one of the instrument panel and the door panel portions of
13 the integral panel.

14 3. A cover assembly as defined in claim 2, and characterized by
15 one or more of the following features:

16 (a) wherein a foam layer is disposed over the integral panel and a
17 plastic skin layer is disposed over the foam layer;

18 (b) wherein the hinge panel spans a panel juncture zone between
19 the door panel and the instrument panel, and wherein (i) the panel juncture
20 zone optionally includes a styling groove configured to function as a tear
21 seam separating at least a portion of the door panel and the instrument panel,
22 or (ii) the panel juncture zone optionally includes a weakened tear seam
23 separating at least a portion of the door panel and the instrument panel, and
24 the hinge panel preferably includes a hinge panel edge aligned with at least a
25 portion of the tear seam;

26 (c) wherein the hinge panel comprises a second plastics material,
27 said second plastics material preferably being more ductile and less brittle at
28 low temperatures than the first plastics material;

29 (d) wherein the hinge panel comprises metal;

1 (e) wherein the door panel includes a hinge flange extending
2 transversely inward from the inside surface, the hinge flange configured to
3 secure the door panel to a structural member, the hinge panel spanning the
4 hinge flange and door panel in a layered disposition, a portion of the hinge
5 panel being attached to the hinge flange; and

6 (f) wherein the instrument panel includes a collar extending
7 transversely inward from the inside surface and from around the door panel,
8 the collar defining a door-collar interface along the region where the collar
9 extends from the integral panel; and

10 (g) wherein the hinge panel spans the door-collar interface, one
11 portion of the hinge panel being attached to the collar and another portion of
12 the hinge panel being attached to the door panel.

13 4. A cover assembly for concealing an inflatable air bag system of a
14 motor vehicle, the assembly comprising:

15 an instrument panel comprising a first plastics material and configured
16 to mount in the passenger compartment of the motor vehicle;

17 an air bag door panel comprising the first plastics material and formed
18 with the instrument panel as a single integral panel, the door panel being at
19 least partially surrounded by the instrument panel; and

20 a hinge panel connected to an inside surface of the integral panel in a
21 layered disposition, the hinge panel spanning a panel juncture zone between
22 the door panel and the instrument panel.

23 5. A cover assembly as defined in claim 4, characterized by one or
24 more of the following features: (a) the hinge panel comprises a second
25 plastics material and is attached to the inside surface of the integral panel and
26 is insert-molded into an inside surface of at least one of the instrument panel
27 and the door panel, said second plastics material preferably being more
28 ductile and less brittle at low temperatures than the first plastics material;

1 (b) wherein at least a portion of the panel juncture zone includes a
2 styling groove;

3 (c) wherein at least a portion of the panel juncture zone includes a
4 weakened tear seam, and

5 the hinge panel preferably includes a peripheral hinge panel edge
6 aligned with at least a portion of the tear seam;

7 (d) wherein the hinge panel comprises metal; and

8 (e) wherein the instrument panel includes a collar extending
9 transversely inward from the inside surface and from around the door panel
10 defining a door-collar interface; and the hinge panel spans the door-collar
11 interface, a portion of the hinge panel being attached to the collar.

12 6. A method for making an air bag cover assembly, the assembly
13 including an instrument panel comprising a first plastics material and
14 configured to mount in a motor vehicle passenger compartment, an air bag
15 door panel comprising the first plastics material and formed with the
16 instrument panel as a single integral panel, the door panel being at least
17 partially surrounded by the instrument panel, and a hinge panel connected to
18 an inside surface of the integral panel in a layered disposition, the hinge panel
19 being insert molded into an inside surface of at least one of the instrument
20 panel and the door panel; the method comprising the steps of:

21 providing a mold having first and second mold portions, the first and
22 second mold portions forming a mold cavity when closed together, the mold
23 cavity having a shape complementing the shape of the integral panel and
24 hinge panel;

25 forming the hinge panel;

26 placing the hinge panel in the second mold portion;

27 closing the mold;

28 introducing the first plastics material into the mold cavity in molten
29 form;

1 allowing the molten first plastics material to conform to the shape of
2 the mold cavity and to cure in the mold cavity; and
3 opening the mold and removing the completed assembly from the
4 mold.

5 7. The method of claim 6, characterized by one or more of the
6 following features:

7 (a) wherein the step of forming the hinge panel includes the step of
8 forming a hinge panel comprising a second plastics material, and the step of
9 forming the hinge panel optionally includes the step of providing a second
10 plastic material that is more ductile and less brittle at low temperatures than
11 the first plastics material;

12 (b) wherein the hinge panel comprises sheet metal;

13 (c) wherein the step of placing the hinge panel includes the step of
14 placing the hinge panel in the second mold portion in a position spanning a
15 portion of the mold configured to form the panel juncture zone between the
16 instrument panel and door panel portions of the integral panel; and

17 (d) wherein the step of providing a mold includes the step of
18 shaping the lower surface of the mold cavity to form a hinge-flange that
19 protrudes transversely inward from the door panel portion of the integral
20 panel and in which the step of placing the hinge panel in the second mold
21 portion in a position spanning a portion of the mold configured to form a
22 flange juncture zone between the hinge-flange and the door panel.

23 8. A vehicle passenger compartment console assembly comprising:

24 a console body having an outer shell;

25 an access opening disposed in the console body outer shell;

26 a positioning apparatus movably supported within the console body
27 outer shell;

28 at least two storage modules disposed within the shell and movably
29 supported on the positioning apparatus; the storage modules sequentially

1 movable between one or more concealed positions displaced from the access
2 opening and a displayed position adjacent the access opening; the positioning
3 apparatus configured to support any one of the storage modules in the
4 display position while simultaneously supporting at least one of the other
5 storage modules in a concealed position to allow a passenger compartment
6 occupant to gain physical access to a module and its contents through the
7 access opening while leaving other modules concealed within the shell.

8 9. An automotive passenger compartment console assembly as
9 defined in claim 8, characterized by one or more of the following features:

10 (a) wherein the positioning apparatus comprises an electro-
11 mechanical occupant-actuated drive mechanism;

12 (b) wherein the positioning apparatus comprises an occupant-
13 actuated automatic module selection system;

14 (c) wherein the modules are sequentially moveable through the
15 displayed position;

16 (d) wherein the positioning apparatus comprises a carrousel
17 supported for rotation about a carrousel axis; wherein the positioning
18 apparatus preferably comprises a drum-type carrousel supported for rotation
19 about a generally horizontal axis;

20 (e) further including an access door movably supported across the
21 module access opening, the door shaped to cover the access opening in a
22 closed position and movable to an open position uncovering the access
23 opening;

24 (f) wherein at least one of the modules comprises an appliance that
25 is incorporated into the design of the module;

26 (g) wherein at least one of the modules comprises a storage space;

27 (h) wherein the console body is a floor console body supported on a
28 floor of an automobile between a front driver's seat and a front passenger seat
29 of the automobile;

1 (i) further including a forward image display panel supported in a
2 forward end of the console body;

3 (j) further including an aft image display panel supported in an aft
4 end of the console body and image-producing electronic circuitry connected
5 to the aft display panel, and optionally including at least one remote-control
6 unit communicable with the electronic image-producing circuitry;

7 (k) wherein the console body is an instrument panel console body
8 supported in an instrument panel assembly of the automobile, wherein the
9 positioning apparatus preferably comprises (i) a drum-type carrousel
10 supported in the instrument panel console body for rotation about a generally
11 vertical axis or (ii) a drum-type carrousel supported in the instrument panel
12 console body for rotation about a generally horizontal axis, wherein the
13 carrousel preferably is at least partially housed within a central stack portion
14 of the instrument panel assembly, and (iii) wherein the carrousel preferably is
15 rotatable to a closed position and in which the carrousel includes a face panel
16 disposed across the access opening in the closed position.

17 10. A vehicle passenger compartment console assembly comprising:
18 a console body having an outer shell;
19 an access opening disposed in the console body outer shell; and
20 a positioning apparatus movably supported within the console body
21 outer shell, the positioning apparatus including a platform having at least two
22 storage regions, the platform being rotatably supported within the console
23 body outer shell, the positioning apparatus configured to rotate the platform
24 and move a selected one of the storage regions to a display position adjacent
25 the access opening while simultaneously moving the other of the storage
26 regions into a remote position displayed from the access opening.

27 11. An automotive passenger compartment console assembly as
28 defined in claim 10, characterized by one or more of the following features:

- 1 (a) wherein the positioning apparatus comprises an electro-
2 mechanical occupant-actuated drive mechanism;
- 3 (b) wherein the positioning apparatus comprises an occupant-
4 actuated automatic module selection system;
- 5 (c) further including an access door movably supported across the
6 module access opening, the door shaped to cover the access opening in a
7 closed position and movable to an open position uncovering the access
8 opening;
- 9 (d) further including an appliance attached to the platform in one of
10 the storage regions; and
- 11 (e) wherein at least one of the storage regions comprises a storage
12 space.

13 12. A headliner assembly for lining the roof of the passenger
14 compartment of a vehicle, the headliner assembly comprising:
15 a substrate configured to be mounted to a vehicle in a position
16 generally covering a lower surface of a passenger compartment roof, the
17 substrate comprising an upper substrate surface and a lower substrate surface
18 disposed opposite the upper substrate surface, the substrate comprising a
19 moldable material; and
20 a cavity formed into the substrate between the upper substrate surface
21 and the lower substrate surface to distribute air in the passenger compartment
22 or to support electrical wiring, foam and the like.

23 13. A headliner assembly as defined in claim 12, characterized by
24 one or more of the following features:

- 25 (a) wherein the cavity comprises an air duct and in which the
26 headliner includes:
27 an air inlet opening positioned to receive air from a vehicle air
28 handling system, and optionally including a directional air outlet register
29 disposed in the air outlet opening;

1 an air outlet opening spaced from the air inlet opening and disposed in
2 an underside surface of the headliner assembly to direct air from the vehicle
3 air handling system into the passenger compartment;

4 the air duct extending between and connecting the air inlet opening
5 and the air outlet opening to provide gaseous communication between the air
6 inlet opening and the air outlet opening;

7 (b) wherein an elongated conduit defines the cavity, the conduit
8 including:

9 a cable inlet opening positioned to receive electrical or fiber optic
10 cabling into the conduit from a vehicle electrical or fiber optic system; and

11 a cable outlet opening spaced from the cable inlet opening and
12 disposed adjacent a fixture supported on the headliner assembly to allow the
13 cabling to be connected to the fixture, the cable conduit extending between
14 and connecting the cable inlet opening and the cable outlet opening;

15 (c) further comprising foam disposed within the cavity, said foam
16 preferably comprising an energy absorbing foam or an acoustic energy-
17 absorbing foam;

18 (d) wherein the cavity includes an inner wall that envelops foam
19 disposed within the cavity;

20 (e) comprising a plurality of foam-filled cavities disposed in an
21 array at spaced locations;

22 (f) wherein the cavity is integrally formed in the substrate;

23 (g) wherein a decorative cover is disposed on a lower surface of the
24 substrate; and

25 (h) further including a foam layer disposed on a lower surface of
26 the substrate; and a decorative cover optionally is disposed on a lower surface
27 of the foam layer.

28 14. A method for making a headliner comprising a substrate
29 configured to be mounted to a vehicle in a position generally covering a lower

1 surface of a passenger compartment roof, the substrate comprising an upper
2 substrate surface and a lower substrate surface disposed opposite the upper
3 substrate surface, the substrate comprising a moldable material, a cavity
4 formed into the substrate between the upper substrate surface and the lower
5 substrate surface; the method including the steps of:

6 providing a blow mold having a contoured portion shaped to
7 complement the desired exterior contours of the headliner substrate to be
8 formed, the contoured portion including an enlarged region corresponding to
9 a desired cavity position in the substrate to be formed;

10 providing a molten parison in the hollow portion of the blow mold;

11 expanding the molten parison into conforming contact with the
12 contoured portion of the blow mold by injecting gas into the molten parison;

13 allowing the molten parison to harden into the headliner substrate; and

14 removing the headliner substrate from the blow mold.

15 15. The method of claim 14, characterized by one or more of the
16 following features:

17 (a) the step of providing a molten parison includes the step (i) of
18 providing the molten parison between open halves of a two-piece blow mold;
19 and

20 including the additional step (ii) of closing the two blow mold halves
21 together around the molten parison before the step of fully expanding the
22 molten parison;

23 (b) the additional steps of providing a layer of foam on a lower
24 surface of the substrate and providing a layer of cover material on a lower
25 surface of the foam;

26 (c) the additional step of providing foam within the cavity, wherein
27 the step of providing foam preferably includes the steps of:

28 (i) inserting one end of a nozzle into the cavity;

29 (ii) injecting foam into the cavity through the nozzle; and

- 1 (iii) withdrawing the nozzle from the cavity;
- 2 (d) the step of providing a molten parison includes the step of
- 3 extruding the molten parison; and
- 4 (e) the step of expanding the molten parison includes the additional
- 5 steps of:
- 6 (i) inserting a blow pin into the molten parison;
- 7 (ii) injecting the gas into the parison through the blow pin;
- 8 and
- 9 (iii) removing the blow pin from the parison.

10 16. A method of forming a cover assembly for concealing an
11 inflatable air bag system of a motor vehicle, the method comprising the steps
12 of:

13 forming an interior trim panel from a first plastics material, the interior
14 trim panel having a seam at least partially defining an air bag deployment
15 door in the panel, the first plastics material being flexible in a limited
16 temperature range and forming an integral primary hinge about which the
17 door of the panel may swing outwardly from the panel upon separation of a
18 tear seam portion of the seam and outward deployment of an air bag of the
19 supplemental passenger restraining system, the primary hinge further acting
20 as a primary tether to retain the door of the panel within the limited
21 temperature range but having a potentially frangible portion subject to
22 breakage at temperatures below the limited temperature range;

23 forming a supplemental tethering hinge separately from the panel
24 from a second plastics material that is relatively more flexible than the first
25 plastics material at temperatures below the limited temperature range;

26 placing the supplemental tethering hinge in a position spanning the
27 potentially frangible portion of the primary hinge with opposite margins of
28 the supplemental tethering hinge disposed against the panel on opposite
29 sides of the potentially frangible portion;

1 heating the panel and supplemental tethering hinge at their interfaces
2 sufficiently to locally remelt the first and second plastics materials and
3 thereby weld the supplemental tethering hinge to the panel across the
4 potentially frangible portion of the primary hinge; and

5 installing the panel and supplemental tethering hinge assembly on the
6 vehicle structure with the door of the panel arranged in overlying covering
7 relation to the air bag restraining system.

8 17. The method as set forth in claim 16, and characterized by one or
9 more of the following features:

10 (a) the supplemental tethering hinge is ultrasonically welded to the
11 panel;

12 (b) the supplemental tethering hinge is vibration welded to the
13 panel;

14 (c) the supplemental tethering hinge is induction welded to the
15 panel;

16 (d) the supplemental tethering hinge is hot plate conduction welded
17 to the panel;

18 (e) the supplemental tethering hinge is electromechanically welded
19 to the panel;

20 (f) the supplemental tethering hinge is radio frequency welded to
21 the panel;

22 (g) the door portion of the supplemental tethering hinge is formed
23 to have the same general size and shape as that of the door of the panel and is
24 positioned to cover substantially the entire inner surface of the door.

