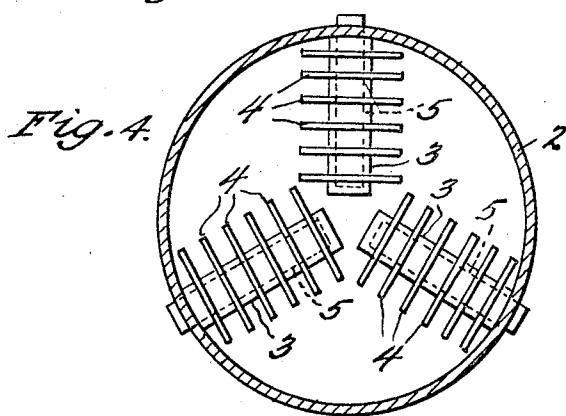
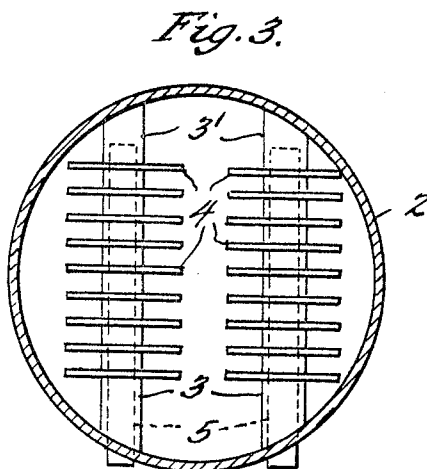
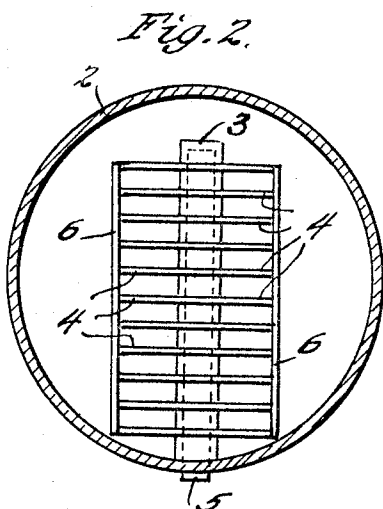
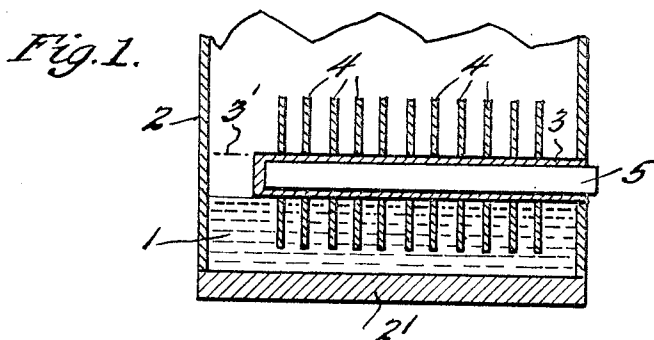


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VACUUM DIFFUSION PUMP
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VACUUM DIFFUSION PUMP

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5 Claims. (Cl. 219—275)

The present invention relates to improvements in vacuum diffusion pumps and more particularly to vacuum oil-diffusion pumps.

Since the rate of evacuation of a vacuum diffusion pump depends largely upon the velocity of the propellant vapor which is produced in the pump by the vaporization of a liquid, the particular manner of generating the propellant vapor is of great importance. In a vacuum oil-diffusion pump, the propellant vapor is generally generated by heating the oil by electric heating means.

In some of the known vacuum oil-diffusion pumps these heating means consist of an electric heating plate or plates which are located underneath the bottom of the pump and are surrounded by air under atmospheric pressure. Such an arrangement of the heating elements has the disadvantage that the heat which is to be transmitted to the oil must first pass through the relatively thick bottom of the pump. The surface area for the heat transfer to the oil is therefore relatively small. Furthermore, since by this heating method the heat is at first transmitted only to the lower layers of oil before the whole body of oil will be heated to the boiling point so as to start the vaporization, these lower layers may be overheated and damaged. The oil may therefore be brought uniformly to the boiling point only when its temperature is increased very slowly from its lower to its upper layers. This type of heating system has the further disadvantage that, since the heating elements are surrounded by air under atmospheric pressure, they are subjected to the corrosive action of the atmospheric oxygen and water of condensation.

