July 14, 1959 L. HIESINGER 2,894,680

DIFFUSION PUMPS

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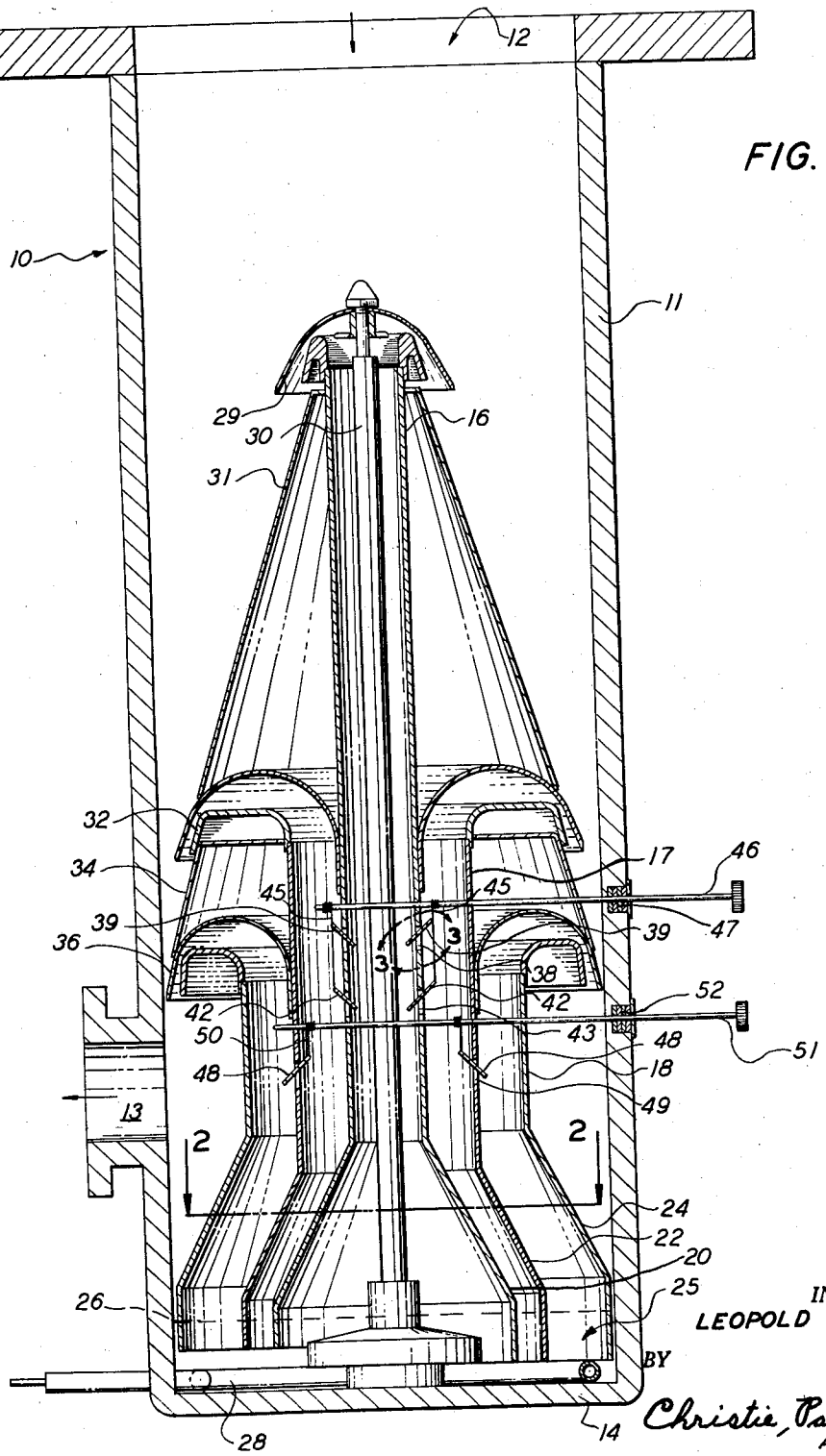


FIG. 1.

INVENTOR.
LEOPOLD HIESINGER

BY

Christie, Parker & Hale
ATTORNEYS

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FIG. 2.

