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(54) Title: ADAPTATIVE UNDER-VEHICLE AERODYNAMIC SCREEN

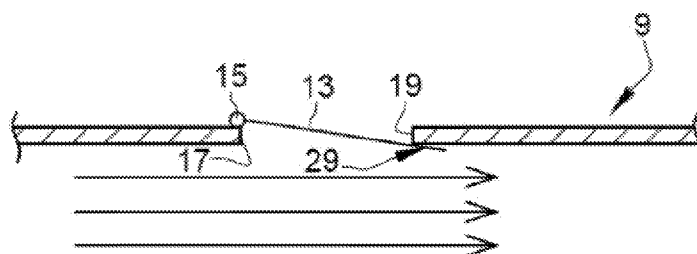


Figure 4

(57) Abstract: An under-vehicle aerodynamic screen (9) comprises a body showing at least one hole (11), the screen (9) comprises one or more flaps (13) moveable between an opened position wherein at least one hole (11) is clear from the one or more flaps (13), and a closed position wherein one or more flaps (13) cover the at least one hole (11) of the screen (9).



ADAPTATIVE UNDER-VEHICLE AERODYNAMIC SCREEN

FIELD OF TECHNOLOGY

The present application relates to an aerodynamic screen which reduces air friction generated under the vehicle during driving and to an automotive vehicle comprising the same.

BACKGROUND

It is known that poor performances in the aerodynamics of a vehicle lead to high fuel consumption. To achieve better aerodynamics of vehicles, one important lever used is an improvement of the under-body aerodynamics, mainly using aerodynamic screens. The aerodynamic screens enable the lower base of the vehicles to have a smooth surface by being mounted in this part and thus enable the friction occurring, due to air during driving to be reduced. The decrease in friction causes fuel saving. The larger is the surface area of said screen, the better is the gain in aerodynamics.

However, the presence of such screens reduces the performances of the vehicle in terms of engine cooling or heat exchange for the Heat Ventilation Air Conditioning (HVAC) system. Poor HVAC performances or poor engine thermic performances (for example when the screen is large and totally closed) can ultimately lead to part failures. Regarding the engine thermic performances, the smaller is the screen the better are the thermic performances.

Therefore, the person skilled in the art is facing a dilemma and needs to find a compromise between two antagonist needs. With such a compromise in mind, aerodynamical screens with holes have been proposed. Figure 1 illustrates such an aerodynamical screen 1 to be placed under the vehicle engine, wherein the screen comprises holes 3 for thermic exchange in its front zone 5. The front zone 5 is intended to be placed in front of the rear zone 7 when the screen 1 is mounted on the vehicle according to the general orientation of the vehicle in its normal direction of movement.

However, by making such a compromise, both aerodynamic and thermic performances are slightly decreased at the end by comparison with the ideal case for each. A solution to improve the situation is still to be found.

Document FR2997912 is related to a lower aerodynamic screen of a motor vehicle front shield comprising lateral air guides shaped to channel air passing under the aerodynamic screen towards the front disc brakes of the vehicle. Each air guide is delimited by two substantially vertical sidewalls and by an upper wall connected to the upper edge of the sidewalls, the air guide being provided downstream, with respect to the direction of air flow, with a window delimited by the rear edge of the sidewalls and the upper wall through which the air opens towards the disc brakes. The air guide further comprises a flap movable between a window closing position and a recessed position at the window.

The document EP3160831 relates to an aerodynamic panel which essentially comprises at least one body covering the bottom of the vehicle, at least one empty area allowing the support arms to hold onto the vehicle while the vehicle is on the assembly line and being on the body, at least one additional panel placed on the empty area on the body after the vehicle leaves the production line, and which saves fuel in the vehicles by reducing the air friction created under the vehicle during driving.

