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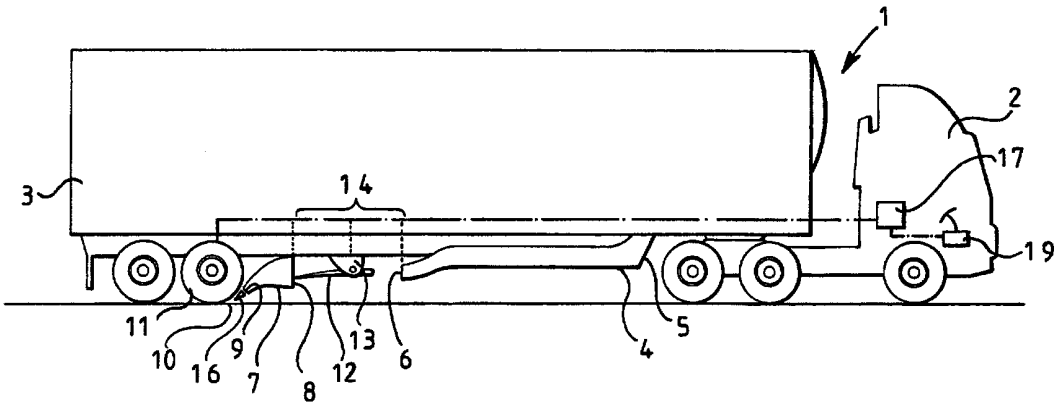
(54) Title: TRACTION ENHANCEMENT APPARATUS FOR A VEHICLE



(57) Abstract: An air guide for a land vehicle (1) comprises a duct (4, 7) having a forward opening (5) with respect to a direction of forward travel for receiving an air flow and a rearward opening (9) for issuing an air flow. The rearward opening (9) is adapted to direct the air flow to a road surface (10) immediately in front of at least one wheel (11) of the land vehicle (1) so as to displace water which may be present on the road surface (10), thereby improving the traction of the wheel (11). The duct (4, 7) may be formed as a forward duct (4) and a rearward duct (7) which are spaced from an in line with each other. An aerofoil (12) may then be mounted between a rearward opening (6) of the first duct (4) and a forward opening (8) of the second duct (7) and pivoted in the flow of air so as to impart lift or downthrust to the vehicle (1).

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TRACTION ENHANCEMENT APPARATUS FOR A VEHICLE

The present invention relates to an apparatus for improving the traction of a land vehicle and also, optionally, for improving the fuel and braking efficiency of the vehicle.

It is known, for example from GB-A-2 295 587, to provide a land vehicle with a roof-mounted aerofoil which serves to generate lift when the vehicle is in forward motion. The lift force helps to reduce the effective weight of the vehicle, thereby improving fuel consumption. However, such an arrangement is unsuitable for improving the traction of a land vehicle.

It is therefore an object of the present invention to provide an apparatus which is able to improve the traction of a land vehicle, for example under conditions of reduced traction, such as in wet conditions and/or when the land vehicle is unladen or only relatively lightly laden.

According to the present invention there is provided an air guide for a land vehicle having at least one wheel, the air guide comprising at least one duct having a forward opening at a forward end with respect to a direction of forward travel and a rearward opening at a rearward end, wherein the forward opening is adapted to

receive a flow of air when the vehicle is in forward motion, and wherein the rearward opening is adapted to direct the flow of air onto a land surface immediately in front of the at least one wheel.

By providing an air flow onto the land surface, which will generally be a road surface, immediately in front of the at least one wheel, any water which may be covering the land surface will tend to be blown away from the area in front of the wheel during forward motion, thus improving the traction of the wheel in wet conditions and helping to reduce spray from the wheel.

Advantageously, the duct is tapered so that the forward opening has a greater area than the rearward opening. This serves to increase the speed of the air flow through the duct and thereby to provide a high pressure flow of air from the rearward opening onto the land surface in order better to disperse water therefrom.

Generally, the duct is adapted to be mounted on the underside of the vehicle, although other positions are also possible provided that the rearward opening is situated just in front of the wheel.

