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CONTROL SYSTEM FOR SURFACE EFFECT MACHINES

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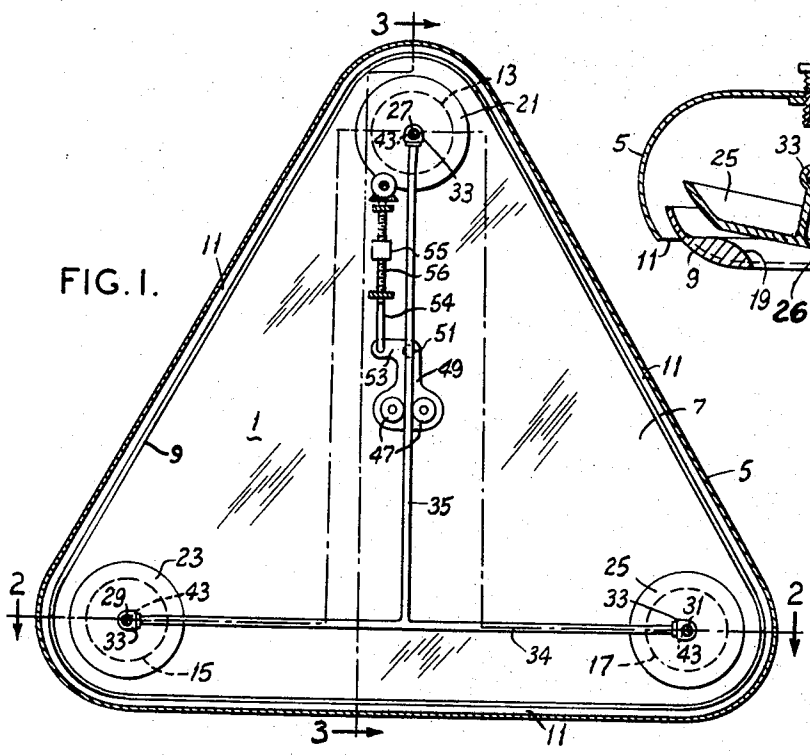


FIG. 1.

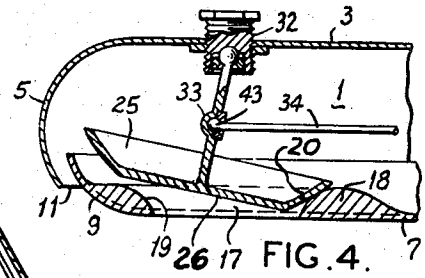


FIG. 4.

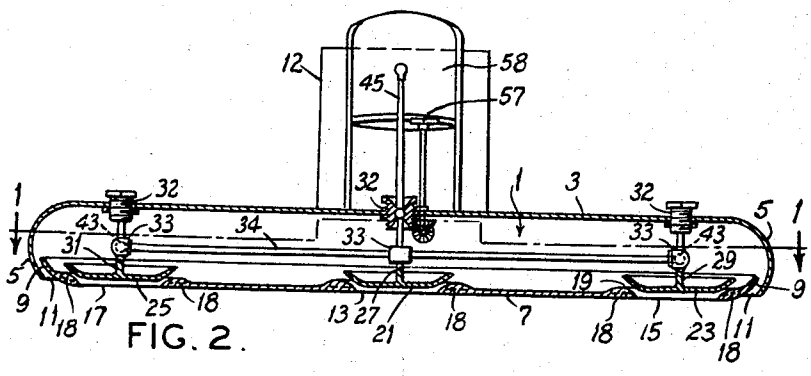


FIG. 2.

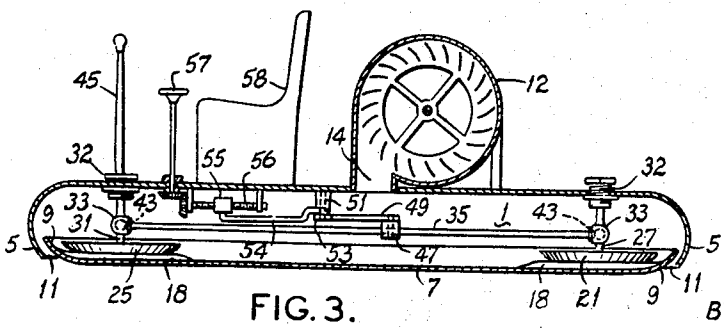


FIG. 3.