25 18. A process of forming a cover assembly for concealing an
26 inflatable air bag system of a motor vehicle, the method comprising the steps
27 of:

28 forming an interior trim panel from a first plastics material, the interior
29 trim panel having a seam at least partially defining an air bag deployment

1 door in the panel, the first plastics material being flexible in a limited
2 temperature range and forming an integral primary hinge about which the
3 door of the panel may swing outwardly from the panel upon separation of a
4 tear seam portion of the seam and outward deployment of an air bag of the
5 supplemental passenger restraining system, the primary hinge further acting
6 as a primary tether to retain the door of the panel within the limited
7 temperature range but having a potentially frangible portion subject to
8 breakage at temperatures below the limited temperature range;
9 forming a supplemental tethering hinge separately from the panel
10 from a second plastics material that is relatively more flexible than the first
11 plastics material at temperatures below the limited temperature range;
12 securing the supplemental tethering hinge to the panel such that an
13 intermediate portion of the supplemental tethering hinge spans the
14 potentially frangible portion of the primary hinge; and
15 installing the panel and supplemental tethering hinge assemblage on
16 the vehicle structure with the door of the panel arranged in overlying relation
17 to the air bag restraining system.

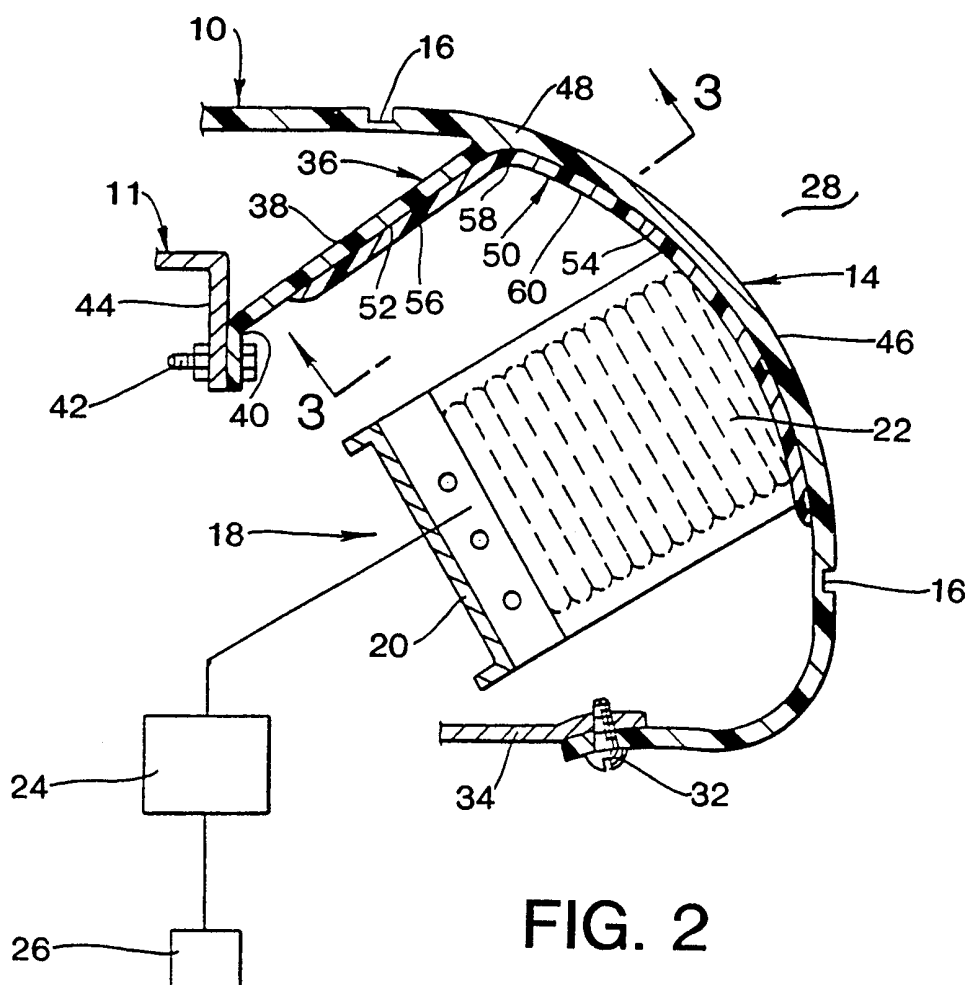
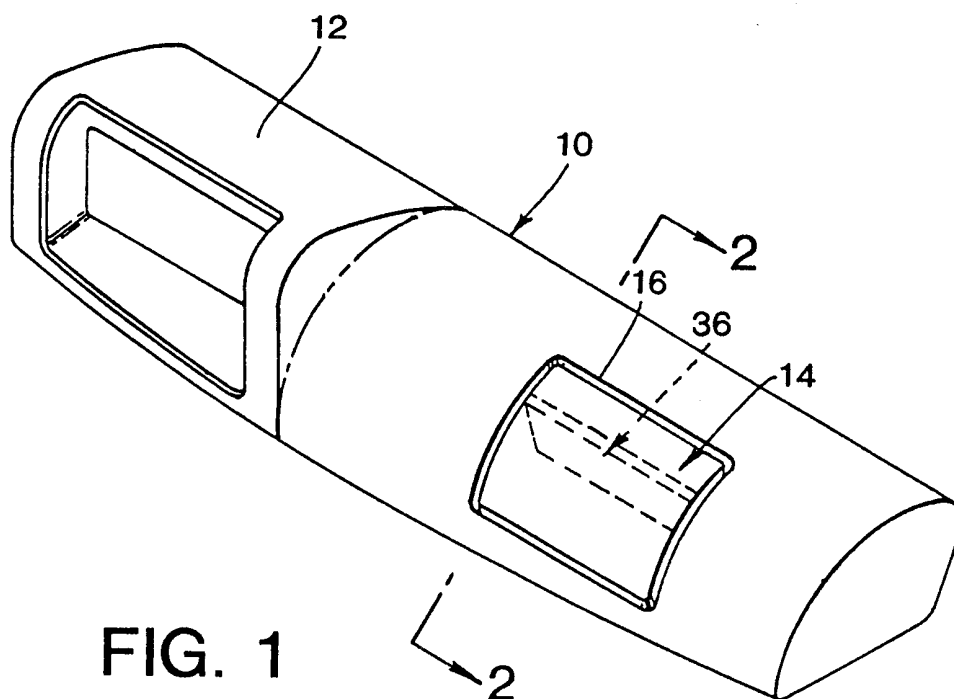
18 19. The method set forth in claim 18, and characterized by one or
19 both of the following features:

20 (a) the supplemental tethering hinge is secured to the panel at least
21 in part by an adhesive; and,
22 (b) the supplemental tethering hinge is formed of a second plastics
23 material and is secured to the panel at least in part by welding.

24 20. An inflatable restraint assembly comprising a trim panel, an air
25 bag door positioned spanning an air bag deployment opening in the trim
26 panel, a frangible tear seam defining at least a portion of the air bag door, and
27 a hard plastic collar is attached to the trim panel, wherein the air bag door is
28 integrally formed with the hard plastic collar.

- 1 21. The inflatable restraint assembly according to claim 20, and
2 characterized by one or more of the following features:
- 3 (a) the air bag door is integrally formed with the hard plastic collar
4 as a single unitary panel;
- 5 (b) the integral air bag door and hard plastic collar comprise a
6 material that is ductile at low temperatures;
- 7 (c) also including a layer of foam covering the unitary panel, said
8 layer of foam optionally including a skin or cover material disposed thereon;
- 9 (d) a plurality of mechanical fasteners for fastening the collar
10 portion of the unitary pattern to a retainer portion of the assembly;
- 11 (e) further comprising a plurality of heat stake bosses or pop rivets
12 for fastening the collar portion of the panel to the retainer;
- 13 (f) the air bag door includes a weakened area which helps to
14 confine tearing and/or breakage to a tear seam;
- 15 (g) the air bag door includes an integral hinge region; and
16 (h) the air bag door includes a ridge which extends outwardly from
17 the outer surface of the collar.

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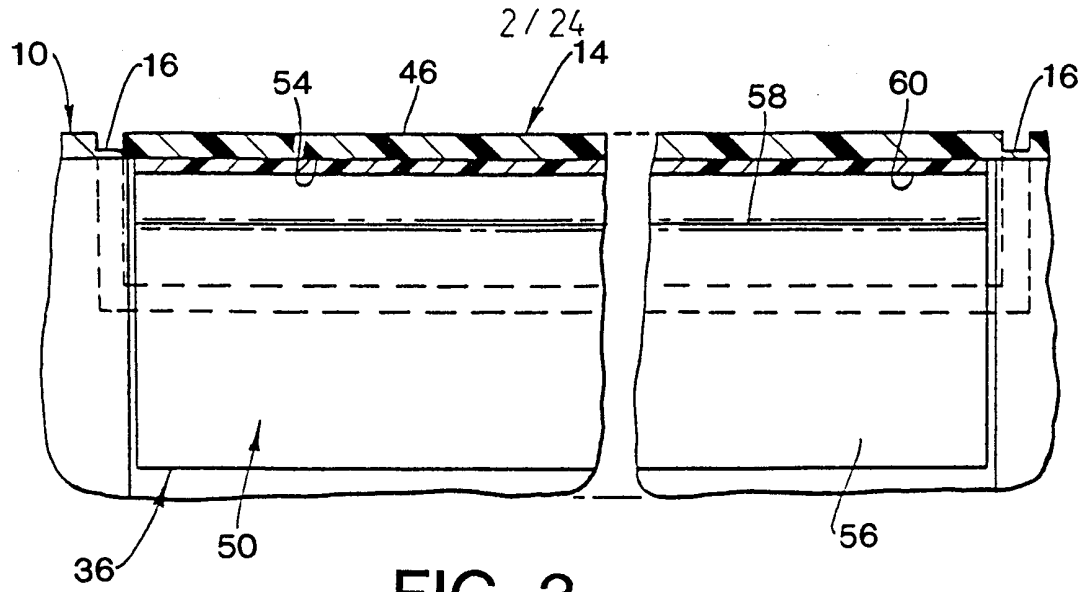


FIG. 3

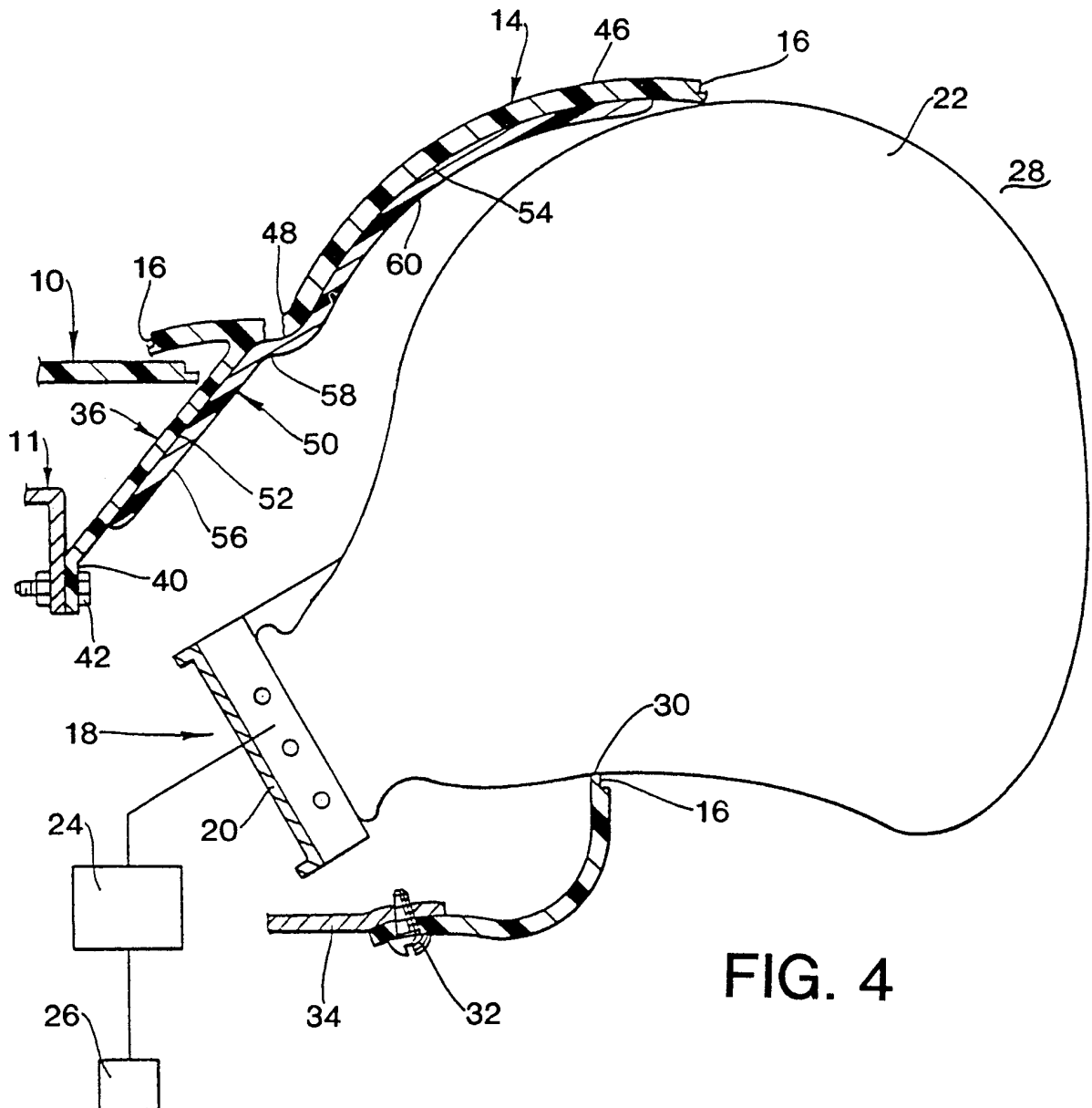


FIG. 4

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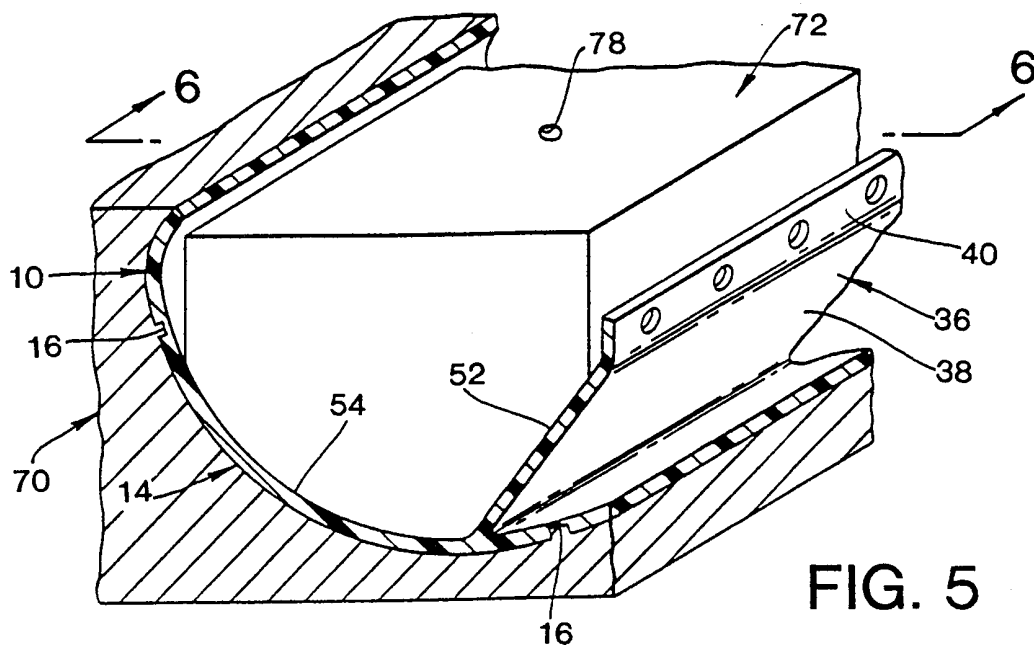


