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3,298,599

PUMP NOZZLE

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2 Sheets-Sheet 1

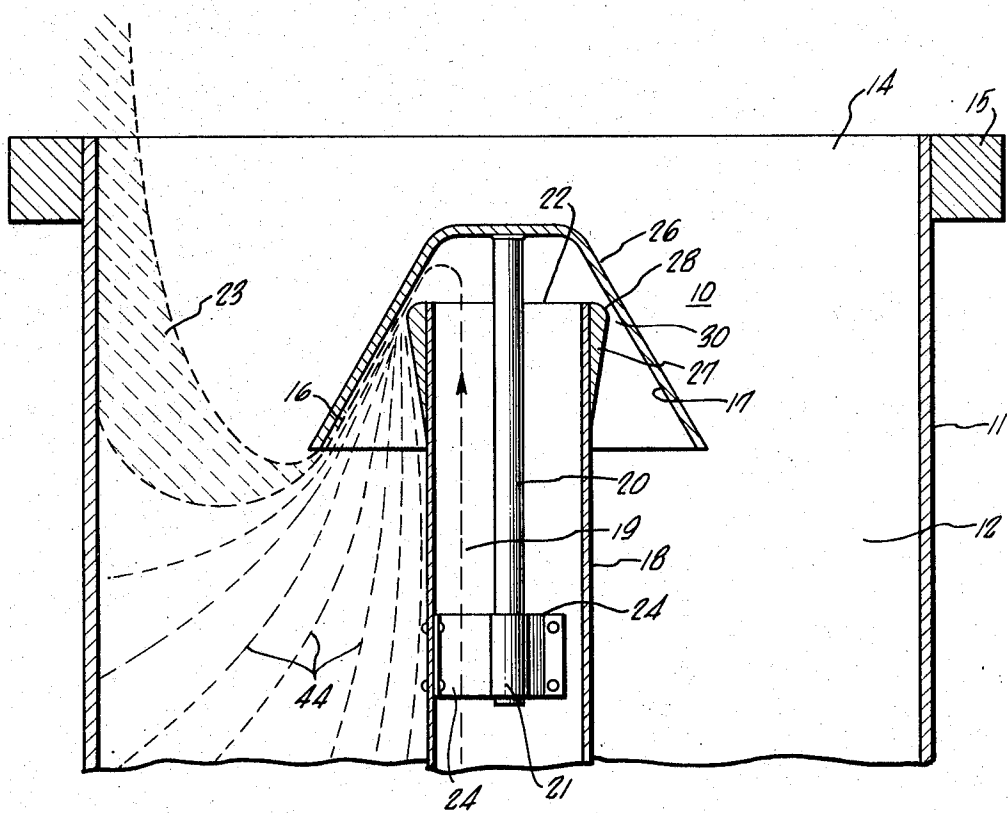


FIG 1

PRIOR ART

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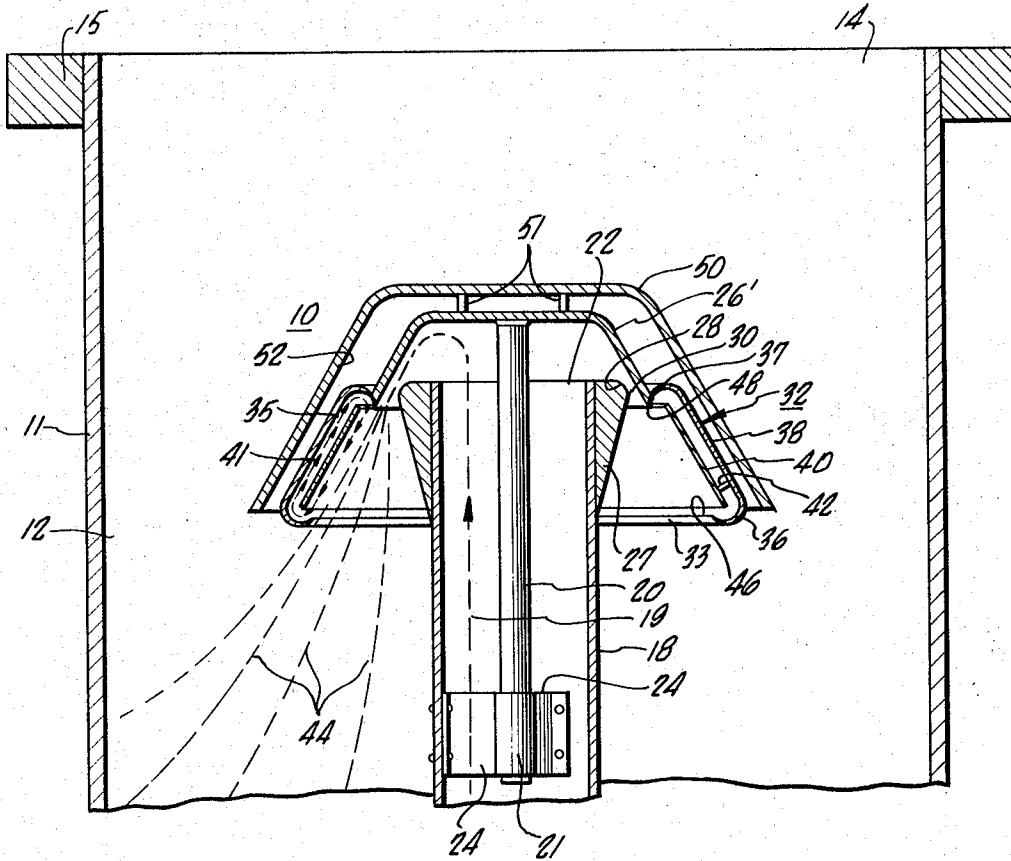
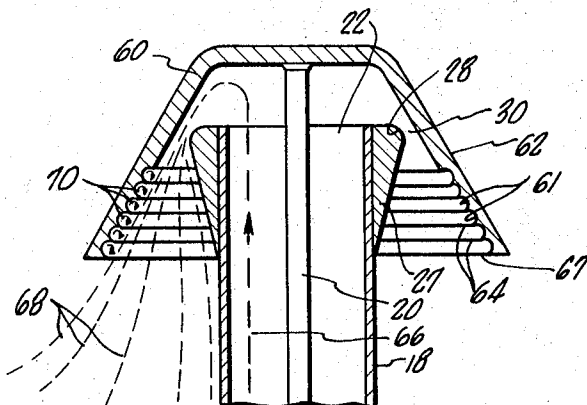


FIG. 2.

FIG. 3.



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1

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PUMP NOZZLE

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8 Claims. (Cl. 230—101)

The present invention relates to pumping apparatus and, more particularly, to pumping fluid nozzles.

Pumping fluid nozzles are well known. One familiar type of pumping fluid nozzle is the type of vapor jet nozzle employed in high vacuum diffusion and ejector pumps. The so-called "backstreaming" in these types of pumps, which occurs when pumping fluid molecules migrate to the mouth of the pump and from there into the chamber or vessel under evacuation, is very disadvantageous, since it tends to contaminate the vacuum chamber or vessel and the objects located therein. In addition, backstreaming pumping fluid molecules collide with gas molecules entering the pump and thus reduce the pumping speed.

The most widely employed method for countering backstreaming resides in the provision of relatively dense baffles in or at the mouth of the pump. Unfortunately, the impedance of the baffle to gas molecules entering the pump increases with progressing baffle density, so that backstreaming is reduced at the expense of pumping speed and efficiency.

More recent efforts to reduce backstreaming were primarily directed to the condensation of pumping vapor molecules that tended to migrate to the mouth of the pump or to the prevention of reevaporation of condensed pumping fluid droplets that formed on the nozzle during the operation thereof.

