March 8, 1966 R. S. JONES 3,239,023

GROUND EFFECT MACHINES

Filed Nov. 9, 1962 2 Sheets-Sheet 1

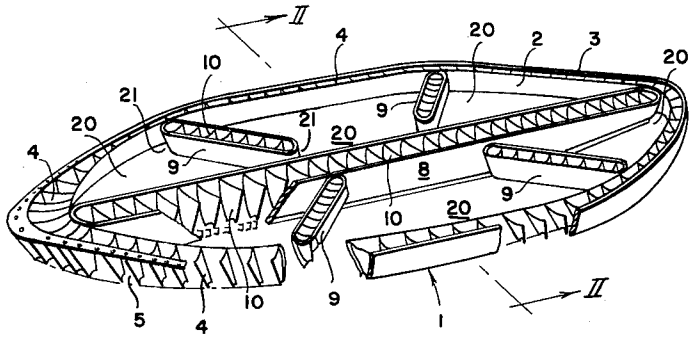


FIG. 1

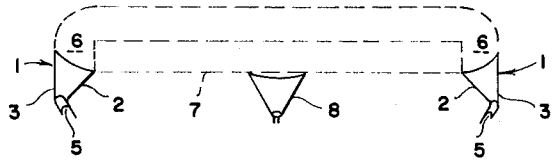


FIG. 2

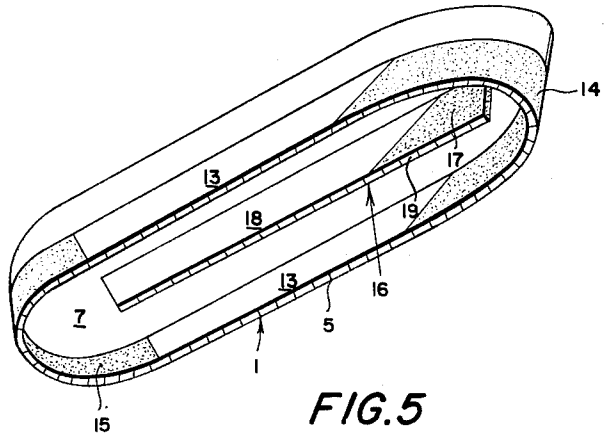


FIG. 5

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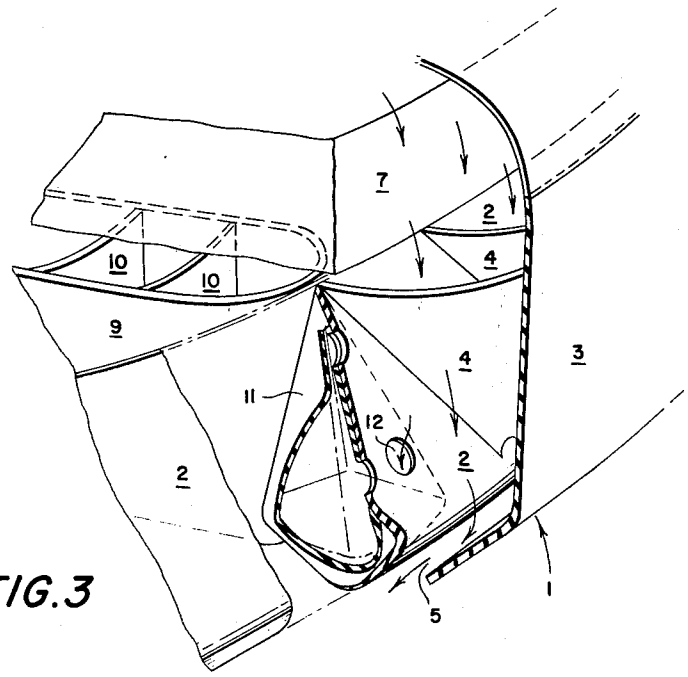


FIG. 3

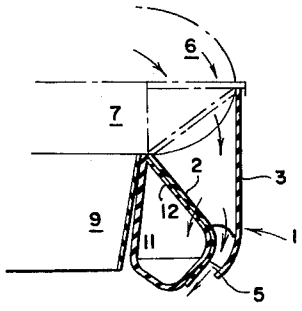


FIG. 4

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GROUND EFFECT MACHINES

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10 Claims. (Cl. 180—7)

This invention relates to ground effect machines of the type which, during at least one mode of operation, are wholly or partially supported by a pressurised gaseous cushion generated under the machine, said gaseous cushion being of air or other gas, or a mixture of gases hereinafter referred to as a "gas" cushion.

