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Grignon et al.

[11] **3,804,197**

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[54] **FLUID-CUSHION-CONTAINING FACILITY FOR GROUND EFFECT MACHINE**

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[73] Assignee: **Bertin & Cie,** Plaisir, France

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **180/116,** 180/127

[51] **Int. Cl.** **B60v 1/16**

[58] **Field of Search** 180/116, 119, 126, 127

[56] **References Cited**

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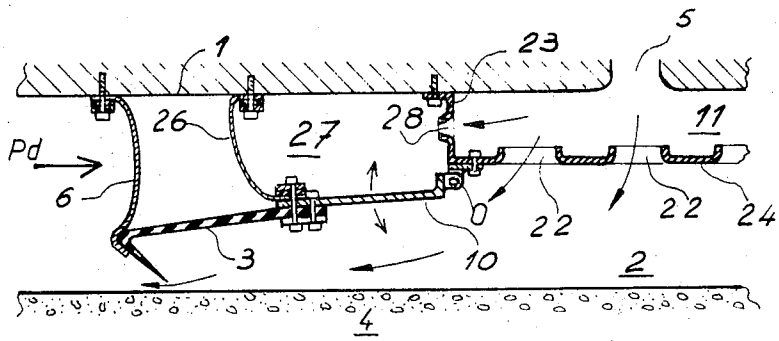
[57] **ABSTRACT**

The invention comprehends a ground effect machine having a moving frame near and opposite to a bearing surface with the interposition of a pressure fluid cushion which is contained at the front, as considered in the direction of movement of said machine, by a front wall adapted to move away from or towards said frame and co-operating with the bearing surface to bound a working cushion fluid leakage gap, said machine comprising means which are sensitive to the dynamic pressure produced by the speed of travel of said machine and which are so coupled with said front wall that any increase in dynamic pressure produces a relative movement of said front wall and said frame towards one another and vice versa.