The present invention provides ways and means for inhibiting or markedly reducing backstreaming without material reliance on condensation phenomena. The present invention also provides ways and means for increasing the speed of the vapor jet and the pump over the speeds attained with prior art nozzle designs.

The invention resides in a pumping fluid nozzle comprising at least one pumping fluid orifice and a wall structure guiding pumping fluid issuing from this orifice and defining at least one recess for recirculating part of the pumping fluid flowing past this wall structure.

The invention will become readily apparent from the following detailed description of preferred embodiments thereof, illustrated by way of example in the accompanying drawings, in which:

FIG. 1 is a longitudinal section of a prior art vapor nozzle with a fraction of a pump housing;

FIG. 2 shows a longitudinal section of a vapor nozzle according to a first embodiment of the invention; and

FIG. 3 shows a longitudinal section of a vapor nozzle according to a second embodiment of the invention.

In the drawings, similar parts are designated by like reference numerals.

The prior art vapor nozzle 10 shown in FIG. 1 constitutes the top nozzle of a high vacuum diffusion pump which has a pump housing 11 that defines a pump chamber 12 and an inlet opening or mouth 14 and a flange 15 adjacent thereto. Prior to operation of the pump, the pump inlet 14 is connected to the vessel to be evacuated (not shown). This vessel and the pump may be pre-evacuated in the usual manner. Pumps of this type are well known. For a fuller description and illustration thereof reference may, for example, be had to U.S. Patent

2

No. 3,075,688 by Francis J. Erhart et al. and U.S. Patent No. 3,075,689 by Donald L. Stevenson; both of these patents being assigned to the present assignee. In these pumps, a pumping medium, such as oil, is evaporated and is supplied to a nozzle assembly of which the nozzle 10 shown in FIG. 1 constitutes the top nozzle.

In FIG. 1, the pumping vapor is supplied to nozzle 10 through a chimney 18, as indicated by a dashed line 19. A solid rod 20 is mounted by a support 21 to extend along part of the longitudinal axis of chimney 18 and to project from the upper end 22 thereof. The support 21 has legs 24 which are attached to the wall of chimney 18. The rod 20 carries a cap or cowl 26 which is spaced from the upper chimney end 22. An annular member 27 is disposed on upper chimney end 22 and has a lip 28 which, together with cowl 26, defines a vapor jet forming annular orifice 30. The orifice 30 is supplied with vapor by the chimney 18, which thus forms the inlet of the nozzle 10.

The pumping vapor issuing from orifice 30, as indicated by dashed lines 44, forms a boundary layer 16 adjacent part of the inner surface 17 of cowl 26. In the prior art structure shown in FIG. 1, appreciable friction developed between the boundary layer 16 and the part of the inner surface just mentioned, resulting in a corresponding drag on the pumping vapor stream. This drag reduced the velocity of the pumping vapor stream. In addition, the friction just referred to increased the tendency of vapor molecules in the boundary layer 16 to diverge laterally and toward the mouth or inlet opening 14 of the pump, once these molecules had left the lower opening of the cowl 26. This divergence and the resulting backstreaming of vapor molecules are schematically illustrated at 23.

The present invention materially inhibits these disadvantages. According to the embodiment of the invention illustrated in FIG. 2, a top nozzle structure similar to that shown in FIG. 1 is provided with a cowl 26' in lieu of the cowl 26 shown in FIG. 1. The cowl 26' defines below the vapor jet-forming orifice 30, a wall structure 32 which serves to guide vapor issuing from orifice 30 to the vapor outlet 33 shown in FIG. 2.

The cowl wall structure 32 defines an annular recess 35 that is composed of a lower gutter 36 adjacent outlet 33, an upper gutter 37 adjacent orifice 30, and a frusto-conical wall portion 38 interconnecting gutters 36 and 37. The cowl wall structure 32 also includes a frusto-conical wall section 40 which is located in recess 35 and, together with wall portion 38, defines an annular channel 41 between gutters 36 and 37. The wall section 40 is mounted on wall portion 38 by wire struts 42.

