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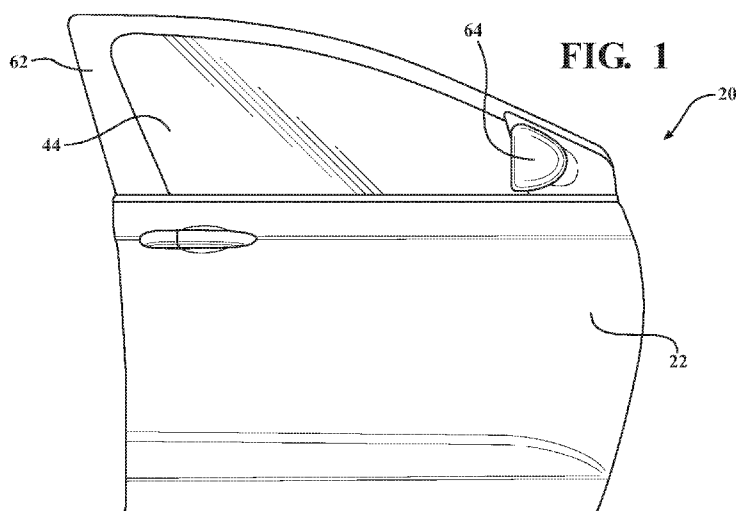
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(54) Title: VEHICLE DOOR ASSEMBLY



(57) Abstract: The vehicle door assembly includes an outer panel which has a rocker sill area and a beltline area. A reinforcement member, which is made of one or more pieces, is attached with the outer panel along at least a portion of an outer periphery of the outer panel. The door assembly further includes a module which is made as a single integral piece and is fixedly attached with the reinforcement member. The module has an inner beltline reinforcement and supports a pair of window channels and a window regulator for controllably raising and lowering a window between an open position and a closed position.

VEHICLE DOOR ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This PCT Patent Application claims the benefit of U.S. Provisional Patent Application Serial Number 62/195,818 filed on July 23, 2015 entitled “Vehicle Door Assembly,” the entire disclosure of the application being considered part of the disclosure of this application and hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention is related generally to vehicle doors.

2. Related Art

[0003] Typical door assemblies include a large number of structural components which are all formed separately and are connected with one another during final assembly of the vehicle. For example, a typical door assembly includes a side impact beam, an outer panel, an outer beltline reinforcement, an inner panel, an inner beltline reinforcement, a module, a window frame, a window regulator, a pane of glass, etc. In many cases, during final assembly of the vehicle, the outer and inner panels are connected with one another before painting. Then, after painting is completed, a module with a window regulator and a pair of window channels is inserted into a space between the inner and outer panels through an opening in the inner panel. A window pane is then lowered through a gap between the inner and outer beltline reinforcements into the window channels.

[0004] There is a continuing need for an improved door assembly which can be manufactured more efficiently, which requires less resources during final assembly of the vehicle and which has less mass than other known door assemblies.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0005] One aspect of the present invention is related to an improved door assembly for a vehicle. The door assembly includes an outer panel that has a rocker sill area, a beltline area and an styled outer surface. A reinforcement member, which is made of one or more pieces, is attached with the outer panel around at least a portion of an outer periphery of the outer panel. The door assembly further includes a module that is made as a single integral piece and is fixedly attached with the reinforcement member. The module has an inner beltline reinforcement and supports a pair of window channels and a window regulator for controllably raising and lowering a window between an open position and a closed position.

[0006] The module is configured such that it may be pre-assembled with door hardware, such as the window channels, the window regulator, and the window before the module is attached with the outer panel or the reinforcement member. Attaching the window with the module before to attaching the module with the outer panel and the reinforcement member allows for quicker, more efficient assembly of the vehicle by eliminating the step of inserting the window between an inner panel and an outer panel. Additionally, making the module as one piece reduces the total mass of the door assembly by eliminating the fasteners that typically connect the module with an inner panel.

[0007] According to another aspect of the present invention, the one-piece module further includes a window frame which extends through a closed shape around an opening for receiving the window when the window is in the closed position.

[0008] According to yet another aspect of the present invention, the one-piece module is made of a non-metallic material.

[0009] According to still another aspect of the present invention, the non-metallic material of the one-piece module is a carbon fiber reinforced polymer.

[0010] According to a further aspect of the present invention, the outer panel and the reinforcement member are both made of metal.

[0011] According to yet a further aspect of the present invention, a primary seal is attached with the module and extends through a closed loop for sealing the door assembly with a vehicle body.

[0012] According to still a further aspect of the present invention, at least one trim piece is joined with the module and at least partially covers a face of the module opposite of the outer panel.

[0013] According to another aspect of the present invention, the door assembly further includes a side impact beam which is attached with the reinforcement member.

[0014] According to yet another aspect of the present invention, the reinforcement member is attached with the outer panel along at least a portion of the outer periphery.

[0015] According to still another aspect of the present invention, the reinforcement member is made as one integral piece.

[0016] Another aspect of the present invention is related to a method of making a vehicle door. The method includes the step of preparing an outer panel and a reinforcement member that has an outer beltline reinforcement. The method proceeds with the step of fixedly attaching a pair of window channels and a window regulator with a one-piece module. The method continues with the step of inserting a window into the window channels and operatively connecting the window regulator with the window. The method proceeds with the step of fixedly attaching the module with the outer panel and the reinforcement member only after the window channels and the regulator have been fixedly attached with the module and only after the window has been inserted into the window channels and operatively connected with the window regulator.

[0017] According to another aspect of the present invention, the method further includes the step of stamping the outer panel from a single sheet of metal.

[0018] According to yet another aspect of the present invention, the method further includes the step of die casting the reinforcement member.

[0019] According to still another aspect of the present invention, the method further includes the step of compression molding the module out of a carbon fiber reinforced polymer.

[0020] According to a further aspect of the present invention, the method further includes the step of fixedly attaching the reinforcement member with the outer panel.

[0021] According to yet a further aspect of the present invention, the method further includes the step of fixedly attaching a side impact beam with the reinforcement member.

[0022] According to still a further aspect of the present invention, the method further includes the step of attaching a primary seal with the module for sealing the door assembly with a body of the vehicle.

[0023] According to another aspect of the present invention, the method further includes the step of fixedly attaching at least one trim piece with a face of the module opposite of the outer panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] These and other features and advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0025] Figure 1 is a front elevation view of an exemplary embodiment of a door assembly;

[0026] Figure 2 is a back elevation view of the door assembly of Figure 1;

[0027] Figure 3 is a back elevation view of the door assembly of Figure 1 with a trim piece removed.

