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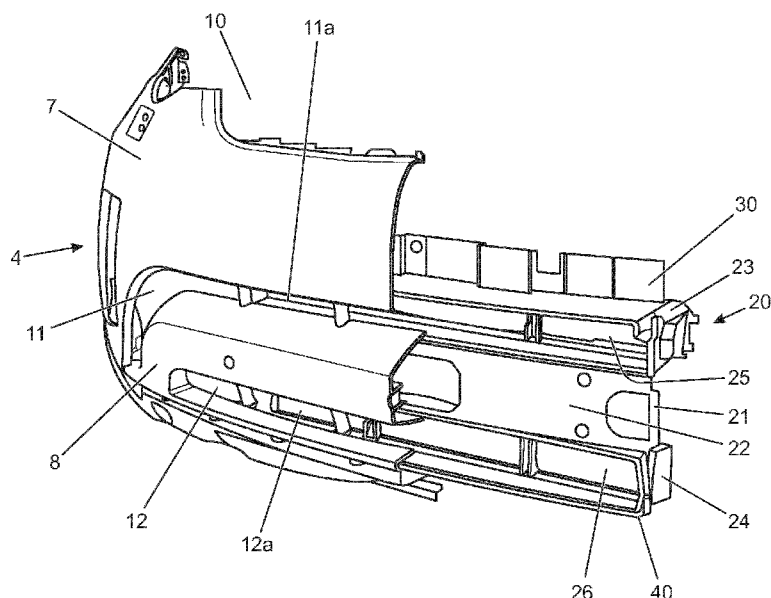


Figure 2

(57) Abstract: An air flow system for a vehicle comprising a housing adapted to be mounted to a bumper beam of a vehicle, the housing comprising at least one duct portion configured so as to be disposed adjacent to an upper or lower surface of the bumper beam when mounted thereto; the at least one duct portion comprising an inlet and an outlet defining a passage therebetween for conveying air in a direction substantially parallel to said upper or lower surface.

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AIR FLOW SYSTEM FOR ENGINE COOLING

TECHNICAL FIELD

- 5 The present disclosure relates to an air flow system for engine cooling. Aspects of the invention relate to an air flow system, to a vehicle comprising an air flow system, to a method of assembling a plurality of air flow systems, and to a method of designing a plurality of air flow systems.

10 BACKGROUND

- A vehicle engine may be cooled using air that is allowed to enter the engine compartment via one or more openings in a panel assembly, for example a bumper or other leading edge assembly. In order to improve cooling efficiency and reduce the aerodynamic drag caused by the openings, and in some cases in order to meet regulatory requirements, it is often necessary or at least desirable to direct air from an opening in a panel assembly towards the radiator via a passage that is sealed with respect to the opening. However, the need to provide a seal between a passage for directing air towards a radiator and a panel assembly places additional design constraints on the air delivery system. In addition, it may from time to time become necessary to replace the seal between the passage and the panel assembly, which may require replacement of the entire component that provides the passage.

- It is an aim of the present invention to address disadvantages associated with the prior art.

SUMMARY OF THE INVENTION

- According to an aspect of the present invention there is provided an air flow system for a vehicle. The air flow system comprises a housing adapted to be mounted to a bumper beam of a vehicle. The housing comprises at least one duct portion configured so as to be disposed adjacent to an upper or lower surface of the bumper beam when mounted thereto. The at least one duct portion comprises an inlet and an outlet

defining a passage therebetween for conveying air in a direction substantially parallel to said upper or lower surface.

Embodiments of the invention therefore provide a compact, space efficient,
5 arrangement of an airflow system for a vehicle, in which the main body of the airflow system (i.e. the housing) is mounted to the bumper beam of the vehicle such that the duct portion/s thereof are positioned above and/or below the bumper beam. Advantageously, this arrangement may reduce the space within the engine compartment occupied by the housing of the airflow system and/or reduce the space
10 occupied by the housing of the airflow system between the bumper beam and a vehicle panel assembly disposed upstream of the duct portion/s.

The at least one duct portion may be configured so as to be adjacent to the upper surface of the bumper beam.

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The at least one duct portion may be configured so as to be adjacent to the lower surface of the bumper beam.

The air flow system may comprise first and second duct portions configured so as to
20 be adjacent to upper and lower surfaces of the bumper beam, respectively. Having two duct portions positioned so as to sandwich the bumper beam from the top and bottom allows greater air cooling to be delivered to components of the engine, or any other components requiring cooling.

25 The or each duct portion may be configured to receive an adapter for conveying air from an opening in a vehicle panel assembly to the inlet thereof. The use of adapters formed separately from the housing enables bespoke adapters to be used with standardised housing parts which may be used across vehicle lines.

30 The housing may comprise a body portion configured to be mounted to a front face of the bumper beam.

The inlet of the or each duct portion may be elongate in a direction substantially parallel to the length of the bumper beam.

The outlet of the or each duct portion may have a cross-sectional area substantially equal to that of the inlet.

- 5 The housing may be provided with at least one valve element that is selectively movable between an open position in which air flow through the passage is permitted and a closed position in which air flow through the passage is restricted.

10 The at least one valve element may be provided adjacent to the inlet of the at least one duct portion. In this way, the at least one valve element may be provided in the portion of the housing that is positioned furthest forward in the vehicle, thereby reducing drag at the front of the vehicle when the valve element is closed when compared to a system in which the valve elements are provided further towards the rear of the vehicle.

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The air flow system may comprise an adapter configured to couple to the inlet of the at least one duct portion of the housing and extend outwardly from the housing for conveying air from an opening in a vehicle panel assembly to the inlet.

- 20 According to another aspect, there is provided a vehicle comprising an air flow system as described in the preceding paragraphs.

25 The vehicle may comprise a bumper beam to which the housing of the air flow system is mounted. In embodiments, the bumper beam is provided as a forward structural beam positioned towards the front of the vehicle.

The inlet of the at least one duct portion may be substantially flush with a front surface of the bumper beam.

- 30 The or each duct portion of the housing may extend substantially across a width of the bumper beam in a direction towards the rear of the vehicle.

The vehicle may comprise a vehicle panel assembly. The vehicle panel assembly may comprise at least one opening therein, and the adapter may be arranged to convey air from the opening of the vehicle panel assembly to the inlet.

- 5 The adapter may sealingly engage an inside surface of the vehicle panel assembly around the periphery of the opening.

The housing may comprise first and second duct portions that are adjacent to upper and lower surfaces of the bumper beam, respectively.

10

The vehicle may comprise a cooling apparatus disposed rearwards and adjacent to outlets of the or each duct portion of the air flow system.

- 15 According to an aspect of the present invention there is provided an adapter for an air flow system comprising a housing defining a passage for directing air from an opening in a vehicle panel assembly towards an engine of an automotive vehicle. The adapter may be formed separately to the housing, may be configured to extend outwardly from the housing, and may be configured to provide a seal between the housing and the vehicle panel assembly.

