ABSTRACT: A device for supplying a chamber confining a cushion of fluid under pressure issuing from a pressure fluid source through a duct extending into said cushion-confining chamber, comprising at the outlet port of said duct into said chamber a nonreturn valve so devised as to close automatically and seal off said duct outlet responsively to any notable overpressure occurring in said chamber.
DEVICES FOR SUPPLYING FLUID UNDER PRESSURE TO GROUND EFFECT MACHINES

The fluid cushions which are bounded laterally by confining walls such as skirts or the like and which provide lift and possibly guidance for ground effect machines are often the seals of transient overpressures which may have detrimental effects on the fans supplying fluid to such cushions.

Large overpressures are likely to occur in seagoing machines when one or more cushion-confining chambers may plunge and thereby cause water to ram therein, with a consequential rate of increase in pressure which is inversely proportional to the overall length of the chambers and their supply ducts.

It is a main object of the present invention to segregate said ducts from the cushion chambers when such liquid rams drive into the chambers, thereby to enable restoring balance to be attained for a shorter stroke, that is to say for a lesser degree of penetration of the water into the chamber. Such segregation affords yet another benefit in that it averts any danger of excessive back pressure proceeding along the ducts up to the supply fans, with consequent serious overall disrupting effects.

Finally, it is not without advantage to protect the ducts and fans against the ingress of corrosive sea water.

In accordance with the present invention, each cushion chamber is segregated from its supply duct by a check valve so devised as to close and seal off the outlet of said duct whenever an accidental back pressure is produced in the chamber and thereby prevent such back pressure from progressing along the duct.

It is to be noted that it has already been proposed to fit valves into the conduits for delivering pressure fluid into cushion chambers bounded by skirts. An arrangement of this kind is set forth in Guineau U.S. Pat. Nos. 5,233,692 and 3,373,837, but in this case the valves were servo-controlled valves, not free valves, and furthermore operated in reverse fashion to those of the present invention; they closed responsive to a pressure drop in the associated cushion in order to prevent such pressure drop from reverberating throughout the other cushions, whereas the nonreturn valve of the present invention is adapted to close in response to an overpressure in the cushion, as already indicated.

In a preferred embodiment of the present invention, the check valve includes a membrane which flexes between a support against which it bears when at rest, thereby to leave wide open the outlet port of the supply duct, and a seat against which it is applied whenever a substantial back pressure occurs, thereby to segregate the cushion chamber from said duct. This membrane is preferably made of a flaccid material devoid of significant natural elasticity.

In the accompanying drawings:

FIG. 1 shows diagrammatically in partial vertical section a ground effect machine provided with the improvement according to this invention, as localized within the circle designated by the reference letter A;

FIG. 2 is a sectional view on an enlarged scale of the detail A of said improvement;

FIG. 3 is a top plan view with partial cutaway;

FIGS. 4 and 5 are views corresponding to FIGS. 2 and 3 respectively, showing an alternative embodiment of the invention;

and FIG. 6 schematically illustrates an application of the invention to a cushion at least partly confined by a fluid curtain.

The ground effect machine depicted in FIG. 1 comprises a plurality of supported by pressure fluid cushions formed in plenum chambers 2 bounded by skirts or confining walls 3. The fluid under pressure is conveyed from fans 4 through ducts 5.

In the plane of the outlet port of supply duct 5, inside the plenum chamber 2, is fixed a grid 6 (see FIGS. 2 and 3) which may be devised in a variety of ways. A perforated, perforated sheet metal, or expanded metal. The grid 6 is secured to the undersurface of platform 1 by means of a flange or ring 7.

Secured to the latter, by one of their ends, are threaded stays 8 (numbering three in the exemplary embodiment herein considered) extending from platform 1 into the interior of plenum chamber 2. Fixed to the other ends of stays 8 is a frame 9, shown as being rectangular in the example portrayed in FIG. 3. This frame is suspended beneath platform 1, in spaced relationship therewith, on the same side as the supporting surface, by means of nuts 10 secured on stays 8. Above frame 9, a second grid 10 is fixed along two opposite sides a—a and b—b of frame 9. Grid 10, which has a greater section than the rectangle aabb, is folded in its middle along the line c—c, whereby to form a dihedron. Accommodated between grid 6 and grid 10 is a membrane 11 made of flaccid fluidtight material. Membrane 11 is clamped between a diametrical line of grid 6 and the apex of grid 10, along the line c—c, by means of a rigid tube 12 restrained by two bolts 13.