[0028] Figure 4 is a perspective view of an outer panel and a door ring and a side impact beam of the door assembly of Figure 1;

[0029] Figure 5 is a front elevation view of a module of the door assembly of Figure 1;

[0030] Figure 6 is a back elevation view of the module of Figure 5;

[0031] Figure 7 is a back elevation view of the module of Figure 5 pre-assembled with door hardware and a window; and

[0032] Figure 8 is an alternate embodiment of the door ring.

DETAILED DESCRIPTION OF THE ENABLING EMBODIMENT

[0033] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, an exemplary embodiment of an improved vehicle door assembly **20** is generally shown in Figures 1-3. In the exemplary embodiment, the door assembly **20** is a front, passenger door of a car. However, it should be appreciated that the door assembly **20** may be configured for either side and for either the front or the back of the vehicle. The door assembly **20** may also be configured for use in any suitable type of vehicle including, for example, a pickup truck, a sport utility vehicle, etc.

[0034] Referring now to Figure 4, the door assembly **20** includes a generally rectangularly shaped outer panel **22** with a painted outer styled surface (shown in Figure 1) and a reinforcement member or inner panel (hereinafter referred to as a “door ring **24**”) which is attached with an inner surface of the outer panel **22** to structurally reinforce the outer panel **22**. The outer panel **22** is preferably stamped to its final or near-final shape from a single sheet of aluminum or an aluminum alloy. However, any suitable material may be employed including, for example, magnesium, a magnesium alloy, steel or an alloy steel.

The outer panel **22** extends in a vertical direction from a beltline area to a lower sill area and in a longitudinal (forward/backward) direction from a front to a back.

[0035] The door ring **24** is made as one or more pieces and has a generally rectangularly shaped outer periphery that generally matches an outer periphery of the outer panel **22** but further includes a sideview mirror mount **26**. In this embodiment, the door ring **24** is made as multiple pieces which are individually stamped to their respective shapes and are then joined together. The door ring **24** and outer panel **22** are attached with one another along at least a portion of their respective outer peripheries. The exemplary embodiment of the door ring **24** has an outer beltline reinforcement **28**, a pair of side portions **30** and a lower portion **32** which surround an opening. One of the side portions **30** includes a pair of generally flat hinge mounts **34** for receiving door hinges (not shown). The door ring **24** may be attached with the outer panel **22** through any suitable attachment means or combination of attachment means including, for example, mechanical fasteners (such as rivets or bolts), welding, brazing, material deformation, a single shear joint, a double shear joint, coach joints, resistance spot welding, gas metal arc welding, gas tungsten arc welding, laser welding, etc. For example, in the exemplary embodiment, the side portions **30** and the outer beltline reinforcement **28** are attached with the outer panel **22** via a plurality of fasteners (such as rivets or bolts), and the outer panel **22** is deformed to wrap around an area of the lower portion **32** of the door ring **24**. The door ring **24** is preferably made of aluminum or an aluminum alloy. However, any suitable material may be employed.

[0036] A side impact beam **36** is attached with and extends between the side portions **30** of the door ring **24** for strengthening the door assembly **20** to resist deformation and collapse in the event of a side impact collision. The side impact beam **36** is preferably made of steel or a steel alloy but any suitable material may be employed. The side impact

beam **36** may have any suitable shape or configuration for reinforcing the outer panel **22** and the door ring **24**.

[0037] Referring now to Figures 3, 5 and 6, the door assembly **20** further includes an inner carrier (hereinafter referred to as a module **38**) which is fixedly attached with the door ring **24** via a plurality of fasteners, such as rivets or bolts. The module **38** is made as one integral piece of material and presents a door portion **40** and a generally triangularly shaped window frame **42**. The door portion **40** of the module **38** substantially covers the opening of the door ring **24**, and the window frame **42** extends vertically upwardly from a top end of the door portion **40**. The window frame **42** has an opening for supporting a pane of glass, or a window **44** (shown in Figures 1 and 2) when the window **44** is in a closed position. In the exemplary embodiment, a portion of the window frame **42** is provided with a lattice-shaped structure of ribs for strengthening the window frame **42**.

[0038] A primary seal **46** is attached with the module **38** for establishing a fluid tight seal between the door assembly **20** and a body (not shown) of the vehicle. In the exemplary embodiment, the primary seal **46** extends through a closed shape around both the door portion **40** and the window frame **42**, but it should be appreciated that the primary seal **46** could take any suitable shape depending on the geometry of the door assembly **20**. The primary seal **46** is preferably attached with the module **38** via a plurality of fasteners that are spaced from one another along the primary seal **46**. The primary seal **46** is preferably made of an elastic material, such as rubber, but any suitable material may be employed.

[0039] The module **38** supports much of the door hardware including, inter alia, switches (not shown); sensors (not shown); a speaker **48**; an inner handle mechanism **50**; a window regulator **52**; a pair of window channels **54**; weather stripping (not shown) for sealing the module **38** with the window **44**; one or more trim pieces **56**; and one or more wiring harnesses (not shown). The speaker **48** is disposed in a speaker opening **58** on the

module **38**. The window regulator **52** includes an electric motor and a pulley system which is configured to controllably raise the window **44** to a closed position and lower the window **44** to an open position. The window channels **54** are disposed in spaced and parallel relationship with one another and function to support and guide this movement between the open and closed positions. When it is in the open position, the window **44** is disposed in a gap between the door ring **24** and the module **38**. The door hardware may be fixedly attached with the module **38** through any suitable means or combination of means including, for example, fasteners, adhesives, brazing, material deformation, etc.

[0040] The module **38** is made as one integral piece of a single, lightweight material and also includes an inner beltline reinforcement **60** which is aligned with the outer beltline reinforcement **28** of the door ring **24**. In the exemplary embodiment, the inner beltline reinforcement **60** includes a plurality of ribs that extend along a portion of the length of the module **38** for strengthening the module **38** adjacent to the window frame **42**. Preferably, the module **38** is made of a carbon fiber reinforced polymer (CFRP) material which is shaped to its final or near final shape through a compression molding operation. CFRP has been found to provide exceptional strength and mass savings advantages. However, other lightweight materials, such as magnesium or a magnesium alloy, may be employed.