6 Claims, 9 Drawing Figures



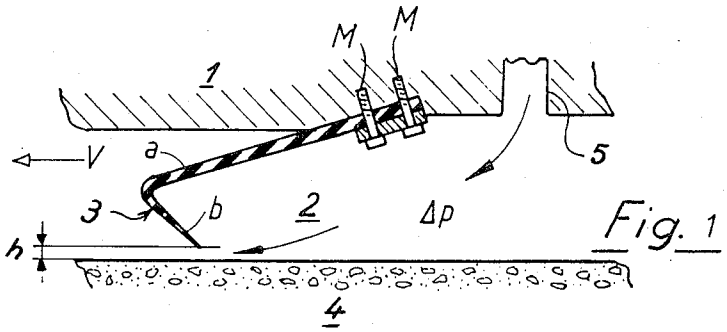


Fig. 1

Fig. 2

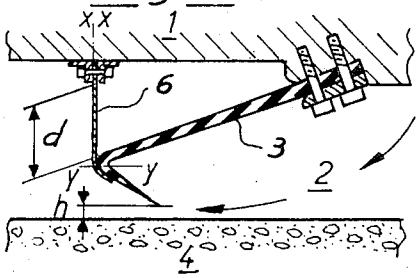


Fig. 3

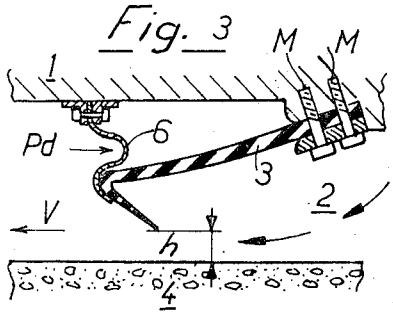


FIG. 4

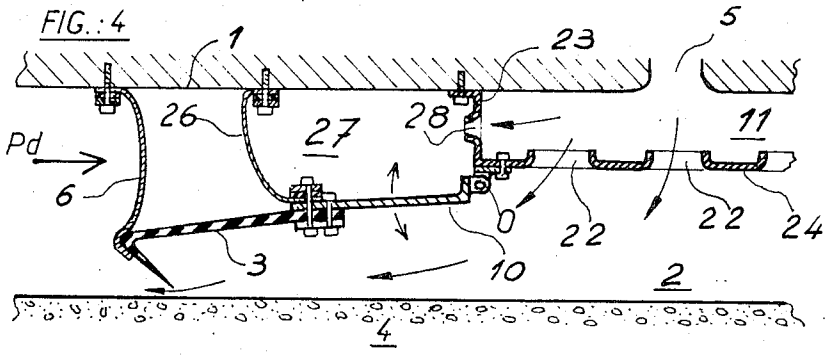


Fig. 5

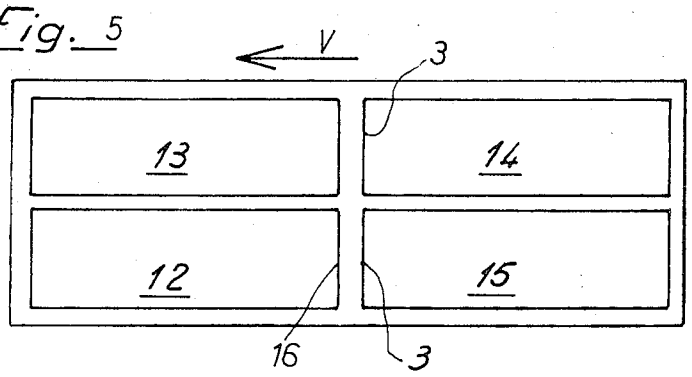


FIG.:6

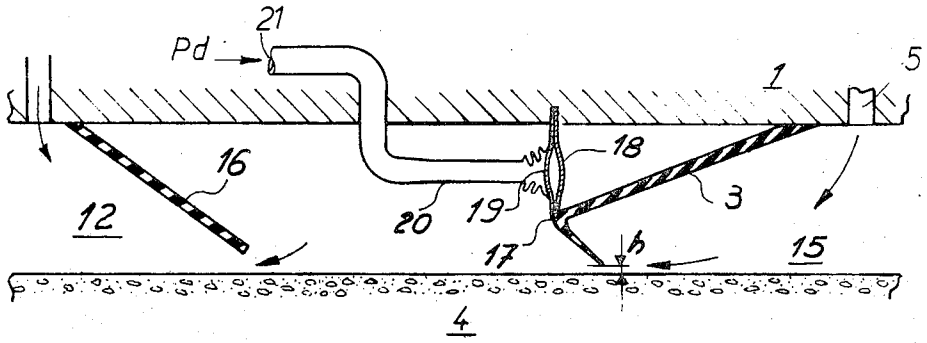


FIG.:6a

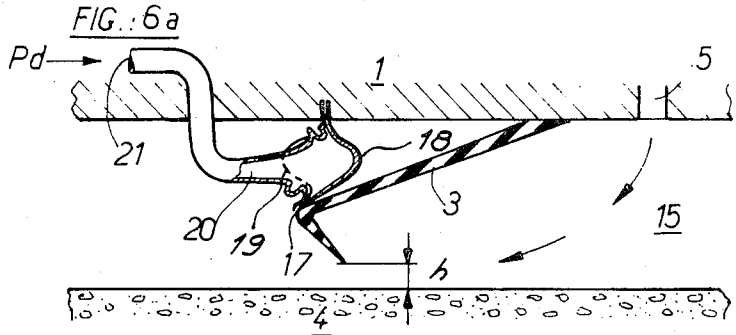
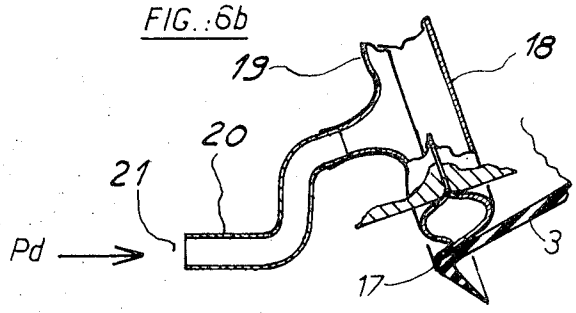


FIG.:6b



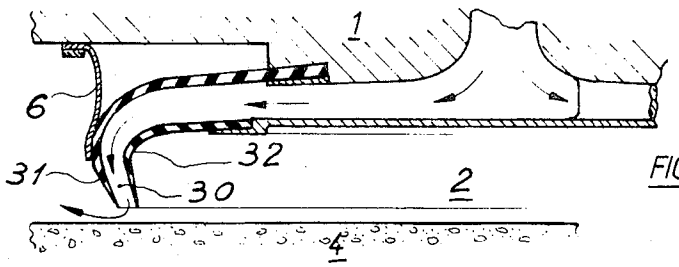


FIG.:7

FLUID-CUSHION-CONTAINING FACILITY FOR GROUND EFFECT MACHINE

French Patent Application 15.13276 discloses means for containing a fluid cushion providing lift or guidance for a vehicle moving along a bearing surface. Such means, known variously as containing seals or skirts or walls and embodied, with advantage by means of a flexible substance such as neoprene or some other elastomer, must of course be positioned near the bearing surface, otherwise there is an excessive leakage of pressure fluid from the cushion and so a prohibitively large generator is needed. On the other hand, if the containing wall is too near the bearing surface, frequent rubbing contacts between the wall and the surface due to the inevitable irregularities of the latter lead of course to premature wear of the walls and to the vehicle passengers suffering discomfort.

