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HIGH VACUUM DIFFUSION PUMP

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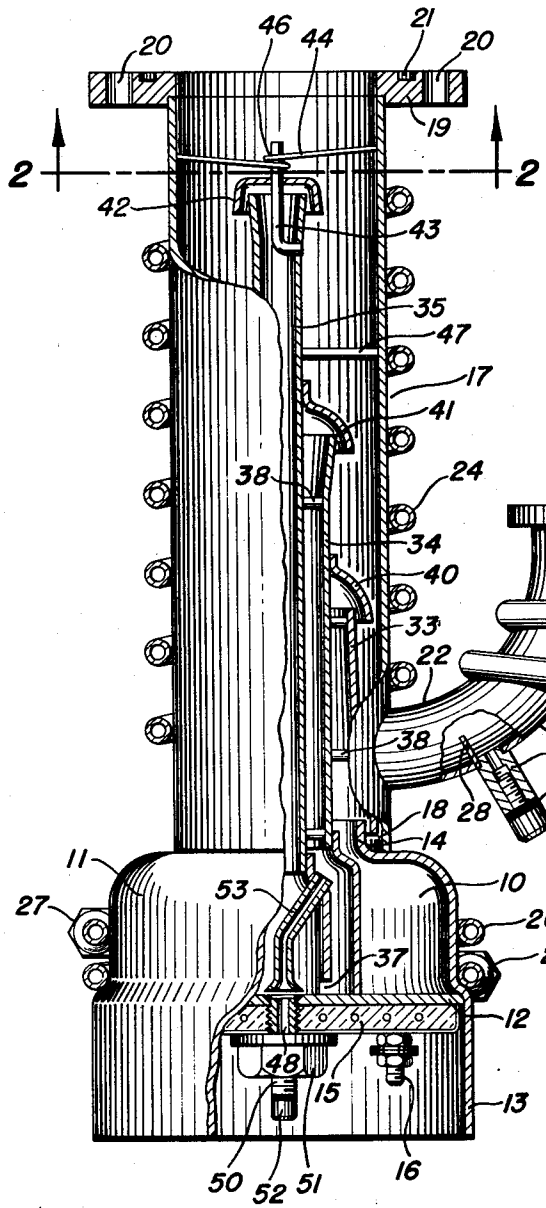

FIG. 1

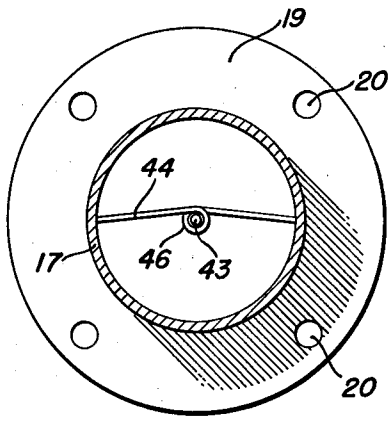

FIG. 2

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HIGH VACUUM DIFFUSION PUMP

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4 Claims. (Cl. 230—101)

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This invention relates to vacuum pumps and is particularly concerned with high vacuum diffusion pumps.

High vacuum diffusion pumps have come into general use for pumping in the range below 1 mm. Hg and particularly below about 100 microns Hg. One of the more common types used, particularly with organic pump fluids, is the vertical fractionating diffusion pump having a boiler, a generally cylindrical pump casing extending upwardly from the boiler with the open upper end of the casing being flanged for connection to a system to be evacuated, and one or more vapor chimneys having their lower end resting on the bottom of the boiler to form a series of interconnected boiler compartments and extending upwardly into the casing to terminate in a jet nozzle assembly. For satisfactory operation, the bottom of the chimney or chimneys must rest squarely on the bottom of the boiler, and the chimney should be properly centered within the casing. Since the pumps must be disassembled and cleaned periodically, ease of disassembly is a desirable feature particularly as regards removal of the chimney and jet assembly.