[0041] The unique construction of the module **38** allows it to be pre-assembled with the door hardware and with the window **44** before the module **38** is attached the door ring **24**. The module **38** with the pre-attached hardware may then be joined with the door ring **24** and the outer panel **22** after the outer panel **22** has gone through painting with the remainder of the vehicle's exterior surface. This provides for manufacturing cost savings by eliminating the common step of inserting the window between inner and outer door panels as is typically required during final assembly of the vehicle. Additionally, a door manufacturer may pre-assembly the module **38** with at least some of the door hardware

before sending the module **38** to a final assembly plant for the vehicle, thereby saving valuable space and resources in the final assembly plant and allowing an assembly line for the vehicle to operate more quickly by reducing the time required to assemble each vehicle. The inner trim pieces **56** and one or more outer trim pieces **62** and a sideview mirror **64** may also be added to the module **38** either before or after the module **38** is fixedly attached with the outer panel **22** and the door ring **24**.

[0042] An alternate embodiment of the door ring **124** is generally shown in Figure 8 with like numerals, separated by a prefix of “1”, indicating corresponding parts with the embodiment described above. The door ring **124** of this embodiment is differentiated from the above-described embodiments because it is constructed as one integral piece which is shaped to final or near final form through die casting.

[0043] Another aspect of the present invention is a method of making a vehicle. The method includes the step of stamping an outer panel **22** from a single sheet of material, such as aluminum. The method proceeds with the step of die casting a door ring **24** with an outer beltline reinforcement **28** with a metal, such as aluminum. The method continues with the step of fixedly attaching the door ring **24** to the outer panel **22**. The method proceeds with the step of attaching the outer panel **22** and the door ring **24** with a portion of a vehicle. The method continues with the step of painting the vehicle including an outer surface of the outer panel **22**. The method proceeds with the step of compression molding a one-piece module **38** out of a CFRP. The method continues with the step of fixedly attaching a pair of window channels **54** and a window regulator **52** with the one-piece module **38**. The method proceeds with the step of inserting a window **44** into the window channels **54** and operatively connecting the window regulator **52** with the window **44**. The method continues with the step of fixedly attaching the one-piece module **38** with the outer panel **22** and the door ring **24** only after the window channels **54** and window regulator **52** have been fixedly

attached with the module **38** and only after the window **44** has been inserted into the window channels **54** and is operatively connected with the window regulator **52**.

[0044] Obviously, many modifications and variations of the present invention are possible in light of the above teachings and may be practiced otherwise than as specifically described while within the scope of the appended claims.

CLAIMS

What is claimed is:

Claim 1. A door assembly for a vehicle, comprising:

an outer panel having a rocker sill area and a beltline area and a front and a rear and a styled surface;

a reinforcement member made as at least one piece and being attached with said outer panel around at least a portion of an outer periphery of said outer panel;

a module made as a single integral piece and fixedly attached with said reinforcement member; and

said module including an inner beltline reinforcement and supporting a pair of window channels and a window regulator for controllably raising and lowering a window between an open position and a closed position.

Claim 2. The door assembly as set forth in claim 1 wherein said one-piece module further includes a window frame which extends through a closed shape around an opening for receiving the plane of glass when the plane of glass is in a window up position.

Claim 3. The door assembly as set forth in claim 2 wherein said one-piece module is made of a non-metallic material.

Claim 4. The door assembly as set forth in claim 3 wherein said non-metallic material of said one-piece module is a carbon fiber reinforced polymer.

Claim 5. The door assembly as set forth in claim 2 wherein said outer panel and said reinforcement member are each made of metal.

Claim 6. The door assembly as set forth in claim 2 further including a primary seal attached with said module and extending through a closed loop for sealing said door assembly against a body of the vehicle.

Claim 7. The door assembly as set forth in claim 2 further including at least one trim piece joined with said module and at least partially covering a face of said module opposite of said outer panel.

Claim 8. The door assembly as set forth in claim 2 further including a side impact beam attached with said reinforcement member.

Claim 9. The door assembly as set forth in claim 2 wherein said reinforcement member is attached with said outer panel along at least a portion of said outer periphery.

Claim 10. The door assembly as set forth in claim 2 wherein said reinforcement member is made as one integral piece.

Claim 11. A method of making a vehicle door for a vehicle, comprising the steps of:

preparing an outer panel and a reinforcement member which includes an outer beltline reinforcement;

fixedly attaching a pair of window channels and a window regulator with a one-piece module;

inserting a window into the window channels and operatively connecting the window regulator with the window; and

fixedly attaching the module with the outer panel and the reinforcement member only after window channels and regulator have been fixedly attached with the module and only after the window has been inserted into the window channels and has been operatively connected with the window regulator.

Claim 12. The method as set forth in claim 11 wherein the one-piece module includes a window frame.

Claim 13. The method as set forth in claim 12 wherein the one-piece module is made of a non-metallic material.

Claim 14. The method as set forth in claim 13 wherein the non-metallic material of the one-piece module is a carbon fiber reinforced polymer.

Claim 15. The method as set forth in claim 14 further including the step of compression molding the one-piece module.

Claim 16. The method as set forth in claim 12 further including the step of stamping the outer panel from a single sheet of metal.