These documents fail to provide a satisfactory response to the problem of the decrease of the aerodynamic and thermic performances due to the presence of an under-vehicle aerodynamic screen comprising holes on the vehicle. The application intends to solve the said problem or at least to improve the situation so that the vehicle will show an improved compromise in aerodynamic and thermic performances.

SUMMARY

In this respect, and according to a first aspect, the application provides an under-vehicle aerodynamic screen comprising a body showing at least one hole, the screen is remarkable in that it further comprises one or more flaps moveable between an opened position wherein at least one hole is clear from the one or more flaps; and a closed position wherein one or more flaps cover the at least one hole of the screen.

As it is understood from the given definition, the application provides an adaptative under-vehicle aerodynamic screen that can show or not holes depending on the needs of the vehicle. When the need is to reduce air friction and therefore to improve the aerodynamic performance of the vehicle, the one or more flaps are in the closed position leading to a closed screen showing a large surface area. When the need is to improve heat exchange and therefore the thermic performance of the vehicle, the one

or more flaps are in the opened position so that the screen shows one or more holes. An advantage of the application is the possibility of have holes of a larger area on the screen without loss in the aerodynamic performances.

To this end, in an alternative embodiment of the application, at least one flap is moveable from its opened position to its closed position by rotation around an axis. Alternatively, at least one flap and its rotation axis are moulded together in a single piece.

Alternatively, the at least one hole of the screen comprises a front edge and a rear edge wherein the front edge is intended to be placed in front of the rear edge when the screen is mounted on a vehicle, and the screen is remarkable in that the axis of the flap is mounted on the front edge of the hole. This configuration allows the flap to act as a passive means.

Indeed, the application is remarkable in that the screen according to the application uses passive means to adapt itself from a situation wherein the flaps need to be closed to a situation wherein the flaps need to be opened and vice-versa. The movement of at least one flap from its opened position to its closed position and its maintenance in the closed position is due to the thrust of the air passing under the vehicle when the vehicle is travelling at a speed above a given threshold, for example, above 20 km/h. Indeed, at such a speed, the need for aerodynamic performances is more important than the need in thermic performances. The movement of the flap from its closed position to its opened position and its maintenance in the opened position is due to the gravity forces when the vehicle is travelling at a speed below a given threshold, for example below 20 km/h. Indeed, at such a speed, the need for thermic performances is more important than in aerodynamic performances.

In an alternative embodiment, at least one flap is made of a flexible material. Alternatively, the flexible material is selected from an elastomeric material selected from ethylene propylene diene monomer rubber (EPDM rubber), thermoplastic elastomers (TPE), thermoplastic polyurethanes (TPU), styrene-butadiene rubber (SBR), latexes or any mixtures thereof. The use of a flexible material prevents the flap to be damaged in case it comes in contact with an object or a relief on the ground.

According to an embodiment of the application, the screen comprising a lower side and an upper side, wherein the lower side is intended to face the ground when the

screen is mounted on a vehicle; the screen is remarkable in that at least one flap is fastened to the screen by fastening means wherein said fastening means are arranged on the upper side of the screen and/or wherein said fastening means are clipping means.

Advantageously, at least one flap comprises an axis with projecting ends on both sides; and the screen is remarkable in that the fastening means shown by the body of the screen are clipping means which are in the form of reliefs configured to receive and retain the projecting ends of the rotation axis. Alternatively, the reliefs and the body of the screen are moulded together in a single piece.

In an embodiment, wherein the screen comprises a lower side and an upper side with the lower side being intended to face the ground when the screen is mounted on a vehicle; and at least one flap comprises a proximal end on the side of the axis of rotation and a distal end on the side opposite to the axis of rotation, the screen is remarkable in that the length of the flap, measured between its proximal and distal ends, is longer than the length of the hole so that the distal end of the flap is in contact with the lower side of the screen when the flap is in its closed position.

In an embodiment, at least one flap shows a thickness equal to or less than 1 mm, alternatively, equal to or less than 0.5 mm.