In the structure shown in FIG. 2, part of the vapor flowing past wall structure 32 and wall section 40 is skimmed off by the lower gutter 36 which, for this purpose, has a knife edge 46 pointing in the direction of the orifice 30. This skimmed off vapor is turned about by gutter 36 and is directed into channel 41 between outer wall portion 38 and inner wall section 40. The upper gutter 37 redirects this vapor for flow along the inner surface of wall section 40 which, in turn, guides this vapor to lower gutter 36. In this manner, vapor is continuously circulated along the outer surface of the vapor stream issuing from nozzle orifice 30. The inner edge 48 of gutter 37 is located below orifice 30 so as not to interfere with the operation thereof. Part of this circulating vapor may reenter the vapor stream, while fresh vapor from the main stream may replenish this circulatory whirl. Moreover, the vapor issuing from orifice 30 creates a suction

at upper gutter edge 48 and a pressure at lower gutter edge 46 so that the circulation in cowl 32 is kept in motion. The wall section 40 promotes an orderly course of this circulation, in that it defines a channel 41 in which vapor may flow in one direction without being materially disturbed by vapor that flows in the other direction.

In this fashion, the main stream of vapor, and particularly the vapor portion flowing adjacent wall structure 40 in recess 35, rides on a continuously moving cushion of vapor. This has the advantage of permitting the vapor main stream to pass through the lower portion of cowl 26' without having an undue drag exerted thereon. The vapor stream issuing from nozzle 10 will, therefore, be characterized by high velocity and by a substantial retention of the directional force imparted by the jet orifice and the nozzle skirt, so that migration of vapor molecules to the mouth of the pump is materially inhibited.

During operation of the pump, condensation of vapor in the recess 35, and particularly in gutter 36, as well as condensation along wall section 40 should be avoided. To this effect, the support 21 with legs 24, the rod 20, and the cowl 26' may be of a material or materials of high heat conductivity, with the rod 20 conducting heat to the cowl 26' and, indirectly, to the wall structure 32. If desired, the rod 20 may be extended all the way down to the pumping fluid boiler (not shown) and to the heating element structure thereof. In addition, the nozzle 10 in FIG. 2 has been provided with a heat shield 50 that has the form of a cap which extends over the cowl 26', including the major part of its wall structure 32. The heat shield 50 is mounted on cowl 26' by struts 51, and is preferably provided with a highly polished, bright inner surface 52 to reflect heat dissipated by cowl 26'.

FIG. 3 shows a second embodiment of the invention which includes also the above-mentioned chimney 18 with open end 22, rod 20, and annular member 27 with lip 28. According to FIG. 3, the rod 20 carries a frusto-conical cap or cowl 60 which, together with lip 28, again defines an annular jet orifice 30. The cowl 60 further defines a series of grooves 61 in its wall portion 62 located below orifice 30. The grooves 61 are arranged in parallel planes that extend at right angles to the rod 20 or, in other words, to the axis of rotation of the frusto-conical cowl 60. The wall portion 62 of cowl 60 further defines a series of ridges 64 delimiting the grooves 61. These grooves define recesses of a type similar to the recess defined by wall structure 32 in FIG. 1.

Vapor passing through chimney 18, as indicated by dashed lines 65 in FIG. 3, flows to and passes through the orifice 30. The vapor issuing from orifice 30 flows to the outlet 67 defined by cowl 60 and issues therefrom as indicated by dashed lines 68. Part of the vapor flowing past wall portion 62 of cowl 60 will impinge on the ridges 64 and will be recirculated in grooves 61. FIG. 3 shows a series of whirls 70 to illustrate this point. These whirls again prevent an intimate contact between the vapor in the main stream and the wall portion 62 of cowl 60, so that the vapor issuing from outlet 68 is again characterized by high velocity and by substantial retention of directional force of the type mentioned above. In this manner, migration of vapor molecules to the pump mouth or inlet is materially inhibited.