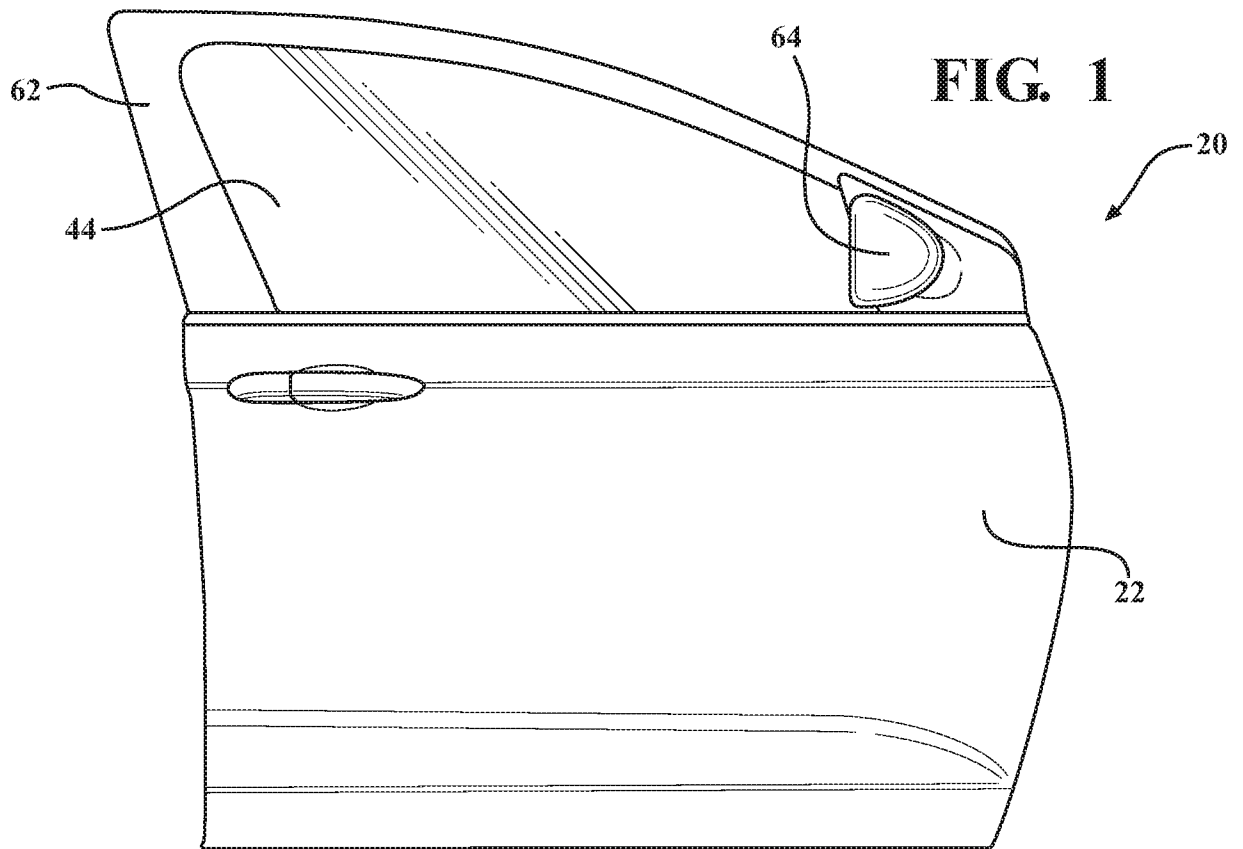
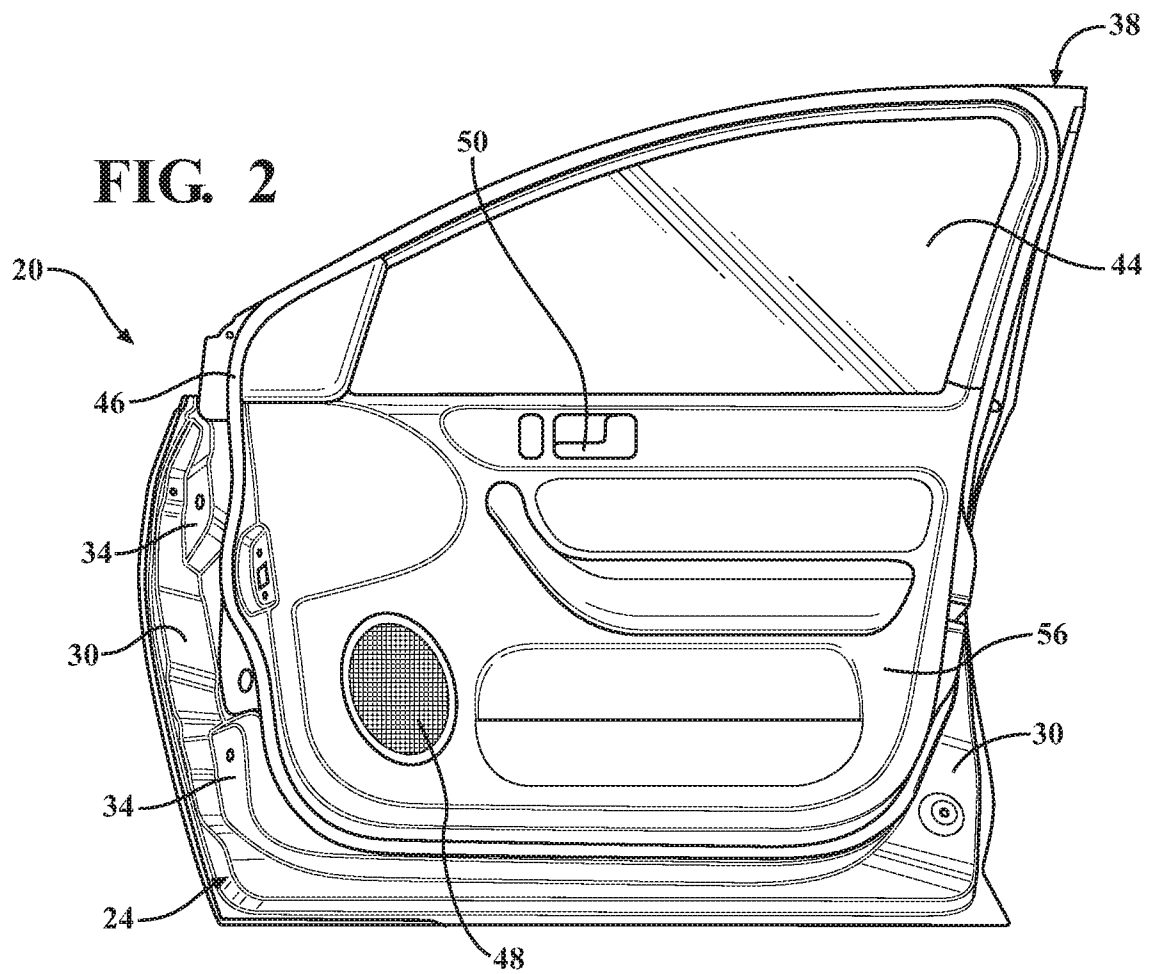
Claim 17. The method as set forth in claim 16 further including the step of die casting the reinforcement member.

Claim 18. The method as set forth in claim 17 further including the step of fixedly attaching the reinforcement member with the outer panel.

Claim 19. The method as set forth in claim 17 further including the step of fixedly attaching a side impact beam with the reinforcement member.

Claim 20. The method as set forth in claim 18 further including the step of attaching a primary seal with the module for sealing the door assembly with a body of the vehicle.

