United States Patent

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[33] **Sweden**
[31] **12475/67**

[54] **FLUID EJECTOR PARTICULARLY FOR CUSHION LEVITATED DEVICES**
4 Claims, 7 Drawing Figs.

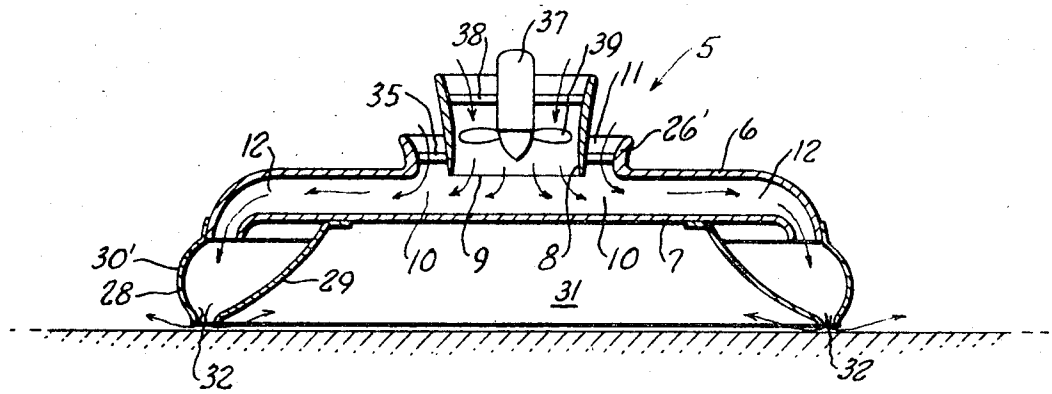
[52] **U.S. Cl.** **239/224**
[51] **Int. Cl.** **B05b 3/10**
[50] **Field of Search** 239/223, 224, 522, 523, 171; 222/136

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Primary Examiner—Stanley H. Tollberg
Attorney—Ira Milton Jones

ABSTRACT: The nozzle from which primary fluid issues has its axis transverse to a pair of spaced apart wall members. It extends through one of the wall members, in which there are secondary fluid inlet means, and has its mouth spaced from the other wall member so that the latter divergingly deflects the incoming primary fluid.



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Fig. 1.

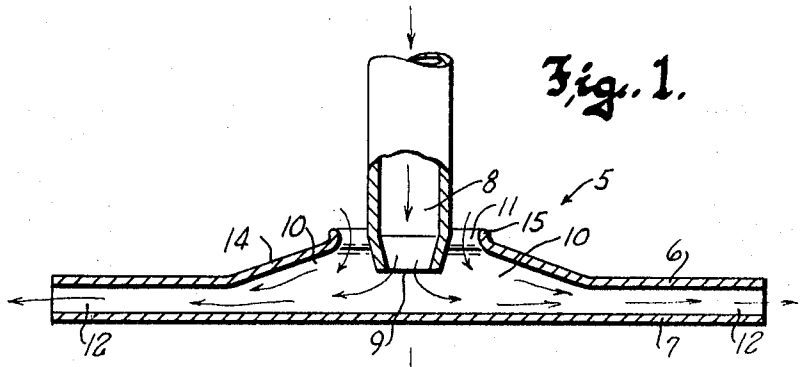


Fig. 2.

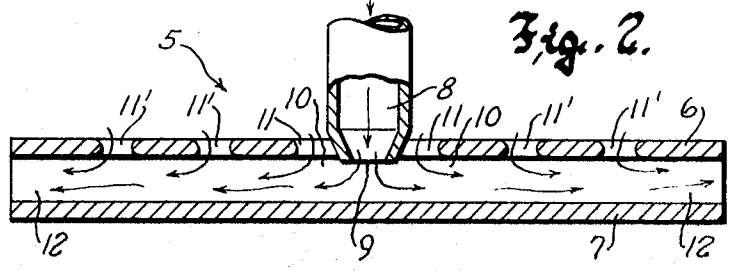


Fig. 3.

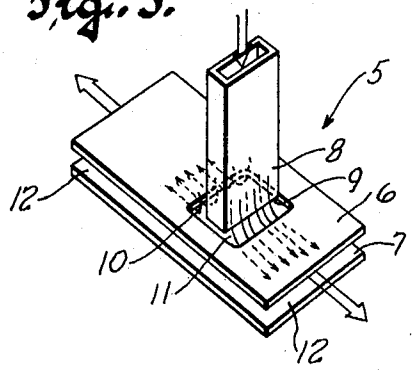


Fig. 4.

