

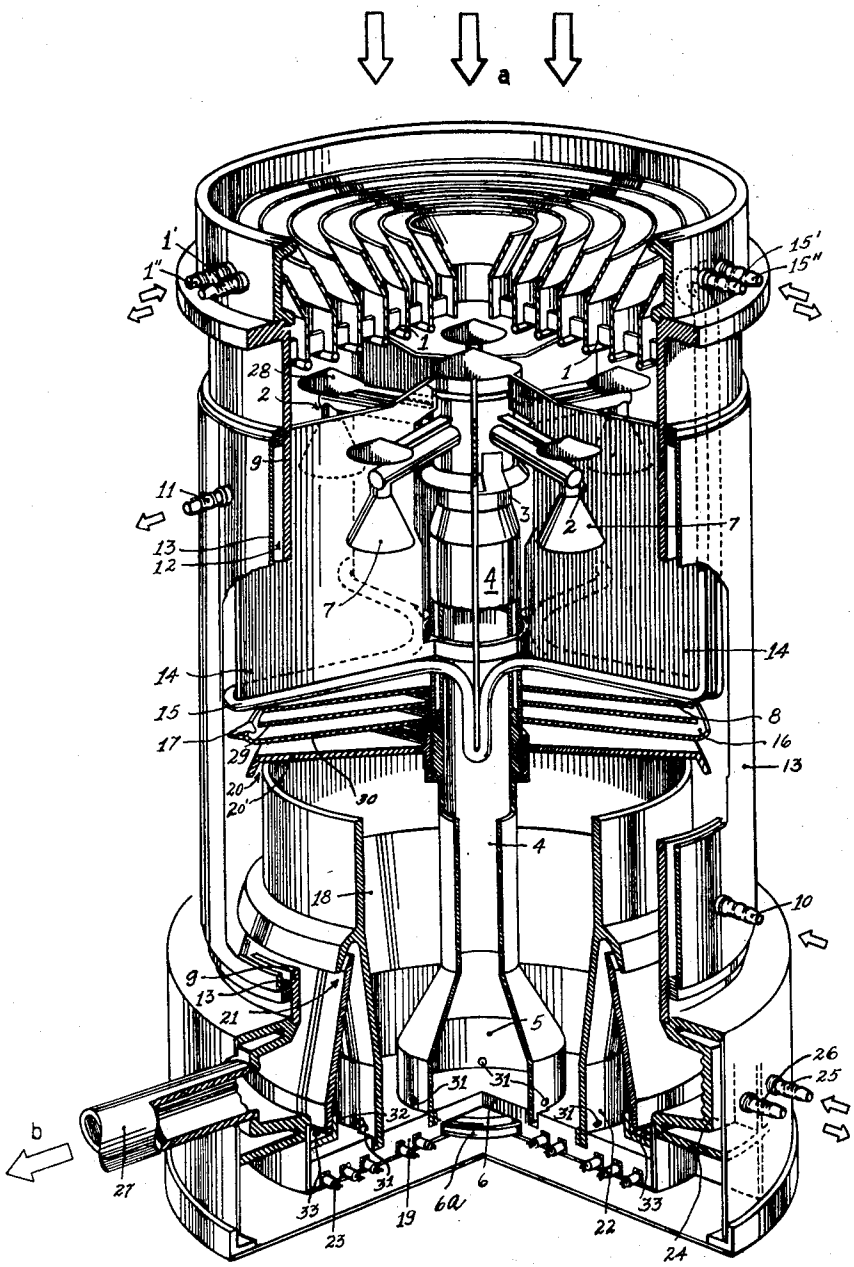
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DIFFUSION PUMP

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DIFFUSION PUMP

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8 Claims. (Cl. 230—101)

The present invention relates to a diffusion pump wherein a novel arrangement of the primary members, combined with some particular devices gives rise to a better efficiency and a smaller size in comparison with other pumps having the same capacity.

According to the invention, the pump, whose operational scheme—known in its principle—is better suited to the medium and large capacities, is essentially composed of two combined elements, one of which forms the stage wherein there is the maximum volumetric capacity at the smallest pressure, and which will be referred to as the first stage, while the other element includes the other two stages forming a so-called "booster" unit.