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- By providing a separate adapter for providing a seal with the vehicle panel assembly the invention allows the design of the housing to be simplified, and allows the seal between the housing and the vehicle panel assembly to be replaced if necessary without replacing the entire housing. In addition, the use of a separate adapter allows a common design of housing to be used in combination with a plurality of different vehicle panel assembly designs. It is therefore possible to use the same housing component across a plurality of vehicle models having different panel assembly designs, for example different variations (including updates) of the same vehicle line and/or vehicles from entirely different lines.

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It will be appreciated that the term panel assembly refers to an assembly comprising one or more external bodywork panels of or for a vehicle, and that the or each panel of the panel assembly may be formed either as a single integrally formed part or as an assembly of parts, for example including an inner skin and an outer skin. It will further

be appreciated that the housing may be formed either as a single integrally formed part or as an assembly of parts. It will further be appreciated that the phrase “towards an engine” may mean towards a radiator of an engine, whether or not the radiator is mounted directly to the engine.

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The adapter may be configured to at least substantially seal the passage with respect to the vehicle panel assembly around the opening or a portion of the opening.

10 A distal edge of the adapter (that is the edge furthest from the housing) may have a profile that at least substantially matches the shape of the vehicle panel assembly. In particular, the distal edge of the adapter may have a profile that at least substantially matches the shape of an inside surface of the vehicle panel assembly around the opening or the portion of the opening. The distal edge of the housing may be configured to form a seal with the vehicle panel assembly extending continuously
15 around the opening or the portion of the opening.

The adapter may have a shape that substantially corresponds to the shape of the passage when viewed from in front of the housing. The adapter may be configured to extend around the passage. The adapter may have a width (as viewed from in front of
20 the housing) that is greater than its height. The adapter may have a length (in a direction extending away from the housing) that is less than its width.

The adapter may comprise attachment means for attaching the adapter to the housing.

25 The attachment means may comprise at least one clip and/or at least one locking formation that is configured to receive a clip. For example, the adapter may comprise a plurality of clip formations that are configured to be received by a corresponding plurality of locking formations (for example apertures) provided on the housing.

30 The adapter may comprise a first portion that is configured to engage the housing and a second portion that is configured to engage the vehicle panel assembly. The first portion may be formed of a first material and the second portion may be formed of a second material different to the first material. The first material is preferably harder than the second material, and the second material is preferably more elastic than the

first material. The first portion may provide a main body of the adapter and the second portion may provide a flexible seal for forming a seal with the vehicle panel assembly.

The first material may be a plastic material.

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The second material may be a rubber material. The second material is preferably an elastic material.

The first portion and the second portion may be integrally moulded together. The first
10 portion and the second portion may, for example, be integrally moulded together using a 2K or "double shot" injection moulding process, or alternatively by overmoulding.

According to a further aspect of the present invention there is provided an adapter for
an air flow system comprising a housing for directing air from an opening in a vehicle
15 panel assembly towards an engine of an automotive vehicle, wherein the adapter is formed separately to the housing, is configured to extend outwardly from the housing, and has a distal edge with a profile that at least substantially matches the shape of the vehicle panel assembly. In particular, the distal edge of the adapter may have a profile that at least substantially matches the shape of an inside surface of the vehicle panel
20 assembly around the opening or a portion of the opening.

According to a further aspect of the present invention there is provided an air flow
system for directing air from an opening in a vehicle panel assembly towards an
engine of an automotive vehicle, the air flow system comprising a housing defining a
25 passage for directing air towards the engine and an adapter as described above. The adapter may be attached to the housing, and optionally attached directly to the housing. The adapter may be detachably attached to the housing, thereby facilitating replacement of the adapter. The adapter may extend continuously around the
passage.

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The housing may be provided with at least one valve element that is selectively movable between an open position in which air flow through the passage is permitted and a closed position in which air flow through the passage is restricted (and optionally at least substantially prevented). The at least one valve element may be configured to

at least substantially close the passage when in the closed position to thereby at least substantially prevent air from flowing through the passage towards the engine. The at least one valve element may be located within the housing, for example within the passage. Alternatively the housing may not be provided with any valve elements for opening and closing the passage and may instead simply provide a permanently open
5 passage for delivering air towards the engine.

The housing may be provided with actuation means for selectively controlling the position of the at least one valve element.

10

The housing may define first and second passages for directing air towards the engine.

The air flow system may comprise first and second adapters formed separately to the housing, wherein each of the first and second adapters is configured to extend
15 outwardly from the housing and to provide a seal between the housing and the vehicle panel assembly. The first adapter may be configured to at least substantially seal the first passage with respect to the vehicle panel assembly around a first opening or a first portion of an opening, and the second adapter may be configured to at least
20 substantially seal the second passage with respect to the vehicle panel assembly around a second opening or a second portion of an opening. The first and second adapters may be provided as separate components. Alternatively a single adapter may be configured to at least substantially seal both of the first and second passages with respect to the vehicle panel assembly.

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The air flow system may further comprise a vehicle panel assembly providing an opening, wherein the passage of the housing is configured to direct air from the opening towards an engine. The adapter may engage the panel assembly, for example an inside surface of the panel assembly, to thereby provide a seal between the
30 housing and the vehicle panel assembly. The seal may extend continuously around the opening or a portion of the opening. The adapter may be configured to at least substantially seal the passage with respect to the panel assembly around the opening or the portion of the opening. The adapter may have a shape that substantially

corresponds to the shape of the opening or the portion of the opening when viewed from in front of the housing.

5 The adapter may be urged against the housing by the panel assembly. This urging may assist with location of the adapter relative to the housing and the panel assembly.

10 The vehicle panel assembly may be a leading edge panel assembly (that is a panel assembly for forming a front end of a vehicle). In this case the opening may be a main opening of the leading edge panel assembly (that is an opening covered by a main front grille). Alternatively, the opening may be a secondary opening of the leading edge panel assembly (that is an opening other than the opening covered by the main front grille), for example a middle opening or a lower opening located below a main front grille. Where the housing defines first and second passages for directing air towards the engine, the first passage may be for directing air from a middle opening located below a main front grille and the second passage may be for directing air from a lower opening located below the main front grille and the middle opening. It will be appreciated that in some cases the secondary opening(s) may be larger in area than the main opening.

20 The vehicle panel assembly may comprise a bumper panel.

The opening may be provided by an aperture extending through a panel of the vehicle panel assembly. For example, the opening may extend through a bumper panel.

25 The opening may be formed between two adjacent panels of the vehicle panel assembly. For example, the opening may be formed between a bumper panel and another panel of the panel assembly such as a second bumper panel, a bonnet panel, or another bodywork panel.

30 According to a further aspect of the present invention there is provided an automotive vehicle comprising an adapter as described above and/or an air flow system as described above. The vehicle may be a road vehicle or an off-road vehicle, for example a car.