FIG. 5

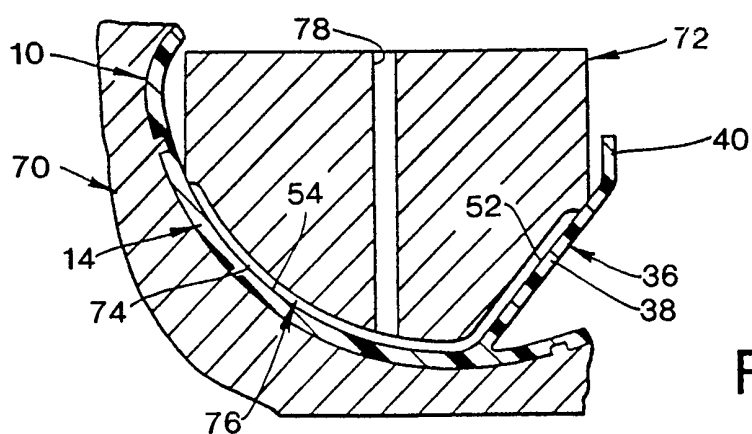


FIG. 6

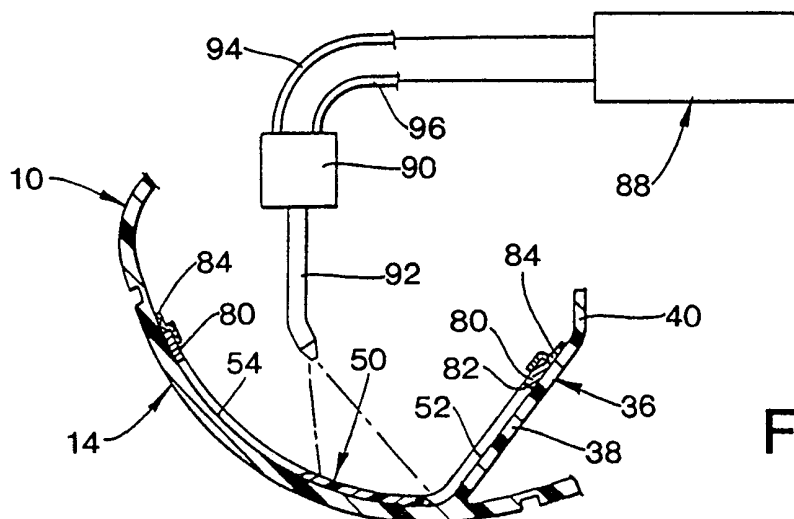


FIG. 7

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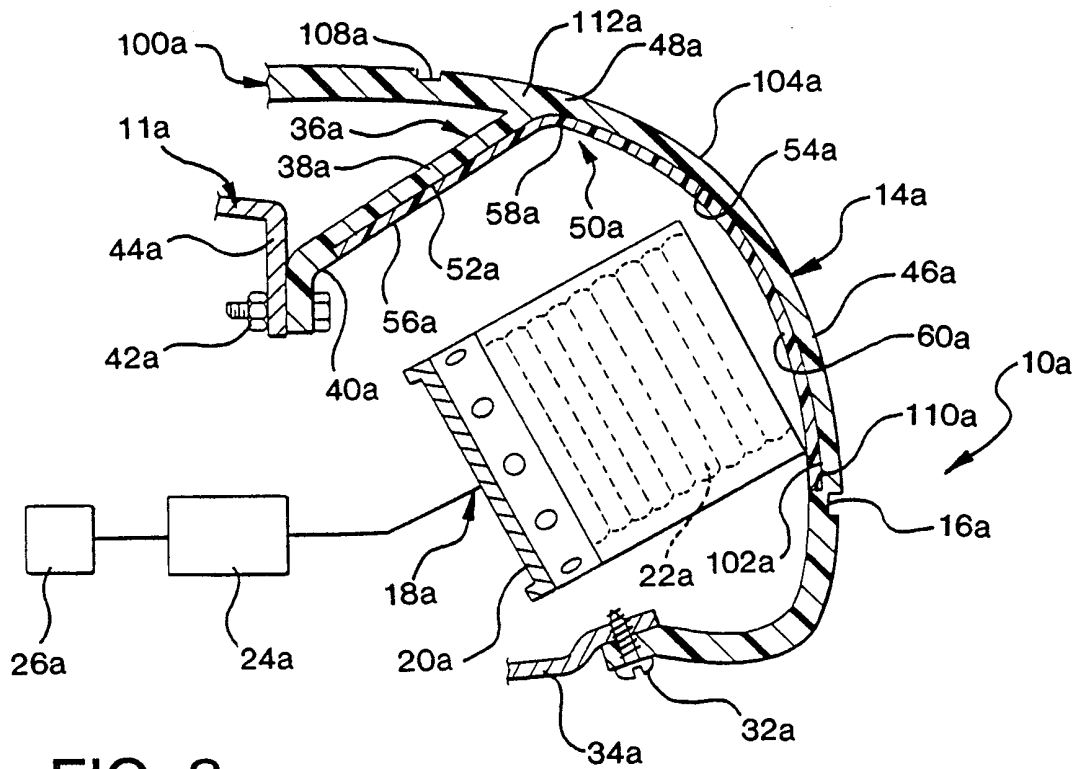


FIG. 8

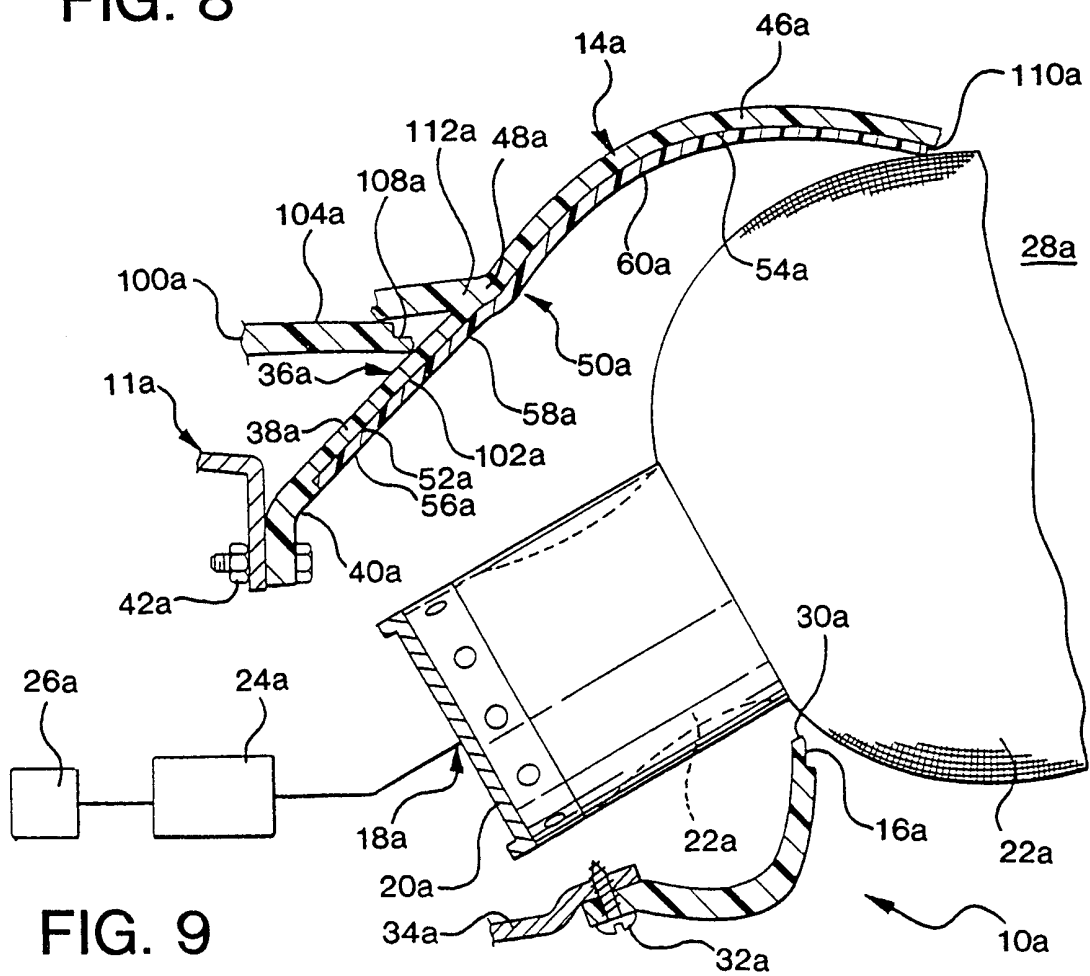
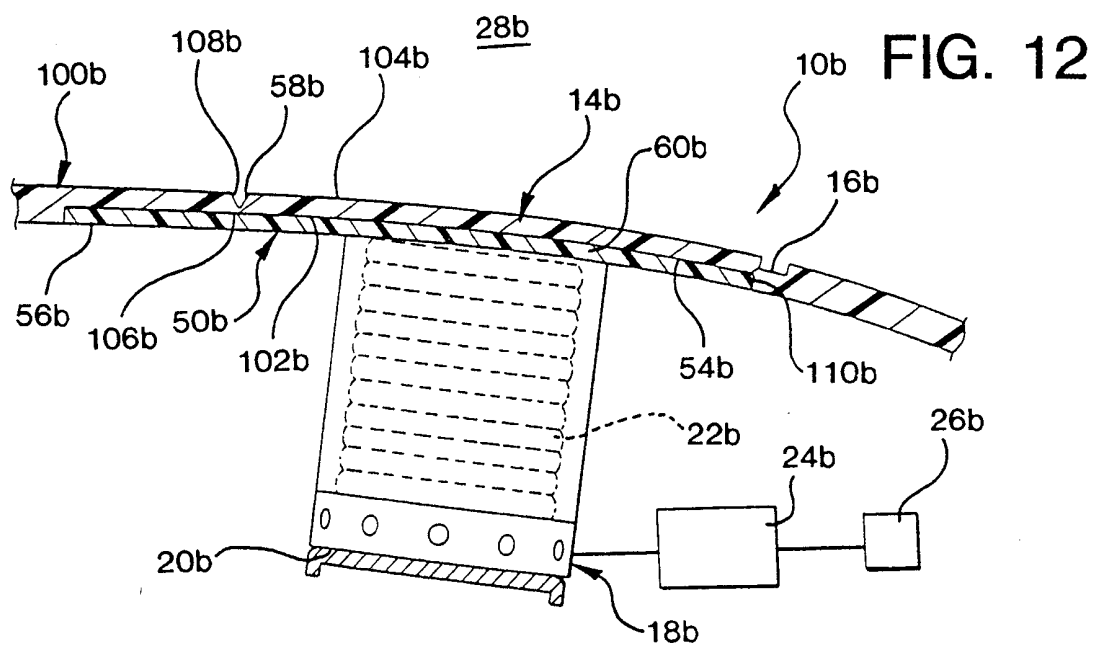
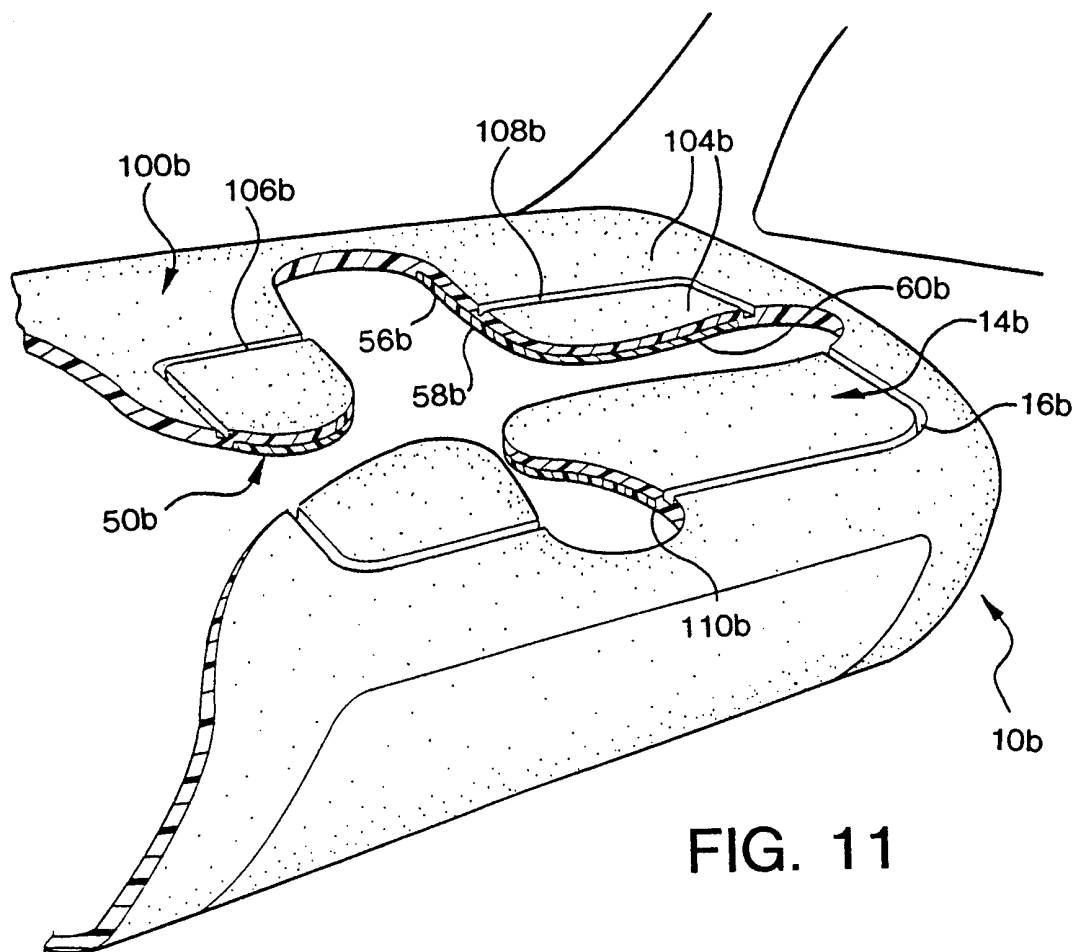