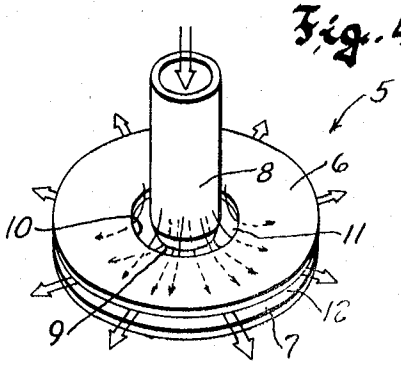
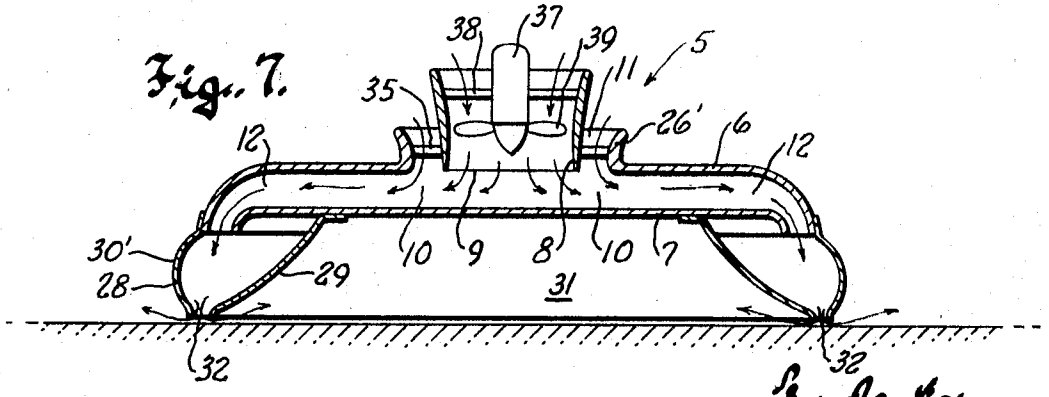


Fig. 7.



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Fig. 6.

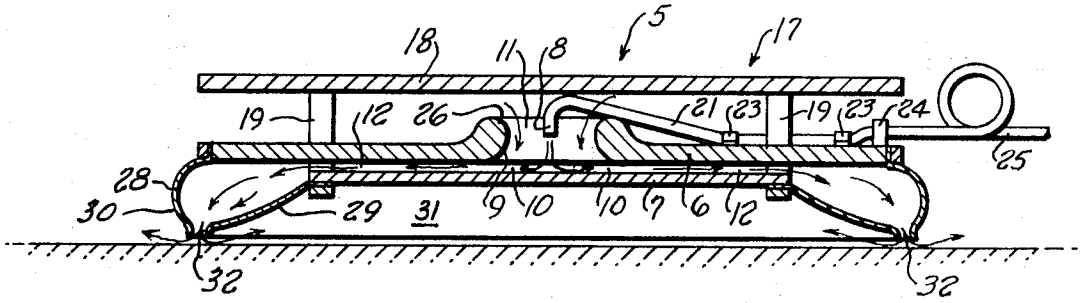
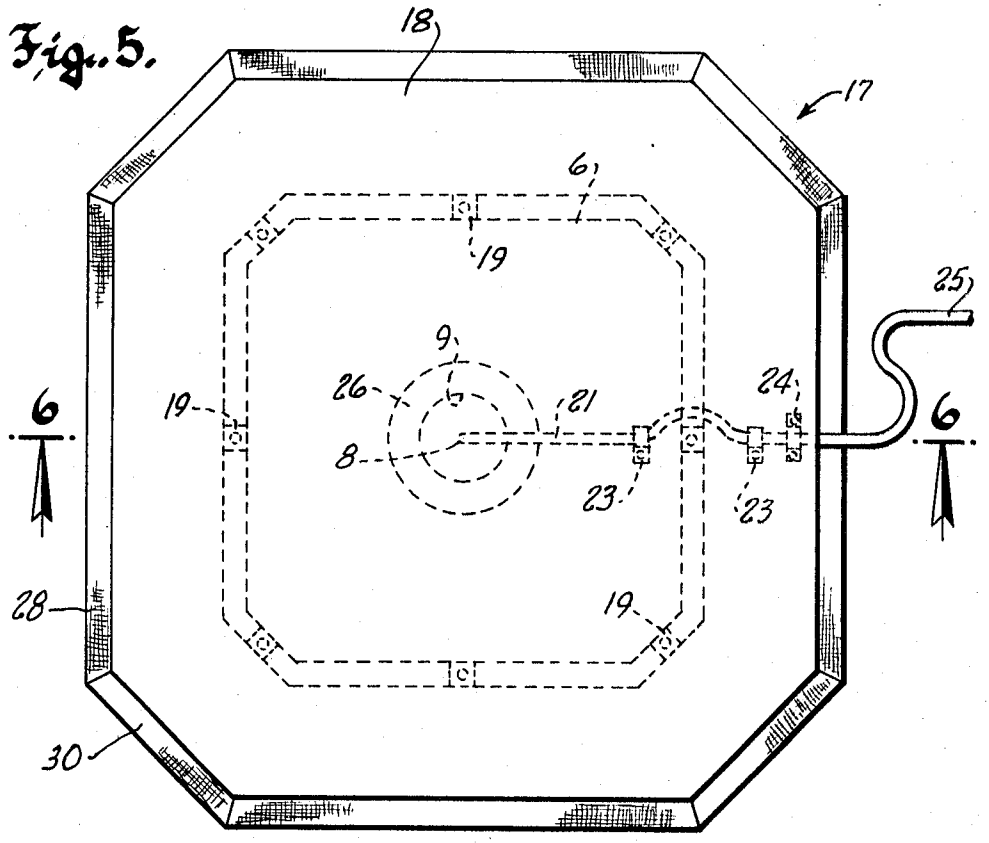