In another known type of vacuum oil-diffusion pumps the propellant vapor is produced by heating the oil by means of so-called Backer tubes which are located in the oil itself. These heating means have the disadvantage that vapor bubbles easily form on some parts of the tubes which reduce the heating efficiency and the heat transfer to the oil, while on the other parts of the tubes the oil will be overheated and damaged. The mentioned disadvantages of the two types of heating means as above described are so serious that they are no longer installed in vacuum diffusion pumps.

There is still another known type of vacuum oil-diffusion pumps in which the pump housing contains vertical tubes which extend through the pump bottom into the oil chamber and are adapted to receive electrically heated rods which are inserted through the open lower ends of these tubes. Since the surface area of these heat-transmitting tubes is relatively small and the specific thermal load upon the oil is therefore very high, it has been proposed to provide these tubes which surround the heating rods with radially extending ribs which project into the oil. Although these ribs slightly increase the size of the heat-transmitting surfaces of the vertical tubes and cause a greater turbulence of the oil, they can hardly reduce the knocking which occurs in the operation of such an apparatus.

It is an object of the present invention to provide a heating system for a vacuum diffusion pump which overcomes all of the above-mentioned disadvantages of the heating means which have previously been employed. According to the invention this object is at-

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tained in a very simple manner by providing the diffusion pump with one or more cylindrical heat-transmitting tubes, each of which is adapted to receive a tubular heating element and is provided with a large number of parallel, outwardly projecting plates of a highly heat-conductive material which are positively connected to these tubes and greatly increase the heat-transmitting surface thereof, and by mounting these tubes in the pump housing in a horizontal position so that the tubes themselves are located above the oil or other liquid, while a part of the plates are immersed from above into the liquid. For generating the propellant vapor, the diffusion pump may be equipped with a single heating element which is inserted from the outside into a tube of the type as above described, or it may be equipped with several heating elements in their respective tubes which extend parallel to each other or radially toward the center of the pump housing at equal angles to each other. Thus, for example, three heating elements may be provided so as to extend at an angle of 120° to each other. By providing the tube which surrounds each heating element with radially projecting plates, the heat is conducted from above into the oil or other propellant. This manner of heating produces the effect that molecules of the liquid propellant are vaporized primarily from the upper layers thereof and that therefore the obnoxious knocking is almost entirely prevented. The propellant vapor is the formed between the lower parts of the plates which are immersed into the liquid, and it is thereafter accelerated by passing through the parts of these plates which are located above the heating element. Since the rate of evacuation of vacuum diffusion pumps depends upon the velocity of the propellant vapor, it is evident that a diffusion pump which is equipped with a heating system according to the invention will have a higher rate of evacuation than a diffusion pump which is provided with one of the conventional heating systems. Furthermore, a diffusion pump which is equipped with a heating system according to the invention also has the advantage over the previous types of diffusion pumps that the back flow of the liquid propellant is much smaller and that the rate of evacuation produced by the pump is much more constant. The horizontal arrangement of the tubes surrounding the heating elements also has the additional advantage that the heating elements are easily accessible and may be quickly exchanged from the outside of the pump without requiring the entire pump to be moved as it was necessary, for example, in the pumps in which the heating rods had to be inserted through the bottom of the pump.

The features and advantages of the present invention will become more clearly apparent from the following detailed description thereof which is to be read with reference to the accompanying diagrammatic drawings, in which:

FIGURE 1 shows a side view of a heating system according to the invention in the lower part of the housing of a vacuum diffusion pump which is shown in a vertical section; while

FIGURES 2 to 4 show top views of three different modifications of the heating system according to the invention, each of which is mounted in the lower part of the pump housing which is shown in cross section.