Claim 21. The method as set forth in claim 18 further including the step of fixedly attaching at least one trim piece with a face of the module opposite of the outer panel.



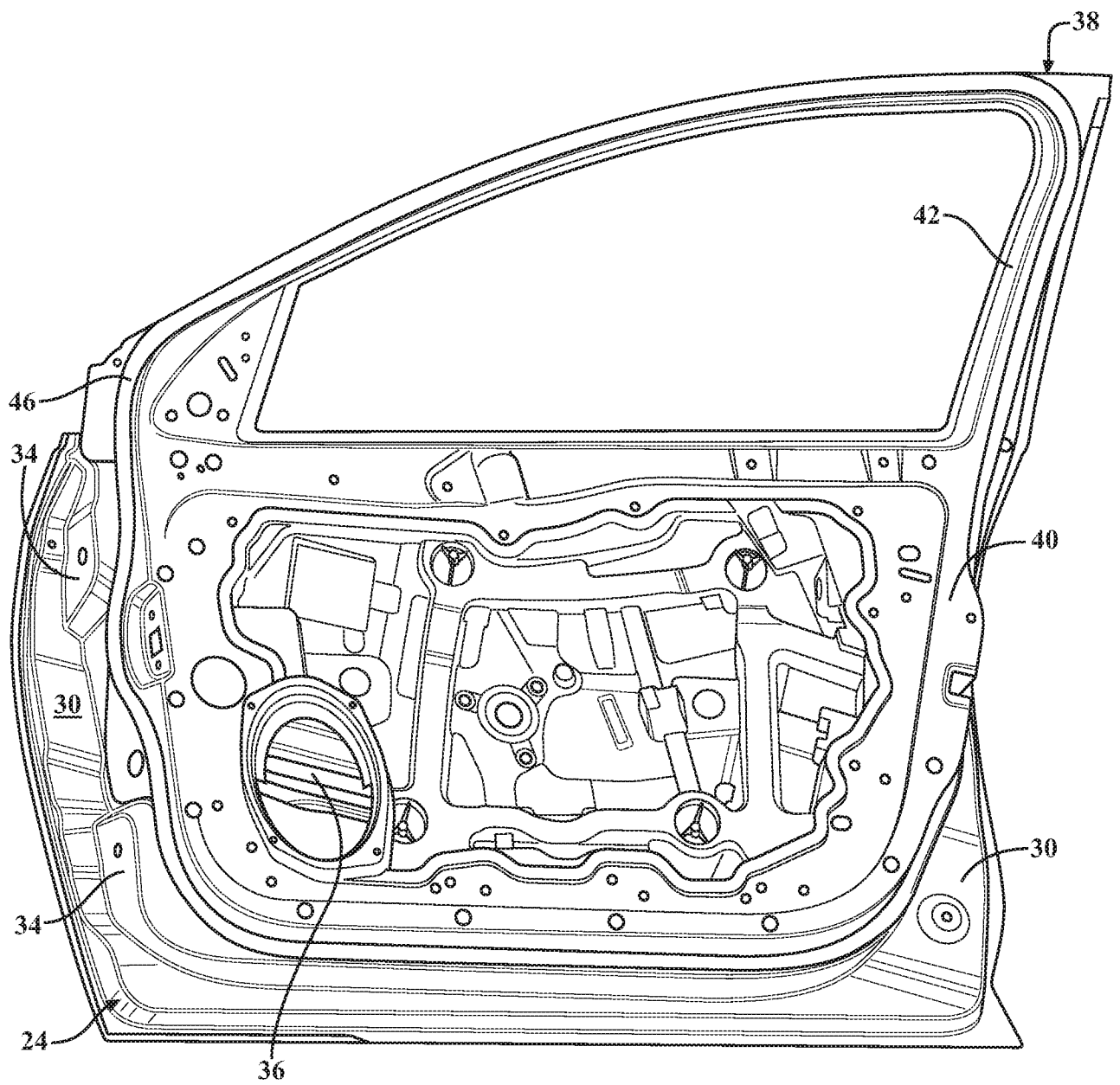


FIG. 3

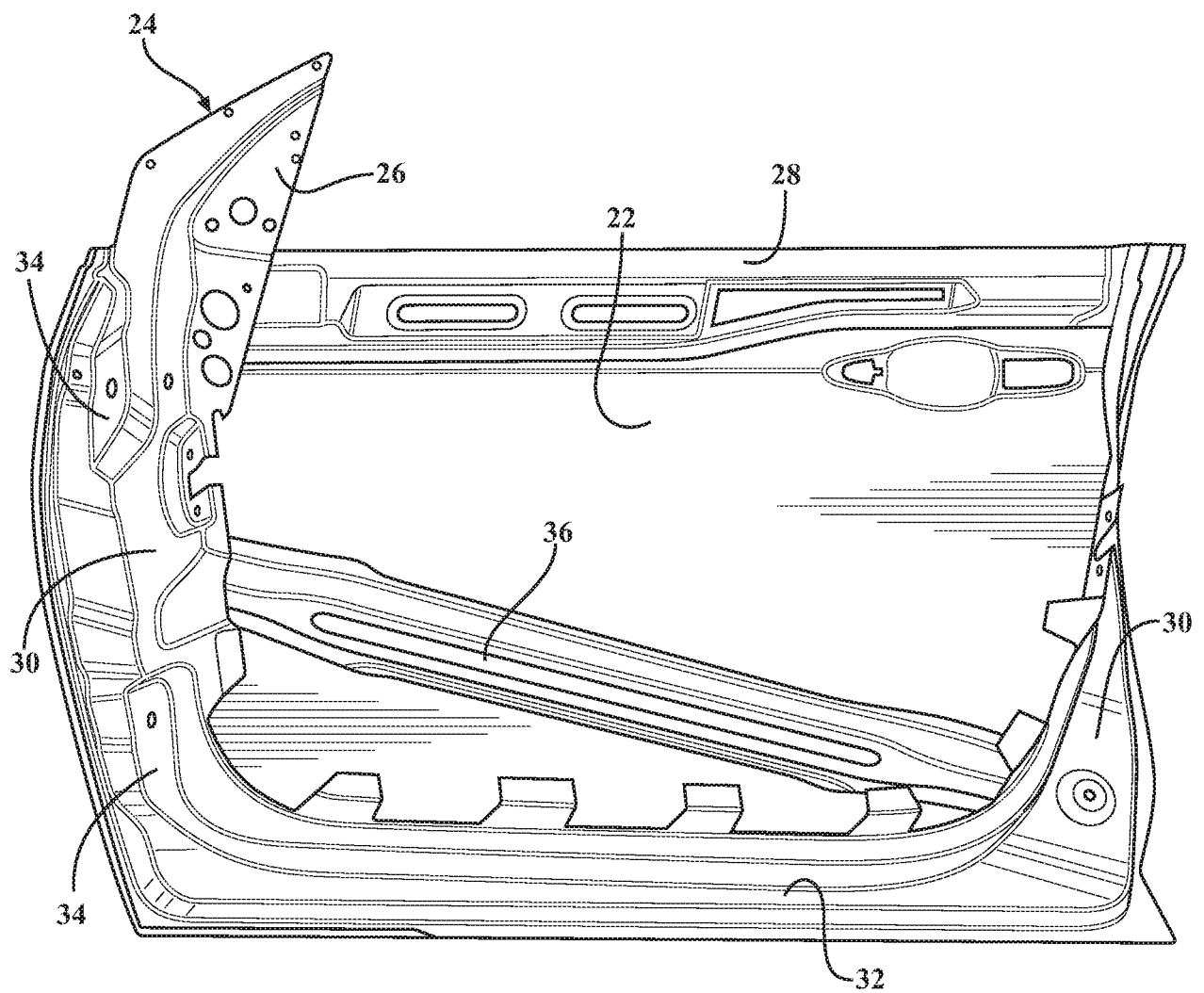


FIG. 4

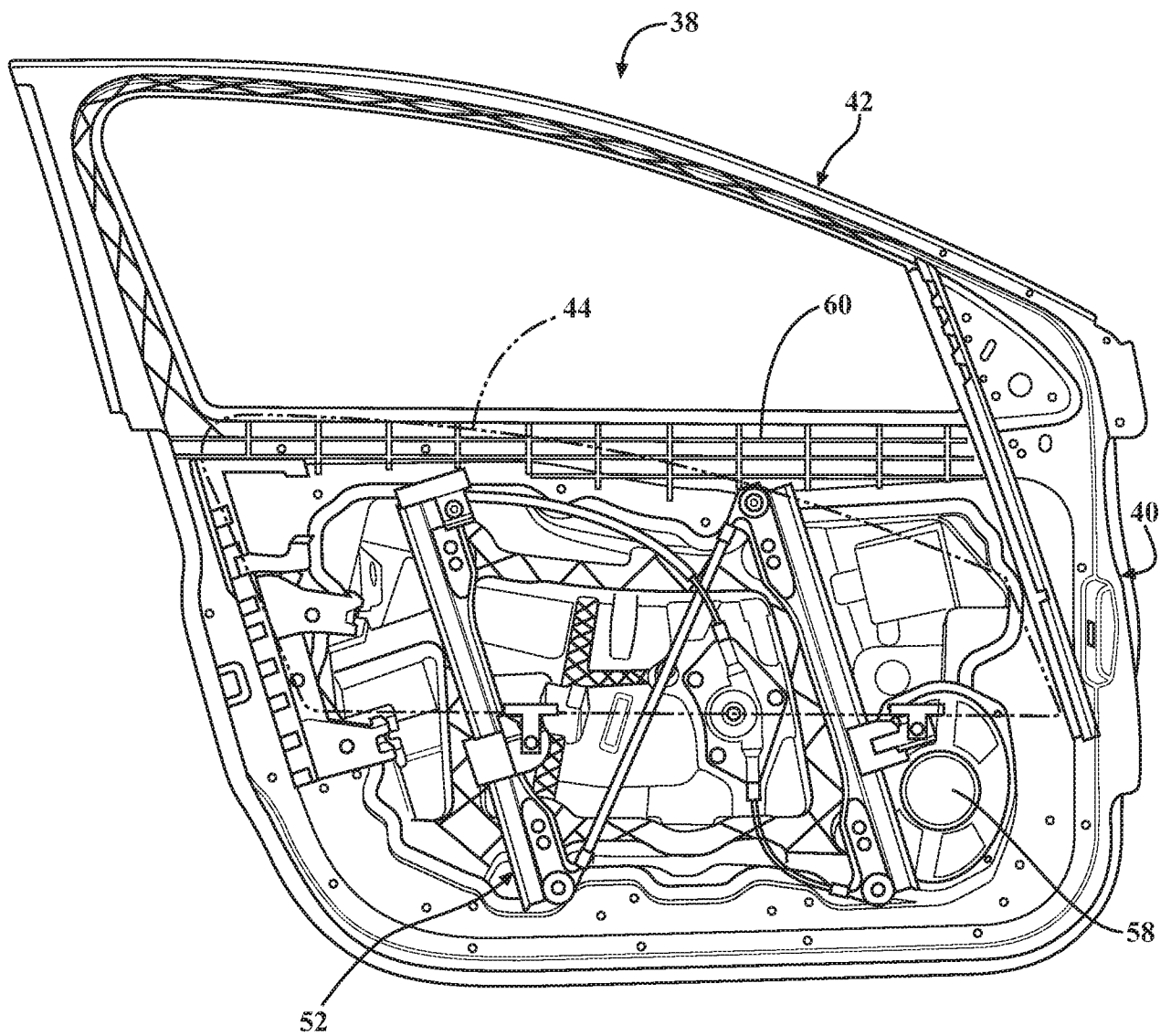


