

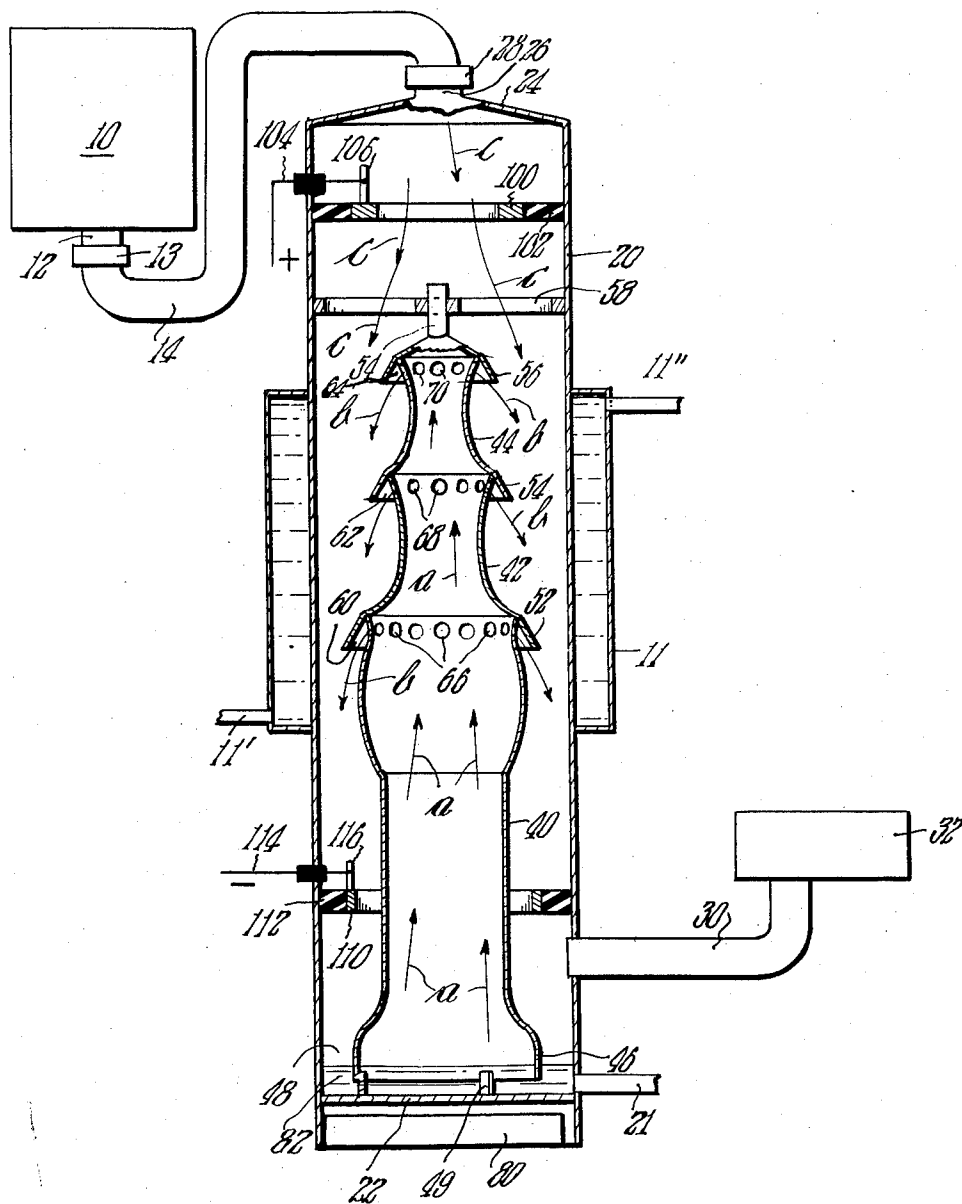
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HIGH VACUUM PUMP

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HIGH VACUUM PUMP

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The present invention relates to new and useful improvements for obtaining high vacua in enclosed receptacles such as bulbs for incandescent lamps, vapor rectifiers, X-ray tubes, electron discharge devices and the like. Such means are further adapted for use in a variety of high vacuum processes such as vacuum distillation, vacuum dehydration, vacuum coating and the like. More particularly, the invention relates to diffusion and condensation pumps for producing high vacuum and particularly to diffusion pumps which use organic working fluids and especially organic working liquids, such as oil or other hydrocarbons which contain relative volatile substances.