Fig. 5.



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FLUID EJECTOR PARTICULARLY FOR CUSHION LEVITATED DEVICES

This invention relates to ejectors wherein a stream of primary fluid issuing from a nozzle is caused to flow through a mixing chamber and to educt a secondary fluid into the mixing chamber; and the invention relates more particularly to an ejector which is relatively short in the direction of flow of the primary fluid out of the nozzle and which is therefore well adapted for incorporation in air cushion supported devices.

Heretofore in ejectors of the general type here under consideration the mixing chamber in which secondary fluid was educted into and mixed with primary fluid extended generally in the same direction as the nozzle from which the primary fluid issued, and the mixing chamber opened into a diffuser that extended further in the same direction and comprised in effect an axial extension of the mixing chamber. To afford a satisfactory transfer of energy between the primary and secondary fluids by viscous mixing of them, it was usually necessary that the mixing chamber have considerable length in the direction of flow. The diffuser into which fluid flowed from the mixing chamber, and in which it expanded and decelerated, also had to have substantial length in the flow direction, due to the necessary limitation of the opening angle of the diffuser.

The general object of the present invention is to provide an ejector that has relatively small extension in the direction of flow of primary fluid out of the nozzle, and which is therefore adaptable to structures which do not permit incorporation of an ejector of the heretofore conventional type wherein the mixing chamber and diffuser were substantially elongated in said direction.

Another object of this invention is to provide an ejector of the character described which is especially well adapted for an air cushion device or ground effect machine, whereby a relatively high speed but small volume stream of primary air, provided by a pump or the like, can be utilized to educt secondary air from the ambient atmosphere, and wherein the primary and secondary air are mixed to produce a large volume of relatively slowly flowing high-pressure air that can be expelled from the ejector for efficient maintenance of an air cushion beneath the device, by which the device is levitated.

With these observations and objects in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawings. This disclosure is intended merely to exemplify the invention. The invention is not limited to the particular structure or method disclosed, and changes can be made therein which lie within the scope of the appended claims without departing from the invention.

The drawings illustrate several complete examples of the physical embodiment of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a more or less diagrammatic vertical sectional view of an ejector constructed in accordance with the principles of this invention, illustrating the fluid flows in the same;

FIG. 2 is a view generally similar to FIG. 1 but illustrating a modified embodiment of the invention;

FIGS. 3 and 4 are perspective views of other modified embodiments of the invention;

FIG. 5 is a plan view of an airborne load supporting pallet incorporating an ejector that embodies the principles of this invention;

FIG. 6 is a sectional view taken on the plane of the line 6–6 in FIG. 5; and

FIG. 7 is a vertical sectional view of an air cushion vehicle having an air intake that comprises an ejector embodying the principles of this invention.

Referring now to the accompanying drawings, the numeral 5 designates generally an ejector according to the invention, comprising, in general, a pair of wall members 6 and 7 that have opposing spaced apart surfaces, and a nozzle 8 for primary fluid that has its axis substantially normal to the two wall members, opens through the wall member 6, and has its mouth 9 spaced from the wall member 7.

Because the wall member 7 extends across the mouth of the nozzle at a distance therefrom, it divergingly deflects the primary fluid issuing from the mouth of the nozzle so that streams thereof flow in opposite directions between the wall members. As the primary fluid flows away from the nozzle between the wall members, it first passes through a mixing chamber or mixing zone 10 in the neighborhood of the nozzle, in which secondary fluid is educted through inlet means 11 in the wall member 6, and thence the mixed primary and secondary fluids flow into a diffuser zone 12 at a greater distance from the nozzle.