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CONTROL SYSTEM FOR SURFACE EFFECT MACHINES

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Original application Nov. 22, 1963, Ser. No. 325,549, now Patent No. 3,276,738, dated Oct. 4, 1966. Divided and this application June 17, 1966, Ser. No. 569,781

7 Claims. (Cl. 180—7)

This application is a division of my application Ser. No. 325,549, filed Nov. 22, 1963, now Patent No. 3,276,738.

The invention relates to surface effect machines and the like and consists particularly in a control system therefor.

Controlling surface effect machines is made difficult because of the absence of friction between the machines and the supporting surface, and consequently there is no positive way of positioning such a machine. Because of the low operating speeds of these machines, aerodynamic forces are of such small magnitude as to be of negligible importance.

Conventional methods of control utilize propellers, air jets from louvers in the sides of the machine, or tilting the machine so it slides in the desired direction. The first two methods require much structure in addition to that required for supporting and propelling the machine, and the third method is not satisfactory because it requires tilting the machine.

It accordingly is a main object to provide a control system for surface effect machines in which propulsion and direction control are combined.

It is a further object to provide valve construction capable of selectively directing a jet of fluid in any desired direction, adaptable for guiding surface effect machines, airplanes, power boats, and other vehicles.

FIG. 1 is a horizontal sectional view along line 1—1 of FIG. 2 of a surface effect machine embodying the invention.

FIG. 2 is a transverse vertical sectional view along line 2—2 of FIG. 1, showing the valves in vertical trim position.

FIG. 3 is a longitudinal vertical sectional view along line 3—3 of FIG. 1.

FIG. 4 is an enlarged transverse vertical sectional view along the left hand end of FIG. 2, showing a valve in a directional position.

Referring now to the drawings, the numeral 1 refers to a generally triangular plenum chamber of a surface effect machine, formed by an upper wall 3, the periphery 5 of which is turned downwardly and slightly rebent inwardly, and a bottom wall 7, the periphery of which is turned upwardly at 9 and positioned inwardly of the top wall periphery 5 so as to form therewith a downwardly and inwardly inclined annular orifice 11.

For providing air or other suitable fluid under pressure to the plenum chamber a blower 12 is mounted on upper wall 3, and its outlet 14 communicates with the interior of the chamber.

Substantially equiangularly and slightly inwardly of its periphery, bottom wall 7 is circularly apertured to form ports 13, 15 and 17 in the shape of rounded approach orifices, the wall portions 18 surrounding the ports being thickened and of generally semitoroidal shape to form seats 19 for convex marginal surface portions 20 of mushroom-shaped valves 21, 23 and 25, the central portions 26 of which are relatively flat. The convex marginal portions are spherical sections and when the valves are closed are in tangential engagement with the rounded margins 19 of the ports. The upwardly extending stems 27, 29 and 31 of valves 21, 23, 25 are spherically fulcrumed at the center of their convexity in screw-type fittings 32 threadably fitted in upper wall 3 to permit the valves to be tilted to uncover any side of the port. The equilateral triangle connecting the centers of the three circular ports is symmetrical with respect to the normal direction of movement, i.e., the longitudinal axis of the vehicle, with the port 13 on the longitudinal axis of the vehicle near its forward end, and ports 15 and 17 at opposite sides of the vehicle longitudinal axis and in transverse alignment with each other.

Intermediate their ends, valve stems 27, 29 and 31 are provided with spherical bearing brackets 33 which are connected to each other by a rigid T-shaped control rod consisting of a transverse member 34 between the stems of rear valves 23 and 25 and connected at its midpoint to the stem of forward valve 21 by a longitudinal member 35, the connections to bearing bracket 33 being in the form of balls 43 at both ends of member 34 and at the forward end of member 35.

Stem 27 of forward valve 21 extends upwardly beyond its fulcrum in fitting 32 to form a control lever 45 projecting upwardly from plenum chamber top wall 3.

Intermediate its ends, member 35 of the T-shaped control rod passes between a pair of transversely spaced lateral guide rollers 47, 47 which form a vertical fulcrum for the control rod so that when control lever 45 is moved to the right, causing valve 21 to uncover the left hand side of forward port 13 thus directing a jet of air to the right, the rear end of member 35 moves to the right, causing member 34 to move to the right and rotating valve stems 29 and 31 to the right about their fulcrums in fitting 32 to uncover the right hand sides of ports 15 and 17, thus directing jets of air to the left and causing the machine to turn to the left.

Conversely, movement of control lever 45 to the left causes the right hand side of front port 13, and the left hand sides of rear ports 15 and 17 to be uncovered, thus directing jets of air to the right from the front port and to the left from the rear ports and turning the machine to the right.