Vacuum pumps have come into wide use in the art of exhausting containers, notably electronic discharge tubes and the like, to pressures of the order of a small fraction of a micron. Basically, such pumps make use of a stream of some vapor flowing through an orifice from a boiler, the orifice being so positioned that the vapor stream entrains gas molecules flowing from a container in which the vacuum is to be produced, and drives these molecules in the direction of a piping system issuing eventually into the atmosphere, the vapor itself being condensed on a properly cooled surface in the path of outflowing of the gases, and then being returned to the boiler for reuse. It is usually most economical to provide the offtake piping system with a so-called backing pump of the mechanical type which reduces the pressure at the outlet from the pump proper. The pump itself is provided with a vapor jet, or a plurality thereof which operate in tandem or series with each other, so that the total pressure rise from the intake to the offtake comprises a number of steps or stages.

Multi stage diffusion pumps are not in themselves new or novel but I have devised certain features which greatly improve the operation of these prior art pumps in a way which will be fully explained below.

In this invention, the pump fluid is vaporized by heat and the vapors pass through a chimney in the pump casing to an umbrella jet, or a plurality thereof, associated with the chimney which directs the vapors in the reverse direction in the annular space in the pump casing around the chimney so that the gas from the chamber being evacuated is diffused into the stream of vapors leaving the jet.

The diffusion pump of this invention having as its object that of increasing the pumping speed, the inner wall of the high vacuum umbrella jet or jets is made to slope inwardly away from the inner surface of the pump casing. This is accomplished by shaping the chimney so that it has a constricted portion in the vicinity of the umbrella jet, thus causing the chimney wall to slope inwardly and downwardly away from the jet. This is said to allow the vapors issuing from the jet to expand inwardly toward the center axis of the pump and to take a general downward direction in the pump casing instead of spreading laterally when they leave the jet.

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The principal objects of the invention are to provide means for obtaining a vacuum greater than the capacity of an ordinary pump, to employ the usual mechanical pump and to supplement the operation thereof with additional means for securing a higher vacuum, and to provide an apparatus and method whereby the evacuation may be obtained with a maximum efficiency so as to approach as near as possible a perfect vacuum.

A further object of my invention is a pump which has a high pumping speed, will produce high ultimate vacuum, and will work against a comparatively high backing pressure, and also is mechanically rugged and commercially feasible for factory and laboratory applications.

The diffusion pump is adapted to achieve extremely low vacuum required in numerous industrial processes. The core of the oil diffusion pump is a jet, housed in a sealed casing connected to a vacuum chamber. The jet is in effect a kettle with its own heating unit beneath an oil container at its base. Inside the sealed casing, it is surrounded by air. The oil is heated until it evaporates. The oil vapor molecules pour out through openings at various levels of the jet, strike the air molecules inside the pump casing and drive them into such concentration that they can be readily drawn away by a mechanical pump. Air molecules from the vacuum chamber take their place and are in turn pumped out until the low pressure goal is reached.

The invention is defined with particularity in the appended claims and preferred embodiments are described in the following specification and shown in the accompanying drawing wherein:

The figure is a sectional view representing diagrammatically an apparatus embodying the means and method of this invention.

