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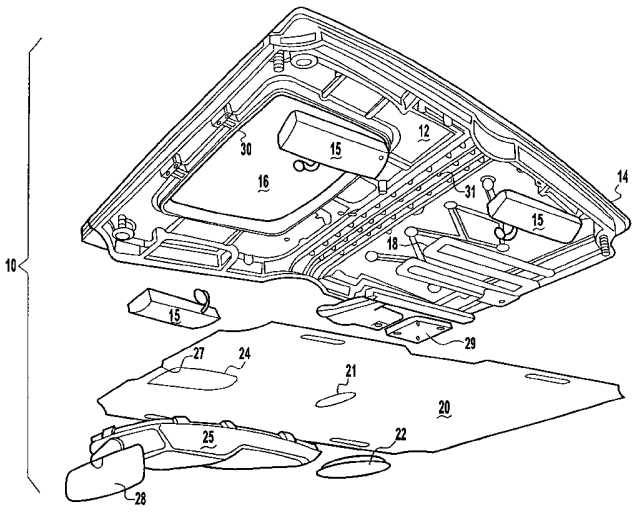
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(54) Title: STRUCTURAL ROOF PANEL SYSTEMS



(57) Abstract: A structural roof panel system for a vehicle includes mounting areas molded in or readily attached to the structural element. In a first embodiment, the roof panel is replaced by an engineered, structural system to support overhead components, the headliner, etc. In a second embodiment, an internal super-structure is located between the roof panel and a nonstructural headliner, all overhead system components being readily attachable to the super-structure at pre-designed and designated locations. In a third embodiment, the structural components are moved to pods, and all overhead components are attached thereto. In each embodiment, the headliner becomes an aesthetic and acoustic cover only that does not require structural strength. Furthermore, in each embodiment, a single, integral roof system can be supplied to a vehicle manufacturer, including the exterior panel, structural support for overhead components, the overhead components attached thereto, and the headliner.

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STRUCTURAL ROOF PANEL SYSTEMS

[0001] This application claims priority to U.S. Provisional Patent Application 06/424,566 filed November 7, 2002 and U.S. Provisional Patent Application 06/424,569 filed on November 7, 2002.

BACKGROUND OF THE INVENTION

[0002] Field of the Invention – The present invention relates generally to roof systems for vehicles and more particularly to roof systems which include a structural element which include or support the exterior roof panel, and which support the headliner and a wide variety of systems commonly used in the overhead portion of vehicles, such as automobiles, vans, SUVs, trucks, and the like. In its preferred embodiments, the present invention relates more specifically to an all-in-one structural system in which the roof panel and the structural support are molded as a unitary body, a second embodiment in which a skeletal super-structure is designed to receive any of a wide variety of overhead components and the roof panel, and a third embodiment in which structural elements to which overhead system components are attached and are moved to the side or front as pods, which again eliminating the need for structural strength for either the roof panel or the headliner.

[0003] Description of the Prior Art – It is common practice in today's vehicle manufacturing field for an vehicle body to be formed, using either a plurality of parts, a uni-body construction system, or the like. Typically, the vehicle roof panel is attached to various pillar supports, and overhead system components are added to the vehicle by passing a structural headliner through the windshield, or other windows of the vehicle, and connecting the overhead systems to the roof panel along the side rails and/or to other structural components, such as roof bows. The assembly of the headliner and overhead system components within the confines of the vehicle interior is a time consuming and expensive part of vehicle assembly. For example, many components must be attached upwardly in the Z axis direction, and manipulation in that area is difficult using robotics or hand labor to complete mechanical attachments, as well as various electrical connections, and the like.

[0004] A large variety of overhead system components are currently used in vehicles, including, but not limited to, sunroofs, dome lights, assist handles, HVAC controls, vents and

ducting, sun protection systems, infotainment components, acoustical features, antennas, aesthetic treatments, instrumentation and navigation systems, storage areas, speaker systems, emergency vehicle warning systems, rear view devices such as cameras positioned to assist in reverse travel of the vehicle or parking, airbags, other impact countermeasure devices or sensors, various types of lighting, center high mount stop lamps (CHMSL), power and signal distribution (P&SD) systems, D-rings, side view systems, close off trim, rail systems, seals, and the like.

[0005] Frequently, some of the above-noted components and others which are in use in the field or which will be developed for use in overhead systems are options and, accordingly, a particular vehicle may include all of them, or some smaller subcombination of a variety of the features. As a simple example, a particular vehicle may be available with or without a sun/moon roof. Another example would be vehicles which are optionally equipped with rear seat DVD or VHS monitors. Numerous additional examples will be readily apparent to those skilled in the art.

[0006] In addition to the problem of variability from vehicle to vehicle, present systems require that the headliner be structural in nature, i.e., be able to support itself, and to act as a support or trim cover for overhead system components which are attached to the headliner or to other structural components of the vehicle, such as roof bows, side rails, and the like. As a result, overhead system combinations with the headliners tend to be heavy, adding yet another burden to the manufacturing issues discussed above. Furthermore, providing structural plastics or other support for headliners requires additional raw materials, and the associated cost and weight related thereto.

[0007] Several U.S. patents describe roof systems, some of which are deemed by their inventors to be modular, although they differ from the structural roof systems of the present invention. For example, in United States Patent No. 5,018,781, issued May 28, 1991, to Kumasaka et al. for "Roof Structure for Modular Vehicle Body and Method of Building the Same," the modular component includes a plurality of sections, i.e., roof rails on the side, rear and front, and a roof. Mechanical fasteners are used to attach the roof to the rails. The rails and roof are assembled to the vehicle as a single component.

[0008] United States Patent No. 6,299,244, issued October 9, 2001, to Tarahomi for "Lightweight Vehicle Body Panels and Method of Blow Molding Vehicle Body Panels". The panel for the roof is blow molded and attachments such as seals or seal retainers may be

secured to peripheral portions thereof. The method of assembling such component to a vehicle comprises blow molding all or a substantial part of the vehicle body panel (a roof is illustrated), and then securing attachments to openings formed on the blow molded body or to peripheral portions thereof.

