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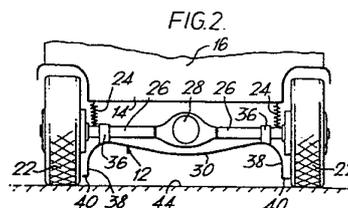
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54 **Ground effect vehicle.**

57 A wheeled vehicle has an undertray shaped to form a venturi duct with a road or like surface over which the vehicle moves, the undertray being carried in substantially fixed relationship with the wheels, so that the vehicle chassis or body can move relative to the wheels without substantial alteration of the shape of the venturi duct. The undertray can comprise the lower wall of a sheel enclosing the vehicle body or chassis.



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GROUND EFFECT VEHICLE
DESCRIPTION

The invention relates to a vehicle having a body, wheels for supporting the vehicle on a support surface, suspension means permitting relative movement between the body and the wheels, and means providing an undersurface for forming a venturi duct with the support surface.

It is known to shape the undersurface of the body of a racing car and to provide the car with longitudinally extending skirts at its sides, in such a manner as to define a venturi duct between the body and a road surface over which it moves, so that the flow of air between the car body and the road surface tends to increase the contact loading of the car to the surface. This so-called "ground effect" depends on the shaping of the undersurface and the skirts so that the air flow in the venturi duct has a velocity everywhere greater than at the airflow exit at the rear of the car. The air consequently has a lower pressure everywhere in the duct than at the exit. This low pressure acts on the undersurface of the car body to generate negative lift. The downward or negative lift component of force acting on the car body is transmitted through the suspension and the springs so as to increase the grip of the tyres on the road. The effect is also to reduce the induced drag of the car, with a consequent reduction in the energy

in moving it.

It is a disadvantage of such an arrangement that the aero-dynamic characteristics dictated by the undersurface shape are affected by its relationship to the road surface, which continuously changes during cornering, acceleration and braking loads. Moreover, the suspension characteristics of the car are changed because they must absorb and transmit the aero-dynamic loads. The design of the skirts provided at the sides of the car to help define the venturi duct is complicated by the need to accommodate considerable movements between the vehicle body and the road surface.

The invention accordingly provides a vehicle having a body, wheels for supporting the vehicle on a support surface, suspension means permitting relative movement between the body and the wheels, and means providing an undersurface for forming a venturi duct with the support surface, characterized in that the means providing the undersurface is carried by the vehicle for movement with the wheels relative to the body.

The means providing the undersurface can conveniently be suspended by suitable fittings or mounting means from uprights or axles carrying the wheels of the vehicle. Such an arrangement minimises necessary design departures from an existing vehicle design, and also facilitates incorporation of the invention in an already existing vehicle. To accommodate movement of the wheels relative to one another, some or all of the mounting means can be flexible or extensible, or the means providing the undersurface can itself be flexible, or both these measures can be combined.

To promote smooth air flow into the venturi duct it can be provided that the means providing the undersurface has a front portion thereof forming a convex rearwardly curved downward extension of the front surface of the vehicle body. To eliminate a

gap in which air can flow between the vehicle body and the upper side of the means providing the undersurface, flexible sealing means can be provided between the means and the vehicle body.

5 In another way of carrying the invention into effect, the means providing the undersurface is part of a shell substantially enclosing the vehicle body.

The means providing the undersurface can have along each side thereof a downwardly extending side
10 portion having a lower edge spaced from the support surface. Because the means is carried in association with the wheels and not by the vehicle body, these lower edges can be close to the support surface, minimising lateral air leakage from the venturi duct.
15 The skirt portions can even be arranged to engage the support surface and can then be flexible to accommodate irregularities in the surface. Instead, such irregularities can be accommodated by arranging that the means providing the undersurface has a
20 downwardly open longitudinal slot extending along each side thereof, and the skirt portions are slidable up and down within the slots.

In accordance with the invention therefore, the position of the means of the vehicle forming the
25 venturi duct relative to the road or support surface is dependent on the relationship of the wheels to the surface, which is normally substantially constant, instead of on the relationship of the vehicle body to the surface, so that the vehicle experiences a
30 predetermined negative lift substantially independent of the attitude of the vehicle to the surface. The operation of the vehicle is consequently more consistent. The means providing the undersurface can be simple in design and can facilitate conversion of
35 a conventional vehicle to a ground effect vehicle.