Because the wall members 6 and 7 are substantially transverse to the nozzle axis and are spaced apart by only small distance, the ejector has a relatively small extension in the direction of the nozzle axis.

In the embodiment of the invention illustrated in FIG. 1, the wall member 6 through which the primary fluid nozzle 8 opens has an outwardly convergent frustoconical portion 14 that is concentric to the nozzle and which terminates in a liplike inner edge 15 that is spaced from the nozzle all around the same to provide an annular secondary fluid inlet means 11. Thus the mixing chamber 10 in the FIG. 1 embodiment of the invention is effectively convergent in the direction of fluid flow therethrough.

As illustrated in FIG. 2, both wall members 6 and 7 can be flat over their entire areas, and in addition to an annular inlet means 11 for secondary fluid around the nozzle, the wall member 6 can have holes 11′ therein at different radially spaced distances from the nozzle axis to provide further secondary fluid inlet means.

The diverging deflection of the primary fluid issuing from the nozzle 8 can be controlled to suit particular requirements. Thus in the embodiment of the invention illustrated in FIG. 3 the fluid streams moving through the mixing chamber 10 and the diffuser 12 are substantially confined to flow in a pair of opposite directions by reason of the nozzle 8 being rectangular in cross section, with a high ratio of length to width, and the secondary fluid inlet means 11 likewise being elongated and extending mainly along the longer sides of the nozzle. In the embodiment of the invention shown in FIG. 4, however, the nozzle 8 is circular in cross section, the secondary fluid inlet means 11 is annular and surrounds the nozzle, and the wall members 6 and 7 are likewise circular in outline; hence the direction of fluid flow is radial in all directions from the nozzle axis.

In each of the above described embodiments of the invention, that portion of the space between the wall members 6 and 7 that is nearest the nozzle serves as a mixing chamber 10, while that portion of the space between the wall members that is farther from the nozzle serves as a diffuser 12, and the configuration of the wall members and the spacing between them, as well as the arrangement of the secondary fluid inlet means 11, can all be designed to afford desired conditions of mixture, pressure and velocity of the fluids.

FIGS. 5 and 6 illustrate an ejector 5 of this invention embodied in an air cushion levitated load supporting pallet 17. In this case the wall members 6 and 7 of the ejector are octagonal in planform, the wall member 6 through which the nozzle extends being uppermost and of somewhat greater size than the wall member 7. A load supporting platform 18, which can be of the same size as the upper wall member 6, is mounted on top of the upper wall member on suitable spacers 19, and the space between said wall member and the platform is made high enough to admit the fork of a forklift truck.

The nozzle 8 in the FIGS. 5 and 6 embodiment comprises the downturned end portion of a tube 21, projecting concentrically down into a central opening in the top wall. Along most of its length the tube 21 overlies the upper surface of the top wall, to which it is attached by means of clips 23. The tube terminates near the periphery of the top wall in a suitable

fitting 24 by which it can be connected with an airhose 25 or the like that communicates with a suitable source of pressure air.

The central hole in the top wall member has a gently rounded lip 26 (see FIG. 6) which cooperates with the nozzle 8 to provide an annular secondary fluid inlet 11 through which atmospheric air is drawn into the space between the wall members 6 and 7.

Connected with the peripheries of the upper and lower wall members respectively are the outer and inner walls 28 and 29 of a hollow inflatable skirt 30 that surrounds the wall members. The skirt projects beneath the lower member 7 and cooperates with the undersurface thereof and with the surface therebeneath to define a plenum 31. Air from the ejector 5 flows through the skirt and out of the same through outlet ports 32 in its bottom to generate in the plenum 31 a pressure fluid cushion by which the device is levitated.

As will be apparent, the hose 25 can be connected with a source of compressed air or the like at considerably higher pressure than that required for the air cushion upon which the device is supported. Such pressure air issues from the nozzle 8 in a relatively high velocity stream and educts atmospheric air through the secondary air inlet means 11. The primary and secondary fluids are of course mixed in the mixing chamber 10, expanded in the diffuser zone 12 and thence issue in all directions laterally into the inflatable skirt. Because of the mixing of secondary atmospheric air with the primary high-pressure air, only a relatively small rate of flow of high-pressure air is required and suitable pressure air sources are therefore readily available.