[0009] A "Roof Module for Automobile" is illustrated and described in U.S. Patent No. 5,887,939, issued March 30, 1999, to Yamaguchi et al. In particular, a roof module includes an attachment area for a function-intensive unit to be mounted thereon including electrical modules and control circuits. The module is attached to the inner surface of the ceiling of a vehicle, and the unit is preferably a case including a plurality of functional parts. A control circuit board includes attachments for roof wire harnesses. These are locked to the module through a preliminary locking member, the wire harness including a connector and a fixing member for fixing the form and the reception connector in the sealing portion. The vast majority of the illustrations refer to the wire harness and the connectors useful in the invention.

[0010] U.S. Patent No. 6,279,889, issued August 28, 2001, issued to Marchart et al., for "Roof Construction for a Vehicle" describes a roof which has a large surface roof opening surrounded by vehicle side members which can be closed by at least one movable roof section and a tailgate. The forward section is displaced toward the rear of the vehicle and under the tailgate using vehicle rails extending in a longitudinal direction and a carrying frame which together form a prefabricated module.

[0011] "Work Vehicle Roof Structure" is described in Schreyer et al., U.S. Patent No. 6,279,978, issued August 28, 2001. This device, primarily used for an operator's cab of a work vehicle, has a sound insulating foam layer between a top surface structure and a bottom surface structure facing the interior of the operator compartment. Adhesives are used to bond the structures together and ventilating channels are included in the device to assist in the air conditioning of the vehicle. The headliner located below the foam liner includes a top surface facing the bottom surface of the foam liner and a bottom surface facing the interior of the compartment. The top surface of the headliner encloses the ventilating channels to form ducts, whereas the top surface of the headliner forms the bottom wall of the ducts. The foam liner forms two side walls and the top wall of the ventilating ducts.

[0012] A number of further patents illustrate various other attempts to provide modular structures for vehicle components. For example, a vehicle body construction having upper and lower sections is disclosed in Barenyi, U.S. Patent No. 2,880,032, issued March 31,

1959, for "Vehicle Body Composed of an Upper and a Lower Section." Another construction comprising two main modular body units is described in Tjaarda, U.S. Patent No. 3,022,105, issued February 20, 1962, for "Composite Automobile Design."

[0013] A technique for joining a roof to the remainder of a vehicle body which comprises inserting pillars into mounting receptacles is shown in Klaasen, U.S. Patent No. 3,127,213, issued March 31, 1964, for "Automobile Roof Mounting." A still further structure for vehicle roof mounting is that shown in Keahn et al., U.S. Patent No. 3,427,068, issued February 11, 1969, for "Vehicle Roof Structure." In this patent, a unitary outer roof panel is joined with a unitary inner roof panel, both being provided with apertures for receiving windshields and rear windows.

[0014] A "Body for a Motor Vehicle, Particularly a Passenger Car" is described in U.S. Patent No. 5,092,649, issued March 3, 1992, to Wurl. In this patent, a top and bottom of a vehicle body are connected at the belt-line so that an existing bottom can be used with different styles of tops.

[0015] Freeman et al., in U.S. Patent No. 5,660,427, issued August 26, 1997, for "Hybrid Vehicle," describes a cab shell having a plurality of panels, at least some of which are made from sheet-molded compound.

[0016] In U.S. Patent No. 5,915,781 issued on June 29, 1999, to DeRees for "Vehicle Body Assembly," a top portion of a vehicle is sealed to a bottom portion using adhesive injected into pre-designated channel cavities formed at the joint interface of the body members.

[0017] Certain foreign patents have also issued having relevance to the subject matter of this invention. In most cases, the comments concerning such foreign patents are based solely on the abstracts thereof, or the drawings, to the extent an abstract was not available.

[0018] Porsche F. AG obtained German patent DE 3204.526.A for "Reinforced Plastics Roof for Car". The frame disclosed herein has hollow section alloys with lower mounting points flattened into tags, the roof being molded in a single piece over a frame. The roof structure is described as self supporting, lightweight, and strong. Metal extrusions are formed at the time of preparation of the roof, and are shaped so that other fittings can be clipped over the edges, such as sealing strips for doors and windows.

[0019] Italian patent 561476 issued to Francis Lombardi & C. S.r.l. a. Vercelli, shows a modular vehicle body construction, including separate doors, side frames which include portions of the fenders, and other body components.

[0020] A "Car Body Structure for Automobile" is disclosed in Mazda Japanese Published Patent Application 1-182175. Upper and lower body parts are joined together by a flange. The upper body part is made of a plurality of steel parts welded together, while the lower body part is made from synthetic resin.

[0021] Nissan, in Japanese Published Application 63-46976 discloses a "Car Body Structure for Automobile" which can be automatically assembled by a robot. The patent discusses dividing the car body into three "blocks": an engine compartment, an upper body, and a lower body. Additional parts including hoods, trunks, fenders, side shields, and the like are added to their respective components in separate lines, and after numerous components are installed, they are matched and combined to the car body.

[0022] Another Japanese Published Application 4,129,886 issued on April 30, 1992, to Toyota for "Module Assembling Structure for Car Body." This document seems to relate primarily to the alignment of a car body part with a lower car body part and flanges which have predefined offsets. The flanges do not interfere with one another at the time of assembly. The flanges are subsequently covered by trim.

[0023] U.K. Patent 746,139 dated March, 1956, issued to Fiat for a "Motor Vehicle Body." In this construction, a plurality of modules, including an upper body having apertures for front and rear windows and a side panel including door openings and fenders are described. The claims to the patent focus on the front end construction for such a vehicle.

[0024] Porsche German Patent 4018592 A1 issued in 1991 will not be described here as it is the priority document for U.S. Patent 5,092,649 discussed above.

[0025] In Dutch patent 8006431, the English abstract indicates that a prefabricated mounting frame for a sliding roof is finished such that the underside forms the inner roof lining of the car. Further, the perimeter preferably corresponds with that of the inside of the car roof, and the mounting frame may include downwardly extending outer corners, connectable to window posts. The preferred finish consists of a layer of hard plastic foam with an inner vinyl or cloth lining which projects outside the perimeter of the frame and has corner flaps. The frame may be partially plastic and include metal fixing flanges embedded in the plastic.

[0026] A structural roof panel system which does not need the headliner or the roof panel to be structural in nature and which maintains flexibility for adding overhead system components to a vehicle would represent a significant advance in this art.

FEATURES SUMMARY OF THE INVENTION

[0027] A primary feature of the present invention is to provide structural roof panels for vehicles which are engineered to receive overhead components.