In an embodiment, at least 10% of the total surface area of the screen consists of one or more holes closable by one or more moveable flaps.

According to a second aspect, the application provides an automotive vehicle comprising an under-vehicle aerodynamic screen according to the first aspect. Alternatively, at least one hole of the screen is facing the tunnel of the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Other aspects and advantages of the application will be clearer after a reading of the following detailed description taken in conjunction with the drawings provided, in which:

Figure 1 is illustrating an under-vehicle aerodynamic screen according to the prior art.

Figure 2 is illustrating an under-vehicle aerodynamic screen according to the application.

Figure 3 is a cross-sectional view of a part of the screen of figure 2 showing a flap in its opened position.

Figure 4 is a cross-sectional view of a part of the screen of figure 2 showing a flap in its closed position.

Figure 5 is a cross-sectional view of a part of the screen of figure 2, showing an example of clipping means cooperating with a projecting end of the axis of rotation of a flap to retain the flap on the screen.

Figure 6 is a view of a flap.

DETAILED DESCRIPTION

In the following description, the term "comprise" is synonymous with "include" and is not limiting in that it allows the presence of other elements in the vehicle, in the screen or in the flap is refers to. It is understood that the term "comprise" includes the words "consist of". Similarly, the terms "lower", "higher" and "upper" will be understood in relation to the general orientation of the vehicle. Thus, "lower" will mean greater ground proximity than "higher" or "upper" along the vertical axis.

Figure 1 has been described in relation to the prior art, reference is now made to figure 2 illustrating an under-vehicle aerodynamic screen 9 according to the application. For clarity purpose, the wording "screen" may be used as a synonym of "under-vehicle aerodynamic screen" in the present description. In a similar way "axis" may be used as a synonym of "rotation axis". In the different figures, the same references designate identical or similar elements.

The application provides an under-vehicle aerodynamic screen 9 comprising a body showing at least one hole (visible on figure 3), the screen 9 is remarkable in that it further comprises at least one flap 13 moveable between an opened position wherein the hole 11 is clear from the flap 13, and a closed position wherein the flap 13 covers the hole 11 of the screen 9. Alternatively, the flap 13 is moveable from its opened position to its closed position by rotation around an axis 15. The number of holes 11 is variable according to the needs of the person skilled in the art. The screen 9 can comprise a single hole 11. In an embodiment, the screen 9 comprises at least two holes 11 (as illustrated in figure 2), such as for example four holes 11. Each hole 11 can be covered by at least one flap 13, alternatively, by one flap 13. According to the application, a large hole 11 can be covered by two or more flaps 13 arranged

successively according to the longitudinal direction of the vehicle and/or according to the transversal direction of the vehicle. In a similar way, a large flap 13 can cover two or more holes 11. On figure 2, each hole is covered by one flap 13.

The flaps can be moved from their opened position to their closed position by any means such as motorised means for example. However, in an alternative embodiment of the application, the one or more flaps 13 are passive means, which means that they move from one position to another without the need for a motorised device. Therefore, alternatively and as illustrated in figure 3, the one or more holes 11 of the screen 9 comprising a front edge 17 and a rear edge 19 wherein the front edge 17 is intended to be placed in front of the rear edge 19 when the screen 9 is mounted on the vehicle, the screen 9 is remarkable in that the axis 15 of rotation of the one or more flaps 13 are mounted on the front edge 17 of the hole 11. In such a configuration, it is understood that the one or more flaps 13 will be folded over the hole 11 by the force of the airflow passing under the vehicle.

