

Oct. 3, 1967

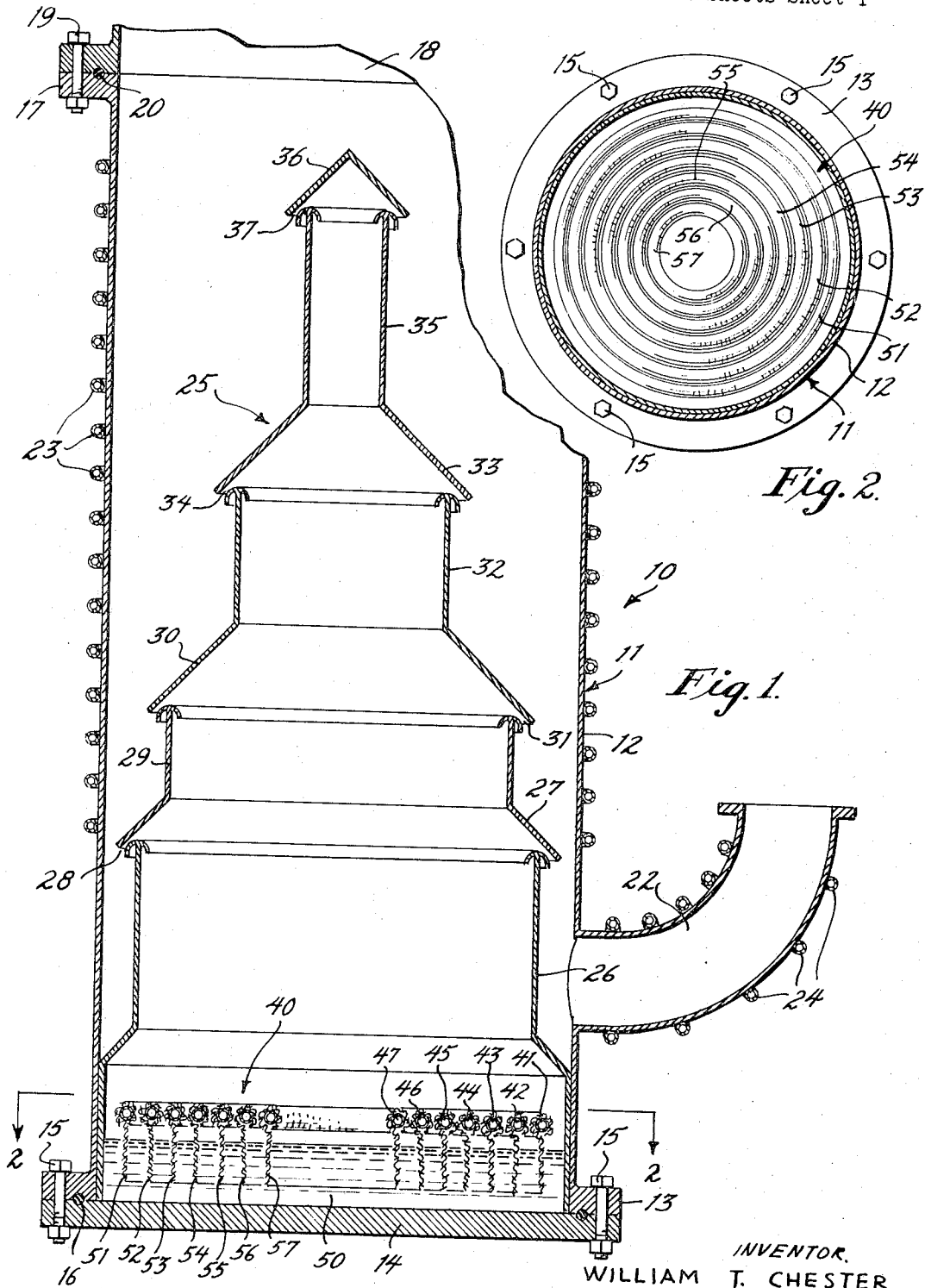
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3,344,979