The vehicle may further comprise an engine towards which the passage of the housing is configured to direct air in use. For example, the passage may be configured to direct air directly to (or at least towards) a radiator of the engine.

- 5 According to a further aspect of the present invention there is provided a method of assembling a plurality of air flow systems for directing air from an opening in a vehicle panel assembly towards an engine of an automotive vehicle, the method comprising: providing first and second housings each providing a passage for directing air from an opening in a vehicle panel assembly towards a vehicle engine; providing first and
10 second adapters each configured to extend outwardly from a housing and to provide a seal between the housing and a vehicle panel assembly; and attaching the first adapter to the first housing to thereby provide a first air flow system and attaching the second adapter to the second housing to thereby provide a second air flow system; wherein the first and second housings are manufactured to the same design; and
15 wherein the first and second adapters are manufactured to different designs, the first adapter having a distal edge that is shaped to sealingly engage a vehicle panel assembly manufactured to a first design and the second adapter having a differently shaped distal edge that is shaped to sealingly engage a vehicle panel assembly manufactured to a second design different to the first design. The method may further
20 comprise incorporating each of the first and second air flow systems into respective first and second vehicles having different vehicle panel assembly designs.

- According to a further aspect of the present invention there is provided a method of
25 designing a plurality of air flow systems for directing air from an opening in a vehicle panel assembly towards an engine of an automotive vehicle, the method comprising: designing a common housing providing a passage for directing air from an opening in a vehicle panel assembly towards a vehicle engine for use in a plurality of different vehicles having different vehicle panel assembly designs; designing a first adapter for use in combination with the common housing, the first adapter having a distal edge
30 that is shaped to sealingly engage a vehicle panel assembly manufactured to a first design; and designing a second adapter for use in combination with the common housing, the second adapter having a distal edge that is shaped to sealingly engage a vehicle panel assembly manufactured to a second design different to the first design.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all
5 embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

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BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

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Figure 1 illustrates a vehicle comprising an air flow system according to one possible embodiment of the present invention;

Figures 2 to 4 illustrate the air flow system;

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Figures 5 and 6 illustrate first and second adapters of the airflow system in isolation; and

Figures 7a to 7c illustrate a housing forming part of the air flow system.

25

DETAILED DESCRIPTION

Figure 1 illustrates a vehicle 1 comprising an engine 2 including a radiator 3 that is located behind a leading edge panel assembly 4 (hereafter referred to as “the panel
30 assembly”) that forms the front of the vehicle. The panel assembly 4 includes a front edge of a bonnet panel 5, a main front grille 6, a main bumper panel 7, and a lower bumper panel 8.

The panel assembly 4 provides a plurality of openings through which air may enter the engine compartment in use of the vehicle in order to cool the engine. The openings include an upper opening or main opening 10 that is defined between the main bumper panel 7 and the bonnet panel 5 and that is covered by a main grille. The openings also include a pair of secondary openings located below the upper opening. The secondary openings include a middle opening 11 that is defined between the main bumper panel 7 and the lower bumper panel 8, and a lower opening 12 that is provided by an aperture extending through the lower bumper panel 8. The middle and lower openings 11, 12 are each elongate and extend across a large portion of the width of the panel assembly 4 and the width of the vehicle 1.

The middle opening 11 is split into a plurality of sections by a plurality of columns that are integrally formed with the lower bumper panel 8 and that extend across the middle opening 11 from the lower bumper panel 8 to the main bumper panel 7, as illustrated in Figure 2. The outer-most columns of the middle opening 11 define the edges of a central portion 11a of the middle opening 11. The lower opening 12 is similarly split into a plurality of sections by a plurality of columns that are integrally formed with the lower bumper panel 8 and that extend across the lower opening 12, with the outer-most columns of the lower opening 12 defining the edges of a central portion 12a of the lower opening 12.

The vehicle is provided with an air flow system 20, illustrated in Figure 2 to 4, for directing air from the middle and lower openings 11, 12 towards the radiator 3 in accordance with one possible embodiment of the present invention. The air flow system 20 comprises an active vane housing 21 that is located behind (that is inboard of) the panel assembly 4 between the panel assembly 4 and the radiator 3. The active vane housing 21 comprises a generally upright body portion 22 that is mounted to a structural beam 9 of the vehicle (as illustrated in Figure 3), and first and second duct portions 23, 24. The first duct portion 23 is integrally formed with the body portion 22 at an upper edge thereof and defines a first (upper) passage 25 extending through the active vane housing 21 for directing air from the middle opening 11 of the panel assembly 4 towards the radiator 3. The second duct portion 24 is integrally formed with the body portion 22 at a lower edge thereof and defines a second (lower) passage 26 extending through the active vane housing 21 for directing air from the lower opening

12 of the panel assembly 4 towards the radiator 3. The first and second passages 25, 26 each extend substantially across the width of the active vane housing 21.

The flow of air through the first passage 25 is controlled by a first set of valve elements or active vanes 27a that are located within the first passage 25 and mounted together on a first common shaft that extends across the width of the first passage, as illustrated in Figures 7a to 7c. The first set of vanes 27a is controlled by an actuator 28 that is located on a side edge of the active vane housing 21. The actuator 28 is operable to rotate the common shaft upon which the first set of vanes 27a is mounted to thereby selectively move the first set of vanes between an open position in which air flow through the first passage 25 is permitted and a closed position in which the valve elements seal the first passage to prevent air flow through the first passage 25. Similarly, the flow of air through the second passage 26 is controlled by a second set of valve elements or active vanes 27b that are located within the second passage 26 and mounted together on a second common shaft that extends across the width of the second passage. The second common shaft is coupled to the first common shaft by a rigid link arm 29 (or alternatively another linking system such as a Bowden cable) located on the opposite side of the active vane housing 21 to the actuator 28. The link arm 29 is configured to operate the second set of vanes 27b in phase with the first set of vanes 27a to thereby selectively open and close the second passage 26 at the same time as the first passage 25.

The air flow system 20 further comprises first and second adapters 30, 40 that are configured respectively to seal the first passage 25 of the active vane housing 21 with respect to the central portion 11a of the middle opening 11 of the panel assembly 4 (that is the region defined between the outer-most columns of the middle opening) and to seal the second passage 26 of the active vane housing 21 with respect to the central portion 12b of the lower opening 12 of the panel assembly 4 (that is the region defined between the outer-most columns of the lower opening). The first and second adapters 30, 40 are illustrated in isolation from the active vane housing in Figures 5 and 6.

The first adapter 30 has a shape that substantially corresponds to the shape of the central portion 11a of the middle opening 11 and to the shape of the first passage 25

of the active vane housing 21 when viewed from in front of the active vane housing 21. The first adapter 30 extends around the first passage 25 and sealingly engages the active vane housing 21 around the first passage 25 around a proximal edge 31 thereof (that is the edge facing towards the active vane housing). It will be appreciated that the first adapter 30 may form a seal with the active vane housing 21 around either the inside surface or the end surface or the outside surface of the first duct portion 23. The first adapter 30 is attached to the active vane housing 21 by a plurality of clips 32 that are integrally formed with the first adapter 30 and which are received within a corresponding plurality of apertures provided on the active vane housing 21.