Figure 3 is a cross-sectional view representing a flap 13 in its opened position, at low speed of the vehicle. Indeed, at a low speed such as a speed equal to or lower than 30 km/h, alternatively equal to or lower than 20 km/h, the flap 13 is naturally open, thanks to gravity. Figure 4 is a view similar to the one of figure 3, with the difference that the flap 13 is now in its closed position because the vehicle has increased its speed. Indeed, at a higher speed, such as at a speed higher than 30 km/h, the flux constraints of the air passing under the vehicle on the flap 13 surface exceed the impact of the flap's weight, leading to the natural closure of the flap 13 on the aerodynamic screen 9. The aerodynamical performances of the vehicle, on which the screen 9 is mounted, are improved when the one or more flaps 13 are in their closed position because the aerodynamic screen is now acting as a closed aerodynamic screen without showing any holes; alternatively a totally closed screen. The thermic performances of the vehicle, on which the screen 9 is mounted, are improved when the one or more flaps 13 are in their opened position because the aerodynamic screen is thus showing one or more holes 11 needed for low-speed thermal management.

The speed threshold at which the one or more flaps 13 will be in their opened position or in their closed position can be defined easily by the person skilled in the art by choosing the material, thickness and axis definition (that will define the weight and the resistive torque when the flap 13 turns on its axis 15) on the one hand, and the

flap's size (that will define the aerodynamic coefficient (known in the art as SCx) of the flap 13) on the other hand.

The material selected to make at least one flap 13 is alternatively a flexible material in order to avoid damaging of the flap 13 in case it comes into contact with an element on the ground such as a stone or a relief present on said ground when the vehicle is travelling with the one or more flaps 13 in their opened position. Alternatively, the flexible material is selected from an elastomeric material selected from ethylene propylene diene monomer rubber (EPDM rubber), thermoplastic elastomers (TPE), thermoplastic polyurethanes (TPU), styrene-butadiene rubbers (SBR), latexes or any mixtures thereof.

At least one flap 13 and its axis 15 of rotation can be produced separately and further assembled together. However, in an alternative embodiment, the flap 13 and its rotation axis 15 are moulded together in a single piece. The rotation axis 15 can be therefore made of the same material than the flap 13 or in another material using an overmoulding process.

With reference to figure 6, it is understood that, advantageously, at least one flap 13 comprises an axis 15 with projecting ends 27 on both sides being received in retaining or fastening means 25 disposed on the screen. To facilitate the rotation of the axis 15 within the fastening means 25, the rotation axis 15 can be made of or coated with a self-lubricating material, selected from nylon, acetal, polyethylene terephthalate (PETP), polyethylene of very high molar mass (UHMW-PE), and polytetrafluoroethylene (PTFE).

In order to avoid excessive weight and to facilitate the transition from the opened position to the closed position, the person skilled in the art will have an advantage using thin flaps 13. In an embodiment, the one or more flaps 13 show a thickness equal to or less than 1 mm; alternatively, equal to or less than 0.8 mm; more alternatively, equal to or less than 0.5 mm; and most alternatively, equal to or less than 0.3 mm.

The flaps 13 can be fastened to the edge of the holes 11 of the screen 9 by any means that let to the flaps 13 the possibility to rotate around their axis 15. For example, it can be fastened by any fastening means 25 cooperating with the axis 15, and alternatively with the projecting ends 27 extended on both sides of the flap 13. In an alternative

embodiment, the said fastening means 25 are clipping means which can be removable clipping fixation means cooperating with complementary means on the screen 9, such as an opening on the body of the screen. In an alternative embodiment illustrated in figure 5, the clipping means 25 are in the form of reliefs configured to receive and retain the projecting ends 27 of the rotation axis 15. Alternatively, the reliefs and the body of the screen 9 are moulded together in a single piece.

The position of the fastening means 25 can be either on the lower side 21 or on the upper side 23 of the screen 9. For clarity reasons, it is specified the lower side 21 is intended to face the ground when the screen 9 is mounted on the vehicle. Alternatively, the fastening means 25 are arranged on the upper side 23 of the screen 9.

