

Jan. 29, 1963

D. L. STEVENSON

3,075,689

VACUUM PUMP

Filed Nov. 20, 1961

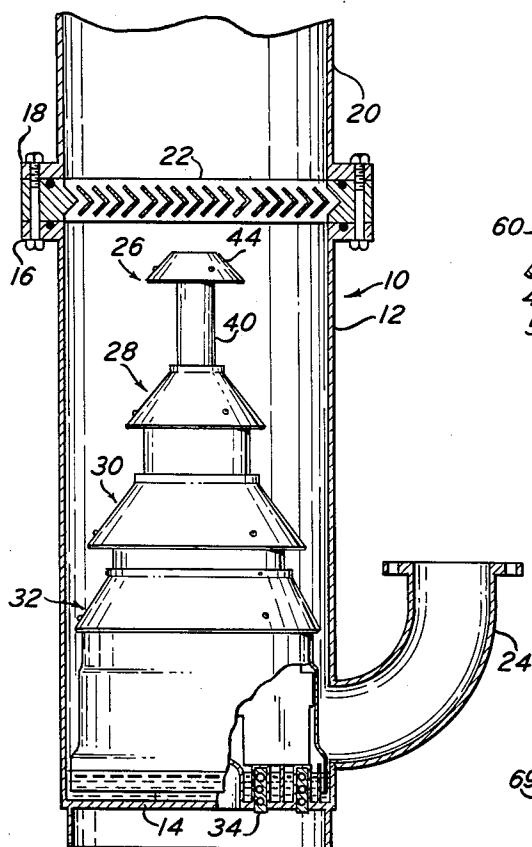


Fig. 1

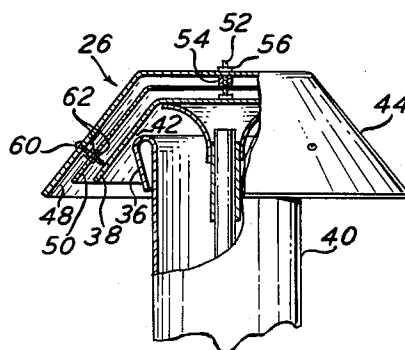


Fig. 2

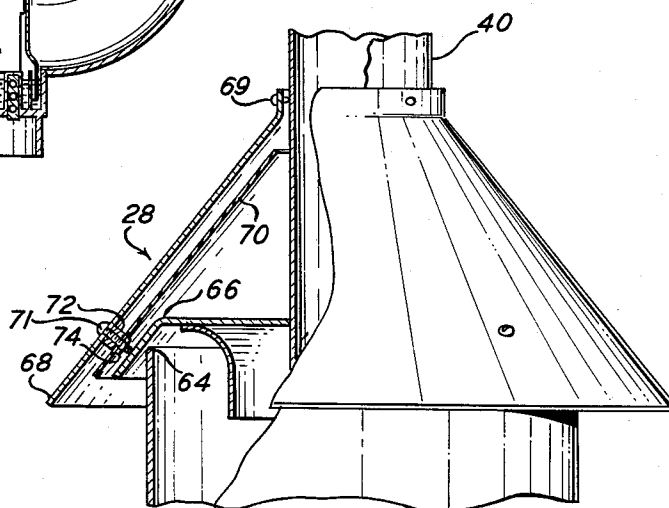


Fig. 3

INVENTOR.
DONALD L. STEVENSON

BY *Bernard A. Chiama*

ATTORNEY

1

3,075,689

VACUUM PUMP

Donald L. Stevenson, Albion, N.Y., assignor to Consolidated Vacuum Corporation, a corporation of New York
Filed Nov. 20, 1961, Ser. No. 153,544
4 Claims. (Cl. 230—101)

The present invention relates to vapor vacuum pumps and, more particularly to diffusion and ejector pumps of the type which utilize a jet nozzle assembly comprising one or more jet nozzles.