FIG. 9

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FIG. 10

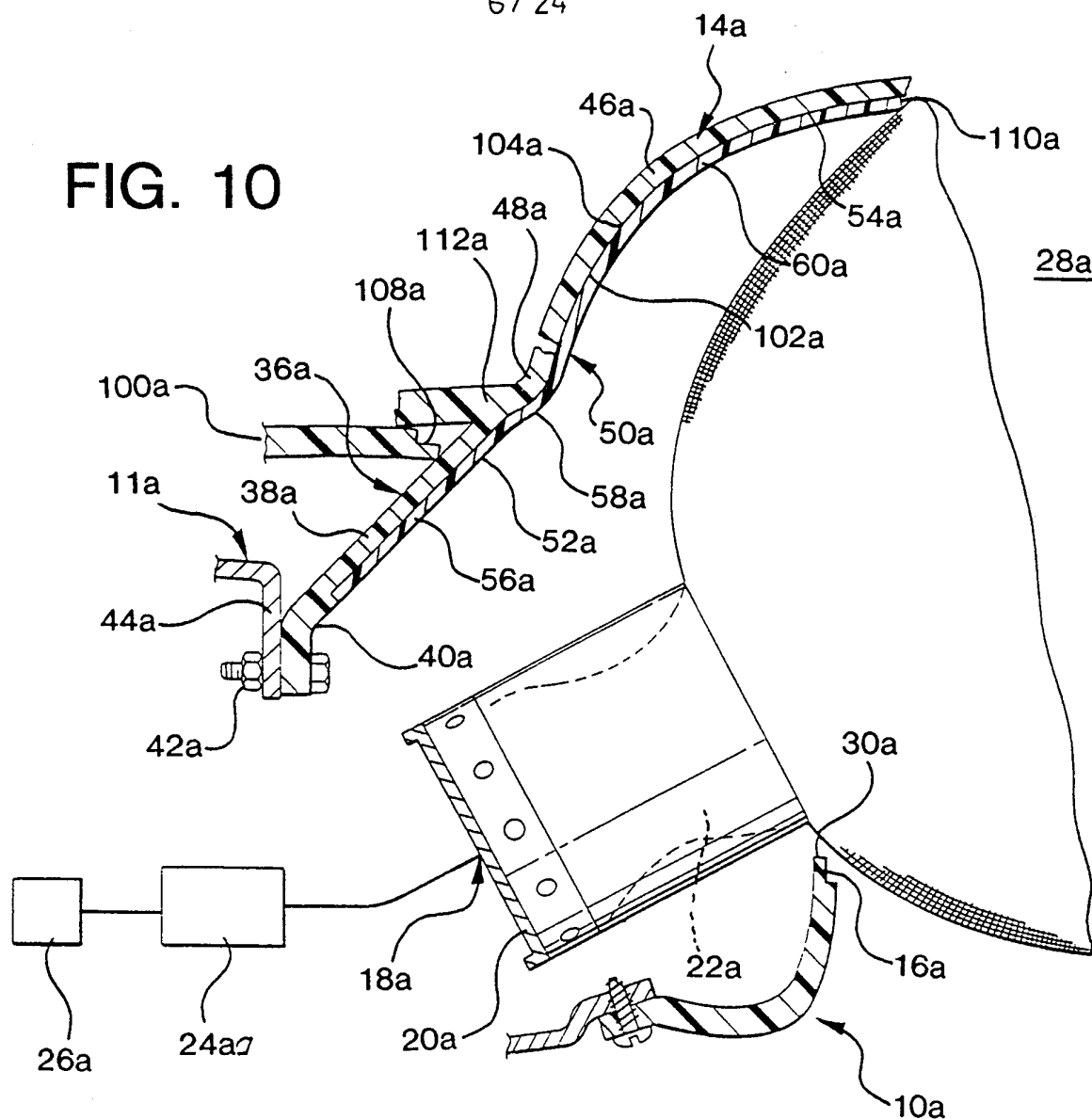
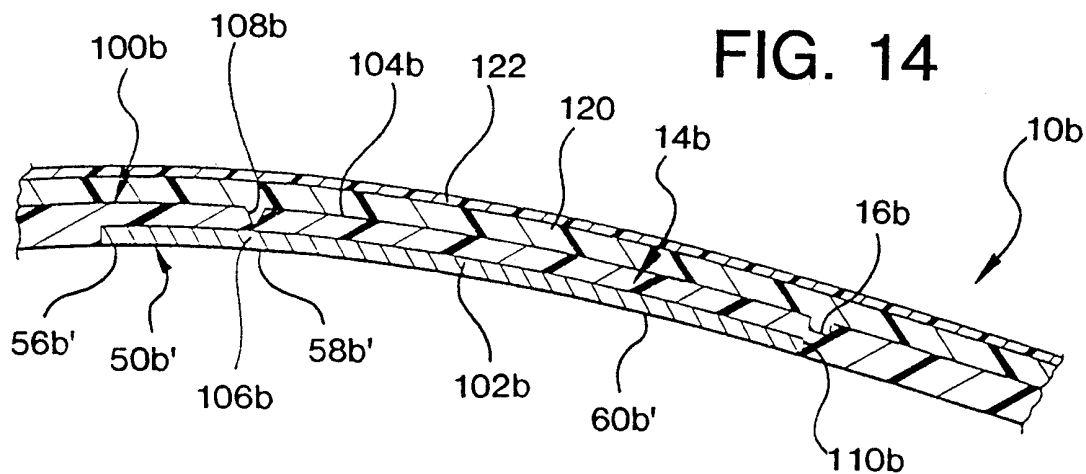


FIG. 14



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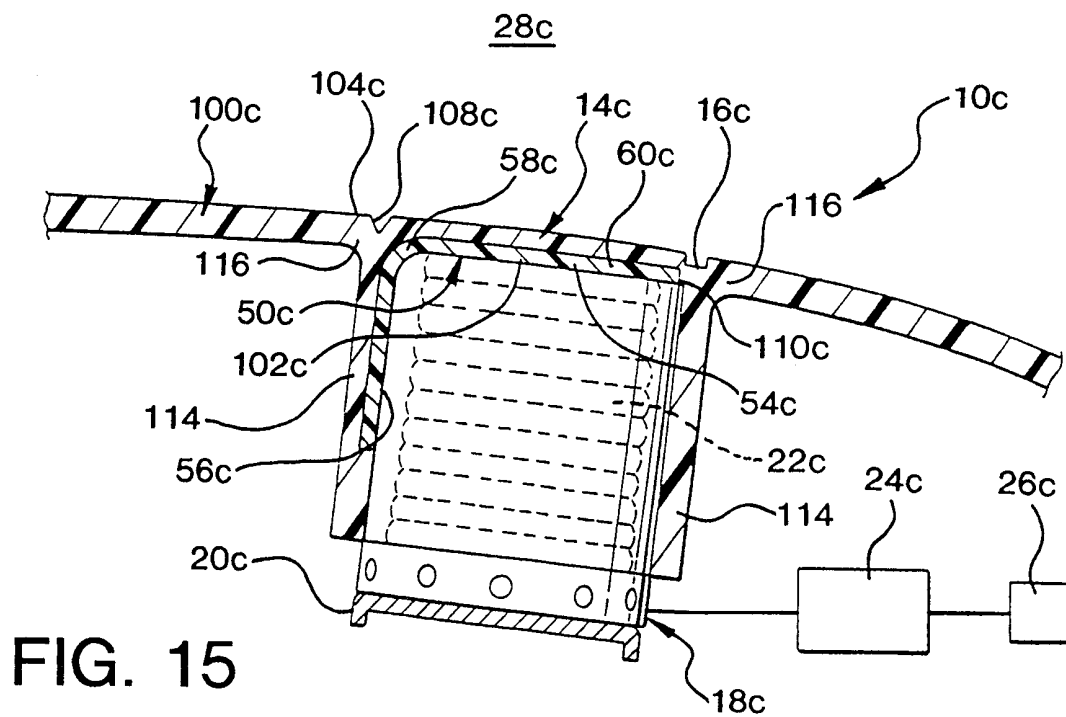
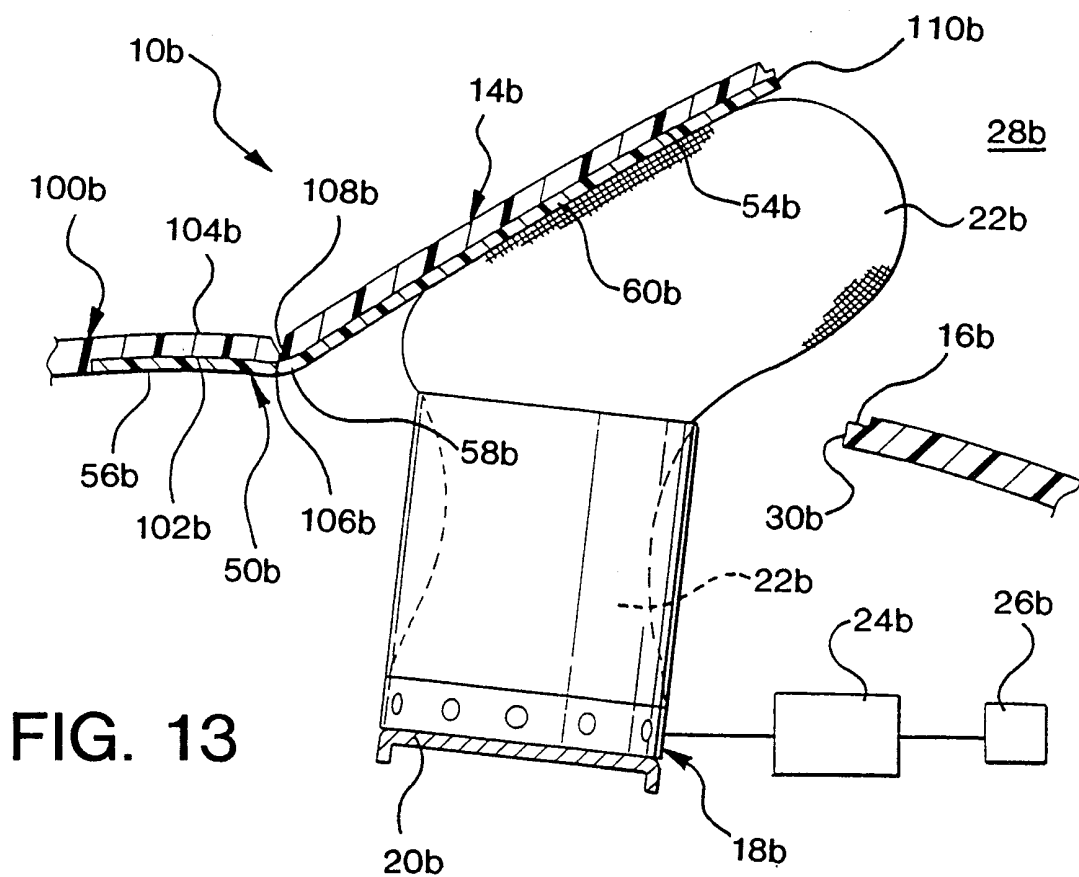


