

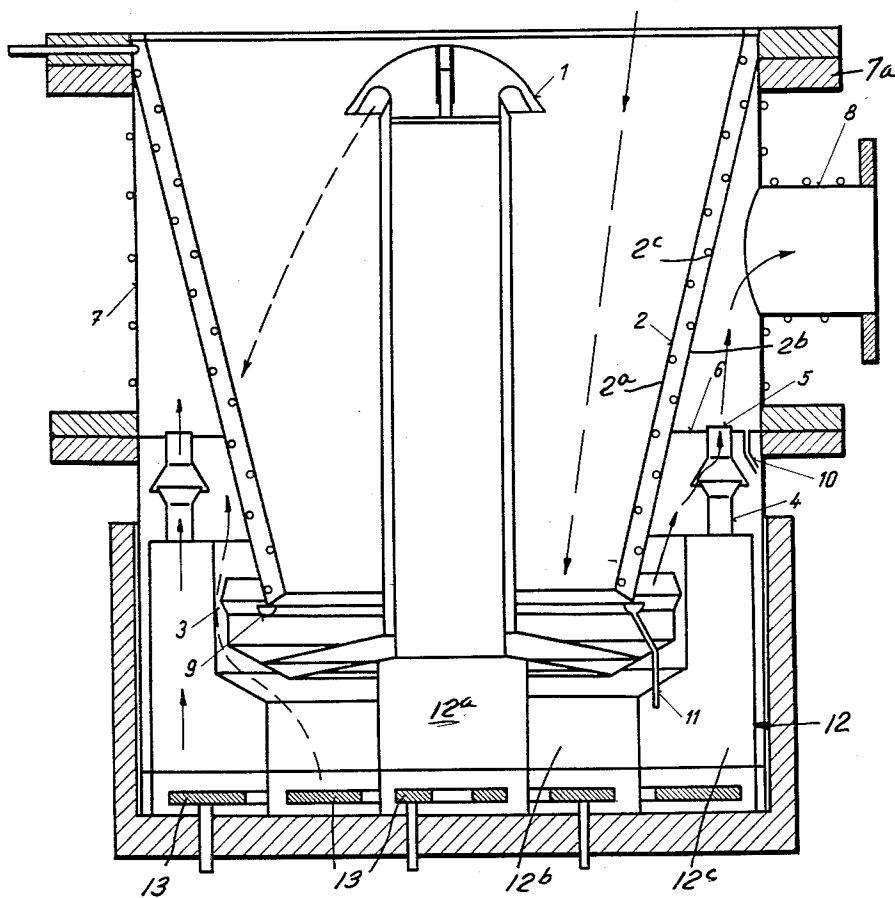
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OIL DIFFUSION HIGH-VACUUM PUMP

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OIL DIFFUSION HIGH-VACUUM PUMP

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This invention relates to high-vacuum diffusion pumps which have a high pumping speed and which are capable of producing high vacua.

Modern high-vacuum techniques have increased the demands made on diffusion pumps with respect to their pumping speed and high final vacuum, and also with respect to the level of the backing-up pressure against which such pumps must act. Further, it has become increasingly important to reduce the quantity of the returning oil vapours, the heat consumed in operating the pump and the overall dimensions of the latter.

It is well known that the largest diffusion pumps have a pumping speed of 35,000 litres per second or more at a pressure of 10^{-4} to 10^{-5} mm. Hg. Such pumps have a suction opening with a diameter of 1000 millimetres and a height of about 3 meters. Such large dimensions of the pumps cause considerable difficulties in connection with the design and mounting of high vacuum installations, and these difficulties are aggravated by the correspondingly large dimensions of the necessary high vacuum valves. Therefore, these installations have to be mounted in large building structures to facilitate removal of the pumps for repair, adjustment, cleaning or replacement. It is obvious that the mentioned difficulties can only be reduced if a way is found of reducing the height of the pumps without reducing their other dimensions and without impairing their otherwise desirable characteristics.