DIFFUSION-PUMP CONSTRUCTION

Filed Aug. 6, 1965

2 Sheets-Sheet 1



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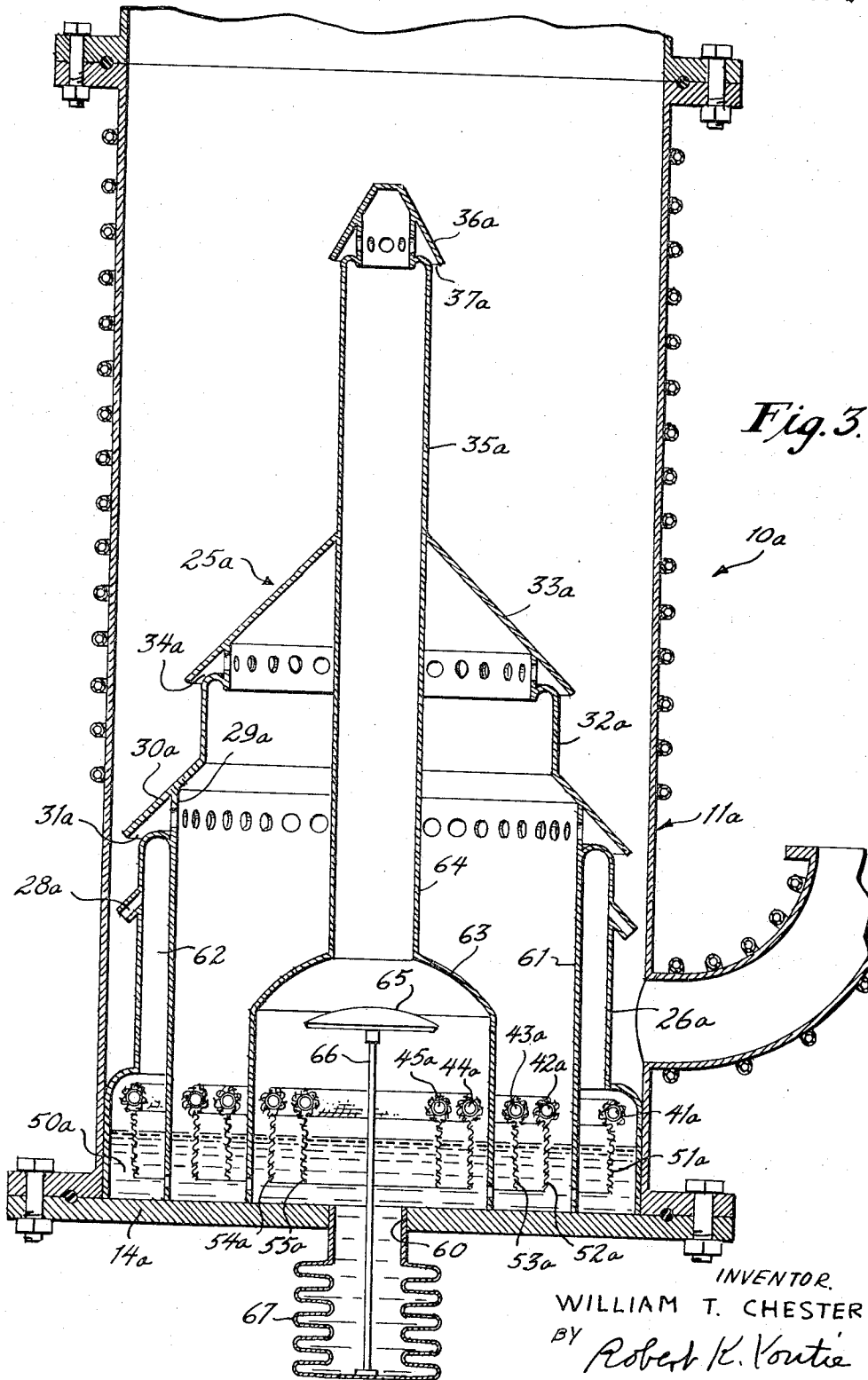
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DIFFUSION-PUMP CONSTRUCTION

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Filed Aug. 6, 1965, Ser. No. 477,900
4 Claims. (Cl. 230-101)

This invention relates generally to diffusion pumps, such as are commonly used for evacuating gases, but is capable of many varied applications all of which are intended to be comprehended herein.