In the specific embodiment of the invention, the reference numeral 10 indicates the vessel or other container which is to be evacuated. For purposes of illustration, I have shown the enclosure for a container as being the particular vessel to be evacuated but it is to be understood that the vessel does not form a part of the present invention, the invention being adaptable for the evacuation of any vessel whether for radio, electric or other purposes. Suffice it to say that the vessel to be evacuated 10 is provided with a neck 12. A coupling member 13 cooperates with the neck 12 to make a gas tight union with a main conduit or intake manifold 14 whereby communication between the vessel 10 and the mechanism about to be described is afforded.

While I have only shown one such vessel 10 as connected to the intake manifold 14, it will be appreciated and understood that as many more may be connected thereto as may be found desirable and within the capacity of the pump about to be described.

Numerals 20 designates a vertically disposed cylindrical pump casing of a conventional pump. Same may be made of glass or metal and may be provided with a cooling jacket such as a water jacket 11 therearound having the conventional inlets and outlets such as 11' and 11'' for the admission and discharge of the coolant employed.

The pump casing is provided with an integral gas tight base 22 and an integral cover or closure 24 at the upper end thereof by which connection to the chamber to be evacuated is made. The closure is provided with a centrally disposed neck or opening 26 for connection to the intake manifold 14 of the system to be evacuated by means of a coupling member 28.

The pump casing 20 is also provided with an integral discharge or exhaust conduit 30 which connects to a mechanical backing pump generally represented by 32,

The backing pump is commonly referred to in the art as a "rough pump."

Conduit 30 represents the high pressure/low vacuum end of the pump and, as will shortly be observed, the exhausted gases pumped by the vapors are led thereinto and passed therethrough for eventual discharge into the atmosphere.

Numerals 40, 42 and 44 designate cylindrical chimney members which may be made of glass and metal and are mounted one above the other so as to be positioned coaxial with each other and so as to form an internal cylindrical chimney arrangement inside of and concentric with the casing 20.

The chimney arrangement illustrated shows a three stage diffusion pump and the members 40, 42 and 44 form freely demountable mating chimneys stacked together in pumping relation to form a vapor-conducting means. The member 40 is provided with an enlarged or flared base portion 46 which fits with a clearance within the lower portion of the pump casing 20 so as to form a narrow annular space 48 between the wall of the casing 20 and the member 40 for the flow of condensate in the annular space between the walls.

The lowermost wall of the member 40 is supported upwardly from the base wall 22 by means of spaced foot members 49 so as to provide communication for the oil between the annular space 48 between the wall of the casing 20 and the area within the area defined by the wall of the member 40 all for purposes as will shortly be observed. If desired, the feet above referred to may be replaced by notches along the lowermost edge of the member 40 whereby the flow of the pump fluid may be permitted with equally effective results.

It might be appropriate to explain at this point that any suitable pump fluid, subsequently to be more fully referred to, may be introduced into the bottom of the pump casing through an inlet 21 from a source of supply thereof (not shown).

Member 42 is superimposed over member 40 and is of such dimension at its lowermost diameter by virtue of an annular outwardly flared skirt portion 52, as shown, as to be receivable over the uppermost extremity or peripheral edge of the member 40 in a more or less fixed nesting relation.

When superimposed, as aforesaid, the walls of the members 40 and 42 are held in spaced relation as to each other so as to provide a throat or jet means, subsequently to be referred to. That is to say, the skirts of the adjacent members 40 and 42 provide walls which slope outwardly from top to bottom in spaced relation so that vapors leaving the chimney, as will shortly be observed, may be directed downwardly and outwardly toward the inner surface of the pump casing in the form of an annular jet.

It will be understood however that, if desired, the members 40 and 42 may be held in spaced relation by other means, such as spacer strips or spiders, all to the end that the members are held in the desired spaced relation so as to provide the downwardly and outwardly projecting annular throat or jet.

Member 44 is similarly superimposed over member 42 and is held relative thereto by the outwardly flared edge 54 of the member 44 which nests over the upper peripheral edge of the member 42, as illustrated. A cap 54 having a lowermost outwardly flared skirt 56 is receivable on the top of the chimney member 44 and is maintained in the nested position illustrated.