As a result of the construction according to the invention, to be described hereinafter, the total height of oil diffusion vacuum pumps can be reduced 30 to 50 percent as compared with conventional oil diffusion vacuum pumps having the same operating characteristics, that is, the same pumping speed, final vacuum, and admissible backing up pressure. Moreover, the vacuum pump according to the invention is also endowed with an improved heat efficiency and has a relatively simpler construction. In accordance with an aspect of the invention, the above desirable results are obtained by providing an oil diffusion pump with a cylindrical outer wall or housing and with a cooler disposed within the housing and in which a high-vacuum nozzle operates the cooler, having the form of a truncated cone with its wider opening uppermost, so that a free space is obtained between the housing and the lower portion of this cooler for the accommodation of inversely mounted nozzles which operate against a higher pressure. Thus, the high vacuum nozzle and the inversely mounted nozzles act against the inner and outer surfaces of the same cooler.

A constructional example of an oil diffusion pump according to the invention is illustrated diagrammatically in the accompanying drawing containing a single vertical sectional view of a multi-stage oil diffusion pump.

Referring to the drawing in detail, it will be seen that the pump embodying the invention includes a high vacuum nozzle 1 opening downwardly, as viewed in the drawing, within a cooler 2 which has the shape of a

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truncated cone with its large diameter end at the top. The cooler includes parallel inner and outer walls 2a and 2b between which a helical cooling coil 2c may be disposed, or the cooling may be effected by the circulation of a cooling medium directly between the walls 2a and 2b. Due to the fact that the lower part of the cooler 2 is narrower than its upper part, a suitable space is obtained between such lower part and a cylindrical housing 7 in which the cooler is suspended for the accommodation of additional nozzles 3 and 4. These nozzles 3 and 4 are inverted relative to the nozzle 1, that is, the nozzles 3 and 4 open upwardly, and in this way the main reduction in height is obtained. The nozzle 3 is annular in shape, and extends around the lower edge of cooler 2, with its configuration being generally similar to conventional diffuser nozzles. Since this nozzle 3 opens into a radially wide gap in the vicinity of the narrow part of the cooler 2, manufacturing tolerances need not be accurately maintained so that manufacture of nozzle 3 is facilitated. The nozzles 4 operate against the backing-up pressure of rotary or other pumps for exhausting the evacuated gases to the atmosphere. In order to obtain economical operating conditions at higher backing-up pressures, the nozzles 4 are preferably of the Laval-type and each has a diffuser 5 supported by a cooled plate 6 extending radially between the outer wall 2b of cooler 2 and the housing 7 of the pump. A flanged connecting socket 8 for connection to the backing-up pressure tube opens radially from housing 7 near to the upper end of the latter which is formed with a flange 7a by which the vacuum pump can be connected to the container or the like to be evacuated, whereby a simple mounting of the valves and also of the backing-up pressure pump with short connecting tubes is made possible. The diffusion pump embodying this invention has a boiler 12 in the bottom of housing 7 which contains the working fluid, for example, oil. The boiler 12 is preferably separated into a central compartment 12a communicating with nozzle 1 and concentric annular compartments 12b and 12c communicating with nozzles 3 and 4, respectively, and the walls or partitions defining the several compartments have openings adjacent their lower edges so that the oil at the bottom of the compartments can circulate between the latter.

The oil in the boiler 12 is heated to a sufficient temperature to cause a copious off-flow of vapor which issues from the nozzles 1, 3 and 4, as represented by the broken-line arrows on the drawing, and thereby exerts a pumping action on gases present in the container or the like connected to the flange 7a by entraining and imparting a translatory velocity to such gases, as represented by the full line arrows on the drawing, which carries the latter out of the socket 8 to the backing-up pump (not shown) discharging to the atmosphere. The necessary heating of the oil is effected by electrical heating elements 13 immersed in the oil.

It will be apparent that the vapor issuing from nozzle 1 flows downwardly along the inner surface of cooler 2, while the vapor issuing from nozzles 3 and 4 flows upwardly along the outer surface of cooler 2. The contact of the vapors with the cool surfaces of cooler 2 condenses the vapors and the resulting oil is returned to the boiler 12 for re-heating.