Most land vehicles to which the present invention is applicable have at least one pair of wheels mounted one at each end of an axle. For these vehicles, the duct may

have two rearward openings, one directed towards the land surface immediately in front of each wheel. Alternatively, two ducts may be provided, one for each wheel. Advantageously, the rearward openings are angled inwards so as to deflect water to an area between the wheels, thereby reducing spray therefrom. Alternatively or in addition, there may be provided air-directing vanes downstream from the rearward openings so as to direct the airflow towards a central region beneath the vehicle.

Embodiments of the present invention are particularly effective when fitted to articulated vehicles having a tractor unit and a trailer unit. The duct may be arranged so as to deflect water from the land surface immediately in front of the rear wheels of the trailer unit, thereby improving their traction with respect to any front wheels of the trailer unit and the wheels of the tractor unit. This can help to reduce or prevent jack-knifing of the trailer unit during braking, since the rear wheels of the trailer unit will have more adhesion to the land surface than the front wheels, thereby exerting a rearward force at the rear end of the trailer unit which will tend to pull the trailer unit into line with the tractor unit.

A fan or propeller may be located within the duct and arranged such that rotation thereof due to air flow through the duct is used to generate electricity or to

pump air into a compressed air storage tank as a means of supplementing engine power, as described for example in the present applicant's co-pending International Patent Application No. PCT/GB00/03853, the disclosure of which is incorporated into the present application by reference.

As a further development of the present invention, the duct may be formed as two parts: a forward duct having a forward opening and a rearward opening and a rearward duct, spaced from and in line with the forward duct and having a forward opening and a rearward opening. A vehicle-mounted aerofoil may then be provided in the space between the forward and rearward ducts so as to interact with the airflow in such a way as to provide lift or downthrust, depending on its orientation, to the vehicle as a whole. Advantageously, the aerofoil is pivotally mounted so as to allow its angle of attack to be varied. The aerofoil may be pivotally mounted about a generally horizontal axis. The aerofoil may be pivotable through a range up to about 5 degrees below horizontal for generating lift. Alternatively or additionally, the aerofoil may be pivotable through a range up to about 30 degrees above horizontal for generating downthrust. In this way, the degree of lift or downthrust can be varied in accordance with requirements. For example, when the vehicle is undergoing normal forward motion, the aerofoil may be angled so as to provide lift to the vehicle as a

whole and thereby help to reduce fuel consumption. When the vehicle is braking, the aerofoil may be angled so as to produce a downthrust which will increase the apparent weight of the vehicle, thereby improving traction and reducing the stopping distance.

Preferably, the orientation of the aerofoil is automatically controlled by an on-board computer so as to provide lift or downthrust as required. By providing a pressure sensing means, such as a torque switch or strain gauge, and linking this with the suspension of the vehicle, it is possible to monitor with the computer the effect of any lift or downthrust on the vehicle as a whole. For example, the angle of attack of the aerofoil may be varied as the vehicle accelerates or decelerates so as to provide a substantially constant magnitude of lift. Alternatively or in addition, the aerofoil may be controlled in such a way that gentle braking does not cause the angle of attack to be changed, but in the event of harsh braking, such as an emergency stop, the aerofoil is pivoted so as to create a downthrust. This may be achieved, for example, by way of a pressure sensitive means, such as a pressure switch, which senses when brakes of the vehicle are being harshly applied above a predetermined threshold pressure.

The air guide of the present invention may be fabricated from various suitable materials, including plastics,

fibreglass, lightweight metals and the like. It may be retrofitted to existing vehicles, or may be provided as an integral component when manufacturing a new vehicle.

The present invention also concerns a land vehicle having at least one wheel and an air guide as hereinbefore defined, wherein the forward opening is adapted to receive a flow of air when the vehicle is in forward motion, and wherein the rearward opening is adapted to direct the flow of air onto a land surface immediately in front of the at least one wheel.

The present invention also relates to a land vehicle provided with an aerofoil mounted on the underside of the vehicle.

The aerofoil may be pivotable about a generally horizontal axis so as to allow its angle of attack to be varied.

A duct may be mounted on the underside of the vehicle, the duct having a forward opening at a forward end with respect to a direction of travel and a rearward opening at a rearward end, the forward end of the duct being adapted to receive a flow of air when the vehicle is in forward motion and the aerofoil being provided to receive the flow of air from the rearward opening of the duct.