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The first adapter 30 extends outwardly from the active vane housing 21 and has a profiled distal edge 33 (that is the edge facing away from the active vane housing) that substantially corresponds to and matches the shape of the inside surface of the panel assembly 4 around the central portion 11a of the middle opening 11. The distal edge 33 of the first adapter 30 sealingly engages the inside surface of the panel assembly 4 around the central portion 11a of the middle opening 11 to thereby seal the first passage 25 of the active vane housing 21 with respect to the central portion 11a of the middle opening 11. In particular, the distal edge 33 of the first adapter 30 forms a seal with the inwardly facing surfaces of the main bumper panel 7 and the lower bumper panel 8 on either side of the first opening 11 between the outer-most columns, and with the inwardly facing surfaces of the outer-most columns to thereby provide the seal. The first adapter 30 is slightly compressed between the active vane housing 21 and the panel assembly 4 in order to ensure a good seal with the active vane housing 21 and with the panel assembly 4, and to assist with location of the first adapter 30 relative to the active vane housing 21 and the panel assembly 4.

The second adapter 40 similarly has a shape that substantially corresponds to the shape of the central portion 12a of the lower opening 12 and to the shape of the second passage 26 of the active vane housing 21 when viewed from in front of the active vane housing 21, and has a profiled distal edge 43 that substantially corresponds to and matches the shape of the inside surface of the panel assembly 4 around the central portion 12a of the lower opening 12. The second adapter 40 is similarly configured to sealingly engage the inside surface of the panel assembly 4 around the central portion 12a of the lower opening 12 to thereby seal the second

- passage 26 of the active vane housing 21 with respect to the central portion 12a of the lower opening 12. In particular, the distal edge 43 of the second adapter 40 forms a seal with the inwardly facing surface of the lower bumper panel 8 both above and below the lower opening 12 between the outer-most columns of the lower opening, and with the inwardly facing surfaces of the outer-most columns of the lower opening to thereby provide the seal. As with the first adapter 30, the second adapter 40 is also attached to the active vane housing 21 by a plurality of clips 42, and is slightly compressed between the active vane housing 21 and the panel assembly 4.
- Each of the first and second adapters 30, 40 is formed as a 2K moulded component in a "one shot" moulding process, and comprises a main body portion 34, 44 which engages the active vane housing 21 and provides the clips 32, 42 for attachment to the active vane housing 21, and a sealing portion 35, 45 that extends around the body portion 34, 44 at the distal edge of the adapter to provide the seal with the inside of the panel assembly 4. The body portions 34, 44 are formed of a hard plastic material (optionally the same material used for the active vane housing), and the sealing portions 35, 45 are formed of a rubber material that is more elastic and less hard than the material of the body portions.
- Referring again to Figure 3, the position and arrangement of the active vane housing 21 with respect to the structural beam 9 will be described in more detail. In the presently described embodiment, the structural beam 9 is a bumper beam of the vehicle 1 that typically defines part of a frontal impact structure of the vehicle 1. The bumper beam is provided towards the front of the vehicle 1 and extends substantially across the width of the vehicle 1. The bumper beam 9 is a C-shaped section beam having respective front, upper and lower surfaces 46, 47, 48 which are generally planar. The active vane housing 21 is mounted to the front face or surface 46 of the bumper beam 9 via fastening means 49 in the form of bolts, screws, rivets or the like. When attached to the bumper beam 9 in this way, the first duct portion 23 is positioned above the bumper beam 9 and sits adjacent to the upper surface 47 of the bumper beam 9. Correspondingly, the second duct portion 24 is positioned below the bumper beam 9 and sits adjacent to the lower surface 48 of the bumper beam 9. In use, air is conveyed or directed through the first and second passages 25, 26 defined by the first

and second duct portions 23, 24 in a direction substantially parallel to the upper and lower surfaces 47, 48 of the bumper beam 9, respectively.

The first duct portion 23 comprises an inlet 50 through which air enters the active vane housing 21 and an outlet 51 through which air exits the active vane housing 21, between which the first passage 25 is defined. Correspondingly, the second duct portion 24 includes an inlet 52 and an outlet 53 defining the second passage 26 therebetween. When mounted to the bumper beam 9, the respective inlets 50, 52 of the first and second duct portions 23, 24 are located substantially flush with the front surface 46 of the bumper beam 9. The first and second duct portions 23, 24 extend rearwards from the front surface 46 of the bumper beam 9 such that the outlets 51, 53 of the first and second duct portions 23, 24 are located to the rear of the bumper beam 9 in use. In some embodiments, the first and second duct portions 23, 24 may terminate at a rear edge 54 of the bumper beam 9. In other embodiments, the bumper beam may be a box section beam having a rear surface such that the outlets 51, 53 of the first and second duct portions 23, 24 are substantially flush with the rear surface of the bumper beam 9.

Referring again to Figures 7b and 7c, the first and second sets of vanes 27a, 27b are positioned at respective inlets 50, 52 of the first and second duct portions 23, 24. In this way, the first and second sets of vanes 27a, 27b are substantially flush or at least generally aligned with the front face 46 of the bumper beam 9 in use.

In use of the vehicle 1, as the vehicle travels forwards air is allowed to pass through the upper opening 10, the middle opening 11 and the lower opening 12. Air passing through the central portion 11a of the middle opening 11 is directed towards the radiator 3 by the first passage 25 of the active vane housing 21, and air passing through the central portion 12a of the lower opening 12 is directed towards the radiator 3 by the second passage 26 of the active vane housing 21 in order to assist with cooling of the engine 2. By providing a seal between the first passage 25 and the central portion 11a of the middle opening 11 and between the second passage 26 and the central portion 12b of the lower opening 12, the first and second adapters 30, 40 ensure efficient delivery of cooling air to the radiator 3 via the active vane housing 21 and prevent leakage of air within the engine compartment.

Air passing through upper opening 10 is also directed towards the radiator 3 by a separate air flow system (illustrated in Figure 4) to further assist with cooling of the engine 2. Air passing through the outer portions of the middle and lower openings 11, 12 may be directed by other separate air flow systems (also illustrated in Figure 4) and
5 may be used to cool front brakes of the vehicle and/or other vehicle systems.

If it is desired to close the first and second passages 25, 26 (for example to reduce the level of engine cooling and/or to reduce aerodynamic drag) then the actuator may be controlled to move the vanes into their closed positions, thereby closing the first and
10 second passages 25, 26. In this case, the first and second adaptors 30, 40 ensure that the central portion 11a of the middle opening 11 and the central portion 12a of the lower opening 12 remain sealed and air is not allowed to leak within the engine compartment.