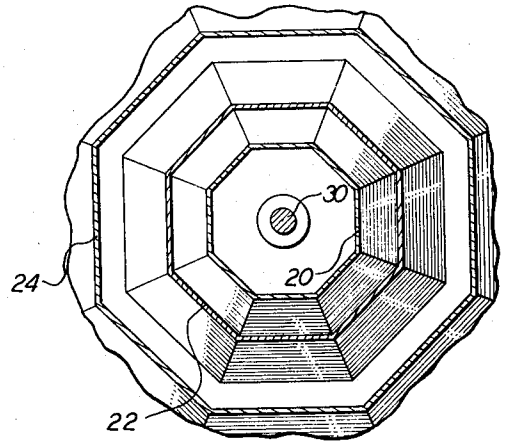


FIG. 3.

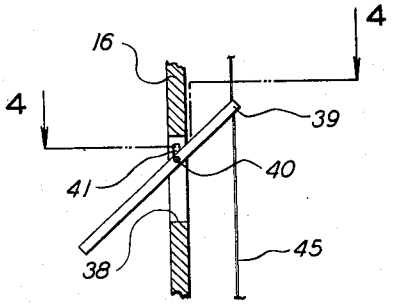
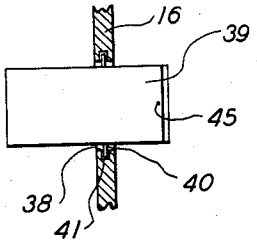


FIG. 4.



INVENTOR.
LEOPOLD HIESINGER

BY

Christie, Parker & Hale
ATTORNEYS

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DIFFUSION PUMPS

Leopold Hiesinger, Wachenbuchen, Kreis Hanau am Main, Germany, assignor to W. C. Heraeus, G.m.b.H., Hanau, Germany

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9 Claims. (Cl. 230—101)

This invention relates to multi-stage diffusion pumps.

A typical multi-stage diffusion pump includes a casing having an inlet and an outlet with a plurality of jets disposed within the casing to direct a pumping vapor from the inlet toward the outlet. The jets are supplied the pumping vapor through conduits or chimneys from a boiler in which the pumping fluid is vaporized. Various types of pumping fluids are used in diffusion pumps, for example, mercury and low boiling organic oils are commonly used.

Ordinarily the jets are spaced from each other in a direction leading from the pump inlet toward the pump outlet. With this arrangement there is a low pressure jet which is nearest the pump inlet, and the other jets are spaced from the low pressure jet toward the pump outlet to operate against pressures which increase with the distance from the low pressure jet.

The present diffusion pumps have no means for adjusting the flow of vapor from the boiler through the individual jets once the pump is put into operation. This is a disadvantage because it is sometimes desirable to change the rate at which each of the jets delivers pumping vapor. For example when the diffusion pump is first put into use, the pressure against which it is pumping is comparatively high, and it is generally advisable to supply the jets nearest the outlet end of the pump with increased amounts of pumping fluid, and at the same time decrease the amount of pumping fluid delivered by the jet or jets nearest the inlet end of the pump. Once the ultimate pressure has nearly been reached, it is desirable to increase the flow of vapor being delivered by the jets near the pump inlet, and place the pump in normal operation.

This invention provides a diffusion pump in which the effective cross-sectional flow area of at least one of the chimneys through which vapor flows from the boiler can be varied during the operation of the pump. Thus, the rate at which the jet connected to that chimney delivers pumping fluid may be varied during the operation of the pump.

This is an important advantage with fractionating oil-diffusion pumps, particularly during the warm-up period of pump operation. Experience has shown that often considerable condensation of the less volatile components occurs on the walls of the chimney, so that the vapor leaving a jet is richer in the more volatile components than the vapor which enters the chimney serving that jet. By reducing the effective cross-sectional flow area of the chimney leading to the low pressure jet during the warm-up period, it is possible to reduce the pumping time required to achieve a given pressure to less than that required if the cross-sectional flow area of the low pressure jet chimney is not reduced. The reason for this is that restricting the flow of vapor through the low pressure jet prevents substantial amounts of the more volatile components from being discharged from the low pressure jet near the pump inlet, which determines the ultimate vacuum produced by the pump. Once the pump is warmed-up, and condensation of the vapor in the chimney reduced so that the vapor is not objectionably rich in volatile components, the flow through the low pressure jet may then be increased so that the low pressure jet is put into efficient operation.