For a better understanding of the present invention and to show how it may be carried into effect reference will now be made, by way of example, to the accompanying drawings, in which:

FIGURE 1 is a side elevation of a vehicle incorporating one embodiment of an air guide according to the present invention;

FIGURE 2 is an underplan view of the vehicle of Figure 1;

FIGURE 3 is a longitudinal cross-section through the vehicle of Figures 1 and 2 showing lift-generating air-flow; and

FIGURE 4 is a longitudinal cross-section through the vehicle of Figures 1 and 2 showing downthrust-generating airflow.

Referring now to Figures 1 and 2, there is shown an articulated vehicle 1 having a tractor unit 2 and a trailer unit 3. A first duct 4, for example of plastics material, is fitted to the underside of the trailer unit 3, the duct 4 having a forward opening 5 and a rearward opening 6. A second duct 7, for example also of plastics material, having a forward opening 8 and two rearward openings 9, is mounted on the underside of the trailer unit 3, spaced rearwardly from the first duct 4 and in

line therewith. The duct 7 is shaped so that the rearward openings 9 are directed towards a road surface 10 immediately in front of the rear wheels 11 of the trailer unit 3. A pivotally mounted aerofoil 12 is mounted between two supports 13 on the underside of the trailer unit 3 in the space 14 between the ducts 4 and 7, the aerofoil being pivotable about a generally horizontal axis. It may be seen that the forward opening 5 of the first duct 4 has a greater area than the rearward opening 6 (that is, the duct 4 is tapered), that the aerofoil 12 has a width corresponding substantially to that of the rearward opening 6 of the first duct 4 and to that of the forward opening 8 of the second duct 7, and that the combined area of the of the two rearward openings 9 of the second duct 7 is less than that of the forward opening 8. Figure 2 also shows in diagrammatic form the location of a fan or propeller 15 which is mounted in the first duct 4 and which is arranged so as to rotate upon the passage of air through the duct 4. Rotation of the fan or propeller 15 may be used to generate electricity to supplement the engine power of the tractor unit 2, to charge a battery (not shown) or to pump air into a compressed air storage tank (not shown) as a means of supplementing engine power as described, for example, in the present applicant's co-pending International Patent Application No. PCT/GB00/03853.

Figure 3 shows the vehicle 1 of Figures 1 and 2 in normal forward motion. Air is collected by the forward opening 5 of the first duct 4 and output from the rearward opening 6. Because the first duct 4 is tapered, the flow of air from the rearward opening 6 is faster than the flow of air into the forward opening 5. The flow of air from the rearward opening 6 is directed over the aerofoil 12 and then into the forward opening 8 of the second duct 7. The aerofoil 12 is pivoted between the supports 13 in such a way that under normal operating conditions the airflow over the aerofoil 12 generates lift, which serves to reduce the weight of the trailer unit 3 and thereby to help reduce fuel consumption. For example, the trailing edge of the aerofoil may be angled at up to about 5 degrees below horizontal so as to generate an appropriate lift. The air flow into the forward opening 8 of the second duct 7 is then directed by way of the rearward openings 9 towards the road surface 10 immediately in front of the wheels 11 of the trailer unit, and in wet conditions serves to displace water from the road surface 10 so as to improve the traction of the wheels 11. Again, due to the combined area of the rearward openings 9 being smaller than that of the forward opening 8, the flow of air out of the second duct 7 is faster than the flow of air thereinto.

Figure 4 shows the vehicle 1 of Figures 1 and 2 when braking. Air flows through the ducts 4 and 7 as before,

the only difference being that the angle of attack of the aerofoil 12 is changed by pivoting the aerofoil 12 between the supports 13 so as to produce a downthrust when air flows thereover. For example, the trailing edge of the aerofoil may be angled at up to about 30 degrees above horizontal, preferably in the range up to 25 to 30 degrees above horizontal, so as to generate an appropriate downthrust. The downthrust serves to increase the weight of the trailer unit 3, thereby improving traction and helping the vehicle 1 to decelerate more quickly. As before, the flow of air is directed from the rearward openings 9 of the second duct 7 onto the road surface 10 immediately in front of the rear wheels 11 of the trailer unit 3 so as to deflect any water therefrom. This has an important consequence when the vehicle 1 is braking: because the traction of the rear wheels 11 is increased relative to the wheels 16 of the tractor unit 2, thereby exerting a rearward force at the rear end of the trailer unit 3, the likelihood of the trailer unit 3 jack-knifing is much reduced.