15 If the seal between the active vane housing 21 and the panel assembly 4 requires replacing after a period of use, for example due to degradation of the sealing portions 35, 45 of the adaptors 30, 40, one or both of the first and second adaptors 30, 40 may be removed and replaced to renew the seal without removing or replacing the active vane housing 21. The separate, detachable adaptors 30, 40 therefore also increase
20 the ease of maintenance of the air flow system 20.

Because the active vane housing 21 does not directly engage the bumper panel assembly 4 but instead sealingly engages the bumper panel assembly 4 via the first and second adaptors 30, 40, it is not necessary for the active vane housing 21 to be
25 specifically shaped and designed to sealingly engage the bumper panel assembly 4. It is therefore possible to reduce the complexity and increase the ease of manufacture of the active vane housing 21. It is also possible to use the same design of active vane housing 21 in multiple different vehicle models having different bumper panel assembly designs. The vehicle models may include different variations (including
30 updates) of the same vehicle line and/or vehicles from entirely different lines. For example, the same design of active vane housing may be used in a first vehicle having a first bumper panel assembly design in combination with first and second adaptors that are specifically designed to sealingly engage the bumper panel assembly of the first vehicle, and also in a second vehicle having a second bumper panel assembly

design different to the first bumper panel assembly design in combination with differently shaped first and second adapters that are specifically designed to sealingly engage the bumper panel assembly of the second vehicle. In this way the same active vane housing may be used in multiple different vehicle models, with only the adapters, which are smaller, cheaper and simpler to manufacture, being produced to different designs for different models. The adapters used in the first vehicle may have distal edges that are specifically designed to match portions of the inner surface of the bumper panel assembly of the first vehicle to ensure good sealing performance, while the adapters used in the second vehicle may have distal edges that are specifically designed to match portions of the inner surface of the bumper panel assembly of the second vehicle.

Many modifications may be made to the above examples without departing from the scope of the present invention as defined in the accompanying claims. For example, in another embodiment the active vane housing 21 could be modified to also include a further passage for directing air from the upper opening 10 (that is the opening covered by the main grille) towards the radiator 3, in which case a further adapter may also be provided for sealing the further passage with respect to the upper opening. Alternatively, the active vane housing 21 could include only a single passage for directing air from a single opening towards a radiator. In addition, in other embodiments the active vanes may be omitted, and the housing may instead provide one or more permanently open passages for directing air from one or more openings towards a radiator. Many other modifications are also possible.

25

CLAIMS

1. An air flow system for a vehicle comprising a housing adapted to be mounted to a bumper beam of a vehicle, the housing comprising at least one duct portion configured so as to be disposed adjacent to an upper or lower surface of the bumper beam when mounted thereto; the at least one duct portion comprising an inlet and an outlet defining a passage therebetween for conveying air in a direction substantially parallel to said upper or lower surface.
2. An air flow system as claimed in Claim 1, wherein the at least one duct portion is configured so as to be adjacent to the upper surface of the bumper beam.
3. An air flow system as claimed in Claim 1, wherein the at least one duct portion is configured so as to be adjacent to the lower surface of the bumper beam.
4. An air flow system as claimed in any preceding claim, comprising first and second duct portions configured so as to be adjacent to upper and lower surfaces of the bumper beam, respectively.
5. An air flow system as claimed in any preceding claim, wherein the or each duct portion is configured to receive an adapter for conveying air from an opening in a vehicle panel assembly to the inlet thereof.
6. An air flow system as claimed in any preceding claim, wherein the housing comprises a body portion configured to be mounted to a front face of the bumper beam.
7. An air flow system as claimed in any preceding claim, wherein the inlet of the or each duct portion is elongate in a direction substantially parallel to the length of the bumper beam.
8. An air flow system as claimed in any preceding claim, wherein the outlet of the or each duct portion has a cross-sectional area substantially equal to that of the inlet.

9. An air flow system as claimed in any preceding claim, wherein the housing is provided with at least one valve element that is selectively movable between an open position in which air flow through the passage is permitted and a closed position in which air flow through the passage is restricted.

5

10. An air flow system as claimed in Claim 9, wherein the at least one valve element is provided adjacent to the inlet of the at least one duct portion.

11. An air flow system as claimed in any preceding claim, comprising an adapter configured to couple to the inlet of the at least one duct portion of the housing and extend outwardly from the housing for conveying air from an opening in a vehicle panel assembly to the inlet.

10

12. A vehicle comprising an air flow system as claimed in any preceding claim.

15

13. A vehicle as claimed in Claim 12, comprising a bumper beam to which the housing of the air flow system is mounted.

14. A vehicle as claimed in Claim 13, wherein the inlet of the at least one duct portion is substantially flush with a front surface of the bumper beam.

20

15. A vehicle as claimed in Claim 13 or Claim 14, wherein the or each duct portion of the housing extends substantially across a width of the bumper beam in a direction towards the rear of the vehicle.

25

16. A vehicle as claimed in any of Claims 12 to 15 when dependent on Claim 11, further comprising a vehicle panel assembly, the vehicle panel assembly comprising at least one opening therein, and the adapter being arranged to convey air from the opening of the vehicle panel assembly to the inlet.

30

17. A vehicle as claimed in Claim 16, wherein the adapter sealingly engages an inside surface of the vehicle panel assembly around the periphery of the opening.

18. A vehicle as claimed in any of Claims 12 to 17 when dependent on Claim 4, wherein the first and second duct portions are adjacent to upper and lower surfaces of the bumper beam, respectively.

- 5 19. A vehicle as claimed in any of Claims 12 to 18, comprising a cooling apparatus disposed rearwards and adjacent to outlets of the or each duct portion of the air flow system.

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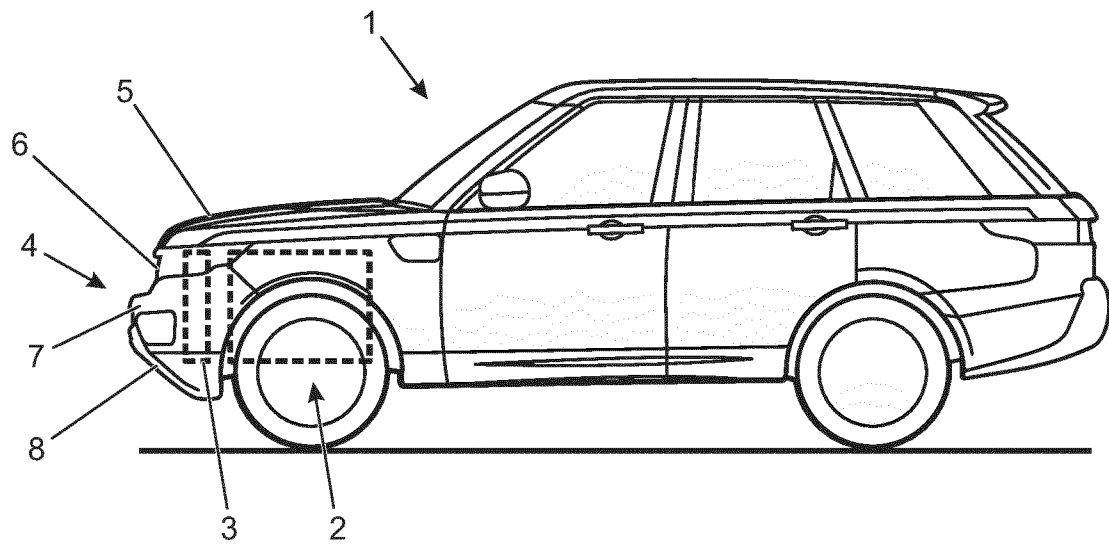


