This invention relates to vacuum pumps and more particularly to an improved high vacuum diffusion pump.

A principal objective of the present invention is to provide an improved diffusion pump having greatly reduced gas inleakage real or virtual when attached or secured to a system to be evacuated.

Another objective of the present invention is to provide an improved diffusion pump which is rugged in construction and cheap to manufacture.

Still another objective of the invention is to provide a diffusion pump of the above type which can be permanently secured, such as by welding, to the system to be evacuated and yet can be readily disassembled and assembled.

Other objectives of the invention will, in part, be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objectives of the invention reference should be had to the following detailed description taken in connection with the accompanying drawing wherein there is shown a diagrammatic sectional view of one preferred embodiment of the present invention.

The successful operation in the high vacuum range is dependent in part on the chamber or system to be evacuated being free of any appreciable sources of gas leaks. One source of gas leaks which presents a serious problem in the high vacuum range is that due to seals and sealing elements for connecting equipment such as vacuum pumps and the like to the vacuum system which is to be maintained in the high vacuum range. Gases which originate in the sealing elements, or through the sealing elements, restrict the ultimate vacuum that is attainable.

Conventionally, the upper end of the casing of vacuum diffusion pumps is provided with a flange whereby the inlet port can be bolted or secured to the chamber to be evacuated. In the process of evacuating a chamber, the point of connection of the pump to the vacuum chamber provides a gas leak source real or virtual which restricts the ultimate vacuum attainable.

As a result, the present invention is directed to an improved high vacuum diffusion pump by which the above objects are achieved and the disadvantages referred to overcome. In a preferred embodiment of the present invention the diffusion pump comprises a substantially cylindrical pump body and a vapor jet assembly positioned within the pump body, the jet assembly being smaller than the pump body and defining a pumping chamber within the pump body. The jet assembly preferably includes a plurality of jets designed to discharge jets of diffusion pump oil vapors downwardly in the pump chamber. At the bottom of the pump body there is provided a boiler for vaporizing diffusion pump oil, these vapors passing upwardly through the jet assembly and outwardly and downwardly through the jets. A foreline is connected to the pump body adjacent the bottom of the pumping chamber and preferably forms an ejecting stage having a high forepressure tolerance. A vacuum seal is provided at a point in the pump casing adjacent the high pressure area of the vacuum diffusion pump. By the term "high pressure area" as used in the specification and claims is meant the area below the top jet and the oil vapor jet formed therefrom. In this manner any gases originating from the atmosphere or in the sealing elements, and which enter the diffusion pump will pass into the high pressure area of the diffusion pump chamber and will be removed by operation of the pump. Additionally by positioning the vacuum seal adjacent the high pressure area of the diffusion pump there will be less outgassing from the sealing elements than would occur if the vacuum seal were positioned above the top vapor jet or adjacent to the system to be evacuated such as is done conventionally.

In a preferred embodiment of the present invention the vacuum seal preferably comprises a cooled O-ring flanged seal of the type described in the copending application of Irmo Parkas, Serial No. 3674, filed January 20, 1960, now Patent No. 3,058,232. In a preferred embodiment the seal comprises a first flange with two recesses and a second flange having a substantially flat surface. The recessed flange is used to retain gaskets which may be composed of rubber, neoprene, polymerized vinyl chloride or related synthetic rubber elastic materials. At least one of the flanges preferably has a channel hollowed out of it. The flanges when placed in close proximity thus co-operate with the gaskets and the channel space to provide a conduit for a cooling liquid. When the flanges are placed together they are preferably designed to provide a heat barrier for at least the inner one of the two rubber gaskets. The cooling of the flange and gasket material is believed to reduce the outgassing rate of the material which is employed as a gasket. At pressures on the order of 10^-4 torr, for example, even a minute amount of hydrocarbons escaping from the gasket material can place an enormous volumetric pumping load on the system. By cooling the gasket material, particularly to temperatures below 0°C, this outgassing rate appears to be drastically reduced. Cooling also reduces diffusion of gases through the gasket material.