As shown in Figure 2, the rearward openings 9 may be angled inwards so as to deflect water to an area between the wheels 11, thereby reducing spray from the wheels. Alternatively or in addition, as shown in Figure 1, there may be provided air-directing vanes 16 downstream from the rearward openings 9 so as to direct the airflow towards a central region beneath the vehicle.

Preferably, as illustrated diagrammatically in Figures 1 and 2, the orientation of the aerofoil is automatically controlled by an on-board computer 17 so as to provide lift or downthrust as required. By providing a pressure sensing means 18, such as a torque switch or strain gauge, and linking this with the suspension of the vehicle, it is possible to monitor the effect of any lift or downthrust on the vehicle as a whole. For example, the angle of attack of the aerofoil may be varied as the vehicle accelerates or decelerates so as to provide a substantially constant magnitude of lift. Alternatively or in addition, the aerofoil may be controlled in such a way that gentle braking does not cause the angle of attack to be changed, but in the event of harsh braking, such as an emergency stop, the aerofoil is pivoted so as to create a downthrust. This may be achieved, for example, by way of a pressure switch 19 which senses when the brakes of the vehicle are being harshly applied above a certain threshold pressure.

CLAIMS

1. An air guide for a land vehicle having at least one wheel (11), characterised in that the air guide comprises at least one duct (4, 7) having a forward opening (5) at a forward end with respect to a direction of forward travel and a rearward opening (9) at a rearward end, wherein the forward opening (5) is adapted to receive a flow of air when the vehicle is in forward motion, and wherein the rearward opening (9) is adapted to direct the flow of air onto a land surface (10) immediately in front of the at least one wheel (11).

2. An air guide as claimed in claim 1, characterised in that the forward opening (5) has an area greater than that of the rearward opening (9).

3. An air guide as claimed in claimed in claim 1 or 2, characterised in that the at least one duct (4, 7) is adapted to be mounted on an underside of the land vehicle.

4. An air guide as claimed in any preceding claim, characterised in that the at least one duct (4, 7) has two rearward openings (9), the openings being adapted to direct the flow of air onto a land surface (10) immediately in front of each of a pair of wheels (11) mounted at either end of an axle.

5. An air guide as claimed in claim 4, characterised in that the two rearward openings (9) are angled towards each other.

6. An air guide as claimed in claim 4 or 5, characterised in that air-directing vanes (16) are provided downstream from the rearward openings (9) so as to direct the airflow towards a central region beneath the vehicle.

7. An air guide as claimed in any preceding claim, characterised in that the air guide comprises a first duct (4) having a forward opening (5) at a forward end with respect to a direction of forward travel and a rearward opening (6) at a rearward end, and a second duct (7) spaced rearwardly from and in line with the first duct and having a forward opening (8) at a forward end and a rearward opening (9) at a rearward end, the rearward opening of the second duct being adapted to direct the flow of air onto a land surface (10) immediately in front of the at least one wheel (11), further comprising an aerofoil (12) located between the first and second ducts such that air flowing from the rearward opening (6) of the first duct into the forward opening (8) of the second duct passes over the aerofoil (12).

8. An air guide as claimed in claim 7, characterised in that the aerofoil (12) is pivotally mounted so as to allow its angle of attack to be varied.

9. An air guide as claimed in claim 8, characterised in that the aerofoil (12) is pivotally mounted about a generally horizontal axis.

10. An air guide as claimed in claim 9, characterised in that the aerofoil (12) is pivotable through a range up to about 5 degrees below horizontal for generating lift.

11. An air guide as claimed in claim 9 or 10, characterised in that the aerofoil (12) is pivotable through a range up to about 30 degrees above horizontal for generating downthrust.

12. An air guide as claimed in any one of claims 8 to 11, characterised in that the aerofoil (12) is pivotable under the control of a computer (17).