For effecting forward movement of the machine, lever 45 is moved rearwardly, thus rotating valve 21 forwardly about its fulcrum in fitting 32 and uncovering the forward side of port 13, and T-shaped control rod 34, 35 moves forwardly, thus causing valves 23 and 25 similarly to uncover the forward sides of ports 15 and 17, thus directing jets of air rearwardly through the ports and propelling the machine forward. Rearward movement of the machine is conversely effected by moving the control lever 45 forward.

For effecting lateral trim, rollers 47, 47, between which member 35 is fulcrumed, are mounted on the longitudinally extending arm 49 of a horizontal bell crank fulcrumed at 51 on the top wall 3 of the plenum chamber and the transversely extending arm 53 of the bell crank is connected by a pitman 54 to a block 55 mounted on longitudinal screw 56 rotated by handwheel 57, so that when, by means of wheel 57, screw 56, block 55, and pitman 54, bell crank 49, 53 is rotated about its fulcrum 51, control rod 34, 35 will be similarly moved to the left or right, causing a corresponding opening in the same lateral direction of all three valves, with resultant jets of air expelled through all the ports in the same lateral direction to effect the desired lateral trim.

An operator's seat 58 may be provided adjacent control lever 45 and lateral trim wheel 57.

Vertical trim is effected by individually screwing fittings 32 upwardly or downwardly in top wall 3, thus causing a corresponding vertical movement of valves 21, 23 or 25 relative to their seats on the thickened rims 18 of their ports.

Operation of the controls is as follows: The main support ground cushion is supplied by orifice 11. For normal

forward movement, control lever **45** is held in a rearwardly inclined position, thus opening the forward portions of port **13**, and through control rod **34**, **35** of ports **15** and **17**. If it is desired to turn the machine to the left or right, the control lever is manipulated in the opposite direction, thus opening the right or left side, respectively, of ports **13**, and, through the pivoting of member **35** about its fulcrum at **47**, **47**, opening ports **15** and **17** on their sides opposite to the opening of port **13**, producing air jets in a correspondingly opposite direction with consequent turning of the machine. Lateral trim is provided by manipulating wheel **57** to offset rollers **47**, **47** laterally from their normal centered positioned and thereby correspondingly move control rod **34**, **35** laterally from its normal centered position, causing a corresponding opening of all the valves in the same direction laterally. Operation in reverse is accomplished by moving control lever **45** forward from its normal vertical position, thereby opening the rear sides of port **13** and, through control rod **34**, **35** of ports **15** and **17** to provide forwardly directed jets of air from the ports.

The invention may be modified in various respects as will occur to those skilled in the art and the exclusive use of all modifications as come within the scope of the appended claims is contemplated.

What is claimed is:

1. A control device for transport machines supported and movable on a cushion of pressurized air therebeneath comprising vertically spaced walls defining a plenum chamber therebetween, ports in the bottom wall in communication with the plenum chamber and air cushion therebeneath and spaced apart lengthwise of the machine, valves having generally convex lower surfaces normally seated in said ports and being mounted on the machine for universally tilting about a fulcrum which is at the center of their convexity, means for selectively tilting a forward valve about its fulcrum to open a predetermined side of its port, and linkage means connecting said forward valve and a rear valve for transmitting fore and aft movements of said forward valve to said rear valves and

transverse movements opposite to that of said forward valve to said rear valves, said valves including upwardly extending central stems universally fulcrumed at the center of their convexity.

2. A control device according to claim **1** in which said ports comprise rounded approach orifices and the convex surfaces of said valves are in tangential engagement with the rounded margins of the ports when the valves are in the fully closed position.

3. A control device according to claim **1** in which said linkage means includes a rigid structure extending lengthwise of said machine and pivotally connected to said forward and rear valve stems, there being lateral guide means mounted on the machine intermediate said forward and rear valves and engaging said rigid structure to form a vertical axis fulcrum therefor whereby to effect such opposite transverse movements of said forward and rear valves while accommodating fore and aft movements of said rigid structure.

4. A control device according to claim **3** in which said lateral guide means is shiftable transversely of the machine to cause corresponding transverse shifting of said rigid structure and simultaneous movement of all said valves in the same transverse direction to effect lateral trim.

5. A control device according to claim **1** in which the fulcrums of said valve stems are selectively vertically movable whereby to vary the vertical spacing of said valves from said ports and provide lateral trim.

6. A control device according to claim **1** including additional means for moving said linkage and all of said valves in the same transverse direction.

7. A control device according to claim **1** in which said forward port is on the longitudinal axis of the machine and there are two of said rear ports spaced longitudinally from said forward port and symmetrically disposed relative to said longitudinal axis.

No references cited.

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