FIG. 5

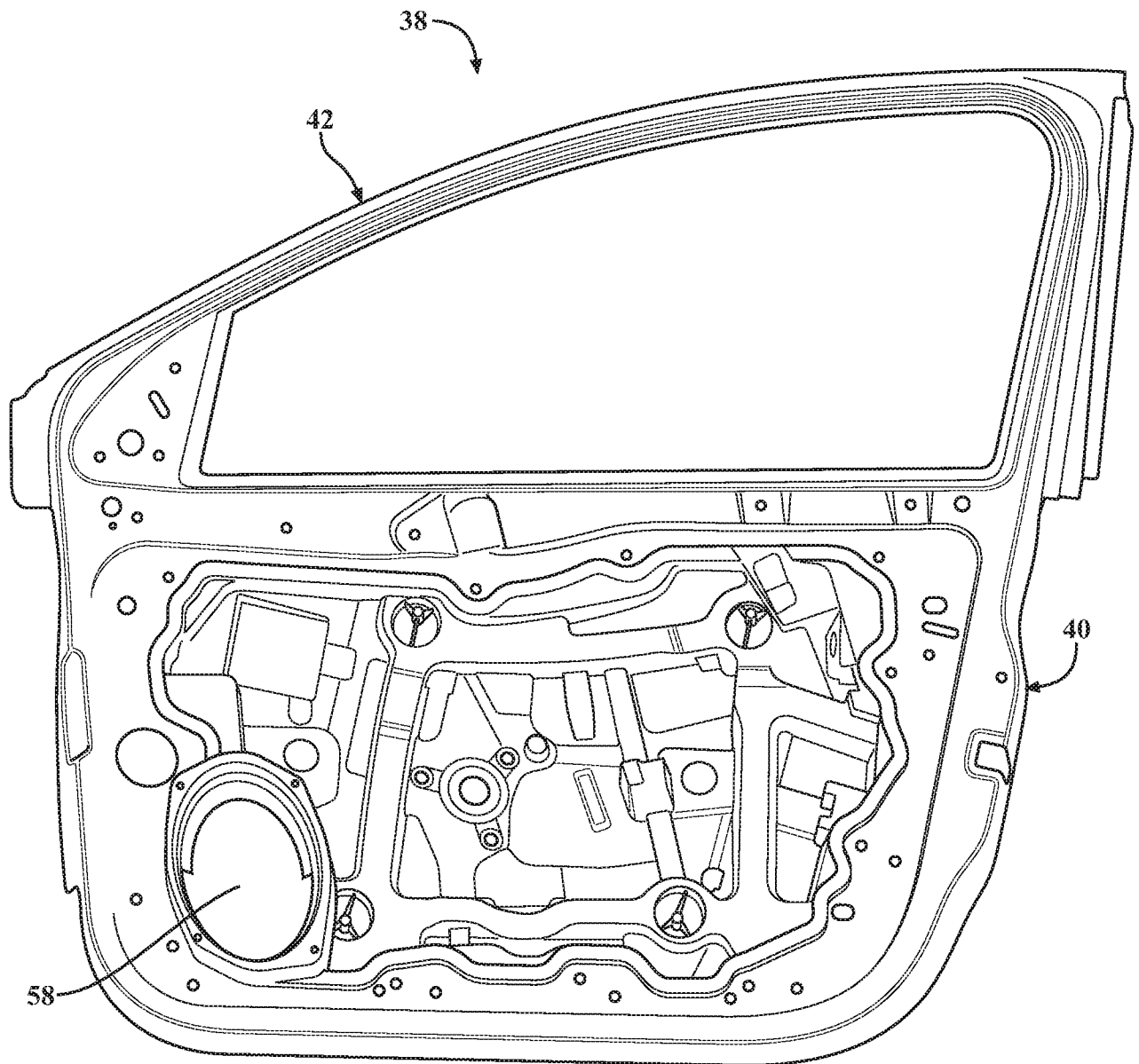
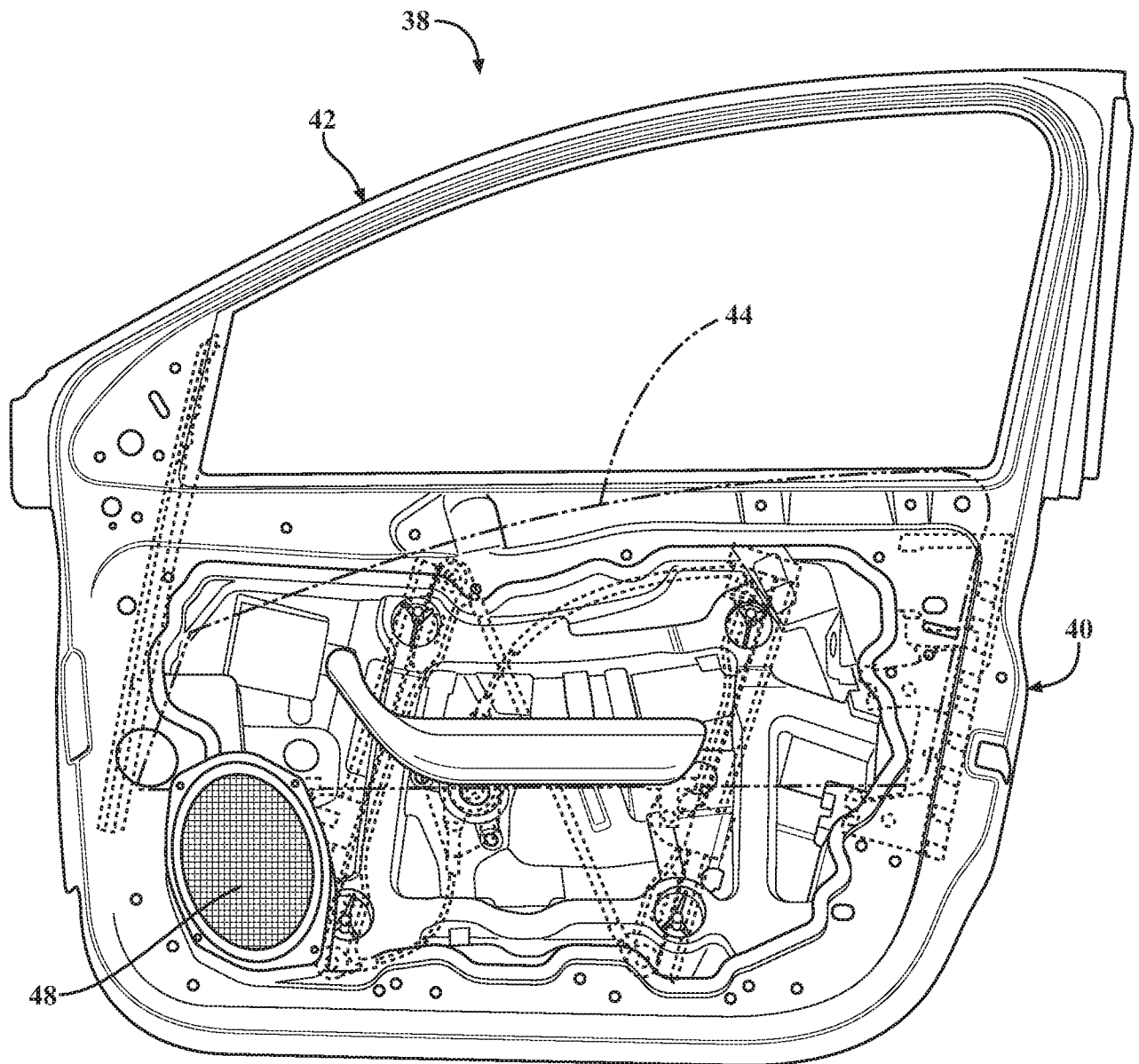
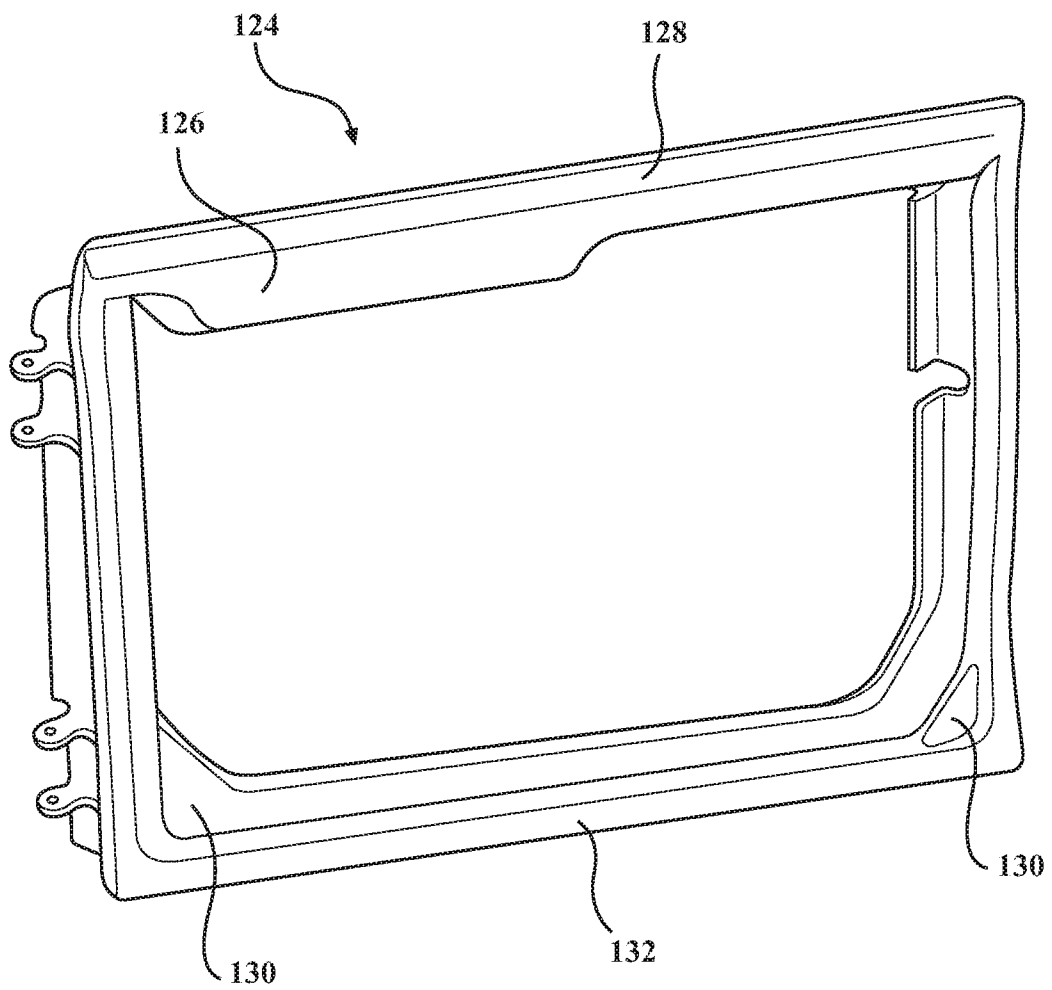