[0028] Another feature of the present invention is to provide an all-in-one roof system in which the roof panel and the structural support therefor are integral and engineered to receive overhead components, subsystems, etc.

[0029] Another feature of the present invention is to provide a structural roof panel system for a vehicle in which a skeletal super structure is designed to receive any combination of a variety of overhead systems, and in which the external panel and the headliner need not be structural.

[0030] Another feature of the present invention is to provide a structural support for overhead vehicle components located as pods which extend along the side and/or the front and rear of the vehicle, again eliminating the requirement that the roof panel or the headliner be structural in nature.

[0031] A yet further feature of the present invention is to provide structural roof panel systems for vehicles which reduce assembly cost and time.

[0032] Another feature of the present invention is to provide structural roof panel systems for vehicles which can be created by any of a number of forming or molding techniques, such as injection or sheet molding, pressed fibrit, stamping, forming, casting, and the like.

[0033] A different feature of the present invention is to provide structural roof panel systems for vehicles in which the external panel can be prepared by molding, or can be painted, wrapped, coated, covered with a film, hand molded in color, etc.

[0034] Another feature of the present invention is to provide structural roof panel systems for vehicles in which a single part can replace a large number of components in the assembly process and can be shipped to an OEM final assembly plant as a single part for a customer's vehicle.

[0035] A different feature of the present invention is to provide structural roof panel systems for vehicles which can be readily attached to other vehicle body components using adhesives, joints, fasteners, welding, MIG, or the like, and in which, in the most preferred embodiments, are self locating about the perimeter of the vehicle body.

[0036] Another feature of the present invention is to provide modules for vehicle assembly which permits Z-axis attachment of interior components (such as seats) and wherein the module itself may include self-aligning locating systems to minimize the requirement for mechanical fasteners.

[0037] Another feature of the present invention is to provide parts to an OEM assembly plant which may be bar coded, embedded with a smart chip, or the like for selection by robotic or manual labor for subsequent assembly to a vehicle.

[0038] Yet a further feature of the present invention is to provide a belt-line-up structural module for vehicle assembly which includes a variety of content including overhead systems, package trays and associated systems, front and rear wiper assemblies, seals, wiring, HVAC components, occupant protection systems, etc.

[0039] A still further feature of the present invention is to allow for use of simple, non-structural, die-cut, stretched, or otherwise prepared materials for the headliners that are attached to the structural roof panel systems of the present invention.

[0040] A still further feature of the present invention is to provide structural roof panel systems for vehicles in which acoustical material may be added between a headliner and the structural components of the panel system, using inexpensive materials, rather than expensive materials made as part of the headliner system itself.

[0041] How the above and other features of the present invention are accomplished will be described in connection with the following detailed description of the preferred embodiments, taken in conjunction with the FIGURES. Such features can be realized in the aggregate, individually, or in various subcombinations as will become apparent as the description continues. In one embodiment, a structural roof panel system includes a single molded or formed roof panel in which a variety of knock-out or predetermined holes and accessing locations are provided behind the Class A interior and exterior surfaces. In this embodiment, for example, optional components can be added or not depending on customer or dealer preference, including such items as sunroofs, infotainment systems, and the other

enumerated overhead components identified above. The Class A exterior surface can be supplied by any suitable technique such as painting, e-coating, in mold painting, the use of films, molded in color, etc., to match other body parts prepared at different locations. The headliner becomes merely a cover and need not be structural since the heavy components are attached to the molded, stamped, or formed roof panel.

[0042] In a second embodiment, the features are accomplished by providing a super-structure in the form of a skeleton located between a nonstructural headliner and an external, non-structural body roof panel. As with the all-in-one embodiment, the structural overhead components identified above are attached to the super-structure which supports the weight thereof. Accordingly, neither the roof panel nor the headliner needs to be structural, and assembly of the three components results in a structural roof panel system which may be installed as a single unit.

[0043] In a third embodiment of the invention, structural support for the roof panel and for the headliner, as well as for overhead system components, is provided by pods which, for example, may extend along the side rails of the vehicle or the front or rear headers.

[0044] In a fourth embodiment of the invention, a belt-line-up structure is preferably preassembled by a Tier 1 manufacturer and shuttled as a completed unit to an OEM assembly plant for attachment to the rest of the vehicle in a single step. The belt-line-up structure can include the exterior class-a surface to match the remainder of the vehicle and may include structural roof components which are molded as a single unit, or which include structural roof panel systems using pods or super structures. The belt-line-up structure reduces OEM capital costs, manufacturing space and labor requirements, and also reduces overall costs for the Tier 1 supplier by enhancing manufacturing efficiencies and simplifying component attachment, resulting in net cost savings for both. The belt-line-up structure can be formed in any of a variety of techniques which will be described below and may be attached to the remaining components of the vehicle using any of a variety of attachment techniques, including self-locating devices and adhesives. In the belt-line-up structure of the most preferred form of this embodiment, pillar structures are included and are also given class-a surface treatments, while non-visible areas of the pillars can remain raw, body colored, or covered with a base coat such as matte black. Other belt-line-up components (such as package shelf, windshield and upper components) may also be provided in the modular unit.

[0045] In any of these embodiments, other ways in which the features are accomplished will become apparent to those skilled in the art after they have read this specification, such other ways being deemed to fall within the scope of the present invention if they fall within the scope of the claims which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] FIGURE 1 is an exploded view of an all-in-one roof system showing an engineered structural roof panel system and several overhead system components that can be added thereto;

[0047] FIGURE 2 is an exploded view of a structural roof panel system including a super-structure to which various overhead system components may be affixed;

[0048] FIGURE 3 is an exploded view of a structural roof panel system in which side pods are used to carry overhead system components, again shown in exploded form; and

[0049] FIGURE 4 is a perspective, exploded view of a further embodiment of the invention.

[0050] In the various FIGURES, like reference numerals are used to indicate like components.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0051] Before proceeding with the detailed description of the preferred embodiments of the structural roof panel systems of the present invention, several general comments can be made about the applicability and the scope thereof.