Under normal operating conditions, the fluid under pressure from source 4 flows from duct 5 into cushion 2 in the direction of the arrows f (shown in FIG. 2). Membrane 11 is then subjected to the dynamic effects of the fluid and occupies the position shown in dot-dash lines and is applied against the grid 10. Should the pressure in cushion 2 suddenly increase accidentally and thereby cause strong back pressure, the membrane immediately flaps upwards and is applied beneath grid 6, thereby acting as a check valve which prevents the back pressure in cushion 2 from being transmitted to duct 5 and segregates the one from the other.

Such automatic and virtually instant closure of valve membrane 11 responsive to an overpressure which occurs in cushion 2 and which overcomes the normal flow, is due to two concurrent phenomena:

Firstly, the overpressure which rises through the chamber, from the lower free edges of the walls 3 bounding the same, circumvents the membrane 11 in the direction of the arrows F and penetrates into duct 5. At the level of the membrane, the fluid duct is narrowed, producing a speeding up effect which creates a static vacuum on the upper surface of the membrane. This vacuum attracts the membrane upwards and applies it against inlet grid 6.

Secondly, the sudden overpressure occurring at the base of the cushion creates pressure waves which act on membrane 11 independently, before the overpressure proper can reach it.

In the alternative embodiment shown in FIGS. 4 and 5, the check valve device comprises, as previously described, two grids 14 and 15, but in this instance the latter are substantially conical in shape. The two cones are joined as follows: conical grid 14, which is positioned directly at the outlet port of supply duct 5 into the chamber, is fixed along its base at 14a to platform 1, while conical grid 15 is fixed along its base to a ring 16 disposed in spaced coplanar relationship with platform 1, on the side thereof proximate the supporting surface. Ring 16 is secured to platform 1 through the agency of threaded stays 17 (numbering three in this embodiment likewise). Between the two cones 14 and 15 is positioned a circular, flaccid fluidtight membrane 18 sandwiched at its central portion between two flanges 19 and 20 fixed to the apices of the cones.

Under normal operating conditions, membrane 18 is applied over conical grid 15 responsive to the dynamic action of the supply fluid. Should a back pressure, shown by the arrows F, occur in cushion 2, the membrane 18 then acts as a check valve and is fetched into application against conical grid 14 whereby to segregate duct 5 from cushion 2.

As FIG. 5 clearly shows, when membrane 18 is subdivided into three sectors of approximately 120° each, the purpose of which is to facilitate deformation of the membrane.

The check valve device of the present invention is likewise applicable to cushions confined at least partially by a fluid curtain, of the kind for instance described in Berlin U.S. Pat. No. 3,140,753. Thus, any membrane. In FIG. 6, the valve device described with reference to FIGS. 2 and 3 has been transposed in full to the embodiment of FIG. 6 (in which like parts are designated by like reference numerals), except that, instead of
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debouching directly into cushion 2, supply duct 5 has port in an intermediate plenum chamber 21 communicating with a peripheral nozzle 22 through which is discharged the fluid curtain 23 confining the cushion.

In this form of embodiment, closure of check valve 11 will be caused primarily by the effect of the pressure waves propagated through nozzle 22 and rising up to membrane 11.

We claim:

1. A surface effect machine having a plenum chamber, pressure fluid supply means and piping means extending from said pressure fluid supply means and ending with an outlet opening into said plenum chamber to discharge pressure fluid therein to and maintain pressure therein at a normal operative value, wherein the improvement comprises a pressure-sensitive, outlet control, check valve system movable between a rest position in which said outlet is wide open irrespective of whether or not said pressure fluid supply means is in operation and so long as said pressure does not substantially exceed said normal operative value, and a work position in which said outlet is closed in response to overpressure in said plenum chamber in substantial excess of said normal operative value whereby said overpressure is prevented from proceeding along said piping means towards said supply means and is confined to said plenum chamber, said check valve system comprising a substantially unbiased membrane which freely flexes to said opening rest position and to said closing work position.

2. Machine as claimed in claim 1, wherein said check valve system further comprises a stationary support on which said membrane is backed when in said opening rest position thereof, and a stationary seat against which said membrane is applied when in said closing work position thereof.

3. Machine as claimed in claim 2, wherein said support and said seat respectively comprise grids between which said membrane is interposed.

4. Machine as claimed in claim 3, wherein said grids have adjacent inner portions sandwiching a central portion of said membrane, and outer portions which diverge away from each other starting from said adjacent inner portions, said membrane being adapted to flex about said central portion thereof.

5. Machine as claimed in claim 4, wherein said grids are of general frustoconical shape of opposite conicity with the minor bases thereof forming said adjacent inner portions.

6. Machine as claimed in claim 1, wherein said membrane is of generally circular shape and comprises separate sectors.