FIG. 6

**FIG. 7**

**FIG. 8**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/43705

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B60J 5/04 (2016.01)

CPC - B60J 5/00, B60J 5/0412

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 (8): B60J 5/04 (2016.01)

CPC: B60J 5/00, B60J 5/0412

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC (8): B60J5/00, E06B3/00, B62D65/00, B62D 65/06, B60R 13/02 (2016.01)

CPC: B60J 5/0401, B60J5/0402, B60J 5/0406, B60J 5/0411, B60J 5/0413, B60J 5/0415, B60J 5/0416, --- See Extra Sheet ---

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase; Google Web; Google Patents

Search Terms Used: Search Terms Used Door, assembly, construct*, fabricat*, join*, manufact*, outer, exterior, out*, external, outdoor, peripheral, panel, surface, module, carrier, plate, member, component*, hardware, window, regulator, beltline, belt line

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,800,638 A (Herringshaw et al.) 31 January 1989 (31.01.1989), entire document, especially fig. 1-4, 6-7; col. 4, ln 5-20, ln 25-29; col. 8, ln 29-41; col. 9, ln 16-58; claim 1, claim 4	1-2, 5-12, 16
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Y		17-21
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A		3-4, 13-15
Y	US 7,581,779 B2 (Baumgart et al.) 01 September 2009 (01.09.2009), entire document, especially col. 3, ln 52-56	17-21
A	US 6,536,164 B1 (Kirejczyk) 25 March 2003 (25.03.2003), entire document, especially col. 3, ln 46-53	3-4, 13-15
A	US 2001/0038228 A1 (Morrison et al.) 08 November 2001 (08.11.2001), entire document	1-21
A	US 5,857,732 A (Ritchie) 12 January 1999 (12.01.1999), entire document	1-21
A	US 5,906,072 A (Feige et al.) 25 May 1999 (25.05.1999), entire document	1-21
A	US 6,176,542 B1 (Gooding et al.) 23 January 2001 (23.01.2001), entire document	1-21
A	US 6,449,907 B2 (Nishikawa et al.) 17 September 2002 (17.09.2002), entire document	1-21

☐ Further documents are listed in the continuation of Box C.

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

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Date of the actual completion of the international search

27 September 2016

Date of mailing of the international search report

21 OCT 2016

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Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/43705

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

CPC (cont.): B60J 5/042, B60J 5/0427, B60J 5/0463, B60J 5/0465, B60J 5/0466, B60J 5/0481, B60J 5/0468, B60R 13/043, B60R13/06, B60R13/0243, B60R 2013/0293, B62D 65/00, B62D 65/06 (keyword limited; terms below)