[0052] First, a variety of overhead system components are illustrated in the various FIGURES, including airbags, mirrors, antenna grids, sunroofs, overhead consoles, dome lights, visors, and wire harnesses. The illustrated components should not in any way be considered limiting with regard to the overhead system components which can be included with the structural roof systems. A more complete, but still not limiting, list of possible components includes sunroof/moon roof systems, folding canvas, T-tops, glass roof panels, HVAC controls, HVAC vents, HVAC ducting, headrests, sun protection systems, infotainment components and systems, multiple antennas, single antennas, acoustic treatments, headliners, instrumentation and navigation systems, storage components, speakers, emergency warning

systems, rearview/outside viewing cameras or displays, airbags, other head impact countermeasures, occupant sensing systems, lights, CHMSL, P & SD systems, D-rings, side view systems, close out trim, rail systems, or the like.

[0053] The illustrated embodiments do not in all cases show the way in which overhead equipment is attached to the structural component of the structural roof panel systems, and it should be clearly understood that the attachment systems, in and of themselves, are not part of the present invention. The various overhead components mentioned above, and others which may now be in use or which may subsequently be developed for use in vehicles, may be attached by any type of suitable connectors, or attachment systems, including adhesives, snap-in arrangements, Velcro7, straps, threaded fasteners, rivets, bolt and nut arrangements, interference fit, ties, clips, and the like. The invention in no way should be deemed limited by the technique used to attach any particular component to the structural element of the structural roof panel systems of the present invention.

[0054] Roof panels can be individually created or combined with the structural system (in one embodiment) and may be made by any number of molding or forming techniques such as injection molding, casting, reinforced injection molding, sheet molding, stamping, casting, hydro-forming pressed fibrit, lay-up or other techniques currently utilized to prepare panels for vehicles. Moreover, the roof panels may receive their class "A" exterior surface through any of a variety of known techniques such as painting, e-coating, in-mold painting, the applications of films, mold in color, etc. Still further, the particular materials from which the roof panels can be made include metals, metal alloys, resins, reinforced resins, and the like.

[0055] The technique by which the various components of the roof systems of the present invention are assembled can also be widely varied. While in most cases, the complete roof system will be installed at a vehicle assembly plant by lowering it on the Z-axis, the build up of the roof system itself, since it is done at a different facility, can be done in an inverted state, so that the weight thereof does not need to be supported from above, and workers or robotic equipment may more easily work on the system. While a preferred technique will be described for the combination of the structural roof panel systems of the present invention with the vehicle, it is also possible that they can be installed from the inside vehicle bottom up. In either case, it is also preferred to have locator systems on the structural roof panel systems, to be aligned with locator elements on the vehicle perimeter. This technique will avoid fixturing

and tooling costs at the OEM assembly plant. The inclusion of particular self-locating elements, the number thereof, or their use at all is optional and not to be deemed limiting with regard to the scope of the invention.

[0056] Another aspect of the invention described in this application is the separate assembly of the structural roof system by a Tier 1 supplier and the delivery thereof to the OEM for attachment to other vehicle components. One technique for specifying a particular structural roof system for use with a particular vehicle body proceeding down an assembly line is to use bar codes, but any other type of identifying technique may be used, e.g. smart chips. The OEM will pick an appropriate roof panel system from the shipping system (for example racks with flexible supports) and by the use of robotics or manual labor, attach the structural roof panel system to the roof perimeter with any of the variety of attachment systems and locators described above. The particular techniques employed to seal the structural roof systems to the remainder of the vehicle is not shown in the drawings, but it should be apparent to those skilled in the art that seals are needed to protect the vehicle interior against water, dust, wind, noise and the like.

[0057] The particular type of headliner to be used with the structural roof panel systems of the present invention can be varied widely and may be selected from any of those currently used or known to the art. The headliner need not be structural, as indicated above, but various attributes such as acoustic control, aesthetics, head impact countermeasure features, and the like, which are features of existing systems, can readily be used in the present invention. Furthermore, while the disclosed structural roof panel systems of the present invention do not require that either the roof panel (as a separate element) or the headliner be structural in nature, the degree of structural effect on the overall system can range from zero to a substantial amount without departing from the scope of the present invention. For example, the headliner may be thermoformed and have sufficient structure to withstand damage during shipment from its place of manufacture to the structural roof panel system assembly location, and the roof panel may have sufficient structure to avoid damage during its shipment, finishing, or the like. The overall strength of the structural roof system will be influenced by the structural roof component shown in the three embodiments, with potential additive input from the headliner, the roof panel, or in some cases, the overhead system components themselves.

[0058] Proceeding now to the description of four embodiments of the invention, FIGURE 1 shows an exploded view of an all-in-one structural roof panel system according to the first embodiment. The overall roof system is designated by the reference number 10, while the structural all-in-one engineered structural component is indicated at the reference numeral 12. As can be seen from FIGURE 1, the roof panel 14 is formed with the structural component 12, and a sunroof or other "optional equipment" can be added by knocking out predetermined areas, such as 16. Various overhead system components are also illustrated in FIGURE 1. They include side airbag modules 15, an antenna farm 18, a headliner 20, including an aperture 21 adapted to receive a dome light 22, and an aperture 24 adapted to receive an overhead console 25. An edge cut-out 27 is also included to accommodate rearview mirror 28. A motor for a sunroof is also illustrated 29. As has been clearly set forth above, the number and location for the various components which may be added to the all-in-one roof system 10 can be widely varied, and structural ribs 31 are provided at various locations and are adapted to receive such components.

[0059] What differentiates the all-in-one structural roof panel system 10 from the other embodiments is that the roof panel 14 is formed with the structural component 12 and preferably is formed integrally therewith, although two-step over-molding co-molded, or inlayed molding operations could be employed if desired. Other techniques for joining roof panel 14 to the structural element 12, as separate components, could also be employed, such as the use of adhesives and the like. Preferably, however, components 12 and 14 are formed in a single molding, casting, forming, or other process.

[0060] A second embodiment is depicted in FIGURE 2, which includes a super-structure system 40 having a super-structure element 42, a roof panel 43, and a headliner 45. In this embodiment, roof panel 43 is added as a separate assembly set to the super-structure 42, along with other overhead components illustrated here, including wire harness 46, visors 48, a rearview mirror 49, an overhead console 50, airbag assemblies 52, and antenna grid 54.

[0061] The super-structure 42 is preferably made from a resin, which may be reinforced if desired. The super-structure 42 includes a network of supporting ribs 55, as well as other predesignated attachment areas for the listed overhead components, or other overhead components which may be selected by the dealer or customer. The joining of the overhead components, as well as the headliner 45 and roof panel 43, may be accomplished using any of the fastening techniques described above.