As is well known to those versed in the art, diffusion-pump operation involves both the heat transfer to and heat removal from the pump, which requirements are essentially in conflict, and by prior diffusion-pump constructions have been excessive due to undesired heat transfer within the pump.

It is, therefore, an important object of the present invention to provide a unique diffusion-pump construction which considerably reduces the requirements both of heating and cooling, resulting in pump operation with greatly reduced power requirements.

It is a further object of the present invention to provide a diffusion pump of the type described wherein the pump casing may be provided with a detachable bottom to greatly facilitate manufacture and maintenance operations.

It is still a further object of the present invention to provide a diffusion pump having the advantageous characteristics mentioned in the preceding paragraphs, which is extremely simple in construction, durable and reliable in operation throughout a long useful life, and which can be more economically manufactured for sale at a reasonable price.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings, which form a material part of this disclosure.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter described, and of which the scope will be indicated by the appended claims.

In the drawings:

FIGURE 1 is a longitudinal sectional view showing a diffusion pump constructed in accordance with the teachings of the present invention;

FIGURE 2 is a sectional plan view taken generally along the line 2-2 of FIGURE 1; and

FIGURE 3 is a longitudinal, sectional elevational view similar to FIGURE 1, but showing a slightly modified embodiment of the instant invention.

Referring now more particularly to the drawings, and specifically to FIGURE 1 thereof, a diffusion pump is there generally designated 10, and includes a casing 11 which may be of generally cylindrical, upright overall configuration. The casing 11 may include a generally cylindrical, upstanding side wall 12 having its lower and upper ends open. A lower-end flange 13 may extend externally about the open lower end, and external circumferential flange 17 may extend about the upper side-wall end. A generally circular plate 14 may extend across the open lower end to define a bottom for the casing 11. The lower casing end or bottom 14 may have its peripheral margin underlying the flange 13 and detachably secured thereto by suitable fastener means, such as bolts 15. Suitable sealing means, such as a gasket or O-ring 16 may extend about and be arranged between the lower-end flange 13 and bottom plate 14 to hermetically seal the connection therebetween. Thus, the casing bottom 14 is detachably secured to the casing side wall 12. If desired, the gasket 16, or other suitable sealing means may be em-

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ployed having heat-insulation properties; and, the casing bottom 14 may be dished or recessed, for purposes appearing presently.

The upper end of casing side wall 12 may be connected to an inlet conduit or duct 18 by any suitable connection means, such as fasteners 19 secured to the upper-end flange 17 and a sealing gasket or O-ring 20.

In the lower region of the casing 11, extending from the casing side wall 12 at a location adjacent to and spaced from the lower end thereof, may be an outlet or elbow 22 for connection to a suitable outlet conduit (not shown).

Associated with the casing 11, spaced above the lower end thereof, there is usually provided suitable cooling means which may take any desired form, such as air cooling, water cooling, or the like. By way of illustration, and without limiting intent, there are illustrated cooling coils 23 circumposed about the casing side wall 12 above the outlet 22, and additional cooling coils 24 circumposed about the outlet 22. The cooling coils may circulate a cooling medium, such as water, to remove heat from the casing. While other suitable cooling means may be provided, if resired, under certain circumstances positive cooling may not be necessary in practice according to the teachings of the instant invention.