The present invention can be usefully embodied in racing cars but is applicable also to other road vehicles for example, private cars, commercial

vehicles and buses. The invention can be embodied in rail vehicles also where negative lift is desired.

The invention is further described below by way of example only and without limitation of the scope thereof with reference to the accompanying drawings, in which:

Figure 1 is a schematic side view of a commercial goods vehicle embodying the invention;

Figure 2 is a partial schematic sectional end view of the vehicle of Figure 1 taken rearwardly of the rear axle thereof; and

Figure 3 is a schematic sectional front view of a racing car embodying the invention.

The commercial goods vehicle 10 illustrated in Figures 1 and 2 is of conventional structure except for the addition thereto of a ground effect undertray 12 in accordance with the invention. The vehicle 10 has a chassis 14 mounting a compartment 16 for carriage of goods and a cabin 18 which accommodates the driver and contains the vehicle engine. Front and rear wheels 20, 22 are carried by the chassis 14 by suspensions of which springs 24 of the rear axle suspension are shown in Figure 2 extending between the chassis 14 and half-shaft casings 26 extending from a differential casing 28.

In accordance with the invention, the vehicle 10 is provided with an undersurface beneath the chassis 14 by the undertray 12. As appears from Figure 1, the undertray 12 is a generally sheet-like construction, having a floor 30 which appears generally linear in transverse cross-section except where departures from linearity are appropriate to accommodate underlying portions of the vehicle for example the differential casing 28 as shown in Figure 2. The floor 30 has a front portion 32, which forms a convex rearwardly curved downward extension of the front surface of the cabin 18, and which extends to a throat 33.

From the throat 33, the floor 33 extends rearwardly, sweeping gradually upwardly to end at the lower rear edge of the chassis 14 or the compartment 16. The shape of the undersurface, if inverted, would
5 correspond generally to the upper surface of an aerofoil. At its lateral edges, the floor 30 has downwardly extending skirt portions 38 which extend linearly in the front-to-rear direction of the vehicle adjacent to and on the inner side of the
10 wheels. The lower marginal edges 40 of the skirt portions 38 are uniformly horizontal except for the front portions 42 which are convexly curved downwardly and rearwardly from the lower front edge of the cabin 18.

15 The undertray 12 is supported beneath the vehicle, not by attachment to the chassis 14 but by securement to the wheel axle structures. Thus the undertray 12 is connected to the front axles by fittings 34, and to the rear half shaft casings 26
20 by brackets 36 extending therearound. To accommodate movement of the chassis 14, and thus of the compartment 16 and cabin 18, relative to the undertray 12, the connections of the undertray to the chassis are effected by flexible inserts between the undertray
25 and the chassis. A certain relative movement between the front and rear axle structures of the vehicle is accommodated either by the inherent flexibility of the material of the undertray 12, or by an appropriate degree of compliance in desired directions provided in
30 the fittings 34 or the brackets 36, or both.

The shapes of the central and rear floor portions 34, 36 are such that the undertray 12 forms a venturi duct with the road surface 44 over which the vehicle
10 travels. Air flowing into the duct experiences an increase in speed as it progresses along the duct to
35 the throat 33 and it then diffuses smoothly back to the free-stream velocity at the trailing edge of undertray 12. Wherever the velocity is greater than

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the free-stream velocity, there is a reduction in pressure which reduces lift of the vehicle and aids ground engagement.

5 The negative lift produced by the venturi duct acts on the undertray 12, and is thus transferred directly to the road wheels 20, 22 through the fittings 34 and brackets 36. Because the undertray 12 is carried by the wheel support structure of the vehicle, no allowance need be made for the movements
10 permitted by the suspension means, of the chassis relative to the road surface 44. The marginal edges 40 of the skirt portions 38 consequently can be designed to be quite close to the ground surface 44.

15 In the racing car 52 embodying the invention and shown in Figure 3, substantially the entire vehicle outer surface, instead of the effective undersurface of the car only, is substantially fixed with relation to the road wheels.

20 The car 52 thus comprises a body or chassis 54 mounting the engine and the fuel tank, and accommodating the driver. The road wheels 56 are carried by the chassis by way of suspension means including springs 58. Instead of having an outer
25 shell carried directly by the chassis 54, the car has an outer shell 60 which surrounds the chassis with clearance and is carried by the suspension means by way of springs 61 for movement substantially with the wheels 56 regardless of changes in the attitude of the
30 chassis to the wheels accommodated by the suspension means.