FIG. 16

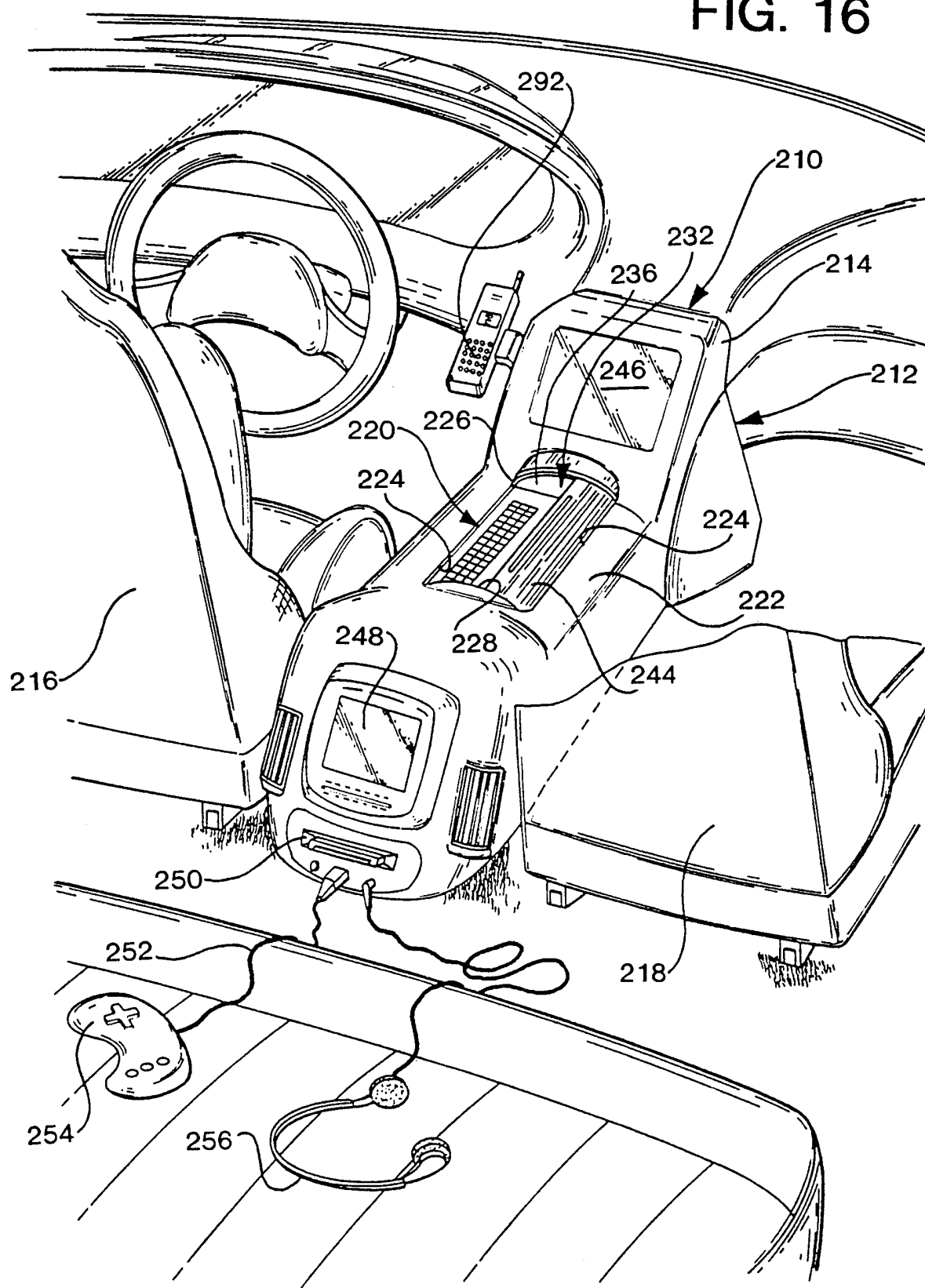
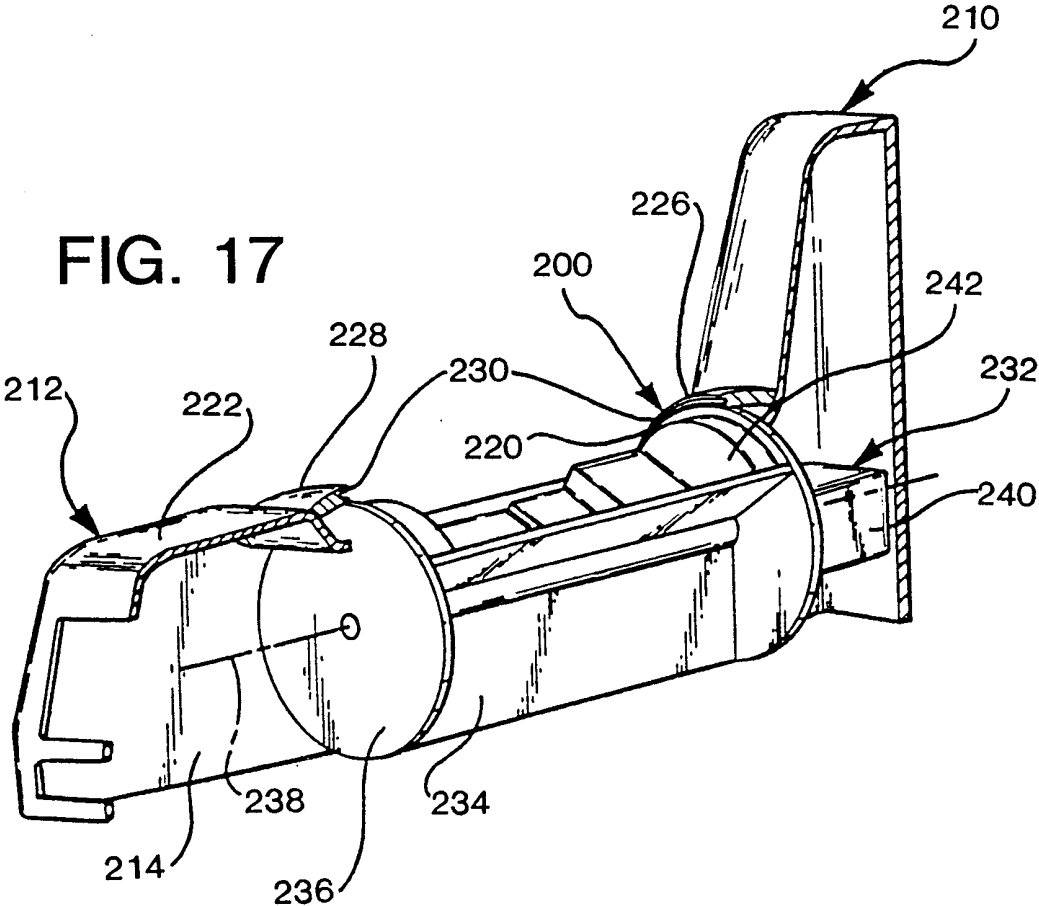
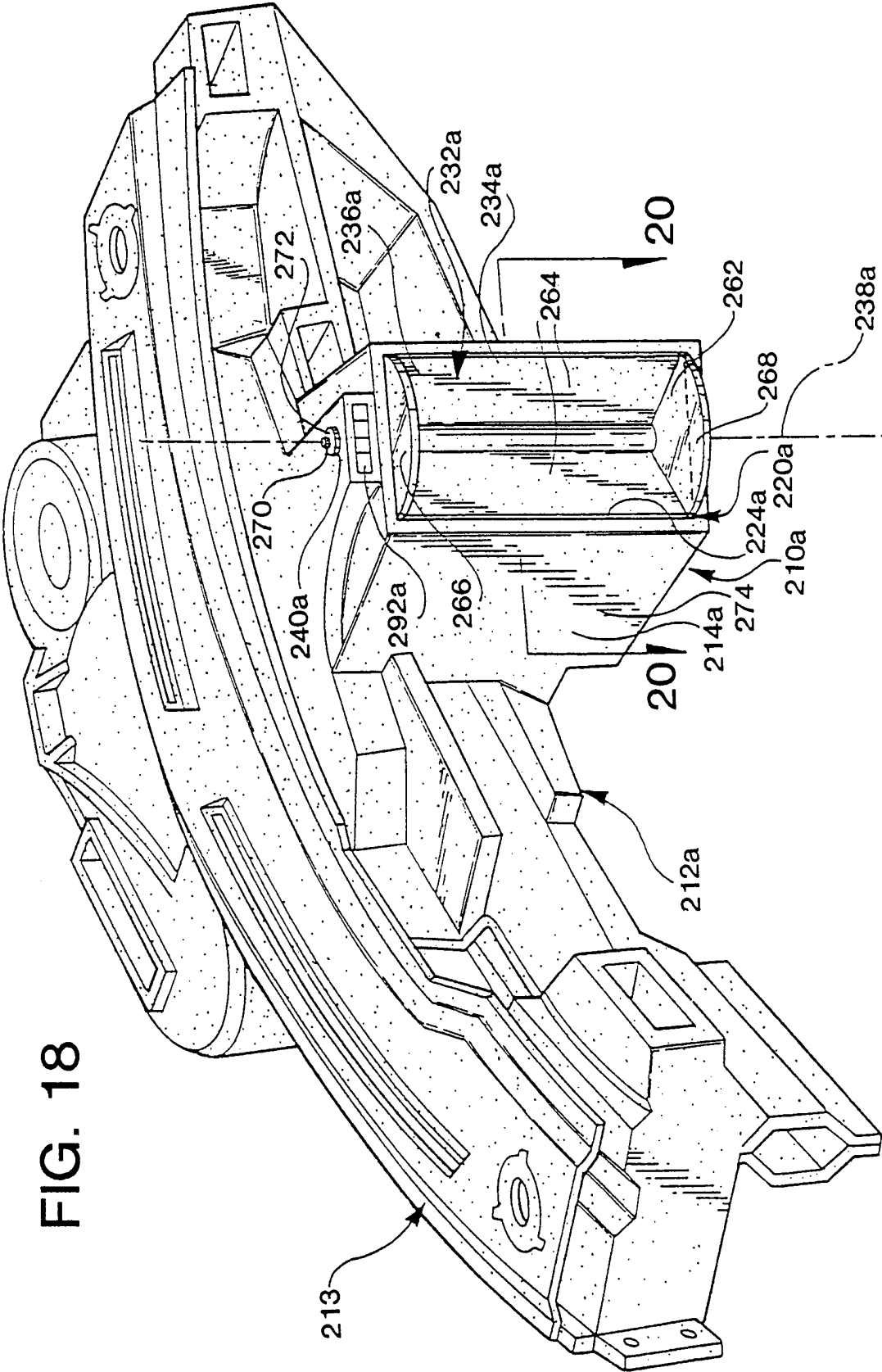


FIG. 17



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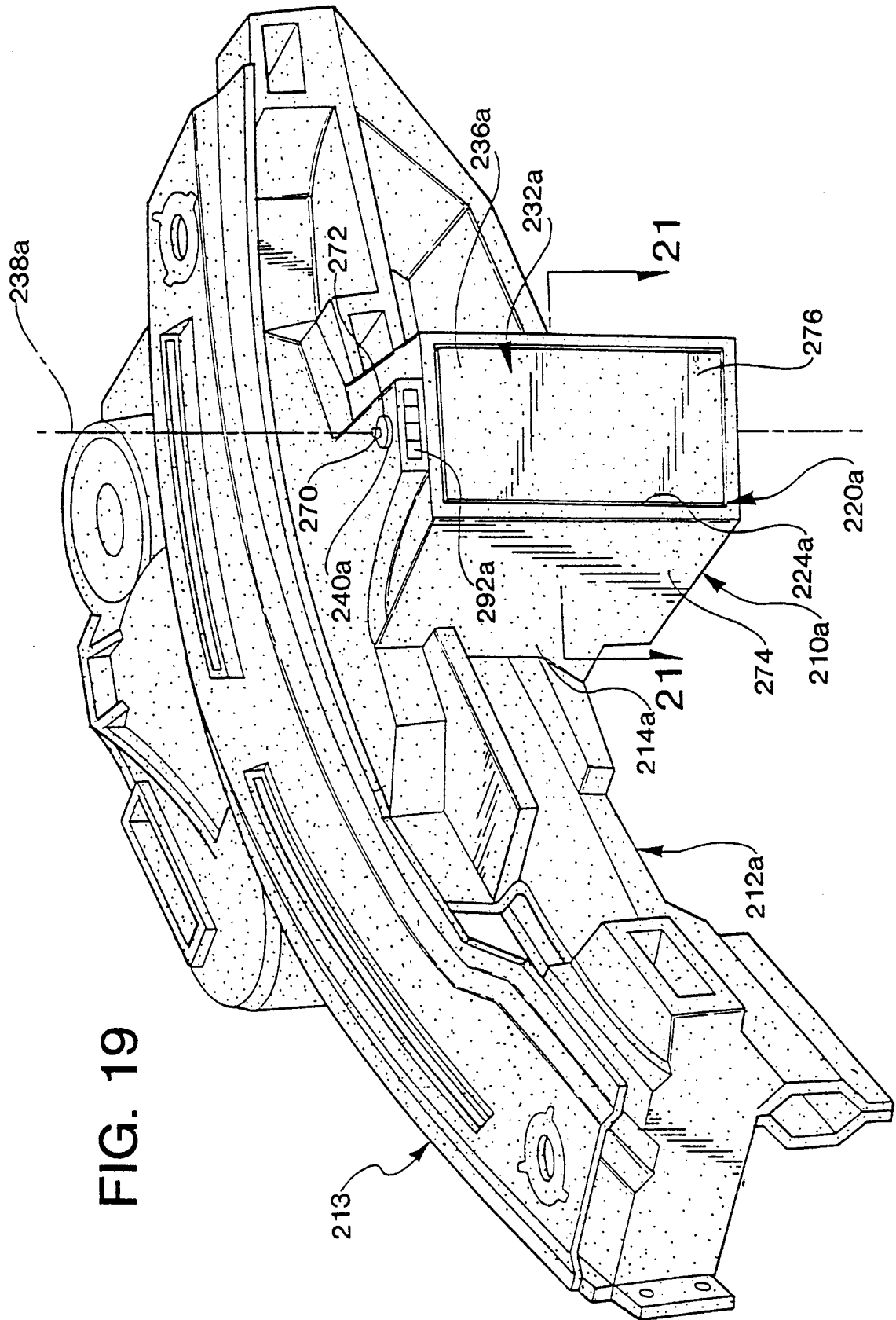