These disadvantages are all the more noticeable if the contacting occurs repeatedly and periodically as in the case of a tracked ground effect machine, for the track or guideway may consist of elements of identical length interconnected by way of sealing or expansion joints. The repeated passage of the walls, often at a constant speed, over the joints causes impacts and rapid wall wear.

It is an object of this invention to improve the cushion-containing means so as to greatly reduce contact between the containing wall and the bearing surface opposite thereto. The invention is of use more particularly for cushions whose front containment takes the form of a front wall adapted to move away from or towards the ground effect machine frame or chassis and to co-operate with the bearing surface to bound a working cushion fluid leakage gap or daylight clearance.

According to this invention, means sensitive to the dynamic pressure produced by the speed of travel of the machine are so coupled with the front wall that any increase in dynamic pressure produces a relative movement of the front wall and of the frame or chassis towards one another and vice versa.

The following description, made with reference to the accompanying exemplary non-limitative drawings, will show clearly how the invention can be carried into effect.

In the drawings:

FIG. 1 is a diagrammatic view in partial longitudinal section showing a front cushion-containing wall according to this invention;

FIGS. 2 and 3 are views similar to FIG. 1 showing two different positions of such a wall under the control of a dynamic pressure detector according to a feature of this invention;

FIG. 4 is a similar view showing a constructional variant of this invention;

FIG. 5 is a very diagrammatic inverted plan view of a multiplecushion ground effect machine;

FIG. 6 is a diagrammatic view in partial longitudinal section of a dynamic pressure detector according to another feature of this invention;

FIGS. 6*a* and 6*b* show the operation of the device shown in FIG. 6; and

FIG. 7 is a sectioned view showing a facility according to the invention as used with curtained pressure fluid spaces.

To facilitate the description now to be given, a machine borne and/or guided by one or more fluid cushions will hereinafter be called an air cushion vehicle, and the facility containing the air cushion will hereinafter be called a skirt.

Referring to FIG. 1, there can be seen the bottom of a vehicle frame or chassis 1 borne by an air cushion 2 contained by a flexible skirt 3 above a bearing surface 4. Compressed air is supplied by a generator (not shown) through a line 5; once the overpressure Δp in the cushion becomes sufficient to lift the air cushion vehicle (ACV), the air escapes below the skirt 3 through a daylight clearance of height h.

Preferably, the skirt 3 in shape resembles a dihedron with an angle projecting to the front, the dihedron top part a which is contiguous with the frame 1 being secured therein along a line defined by securing means MM, the bottom part b being free and determining the leakage gap. The bottom part b slopes towards the inside of the vehicle so as to be able to follow random unevennesses and to retract when obstacles are passed over so as to offer very little resistance.

Once sufficient overpressure Δp has been reached in the space or enclosure 2 to bear the vehicle weight, a leakage of air occurs via the daylight clearance gap h around the skirt periphery.

According to the invention, so that the skirt bottom edge does not strike obstacles higher than the height h, the facility shown in FIG. 2 is used, where a flexible and preferably impermeable cloth 6 extends over the whole front width of the skirt 3 and is secured to the frame 1 along a line xx and to the vertex edge of the skirt along a line yy, the joints along these two lines — which are spaced apart from one another by a distance d — being hermetic in the direction of vehicle movement, although the two substantially triangular side sections at the ends stay open to atmosphere — i.e., they experience atmospheric pressure at zero speed.

When the vehicle is stationary and the lift overpressure Δp is produced in the enclosure 2, the two surfaces of the cloth or diaphragm or the like 6 are in contact with the surrounding air at atmospheric pressure, and so the pressure acting on these two surfaces is equal to atmospheric pressure.

When the vehicle starts to move in the direction indicated by an arrow V in FIG. 3, the front surface of the diaphragm 6 experiences a dynamic pressure Pd arising from the speed of vehicle movement. Since the pressure Pd is above atmospheric pressure, the space between the inside surface of cloth 6 and the frame 1 is at a slight negative pressure and the cloth 6 tends to become concave in shape, so that the distance d lessens and the dihedron wall 3 rises around its fixing axis MM, so that the daylight clearance h increases. Since the pressure fluid generator has particular pressure and delivery characteristics and performances, the fluid delivery to cushion 2 stays the same for a given speed of movement. Depending upon the speed of movement, the rate of fluid escape from the cushion is proportional to the difference between cushion pressure and the dynamic pressure. Consequently, for a given cushion width and for a given vehicle speed (and therefore for a given dynamic pressure) the daylight clearance height h is controlled by a corresponding variation of the width d of the diaphragm 6.

Another possible use is shown in FIG. 4, where the skirt 3 is connected to the frame 1 via a suspension de-

vice. Pressure fluid is supplied by a compressor (not shown) to the cushion **2** through a line **5** which opens into a first expansion chamber **11** and then, by way of a pressure reducer **22** in the bottom **24** of chamber **11**, in the chamber or space **2**.

