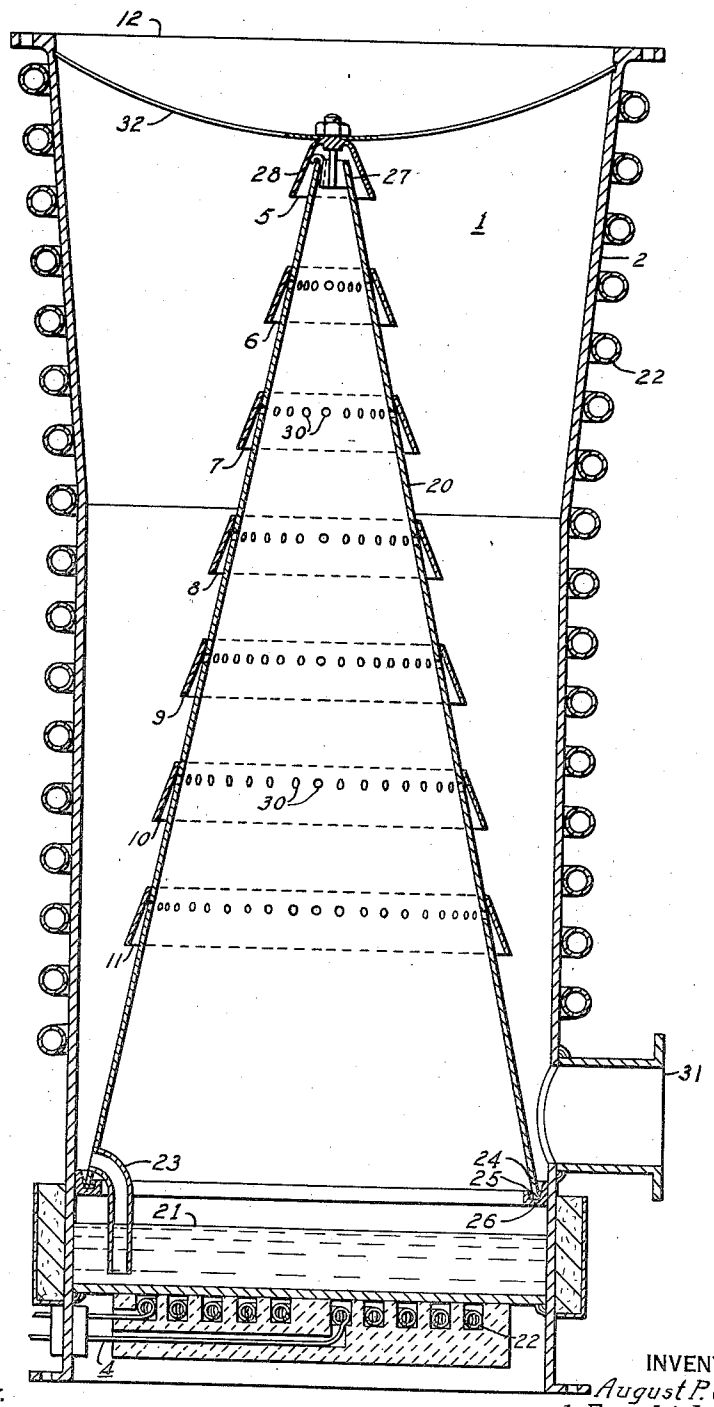
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WITNESSES:

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Our invention relates to a vapor pump and particularly to a vapor pump for delivering large volumes of vapor against a relatively high back pressure.

Considerable difficulty has been experienced in developing vapor pumps capable of delivering large quantities of vapor or non-condensable gases against a relatively high back pressure, that is, a back pressure of the order of efficient operation of the rotating oil sealed mechanical pumps.

Heretofore diffusion pumps designed for high pumping speeds and high ultimate vacuum inherently have low maximum exhaust pressures and likewise diffusion pumps designed for high maximum exhaust pressure have low speeds and low ultimate vacuums.