The size of at least one flap 13 is alternatively selected by the person skilled in the art to be larger than the hole 11 it intends to cover. This allows avoiding material entering the space above the screen 9 while the vehicle is travelling at high speed. Thus, in an embodiment wherein at least one flap 13 is comprising a proximal end on the side of the axis 15 of rotation and a distal end 29 on the side opposite to the axis of rotation 15, the screen 9 is remarkable in that the length of the flap 13 measured between its proximal and distal 29 ends, is longer than the length of the hole 11 so that the distal end 29 of the flap 13 is contacted on the lower side 21 of the screen 9 when the flap 13 is in its closed position. In other words, there is an overlapping of the flap 13 and the body of the screen at the distal end 29 of the flap 13 when it is in the closed position.

The application allows the size of the hole(s) 11 to be enlarged as compared to the size of prior art holes. It also allows for increasing the number of holes 11. In both cases, the surface area of the screen 9 which is formed with holes 11 can be increased as the holes 11 can be closed. In an embodiment, at least 10 % of the total surface area of the screen 9 consists of one or more holes 11 closable by moveable flaps 13; alternatively at least 15 %, more alternatively at least 20 %.

The location of the holes 11 will be selected easily by the person skilled in the art according to its needs. Advantageously, at least one hole is placed at the front part 5 of the screen 9. In an embodiment, at least one hole 11 of the screen 9 is facing the tunnel of the vehicle when the screen is mounted on the vehicle.

In an under-vehicle aerodynamic screen comprising four holes each being sized 40

mm over 120 mm, the gain in SCx is a reduction of about 0.3 dm^2 . This amounts to a reduction in fuel consumption of about 0.006 L/ 100 km. With larger holes sized 80 mm over 120 mm, the gain in SCx is a reduction about 0.6 dm^2 , which corresponds to a reduction in fuel consumption of about 0.012 L/ 100 km. Bigger holes also come with better thermal management performance at low speed (better under bonnet temperatures, HVAC head pressure decreases by 0.3 to 0.5 bars).

WHAT IS CLAIMED IS:

1. An under-vehicle aerodynamic screen (9) comprising a body showing at least one hole (11), the screen (9) being characterised in that it further comprises one or more flaps (13) moveable between an opened position wherein at least one hole (11) is clear from the one or more flaps (13); and a closed position wherein one or more flaps (13) cover the at least one hole (11) of the screen (9).
2. The under-vehicle aerodynamic screen (9) according to claim 1, characterised in that at least one flap (13) is moveable from its opened position to its closed position by rotation around an axis (15); alternatively, at least one flap (13) and its rotation axis are moulded together in a single piece.
3. The under-vehicle aerodynamic screen (9) according to claim 2, at least one hole (11) of the screen (9) comprising a front edge (17) and a rear edge (19) wherein the front edge (17) is intended to be placed in front of the rear edge (19) when the screen (9) is mounted on a vehicle, the screen (9) is characterised in that the axis (15) of the flap (13) is mounted on the front edge (17) of the hole (11).
4. The under-vehicle aerodynamic screen (9) according to any one of claim 1 to 3, characterised in that at least one flap (13) is made of a flexible material; alternatively, the flexible material is selected from an elastomeric material selected from ethylene propylene diene monomer rubber, thermoplastic elastomers, thermoplastic polyurethanes, styrene-butadiene rubbers, latexes, or any mixtures thereof.
5. The under-vehicle aerodynamic screen (9) according to any one of claim 1 to 4, the screen (9) comprising a lower side (21) and an upper side (23), wherein the lower side (21) is intended to face the ground when the screen (9) is mounted on a vehicle; the screen (9) is characterised in that at least one flap (13) is fastened to the screen (9) by fastening means (25) wherein said fastening means are arranged on the upper side (23) of the screen (9) and/or wherein said fastening means (25) are clipping means.
6. The under-vehicle aerodynamic screen (9) according to claim 5; at least one flap (13) comprising an axis (15) with projecting ends (27) on both sides; the screen (9) is characterised in that the fastening means (25) shown by the body of the screen (9) are clipping means which are in the form of reliefs configured to receive and retain the projecting ends (27) of the rotation axis (15); alternatively, the reliefs and the body of the screen (9) are moulded together in a single piece.

