July 12, 1960 A. FRANKEL 2,944,599

FLASH EVAPORATOR

Filed April 2, 1957

Fig. 1.

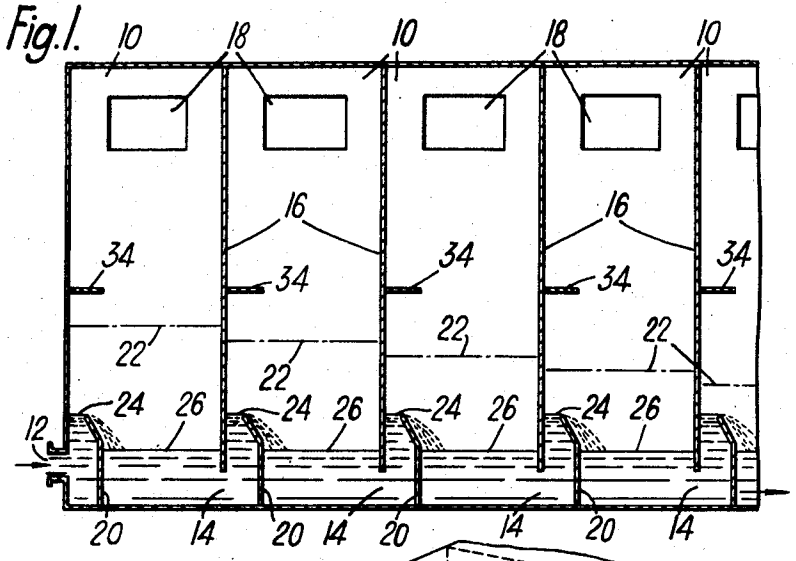



Fig. 2.

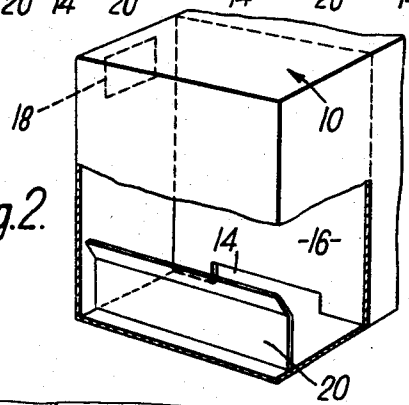
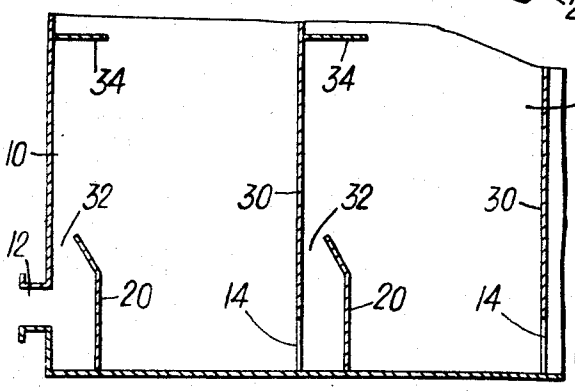



Fig. 3.




Inventor
Adolf Frankel
By Dowell & Dowell
Attorneys

United States Patent Office 2,944,599 Patented July 12, 1960



2,944,599

# FLASH EVAPORATOR

Adolf Frankel, Gosforth, Newcastle-on-Tyne, England, assignor to Richardsons, Westgarth & Co. Limited, Northumberland Engine Works, Wallsend, Northumberland, England

Filed Apr. 2, 1957, Ser. No. 650,217

Claims priority, application Great Britain Apr. 4, 1956

1 Claim. (Cl. 159—2)

This invention relates to evaporators.

In multi-stage flash-type evaporators, it is usual to provide a series of flash chambers wherein part of the heated liquid is evaporated. The heated liquid is passed from flash chamber to flash chamber through orifices joining the lower parts of the flash chambers which are arranged vertically side by side, and the vapour passes upwards and out of each flash chamber through an outlet located in its upper part.

It is a feature of such evaporators that, during normal operation, the pressure and corresponding saturation temperature within the flash chambers decreases from flash chamber to flash chamber, and it is highly desirable from the point of view of efficient operation of the evaporator that there should be no leakage of vapour between adjacent flash chambers through the orifices provided for the passage of the liquid being evaporated.

