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GB 2108063 A WO 88/09737 A US 4772062 A

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Online datbases:WPI

(54) Motor vehicle having ground effect producing aerodynamic surfaces

(57) The underside of a car 10 defines with the road surface a venturi throat 4 and a diffuser 2. The airflow through the venturi throat 4 provides a downforce F which acts on the vehicle through the aerodynamic centre of pressure (C.O.P). The position of the centre of pressure can be varied by an adjustable rear aerofoil (figure 3) or by an electric fan 8. The fan 8 removes slow moving air from the boundary layer formed at the top wall of the rear diffuser 2.

The means to vary the centre of pressure can be activated by the driver or automatically in response, for example, to heavy braking of the vehicle.

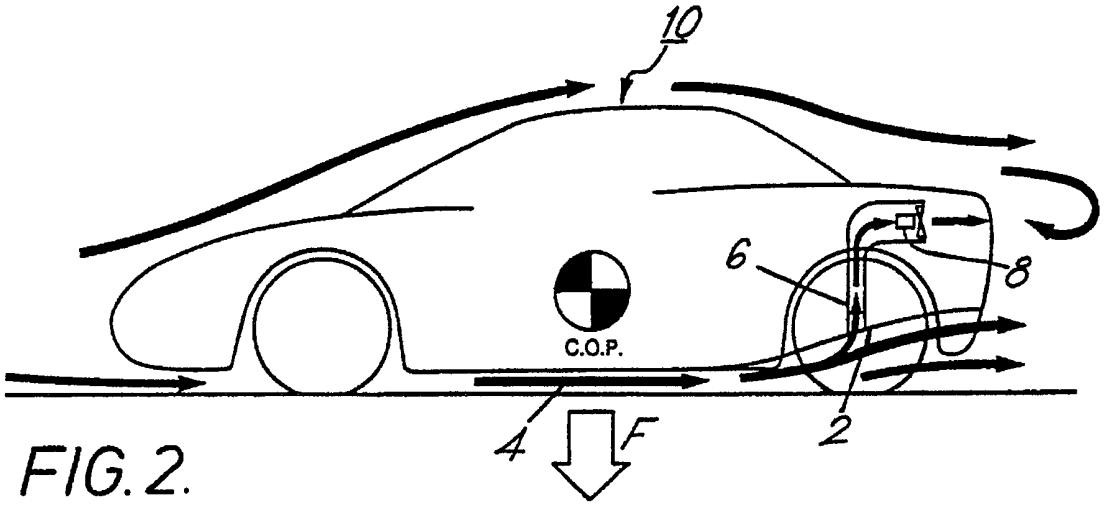

FIG. 2.

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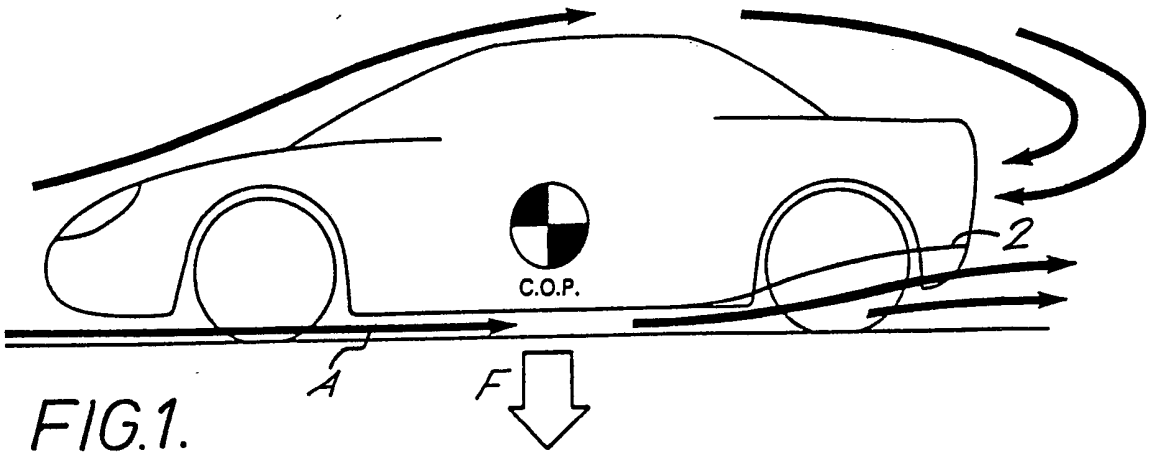

FIG.1.