Located within the casing 11 may be a series of jet stages, generally designated 25, which may be essentially conventional in construction. A lower jet stage 26 includes a cylinder or chimney upstanding in spaced relation within the casing side wall 12 from the casing bottom 14 and having at its upper end a circumferentially extending downwardly and outwardly flaring deflector 27. The upper-end deflector 27 combines with the adjacent upper region of the chimney 26 to define a circumferentially arranged series of downwardly and outwardly extending fluid openings 28, preferably having venturi-type constrictions. A second jet stage or chimney 29 upstands from the upper end of circumferential deflector 27, being spaced concentrically within side wall 12 and of a diameter less than that of chimney 26. An outwardly divergent deflector 30 is arranged over the upper end of chimney 29 and combines with the latter to provide a circumferentially spaced series of fluid-outlet or jet openings 31, similar to the fluid openings or jets 28. An additional jet stage or chimney 32, of further reduced diameter, may upstand from the upper end of deflector 30 and be provided at its upper end with a downwardly and outwardly diverging, circumferentially extending deflector 33. A circumferential array of downwardly and outwardly extending fluid openings or jets 34 may be provided in the upper end of chimney 32, below deflector 33. A final jet stage or chimney 35 may upstand from the upper end of deflector 33, being of a diameter less than that of the next lower jet chimney 32, and may be provided at its upper end with a generally conical deflector 36 having immediately therebelow a circumferential array of downwardly and outwardly projecting jet openings or fluid outlets 37.

Located in a lower region of the casing 11, spaced between the casing bottom 14 and outlet 22, there may be provided suitable heating means, generally designated 40. In the illustrated embodiment, the heating means 40 includes a series of circular heating coils 41, 42, 43, 44, 45, 46 and 47. The coils 41-47 may be separate and independent, or may be the convolutions of a single spiral. Of course, other configurations of heating elements may also be employed. The heating means 40 may be of any suitable type, such as electrical-heating elements, steam-heating tubes, or other, as desired.

Spaced below the heating means 40, the casing bottom 14 and adjacent portion of casing side wall 11 combine to define a sump receiving a liquid 50. The sump liquid 50 may be any type suitable for convenient vaporization

and condensation, such as the various oils now employed, or otherwise.

Extending about each of the heating elements 41-47, and depending therefrom into the sump liquid 50 are a plurality of wicks 51, 52, 53, 54, 55, 56 and 57. The wicks may be of any suitable type, preferably heat-resistant, adapted to conduct the sump liquid 50 upward for engagement with the heating elements 41-47. Suitable wicking has been found to be fiberglass fabric, serving to conduct by capillary action the sump liquid into the heating elements.

By this construction, relatively little heat is required, only that sufficient to vaporize the relatively thin film of liquid carried by the wicks to the heating elements, it not being necessary to heat the entire quantity of sump liquid 50 to the point of vaporization, as in previous diffusion-pump constructions. It therefore follows that the lower region of the casing 11, including the casing bottom 14 and adjacent region of side wall 12, may remain relatively cool, so that less cooling action is required of the cooling means 23 and 24 to achieve the desired heat removal at the casing side wall 12 and outlet 22.

As mentioned hereinbefore, the casing bottom 14 may be dished so that the sump liquid 50 would be located entirely below the casing side wall 12, further isolating the heating and cooling actions.

Also, if desired, the several jet stages or chimneys may be separate, each having its own heating means operating at a desired temperature as required by the duty of the corresponding stage.

A further embodiment is shown in FIGURE 3, the pump there being generally designated 10a and including a casing 11a which may be substantially identical to the casing 11, except for the casing bottom 14a. In particular, the casing bottom 14a may be formed with a central thru opening 60, for a purpose appearing presently.

The jet stages 25a may include a lower stage or cylindrical chimney 26a upstanding from the bottom 14a and having an inner cylindrical wall 61 spaced within the chimney 26a to define a generally annular chimney space 62. A circumferential array of jets or fluid outlets 28a may be provided in the external chimney wall 26a. The inner chimney wall 61 extends upward beyond the chimney 26a, as at 29a to there provide a second-stage chimney having at its upper end a downwardly diverging deflector 30a which combines with the chimney 29a to define a circumferential array of downwardly and outwardly directed jets or fluid outlets 31a. A further jet stage 32a is defined by a chimney of reduced diameter upstanding from the circumferential deflector 30a and provided at its upper end with a circumferential downwardly and outwardly extending deflector 33a combining with the chimney 32a to provide a series of outwardly and downwardly divergent fluid outlets or jets 34a.