Figure 1

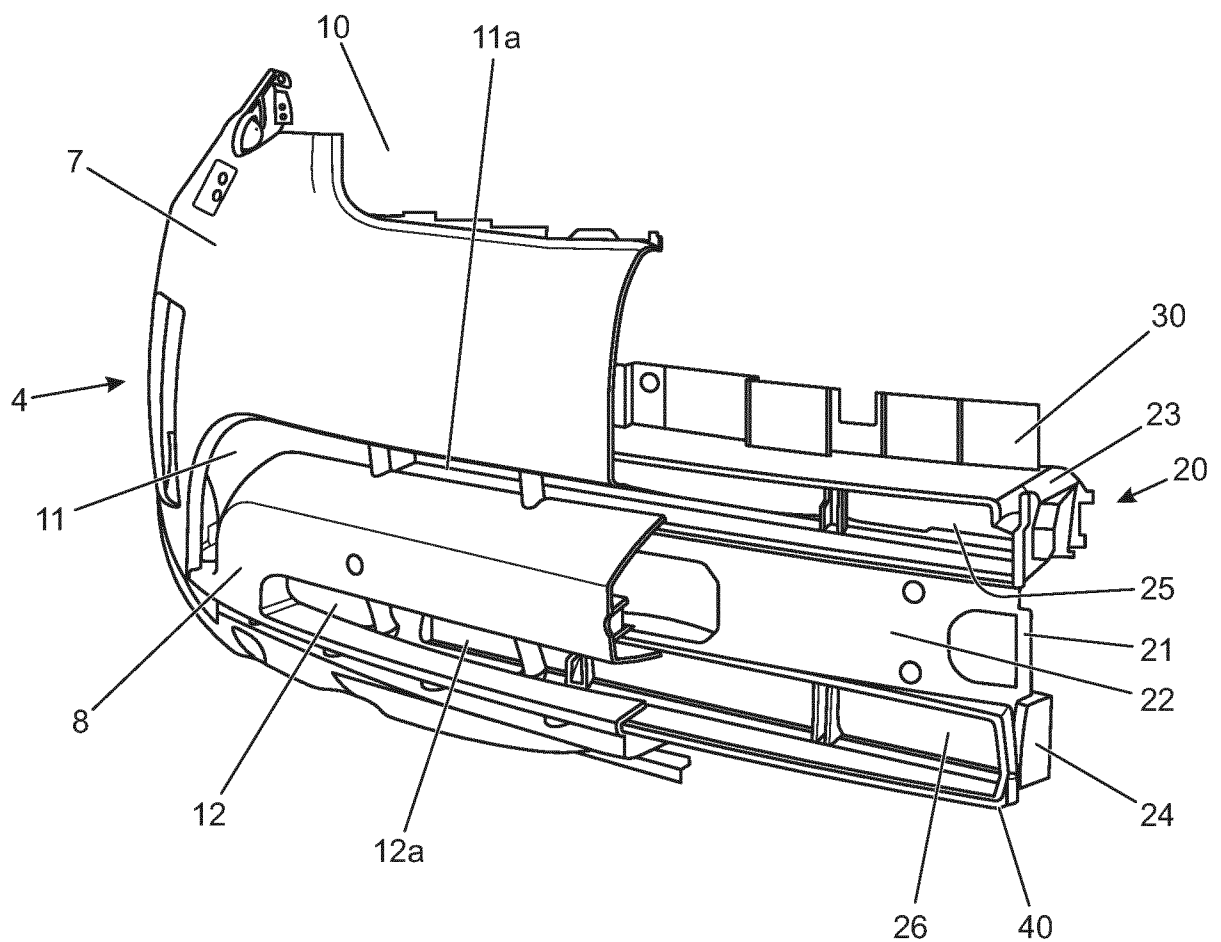


Figure 2

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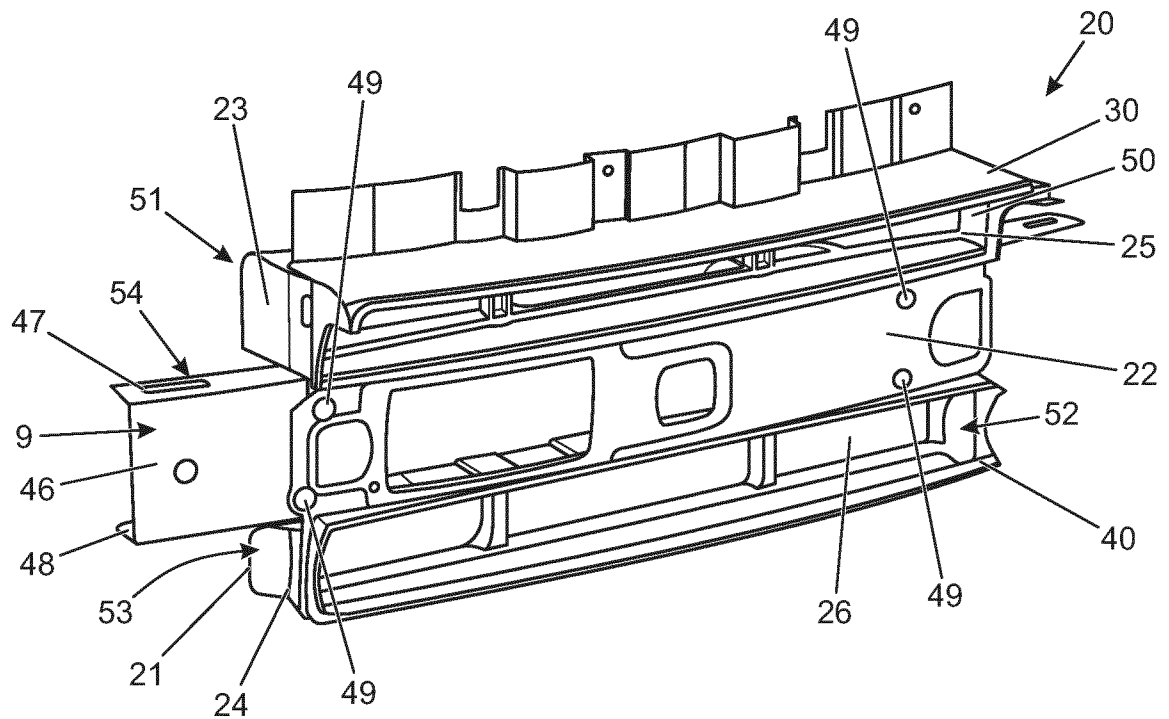