FIG. 19

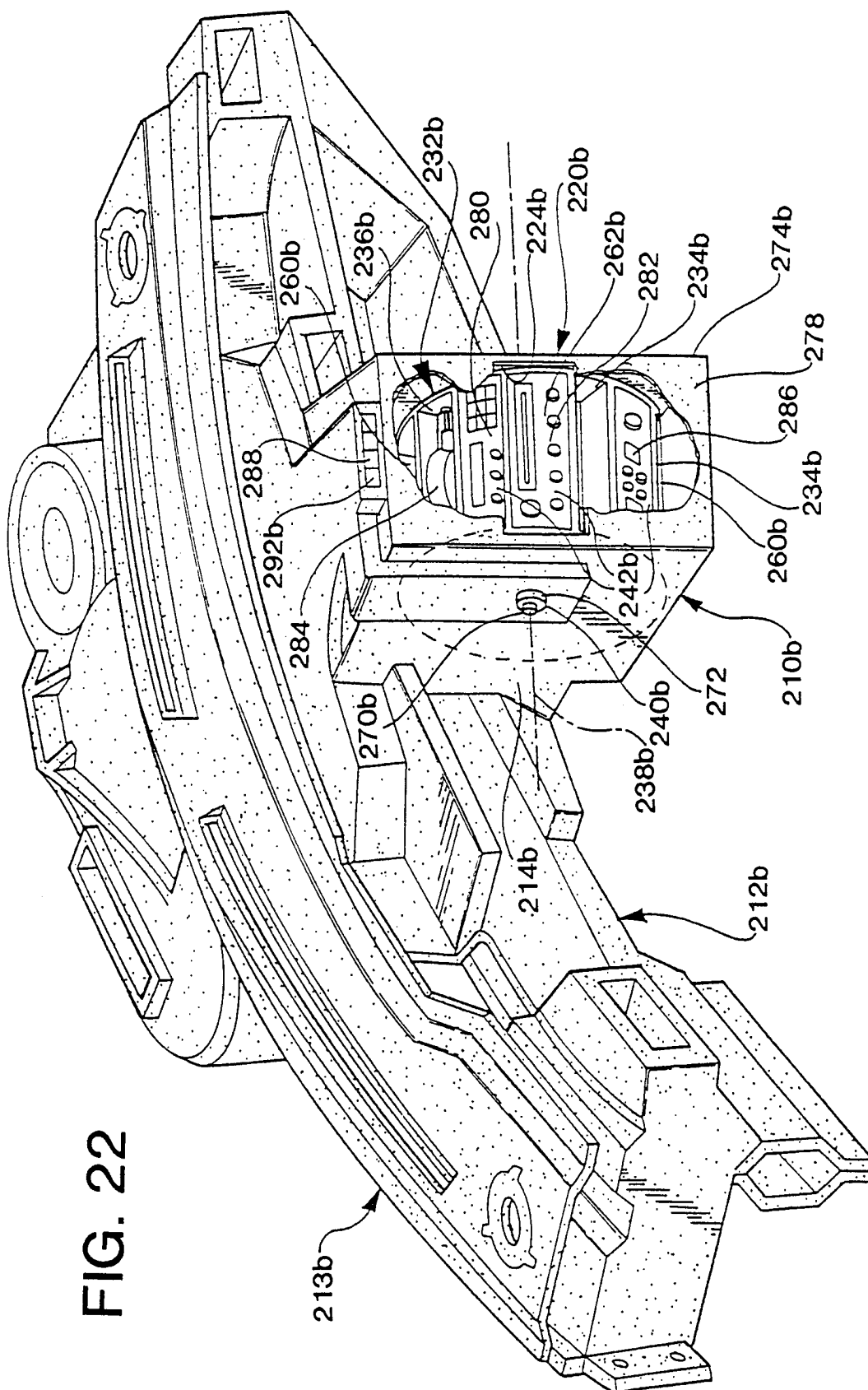


FIG. 22

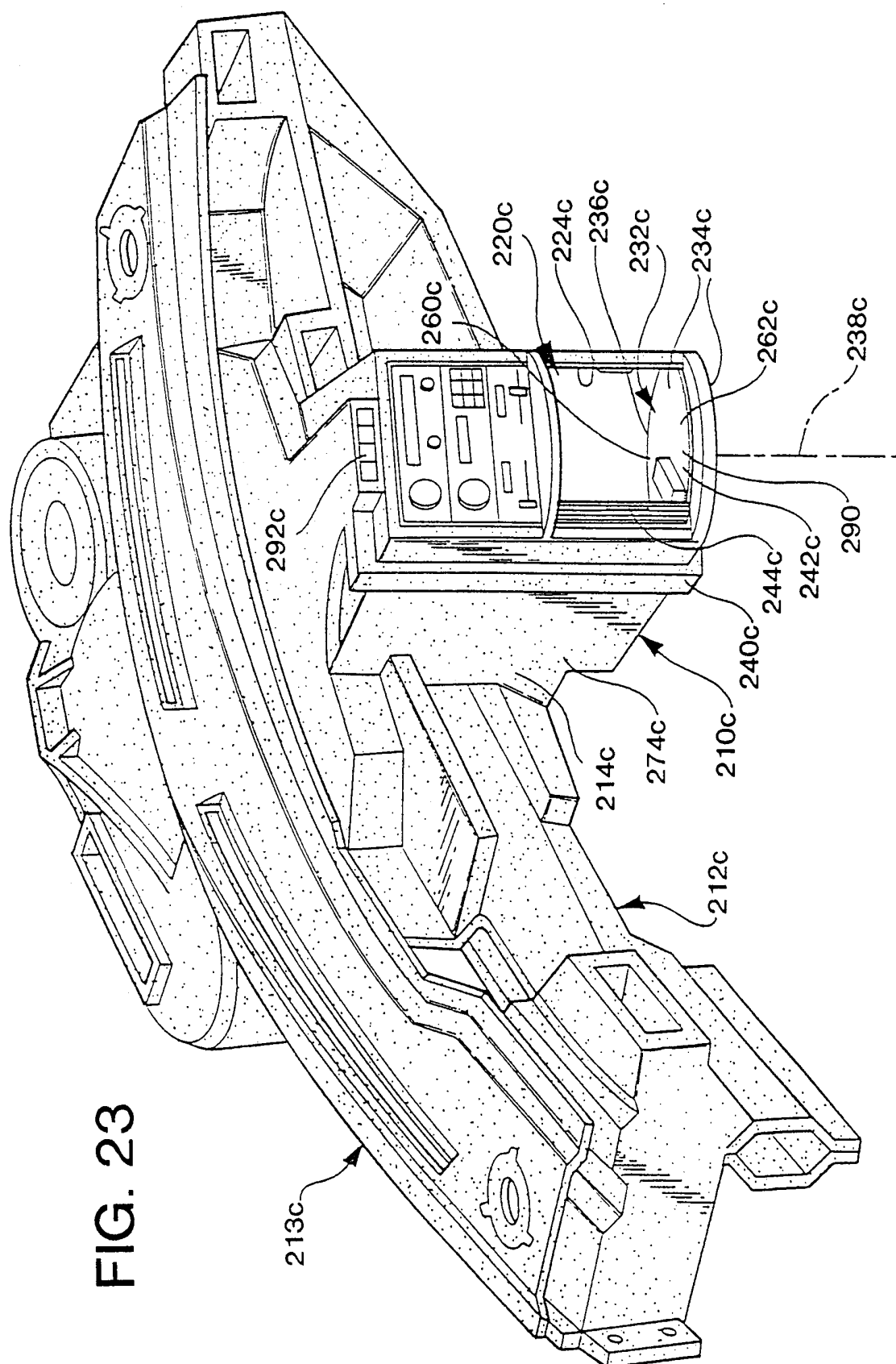


FIG. 23

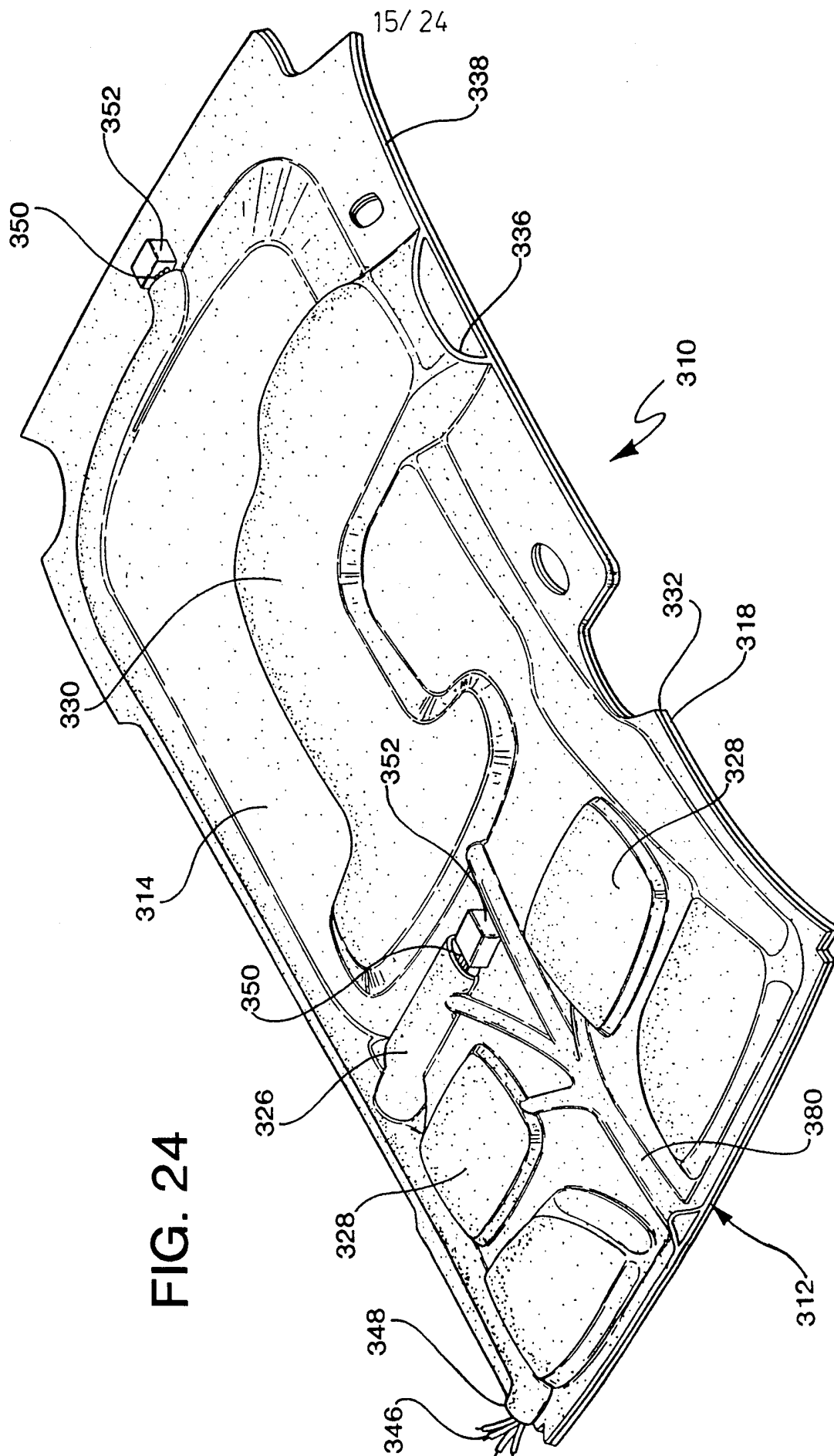


FIG. 24

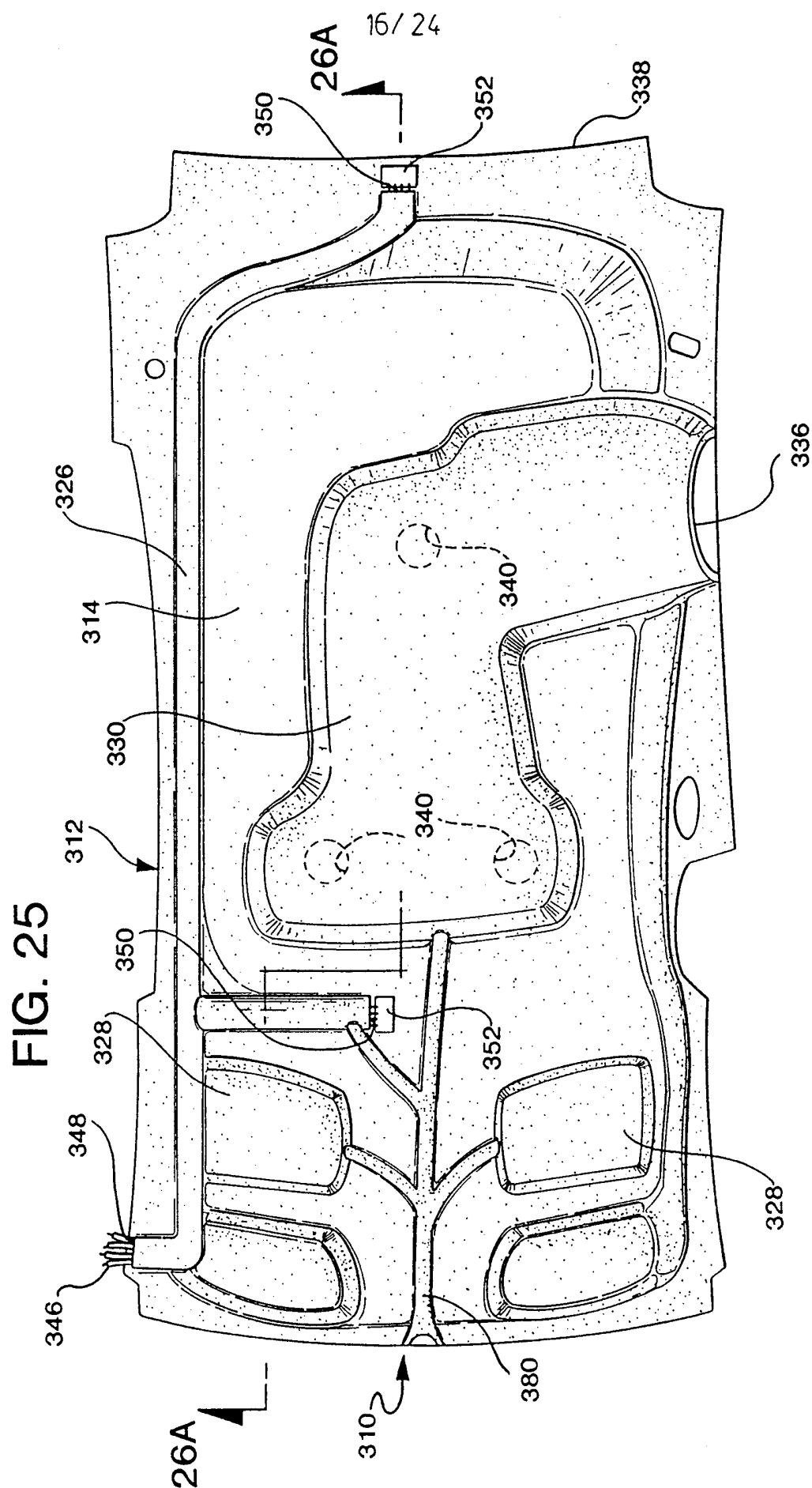


FIG. 26A

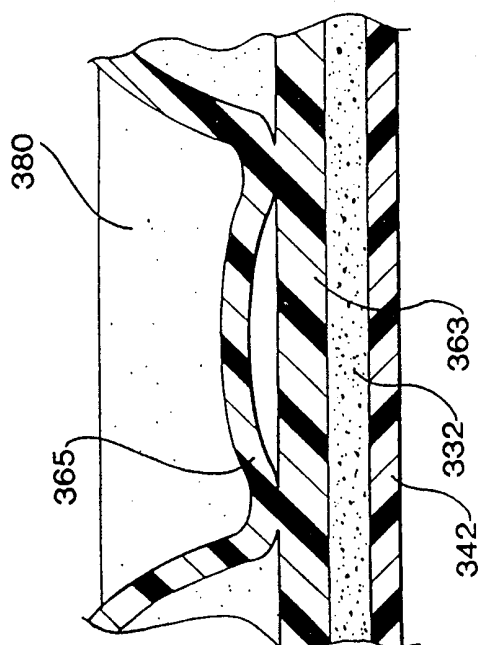