The wall containing the cushion **2** is embodied as a rigid plate **10** adapted to pivot around a transverse pivot O extending along side curtain **23** of expansion chamber **11**. Advantageously, plate **10** is extended outwardly by a flexible curtain **3** in shape substantially resembling a dihedron.

Connection of the plate **10** and lip **3** to frame **1** is by means of a diaphragm **26**, which therefore bounds a chamber **27** which, by way of apertures **28**, is maintained at substantially the same pressure as the expansion chamber **11**. The edge line of the dihedron **3** is connected to the frame **1** by a diaphragm **6** which is of a kind according to this invention and which, when it experiences the dynamic pressure Pd due to vehicle movement, moves member **3** away from the surface **4** over which the vehicle is travelling.

The invention is also of use for an air cushion contained by a flexible containing wall or skirt disposed elsewhere than at the front of the vehicle as, for instance, in the case of a cushion disposed behind a front cushion, as shown in FIGS. **5** and **6**, where two front cushions **12, 13** are followed by two rear cushions **14, 15.**

The facility according to this invention is suggested for the front skirts **3** of the rear cushions **14, 15.** As can be seen more clearly in FIG. **6**, the front skirt **3** of the rear cushion **15** is disposed behind the rear skirt **16** of the front cushion **12.** The dihedron edge line **17** is connected to the underside of the vehicle frame or chassis **1** by two substantially rectangular flexible diaphragms **18, 19** hermetically joined together over their entire periphery. Secured to front diaphragm **19** is an elbowed tube **20** whose inlet orifice **21** is positioned directly in the area of dynamic pressure Pd when the vehicle is moving, as can be seen in FIGS. **6***a* and **6***b*. In this case there is a delivery of air at the dynamic pressure (as defined by the diameter of the tube **20** and by the dynamic pressure) through the tube into the load or pressure cell formed by the diaphragms **18, 19,** this air tending to separate the diaphragms **18** and **19** fron one another and thus move the edge line **17** towards the underside of frame **1.**

A description has been hereinbefore given of air cushions contained at the front by physical containing skirts or walls or the like forming a solid front wall. However, the facility according to the invention is of course also of use with curtained cushions, as can be seen in FIG. **7**, which shows a pressure fluid chamber **2** contained by a peripheral curtain delivered by a nozzle **30** bounded by two flexible walls **31, 32.** The flexible diaphragm **6** according to this invention connects the outside wall **31** to the vehicle frame **1.** Consequently, the curtain-forming nozzle **30** can have its position between frame **1** and bearing surface **4** adjusted, and its relative position is controlled by the dynamic pressure, after appropriate detection by the diaphragm **6.**

We claim:

1. A ground effect machine having a frame movable along a bearing surface with the interposition of a pressure fluid cushion of polygonal planshape having a rectilinear front side transverse to the direction of motion of said machine, comprising:

adjustable cushion seal means defining said front side and comprising an angular-shaped wall having two generally planar wall portions interconnected through a generally dihedral edge, one of said wall portions projecting forwardly and at obliquity from an edge thereof attached to said frame towards said bearing surface up to said dihedral edge and the other of said wall portions projecting rearwardly and at opposite obliquity from said dihedral edge toward said bearing surface up to a free daylight-clearance bounding edge, whereby said dihedral edge occupies a foremost location on said angular-shaped wall and forms a leading edge thereof extending transversely with respect to said direction of motion, and

dynamic pressure sensitive means responsive to the air speed of said machine and interposed between said frame and said leading edge, for urging said leading edge towards said frame upon an increase in dynamic pressure being sensed by said pressure means, and conversely.

2. Machine as claimed in claim **1**, wherein said former-mentioned planar wall portion is relatively large and forms a major arm of said angular-shaped wall, and said latter-mentioned planar wall portion is relatively small and forms a minor arm of said angular shaped wall.

3. Machine as claimed in claim **2**, wherein said leading edge, said free daylight-clearance bounding edge and said attached edge of said angular-shaped wall are successively spaced from front to rear, said free edge being located intermediate said leading edge and said attached edge with respect to said direction of motion.

4. Machine as claimed in claim **2**, wherein said angular-shaped wall is throughout of resilient material and said wall portions are interconnected at said dihedral edge to form a unitary V-shaped flexible element.

5. Machine as claimed in claim **4**, wherein said dynamic pressure sensitive means comprises a flexible inextensible sheet-like member extending transversely with respect to said direction of motion and having both its faces exposed to ambient air.

6. Machine as claimed in claim **4**, further comprising a rigid plate hinged to said frame about a transverse axis, said former-mentioned wall portion having said attached edge thereof fixed to said hinged plate.

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