A machine of this type, according to my present invention, is characterised by a main gas discharge system which discharges pressurised air or other gaseous mixture from the bottom of side, end, or peripheral downwardly extending walls or skirting, so as to generate a gaseous cushion and retard dissipation of said gaseous cushion upon which the machine rides, and downwardly extending walls or keels arranged to partition the overall cushion area and from the bottom of which pressurised stabilising gas is discharged so as to cause, upon pitching or rolling, creation of a pressure differential within the overall cushion area, which imparts a righting moment to the machine, and further characterised by at least those parts of the walls or skirting, partitions or keels likely to be subjected to primary wave or obstacle impact being of flexible construction.

The advent of extending the stabilising gas jets downwardly from the base of the machine, in addition to the main gas jets, together with the provision of walls and/or skirting and keels both for encompassing the cushion area and for the partitioning thereof provides a machine which can attain a greater ground-surface-clearance height for a given power output, whilst maintaining the necessary stability in the pitch and roll senses. That is to say, the main side or peripheral skirting or walls can be made deeper so as to provide a greater surface clearance for the main base structure of the machine without the necessity to increase the power of the stabilising jets.

Naturally, depending upon the design detail of the machine, the whole of the skirtings, walls or keels can be, and in many cases will be preferably, wholly flexible in construction to reduce impact effects.

The ability of a ground effect machine to operate satisfactorily depends upon the obstacle clearance height and stability relative to sea conditions and wavelengths encountered. These conditions depend mainly upon the geographical location of the theatre of operations. The invention enables matching of the stability in the pitch and roll senses with a given set of sea and wave conditions likely to be encountered in a particular operating region, to give the machine the best "ride."

Two constructions of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view from above of a flexible peripheral main skirting and stabilising jet keel arrangement shown removed from the rigid base platform structure of a peripheral jet type ground effect machine.

FIGURE 2 is a detail in part section, substantially on the line II—II of FIGURE 1.

FIGURES 3 and 4 are diagrammatic sections of gap closing cones used between the peripheral duct and stability curtain.

FIGURE 5 is a perspective view from beneath a side

wall type machine showing flexible end portions to the sidewalls and stability keel.

Referring to FIGURES 1 to 4, the main peripheral skirting 1 consists of inner and outer flexible walls 2 and 3, made for example of rubberised material reinforced by canvas or nylon mesh. The drawing shows part of the outer wall 3 removed to illustrate the internal construction. The walls 2 and 3 are spaced apart by cross-diaphragms 4 which divide and shape the skirting to form a series of jet orifices 5. As shown in FIGURE 2, the skirting is secured over the main pressure gas supply ducts 6 which surround the main base platform structure 7 of the machine, and so flexibly extends the jet system downwardly below the base. The skirting 2, 3 surrounds the cushion area and the ground effect pressurised cushion is generated by the discharge of pressurised gas through the jets 5, and both the skirting and the gas jet therefrom helps to retard the dissipation of the gas cushion and so cause an increase in the ground clearance height of the platform 7. In order to maintain the stability of the machine in the pitch and roll senses at this increased clearance height, without having to increase the power of the stabilising jets which discharge into the cushion area through ducts in the platform 7, the stabilising jets are also extended below the platform 7 by means of similarly constructed flexible keels 8 and 9. The arrangement illustrated in FIGURE 1 is suited to a machine having a substantially elliptical planform, and comprises the main fore-and-aft stabilising keel 8 and four athwartship keels 9. The distance which these keels 8 and 9 extend downwardly below the base platform 7 should not be less than the distance the main peripheral skirting 1 extends downwardly minus half the hoverheight, and not greater than the distance the skirting 1 suspends plus the hoverheight if optimum performance is to be obtained. The term hoverheight may be defined as the surface clearance between the jet orifice 5 at the bottom of the skirting 1 and the ground surface when the machine is in the static hovering condition. The jet keels 8 and 9 are formed into flexible gas ducts by the cross diaphragms 10, and the keels partition the cushion area into stabilising compartments 20, which in operation produce a pressure differential upon pitching or rolling which applies a righting moment to the machine. The main skirting 1 and the keels 8 and 9 are discrete components which are not interconnected. In this way each can flex individually when subjected to wave or obstacle impact. Gaps 21 are arranged between the ends of each keel 9, the central fore-and-aft keel 8 and the peripheral skirting 1. The size of these gaps 21 determines the stability characteristics of the machine by allowing a certain rate of gas "cross flow" between one stabilising compartment 20 and another, thus affecting the pressure differential between compartments 20 and, therefore, the damping effect during pitch or roll. The gaps 21 are, therefore, of predetermined size to match the prevailing sea conditions for a particular area of operation. However, these gap sizes are difficult to determine, and it is necessary to have some means of adjusting the gap, or closing it completely if necessary.

In the construction shown, the gaps 21 between the athwartship keels and the main peripheral skirting are, as illustrated in FIGURE 4, narrowed or closed by flexible inflatable components 11 which are carried by the main peripheral skirting 1, and which form part of the inner skirting wall 2. The inflatable components 11 are inflated by pressurised gas derived from the main cushion generating gas through ports 12. In modified arrangements, the components 11 can be separately inflated by an independent gas supply.