The speed of a diffusion pump can be defined as the volume extracted by the pump in unit time measured at the mean pressure during the unit time interval. The common unit of speed is liters per second at the mean pressure in microns. A common method for calculating the theoretical speed of a diffusion pump is to use the formula for the speed of an orifice ($S=75A$) multiplied by a pump factor (H), determined by the design of the pump. The H factor of a given pump is obtained by dividing the actual pump speed by the theoretical pump speed. The theoretical speed is obtained by assuming an orifice of area A having a pressure of one micron at one side and an infinite vacuum on the other. Since a pump never operates under such conditions, the actual speed is divided by the theoretical speed to secure the pump factor H. Thus:

$$S=75AH$$

where

S is speed in liters

A is area in square inches between the outer diameter of the top jet and the pump barrel

H is a factor determined by design features such as design of jet, pumping fluid used, boiler pressures, back streaming, etc.

The distance from the barrel wall to the outer diameter of the top jet is referred to as the "pumping radius." The maximum diameter of the hood or shroud 28 forming or directing the vapor blast is the outer diameter of the top jet and the pumping radius is the minimum distance from hood 28 to wall 2. It follows, from the formula, that for a high speed pump, a large pumping radius is necessary. Because of the large pumping radius, the compression ratio across the top jet is small. Therefore, other jets must be applied in series with the top jet

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to compress the gas to a pressure where it can be efficiently handled by a booster pump or a rotary vacuum pump. These large pumping radii afford low impedance to backstreaming gas molecules, permitting the primary pump to work only against low exhaust pressures.

To pump against high exhaust pressures it is necessary to provide a jet where a large volume of vapor is released in a small region, thus creating a very solid umbrella of vapor which backstreaming air molecules have great difficulty in penetrating.

In order to provide a high-capacity high-speed pump, we have provided a pumping casing having an enlarged intake opening compared to the cross sectional volume of the pumping chamber and have provided this expanded pumping chamber with a chimney of substantial conical formation through which vapor is conducted from a boiler to a plurality of successive pumping jets.

In the pump according to our invention, the pumping chamber or at least the upper portion thereof is constructed of outwardly flaring design so that the intake opening is of relatively greater size than the cross sectional area of the pumping chamber. The pumping vapor is then supplied to a plurality of successive jets by means of a conical vapor passage or chimney terminating in proximity to the intake opening and providing vapor passage to a relatively small or intake nozzle and also to a plurality of substantially constantly increasing nozzles in a constantly decreasing pumping chamber.

We thus provide a large pumping radius on the intake end of the pump and acquire the characteristic of high speed and low ultimate pressure while the final jet operates a solid umbrella of vapor in a space with a small pumping radius and so will operate against a high exhaust pressure.

It is accordingly an object of our invention to provide a high-speed high-pressure vapor pump.

It is another object of our invention to provide a simplified pumping construction.

It is a further object of our invention to provide a pump constructed of a plurality of simple spinnings.

Other objects and advantages of our invention will be apparent from the following detailed description taken in conjunction with the accompanying drawing, in which the figure is a sectional elevation of a pump according to our invention.

In the illustrated embodiment of our invention, the pumping chamber 1 is constructed of

a metallic cylinder 2 in the bottom of which is placed a boiler 4 for producing the vapor for actuating the pumping jets 5 to 11. The pumping chamber 1 or at least the top portion thereof is outwardly flared to provide an opening 12, to be connected to the space to be evacuated (not shown), which is considerably larger than the cross sectional area of the bottom of the pumping chamber 1. The vapor from the boiler 4 is delivered to a substantially conical chimney 20 which is sealed in vapor-tight relation to the pumping chamber 1 above the surface of the vapor producing liquid 21 in the boiler 4. The chimney 20 then delivers vapor to a plurality of successive jets 5 to 11 in a constantly decreasing pump chamber 1 so that the jet 5 operating against the lowest pressure is in the maximum pumping area and the jet 11 pumping against the maximum pressure is in the minimum pumping area.