7. The under-vehicle aerodynamic screen (9) according to any one of claim 2 to 6, wherein the screen (9) comprises a lower side (21) and an upper side (23) with the lower side being intended to face the ground when the screen (9) is mounted on a vehicle; and at least one flap (13) comprises a proximal end on the side of the axis (15) of rotation and a distal end (29) on the side opposite to the axis (15) of rotation, the screen (9) is characterised in that the length of the flap (13), measured between its proximal and distal (29) ends, is longer than the length of the hole (11) so that the distal end (29) of the flap (13) is contacted on the lower side (21) of the screen (9) when the flap (13) is in its closed position.
8. The under-vehicle aerodynamic screen (9) according to any one of claim 1 to 7, characterised in that at least one flap (13) shows a thickness equal to or less than 1 mm, alternatively, equal to or less than 0.5 mm.
9. The under-vehicle aerodynamic screen (9) according to any one of claim 1 to 8, characterised in that at least 10 % of the total surface area of the screen (9) consists of one or more holes (11) closable by one or more moveable flaps (13).
10. An automotive vehicle characterised in that it comprises an under-vehicle aerodynamic screen (9) according to any one of claims 1 to 9; alternatively, at least one hole (11) of the screen (9) is facing the tunnel of the vehicle.

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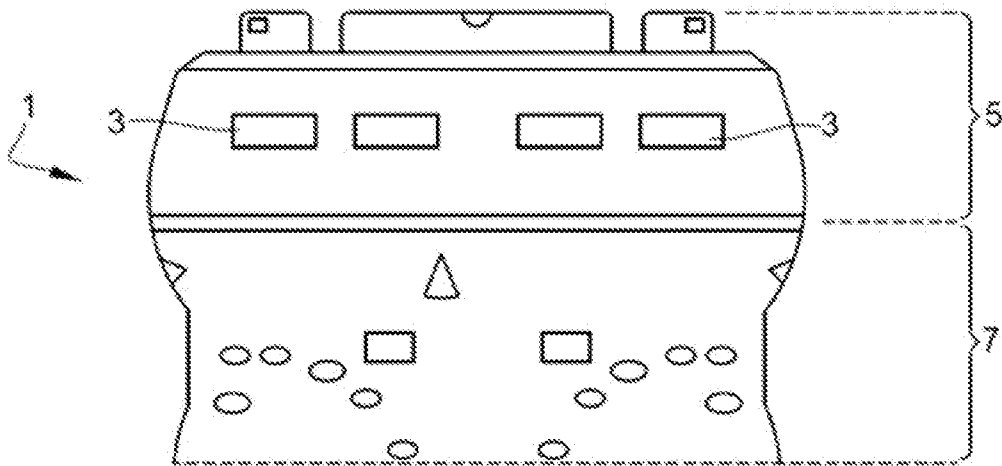


