United States Patent

[11] 3,620,325

[72] Inventors **Marc Faure**
Saint-Maur-Des-Fosses;
Louis Arsandaux, deceased, late of Paris, France by Marthe Marie Louis Arsandaux, legal representative

[21] Appl. No. **870,543**
[22] Filed **June 10, 1968**
[45] Patented **Nov. 16, 1971**
[73] Assignee **Societe D-Etudes et De Developpement Des Aeroglisseurs Marins Terrestres Et Amphibies S.E.D.A.M.**
Paris, France
[32] Priority **June 8, 1967**
[33] **France**
[31] **109,638**

[54] **DEFORMABLE SKIRTING SYSTEM FOR SURFACE EFFECT MACHINE**
8 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **180/127,** 161/47, 161/55, 161/76, 161/98
[51] **Int. Cl.** **B60v 1/16**
[50] **Field of Search** 180/127, 121; 161/47, 55, 57, 76, 98

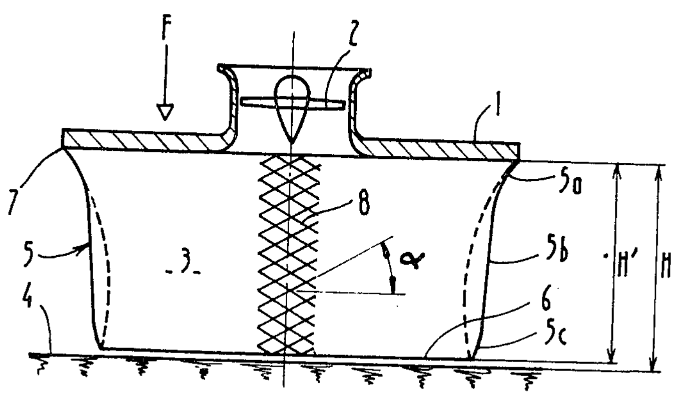
[56] **References Cited**

UNITED STATES PATENTS

526,546	9/1894	Straus	161/76
1,334,796	3/1920	Robinson	161/55 X
1,427,708	8/1922	Williams	161/98 X
3,211,246	10/1965	Lewis	180/127
3,212,627	10/1965	Beebee	161/55 X
3,327,797	6/1967	Bertin	180/127
3,371,738	3/1968	Bertin	180/127
3,438,457	4/1969	Guienne et al.	180/121
3,511,331	5/1970	Landry	180/127

Primary Examiner—A. Harry Levy
Attorney—Stevens, Davis, Miller & Mosher

ABSTRACT: A ground effect machine having a deformable skirt of heterogeneous structure which comprises (i) a flexible reticulated reinforcement structure formed of an interwoven array of wires or cables, and (ii) a flexible fluidtight lining which embeds or is otherwise joined to said reticulated structure and which is formed of a closed continuous surface, said wires or cables being oppositely inclined with respect to meridian lines of said lining surface as well as to parallels thereof.