Generally, the use of diffusion and ejector pumps for creating vacuum involves the very disagreeable phenomenon of backstreaming which occurs when molecules of oil vapor migrate back into the vessel to be evacuated. Various measures have been taken to counter this movement of oil vapor, most notably, the use of highly cooled baffles and the like which are positioned between the vacuum pump and the vessel to be evacuated. The disadvantages in using baffles is that the conductance therethrough is seriously limited and this in turn greatly reduces the effective pumping speed of the pump and baffle combination. Generally, the amount of backstreaming through a baffle of conventional design is inversely proportional to the impedance of the baffle, that is, the more the baffle is capable of reducing the backstreaming the less conductance there is through the baffle.

Other attempts to minimize backstreaming have involved the use of a high conductance baffle and so-called "cold caps" on each of the nozzles from which the vapor jet issues, more notably, the top jet nozzle. These cold caps are cooled by various devices such as Peltier couples or cooling coils coiled around the cap and connected to an outside source of cooling medium. The cooling of these caps requires equipment that is relatively expensive and conduits connecting the cooling devices to equipment located outside the pump extends through the wall of the pump housing thus offering an increased number of places where leaks may develop.

It is the principal object of the present invention to minimize backstreaming in a vapor type vacuum pump utilizing a minimum of parts and at relatively low cost.

Other objects and advantages will become apparent after studying the following description and claims taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is vertical section through a diffusion vacuum pump showing the association of the present invention with the pump;

FIGURE 2 is a fragmentary view, partly in section, of the top jet nozzle of the pump of FIGURE 1, showing the present invention applied thereto;

FIGURE 3 is an enlarged fragmentary view of another jet nozzle of the pump showing the present invention applied thereto.

Referring more particularly to FIGURE 1 of the drawing, there is shown a diffusion vacuum pump generally indicated by the reference numeral 10 which includes a hollow cylindrical casing 12 with an integral bottom wall 14. The upper end of the pump is provided with a suitable inlet flange 16 to which a cooperable flange 18 of a vessel 20 to be evacuated may be secured. Arranged between the flanges 16 and 18 is a baffle 22 which serves to condense the oil vapor which tends to migrate from the pump toward the vessel 20. The discharge side of the pump is provided with a pipe 24, one end of which opens into the lower portion of the casing 12.

With the pump casing there is centrally arranged a hollow nozzle assembly comprising a plurality, and in this case four, jet nozzles indicated at 26, 28, 30, 32. Vapors rising in the interior of the nozzle assembly due to vaporization of pump fluid are directed out of the respective orifices in the downwardly directed jet nozzles. A suit-

2

able heater 34 located within the nozzle assembly and arranged on the bottom wall 14 serves to heat pump fluid to cause vaporization thereof.

In FIGURE 2, the jet nozzle 26 is illustrated as comprising a lip portion 36 and a frusto-conical skirt 38 spaced slightly radially therefrom. The illustrated jet nozzle arrangement is conventional and, as known in the art, hot oil vapors are driven upwardly through the chimney 40 of the nozzle assembly and expelled at great speed out of the annular spacing 42 between the lip 36 and the skirt 38. Normally the greater portion of these vapors are directed downwardly through the pump housing in order to achieve pumping action, however, a small amount of the vapors turn the lower edge of the skirt and migrate upwardly toward the baffle 22. This migratory oil vapor is condensed by the baffle and oil droplets, resulting therefrom, will drop down into the heater portion of the pump to be vaporized.

In order to minimize "backstreaming" or the migration of the oil vapor in the direction of the intake end of the pump housing, the top jet nozzle 26 is provided with an insulator cap 44 which conforms generally to the frusto-conical shape of the skirt 38 but overlaps the lower edge thereof for a considerable distance. The lower edge of the cap extends toward the fringes of the jet stream emanating from the jet nozzle and serves to deflect the vapors which turn outwards around the lower edge of the skirt 38 and would normally drift upwardly toward the flange 16. These migratory vapors which impinge upon the cap 44 heat the same somewhat and, in order to prevent re-evaporation of the oils which may condense on the cap, the same is maintained in a condition where re-evaporation cannot occur.

In the present invention, this is accomplished by preparing the cap 44 as an insulated body and to this end, the inner or under-surface 48 is made reflective and a heat shield 50 is provided between the cap and the skirt of the nozzle 26. Both the upper and the lower surfaces of the shield 50 are reflective. The reflective under-surface 48 of the cap and the reflective lower surface of the shield heat and tend to minimize the heat that would develop on the cap by hot vapors emanating from the jet nozzle 26. This reduction in the amount of heat reaching the cap 44 permits the natural loss of heat through radiation from the jet structure to the walls of the pump casing to maintain the temperature of the cap at a sufficiently low point to prevent re-evaporation of the condensed vapor.