[0062] The third embodiment of the present invention is illustrated in FIGURE 3 and can be designated as the pod system 60. In the third embodiment, the roof panel 62 and the headliner 64 need not be structural, since overhead components, the panel 62 and headliner 64 are supported by structural pods 66. In the illustrated embodiment, a pod 66 extends along either side of a completed vehicle, but as indicated above, additional pods may be added fore and aft, or fore and aft pods may replace the side pods 66. Only a few overhead components are illustrated in this FIGURE, including visors 70, a wire harness 72, and airbag canisters 74. As shown, the airbag canisters 74 fit within pockets 75 in pods 66.

[0063] Proceeding now to the description of another alternate embodiment of the invention, FIGURE 4 is an exploded view showing a clam shell-like vehicle construction 80. Construction 80 includes a main vehicle body 82, a door modular assembly 84, and the upper vehicle module 86. In the illustrated embodiment, upper module 86 includes an integral roof panel 88, the A-pillars 90, the C-pillars 92, and a portion of the B-pillars 94. In addition, a package shelf 98 and a front plate 100 are provided, the latter including the windshield wiper assemblies 102. In the exploded form, it can be appreciated that the instrument panel 105, a floor structure 108, front row seats 110, a floor console 114, and rear seats 112 may all be inserted into body 82, in the Z-axis direction. While not specifically shown in FIGURE 4, an alternate embodiment would have the upper surface of instrument panel 105 constructed as part of the upper vehicle module 86, so that the IP upper would be assembled to the remaining components of the instrument panel when upper vehicle module 86 is fully loaded and attached to the remaining components.

[0064] Without repeating all of the information contained in the introduction to this section of the specification, it should be clearly understood that the glass for the front and rear of the upper vehicle module 86 could be furnished along with the module or added separately on the final assembly line. In addition, materials and surface treatments can be selected from those described above.

[0065] With regard to the B-pillar 94, in FIGURE 4, the portion attached to upper vehicle module 86 is received within coupler 99 attached to the body.

[0066] Referring once again to upper vehicle module 86, it will be noted that locators 97 are provided at the base of both the A- and C-pillars for attachment of door modules, or for securing the upper vehicle module 86 to the body 82 as described hereinabove.

[0067] While the present invention has been described above in connection with four preferred embodiments and illustrations thereof, the invention is not to be limited by such description or illustrations, but is to be limited solely by the scope of the claims which follow.

WHAT IS CLAIMED IS:

1. A structural roof system for a vehicle comprising:

a roof panel;

a structural element adapted to receive at least one overhead component; and

a headliner coupled to the roof element, wherein the roof element provides a substantial portion of the structural capability of the roof system.

2. The structural roof system of Claim 1, wherein the roof panel and structural element are integrally formed.

3. The structural roof system of Claim 1, wherein the roof panel is formed as a separate part from the structural element and has sufficient structural strength to withstand finishing, shipping, and assembly to the structural roof system.

4. The structural roof system of Claim 1, wherein the headliner has sufficient structural strength to withstand formation, shipping, and assembly to the structural roof system.

5. The structural roof system of Claim 1, wherein the at least one component is selected from the group consisting of lights, assist handles, hooks, airbags, antennas, a sun roof, mirrors, consoles, and motors.

6. The structural roof system of Claim 1, wherein the at least one overhead component is selected from the group consisting of wire harnesses, seals, folding canvas, T-tops, glass roof panels, HVAC vents, HVAC ducts, HVAC controls, headrests, sun protection systems, infotainment components and systems, acoustic treatments, instrumentality, navigation systems, storage components, speakers, emergency wiring systems, displays, cameras, switches, impact countermeasures, occupant detection or sensing systems, center high mount stop lights, power and signal distribution components, tools, air purification systems, bezels, close-off trim, rail components, side and/or rear view camera components.

7. The structural roof system of Claim 1 wherein the roof panel has an exterior class "a" surface.

8. The structural roof system of Claim 7, wherein the "a" surface is provided by a process selected from the group consisting of painting, e-coating, in-mold panting, in-mold coloring, or the use of films.

9. The structural roof panel of Claim 1, wherein the roof panel is formed by a process selected from groups consisting of injection molding, casting, sheet molding, reaction injection molding, lay-up, stamping, and pressing.

10. The structural roof system of Claim 1, wherein the roof panel is formed separately from the structural element and is adhered thereto using a technique selected from the group consisting of adhesives, fittings, Velcro®, snaps, clips, straps, fasteners, rivets, fusing, or welding.

11. The structural roof system of Claim 1, wherein each overhead component is attached to the structural element using a technique selected from the group consisting of adhesives, fittings, Velcro®, snaps, clips, straps, fasteners, rivets, fusing, or welding.

12. The structural roof system of Claim 1, wherein the structural element is a superstructure.

13. The structural roof system of Claim 14, wherein the superstructure comprises a plurality of ribs and a plurality of locations adapted to receive overhead components.

14. The structural roof system of Claim 1, wherein the structural element comprises a plurality of spaced apart pods.

15. The structural roof system of Claim 16, wherein each pod includes at least one location adapted to receive an overhead component.

16. The structural roof system of Claim 16, wherein two pods are spaced apart from one another and are arranged to be located adjacent vehicle side rails when the roof system is placed on a vehicle.

17. The structural roof system of Claim 1, further including locators, adapted to facilitate attachment of the structural roof system to a vehicle during assembly.

18. The structural roof system of Claim 1, further comprising one or more belt-line-up components selected from the group consisting of windshields, pillars, a package shelf, seals, covered boxes, wipers, occupant retention systems, side rails, or front and rear cross-car rails.

19. A structural roof system for a vehicle comprising an exterior class A roof panel, a structural layer integrally formed with the roof panel, the layer having a plurality of locations adapted to receive overhead components, a headliner extending across and being attached to the structural layer on a side thereof spaced from the roof panel, a plurality of overhead components attached to the structural layer, and wherein a substantial portion of the structural strength of the roof system is provided by the structural layer.

20. The structural roof system of Claim 21, wherein the structural layer includes ribs and at least one area which can be selectively removed.

