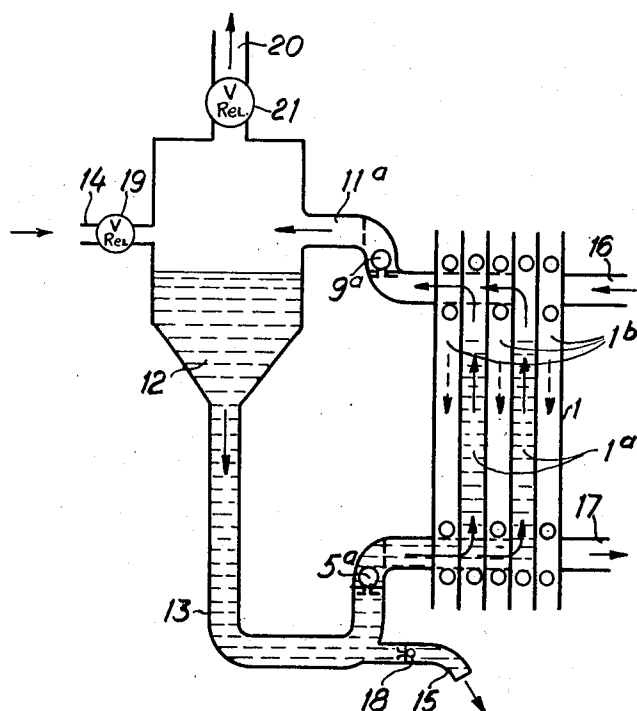


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F. J. WENNERBERG
HEAT OPERATED PUMPING SYSTEM

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INVENTOR.

Fritz Johan Wennerberg

BY

Davis, Koshier & Fairfull

ATTORNEYS

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HEAT OPERATED PUMPING SYSTEM

Fritz Johan Wennerberg, Lund, Sweden, assignor to Ak-tiebolaget Separator, Stockholm, Sweden, a corporation of Sweden

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1 Claim. (Cl. 159—2)

This invention relates to heat-operated pumping systems of the type having a liquid pump which directly utilizes supplied heat as a source of energy for a discontinuous pumping operation.

A pumping system made according to the invention comprises a liquid line having valve-controlled inlet and outlet openings, and a heat-operated pump connected into the line. The heat-operated pump is primarily a heat exchanger, one side of which is connected by two shunt lines to the liquid line and provided with a valve in at least one of these shunt lines, while the other side of the heat exchanger is connected to a heat source. The heat supplied to this other side of the exchanger causes some of the liquid in the first side to boil, and the pressure of the resulting steam forces liquid from this first side through one of the shunt lines so as to displace liquid from the system through a one-way valve against a counter-pressure. Thereafter, part or all of the steam is condensed while liquid enters the exchanger from the liquid line by way of the other shunt line, resulting in a pressure drop in the system whereby fresh liquid is sucked into it; and the pumping cycle is repeated. The liquid is allowed to flow in only one direction through the heat pump or exchanger, preferably by means of check valves in the two shunt lines, although it may be sufficient to provide only one of these lines with a valve.

According to a further feature of the invention, the heat-operated pumping system also serves as an evaporator. In this case, a tank is arranged in the liquid line, and fresh liquid is supplied intermittently to the upper part of the tank through a pressure-controlled valve. The lower part of the tank communicates with a valved opening through which liquid is intermittently discharged from the system, and also communicates with one of the shunt lines leading to the heat exchanger. The upper part of the tank is provided with a steam outlet containing a pressure-operated valve and is connected with the other shunt line leading from the heat exchanger.

For a better understanding of the invention, reference may be had to the accompanying drawings in which

The figure is a schematic view of one form of the new heat-operated pumping system which serves also as an evaporator.

In the plate heat exchanger 1, the heating medium and the liquid to be heated are confined to thin layers as they flow through the exchanger, so that the heating of the liquid is effected as evenly and uniformly as possible, without spotty over-heating. The plate heat exchanger 1 also provide a large heat transfer area without requiring too much space. Also, the plate apparatus 1 may be of the well-known type which can be readily opened for cleaning and inspection.