The condensed oil from the nozzles 1 and 3 is collected in a small annular trough 9 underlying the lower edge of cooler 2 and from which it is discharged into the boiler through a pipe 11. The vapors flowing through the diffusers 5 of the nozzles 4 condense on the outer surface of cooler 2 above plate 6, and the oil collects on plate 6 and is returned to the boiler by way of a suitable pipe or pipes, for example, through a small pipe 10.

Two or three immersion heating elements 13 are used for the heating of the system. The heating element 13 in the boiler compartment 12c associated with the Laval-type nozzles 4 supplies the main part of the heat energy for the evaporation process in all of the compartments of the boiler. The second and third heating elements arranged within the boiler compartments 12a and 12b associated with the nozzle 1 and the nozzle 3, serve, for the most part, to control the pressure of the inner nozzles.

As a result of the described construction, a reduction of the height as well as of the energy consumption of diffusion vacuum pumps with pumping speeds above 250 litres per second can be obtained. Reductions of the dimensions and energy consumption of vacuum pumps are of decisive importance in small as well as in high vacuum installations because the mounting, the housing, the construction, the assembly and the supervision of the pumps are facilitated and also the initial cost and the maintenance costs are reduced.

The actual construction of the diffusion pump, naturally, may differ from that represented diagrammatically in the accompanying drawing; for instance, instead of a single annular nozzle 3, a series of Laval-type nozzles or the like may be used. However, the principle of the arrangement of the vacuum pump as hereinbefore described must be maintained if it is desired to obtain the stated advantages.

What we claim is:

1. An oil diffusion vacuum pump comprising a generally cylindrical housing, a frusto-conical cooler having inner and outer cooling surfaces and arranged coaxially within said housing, inner nozzle means within said cooler opening generally in the axial direction toward the relatively small diameter end of the cooler, outer nozzle means disposed between said cooler and said housing and opening generally in the opposite axial direction, means for producing heated oil vapors and for supplying the same to said inner and outer nozzle means to condense said vapors upon said inner and outer cooling surfaces, respectively, of the cooler, inlet means communicating with the space defined within said cooler, and outlet means on said housing.

2. An oil diffusion vacuum pump comprising an up-standing, generally cylindrical housing, a frusto-conical cooler having inner and outer cooling surfaces, and arranged coaxially within said housing with the relatively small diameter end of said cooler being located at the bottom thereof to define an annular space between said cooler and housing, inner nozzle means opening down-

wardly within said cooler, outer nozzle means opening upwardly in said annular space between said cooler and housing, and means for producing heated oil vapors and for supplying the same to said inner and outer nozzle means to issue from the latter in downward and upward directions, respectively, for condensing upon said inner and outer cooling surfaces, said housing having its upper end open to define an axial inlet for gases to be evacuated which communicates with the interior of said cooler at the upper end of the latter, and also having a radial outlet opening for the gases which communicates with said annular space between said cooler and housing adjacent said upper end of the housing.

3. An oil diffusion vacuum pump as in claim 2; wherein said outer nozzle means includes first nozzle defining means opening upwardly into said annular space adjacent said bottom small diameter end of the cooler, and second nozzle defining means opening upwardly into said annular space and located radially outward and at a higher level with respect to said first nozzle defining means.

4. An oil diffusion vacuum pump as in claim 3; wherein said second nozzle defining means includes Laval-type nozzles having diffusers through which the flow of evacuated gas is induced by the heated oil vapor issuing from said Laval-type nozzles; and further comprising an annular plate extending between said cooler and housing below said outlet opening with said diffusers extending through said plate so that the latter causes all of the evacuated gas to flow through said diffusers on the way to said outlet opening.

5. An oil diffusion vacuum pump as in claim 2; wherein said means producing heated oil vapors includes a boiler at the bottom of said housing containing oil and communicating with said inner and outer nozzle means, heating elements immersed in the oil in said boiler, and means for returning condensed oil to said boiler including an annular trough underlying the lower end edge of said cooler to collect condensed oil draining from the inner and outer cooling surfaces of the cooler, and a drain pipe opening from said trough into said boiler.

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