Figure 3

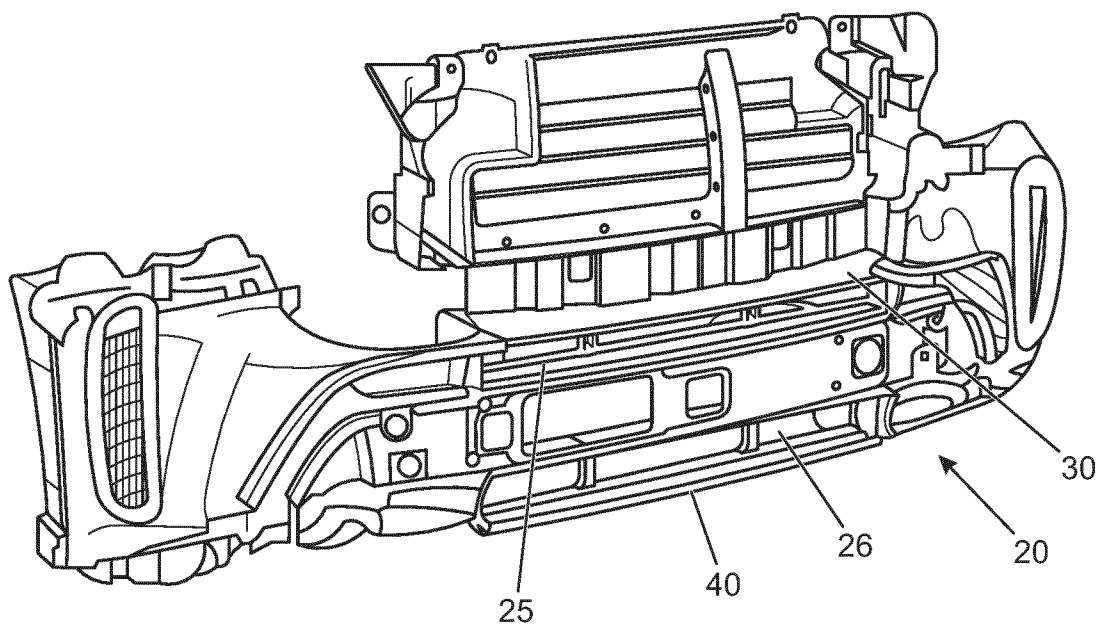


Figure 4

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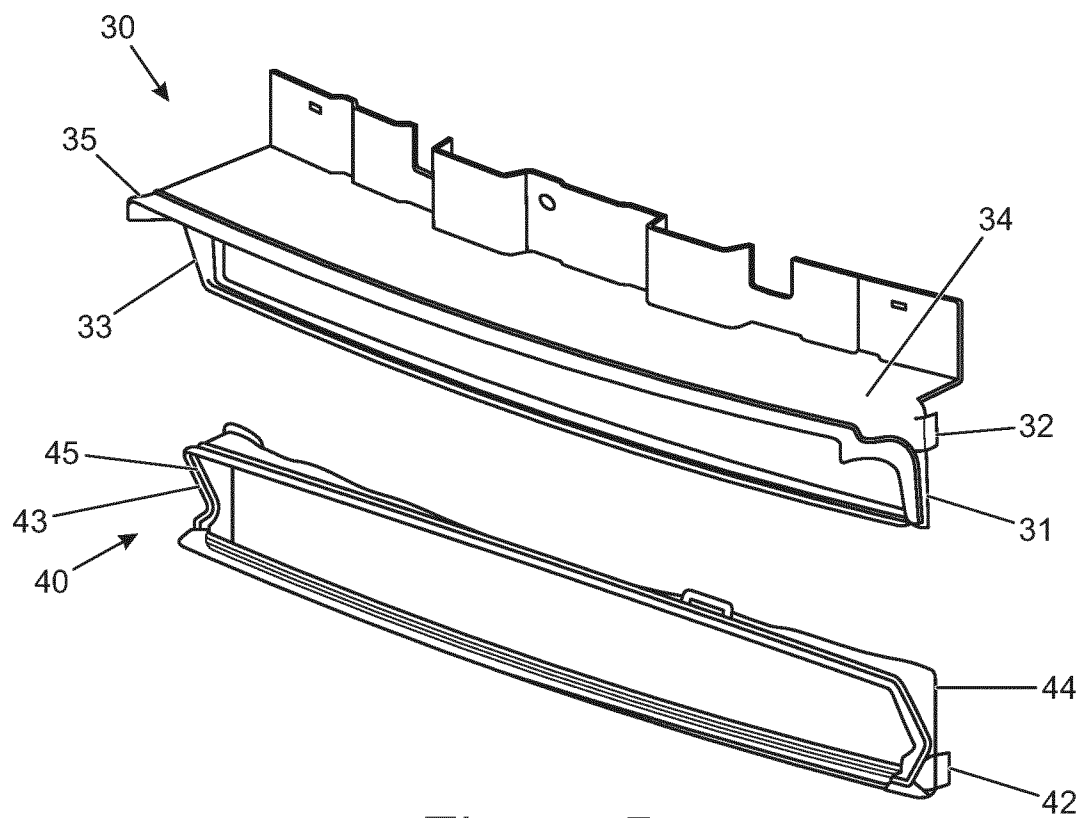