Such leakage can be avoided by so dimensioning the orifices that the liquid level required to pass the circulated quantity of liquid from one flash chamber to the next covers the upstream side of the orifice joining the two. This liquid level varies however with variations in the load on the evaporator. Thus, on full load operation, the head forcing the liquid through the orifice consists of the static head difference between the liquid levels in the two adjacent flash chambers plus the head resulting from the vapour pressure difference within the two chambers. In contrast, on no load or low load operation, there is substantially no vapour pressure difference from flash chamber to flash chamber, and the pressure drop required to force the liquid through the orifice has to be supplied solely by the difference in static liquid levels upstream and downstream of the orifice.

Generally, the orifices connecting the flash chamber are dimensioned so as to suit full load operation. This has the disadvantage however, that on no load or low load operation (for example, when starting up the evaporator), the difference in the liquid levels from flash chamber to flash chamber increases by the amount of vapour pressure head which is available on full load operation but which is now non-existent. As this effect takes place in each stage, it is cumulative and the liquid level in the high pressure flash chambers may rise to such an extent that excessive carry-over of liquid into the distillate takes place or even that some of the liquid spills over from the flash chambers into the associated heaters and contaminates the distillate.

According to the invention, the lower portion of each chamber is provided with a weir **20** or the equivalent the top of which lies above the openings in the chamber through which heated liquid enters and leaves the chamber. The provision of these weirs in the flash chambers prevents an excessive rise of liquid level in the flash chambers on no load or low load operation. At the same time, the weirs prevent a drop in liquid livel on full load operation to an extent which would otherwise allow vapour to escape from flash chamber to flash chamber.



In order that the invention may be thoroughly understood, an example of an evaporator in accordance with it will now be described with reference to the accompanying drawings, in which:

Figure 1 is a vertical section through a number of flash chambers forming part of a flash-type evaporator;

Figure 2 is a perspective view, with parts broken away, of one of the flash chambers shown in Figure 1; and

Figure 3 is a section similar to Figure 1 showing the lower portions of two of the flash chambers.

The apparatus shown in Figure 1 comprises a number of rectangular flash chambers **10** arranged vertically side by side. Heated liquid which is to be partially evaporated in the chambers enters the first chamber through the pipe **12** and passes from chamber to chamber through orifices **14** in the lower parts of the walls **16**. Outlets **18** are provided in the upper parts of each chamber through which vapour is passed out of the chambers.

As shown in Figures 1 and 2, the lower part of each flash chamber is provided with a weir **20** in the form of a plate which extends across the chamber and is connected thereto at its ends. The tops of these weirs lie above the orifices **14** and serve to control the liquid level in the chambers **10** in the following manner.

For any given operating condition, the liquid level upstream of each orifice **14** adjusts itself so that the difference in static head across the orifice plus the vapour pressure difference on either side of the wall **16** are sufficient to transfer the liquid through the orifice and over the top of the weir **20** lying downstream of the orifice. It is of course possible to dimension each orifice **14** in such a way that the pressure drop required to force the circulated liquid quantity through it is of the same order of magnitude or smaller than the vapour pressure difference available at full load between two adjoining flash chambers **10**. Under such conditions it can be arranged that the static liquid level downstream of the orifice **14** is actually higher than the static liquid level upstream, by the amount by which the said vapour pressure difference is larger than the pressure drop across the orifice. Part of the total head available is then destroyed by the liquid spilling over the top of the weir **20** i.e. quite independently of the energy dissipation in the orifice. This additional energy dissipation in the weir means that the orifice has to be designed larger, i.e. to give a smaller pressure drop than would otherwise be needed, but the weir ensures that the liquid level in the upstream stage still covers the orifice entirely and prevents carry-over of vapour from stage to stage.