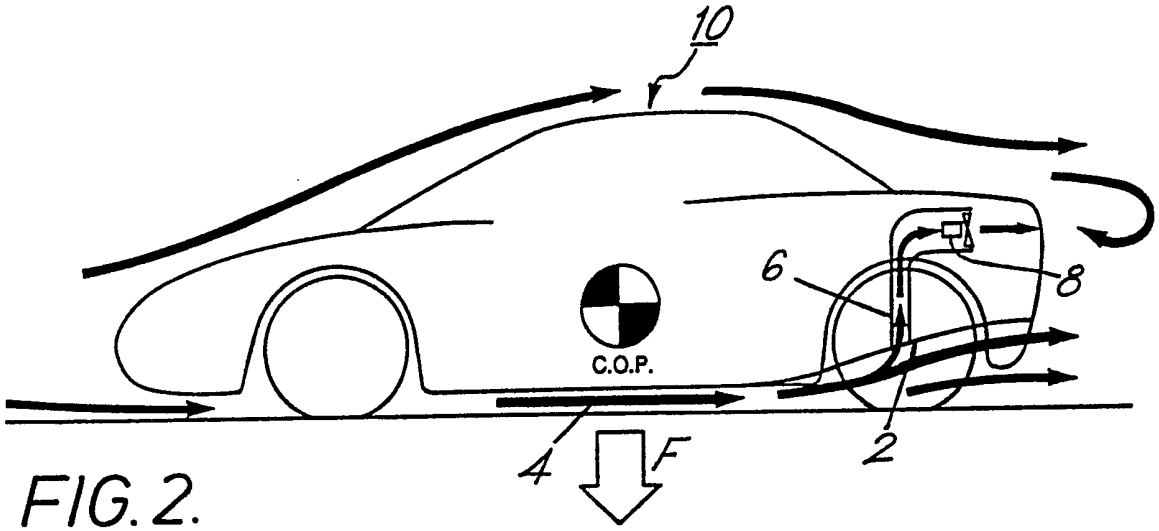

FIG.2.

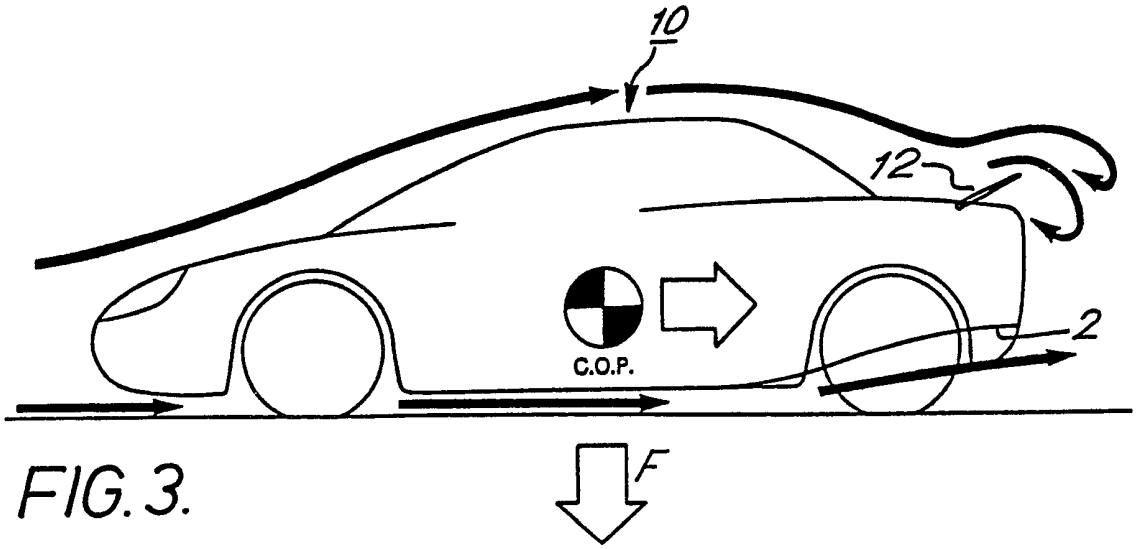

FIG.3.