If desired, the chimney assembly may be positioned concentric with and centrally of the casing 20 by means of a spider member 58 which is secured to the inner wall of the casing 20 and to which the cap 54 is anchored centrally thereof by any suitable means.

Conceivably, a vertically disposed tie rod (not shown) may be positioned along the central axis of the chimney arrangement between the spider member 58 and the base 22 for purposes of holding the chimney components ar-

range in a rigidly fixed position relative to the casing 20.

By such superimposition of chimney components umbrella shaped jet nozzles 60, 62 and 64 respectively are formed between the members 40 and 42, the members 42 and 44 and the members 44 and 54, substantially as shown. The nozzles are adapted to pump in series when furnished with the actuating vapors of a pump fluid, all as will subsequently be observed.

The chimney members 40, 42 and 44 are each provided at the tops thereof with annular rows of openings 66, 68 and 70 respectively which open outwardly into the jet nozzles 60, 62 and 64 respectively provided between the spaced portions of the adjacent chimney members whereby egress of the pump fluid vapors is permitted.

A mechanical or electrical heating means generally represented by numeral 80 is provided below the base 22 of the pump. The heating unit may be of any conventional type, too well known to necessitate a detailed description in this specification.

The member 80 is adapted to heat the body of pump fluid represented by 82 in the base or bottom portion of the casing 20, sometimes referred to as the boiler of the pump, to a temperature sufficient to cause a copious off-flow of vapor. The vapor, represented by arrows *a*, passes upwardly into the chimneys 40, 42 and 44 passing through the openings 66, 68 and 70 respectively and into the jet nozzles 60, 62 and 64 respectively.

The general mode of operation of the pump structure follows: The pumping fluid which may be of any suitable material described in the art as useable in diffusion pumps is heated and the resulting vapor flows up from the surface of the fluid through the respective cylinders 40, 42 and 44.

As aforesaid, the upper ends of the cylinders are designed so as to cooperate with the vapors by admitting same through the openings whereby streams of vapor flow outwardly into the annular spaces or throats or jet nozzles surrounding said cylinders.

The structure is designed to fractionally distill the fluid in the bottom of the casing chamber and more or less selectively supply the different fractions to the different jet nozzles so that only the most phlegmatic constituents are admitted into the uppermost areas of the chimney arrangement, the more volatile constituents being directed to the lower stage jet nozzles.

The vapors, upon reaching the openings, are passed into the jet nozzles and are projected downwardly. They are thus reversed in their direction of travel and are projected outwardly as high velocity streams as represented by arrows 6.

Said streams have the capacity of pumping in tandem or series entrained gases represented by the arrows *c* coming into the member 20 through the conduit 14 from the body 10.

That is, the principal component of velocity of the vapor molecules is substantially parallel to the axes of the cylinders whereby the vapor molecules impart a similar velocity to any gases which they entrain.

As aforesaid, the gas molecules so entering the chamber of the casing are entrained by the downwardly directed vapor from the jet nozzles and are impelled toward the next jet.

The vapors condense upon the cooled casing wall releasing the gas molecules which are then entrained toward the exhaust port by the next jet, the condensate draining down the inner surface of the casing wall through the annular space 48 and back to the boiler.

Though I have shown a water jacket 11 as providing the cooling means around the casing 20, the pump fluid may be otherwise condensed on the walls of the casing 20 as by air or other mechanical cooling means, all as may be desired. The pump fluid flows by gravity downwardly between the casing 20 and the members 44, 42,

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and 40 and thence back into the body of the pump fluid 82.

Pumped gases pass into conduit 30 and are removed from the system by the backing pump 32 connected therewith.

The umbrella like arrangement of the jet nozzles offers throat areas between the adjacent walls of the members 40, 42, 44 and 54 as shown whereby the working vapor expands when it reaches the expanding portion of the jet nozzles, all to the end that greater pumping velocity is obtained. That is to say, expansion of the working vapor does not ensue until the same reaches the throats of the umbrella like jet nozzles, at which time expansion takes place in a beneficial manner, degree and direction.