A final stage 35a includes an inner chimney 63 upstanding from the casing bottom wall 14a in spaced relation within the inner chimney wall 61 and over the bottom-wall opening 60. The chimney 63 includes a reduced upper portion 64 extending upward through and beyond the circumferential deflector 33a where it is provided with a generally conical cover or deflector 36a combining with the upper end of chimney 35a to provide a circumferential array of downwardly and outwardly directed vapor outlets or jets 37a.

In the lower region of casing 11a, spaced over sump 50a, there are provided a series of heating elements 41a, 42a, 43a, 44a and 45a. The several heating elements may be of generally circular configuration, one within the other. The outermost heating element 41a is illustrated as located between the chimney walls 26a and 61, the next pair of heating elements 42a and 43a being located between the chimney walls 61 and 63, and the innermost pair of heating elements 44a and 45a being located within the innermost chimney 63. The several heating elements 41a-45a are each provided with a wick, as at 51a, 52a,

53a, 54a and 55a, respectively. The several wicks 51a-55a are each arranged in engagement with its respective heating element and depending therefrom into the sump liquid 50a.

If desired, the temperature of the various heating elements 41a-45a may be independently controlled, it being apparent that the outer heating element 41a serves to operate the lower stage 26a, the next inner pair of heating elements 42a and 43a serving to operate the jet stages 29a and 32a, and the innermost pair of heating elements 44a and 45a serving to operate the innermost or final jet stage 35a.

In practice, the lower stages commence operation before the upper stages, and the upper stages may serve to delay operation of the lower stages by draining heat. Hence, in the instant embodiment the upper or final stage 35a may be closed until full operation of the lower stages is achieved. Also, it may be desired to only operate the lower stages, without the upper stage, which may also be accomplished in operation of this embodiment.

Toward this end, a closure or valve element 65 is arranged in the chimney 63 mounted on a stem or shank 66 for movement into and out of closing relation with the reduced chimney portion 64 of the final stage 35a. Operation of the final stage may be controlled externally of the pump 10a, if desired, by providing a bellows 67, or other suitable means, connected to the casing bottom 14a in fluid communication through the casing-bottom opening 60, and carrying the valve stem 66. If desired, the bellows 67 may be automatically pressure-operated to open the valve element 65 at the desired pressure. Further, the bellows 67 may be of sufficient size to raise the liquid level and quench the heater means, if desired, as for fast cooldown. Also, the valve 65, or equivalent, may close any selected stage or stages, as desired.

From the foregoing, it is seen that the present invention provides a diffusion-pump construction which fully accomplishes its intended objects and is well adapted to meet practical conditions of manufacture, maintenance and operation.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention and scope of the appended claims.

What is claimed is:

1. In a diffusion pump, the combination comprising a casing having a side wall, top and bottom and an upper inlet and a lower outlet, a sump in a lower casing region for containing liquid to be vaporized, vapor-jet means in said casing above said sump, said vapor jet means comprising a lower chimney, an upper chimney, and closure means selectively closing said upper chimney for selective pump operation without said upper chimney, said closure means comprising a closure element movable upwardly into and downwardly out of closing relation with said upper jet chimney, and closure actuating means depending from said closure through said bottom, and liquid-heating means in a lower region of said casing, said liquid-heating means comprising a heating element spaced over said sump, and a wick engaging said heating element and depending therefrom into said sump for conducting liquid from said sump into engagement with said heating element for vaporization thereby.

2. A diffusion pump according to claim 1, in combination with connection means detachably connecting said casing side wall and bottom.

3. A diffusion pump according to claim 1, said closure-actuating means comprising an actuating member depending from said closure, and an expansible and contractile chamber depending from said bottom in fluid communication with said sump and connected to said actuating member for controlling closure operation responsive to internal pressure.

4. A diffusion pump according to claim 3, said chamber

being manually expansile and contractile to control the sump liquid level.

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