21. A structural roof system for a vehicle comprising:

a roof panel;

a superstructure having a plurality of locations adapted to receive overhead components;

the superstructure having a first and a second side, the roof panel being attached to the first side;

a headliner extending across and being attached to the second side of the superstructure; and

a plurality of overhead components attached to the superstructure, and wherein a substantial portion of the structural strength of the roof system is provided by the superstructure.

22. The structural roof system of Claim 23, wherein the superstructure comprises a network of supporting rails.

23. A structural roof system for a vehicle comprising a roof panel, at least two pods each having first and second sides, the pods being adapted to receive overhead components, the roof panel being attached to the first sides of the pods, a headliner extending across and being attached to the second sides of the pods, a plurality of overhead components being attached to

the pods, and wherein a substantial portion of the structural strength of the roof system is provided by the pods.

24. The structural roof system of Claim 25, wherein the pods are elongate and extend in the fore and aft direction with respect to the vehicle with which the roof system will be used.

25. A modular structural roof system for a vehicle comprising an exterior roof panel, a headliner spaced from the roof panel, a structural member located between the headliner and roof panel, the roof system including a plurality of overhead components and at least one belt-line-up component or system formed as part of the roof system.

26. The modular structural roof system of Claim 27, wherein the belt-line-up components are selected from the group consisting of pillars, windshields, wipers, package shelves, coweling, seals, occupant retention systems, side rails or cross-car rails.