Within the casing 20 and disposed centrally thereof above the chimney arrangement, I position an annular discharge grid 100 which is held in fixed position relative to the wall of the casing 20 by means of insulated member 102. The grid is provided with a suitable lead wire 104 connected thereto at 106 by means of which a positive potential may be supplied thereto from a source (not shown). The lead wire 104 passes from the exterior of the casing 20 through a suitable sealing means to the interior thereof in a manner commonly employed in lamp and bulk work.

Another annular grid ring 110 is disposed within the casing 20 and surrounds the member 40 of the chimney. Same is supported relative to the wall of the casing 20 by means of insulated members 112.

Said grid 110 is provided with a suitable lead wire 114 connected thereto at 116 by means of which a negative potential may be impressed thereon from a source (not shown).

It will be here understood that, if desired, a negative potential may be impressed upon the grid 100 and a positive may be impressed upon the grid 110.

Either alternating or direct current may be employed. If desired, the electrical charges may be pulsed.

When it is desired to obtain the evacuation of a vessel, the initial evacuation may be first obtained by operating the oil pump and the final evacuation may be obtained by continuing to operate the oil pump and by simultaneously therewith establishing the electrical potential between the grids 100 and 110.

I have determined that by carrying on the operation in this manner and by this means an increased and improved high evacuation of the vessel is obtained.

Said increased evacuation rests upon the fact that the charging of the grids causes electrons to be emitted, which electrons are given a certain velocity by the positive (or negative) charge impressed. Said electrons are attracted toward the oppositely charge grid and as they do, they are caused to collide with the gas molecules and to ionize them. That is, they leave the molecules with a positive charge. These positive molecules operate in the intensely electrified field and are attracted toward the grid with a considerable velocity due both to their mass and to the high impressed charge. The great number of molecules moving toward the plate at the same time draws more gas from the vessel to be evacuated and thus obtain a higher vacuum therein.

By such ionization of the oil particles, an improved fine spray is provided all to the end that the exhausting process of the member 10 through the intake manifold is greatly improved.

While I have shown my invention by means of a three stage umbrella like jet system, it is manifest that the invention is not limited to a pump having this number of stages and that the invention is applicable to a single stage or multi stage pump so long as it is provided with at least one umbrella jet.

I claim:

1. A device for obtaining high vacuum in enclosed receptacles comprising, a cylindrical pump casing having

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communication at one end thereof with a chamber to be evacuated and having communication at the opposite end thereof with an exhausting pump, a plurality of cylindrical chimney members mounted coaxially one above the other and forming a cylindrical chimney arrangement inside of and concentric with said pump casing and providing downwardly directed jet nozzles between each of the adjacent pairs thereof, said chimney members having rows of openings leading into the jet nozzles, a heating means for heating a body of pump fluid in the bottom of said casing to a temperature sufficient to produce an upward flow of vapors into said chimney members and through the openings and jet nozzles thereof for deflection downwardly therefrom in a plurality of streams with the streams functioning in series to keep entrained gases led into said pump casing from the chamber to be evacuated, a primary annular grid ring disposed within said pump casing and above said chimney members, a positive potential supplied to said primary grid ring, a secondary annular grid ring disposed within said pump casing and surrounding the lowermost portion of the chimney arrangement and in spaced relation thereof, and a negative potential supplied to said secondary grid ring.