The above mentioned features of small size combined with maximum efficiency which are obtainable in this novel pump are essentially attributable to the arrangement of the device designed for the ejection of oil vapours and the devices designed for the condensing of said vapours, to provide greater efficiency and having improved their operational distribution. Therefore the flow of the oil vapours is divided in the first stage of this pump in a plurality of jets, for which there is provided a large surface exchange condensing system. This plurality of jets, which is equivalent to a plurality of pumps operating in parallel within the same stage, has the essential purpose of remarkably reducing the height of the chamber of the first stage relative to the height which said chamber would otherwise have for a single jet having the total capacity of the group of jets; in addition, the same plurality of jets is well suited to improve the distribution and increase, at the same time, the effective heat exchange surface of the condensing devices, and the dynamic action of the oil vapour on the gas molecules is made more active, owing to a higher density of said vapour, and is better directed and also the condensation of the oil from its vapours is more complete, owing to this improvement. In addition there is provided a thermal barrier between the first stage and the two final stages and while this barrier makes it possible to establish and maintain the lowest possible temperature at the transverse wall portion of the barrier forming the bottom of the first stage chamber, the underlying heating coils of the second stage chamber may be advantageously kept at the desired operating temperature for normal operation without any excessive heat losses due to radiation.

Additionally, the third stage in the same pump is greatly reduced in height by the presence of condensing apparatus having a large surface area. Moreover, according to the invention, provision is made for separate heating and individual temperature regulation of each of the three stages in order to provide improved co-ordination of operation.

The invention will now be described with reference to the accompanying drawing.

In the drawing, the single figure is a perspective view of a three stage diffusion pump embodying the invention, the pump being partly broken away and shown in section to illustrate details of construction.

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Referring to the drawing, the molecules of air from a chamber (not shown) which is being evacuated enter the top of the pump moving downwardly in the direction of the arrows designated *a*. In entering the pump, the molecules pass through a condenser 1 formed of a series of concentric circular baffle members the upper portions of which are downwardly convergent. The lower edges of the convergent baffle members are cooled by a refrigerant circulating in a duct, the coolant being supplied through inlet and outlet hose fittings 1" and 1', respectively. After passing through the condenser 1, the molecules enter a chamber wherein there is disposed a battery of five nozzles or ejectors 2 and a central ejector 3. The ejectors 2 are connected to a central conduit or vertical pipe 4. Oil vapors are produced in a chamber 5 which is heated by a heater 6a disposed below the bottom closure plate 6 of the chamber 5 and the heated oil vapors are conveyed into the interior of said conduit 4, while the central ejector 3 is annular and is directly located around said conduit 4 with its own axis coinciding with the axis of said conduit. In the embodiment of the drawing, the ejectors 2 are illustratively shown as being five in number but in practice the number of ejectors may vary in accordance with the capacity of the pump. These ejectors 2 are however arranged with an axial symmetry around the central conduit 4 and at an appropriate distance therefrom; the jets arriving from said ejectors, have their axes parallel to the axis of said conduit 4; said jets are oriented towards the bottom of the chamber (against the transverse plate 8 of a thermal barrier, later to be described) or however towards the so-called "booster" unit with an angular opening appropriately proportioned and defined by means of suitable deflectors 7. The condensation of the oil vapours occurs on the inner surface of the wall 9 of the chamber and said wall is cooled by an appropriate liquid circulating from an inlet hose fitting 10 to an outlet fitting 11, the coolant being confined in the hollow space 12 formed between said wall 9 and the outer casing 13 of the pump. Further condensation occurs along the walls of the partition members or baffles 14 formed by plates, vertically and radially extending among said jets always in such a way as to be symmetrical relative to the latter. The partitions, formed of thermally conductive material, located among the jets, are cooled at their lower edges by a conduit 15, wherein the refrigerant liquid is circulated from an inlet hose fitting 15" to an outlet fitting 15'. A portion of the thus condensed oil vapor flows along the inner surface of the wall 9 of the chamber, while a portion thereof flows downwardly along the partitions 14 and is collected by the annular gutter 16 from which it is discharged downwardly through the drains 17.