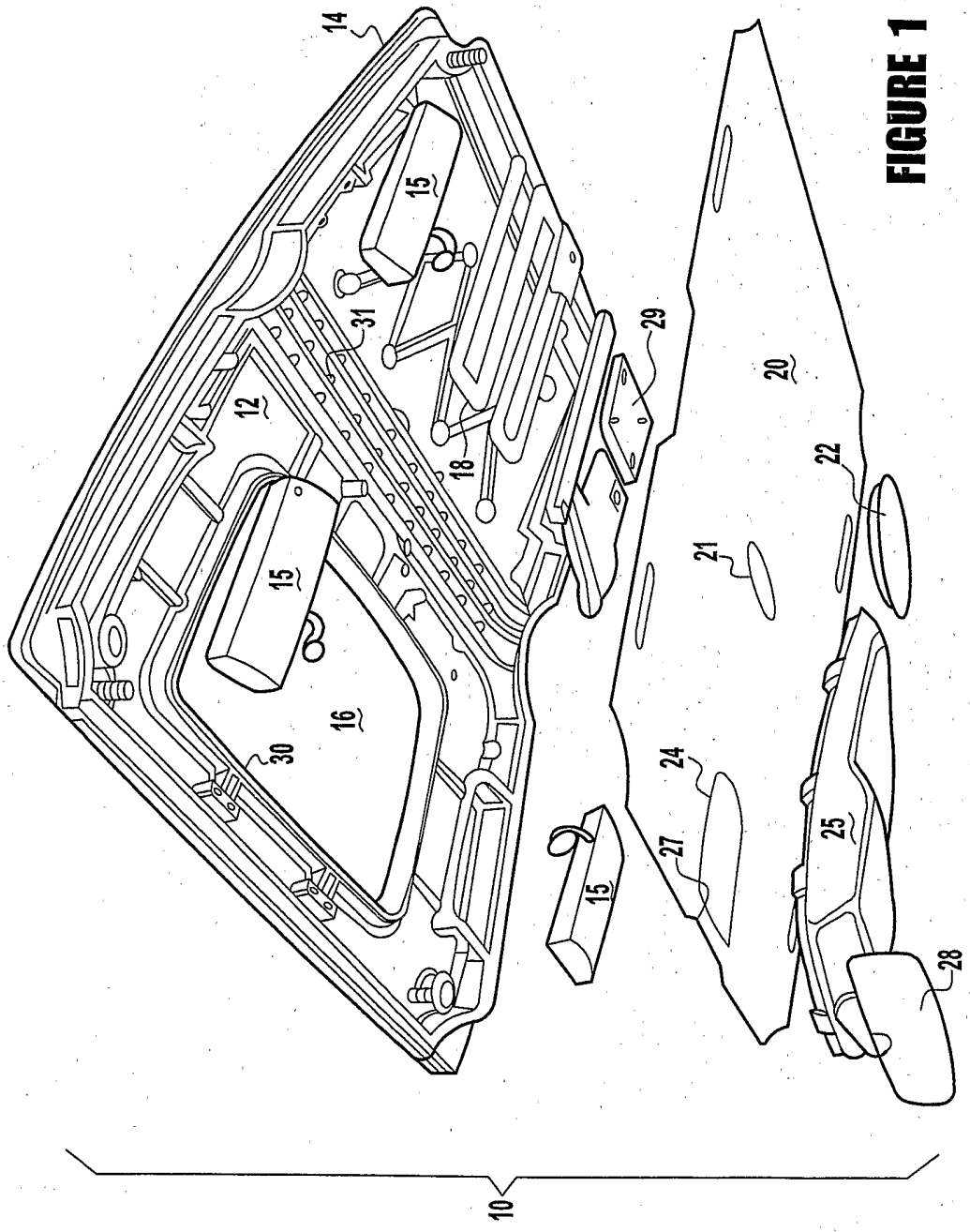


FIGURE 1

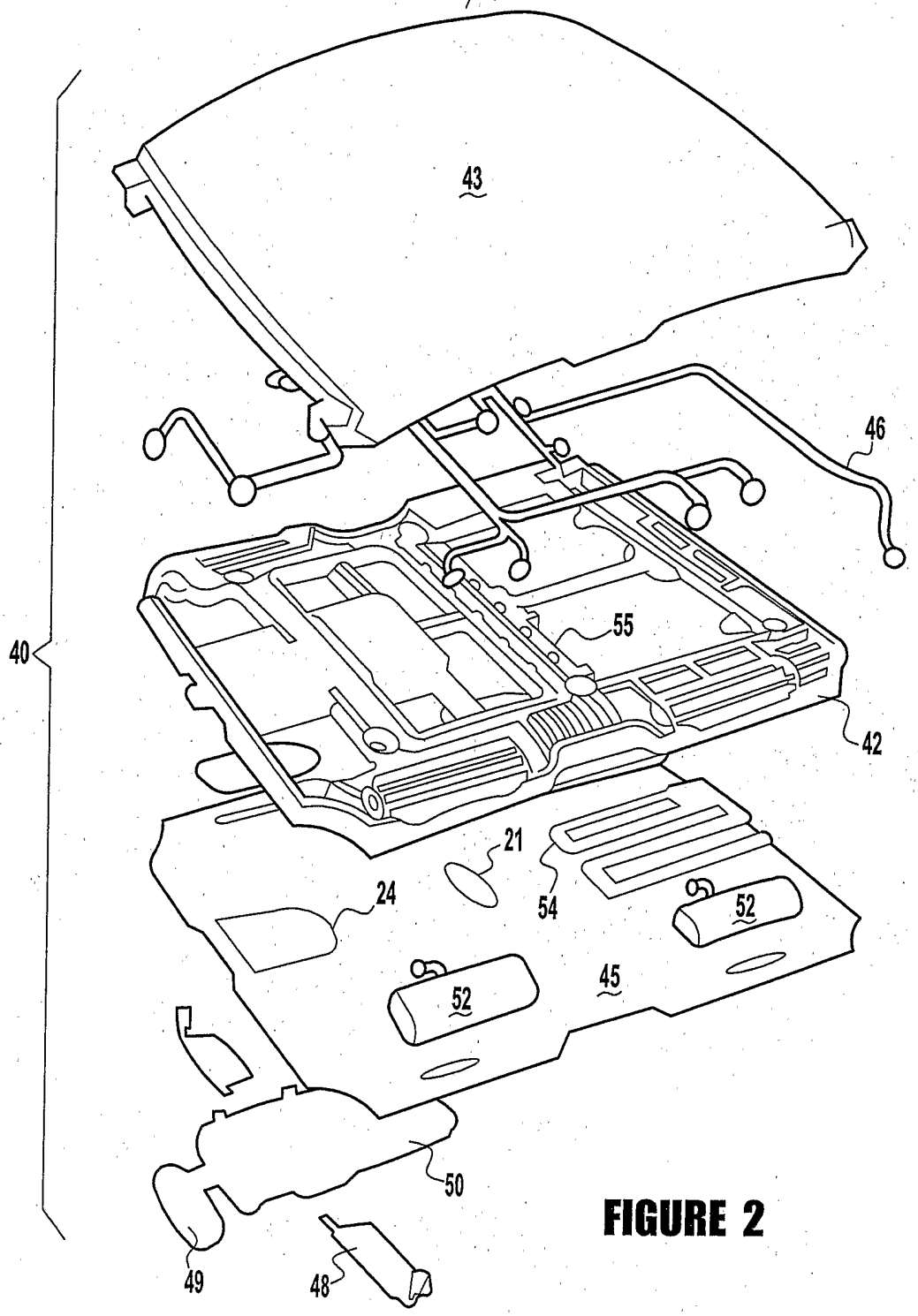


FIGURE 2

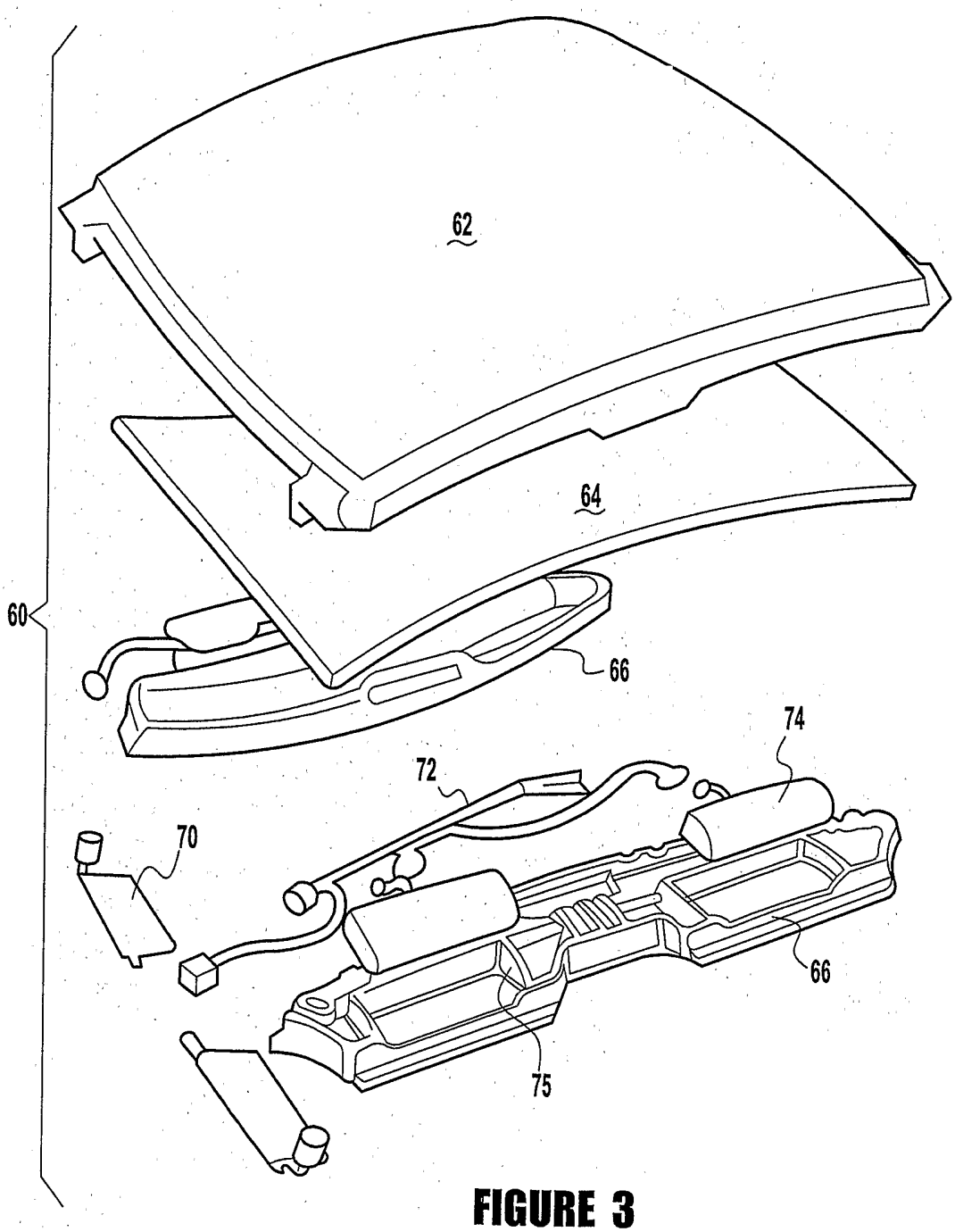


FIGURE 3

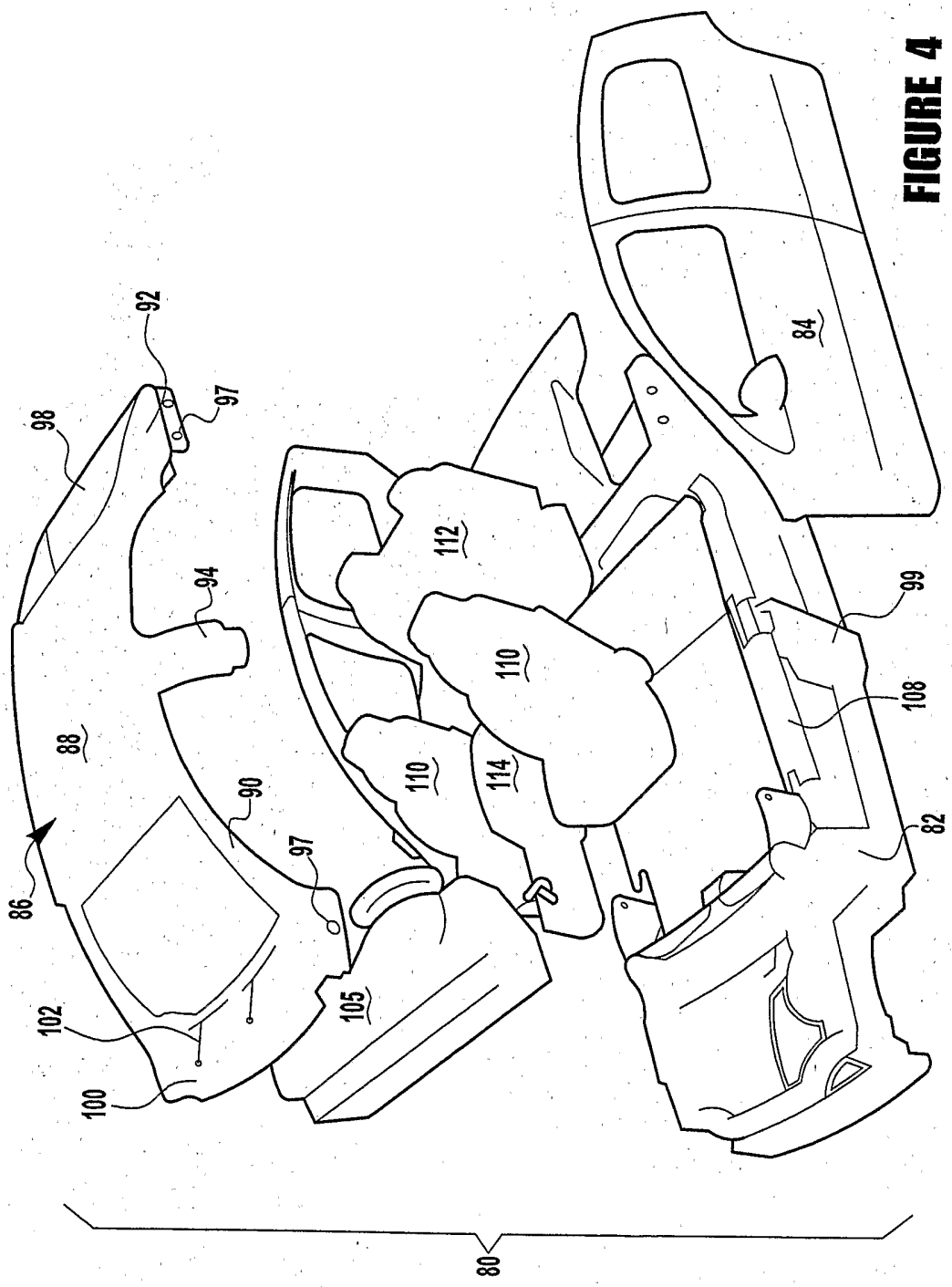


FIGURE 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/34700

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B62D25/06

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B62D B60R

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	DE 38 35 560 A (KAADEN HANS HEINRICH) 26 April 1990 (1990-04-26) column 1, line 56 - line 64 figures 1,2	1,3-12, 17,21,22 2,18 23
Y A	EP 1 138 536 A (WEBASTO VEHICLE SYS INT GMBH) 4 October 2001 (2001-10-04) column 2, line 13 - line 24	2,19,20 1,21,23, 25
Y A	US 3 427 068 A (KEAHN ALBERT G ET AL) 11 February 1969 (1969-02-11) cited in the application figure 1	18,25,26 1,19,21, 23

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 March 2004	29/03/2004

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/34700