Conveniently, the skirting 1 and keels 8 and 9 may be

releasably attached to the base platform 7 of the machine by quick release fastenings such as hinge and draw pin assemblies.

If the stabilising jet keels 8 and 9 are made shorter, relative to the main skirting 1, than the limit hereinbefore stated, then there will be insufficient stability unless the velocity of the stabilising air jets is increased, which would result in uneconomical power requirements. On the other hand, if the stabilising keels 8 and 9 are made longer than the limit hereinbefore stated, they will cause unnecessarily excessive drag, particularly at high operating speeds, and would be subject to considerable wear during overland operation. The greatest increase in stability is obtained when the stabilising keels are in fact made longer than the main skirting 1 and when the gaps 21 are made very small. By adjusting the size of the gaps 21 between the athwartship keels 9 and the fore-and-aft keel 8 and/or the main skirting 1, the stability in pitch and roll may be varied over very wide limits.

FIGURE 5 illustrates different construction, in which a machine has rigid sidewalls 13 downwardly extending from the main base platform structure 7 with flexible downwardly extended end walls 14, 15 at the bow and stern, which include the main annular gas jet system which discharges from the orifice 5 at the bottom of the end walls 14 and 15. A central fore-and-aft stabilising keel generally indicated at 16 is provided, which at the bow is of flexible construction as at 17, whilst the remainer 18 is of rigid construction. The flexible part 17 incoroprates the stabilising gas jets 19 and the rigid side walls 13 and the rigid keel section 18 may also include gas jets discharging from the extremities if desired.

It will also be apparent to those skilled in the art that other arrangements of the cushion compartments, stabilising keels, and gap closing components are possible, without departing from the scope of the invention as defined by the appended claims.

I claim as my invention:

1. In a ground effect machine, a rigid base structure, a substantially fluidtight member extending downwardly from said base structure around the periphery thereof to form an open-bottomed chamber under said base structure, said member having downwardly extending passages therein and openings along the lower edge, pressurized gas generating means for discharging pressurized gas downwardly in said passages to generate and maintain a pressurized gas supporting cushion under said base structure, at least one stabilizing member extending downwardly from said base structure into said chamber to divide said chamber into a plurality of sub-chambers, said stabilizing member having openings along the lower edge for discharging pressurized gas, means for forming at least one gap between adjacent sub-chambers for passage of pressurized supporting gas between said sub-chambers, and means located in the gap of permitting variation in the size of said gap.

2. In a ground effect machine, a rigid base structure, a substantially fluidtight flexible skirting member attached to said base structure and extending downwardly around the perhiphery therof to form an open-bottom chamber under said base structure, flexible stabilizing members extending downwardly from said base structure and dividing said chamber into a plurality of sub-chambers, means for passing pressurized gas into said sub-chambers to form a plurality of pressurized gas supporting cushions, and means for forming at least one gap between adjacent sub-chambers for passage of pressurized supporting gas between said sub-chambers, said last-mentioned means comprising said flexible members.

3. Apparatus as set forth in claim 2 wherein said gap is formed between at least one end of said stabilizing member and the inner wall of said flexible skirting member.

4. Apparatus as set forth in claim 2 further comprising means located in said gap for permitting variation in size of said gap.

5. Apparatus as set forth in claim 3 further comprising inflatable means located in said gap for permitting variation in the size of said gap.

6. In a ground effect machine, a rigid base structure, a substantially fluidtight flexible skirting member attached to said base structure and extending downwardly around the periphery thereof to form an open-bottom chamber under said base structure, said skirting member having openings along the lower edge thereof, means for supplying pressurized gas to said openings to be discharged downwardly to generate and maintain a pressurized gas supporting cushion under said base structure, at least one flexible stabilizing member extending downwardly from said base structure into said chamber to divide said chamber into a plurality of sub-chambers, said stabilizing member having openings along the lower edge thereof for discharging pressurized gas downwardly, and means for forming at least one gap between adjacent sub-chambers for passage of pressurized supporting gas between said sub-chambers, said last-mentioned means comprising said flexible members.

7. Apparatus as set forth in claim 6 wherein said gap is formed between at least one end of said stabilizing member and the inner wall of said skirting member.

8. Apparatus as set forth in claim 7 further comprising inflatable means located in the gap for permitting variation in the size of said gap.

9. Apparatus as set forth in claim 6 further comprising means located in the gap for permitting variation in the size of said gap.

10. Apparatus as set forth in claim 6 wherein said stabilizing member extends downwardly by a distance which is not less than the distance the skirting member extends downwardly minus one-half the hover height, and not greater than the distance the skirting member extends downwardly plus the hover height, the hover height being the distance between the lower edge of the skirting member and the ground surface when the machine is in the static hovering condition.

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