In the system shown in the figure, which also serves as an evaporator, the heat pump comprises a plate type of heat exchanger 1 forming passages 1a and 1b for the liquid to be heated and the heating medium, respectively. The system also comprises a check valve 9a, a pressure

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line 11a, a tank 12, a drop pipe 13 and a suction valve 5a. Periodic circulation through the system is obtained by supply of heat to the liquid in passages 1a of the plate apparatus 1. The liquid is supplied to the system through a feed pipe 14, which, together with the pressure pipe 11a for evaporated liquid, is connected to tank 12 (which may be a so-called cyclone) located at the upper part of the drop pipe 13. A discharge pipe 15 for the concentrated liquid is provided at the lower part of the drop pipe 13. The plate apparatus 1 is provided with feed and discharge pipes 16, 17 for steam and condensate, respectively, communicating with passages 1b of the plate apparatus.

In the operation of the system of the figure, the liquid to be evaporated is led into the tank 12 through the feed pipe 14 until the liquid level reaches a point directly below the opening 14 of the feed pipe in the tank 12. Heat is supplied to passages 1b of the heat exchanger, preferably in the form of steam. The liquid in passages 1a then boils into steam, so that the pressure in the space above the free liquid level in passages 1a increases and the check valve 9a opens. The steam with entrained liquid thus flows out into the tank 12, thereby increasing the pressure in this tank. As a result, part of the steam which has entered tank 12 discharges through the valve 21 until, because of this escape of steam, a somewhat lower pressure has been attained than the steam pressure previously existing in the tank. At this somewhat lower pressure, the valve 21 closes and the steam starts condensing in the tank 12 through contact with the tank wall and the relatively cold, free liquid surface in tank 12. As soon as the steam and entrained liquid have entered the tank 12, the liquid column in tank 12 and in the drop pipe 13 is momentarily pressed down because of the relatively high steam pressure existing at this moment and also because the liquid column in tank 12 now stands higher as a result of the entrained and transferred liquid than the liquid column in the plate heating apparatus 1, these columns tending to come into a state of equilibrium. Consequently, the valves 5a and 18 open as a result of the pressure differential across them. Partially concentrated liquid of a desired concentration passes in part through check valve 18 and through discharge pipe 15; the remainder being returned to the system through check valve 5a. The remainder of the liquid which is returned to the system is cool as compared to the liquid in the passages 1a, thereby cooling the same and condensing steam in the spaces above the free liquid level in the passages 1a in the heater. The liquid spaces between the heat exchange plates are again substantially filled with liquid. Due to the resulting drop in the liquid level in tank 12 and the consequent reduction in steam pressure in tank 12, which pressure is further reduced because the steam is condensed when contacting the relatively cold wall of tank 12 and the liquid surface in this tank, there is created in tank 12 an underpressure in relation to the pressure at the inlet opening 14, whereby the pressure responsive inlet valve 19 opens so that fresh cold liquid is supplied to the tank 12 and the equilibrium is reestablished for the start of another pumping cycle.

By means of the steam escape from tank 12 through discharge pipe 20, the more readily evaporated component of the solution to be evaporated may thus discharge from the system.

The new apparatus may be used to especial advantage for evaporation of mixtures in which at least one component is more volatile than the other components and forms a solvent for them. Partially concentrated liquid is discharged through line 15 only after some period of operation of the apparatus, because during the first cycles of operation no partially concentrated liquid can be sit-

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uated in the lower part of drop pipe 13. After a few cycles of operation, however, so much liquid has had time to circulate through the plate apparatus 1 that, during the following pump strokes of the apparatus, part of the partially concentrated liquid is pumped into the plate apparatus 1 and part is pumped out through the line 15.

An advantage of the system of the figure is that the heat supplied to the plate apparatus, and which is necessary to evaporate the treated liquid, serves at the same time to circulate the liquid through the plate apparatus. The installation is thus economical and simple. It is not necessary to install any circulation pump, which would demand thorough attention in addition to great power consumption. To reduce as much as possible the risk of burning-on in the plate apparatus, air included in the treated liquid (such as milk and the like) may be evacuated therefrom before the liquid is fed to the evaporator.

I claim:

An evaporator system comprising a tank, a liquid conveying line extending upward into the lower part of the tank, the tank having a valve-controlled inlet for the liquid, a heat exchanger of the plate type having one side for a heating medium and a second side for liquid to be

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heated, a pipe line connecting the upper portion of said second side of the heat exchanger to the upper portion of the tank, said upwardly extending liquid conveying line having at its lower portion an extension leading to the lower portion of said second side of the heat exchanger, check valves in said pipe line and extension, respectively, for allowing liquid flow in only an upward direction through said second side, a steam outlet pipe leading from the upper part of the tank, a pressure valve in said steam outlet pipe, a liquid discharge line leading from said extension at a point between the check valve therein and the tank, and a check valve in said liquid discharge line.

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