13. An air guide as claimed in claim 12, characterised in that pressure sensing means (18) is provided for linking with a suspension of the vehicle so as to be able to monitor with the computer (17) the effect of any lift or downthrust on the vehicle.

14. An air guide as claimed in claim 12 or 13, characterised in that pressure sensitive means (19) is provided to pivot the aerofoil (12) to create downthrust when brakes of the vehicle are being applied above a predetermined threshold pressure.

15. A land vehicle having at least one wheel (11) and an air guide as claimed in any preceding claim, characterised in that the forward opening (5) is adapted to receive a flow of air when the vehicle is in forward motion, and in that the rearward opening (9) is adapted to direct the flow of air onto a land surface (10) immediately in front of the at least one wheel (11).

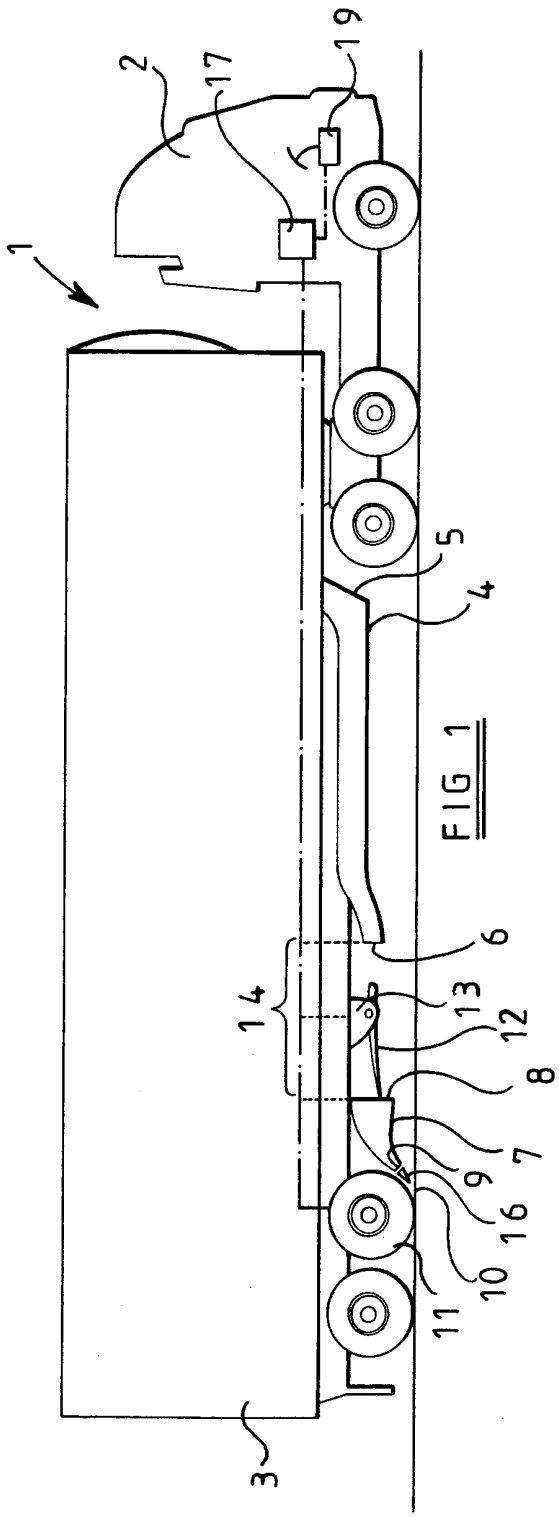
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FIG 1