These surfaces also reflect heat back into the jet nozzle causing it to operate at a somewhat higher temperature, thereby making the stream drier or free of liquid pump fluid, thus improving the quality of the jet stream expelled from the nozzle throat. In effect then the cap 44 serves to deflect oil vapor which would deviate from the main jet stream of the pump and, to prevent the cap from becoming another or secondary source of oil vapor, the cap 44 is effectively maintained at a temperature where re-evaporation does not occur by the provision of the lower reflective surfaces of the cap and the shield. With this arrangement, the need for extraneous cooling devices such as cooling coils, conduction cooling members, Peltier couples and the like for large scale cooling is eliminated.

Deflection of the oil vapors by the shield 44 tends to reshape the otherwise useless fringe portion of the jet stream by directing these vapors back into the jet stream where they can perform useful pumping action. In this manner, the speed of the pump will be increased somewhat over and above a nozzle arrangement without the cap.

The reflective characteristics of the lower-surface of

3

cap 44 in conjunction with the lower reflective surface of the shield 50 produces the net result of retaining the maximum amount of heat possible within the jet nozzle 26. These characteristics of both surfaces also reduces the amount of heat reaching the cap 44 to a degree that the normal heat loss by radiation to the walls of the pump casing is sufficient to maintain the temperature of the cap below that required for re-evaporation of the condensed vapor.

Mounting and separation of the cap 44 and the intermediate shield 50 relative to the other structure of the jet nozzle 26 may be accomplished by any suitable means which will prevent or minimize heat conduction from the relatively hot structural elements of the nozzle 26. As shown in FIGURE 2, a suitable mounting means is illustrated and comprises a vertically projecting screw 52 secured to and extending from the center point of the skirt 38. The screw 52 projects through suitable centrally located apertures formed in the cap 44 and the shield 50. A spacer 54 is arranged on the screw between the shield 50 and the cap to position the former relative to the latter. A lock nut 56 maintains the aforementioned structure upon the jet nozzle 26. In order to maintain a predetermined spacing between the shield and the skirt 38, there is provided a plurality of screws 60 (only one shown in FIGURE 2) threadedly secured to the cap and projecting inwardly therefrom and through suitable apertures formed in the shield 50. A pair of lock nuts 62 received on the screw 60 and positioned on either side of the shield maintains the same in a fixed spaced distance from the cap. The inner end of the screw 60 abuts the skirt 38 and is utilized in conjunction with the screw 52 to space the cap and shield from the skirt and also to secure this structure to the skirt.

The present invention illustrated in FIGURE 2 may also be adapted for the other stages of the diffusion pump illustrated in FIGURE 3. As shown in FIGURE 3, the jet nozzle 28, which comprises the conventional lip portion 64 and skirt 66, is also provided with an insulator cap 68. The under-surface of the cap 68 is made reflective and, mounted below the cap 68, is an intermediate shield 70 which is made reflective on both surfaces. The inner edge of the cap 68 is radially spaced relative to the column or stack 40 by suitable long rivets 69, and a screw 71 and mounting devices 72, 74 arranged on the cap, serve to support the shield 70 in spaced relationship relative to the cap and the skirt 66.

The present invention is distinguished from the invention disclosed and claimed in the copending patent application Serial No. 153,543, filed November 20, 1961, assigned to the same assignee in that the present invention requires an insulated cap formed with a straight conical design and at least one heat reflective shield. Since in the present invention the conical cap is bombarded with vapor molecules at a more glancing angle, the amount of heat produced on the conical cap by the condensed vapor is relatively small or at least smaller than if the lower edge of the cap was formed with a generally vertical extending cylindrical projection shape of the type disclosed in the above referred to copending application. With a straight conical shape cap, as provided in the present invention, the vapor molecules strike the inner surface of the cap at a more glancing angle resulting in a lesser amount of condensed vapor and a correspondingly lesser amount of heat transferred to the cap. On the other hand, in order to project into the fringe portion of the jet stream, the straight conical cap must be extended further than the cylindrical projection of the invention disclosed in the copending patent application resulting in the use of a larger diameter at the base of the cap of straight conical design. This will lessen the pumping speed of the diffusion pump as compared to the speed when using the cap having the design disclosed in the copending patent application. Nevertheless, use of a larger diameter cap of the straight conical design of the

4

present invention does eliminate more backstreaming than is the case with the small diameter cylindrical projection design as disclosed in the copending application.