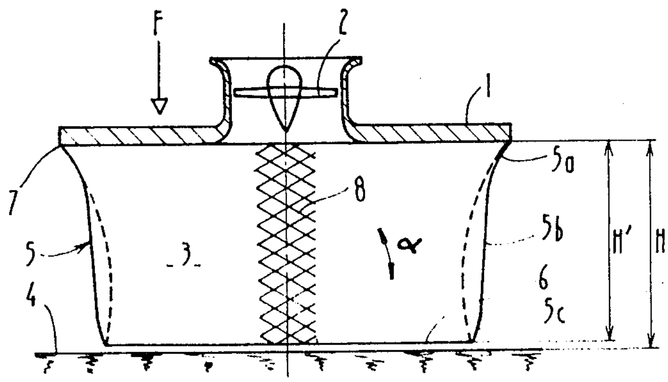


Fig. 1

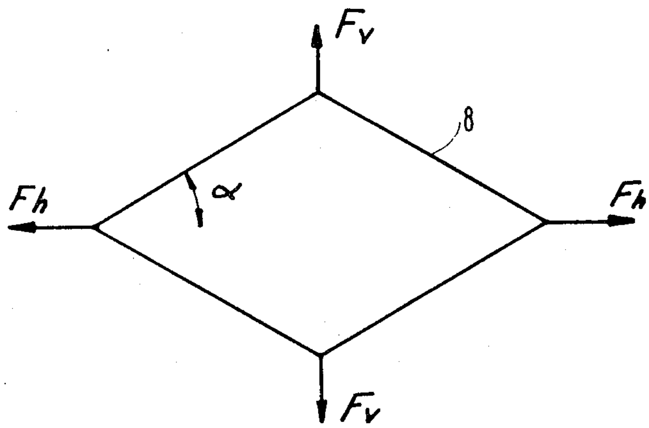


Fig. 2

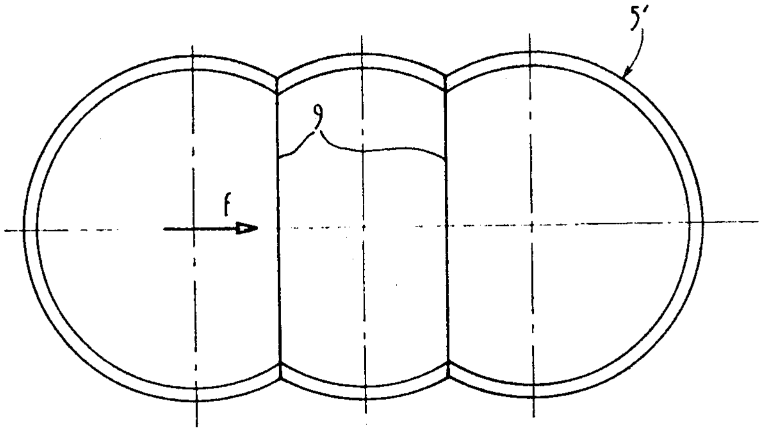


Fig. 3

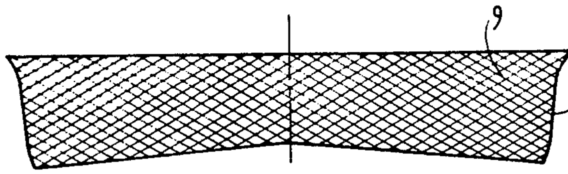


Fig. 4

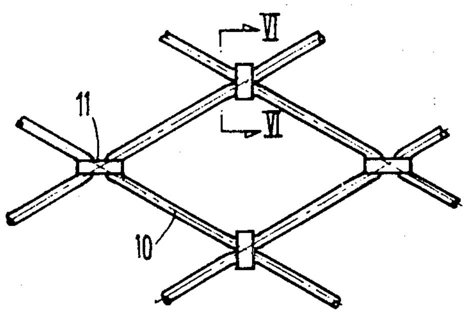


Fig. 5

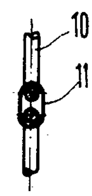


Fig. 6

FIG.: 9

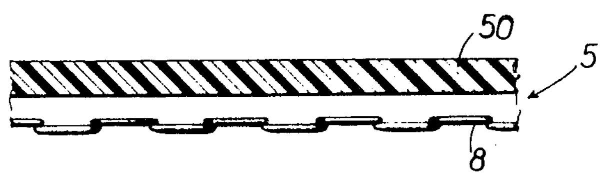


FIG.: 7

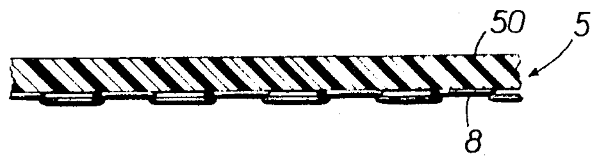
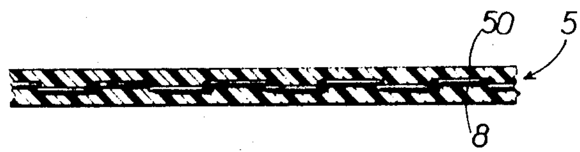


FIG.: 8



DEFORMABLE SKIRTING SYSTEM FOR SURFACE EFFECT MACHINE

The present invention relates to a deformable skirting system for air cushion vehicles or other surface effect machines, which forms a flexible sidewall for a plenum chamber in which the pressure fluid cushion is formed.

