United States Patent [19]

Bertin

[11] **3,900,079**

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[54] **GROUND EFFECT MACHINE PRESSURE FLUID CUSHION CONFINING WALLS**

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

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[30] **Foreign Application Priority Data**

Sept. 5, 1972 France 72.31401

[52] **U.S. Cl.** **180/121;** 180/128

[51] **Int. Cl.** **B60v 1/04**

[58] **Field of Search** 180/121, 127, 126, 124, 180/116, 117, 128

[56] **References Cited**

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Attorney, Agent, or Firm—A. W. Breiner

[57] **ABSTRACT**

A ground effect machine having at least one cushion comprises juxtaposed elementary skirts each fed with pressure fluid, the edge by which each of these skirts is fixed on the machine comprising two substantially rectilinear and opposite elements in such manner that two adjacent skirts touch along their height by a portion of their substantially plane wall. The tension of the skirts, which ensures their stability of shape despite the slight difference between their fixing section and their opening section, is obtained by means of a permeable wall fixed towards the bottom of the skirt and formed with fluid passages the sum of the sections of which is less than the section of the skirt supply conduit so as to maintain a fluid pressure in the top part of the skirt. The permeable wall is designed and adapted to inflate under the effect of said tension and have a curved profile with its convexity directed towards the contact surface which the machine cooperates.

4 Claims, 10 Drawing Figures

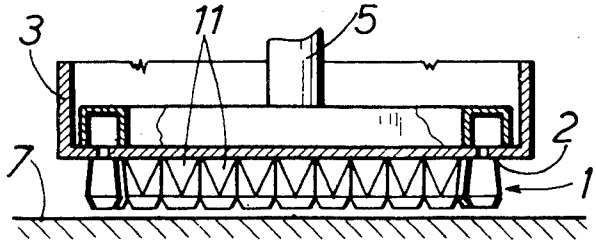


FIG.:1

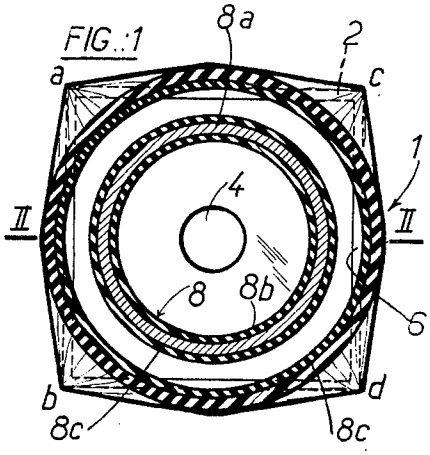


FIG.:2

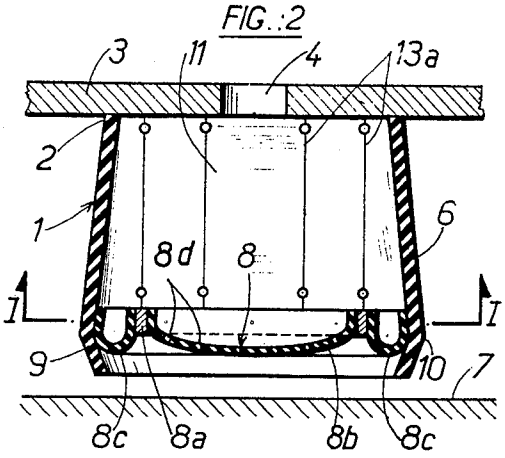
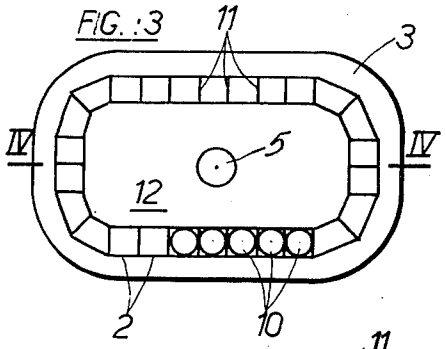


FIG.:3



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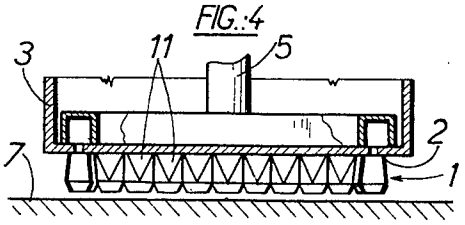