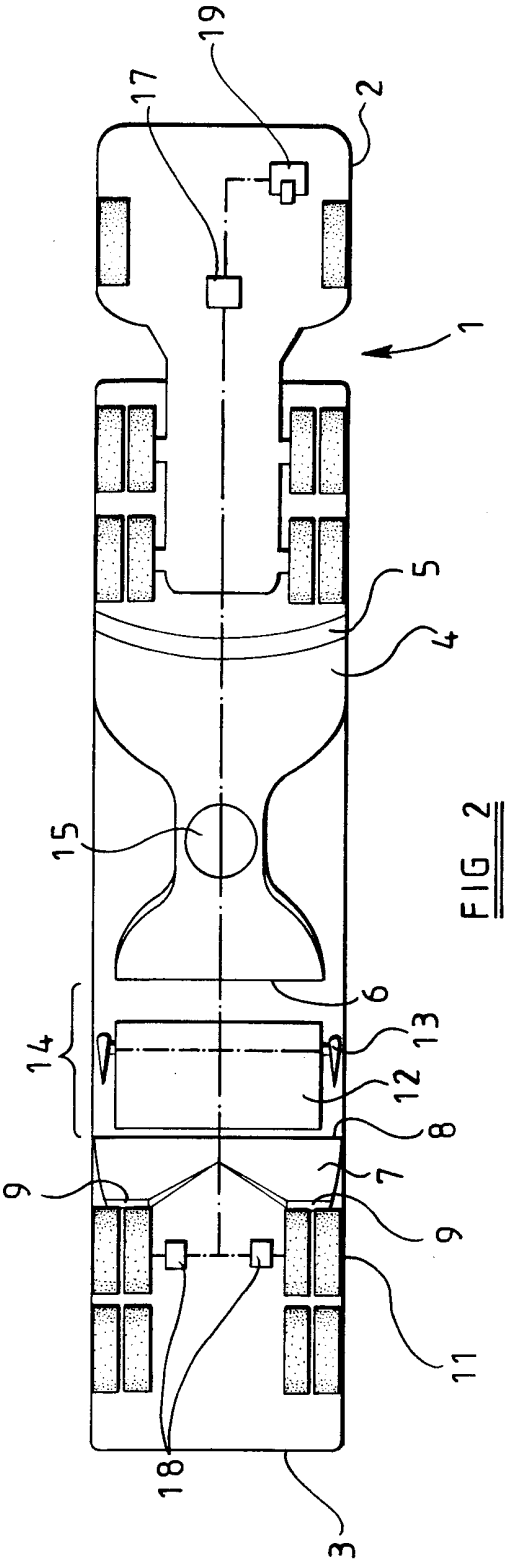
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FIG 2