The residue of air, having a high volume and low pressure, downwardly urged by the dynamic effect of the oil vapor jets, then enters the second stage (belonging to the "booster" unit); in this second stage, according to the invention, the oil vapours heated in the chamber 18, coaxial with the chamber 5 of the first stage, by the heating elements 19, emerge through the annular ejector 20 defined by a space between the lowermost plate 20' of the thermal barrier. The thermal barrier is formed by a series of four vertically spaced plates 8, 29, 30 and 20'. The downwardly deflected jet of emerging vapor comes in contact with the cooled inner surface of the wall 9 and is progressively condensed during its downward movement toward the bottom of the pump. The residue of air, reduced to a medium volume with an increase of pressure, passes into the zone of the third stage, wherein the annular jet 21 of the oil vapours, heated by the heating elements 23 in the outermost heating chamber 22 is present. This jet is directed toward the annular condenser 24 provided with corrugations

which enlarge its heat exchange surface. The condenser 24 is strongly cooled by liquid which flows through the conduits 25 and 26. The residue of air, which finally has attained the smallest volume with the highest pressure, passes from the chamber of this condenser through the outlet fittings 27 in the direction of the arrow designated *b* and into the preliminary air pump, not indicated in the drawing.

Each of the downwardly opening conical deflectors 7 and each of the conduits connecting its associated ejector nozzle 2 with the central conduit 4 is covered by a horizontally extending shield 28. These shields 28 prevent falling droplets of oil condensed from the oil vapor by the condenser 1 from falling on the deflectors 7 which operate at relatively high temperatures. The shields 28 thus prevent re-evaporation of the oil condensate which would otherwise impair the efficiency of the pump.

The three oil vaporizing chambers communicate with each other through small apertures 31 formed at the bases of the partitions which define the chambers. These apertures are located adjacent to the heated base plate 6 and permit the flow of condensed oil from a collecting trough 32 through apertures 33 therein to the base plate 6 for redistribution over the entire area of base plate 6 so that the oil is again vaporized and reused.

If desired, the upper element 8 of the thermal barrier 8-29-30-20' may also be cooled like the radially extending baffle members 14 and the cylindrical wall 9. Such cooling will further tend to reduce possible re-evaporation of oil vapor droplets formed in the condenser 1.

In operation, the gas molecules entering the condenser 1 are drawn downwardly by the action of the oil vapor jets issuing from the nozzles 2, the jets being appropriately confined and directed by the conical deflectors 7. The oil vapor, which entrains the gas molecules, is condensed by contact with the radial baffles 14 while its upward escape from the pump is prevented by condensation in the condenser 1. The thermal barrier 8-29-30-20' prevents re-evaporation of oil droplets formed in the first stage of the pump.

After leaving the first stage, the gas molecules are again entrained and urged toward the pump outlet 27 by further successive jets of oil vapor, annular in form issuing from the annular apertures 20 and 21 disposed in the lower portion of the pump.

While I have shown what I believe to be the best embodiment of my invention, it will be apparent to those skilled in the art that various modifications may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. A vacuum diffusion pump comprising a lateral wall defining a chamber, said chamber being provided with an upper inlet and a lower outlet, means included in said wall for cooling said wall, transversely extending thermal barrier means dividing said chamber into an upper section and a lower section, said barrier means being spaced from said wall to define a first annular passageway therewith, closure means for said lower section disposed at the bottom of said chamber, means for supplying heat to said closure means, a pipe extending from said closure means in said lower section through said transverse barrier means into said upper section, a plurality of downwardly directed nozzles disposed at regularly spaced locations in said upper section and communicating with said pipe, and a first annular partition wall in said lower section extending from said closure means to a location spaced from said barrier means to define a second annular passageway therewith, said first partition wall being coaxial with said pipe, whereby upon connecting said inlet to a vessel to be evacuated and said outlet to a pump, heating of a liquid placed on said closure means causes said liquid to vaporize, a portion of the vapors rising through said pipe and being directed downwardly in said upper section in a series of parallel

streams through said nozzles, said vapors entraining the gas to be removed from said vessel and being cooled and condensed by said lateral wall, the gas passing downwardly through said first annular passageway to be carried along to said outlet by further vapor generated between said pipe and said first partition wall, the further vapor passing first upwardly between said pipe and first partition wall and then being deflected through said second annular passageway by said barrier means to pass downwardly between said first partition wall and said lateral wall.

2. A pump as defined in claim 1, further comprising a plurality of baffles in said upper section extending radially from said pipe toward said outer wall and each extending between two adjacent one of said nozzles.