The conventional vertical diffusion pumps commonly used for many years provided easy removal of the chimneys and jet assemblies since they could simply be inverted and the chimney and jet assemblies would drop out. Although this arrangement was convenient from the standpoint of dismantling the pump, the chimney and jet assemblies were readily damaged by dropping out during shipment, or by someone inadvertently turning the pump upside down, or by rapidly admitting air into an evacuated system which blew the chimney and jet assemblies out of the pump.

It is accordingly an object of this invention to provide a high vacuum vertical diffusion pump which is readily disassembled but which overcomes the aforesaid disadvantages of prior art pumps of this type.

Another object of the invention is to provide means for pinning down the chimney-jet assemblies without adversely affecting the operation of the pump.

Another object of the invention is to provide a vertical diffusion pump including readily insertable and removable means for confining the chimney and jet assemblies against undesirable vertical displacement.

Another object of the invention is to provide a vertical diffusion pump including means for pinning the chimney and jet assembly against vertical displacement without interfering with proper

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seating of the chimneys on the bottom of the boiler.

Another object of the invention is to provide simple but effective means for obviating damage to the jets in case of sudden backsurging of air into an evacuated system.

Other objects will be apparent from the drawings and from the description and claims which follow.

These and other objects are attained by apparatus embodying this invention as described more fully hereinafter with particular reference to the accompanying drawings.

Of the drawings:

Fig. 1 is a view in elevation partly broken away and in section of a vertical diffusion pump constituting a preferred embodiment of the invention; and

Fig. 2 is a section taken along line 2—2 of Fig. 1.

Referring particularly to Fig. 1, a boiler 10 for vaporizing pump fluid is formed by a metal shell 11 and a metal bottom plate 12 welded or otherwise secured to shell 11. Shell 11 extends below plate 12 to form a skirt 13 which serves as a base for the pump. The upper end of shell 11 is necked down to a peripheral lip 14. A conventional resistance heater 15 is bolted or otherwise secured to the lower face of plate 12 for heating the boiler, current being supplied by connection to binding post 16 and a lead off post (not shown).

A generally cylindrical metal pump casing 17 is welded or otherwise secured to the necked down portion of shell 11, the casing 17 being of slightly larger diameter than peripheral lip 14 to form an annular gutter 18 at the top of boiler 10. Annular flange 19 welded to the upper end of casing 17 is drilled at 20, 20 for bolting the pump to a system to be evacuated. An annular groove 21 in the upper face of flange 19 serves as a seat for an O-ring gasket to ensure a vacuum-tight seal between the pump and the system to be evacuated.

A forepressure arm 22 welded or otherwise secured to casing 17 adjacent the lower end of casing 17 and above boiler 10 provides an outlet port for the pump. Forepressure arm 22 is provided with a flange 23 for connecting the outlet port to a backing pump. A coil 24 of copper tubing is wound around casing 17 and forepressure arm 22 and is provided with a suitable connection such as shown at 25 for connecting coil 24 to a source of cooling water as well as a similar exit connection (not shown). A separate coil 26 of copper tubing is wound around shell 11 of boiler 10 and is similarly provided with entrance and exit connections 27, 27 for supplying coil 26 with cooling

water. The forepressure arm has a hemispherical dam 28 mounted inside arm 22 for collecting condensed vapors in arm 22. Drain 30 opens out of arm 22 in front of dam 28, the drain 30 being closed by screw cap 31 and gasket 32.