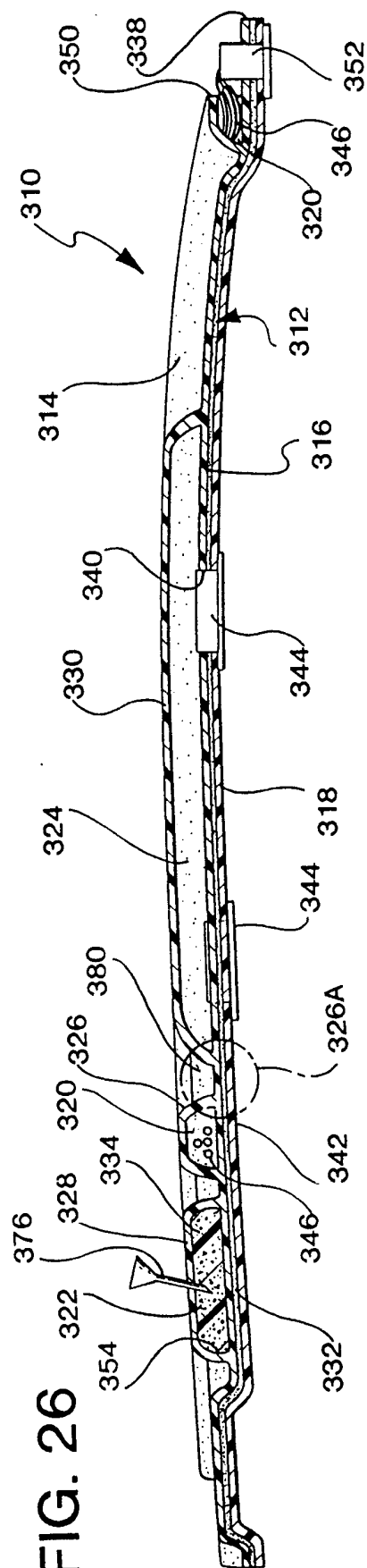
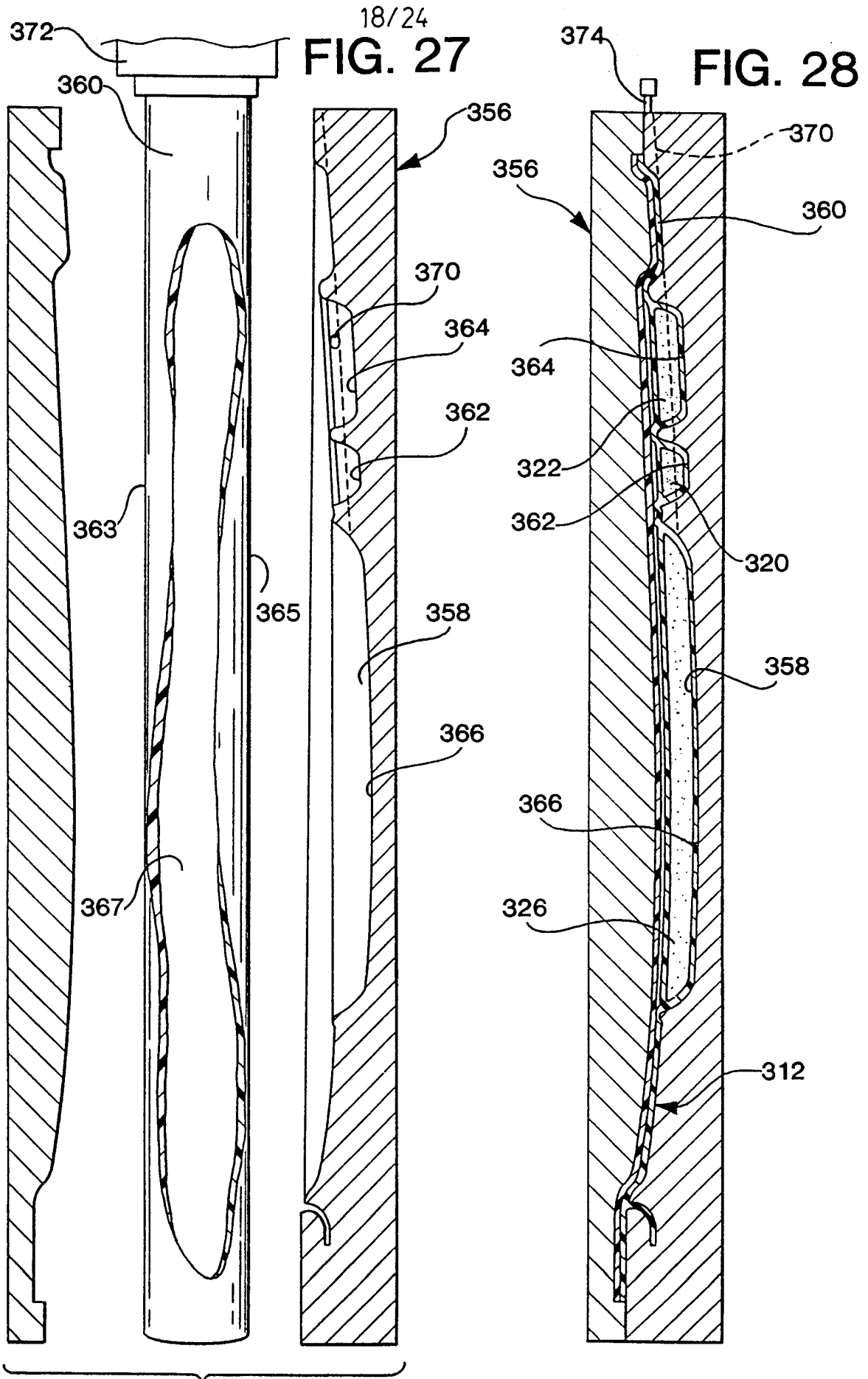
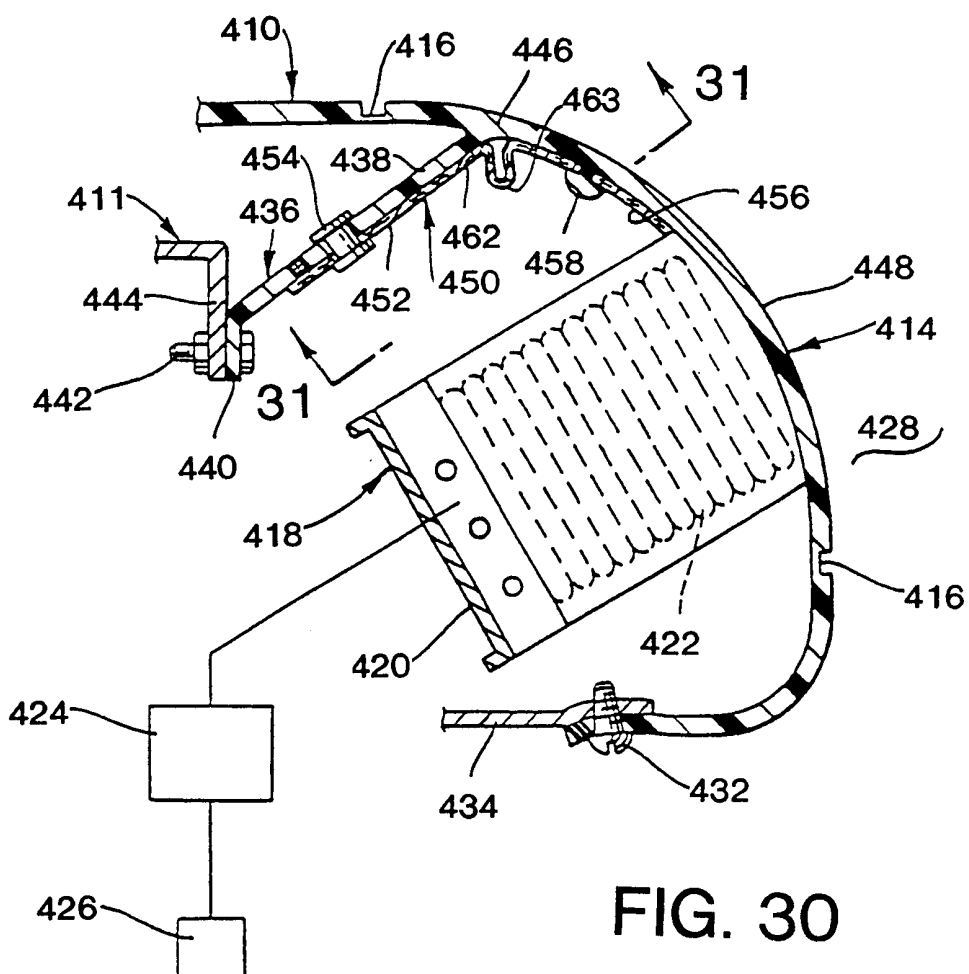
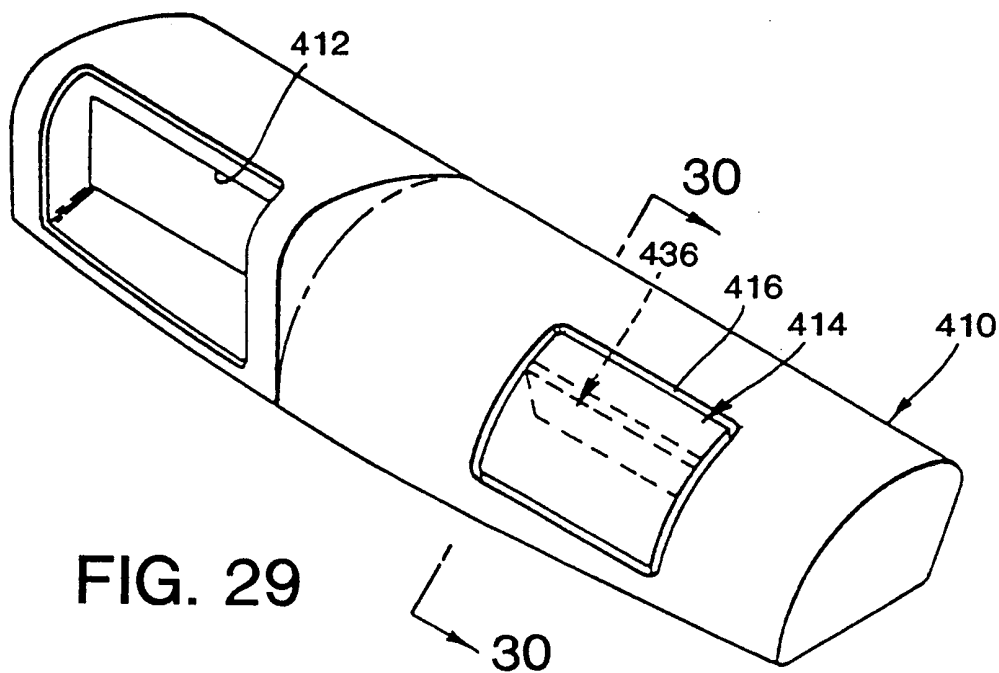


FIG. 26





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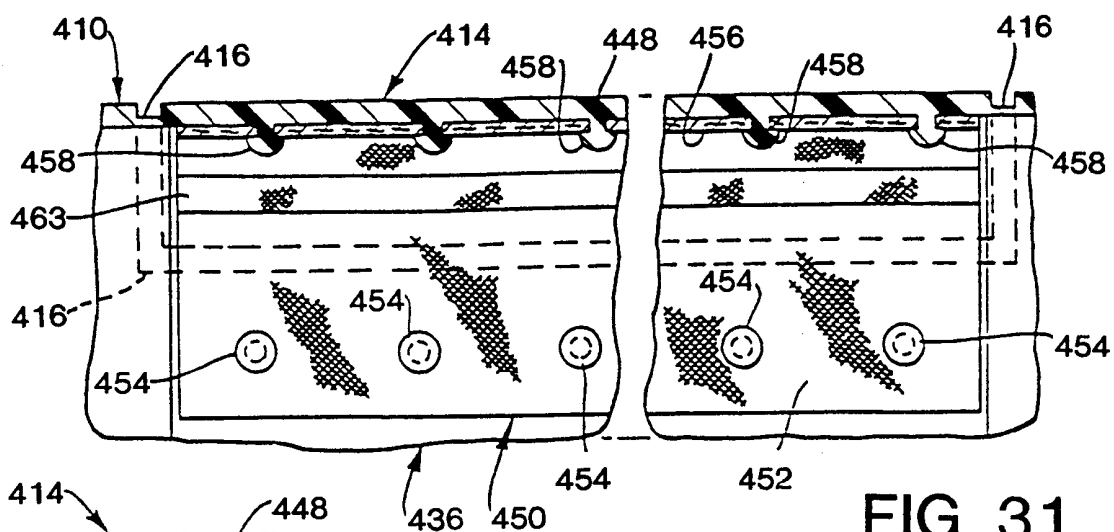