In the preferred form of the invention, the chimneys are concentric and communicate with each other through lateral openings including valves controlling the flow of vapor through the openings. Each valve preferably is a vane mounted in each opening to pivot about a substantially horizontal axis at the upper end of each opening so that the vane may be tilted to extend down into a chimney and cause vapor to flow from that chimney to an adjacent chimney.

These and other aspects of the invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a vertical section of the presently preferred embodiment of the invention;

Fig. 2 is a view taken on line 2—2 of Fig. 1;

Fig. 3 is an enlarged view taken on line 3—3 of Fig. 1; and

Fig. 4 is a plan view taken on line 4—4 of Fig. 2.

Referring to Fig. 1, a diffusion pump **10** includes a cylindrical upright casing **11** having an inlet **12** at its upper end and a lateral outlet **13** just above the lower end of the casing which is closed by a bottom **14**. An inner chimney **16**, an intermediate chimney **17**, and an outer chimney **18** are concentrically and coaxially mounted within the casing. The chimneys may be circular in cross-section, but preferably they are polygonal, such as hexagonal as shown in Fig. 2. The lower end of each of the inner, intermediate and outer chimneys has connected to it outwardly extending sections **20, 22, 24** respectively, and the lower end of each of the sections extends vertically down into a boiler section **25** overlying the bottom of the pump. The normal operating level of pumping fluid in the boiler is shown by dotted line **26**. A heating element **28** is disposed in the bottom of the boiler for vaporizing the pumping fluid.

An annular low pressure jet **29** is connected to the upper end of the inner chimney to discharge pumping fluid vapor down and away from the pump inlet. The low pressure jet and inner chimney are held in place by a vertical tie rod **30** anchored firmly in the bottom of the casing. An annular downwardly and outwardly extending skirt **31** is coaxially disposed around and welded to the upper portion of the inner chimney to reduce the cross-sectional area of the casing in a direction leading away from the pump inlet.

The lower edge of the skirt **31** is welded to the upper surface of an annular intermediate jet **32** connected to the upper end of the intermediate chimney below the low pressure jet to discharge pumping vapor toward the pump outlet. An annular downwardly and outwardly extending skirt **34** is disposed around and welded to the upper portion of the intermediate chimney to reduce the cross-sectional area of the casing in the direction leading away from the pump inlet.

The lower edge of the skirt **34** is welded to the upper surface of an annular high pressure jet **36** connected to the upper end of the outer chimney to discharge pumping vapor toward the pump outlet.

The inner chimney has an upper pair of diametrically opposed upright and rectangular openings **38** to provide communication between the inner chimney and the intermediate chimney. A separate vane **39** is mounted in each opening **38** to pivot about a horizontal axis near the center of each vane. Each vane rests on a pair of outwardly extending pins **40** which rest in the bottom of a vertical groove **41** formed in the sides of the openings **38**. Thus, each of the vanes may be inclined to extend down-

wardly and inwardly into the inner chimney. A second pair of vanes 42 are similarly mounted in a second pair of lower openings 43 in the inner chimney located directly below the upper pair of openings.

A separate vertical flexible wire 45 is connected to the upper edge of each set of upper and lower vanes and is wound around a horizontal rotatable shaft 46 extending through the inner chimney, one side of the intermediate chimney and through the casing wall where it is sealed by packing 47. Thus the position of vanes 39, 42 can be adjusted by rotating shaft 46 to move the vanes between a nearly vertical position and a nearly horizontal position. In this manner the effective cross-sectional flow area of the inner chimney may be varied.

A pair of diametrically opposed vanes 48 are mounted to pivot about a substantially horizontal axis near the upper edge of diametrically opposed rectangular openings 49 in the intermediate chimney. Each of the vanes 48 extends downwardly and outwardly into the outer chimney and are mounted in a manner identical to that shown in Figs. 3 and 4. The upper end of each of the vanes 48 is connected to a separate flexible wire 50 which is wound around a horizontal rotatable shaft 51 journaled through the intermediate and inner chimneys and extending through one side of the outer chimney and the casing where it is sealed by packing 52. Thus the position of the vanes 48 can be controlled by rotating the shaft 51.