Cylindrical vapor chimneys 33, 34 and 35 fabricated of aluminum or other suitable metal are disposed within casing 17 in generally concentric relation with each other and with casing 17. The inner chimney 35 and the intermediate chimney 34 rest on the bottom 12 of boiler 10 and divide boiler 10 into a series of concentric boiler compartments which are interconnected in series by notches in the lower ends of chimneys 34 and 35. The notch in inner chimney 35 is shown at 37, the notch (not shown) in chimney 34 being spaced 180° from notch 37 in order to provide a tortuous path through the boiler compartments. Vapor chimneys 33, 34 and 35 are connected to each other by rod spacers 38, 38 welded or otherwise secured to the respective chimneys. The lower end of outer chimney 33 extends into gutter 18 formed by lip 14 of shell 11 and the lower end of casing 17. Chimney 33 is secured to intermediate chimney 34 by spacers 38, 38 such that the lower end of chimney 33 is out of contact with the sides or bottom of gutter 18.

Chimney 33 is provided with a jet cap 40 of aluminum or other suitable metal welded to chimney 34 in position to form a jet nozzle assembly with the upper end of chimney 33. Chimney 34 is likewise provided with a metal jet cap 41 welded to inner chimney 35 to form a jet nozzle assembly with the upper end of chimney 34. The long inner chimney 35 which extends to the low pressure region of the casing adjacent the inlet is provided with a metal umbrella cap 42 positioned to form a jet nozzle assembly with the upper end of chimney 35. Umbrella cap 42 is mounted on centering post 43 which in turn is welded or otherwise secured to the inner wall of chimney 35, the lower end of post 43 being bent at right angles to the vertical section for contact with the sidewall of the chimney while the centrally disposed vertical section of post 43 projects upwardly above the upper end of chimney 35 and its jet cap 42.

The chimney and jet assemblies are pinned against vertical displacement by spring clip 44 desirably consisting of a single length of spring wire extending diametrically across the internal diameter of casing 17 immediately above umbrella cap 42. Spring clip 44 is formed with an open central loop 46 encircling post 43 and the projecting ends of clip 44 extending into close contact with the inner face of casing 17 whereby clip 44 is pinned across the throat of the pump casing. Clip 44 is preferably dimensioned so that, in its normal looped but untensioned condition, the clip is slightly longer than the diameter of casing 17. The clip 44 is readily inserted by forcing the ends of the clip toward each other in the direction of the central loop so as to tension the clip, positioning the clip on post 43, and then allowing the clip to spring back towards the untensioned position whereby the ends of the spring wire are pinned firmly against the inner face of the casing with the springing action of the central loop exerting lateral pressure on the ends. In the preferred embodiment, the portions of clip 44 projecting outwardly from the central loop 46 are slanted slightly upwardly from the central loop to the ends of the clip whereby pressure upwardly against the center of the clip serves to wedge it more tightly in the casing throat.

The central loop 46 of clip 44 desirably is of slightly larger diameter than the post 43 which it encircles so that the post has a limited area for lateral movement. The chimney and jet assemblies are centered in the casing by spider 47 welded to chimney 35, the spider 47 being dimensioned so that it readily fits into casing 17 without jamming.

In the preferred embodiment illustrated in the drawings, the bottom plate 12 of boiler 10 and the heater 15 have a threaded drain 48 tapped therethrough and opening into the boiler compartment defined by the lower end of inner chimney 35. A hollow, externally threaded plug 50 is screwed into threaded opening 48, plug 50 being locked in place by lock nut 51 and capped by cap and gasket 52. A metal tube 53, having its upper end projecting through the wall of chimney 35 into the space between chimneys 34 and 35, is secured to and suspended from chimney 35 with the lower flared end of tube 53 being disposed immediately above drain 48.

In fabricating the pump illustrated in the drawings, the boiler 10, heater 15, casing 17 and forepressure arm 22 are welded or otherwise secured together into an integral unit. The chimneys 33, 34 and 35, jet-caps 40, 41 and 42 and tube 53 are also assembled as an integral unit. With the drain plug 50 locked in place and capped, the chimney-jet assembly is lowered into casing 17 until the lower ends of chimneys 34 and 35 are resting squarely on the bottom 12 of boiler 10 and the lower end of outer chimney 33 hanging in gutter 18. Spider 47 serves to ensure proper centering of the chimneys inside the casing, the spider 47 having a loose fit inside casing 47 so that chimneys 34 and 35 can seat squarely on plate 12 forming the bottom of boiler 10. Proper seating of chimneys 34 and 35 on plate 12 is important to ensure proper fractionating action of the pump fluid without objectionable seepage of fluid under the ends of the chimneys 34 and 35.