Such deformable skirts are often given in practice a tapering outline at least adjacent their free end with a cross section which is circular or part circular, e.g. a frustoconical shape, as described in BERTIN U.S. Pat. No. 3,388,766.

The present invention relates more specifically to a deformable skirt of heterogeneous structure comprising a flexible coating of fluidtight material forming a closed continuous surface having meridian lines—e.g. generatrices in the case of a surface of revolution—defined by the intersections of said surface with longitudinal planes and parallels—e.g. directrices in the above-mentioned case—defined by the intersections of said surface with transverse planes, said flexible coating being joined to a flexible reticulated brace formed of an interlocked meshwork of wires, cables, filaments or the like (hereinafter referred to as "wires").

In accordance with the invention, said wires have opposite inclinations with respect to both said meridian lines and said parallels.

In a preferred embodiment of the present invention, said wires extend along helices in one or more layers, the helices forming, with said transverse planes, an angle whose tangent is smaller than or equal to $1/\sqrt{2}$, that is an angle smaller than or equal to 35.4°.

The results attained with the heterogeneous skirt of the present invention are as follows:

the reinforcement wires undergo tensile stress only and therefore have a long life,

any pressure increase inside the skirt causes its shortening and therefore cushion volume decrease, thus ensuring good suspension of the vehicle,

any increase in load causes a decrease in skirt height, resulting in a decrease in vertical accelerations over waves or uneven ground.

In the accompanying drawings:

FIG. 1 is a view in vertical section, showing a skirt according to the invention;

FIG. 2 is an explanatory diagram;

FIG. 3 is a plan view of a lobated skirt with flexible partitions forming ties;

FIG. 4 is a view in elevation of a partition tie taken along arrow *f* in FIG. 3;

FIG. 5 shows part of an embodiment of meshwork, and

FIG. 6 is a section along line VI—VI in FIG. 5.

FIGS. 7, 8 and 9 are schematic fragmentary cross sections illustrating three different space relationship between the fluidtight coating and the meshwork of wires.

FIG. 1 diagrammatically shows a platform 1 of a ground effect vehicle equipped with a ducted fan 2 supplying compressed air to a supporting cushion 3 bounded at the top and bottom respectively by the said platform 1 and the ground or water surface 4, and bounded at the sides by a flexible skirt 5 of circular cross section, tapering towards the free bottom end 6 adjacent the surface 4, and attached at its opposite end 7 underneath platform 1.

The skirt comprises a reticulated flexible brace structure 8 (for the sake of simplicity, the structure is shown only in the central part of FIG. 1) comprising an interlocked meshwork of wires made of textile, glass, steel or other materials. The wires form two symmetrical layers or series of layers arranged in helices forming an angle $\alpha \leq 35.4°$ approximately (tangent $\alpha \leq 1/\sqrt{2}$), on either side of a horizontal plane.

Actually the wires of the interlocked meshwork 8 have opposite inclinations with respect to meridian lines of the skirt 5 as well as to parallels thereof. The meridian lines may be defined as being the intersections of the skirt with longitudinal (vertical) planes whereas the parallels would be defined as being the intersections with transverse (horizontal) planes. If the skirt is a body of revolution, the meridian lines are generatrices and the parallels are directrices.

The skirt is made fluidtight and stiffened by a rubber or plastics coating 50 which may be applied over the flexible reticulated structure 8 (see FIG. 7); alternatively the latter may be embedded in the material of the coating 50 (see FIG. 8) or spaced therefrom (see FIG. 9) and in this latter case a mere attachment at the ends 6, 7 of the skirt may be provided between the two components.

When at rest, skirt 5 is shaped in the form indicated by the dotted line in FIG. 1, having a curved cross section which is concave towards the outside.

Under operating conditions, the internal pressure forces skirt 5 into the cross section shown by solid lines. This curve, from the attachment end 7 downwards, comprises a substantially toroidal element 5*a* which gradually changes into a frustoconical element 5*b* of low conicity (0° to 10°) which in turn is bounded by a substantially frustoconical element 5*c* of greater conicity.