The vanes can be controlled by any suitable means other than the shafts shown. For example cable controls or electro-magnetically actuated devices, such as solenoids, may be used.

The operation of the apparatus is as follows:

When it is desired to restrict the flow of pumping fluid being delivered through the inner chimney, such as when the diffusion pump is first started, the shaft 46 is rotated to move the vanes to the inclined position shown in Fig. 1 so that the cross-sectional flow area of the inner chimney is reduced and so that vapor flowing up the inner chimney is deflected through the openings 38 into the intermediate chimney. If desired, the vanes 48 in the wall of the intermediate chimney may be positioned as shown in Fig. 1 to deflect pumping fluid vapor from the outer chimney through the openings 49 into the inner chimney.

Once the jets are to go into normal operation, the rotatable shafts are turned so that the vanes are pulled up to an almost vertical position, thus closing the openings 38 and 49 and opening the chimneys for full flow.

The vanes may also be positioned at right angles to the positions shown in Fig. 1 and thereby cause vapor to be deflected from the intermediate chimney to the inner chimney and to the other chimney.

Thus, the invention provides diffusion pumps which are readily adjustable for optimum efficiency with various types of pumping fluids, and without requiring any modification of the pump structure when changing from one type of pumping fluid to the other.

I claim:

1. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, and means above the pumping fluid in at least one of the chimneys for adjusting the cross-sectional flow area to direct a portion of the vapor flow in the chimney to at least one other chimney and jet.

2. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, a pivotable vane above the pumping fluid attached to at least one of the chimneys, said one chimney including at least one aperture adjacent the pivotable vane and means for moving the vane into and out of the chimney to control the vapor flow between said one chimney and at least one other chimney.

3. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, at least one of the chimneys having a lateral aperture above the pumping fluid connecting it to another chimney, a pivotable vane disposed in the aperture, and means for pivoting the vane during the operation of the pump to control the flow of vapor through the aperture.

4. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, the chimneys being vertical and concentrically arranged, at least one of the chimneys having a lateral aperture above the pumping fluid to provide communication with an adjacent chimney, a pivotable vane mounted in the upper portion of the aperture, and means for moving the vane in and out of the chimney interior during the operation of the pump to vary the amount of vapor flowing through the aperture.

5. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, a plurality of pivotable vanes symmetrically attached to at least one of the chimneys, said one chimney including an aperture adjacent each of the pivotable vanes and means for moving the vanes together into and out of the chimney during the operation of the pump to control the vapor flow between said one chimney and at least one other chimney.

6. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, the chimneys being vertical and concentrically arranged, at least one of the chimneys having a polygonal cross-section, a lateral aperture in the polygonal chimney above the pumping fluid to provide communication with an adjacent chimney, a pivotable vane mounted in the upper portion of the aperture, and means for moving the vane in and out of the chimney interior during the operation of the pump to vary the amount of vapor flowing through the aperture.

7. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets disposed in the casing between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, a plurality of pivotable vanes attached to at least one of the chimneys, said one chimney including an aperture adjacent each of the pivotable vanes, at least two of the vanes being vertically spaced from each other, and means for moving the vanes together into and out of the chimney during the operation of the pump to control the flow of vapor between said one chimney and at least one other chimney.

8. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a

pumping fluid, a plurality of vapor jets between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, at least two of the chimneys being interconnected by a lateral opening above the pumping fluid, and a valve disposed in the opening for controlling the degree of communication between the two interconnected chimneys.

9. A multi-stage diffusion pump including a casing having an inlet and an outlet, a boiler for vaporizing a pumping fluid, a plurality of vapor jets between the inlet and outlet to direct vapor from the inlet to the outlet, a separate chimney connected to each jet and extending to the boiler for delivering vapor to its respective jet, at least two of the chimneys being interconnected by a

lateral opening above the pumping fluid, a valve disposed in the opening for controlling the degree of communication between the two interconnected chimneys, and means for operating the valve while the pump is in operation.

References Cited in the file of this patent

UNITED STATES PATENTS

2,150,685	Hickman	Mar. 14, 1939
2,206,093	Hickman	July 2, 1940
2,465,590	Hickman	Mar. 29, 1949

FOREIGN PATENTS

513,560	Canada	June 7, 1955
746,393	Great Britain	Mar. 14, 1956