FIG.:6

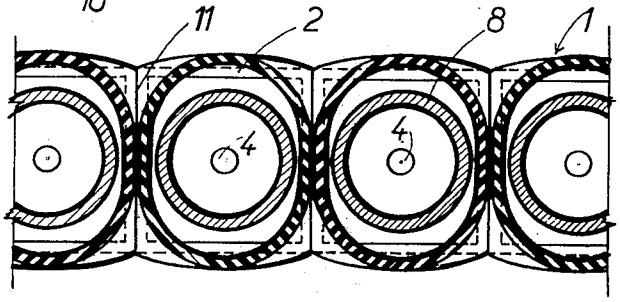
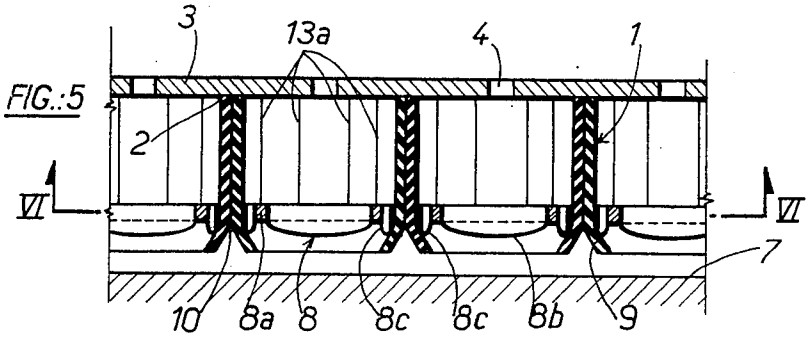


FIG.:5



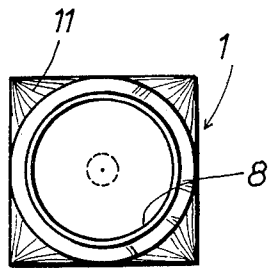


FIG.:8

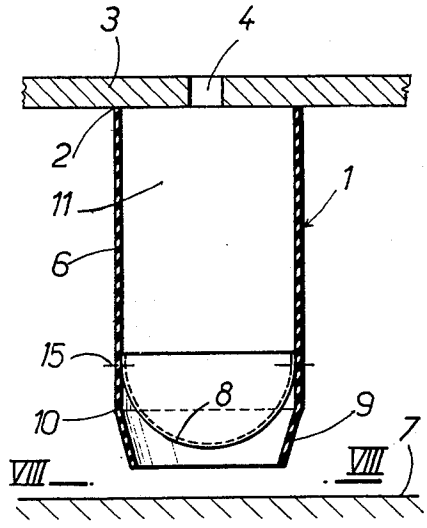


FIG.:7

FIG.:9

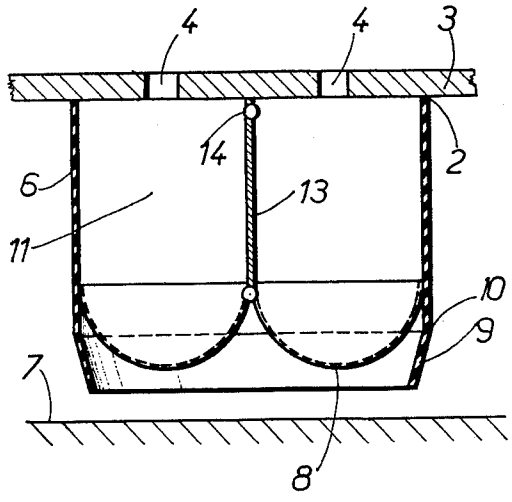
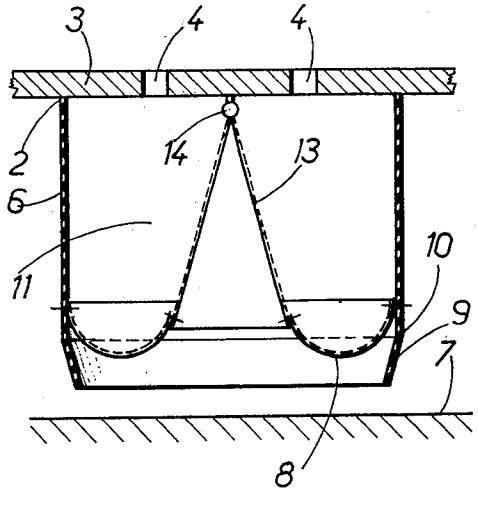


FIG.:10



GROUND EFFECT MACHINE PRESSURE FLUID CUSHION CONFINING WALLS

This invention relates to a means for confining a pressure fluid cushion for a ground effect machine cooperating with a bearing surface along which it can move, the said means enabling appreciable pressures to be contained while having great flexibility in a direction substantially perpendicular to the said surface.

Ground effect machines are known which have a platform or other structural part and which move with respect to a bearing surface with the interposition of a pressure fluid cushion system making use of one or, preferably, more flexible bodies secured to the said structure from which they project in the direction of the said bearing surface as far as a free end adjacent the latter, each flexible body being formed on the one hand by an endless fluidtight wall forming a skirt and, on the other hand, a transverse partition which is permeable to the said fluid and connected peripherally to the said endless side wall near the said free end so as to define a first space directly fed with pressure fluid and extending from the said structure to the said transverse partition, and a second space fed by the fluid after it has passed through the said partition and extending from the latter to the said bearing surface.