Spring clip 44 is then tensioned as described hereinabove, slipped on the post 43, and allowed to spring into pinning position against the inner face of casing 17. The diameter of the central loop 46 is sufficient to keep the clip 44 out of contact with post 43 whereby the chimneys can seat freely on the bottom of boiler 10.

The assembled pump can then be shipped without elaborate precautions to protect the chimney-jet assemblies since they are pinned against vertical displacement.

In operating the pump embodying the invention, a suitable organic pump fluid is charged into the boiler, the inlet port flange 19 is bolted to the system to be evacuated and the forepressure arm is connected to a mechanical backing pump by means of flange 23. Cooling fluid is circulated through coil 24, and the heater is energized to vaporize pump fluid in the boiler. In operation, pump fluid vapors formed in each of the boiler compartments ascend through the respective chimneys and emerge through the jet nozzles into the casing. The vapors are condensed on the cooled casing wall, the pump fluid condensate runs down into gutter 18 where it forms a liquid seal around the lower end of chimney 33, and the fluid overflows into the outer boiler compartment between chimney 34 and shell 11. The highest vapor pressure components of the pump fluid are revaporized in this outer

boiler compartment and ascend to emerge through the jet nozzle formed by chimney 33 and cap 43. The high vapor pressure components thus exert their pumping action in the highest pressure zone of the pump adjacent the forepressure outlet. Any highly volatile components of the pump fluid which escape from the pump proper are condensed in the forepressure arm and are collected by dam 28 and segregated from the remainder of the pump fluid. These condensed volatiles usually form only a minor percentage of the pump fluid and can be drawn off through drain plug 38 when operation of the pump is interrupted.

After the highest vapor pressure components of the pump fluid are vaporized in the outer boiler compartment, the remaining fluid flows into the intermediate boiler compartment where the intermediate vapor pressure components are evolved and ascend to exert their pumping action in an intermediate pressure zone of the pump. The remaining low vapor components of the pump fluid flow into the innermost boiler compartment and, after being vaporized, ascend inside chimney 35 and exert their pumping action in the lowest pressure zone of the pump adjacent the inlet end of the pump.

The tarry residues and decomposition products of the pump fluid tend to collect in the innermost boiler compartment. Upon prolonged heating, these materials tend to evolve gases which would impair the efficiency of the pump if permitter to ascend chimney 35. Tube 53 serves to channel such gases into a higher pressure zone of the pump, however, where their deleterious effect on the pump efficiency is minimized. Drain 48 can be used for draining all or part of the pump fluid from the boiler and tube 53 also serves to collect and channel out of the inner compartment any air which might leak through drain 48.

Occasionally during evacuation operations, vacuum may be broken suddenly due to failure of some part of the system or other cause. When the system is opened suddenly to atmosphere, the back surge of air through the pump is sufficient to blow the chimney-jet assembly out of the pump unless the assembly is pinned in place in accordance with this invention. The spring clip embodying this invention effectively prevents a blowout of this kind with its attendant damage to the chimneys and jet caps.

In the pump embodying this invention, however, the spring clip is readily removed when it is desired to disassemble the pump for cleaning. The clip does not interfere with the pumping action of the pump since it does not block any substantial area of the pump throat, and allows the chimneys to rock slightly so as to seat freely on the bottom of the boiler.

While the invention has been described in considerable detail with reference to a preferred embodiment thereof, it will be understood that variations and modifications can be effected in the apparatus embodying the invention without departing from the spirit and scope of the invention as described hereinabove and illustrated in the drawings and as defined in the appended claims.