FIG. 31

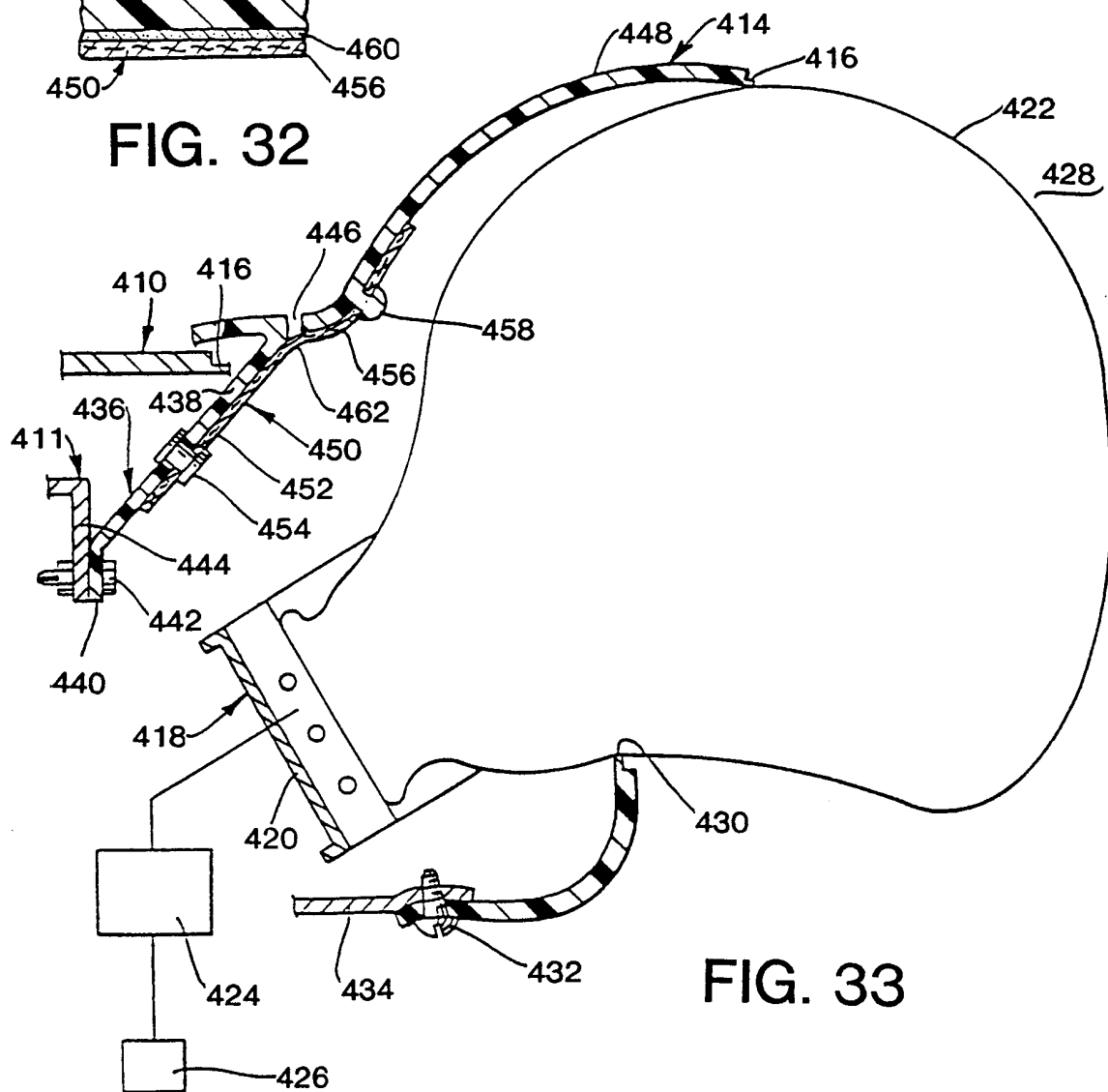


FIG. 32

FIG. 33

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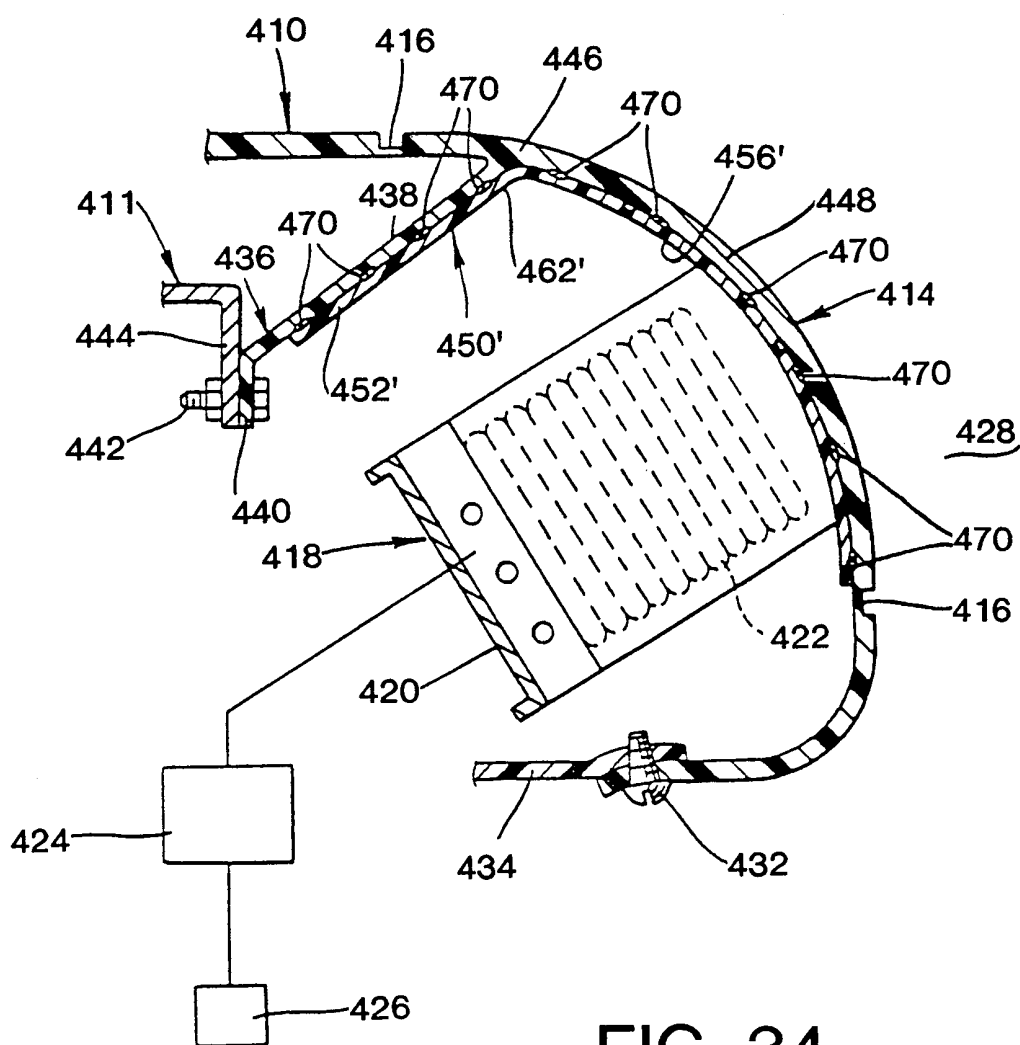


FIG. 34

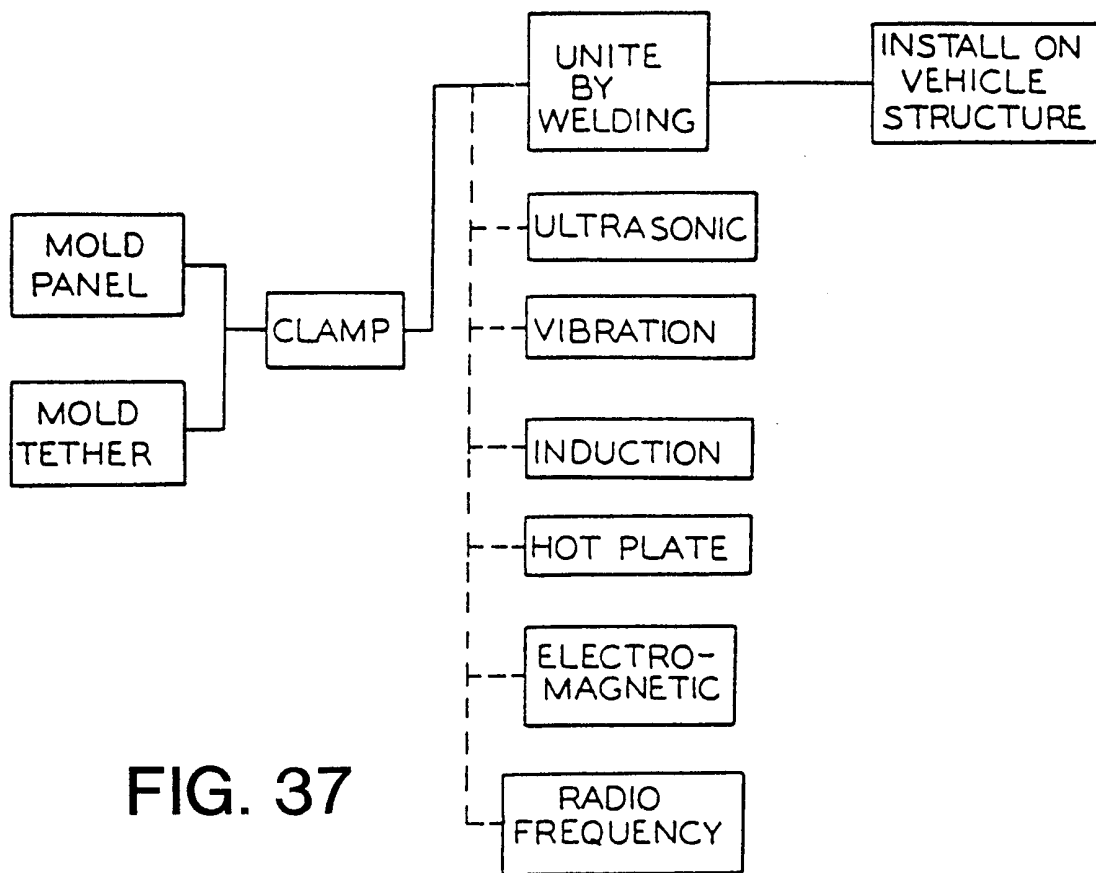


FIG. 37

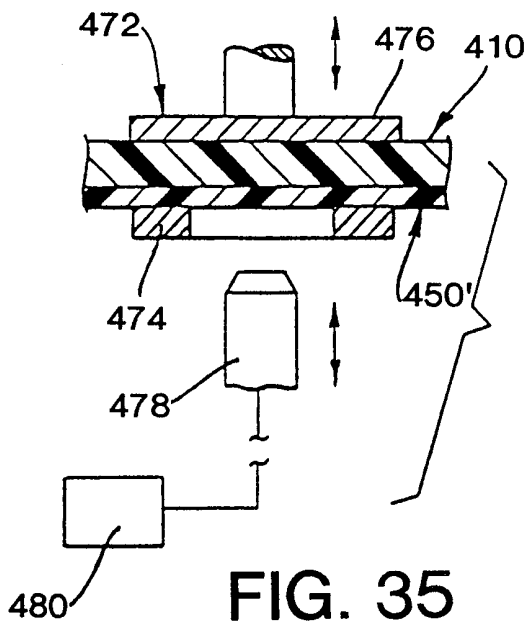


FIG. 35

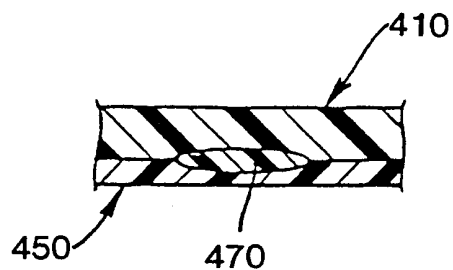


FIG. 36

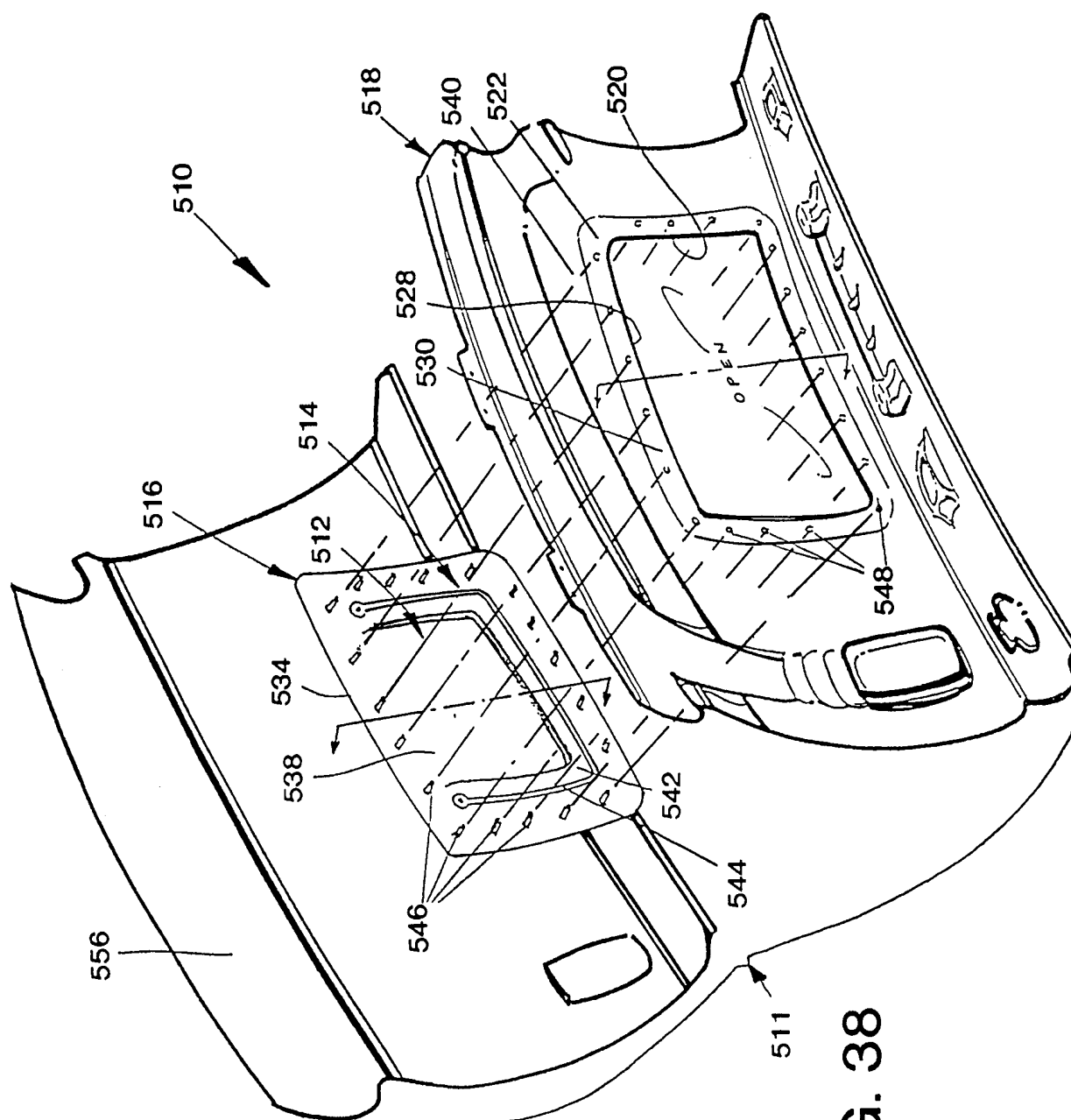


FIG. 38

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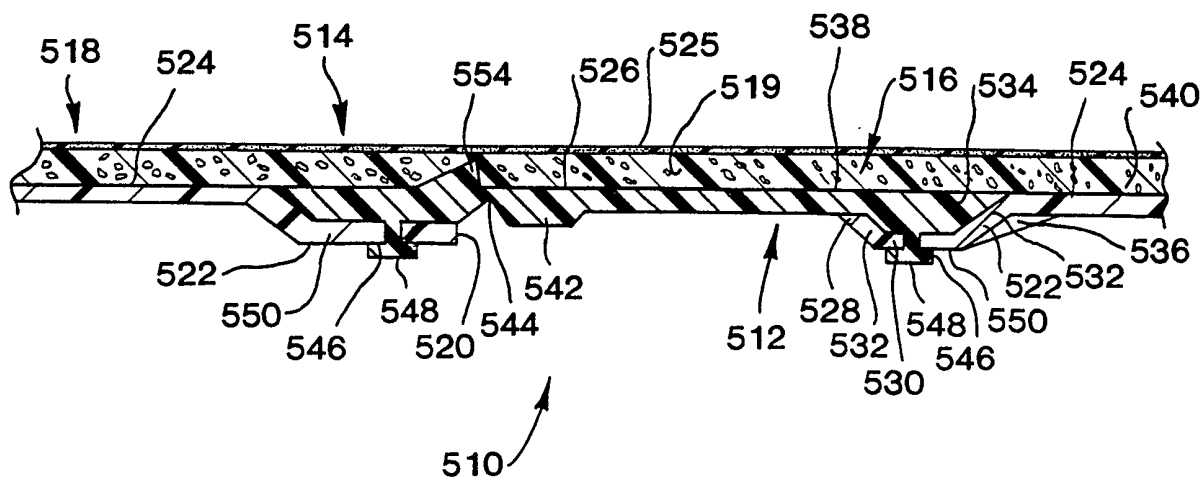


FIG. 39

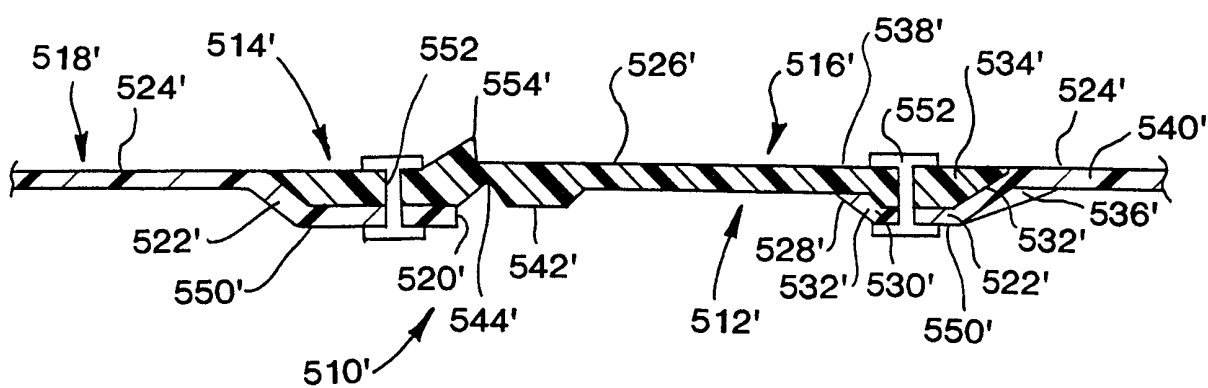


FIG. 40