The outside of the pumping chamber is provided with suitable cooling devices, such as cooling coils 22, so that the wall 2 is a condensing surface for returning the pumping vapor to liquid form so that it may return through a suitable passage 23 to the boiler 4 to be reevaporated. The conical chimney 20 is made of a spinning open at both ends, the large end 24 of the spinning 20 being sealed by means of a gasket 25 to a ledge 26 welded to the inner surface of the cylinder 2. The smaller end 27 of the spinning 20 is covered by a directive hood 28 to provide the low pressure pumping jet 5 operating in the maximum pumping area. The chimney 20 is provided with substantially evenly spaced rows or arrangements of openings 30 to provide a successive arrangement of jets 6 to 11, each of the jets being of larger size in the direction of the increasing pump pressure and in the direction of diminishing pump area so that the high pressure jet 11 adjacent the bottom of the pump chamber 2 and just above the outlet opening 31 for the pumped gases is of the maximum size in the minimum pumping area.

This arrangement tends to produce a rapid flow of gases from the low-pressure to the high-pressure end of the chamber while diminishing area prevents backstreaming or back diffusion of vapor or condensed gases from the high-pressure to the low-pressure area.

The various jets 5 to 11 are preferably provided by providing a single spinning whose angle is of the proper proportion to the angle of the chimney cone 20 and after the spinning is produced, successive rings are cut therefrom so that the inside diameter of the larger ring is equal to the outside diameter of the next smaller ring so that all of the spinning being cut into rings provides the successive-cone-like jets welded or otherwise secured to the chimney cone 20.

Preferably, a hold down 32 is provided to maintain the chimney 20 in vapor-tight relation with the gasket 25 adjacent the vapor evolving chamber 4.

In a commercial embodiment of our invention

the bottom inside diameter of the pump casing 2 is about 20 inches and increases in diameter to the top or intake end 12. The conical chimney spinning 20 has a diameter of 19 inches at the base 24 and a diameter of 1½ inches at the top with an axial length of 43½ inches. The primary jet cap 5 and six auxiliary jet hoods are cut from a conical spinning having a maximum diameter of the order of 16¼ inches and a slope of 25°.

Such a pump has a primary pumping radius of the order of 10 inches and was found to have a pumping speed of 4,000 liters per second with a suction pressure of 2 microns or 8,000 micron-liters per second.

While for purposes of illustration, we have shown and described a specific embodiment of our invention, it will be apparent that changes and modifications can be made therein without departing from the true spirit of our invention or the scope of the appended claims.

We claim as our invention:

1. A vapor pump comprising a pump casing increasing in cross sectional area from the high-pressure to the low-pressure end, a vapor evolving chamber in the base of said casing, a substantially conical vapor chimney sealed to said casing adjacent said vapor evolving chamber, a plurality of vapor jets fed by said chimney, the jet at the low-pressure end of said pump having a large pumping radius and the jet at the high-pressure end having a low pumping radius.

2. A high-speed high-pressure vapor pump comprising a pumping chamber converging from the low to the high-pressure end, a vapor chimney in said chamber converging from the high to the low-pressure end, a plurality of pumping jets fed by said chimney, said jets having decreasing pumping radius from the low-pressure to the high-pressure end.

3. A diffusion pump comprising a pump chamber, a substantially conical vapor chimney in said chamber, a plurality of substantially frusto-conical cowls secured on said chimney and vapor passages through said chimney wall under said cowls.

4. A diffusion pump comprising a pump chamber, a substantially conical vapor chimney in said chamber, a plurality of substantially frusto-conical cowls substantially uniformly distributed along said chimney, the outer diameter of each cowl being substantially equal to the inner diameter of the next succeeding cowl.

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