I claim:

1. In a vertical diffusion pump of the type comprising a generally cylindrical pump casing having an open upper end adapted to be connected to a system to be evacuated, a boiler opening into the lower end of said pump casing, at least one removable cylindrical vapor chimney disposed in said casing in generally concentric relation therewith, the lower end of said chimney resting on the bottom of said boiler, the upper end of said chimney being in an upper zone of said casing, and jet cap means cooperating with said upper end of said chimney, said jet cap means and said chimney forming a jet nozzle assembly, said chimney being unsecured to said boiler and to said casing, the improvement which comprises post means secured to said chimney and projecting upwardly beyond the upper end of said chimney, and pinning means loosely encircling said post means and extending outwardly into engagement with the inner face of said casing, said pinning means exerting spring pressure against said casing effective to resist vertical displacement of said pinning means.

2. In a vertical diffusion pump of the type comprising a generally cylindrical pump casing having an open upper end adapted to be connected to a system to be evacuated, a boiler opening into the lower end of said pump casing, at least one removable cylindrical vapor chimney disposed in said casing in generally concentric relation therewith, the lower end of said chimney resting on the bottom of said boiler, the upper end of said chimney being in an upper zone of said casing, and jet cap means cooperating with said chimney and forming therewith a jet nozzle assembly, said chimney being unsecured to said boiler and to said casing, the improvement which comprises post means secured to said chimney and projecting upwardly beyond the upper end of said chimney, and pinning means encircling said post means and extending generally diametrically across the space inside said casing into engagement with the inner face of said casing, said pinning means comprising a spring wire formed with a central loop encircling said post means and the end portions of said wire projecting radially outward from said central loop with the ends of said wire pressed tightly against said casing, said central loop being of slightly larger diameter than said post means and permitting limited lateral movement of said post means within said loop.

3. In a vertical diffusion pump of the type comprising a generally cylindrical pump casing having an open upper end adapted to be connected to a system to be evacuated, a boiler opening into the lower end of said pump casing, at least one removable cylindrical vapor chimney disposed in said casing in generally concentric relation therewith, the lower end of said chimney resting on the bottom of said boiler, the upper end of said chimney being in an upper zone of said casing, and a jet nozzle assembly including said upper end of said chimney, said chimney being unsecured to said boiler and to said casing, the improvement which comprises a centering post secured to said chimney and projecting upwardly beyond the upper end of said chimney, and pinning means comprising a spring wire positioned immediately above the upper end of said chimney and extending across the internal diameter of said casing, said spring wire being formed with a central open loop encircling said centering post and end portions extending outwardly from said loop into contact with the inner face of said casing, said looped spring wire being dimensioned to exert positive spring pressure against the inner face of said casing and thereby resist vertical displacement of said pinning means.

4. In a vertical diffusion pump of the type comprising a generally cylindrical pump casing having an open upper end adapted to be connected to a system to be evacuated, a boiler opening into the lower end of said pump casing, at least one removable cylindrical vapor chimney disposed in said casing in generally concentric relation therewith, the lower end of said chimney resting on the bottom of said boiler, the upper end of said chimney being in an upper zone of said casing, and a jet cap mounted on said chimney and with said chimney forming a jet nozzle assembly, said chimney being unsecured to said boiler and to said casing, the improvement which comprises a centering post secured to said chimney and projecting upwardly beyond the upper end of said chimney, and pinning means comprising a single length of spring wire extending generally diametrically across the inner diameter of said casing immediately above the upper end of said chimney, said spring wire being formed with a central loop in said wire encircling said post and having the ends of said wire pinned against the inner face of said casing, said central loop being of slightly larger diameter than said post and thereby permitting limited lateral movement of said post, the portions of said wire projecting outwardly from said central loop into contact with said casing having a slight upward angle from said post to said casing.

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