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IMPROVEMENTS IN OR RELATING TO GROUND EFFECT ROAD VEHICLES

The present invention relates to ground effect road vehicles.

It is known to provide a ground effect road vehicle whose underside is arranged to define a venturi throat with the ground, this venturi throat communicating with a rear diffuser whereby travel of the vehicle generates an aerodynamic downforce acting through a centre of pressure of the vehicle. The downforce enhances tyre adhesion.

The centre of pressure can move considerably depending upon driving conditions, braking of the vehicle, and changes of chassis ride, height and pitch. Movement of the centre of pressure causes vehicle instability.

It is an object of the present invention to address the stability problems currently encountered with ground effect road vehicles.

According to a first aspect of the present invention, there is provided a ground effect road vehicle whose underside is arranged to define a venturi throat with the ground, the venturi throat communicating with a rear diffuser whereby travel of the vehicle generates an aerodynamic downforce acting through a centre of pressure of the vehicle, and wherein the vehicle carries means to control or vary the position of said centre of pressure.

In an embodiment, said means carried by the vehicle comprise means to vary the profile of the air flow produced by the venturi throat and the rear diffuser to stabilise the position of the centre of pressure.

By varying the profile of the air flow the percentage

change in, for example, ride height to the air flow ratio can be decreased with a resultant decrease in movement of the centre of pressure. This provides greater stability in the centre of pressure position and leads to greater stability of the road vehicle. It is also possible to increase the downforce and to reduce the drag by appropriate variation of the air flow profile.

In a preferred embodiment, said means to vary the profile of the air flow comprise means to remove slow moving boundary layer air from the rear diffuser. Said means, for example, may comprise one or more fans.

In a preferred embodiment, one or more air ducts are provided in the vehicle body which open in a boundary wall of the rear diffuser. Air flow through the ducts diverts slow moving air at the boundary of the rear diffuser. Whilst it would be possible to allow the travel of the vehicle to move air through the or each said duct, it is preferred that one or more fans to force air therethrough should be provided in the or each said duct.

Additionally and/or alternatively, said means carried by the vehicle comprises means to vary the geometry of the vehicle to move its centre of pressure.

In this respect, the geometry of the vehicle is preferably altered in a manner to move the centre of pressure. This can be done, for example, when heavy braking of, or external factors acting on, the vehicle are acting to vary its centre of pressure. In such circumstances, the geometry is varied such that the variation of the centre of pressure caused thereby opposes the changes caused by the external factors and/or heavy braking.

In a preferred embodiment, said means to vary the geometry of the vehicle comprises means for deploying spoiler means, for example, a foil or wing. For example, said means may be arranged to deploy a rear foil to a position to increase base suction on the car.

Control means, preferably comprising a drive mechanism for the spoiler means, are provided. The control means may be operable by the driver. Additionally and/or alternatively, the control means may be responsive to the sensor means, and operable to actuate the foil in dependence upon the information provided by the said sensor means. For example, the sensor means may be arranged to sense the application of heavy forces, such as braking forces, on the vehicle such that the control means may deploy the spoiler means in response thereto. In a preferred embodiment, the sensor means determine the braking force and the speed of the vehicle.

Embodiments of the present invention will hereinafter be described, by which of example, with reference to the accompanying drawings, in which:

Figure 1 shows schematically the air flow associated with a ground effect road vehicle;

Figure 2 shows an embodiment of a ground effect road vehicle of the invention having means to vary the profile of the air flow; and

Figure 3 shows schematically a further embodiment of a ground effect road vehicle of the invention having means to alter the geometry of the vehicle.

Figure 1 shows schematically a ground effect road vehicle. As is known, ground effect aerodynamics, which was discovered on Grand Prix racing cars in the late 1970s, is a system which manages the air flow under a road

vehicle. The underside of the vehicle is arranged to define a venturi throat under the vehicle, through which an airstream A is accelerated. This airstream is then expanded out of a rear diffuser 2. The airflow provides an aerodynamic downforce indicated at F which acts to enhance tyre adhesion. This force F acts through a point known as the aerodynamic centre of pressure (C.O.P). In the vehicle shown in Figure 1, the rear design is such as to provide base suction at the rear of the car which further increases the downforce F.