The changes in the shape of meshwork 8 will be explained with reference to FIG. 2.

Considering a rhombus-shaped mesh of the crossed meshwork, it is seen that it is subject to the following forces under constant cushion pressure.

The horizontal force Fh is proportional to the relative pressure in the skirt and to its surface, and therefore the diameter of the skirt. As the skirt is slightly conical, the force decreases slightly from top to bottom. At the bottom, the force decreases rapidly because of the considerable decrease in static pressure inside the skirt.

The second force is the vertical force Fv, due to the weight and to the conicity of the skirt. It reaches its maximum value at the top and decreases steadily to zero at the bottom. At is maximum, Fv is of the order of 10 to 20 percent of Fh.

If the coating material was not stressed, the equilibrium position of the skirt would give values of α of the order of 5° to 10° at the top and less than 1° at the bottom. Actually, when the skirt is constructed, before the coating has been vulcanized or cured, the value of α is less than approximately 35°. In operation, the equilibrium position will correspond to a value of α which decreases as the load increases (since pressure increases and so does Fh) and in proportion to the elasticity modulus of the coating material which is now stressed. The device thus has a reduced general rigidity. General rigidity denotes the ratio dF/dH where dF is the variation in the load and dH is the resulting variation in the hoverheight of platform 1. Clearly, a reduction in general rigidity is desirable for a good suspension effect.

When load F increases, resulting in an increase in internal pressure, α decreases, resulting in a decrease in the height H of the skirt and an increase in its diameter. The two effects of height decrease and diameter increase in association result in a change in cushion volume which may be positive, zero or negative, depending on the value of α. Calculations show that:

When $\tan^2\alpha = 0.5$ i.e. when $\alpha =$ approximately 35.4°, there is no variation in volume,

When $\tan^2\alpha > 0.5$, the volume increases with pressure, and

When $\tan^2\alpha < 0.5$, the volume decreases when the pressure increases.

The latter condition is desirable, in order to obtain good suspension. In practice, therefore, α is made less than 35.4° for the skirt under normal operating conditions.

Meshwork 8, which has been described for a skirt of circular cross section, can be applied to skirts having a number of lobes such as those denoted by 5′ in FIG. 3 which have a cross section bounded by circular arcs. The meshwork may extend on the outer containing wall and/or on the inner dividing partitions (see FIG. 4).

The reticulated structure 8 of wires can be constructed in various ways. FIGS. 5 and 6, by way of example, show an embodiment comprising a multiplicity of deformable loops 10 interconnected at four equidistant points by rings 11 and assuming a rhomboidal shape. The material for the coating (not shown) can subsequently be cast over the loops to form the coating.

Claims:

1. A deformable skirting system for a surface effect machine, comprising a flexible coating of fluidtight material forming a continuous endless surface of a geometric shape admitting of meridian lines and parallels, and a flexible reticulated brace joined to said coating and formed of an interlocked meshwork of first threadlike members having an inclination in one angular direction with respect to both said meridian lines and said parallels, and of second threadlike members having a like inclination in the opposite angular direction with respect to both said meridian lines and said parallels.

2. Skirting system as claimed in claim 1, wherein said threadlike members extend along helices forming, with said parallels, an angle whose tangent is not greater than $1/\sqrt{2}$, that is an angle not greater than 35.4°.

3. Skirting system as claimed in claim 1, wherein said reticulated brace comprises a meshwork formed of successive deformable generally quadrangular loops and interlocking means securing adjacent vertices of said loops to each other.

4. Skirting system as claimed in claim 3, wherein said interlocking means comprise rings engaging adjacent vertices of said loops.

5. Skirting system as claimed in claim 3, wherein said loops are of general rhomboidal shape.

6. Skirting system as claimed in claim 1, wherein said reticulated brace is embedded within the material of said coating.

7. Skirting system as claimed in claim 1, wherein said reticulated brace is applied against said coating.

8. Skirting system as claimed in claim 1, wherein said reticulated brace and said coating are joined endwise to, but are otherwise spaced from, each other.

* * * * *