Referring now more particularly to the drawing, the pump body is illustrated generally at 10 in the form of a substantially cylindrical tube comprising an upper casing 12 and a lower casing 14. Within the pump body there is a jet assembly which is generally indicated at 16. The pumping space between the jet assembly and the interior of the cylindrical pump body is shown at 18. The pump body is provided with a foreline 20 and a diffuser section 20A formed integrally therewith. At the bottom of the pump body there is provided a boiler which comprises a heater 24 and a boiler plate 25 and also a space 26 in which a quantity of pump oil may be confined. The jet assembly preferably comprises a plurality of downwardly directed jets 28, 36 and 32 and an ejector stage jet 34. The top jet 36 is fed by a vapor tube (not shown) extending from adjacent the bottom of the jet assembly and is connect with the top of the jet assembly. Cooling coils 36 and 38 are provided around portions of the pump body and the foreline. The upper casing 12 of the pump body encloses at least the top jet and preferably a major portion of the jet assembly and is preferably welded to its upper end 40 to a wall 42 which defines a vacuum chamber. Foreline is also evacuated. The lower casing 14 of the pump body containing the boiler and foreline is secured to the upper casing 12 by vacuum seal generally illustrated at 46. The vacuum seal 46 preferably comprises a lower flange 48 attached to the lower casing 14 and an upper flange 50 forming the lower end of casing 14. The lower flange 48 is preferably provided with two recesses 52 and 54 and a channel 56. Positioned in recesses 52 and 54 are gaskets 57 and 58. The flanges when secured together as by bolts 60 cooperate
with the gaskets and the channel space to provide a conduit for a cooling liquid to cool the gaskets. The upper flange 59 is preferably provided with a conduit 62 for introducing the cooling liquid from a source not shown into channel 56.

In operation of the diffusion pump described above, the upper end of casing 12 of the pump body 10 is welded to the vacuum chamber to be evacuated and the foreline 29 is connected to a suitable backing pump (not shown) such as a conventional mechanical vacuum pump. Cooling coils 35 and 38 are connected to a suitable source (not shown) of a cooling fluid such as water and the cooler is filled with a suitable diffusion pump oil. Also conduit 63 is connected to a suitable source (not shown) of cooling fluid such as water or brine. The mechanical vacuum pump is then operated to remove most of the air from the diffusion pump and the chamber being evacuated.

The heater 24 is energized to heat the pump oil to a sufficiently elevated temperature to vaporize the oil. The vapors generated in the pump boiler travel up the inside of the jet assembly and are discharged from the jets 26, 30 and 32 with high velocities thus pumping air from the chamber and forcing it out of the foreline. The hot oil vapor jets condense on the inside of the surface of the cooled pump body and run down the pump body until it reaches the boiler. Air and entrainment of vapor or outgassing of gases from the vacuum seal 46 enter the pump chamber adjacent thereto and are pumped along with air from the vacuum chamber 44 out the foreline.

In a preferred embodiment of the present invention, the vacuum seal 46 is positioned within the space defined by the points of impingement 64, 66, for example on the casing wall of a pair of adjacent vapor jets, (indicated by the dotted lines) in the high pressure area of the pump chamber. Thus the vacuum seal is not struck by the vapor jets as they discharge downwardly in the pump chamber. In this manner cooling of the vacuum seal is more effective and outgassing which would result from further heating of the seal elements by direct impingement of a vapor jet on the seal is maintained at a minimum.

While the invention has been described with respect to preferred embodiments thereof, numerous modifications can be made within the spirit thereof. For example, the vacuum seal 46 can be positioned at any point below the vapor jet or the top jet. Where greater facility of assembling and disassembling the pump is desired, the seal can be positioned between the foreline and the boiler. With this arrangement the foreline does not have to be disassembled in order to disassemble the pump. In this position however greater cooling of the seal is required to compensate for the heat transferred from the boiler.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An improved oil diffusion pump comprising a vertical pump body and a vapor jet assembly positioned therein, the pump body comprising upper and lower tubular wall portions surrounding the vapor jet assembly, the upper and lower wall portions being connected by a demountable vacuum seal for assembling and disassembling the pump, the seal being positioned at a point on the pump body adjacent the high pressure area whereby gases entering the pump body at the seal are removed by operation of the pump, said seal being the sole demountable seal of the pump body, and means for cooling the seal.