3. A pump as defined in claim 2 further comprising means including a circulation duct disposed in thermally conductive relationship with respect to said baffles, said duct extending exteriorly of said chamber and being adapted to receive and circulate a coolant therein for cooling said baffles, and means disposed below said baffles for receiving condensate formed on said baffles.

4. A pump as defined in claim 1, further comprising a second annular partition wall disposed between said first partition wall and said lateral wall, said second wall extending from said closure means toward said first partition wall to define a third annular passageway therewith, said first partition wall being provided with a downturned lip above said third annular passageway to deflect downwardly vapor generated between said first and second partition walls.

5. A vacuum diffusion pump comprising an outer wall defining a chamber, said chamber being provided with an upper inlet and a lower outlet, means included in said outer wall for cooling said outer wall, transversely extending thermal barrier means dividing said chamber into an upper section and a lower section, the periphery of said barrier means being spaced from said wall to define a first annular passageway therewith, a closure for said lower section disposed at the bottom of said chamber, means for supplying heat to said closure, a pipe extending from said closure in said lower section through said barrier means into said upper section, a plurality of baffles in said upper section extending radially from said pipe toward said outer wall, a plurality of downwardly directed nozzles communicating with said pipe and each disposed in said upper section between two adjacent ones of said baffles, and a first annular partition wall in said lower section extending from said closure to a location spaced from said barrier means to define a second annular passageway therewith, said first partition wall being coaxial with said pipe, whereby upon connecting said inlet to a vessel to be evacuated and said outlet to a pump, heating of a liquid placed on said closure causes said liquid to vaporize, a portion of the vapors rising through said pipe and being directed downwardly in said upper section in a series of parallel streams through said nozzles, said vapors entraining the gas to be removed from said vessel and being cooled and condensed by said outer wall, the gas passing downwardly through said first annular passageway to be carried along to said outlet by further vapor generated between said pipe and said first partition wall, the further vapor passing first upwardly between said pipe and first partition wall and then being deflected through said second annular passageway by said barrier means to pass downwardly between said first partition wall and said outer wall.

6. A pump as defined in claim 5, further comprising a condenser within said upper section between said inlet and said nozzles, and a hood disposed above each of said nozzles, whereby any vapor condensed by said condenser is prevented by said hood from falling onto a nozzle which has been heated by said portion of the vapors rising through said pipe.

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7. A vacuum diffusion pump comprising a cylindrical outer wall defining a chamber and provided with an upper inlet and a lower outlet, thermally insulative transverse separation means dividing said chamber into an upper section and a lower section, said separation means being spaced from said wall to define a first annular passageway therewith, means included in said outer wall for cooling said sections, a closure for said lower section disposed at the bottom of said chamber, heating means disposed in thermally conductive relationship with respect to said closure for supplying heat to said closure, a pipe extending from said closure in said lower section through said transverse separation means into said upper section, a plurality of baffles in said upper section extending radially from said pipe toward said outer wall, means for cooling said baffles, means including a circulation duct disposed in thermally conductive relationship with respect to said baffles, said duct extending exteriorly of said chamber and being adapted to receive and circulate a coolant therein disposed beneath said baffles for receiving condensate formed on said baffles, a plurality of downwardly directed nozzles communicating with said pipe and each disposed in said upper section between two of said baffles, first and second annular partition walls in said lower section extending upwardly from said closure coaxially with said pipe, said first partition wall defining a second annular passageway with said transverse separation means and being provided

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with a downturned lip, said second partition wall defining with said downturned lip a downwardly directed third annular passageway, whereby upon connecting said inlet to a vessel to be evacuated and said outlet to a pump, heating of a liquid placed on said closure causes said liquid to vaporize, a portion of the vapors rising through said pipe and being directed downwardly in said upper section in a series of parallel streams through said nozzles, said vapors entraining the gas to be removed from said vessel and being cooled and condensed by said outer wall, the gas passing downwardly through said first annular passageway to be carried along to said outlet by further downwardly directed vapor generated between said pipe and said first partition wall and between said partition walls.

8. A pump as defined in claim 7, wherein said means for supplying heat to said closure is subdivided into separately heated portions for independently heating liquid furnishing vapor to said pipe, between said pipe and said first partition wall, and between said first and second partition walls.

References Cited in the file of this patent

UNITED STATES PATENTS

2,112,037	Malter	Mar. 22, 1938
2,291,054	Nelson	July 28, 1942
2,508,765	Morand	May 23, 1950