FIG. 7 illustrates an ejector 5 of this invention embodied in an air cushion vehicle or ground effect machine, to provide the air intake thereof. In this case the upper and lower wall members 6 and 7 are circular in planform, but their marginal edge portions are curved downwardly. The space between them opens downwardly into an inflatable hollow skirt 30' that extends all around the vehicle to define a plenum 31 therebeneath. The outer wall 28 of the hollow skirt is secured to the outer edge of the upper wall member 6, and its inner wall 29 is secured to the undersurface of the bottom wall member 7, inwardly of the downturned marginal edge portion thereof. The skirt has air outlets 32 in its bottom.

The upper wall member has a central opening defined by an upturned circumferential lip 26', and the nozzle 8 comprises a short tube that is suspended from the lip 26' by radial braces 35. The nozzle 8 and the lip 26' of course cooperate to define an annular secondary fluid inlet means 11. An engine unit 37, supported by radial braces 38 in the upper portion of the nozzle, drives a fan 39 which is concentric to the lower portion of the nozzle tube and by which air is drawn down through the tube and propelled against the lower wall member 7, which of course deflects it radially outwardly in all directions. Secondary air, drawn in through the annular inlet 11, is mixed with the primary air in the mixing chamber zone 10 that is adjacent to the nozzle, and the mixed fluids expand in the annular diffuser zone 12 which is radially spaced from the nozzle and then issue into the self-supporting inflatable skirt 30', whence the air flows out through the openings 32 in the bottom of the skirt to form a fluid cushion beneath the vehicle.

It will be obvious to those skilled in the art that a plurality of ejectors of this invention can be firmly connected in side-by-side relation to a single load supporting platform, or to the hull of a single air cushion vehicle, to provide a high degree of lift and stability.

From the foregoing description taken with the accompanying drawings, it will be apparent that this invention provides an efficient ejector which is of short extension in the direction of flow of primary fluid thereinto and which is thus well adapted for use in air cushion levitated devices as well as for other applications in which it is undesirable to use a heretofore conventional ejector because of its length in said direction.

I claim:

1. An ejector comprising:

A. a nozzle having an outlet from which primary fluid can be expelled at substantial velocity for flow along a path parallel to the nozzle axis;

B. a first wall member having a surface which is transverse to the nozzle axis and which is spaced from and faces the nozzle outlet and extends substantial distances to outlet zones spaced to opposite sides of the nozzle, all portions of said surface that lie between said outlet zones and a zone axially opposite the nozzle outlet being continuous, unobstructed and substantially flat so that fluid which has issued from the nozzle flows divergently in straight paths along said surface for substantial distances in opposite directions transverse to the direction of flow that it had upon issuing from the nozzle outlet; and

C. a second wall member having a surface which is also generally transverse to the nozzle axis and which opposes and is spaced from said surface of the first wall member to cooperate therewith in confining fluid to flow in said opposite directions, said second wall member having a medial aperture therein through which the outlet portion of the nozzle projects and having inlet means therein through which secondary fluid can be educted into the primary fluid.

2. The ejector of claim 1, further characterized by:

said aperture in the second wall member through which the outlet portion of the nozzle projects being larger than the outlet portion of the nozzle and being coaxial therewith so that the edge of said aperture is spaced from the nozzle all around the same to define said inlet means.

3. The ejector of claim 1, further characterized by:

A. said wall members extending substantially horizontally, with the first wall member lowermost;

B. load carrying structure supported by said wall members; and

C. downwardly opening outlet means at which said wall members terminate and into which the space between them opens, said outlet means projecting beneath and extending around said first wall member to cooperate with its undersurface and a surface therebeneath in defining a plenum in which fluid emitted from the outlet means forms a cushion that supports the device.

4. An air cushion supported device of the type comprising a bottom wall member that defines a downwardly facing surface, means extending around said bottom wall member and projecting beneath said bottom surface thereof to cooperate with said surface and a surface therebeneath in defining a plenum, and outlet means at the bottom of the device from which air is emitted into the plenum to maintain an air cushion therein, said device being characterized by:

A. a nozzle from which primary air can be discharged, said nozzle

1. having its axis normal to the bottom wall member and spaced radially inwardly from all portions of the periphery thereof, and

2. having its mouth spaced above the bottom wall member so that primary air issuing from the mouth of the nozzle is divergingly deflected by the bottom wall member;

B. an upper wall member

1. spaced above the bottom wall member and

2. through which the nozzle opens,

3. said upper wall member having inlet means therein adjacent to the mouth of the nozzle through which secondary air can be educted into primary air flowing between the wall members; and

C. means communicating the space between the wall members with said outlet means, the last named means being connected with the wall members and comprising said means extending around the bottom wall member.