2. A high vacuum diffusion pump comprising a pump body, a vapor jet assembly positioned within said pump body, said jet assembly being smaller than said pump body and defining a pumping chamber within said pump body, said jet assembly having a plurality of jet nozzles arranged to discharge jets of diffusion pump oil vapors downwardly into said pumping chamber, a boiler for vaporizing diffusion pump oil at the bottom of said pump body, a foreline connected to said pump body adjacent the bottom of said pumping chamber, said pump body comprising an upper casing wall welded to said vacuum chamber and a lower casing wall, a seal for connecting said casing walls at a point below the vapor jet of the top jet nozzle of said jet assembly and means for cooling said seal, upper casing wall presenting a continuous solid target to the vapor jet of the top jet nozzle.

3. In a high vacuum diffusion pump comprising a pump body, a vapor jet assembly positioned within said pump body, said jet assembly being smaller than said pump body and defining a pumping chamber within said pump body, said jet assembly arranged to discharge jets of diffusion pump oil vapors downwardly into said pumping chamber, a boiler for vaporizing diffusion pump oil at the bottom of said pump body, a foreline connected to said pump body adjacent the bottom of said pumping chamber, the improvement which comprises a pump body comprising an upper casing wall enclosing a major portion of said jet assembly and a lower casing wall forming the bottom of said pump body and containing the boiler and foreline and demountable seal means for connecting said upper casing wall to said lower casing wall at a point adjacent the high pressure area of said pumping chamber and means for cooling said seal means, said upper casing wall forming a portion of a continuous tubular extension of a chamber to be evacuated.

4. In a high vacuum system comprising a vacuum chamber and a high vacuum diffusion pump for evacuating said chamber, said diffusion pump comprising a pump body, a vapor jet assembly positioned within said pump body, said jet assembly being smaller than said pump body and defining a pumping chamber within said pump body, said jet assembly arranged to discharge jets of diffusion pump oil vapors downwardly to said pumping chamber, a boiler for vaporizing diffusion pump oil at the bottom of said pump body, a foreline connected to said pump body, the improvement which comprises a pump body comprising an upper casing wall welded to said vacuum chamber and a lower casing wall, a seal means for connecting together said upper and lower casing walls comprising a pair of flanges adjacent the foreline, a rubber sealing gasket positioned between said flanges for sealing said flanges, means for compressing said gasket and means for circulating a cooling fluid in cooling relationship with said gasket to lower the temperature to below ambient temperature.

5. A high vacuum system comprising a vacuum chamber and a high vacuum diffusion pump for evacuating said chamber, said diffusion pump comprising a pump body, a vapor jet assembly positioned within said pump body, saidjet assembly being smaller than said pumping body and defining a pumping chamber within said pumping body, said jet assembly having a plurality of jets arranged to discharge jets of diffusion pump oil vapors downwardly into said pumping chamber, a boiler for vaporizing diffusion pump oil at the bottom of said pump body, a foreline connected to said pump body adjacent the bottom of said pumping chamber, said pump body comprising an upper casing wall welded to said vacuum chamber and a lower casing wall, a seal for connecting said casing walls at a point below the high pressure area of said pumping chamber and within space defined by adjacent vapor jets and means for cooling said seal.

6. A diffusion pump comprising a tubular vertical wall
surrounding a vapor jet assembly, means for cooling the wall, a boiler located at the lower end of the tubular wall, a foreline connected to the lower end of the wall above the boiler, the vapor jet having a vertical series of jet nozzles for discharging a series of jets against the inner surface of the wall, the jets forming boundaries between low pressure areas above the jets and high pressure areas below the jets, the wall being formed of upper and lower tubes connected end-to-end at a high pressure area by a demountably sealed connection, the upper tube surrounding the upper portion of the vapor jet assembly and presenting a continuous metallic surface thereto.

7. The pump of claim 6 wherein the demountably sealed tube connection is located out of the direct path of any jet and below at least two jets.

8. The pump of claim 7 wherein the demountably sealed tube connection comprises matching flanges welded to the adjacent ends of the tubes and compressing a rubber sealing gasket therebetween, and means located in at least one of the flanges for cooling said gasket.

9. The diffusion pump of claim 8 wherein the foreline is connected to the lower tube.

References Cited by the Examiner

UNITED STATES PATENTS
2,978,788 4/37 Bancroft 230—101
2,702,156 2/55 Nakaji et al. 230—101

FOREIGN PATENTS
587,800 5/47 Great Britain.

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