If desired, the vapor employed in the embodiments shown in FIGS. 2 and 3 may be superheated, which will further inhibit condensation of vapor in the nozzles shown herein.

When considering FIGS. 2 and 3, it will of course be understood that the vapor will not just issue at the locations illustrated, but will leave the nozzle in the form of the familiar vapor umbra.

It will also be understood that the invention has utility in connection with fluid nozzles other than those specifically illustrated herein. These and other modifications will be apparent to those skilled in the art.

I claim:

1. A pumping fluid nozzle comprising a pumping fluid orifice, a wall structure guiding pumping fluid from said orifice and defining at least one recess for recirculating part of the pumping fluid flowing past said wall structure, and means for supplying heat to said wall structure to inhibit condensation of pumping fluid in said recess.

2. A pumping fluid nozzle comprising a pumping fluid orifice, a wall structure guiding pumping fluid from said orifice and defining at least one recess for recirculating part of the pumping fluid flowing past said wall structure, and means for reducing the radiation of heat from said wall structure to inhibit condensation of pumping fluid in said recess.

3. A pumping fluid nozzle comprising a pumping fluid orifice, a wall structure guiding pumping fluid from said orifice and defining at least one recess for recirculating part of the pumping fluid flowing past said wall structure, and means for supplying heat to said wall structure and for reducing the radiation of heat from said wall structure to inhibit condensation of pumping fluid in said recess.

4. A pumping vapor nozzle comprising a frusto-conical cowl having a lower rim defining an outlet opening for pumping vapor, an annular lip member disposed inside said cowl for defining an annular vapor jet-forming orifice located a predetermined distance above the lower rim of the cowl, and means for supplying pumping vapor to said orifice, the pumping vapor passing through and issuing from said orifice and flowing to said outlet opening, and said frusto-conical cowl defining between said orifice and said lower rim at least one recess for recirculating part of the pumping vapor flowing past the inner surface of said cowl.

5. A pumping vapor nozzle comprising a frusto-conical cowl having a lower rim defining an outlet opening for pumping vapor, an annular lip member disposed inside said cowl for defining an annular vapor jet-forming orifice located a predetermined distance above the lower rim of the cowl, and means for supplying pumping vapor to said orifice, the pumping vapor passing through and issuing from said orifice and flowing to said outlet opening, and said frusto-conical cowl defining between said orifice and said lower rim a plurality of circular recesses extending along the inner surface of the cowl and having circular ridges located therebetween for recirculating part of the pumping vapor flowing past the inner surface of said cowl.

6. A pumping vapor nozzle comprising a frusto-conical cowl structure having a lower rim defining an outlet opening for pumping vapor, an annular lip member disposed inside said cowl structure for defining an annular vapor jet-forming orifice located a predetermined distance above the lower rim of the cowl structure, and means for supplying pumping vapor to said orifice, the pumping vapor passing through the issuing from said orifice and flowing to said outlet opening, and said frusto-conical cowl structure defining adjacent said lower rim a first annular gutter having a knife edge facing in the direction of said orifice for deflecting part of the vapor flowing to said outlet opening, said frusto-conical cowl structure further defining an outer frusto-conical wall portion and an inner frusto-conical wall portion extending from said first gutter to a region adjacent said orifice and forming an annular channel for said deflected vapor, and a second gutter being connected to said channel at said region adjacent said orifice and having an outlet edge below said orifice for recirculating said deflected vapor in the direction of the outlet rim of the cowl structure and along said inner frusto-conical wall portion to assist the flow of vapor from said orifice to said outlet opening.

7. A pumping vapor nozzle as claimed in claim 6 including means for supplying heat to said frusto-conical cowl structure to inhibit condensation of pumping vapor in said first and second gutters and on said inner and outer frusto-conical wall portions.

5

8. A pumping vapor nozzle as claimed in claim 6, including a frusto-conical heat shield extending over said cowl structure for reducing the dissipation of heat therefrom.

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6

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