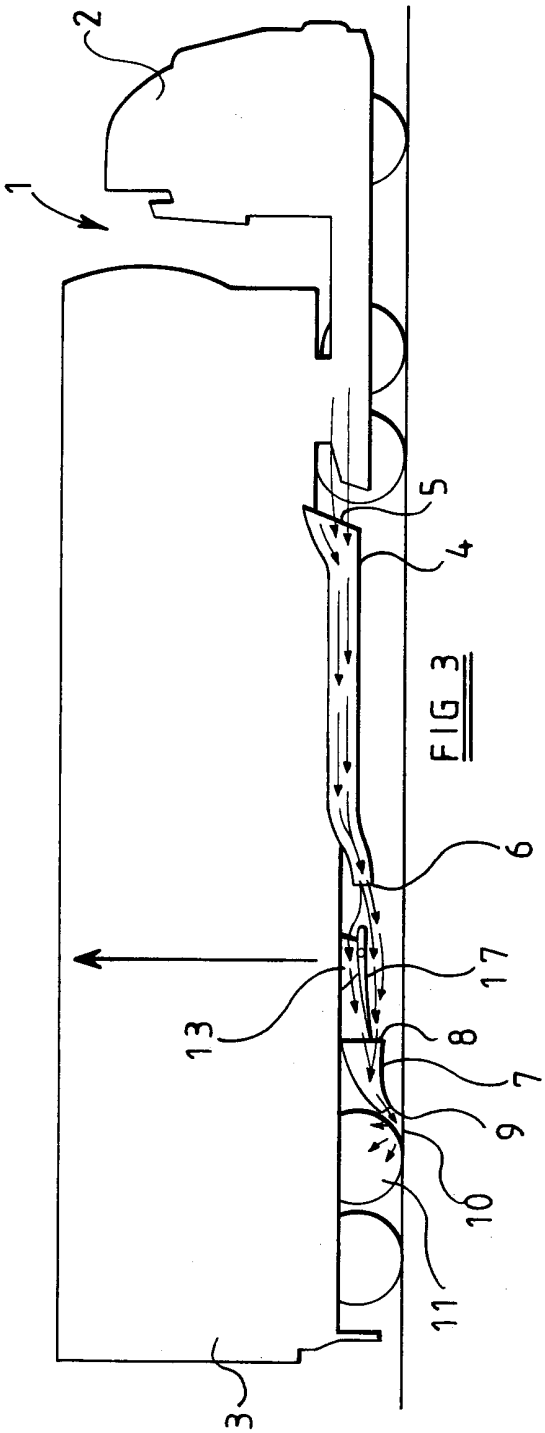

FIG 3

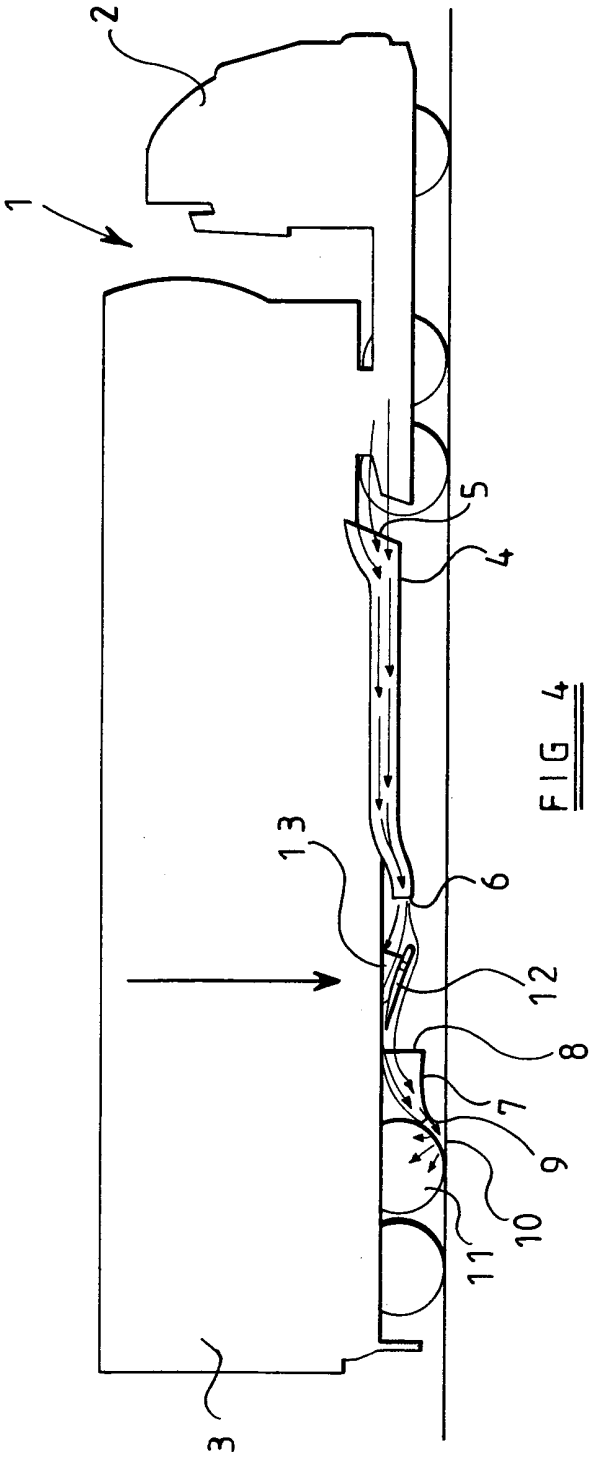

FIG 4

INTERNATIONAL SEARCH REPORT

Int(ional Application No
PCT/GB 00/04336

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B62D25/16 B62D35/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B62D

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 practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 219 974 A (WHITE KEVIN PETER) 28 December 1989 (1989-12-28) page 1, line 34 - line 35; claim 4; figure 1	1-6
A	GB 2 295 587 A (FLYNN JOHN PATRICK PETER) 5 June 1996 (1996-06-05) cited in the application the whole document	1,7

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

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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

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Date of the actual completion of the international search	Date of mailing of the international search report
15 February 2001	22/02/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Tamme, H-M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ional Application No
PCT/GB 00/04336

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2219974 A	28-12-1989	US 5074592 A	24-12-1991
GB 2295587 A	05-06-1996	NONE	