Under part load or no load conditions, when the pressure difference from stage to stage is small or absent, the liquid level in the flash chambers starts rising, as described previously. In this case, however, as soon as the liquid level upstream of an orifice **14** has risen above the top of the weir **20** located in the corresponding flash chamber, the energy dissipation across the weir ceases and the whole of the static head difference becomes available to pass the circulated liquid through the orifice **14**, which is now designed to give a smaller pressure drop, as described above. The liquid levels in the chambers on no load operation are shown at **22** in Figure 1. This ensures that the rise in the levels of the liquid in the flash chambers on no load or low load operation is kept well within permissible limits, and is in any case much smaller than what would be possible without the weirs. The liquid levels in the chambers on full load operation are shown at **24** and **26** in Figure 1.

As will be noted from Figure 3, the weirs **20** are arranged close to the chamber walls **30** in such a way that secondary orifices **32** are formed at or near the top of the weirs. It is of course possible, and may in some cases be convenient, to form such secondary orifices with-

out using the walls **30** as part of their boundary. In the embodiment shown, the secondary orifices **32** are made smaller than the primary orifices **14**, and they take over the control of the brine flow from flash chamber to flash chamber. The effect obtained is that the flashing-off process takes place mainly when the liquid is discharged through the secondary orifices **32**, and this causes the heated liquid entering each chamber to be projected upwards through the secondary orifices, which improves the evaporation. Moreover, when the full pressure difference is available across the flash chambers but the quantity of brine circulated through the system is reduced below the full load quantity, a certain amount of vapour may enter the space inside the weirs, i.e. between the primary orifices **14** and the secondary orifices **32**. Such vapour even in very small quantities, considerably decreases the density of the liquid-vapour mixture discharged through the secondary orifice **32**, and this effect, for a given mass flow through the orifice, increases the pressure drop required to project the mixture through the orifice.

The arrangement thus has a stabilising effect on the flow of the heated brine from chamber to chamber, because any vapour loss across the primary orifice **14** causes a considerable increase in the pressure drop required to project a given mass flow across the secondary orifice **32**, and this in turn necessitates a rise in the static liquid level ahead of the primary orifice **14** to produce the necessary increase in pressure drop. This last effect, in turn, reduces the tendency for increased vapour loss across the primary orifices **14** with reduced circulation, while maintaining all the advantages described above regarding the prevention of flooding when the full brine quantity is circulated but there is no pressure drop across the flash chambers.

As already mentioned, the secondary orifices **32** are smaller than the primary orifices **14**. Preferably, the cross-sectional area of the orifices **14** is at least twice that of the orifices **32** so that the pressure drop across the orifice is reduced when brine is circulated through them on starting up the evaporator, i.e. when there is no vapour pressure difference between the flash chambers.

Baffle plates **34** are arranged above the orifices **32** in such a way that the liquid is projected on to them on leaving the secondary orifices. The baffle plates prevent the liquid from being thrown up in large quantities to excessive heights, and they also assist the evaporation by dispersing the particles of liquid.



I claim:

In a flash evaporator, a rectangular fluid-evaporating section defined by a pair of flat side walls, a pair of flat end walls, one of said end walls constituting an upstream end wall, a flat top wall and a flat bottom wall, flat generally rectangular partition walls in said section dividing said section into at least three adjacent rectangular flash chambers arranged in a straight line horizontally and contiguously, said partition walls each extending from one of said side walls to the other of said side walls and from said top wall to said bottom wall, a simple aperture in the lower portion of each one of said partition walls providing communication between adjacent pairs of said flash chambers, and a similar aperture in the lower end of each end wall, a plurality of simple outlet apertures in the upper portion of said flash chambers respectively, said apertures being in one of said side walls of said section, said last-mentioned apertures being located one each in the respective flash chambers, and serving as vapor outlets, a plate-like weir member arranged in each of the lower portions of said flash chambers, said members being disposed adjacent to and downstream of the said apertures in the lower portions of said upstream end wall and said partitions, each weir member comprising a flat vertical lower portion and an inclined upper portion, said upper portion being inclined in upstream direction, baffle means fixed above said weir member to that wall of each chamber which is upstream of said weir member, said baffle means being in the form of a flat plate-like member extending from said last-mentioned wall of said flash chamber at right angles thereto.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 881,523 | Winter | Mar. 10, 1908 |
| 2,693,350 | Ragatz | Nov. 2, 1954 |
| 2,759,882 | Worthen et al. | Aug. 21, 1956 |