The shell 60 provides an appropriate aerodynamically shaped outer surface for the vehicle, and has an upper wall 62, with downwardly extending side
35 portions 64 inwardly of and adjacent the wheels 56, and a lower wall 66 which has a central longitudinal depression to accommodate the chassis 54. The lower wall 66 is shaped longitudinally to form a venturi

duct with the road surface 44.

These downturned side portions 64, or downwardly extending side portions 68 of the lower wall 66, could constitute skirts at the sides of the venturi duct, but it is preferred that these portions 64, 68 be slightly spaced apart to slidably receive between them separate skirts 70, the lower edges of which ride on the road surface 44. In this way, an excellent seal of the sides of the venturi duct of the road surface 44 is achieved.

It will be evident that the chassis 54 together with the suspension means and the wheels 56 constitute a complete vehicle, which however lacks an appropriate outer casing. This is supplied by the shell 60, which provides not only an aero-dynamically appropriate front, rear and upper surfaces, but also a lower surface providing the vehicle with negative lift, which is applied directly to the wheels 56.

The invention can of course be embodied in other ways, and to other kinds of vehicles than as specifically described.

CLAIMS:

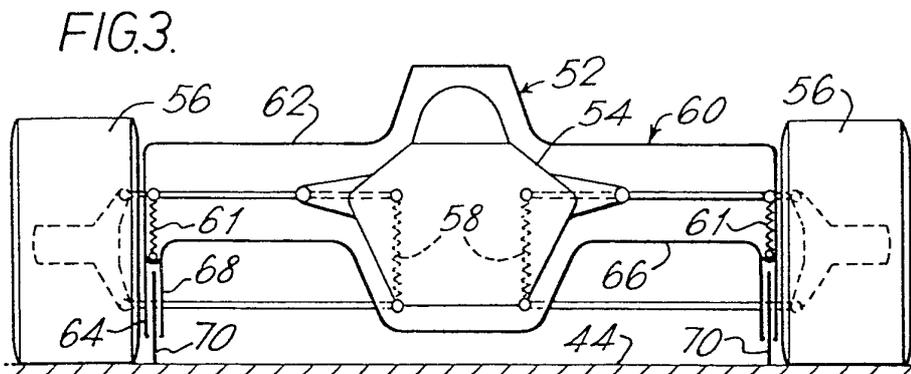
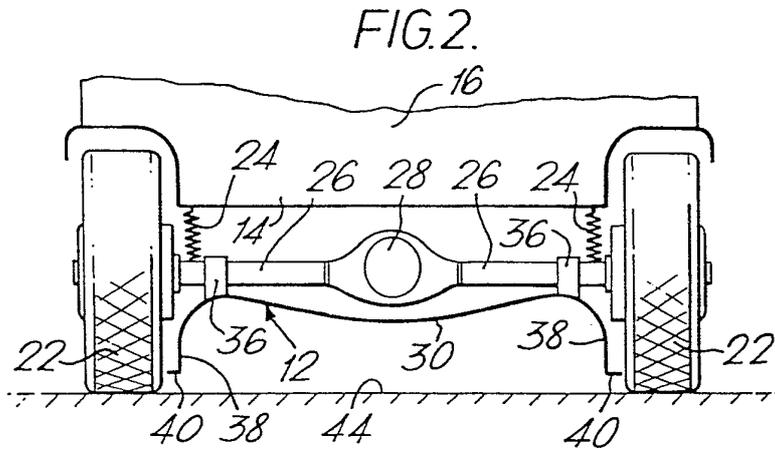
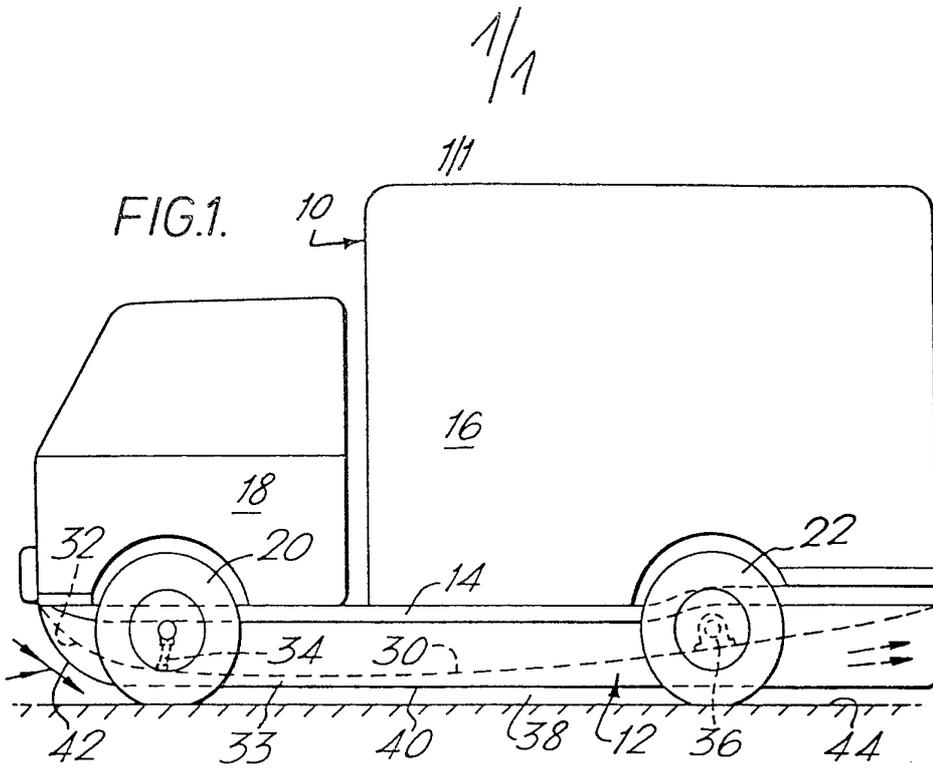
1. A vehicle having a body, wheels for supporting the vehicle on a support surface, suspension means permitting relative movement between the body and the wheels, and means providing an under-
5 surface for forming a venturi duct with the support surface, characterized in that the means (12, 60) providing the undersurface (30, 66) is carried by the vehicle for movement with the wheels (22, 56) relative to the body (14, 54).
- 10 2. A vehicle as claimed in claim 1 having axles for the wheels and wherein the means (12) providing the undersurface (30) is suspended from the axles by mounting means (34, 36).
- 15 3. A vehicle as claimed in claim 2 wherein the suspension means permits movement of at least one of the wheels (20, 22) relative to the remaining wheels, and the mounting means (34, 36) are arranged to accommodate this relative movement.
- 20 4. A vehicle as claimed in claim 2 or 3 wherein the suspension means permits movement of at least one of the wheels relative to the remaining wheels and the means (12) is flexible to accommodate this relative movement.
- 25 5. A vehicle as claimed in claim 2, 3 or 4 having flexible sealing means between the means (12) and the vehicle body (14).
- 30 6. A vehicle as claimed in any preceding claim wherein the means (12) has a front portion (32) thereof forming a convex rearwardly curved downward extension of the front surface (18) of the vehicle body.
- 35 7. A vehicle as claimed in claim 1 wherein the means (60) providing the undersurface (66) is part of a shell (52) substantially enclosing the vehicle body (54).
8. A vehicle as claimed in any preceding claim wherein the means (12, 60) has along each side thereof