Figure 1

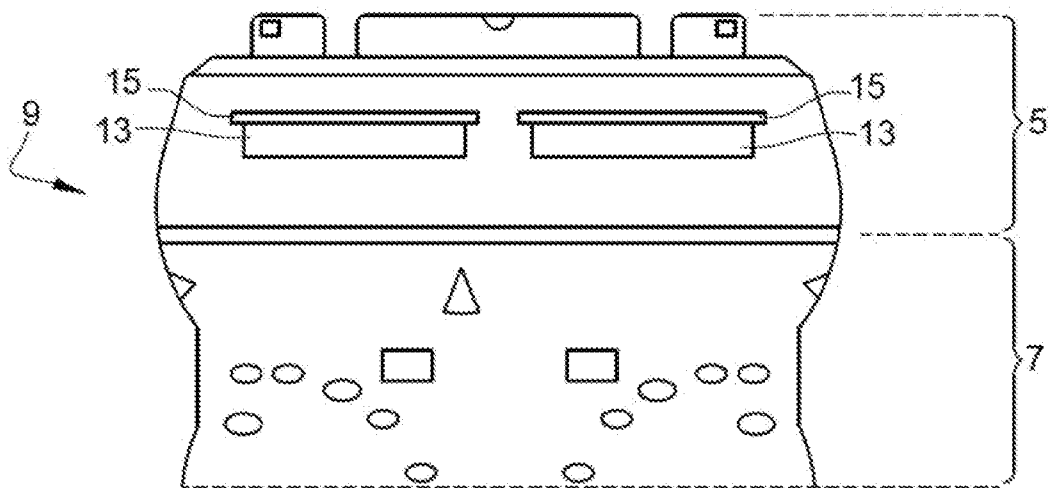


Figure 2

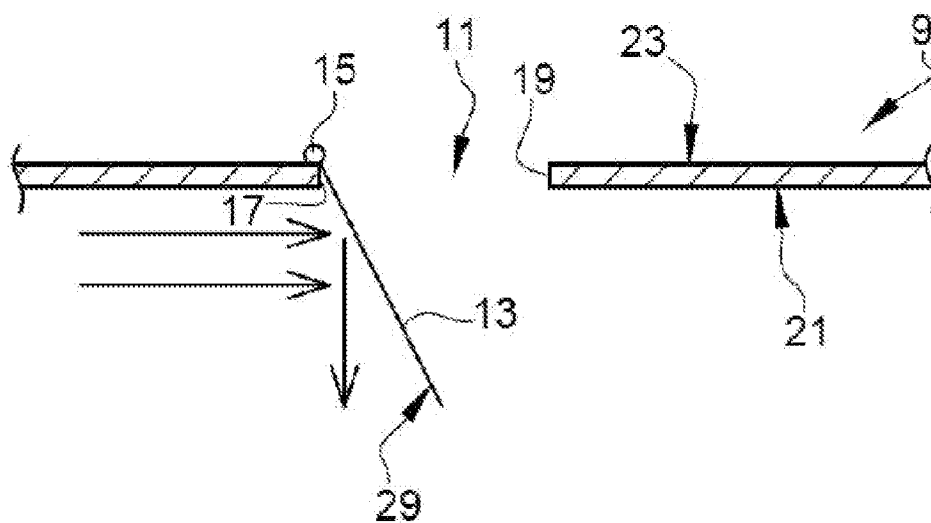


Figure 3

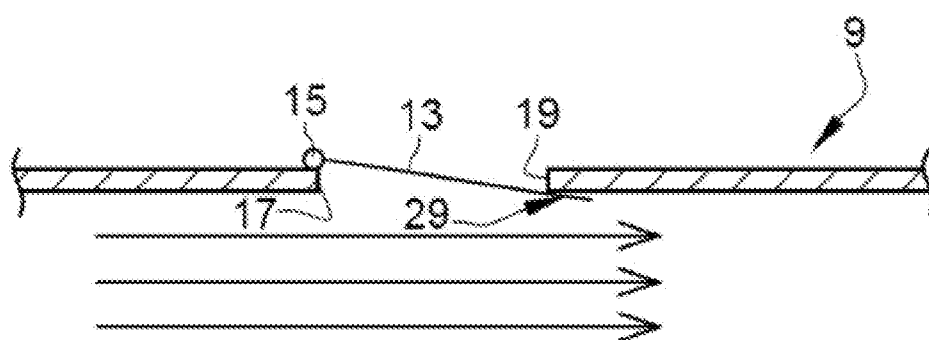


Figure 4

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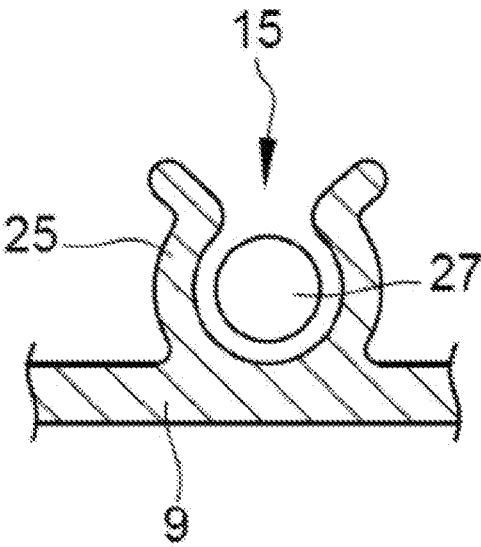


Figure 5

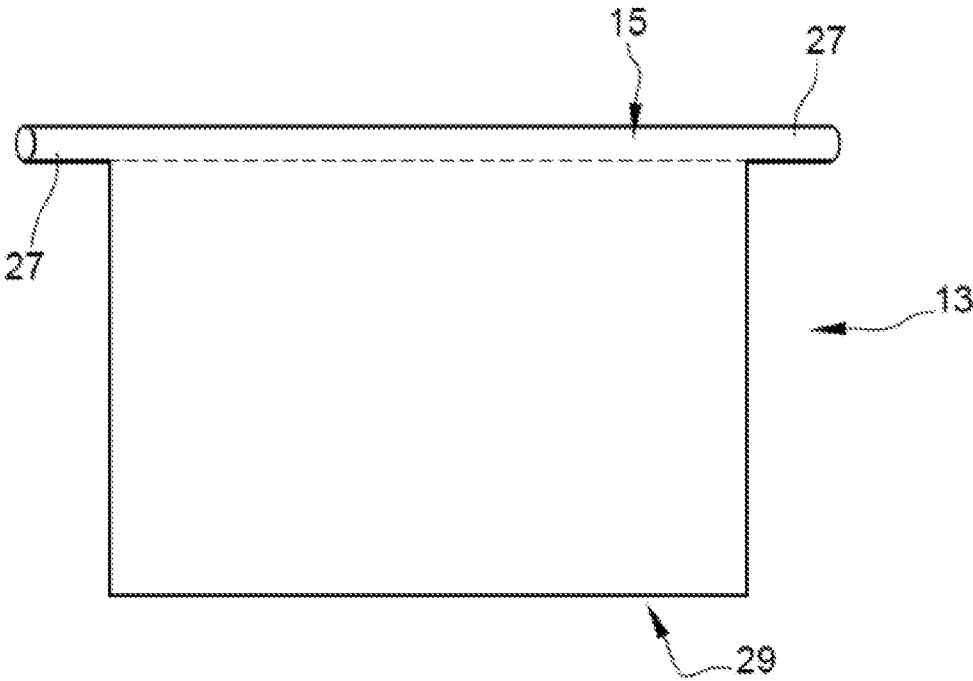


Figure 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/103512

A. CLASSIFICATION OF SUBJECT MATTER

B62D 35/02(2006.01)i; B60K 11/08(2006.01)i

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)

B62D 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)

WPI, EPODOC, CNKI, CNPAT: aerodynamic, screen, plate, flap, board, under, heat, hole, window, open+, close+, axis, flexible, clip+, airflow, current, blow

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2015232138 A1 (MCLAREN AUTOMOTIVE LTD.) 20 August 2015 (2015-08-20) the whole document	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/103512

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				US	2017101140	A1	13 April 2017
				GB	2520888	B	20 November 2019
				US	10099731	B2	16 October 2018
				GB	2520888	A	03 June 2015
				US	2017101139	A1	13 April 2017
				US	9561827	B2	07 February 2017
				WO	2014044490	A1	27 March 2014
				GB	201216941	D0	07 November 2012
				GB	201505571	D0	13 May 2015
				US	2019031253	A1	31 January 2019