2. Device for obtaining a high vacuum in an enclosed receptacle comprising, a cylindrical pump casing having communication at one end thereof with the receptacle to be evacuated and having communication at the opposite end thereof with an exhausting pump, a plurality of coaxially arranged chimney members forming a chimney arrangement disposable inside of said pump casing with downwardly directed jet nozzles between each of the adjacent pairs thereof, said chimney members having openings leading into the jet nozzles, a heating means for the heating of a body of pump fluid in the bottom of said pump casing for the production of an upward flow of vapors into said chimney members and outwardly through the openings and jet nozzles thereof for deflection downwardly therefrom in a plurality of streams for entrainment of the gases led into said pump casing from the receptacle being evacuated, a primary annular grid ring disposed within said pump casing and above said chimney members, a positive potential supplied to said primary grid ring, a secondary annular ring concentrically disposed around the lowermost portion of the chimney arrangement and in spaced relation thereto, and a negative potential supplied to said secondary grid ring.

3. A device for obtaining high vacuum in enclosed receptacles comprising, a pump casing having communication at one end thereof with a chamber to be evacuated and having communication at the opposite end thereof with an exhausting pump, a chimney arrangement inside of and concentric with said pump casing having a plurality of downwardly directed rows of jet nozzles extending outwardly therefrom, said chimney arrangement having rows of openings leading into the jet nozzles, a heating means for heating a body of pump fluid in the bottom of said casing to a temperature sufficient to produce an upward flow of vapors into said chimney arrangement and through the openings and jet nozzles thereof for deflection downwardly therefrom in a plurality of streams to keep entrained gases led into said pump casing from the chamber to be evacuated, a primary annular grid ring disposed within said pump casing and above said chimney arrangement, a positive potential supplied to said primary grid ring, a secondary annular grid ring disposed within said pump casing and circumscribing said chimney arrangement below said jet nozzles, and a negative potential supplied to said secondary grid ring.

4. A device for obtaining a high vacuum in an enclosed receptacle comprising, a pump casing having communication at one end thereof with the receptacle to be evacuated and having communication at the opposite end thereof with an exhausting pump, a chimney member disposed within said pump casing and having a plurality of rows of downwardly directed jet nozzles

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therearound, said chimney member having openings leading into each of the jet nozzles, heating means for the heating of a body of pump fluid in the bottom of said pump casing for the production of an upward flow of vapors into said chimney member and outwardly through the openings and jet nozzles thereof for deflection downwardly therefrom in a plurality of streams for entrainment of the gases led into said pump casing from the receptacle being evacuated, a primary annular grid ring disposed within said pump casing and above said chimney member, a positive potential supplied to said primary grid ring, a secondary annular ring concentrically disposed around said chimney member, and a negative potential supplied to said secondary grid ring.

5. Evacuation apparatus for evacuation of a receptacle, comprising a pump housing, a chimney arrangement internally of said housing having at least one jet nozzle extending outwardly therefrom, said chimney arrangement having a plurality of openings communicating from the interior of said chimney and leading into said jet nozzle, heating means for heating a body of fluid in the lower area of said housing to a temperature sufficient to produce an upward flow of vapors into said chimney arrangement and through said openings and jet nozzle for deflection downwardly therefrom in a jet stream for entrainment of gases fed into said housing from the receptacle being evacuated, electrode means within said housing including at least a pair of electrodes spaced from one another and being electrically charged each of

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opposite polarity to facilitate deflection downwardly of said jet stream for increasing the degree of evacuation of said receptacle.

6. Evacuation apparatus for evacuation of a receptacle, comprising a pump housing having inlet and outlet means, a chimney arrangement internally of said housing having at least one jet nozzle extending outwardly therefrom, said chimney arrangement having a plurality of openings communicating from the interior of said chimney and leading into said jet nozzle, heating means for heating a body of fluid in the lower area of said housing to a temperature sufficient to produce an upward flow of vapors into said chimney arrangement and through said openings and jet nozzle for deflection downwardly therefrom in a jet stream for entrainment of fluid fed into said housing from the receptacle being evacuated, and electrode means within said housing including a pair of electrodes, one being positioned in an area adjacent said inlet means and the other being positioned in an area adjacent said outlet means, said electrodes being energized for applying an electrical charge to entrained fluids to pump said fluids in the direction of said jet stream for increasing the degree of evacuation of said receptacle.

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