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a downwardly extending side portion (38, 64, 68) having a lower edge spaced from the support surface (44).

5 9. A vehicle as claimed in anyone of claims 1 to 7 wherein the means (12, 60) has along each side thereof a downwardly extending skirt portion (70) having a lower edge, the skirt portions being arranged to engage the support surface (44).

10 10. A vehicle as claimed in claim 9 wherein the means (12, 60) has a downwardly open longitudinal slot extending along each side thereof, and the skirt portions (70) are slidable up and down within the slots.





European Patent
Office

EUROPEAN SEARCH REPORT

0030122

Application number

EI 80 30 4245

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<p><u>FR - A - 1 063 557</u> (PASSUELLO) * Whole patent *</p> <p style="text-align: center;">--</p>	1,2	B 62 D 35/02 37/02
F	<u>FR - A - 2 363 472</u> (SOCIETE EUROPEENNE DE PROPULSION)	1	TECHNICAL FIELDS SEARCHED (Int. Cl.) B 62 D
A	<u>GB - A - 1 419 497</u> (OXLADE)	1	
A	<u>US - A - 4 072 336</u> (RUZICKA)	1	
A	<u>US - A - 2 062 016</u> (LEZY)	1	

			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
<p>The present search report has been drawn up for all claims</p>			& member of the same patent family. corresponding document
Place of search	Date of completion of the search	Examiner	
The Hague	05-03-1981	SCHMAL	