FIGURE 1 illustrates diagrammatically the lower part of the nozzle assembly housing 2 of a vacuum diffusion pump which contains a liquid propellant 1, for example, oil, above the bottom 2' of the housing. Closely above the surface of the liquid at least one tube 3 is mounted in a horizontal position in the housing 2 and hermetically secured thereto. This tube 3 carries a plurality of parallel plates 4 of a highly heat-conductive material which are also conductively connected to the tube. As

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shown in full lines in FIGURE 1, tube 3 may either be open only at one end for inserting an electrical heating element 5 therein or, as shown in dot-and-dash lines, it may extend entirely through the pump housing 2 and be open at both ends to permit the heating element 5 to be easily exchanged whenever necessary. The temperature of the heating element 5 is transmitted to the liquid propellant 1 by the lower parts of the plates 4 so as to vaporize the liquid between these plates. The propellant vapor then rises between the plates and is accelerated by the parts of plates 4 which are located above the heating element 5.

FIGURE 2 shows a modification of the invention in which the lateral ends of plates 4 are connected to each other by end plates 6 which further increase the area of the heat-transmitting surfaces and confine the propellant between the plates 4 within a chimneylike boiling chamber which is open at its upper and lower ends. The chimney effect which is thus attained increases the heating and vaporizing as well as the vapor-accelerating effects of the plates.

FIGURE 3 shows the lower part of a pump chamber 2 in which two horizontal tubes 3 are mounted parallel to each other. Each of these tubes 3 carries a plurality of parallel plates 4 of a highly heat-conductive material and contains an electric heating element 5.

FIGURE 4 finally shows another and very preferred modification of the invention in which three horizontal tubes 3, each of which again carries parallel plates 4 and contains a heating element 5 are mounted in the lower part of the pump chamber 2 so as to extend radially toward a point near the center of the chamber and at an angle of 120° to each other. This arrangement results in a very uniform and efficient heating of the propellant and a very high rate of evacuation of the diffusion pump.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. In a vacuum diffusion pump having a vertical cylindrical housing and a bottom wall secured to the lower end thereof and defining therewith a nozzle assembly for expanding and accelerating oil vapor, an oil charge disposed in the lower end of said housing, a plurality of horizontally disposed cylindrical tubes secured within said housing above the upper surface of said oil charge, said tubes being each provided with an open end which is disposed exteriorly of said housing, an electric heating element disposed within each of said tubes for continuously generating oil vapor from said oil charge, each of said tubes having a plurality of longitudinally spaced parallel heat conductive plates secured thereto perpendicular to the axis thereof, the lower parts of said plates being immersed into said oil charge for heating and vaporizing said oil, and the upper parts of said plates extending above

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the liquid oil charge to further heat the vapor which rises vertically after being formed and which passes between the upper parts of said plates, said further heating by the upper parts of said plates accelerating the flow of vapor formed from said oil charge.

2. A vacuum oil-diffusion pump as defined in claim 1, in which at least two of said horizontal tubes are each adapted to contain an electric heating element and carrying a plurality of said plates and are secured within said chamber in a position substantially parallel to and laterally spaced from each other.

3. A vacuum oil-diffusion pump as defined in claim 1, in which at least three of said horizontal tubes are each adapted to contain an electric heating element and carrying a plurality of said plates and project inwardly from the wall of said chamber, at least two adjacent of said tubes being at substantially equal angles to each other.

4. In a vacuum diffusion pump having a vertical cylindrical housing and a bottom wall secured to the lower end thereof and defining therewith a nozzle assembly for expanding and accelerating oil vapor, an oil charge disposed in the lower end of said housing, a horizontally disposed cylindrical tube secured within said housing above the upper surface of said oil charge, said tube being provided with an open end which is disposed exteriorly of said housing, an electric heating element which is disposed within said tube and is operative to continuously generate oil vapor from said oil charge, a plurality of longitudinally spaced parallel heat conductive plates which are secured to said tube perpendicular to the axis thereof, the lower parts of said plates being immersed into said oil charge for heating and vaporizing said oil, and the upper parts of said plates extending above the liquid oil charge to further heat the vapor which rises vertically after being formed and which passes between the upper parts of said plates, said further heating by the upper parts of said plates accelerating the flow of vapor formed from said oil charge.

5. A vacuum oil-diffusion pump as defined in claim 4, further comprising end plates connecting the lateral ends of said plates to each other for further increasing the size of the heat-transmitting surface of said tube and defining a chimneylike chamber containing said plates.

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