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 38 20 845 A (WEBASTO AG FAHRZEUGTECHNIK) 28 December 1989 (1989-12-28)	19,20, 25,26
A	column 2, line 63 -column 3, line 19 figure 1	1,21,23
A	DE 34 20 781 A (STUEBBE GMBH MASCHF) 31 January 1985 (1985-01-31) page 12, line 14 - line 18	1,19,21, 23,25

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int[redacted]ional Application No
PCT/US 03/34700

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 3835560	A	26-04-1990	DE	3835560 A1	26-04-1990
EP 1138536	A	04-10-2001	DE	10015504 A1	11-10-2001
			EP	1138536 A2	04-10-2001
US 3427068	A	11-02-1969	BE	722908 A	01-04-1969
			DE	1804687 A1	22-05-1969
			FR	1590014 A	06-04-1970
			GB	1171258 A	19-11-1969
			SE	352040 B	18-12-1972
DE 3820845	A	28-12-1989	DE	3820845 A1	28-12-1989
			FR	2632908 A1	22-12-1989
			GB	2220392 A ,B	10-01-1990
			JP	2014921 A	18-01-1990
			SE	8901688 A	22-12-1989
DE 3420781	A	31-01-1985	DE	3420781 A1	31-01-1985
			AT	38807 T	15-12-1988
			DE	3566376 D1	29-12-1988
			WO	8505604 A1	19-12-1985
			EP	0214138 A1	18-03-1987
			JP	61502324 T	16-10-1986