By adjusting the design and profile of the venturi throat, and of the diffuser, and of the rear of the car, various amounts of downforce can be achieved. This downforce is generally more efficient at providing stability for the vehicle than devices such as air ducts, spoilers and wings.

Whereas the aerodynamic forces act on the vehicle through the centre of pressure (C.O.P), dynamic forces act upon the vehicle through its centre of mass or its centre of gravity. When the aerodynamic forces are small, because of the profile of the vehicle or its low velocity, the position of the centre of pressure is of little consequence. But when the vehicle velocity is high and/or significant aerodynamic forces are being produced, then the position of the centre of pressure becomes very important. In this respect, aerodynamic forces increase as the square of the vehicle velocity.

Ideally, for stability, the centre of pressure should be close to or coincide with the centre of gravity. But even if this difficult target is achieved, the centre of pressure moves considerably under extreme vehicle pitch conditions. The worst case is usually under heavy braking. As the forward weight transfer occasioned by the braking

forces pitches the vehicle nose downwardly, and the tail upwardly, the centre of pressure moves forwardly adding to the weight transfer problem and causing vehicle instability. This instability obviously effects the balance and handling of the vehicle. The embodiments illustrated hereinafter control the movement and position of the centre of pressure and thereby enable the correct position to be maintained over a range of vehicle ride heights and pitches.

In Figure 2, there is shown an embodiment of a ground effect road car 10 having a venturi throat, indicated at 4, and a rear diffuser indicated at 2. As is shown schematically, an air duct 6 is provided in the rear of the vehicle and communicates with the top surface of the rear diffuser 2. This air duct 6 is arranged to communicate externally of the rear of the car and includes a fan or fans 8 arranged to pull air through the duct. The or each fan 8 is preferably electrically driven. The duct 6 may extend substantially across the width of the rear diffuser 2 or a number of individual ducts 6 thereof may be provided across the width.

The fan or fans 8 remove air from the top boundary wall of the rear diffuser 2. This air is generally slow moving boundary layer air, which has been slowed down by its contact with the boundary of the rear diffuser. The removal of this air allows a more accurate flow profile to be produced from the venturi throat 4 into the diffuser 2. There is also a thinner overall boundary layer of air under the car. This decreases the percentage change of the ride height to air flow ratio, and thereby decreases any resultant movement in the centre of pressure caused by changes in the ride height. The change in air flow profile also increases the downforce and reduces drag.

Figure 3 shows schematically a further embodiment of a ground effect car 10 having means by which the geometry of the car may be varied. In this respect, a foil 12 is provided on the rear profile of the car but is arranged to be movable. For example, the foil 12 preferably extends substantially over the width of the rear of the car, and is connected to the rear by way of a transversely extending pivot axis (not shown). The foil 12 may be arranged to lie flush with or be received within the rear profile of the car 10. However, when required it may be deployed upwardly to the position shown in Figure 3. When it is deployed at a angle to the rear profile, it increases the rear base area of the car and enervates a larger than normal base suction area. This base suction interacts with the underside of the car and increases the pressure drop along the length of the car and therefore increases the underbody downforce. The deployment of the foil 12 also has the effect of moving the centre of pressure rearwardly as indicated in Figure 3.

The foil 12 may be deployed by the driver, for example, in dependence upon the road conditions. If required, the driver can be assisted in choosing the correct position of the foil by processor means carried by the car which may be responsive to sensors measuring parameters of the vehicle and of its travel.

It is also possible to deploy the foil 12 automatically to move the centre of pressure during heavy braking of the car to counteract the large forward movement of the centre of pressure which occurs under such conditions. In this embodiment, sensors (not shown) are provided on the car and are responsive to parameters thereof. For example, the sensors may measure the brake line pressure and the vehicle speed. An electronic control unit (not shown) is arranged to receive information from

the sensors. When the brake line pressure and vehicle speed are in excess of predetermined values, indicating that a heavy braking manoeuvre has been commenced, the control unit is arranged to deploy the foil 12.