In order to insure further maintaining the cap 44 in a condition to prevent re-evaporation of condensed vapor, the upper surface of the cap may be coated with a material having a higher emissivity than the normal metallic surface of the cap. An example of such a high emissivity material for use with a cap made from aluminum would be a black dyed anodized surface.

From the foregoing it will be apparent that the present invention may be applied to any or all of the jet nozzle of the nozzle assembly of a diffusion pump. The provision of an insulated cap deflects oil vapor that would otherwise migrate upstream of the pump and will permit the use of a baffle 22 having a greater conductance. Maintaining the cap in a condition for preventing re-evaporation of oil thereon is attained by the ability of the under-surface of the cap to reflect the heat, the provision of a reflective surface on the shield and the transfer of heat on the cap to the pump walls by normal radiation. In the use of the present invention, there is no need to employ extraneous cooling devices to effect cooling of the caps 44 and 68.

I claim:

1. In a vapor vacuum pump, a pump casing having an inlet, an outlet, and a boiler for heating pump fluid, a nozzle assembly mounted in the pump casing for providing a vapor jet stream, said nozzle assembly having at least one jet nozzle comprising a lip portion and a skirt between which the jet of vapor is expelled for pumping action, a cap surrounding said jet nozzle in spaced relation to said skirt and having an edge extending below said skirt and into the fringe portions of the jet stream, said cap having the surface which is adjacent the jet nozzle reflective thereby to reflect some of the heat emanating from the jet nozzle which would thermally affect said cap, and a shield mounted between said skirt and said cap in spaced relation therebetween for further reducing the transfer heat to said cap.

2. In a vapor vacuum pump, a pump casing having an inlet, an outlet, and a boiler for heating pump fluid, nozzle assembly mounted in the pump casing for producing a vapor jet stream, a said nozzle assembly having at least one jet nozzle comprising a lip portion and a frusto-conical shaped skirt between which the jet of vapor is expelled for pumping action, a radiation cap surrounding said jet nozzle in spaced relation to said skirt and having a shape similar to said skirt, said cap having an edge extending below said skirt and having the surface which is adjacent the jet nozzle reflective thereby to reflect heat emanating from the jet nozzle which would normally offset said cap and a shield mounted in spaced relation between said skirt and said cap for further reducing the transfer of heat to said cap.

3. In a vapor vacuum pump, a pump casing having an inlet, an outlet, and a boiler for heating pump fluid, a nozzle assembly mounted in the pump casing for providing a vapor jet stream, said nozzle assembly having at least one jet nozzle comprising a lip portion and a skirt between which the jet of vapor is expelled for pumping action, a cap surrounding said jet nozzle in spaced relation to said skirt and having an edge extending below said skirt and into the fringe portions of the jet stream, said cap having the surface which is away from said jet nozzle coated with a material of higher emissivity than the material of said cap, and a reflective shield interposed between and spaced from said cap and said skirt for reflecting some of the heat developed by said skirt.

4. In a vapor vacuum pump, a pump casing having an inlet, an outlet, and a boiler for heating pump fluid, a nozzle assembly mounted in the pump casing for providing a vapor jet stream, said nozzle assembly having at least one jet nozzle comprising a lip portion and a skirt

5

between which the jet of vapor is expelled for pumping action, a cap surrounding said jet nozzle in spaced relation to said skirt and having an edge extending below said skirt and into the fringe portions of the jet stream, said cap having the surface which is adjacent the jet nozzle 5 reflective thereby to reflect some of the heat emanating from the jet nozzle which would thermally affect said cap,

6

and a shield interposed between and spaced from said cap and said skirt and having its surface adjacent the skirt made reflective for reflecting some of the heat developed by said skirt.

No references cited.