Flexible bodies of this kind are known wherein the permeable transverse partition is designed to produce an appreciable pressure loss as the said fluid passes through it and is therefore subjected to a relative excess pressure which biases it in the direction of the said bearing surface, the extension of the said flexible body in the direction of thhe said bearing surface being ensured essentially by the said relative excess pressure which is exerted on the said permeable transverse partition.

This procedure, which comprises tensioning or stressing the fluid cushion confining walls by a means specifically introduced for that purpose, is particularly suitable for cases in which the confining means comprises flexible tubular skirts individually receiving the fluid which takes part in lifting the machine.

It has been found that even when appreciable pressures are applied in the inner fluid cushion space, thereby urging such tubular skirts outwardly, the latter no longer tend to be outwardly deflected, and therefore retain their effectiveness.

The object of the present invention is to provide a system of contiguous individual skirts disposed consecutively along the entire periphery of the machine structure in order to confine therein an inner pressure fluid cushion.

To embody such a system, it has already been proposed to use skirts having a evolutive shape i.e., a shape developing from a square or polygonal section at their end fixed to the structure of the machine, to a substantially circular or round section at the opposite free end adjacent the bearing surface (see Bertin U.S. Pat. Nos. 3,369,623 and 3,414,075).

The perimeter by which skirts of this kind are fixed on the machine structure is characterised in that it comprises two substantially rectilinear and opposite elements so that two adjacent skirts are in mutual contact engagement over their height along a substantially plane wall portion. The remainder of the fixing perimeter between these two opposite rectilinear elements may comprise two connecting rectilinear elements so

that the perimeter forms a square or like geometric figure.

The invention is particularly advantageous with skirts of this kind because, since two adjacent skirts must touch along a substantially plane wall, these skirts cannot be given a marked tapered shape and so the pressure of the fluid contained in the skirt has practically no effectiveness to keep the skirt inflated and extended as is the case with conical skirts whose opening area may be much smaller than that of their fixation end (see Bertin, U.S. Pat. No. 3,388,766).

If skirts of this no-or small-taper kind are provided with a transverse partition causing a pressure loss, and bulging towards the bearing surface, then the internal action of the pressure and tension in the downward direction as exerted on these skirts results very satisfactorily in inflation of the skirts and good reciprocal application of the adjacent skirts together with good resistance to crushing and effective damping of the impact of the waves in case of a water - going vehicle.

The invention will be more readily understood from the following description with reference to the accompanying drawings, which is given by way of example.

FIG. **1** is a diagrammatic cross-section on the line I—I in FIG. **2** showing a skirt provided with the improvement according to this invention.

FIG. **2** is a longitudinal section of this skirt on line II—II in FIG. **1.**

FIG. **3** is a diagrammatic bottom plan view of a ground effect machine provided with contiguous individual skirts confining an inner cushion.

FIG. **4** is a diagrammatic longitudinal section on the line IV—IV in FIG. **3.**

FIG. **5** is a partial longitudinal section to an enlarged scale, similar to that in FIG. **2,** of the system of skirts shown in FIGS. **3** and **4.**

FIG. **6** is a cross-section of the line VI—VI in FIG. **5.**

FIG. **7** is a diagrammatic longitudinal section of a alternative embodiment according to this invention.

FIG. **8** is a bottom plan view on the line VIII—VIII in FIG. **7.**

FIGS. **9** and **10** are diagrammatic longitudinal sections of two other alternative embodiments.

Referring to the drawings, a skirt **1** is fixed at **2** beneath a ground effect machine **3** and receives pressure fluid from a supply conduit **5** via an orifice **4** formed in the machine.

The skirt **1** comprises a main tubular body **6** which extends towards the bearing surface **7** and the cloth of which is tensioned mainly by a permeable transverse partition **8** which produces appreciable pressure loss and is fixed peripherally towards the end of the main body **6** remote from the machine structure **3.** Passages of calibrated section **8***d* are formed in the partition **8,** the sum of the sections of the said passages being less than the section of the supply conduit **4.**

To protect the permeable transverse partition **8** against wear or tearing due to contact with the surface **7,** the main body **6** is extended in the direction of the latter by a flexible tapering end **9.**

The skirt is of evolutive configuration which is sometimes known as a "square-round skirt" of the type described in Bertin, U.S. Pat. No. 3,369,623 and suitable for juxtaposition with like skirts to constitute a system of contiguous skirts. In plan view it has a polygonal, for example square, shape at its end **2** connected to the machine structure **3,** and a substantially circular shape

at its free end **10** adjacent the bearing surface **7**. More generally, the perimeter of its end **2** fixed to the machine structure has two opposite sides *a b* and *c d* which are substantially rectilinear and parallel to one another. Also, laterally it has a substantially plane portion **11** of a general trapezoidal shape bearing on one of the rectilinear side *a b* and *c d*, which affords efficient contact engagement with the corresponding adjacent plane portion of a contiguous skirt.