Figure 5

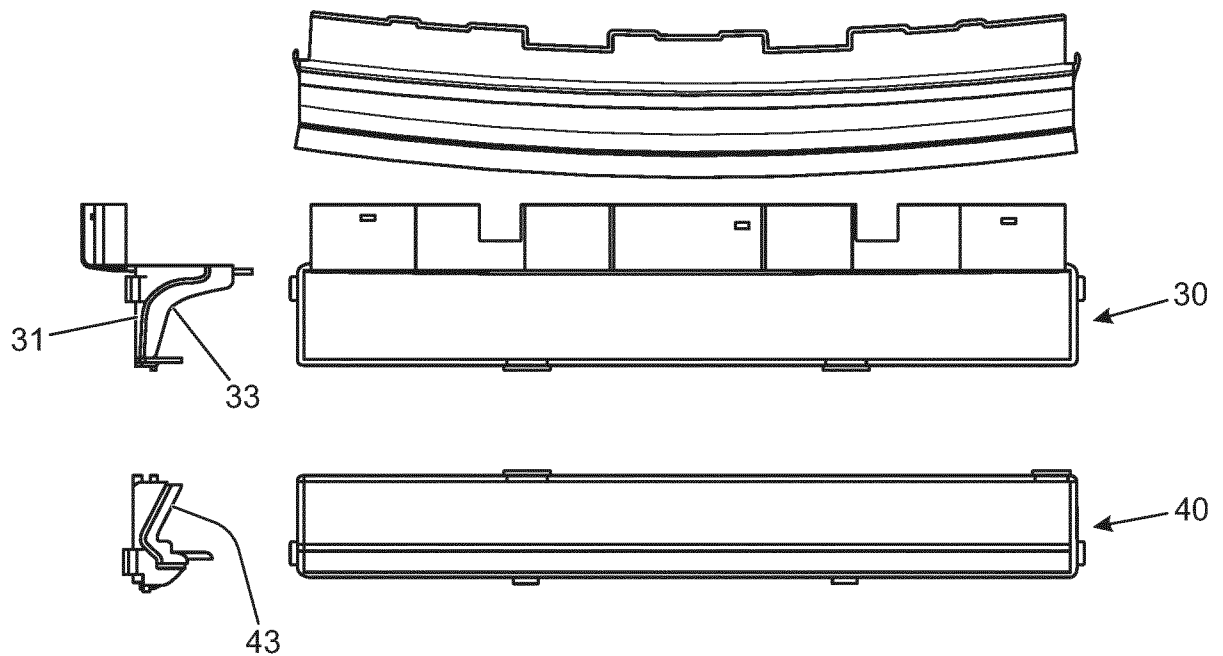


Figure 6

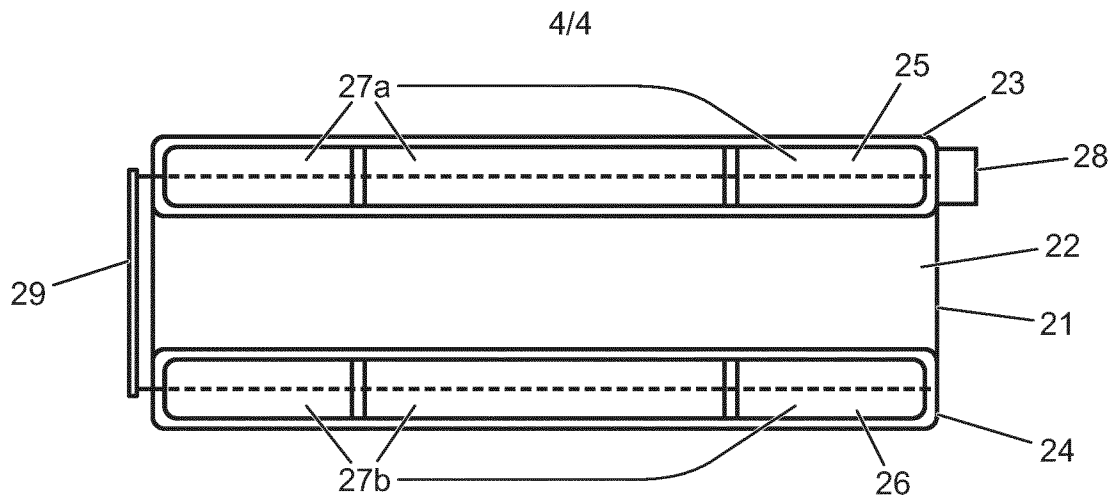


Figure 7a

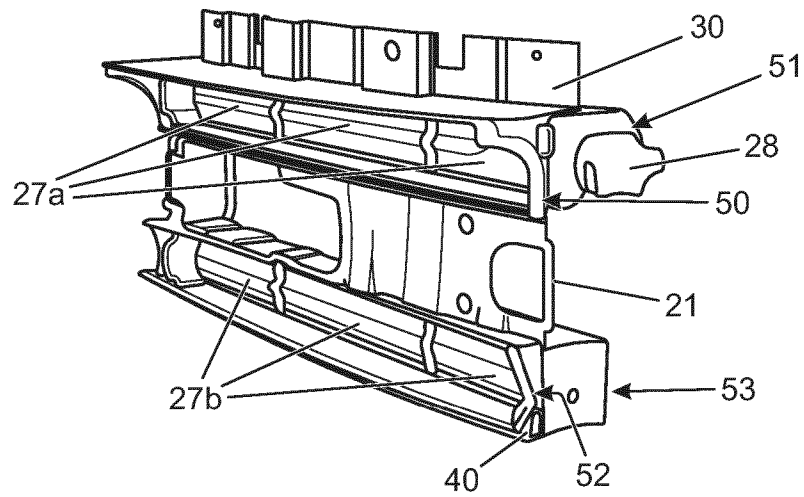


Figure 7b

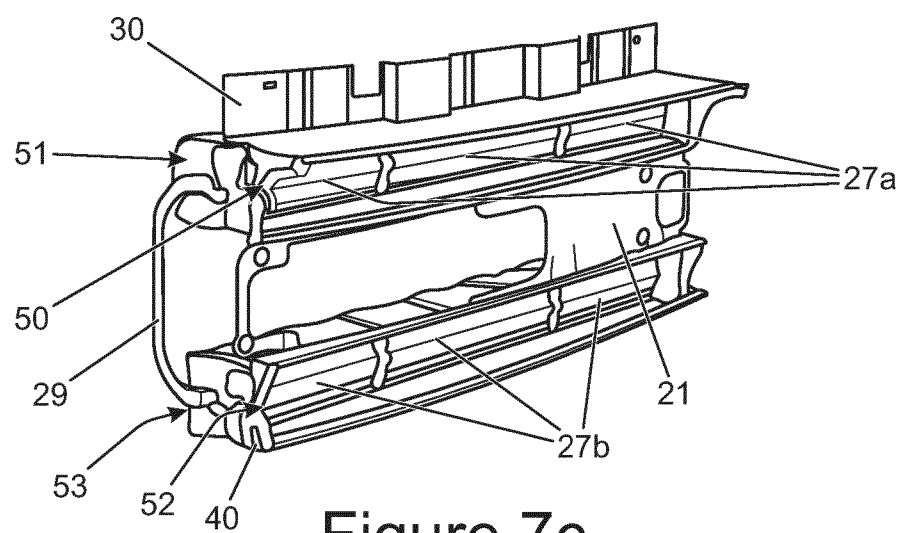


Figure 7c

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/071290

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60K11/08

ADD.

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)

B60K

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015/165939 A1 (VALEO SYSTEMES THERMIQUES [FR]) 5 November 2015 (2015-11-05) figures 1,3,4 -----	1-19
X	US 2014/216834 A1 (ELLIOTT JEFFREY [US] ET AL) 7 August 2014 (2014-08-07) figures 1,2 -----	1-19
X	EP 2 233 343 A2 (AISIN SEIKI [JP]) 29 September 2010 (2010-09-29) figures 1,5 -----	1-19
X	WO 2013/161497 A1 (NISSAN MOTOR [JP]) 31 October 2013 (2013-10-31) figures 1,2 -----	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

6 November 2017

Date of mailing of the international search report

20/11/2017

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Eriksson, Jonas

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/071290

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