As well as counteracting the forward movement of the centre of pressure during a heavy braking manoeuvre, and thereby aiding in the stability of the vehicle, the deployment of the foil 12 also increases the drag coefficient of the vehicle slightly and therefore acts as an air brake to assist in the braking manoeuvre.

It will be appreciated that variations in and modifications to the embodiments described and illustrated may be made within the scope of this application.

CLAIMS

1. A ground effect road vehicle whose underside is arranged to define a venturi throat with the ground, the venturi throat communicating with a rear diffuser whereby travel of the vehicle generates an aerodynamic downforce acting through a centre of pressure of the vehicle, and wherein the vehicle carries means to control or vary the position of said centre of pressure.

2. A ground effect road vehicle as claimed in Claim 1, wherein said means carried by the vehicle comprise means to vary the profile of the air flow produced by the venturi throat and the rear diffuser to stabilise the position of the centre of pressure.

3. A ground effect road vehicle as claimed in Claim 2, wherein said means to vary the profile of the air flow comprise means to remove slow moving boundary layer air from the rear diffuser.

4. A ground effect road vehicle as claimed in Claim 3, wherein said means to remove slow moving boundary layer air comprise one or more fans.

5. A ground effect road vehicle as claimed in any preceding claim, wherein one or more air ducts are provided in the vehicle body which open in a boundary wall of the rear diffuser.

6. A ground effect road vehicle as claimed in Claim 5, wherein one or more fans to force air through the or each said air duct are provided in the or each said duct.

7. A ground effect road vehicle as claimed in any preceding claim, wherein said means carried by the vehicle

comprises means to vary the geometry of the vehicle to move its centre of pressure.

8. A ground effect road vehicle as claimed in Claim 7, wherein the geometry of the vehicle is altered in a manner to move the centre of pressure.

9. A ground effect road vehicle as claimed in Claim 8, wherein the geometry of the vehicle is altered to move the centre of pressure when heavy braking of, or external factors acting on, the vehicle are acting to vary its centre of pressure.

10. A ground effect road vehicle as claimed in Claim 9, wherein the geometry of the vehicle is varied such that the variation of the centre of pressure caused thereby opposes the changes caused by the external factors and/or heavy braking.

11. A ground effect road vehicle as claimed in any of Claims 7 to 10, wherein said means to vary the geometry of the vehicle comprises means for deploying spoiler means.

12. A ground effect road vehicle as claimed in Claim 11, wherein said deploying means is arranged to deploy a rear foil to a position to increase base suction on the car.

13. A ground effect road vehicle as claimed in Claim 11 or 12, wherein control means comprising a drive mechanism for the spoiler means are provided for deploying the spoiler means.

14. A ground effect road vehicle as claimed in Claim 13, wherein said control means are operable by the driver.

15. A ground effect road vehicle as claimed in Claim 13 or

14, wherein said control means are responsive to sensor means, and are operable to actuate the foil in dependence upon information provided by the said sensor means.

16. A ground effect road vehicle as claimed in Claim 15, wherein said sensor means are arranged to sense the application of heavy forces, such as braking forces, on the vehicle such that the control means may deploy the spoiler means in response thereto.

17. A ground effect road vehicle as claimed in Claim 16, wherein said sensor means determine the braking force and the speed of the vehicle.

18. A ground effect road vehicle substantially as hereinbefore described with reference to the accompanying drawings.

Examiner's report to the Comptroller under Section 17 (The Search Report)

GB 9314583.7

Relevant Technical fields

(i) UK Cl (Edition L) B7B (BPF, BPC);

(ii) Int Cl (Edition 5) B62D;

Search Examiner

PHIL THORPE

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

20 SEPTEMBER 1993

Documents considered relevant following a search in respect of claims 1-18

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2108063 A (FORD) - see page 1 lines 93-104, Figures 2 and 3	1, 7, 8, 11, 13
X	WO 88/09737 (ITAL) - see whole document	1-6
X	US 4772062 (BMW) - see column 8 line 61 - column 9 line 41, Figures 1, 9-11	1, 7, 8, 9, 11, 12, 13

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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