In the case of a peripheral assembly of juxtaposed individual skirts **1** which bounds an inner cushion space **12**, the diameter of circle **10** may be substantially equal to, or alternatively slightly greater than, the side of the square **2**. In this way the contiguous skirts have larger wall areas in mutual contact engagement, and this improves sealing-tightness and the efficiency of the peripheral confining assembly. Also, the cushion fluid wetted area on the bearing surface **7** and hence the stability of the machine is increased.

According to this invention, each skirt is provided with a pressure loss entailing permeable partition **8** formed by a flexible web which, under the effect of the pressure, inflates to have a profile with its convexity facing the bearing surface **7**.

The web **8** is required to exert on the skirt **1** a force directed substantially along the wall of the said skirt, the effect of this being not only to stretch the skirt towards the bearing surface **7** but also to increase its resistance to transverse crushing.

It should also be noted that the convex permeable web **8** can, as a result of its flexibility, undergo deformation under the effect of an impact directed towards the machine structure **3**, for example that of a strong wave. In this way it forms a means of damping such an impact, and this provides effective protection, particularly of the supply means.

Finally, the fixing of the permeable flexible web **8** on the skirt **1** which is itself formed by a flexible wall can be carried out simply (for example by sewing, glueing etc.,). In this way it is possible to use a web **8** which is fixed solely to the skirt **1** over its periphery at **15** (FIGS. **7** and **8**).

However, in the case of a skirt having a large diameter and if it is desired to satisfy the above conditions, the magnitude of deflection of the web **8** is liable to be excessive. It can then be given a cusp, for which purpose it may be connected by one or more tie-rods **13** to the structure of the machine **3**.

In this way, in accordance with the embodiments shown in FIGS. **9** and **10**, the web **8** is connected to the machine **3** at a single fixing point **14**.

According to another embodiment (FIGS. **1** to **6**), the permeable partition **8** is made in three parts:

a rigid or relatively non-deformable ring **8***a* connected to the machine structure **3** by tie-rods **13***a*.

a central permeable wall **8***b* fixed to this ring.

a peripheral permeable flexible web **8***c* fixed on the one hand to the ring **8***a* and on the other hand to skirt **1**, said peripheral portion having a part toric shape.

FIGS. **1** and **2** illustrate a "square-round" skirt provided with such a pressure-loss entailing permeable partition **8**. The area of the square **2** may be greater than that of the circle **10** although the diameter of the latter is slightly greater than the sides of the square.

FIGS. **3** and **4** are diagrammatic views of an assembly of contiguous "square-round" individual skirts of the kind shown in FIGS. **1** and **2**, which bound an inner cushion **12**.

FIGS. **5** and **6** are views of this confining assembly to an enlarged scale. The skirts are pressed against one another.

We claim:

1. A ground effect machine having a rigid frame movable along a bearing surface with the interposition of pressure fluid cushions, comprising:

a plurality of individual skirts depending from said frame in juxtaposition next to each other along the periphery of said frame to form by their overall succession a peripheral enclosure for an inner cushion space between said frame and said bearing surface, each of said skirts having two opposite smooth side wall portions which are substantially planar and which extend from said frame over a substantial fraction of the overall extension of the skirt towards said bearing surface, said skirts being fitted so that the adjacent planar smooth wall portions of contiguous skirts tightly apply against each other in areal contact engagement, and

a fluid permeable flexible partition extending transversely across each skirt between those ends of the two opposite planar smooth wall portions thereof which are remote from said frame, said fluid permeable flexible partition being designed for offering some resistance to fluid flow therethrough from the inside of the skirt towards said bearing surface thereby causing a pressure drop upon traverse by said fluid flow and bulging towards said bearing surface to develop a force which extends the skirt away from said frame and stretches likewise both the planar smooth wall portions thereof.

2. Machine as claimed in claim **1**, wherein said fluid permeable flexible partition comprises an incorporated rigid ring inwardly spaced from the skirt wall portion and braced to said frame, whereby said flexible partition presents a multi-cusp outline with an inner bulging section surrounded by said rigid ring and an outer bulging section intermediate said ring and said skirt wall portion.

3. Machine as claimed in claim **2**, comprising a plurality of ties bracing said rigid ring to said frame and connected to spaced points distributed peripherally along said ring.

4. Machine as claimed in claim **3**, wherein said outer bulging section is of part toric shape.

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