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MULTI-STAGE EVAPORATORS HAVING DISTILLAND BY-PASS MEANS

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Fig. 1.

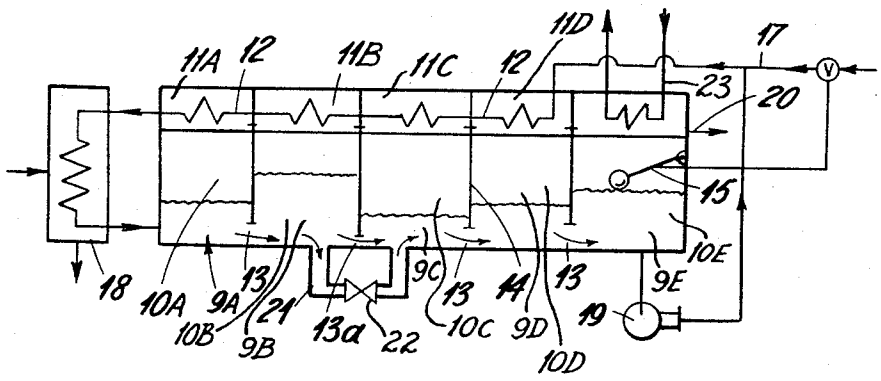
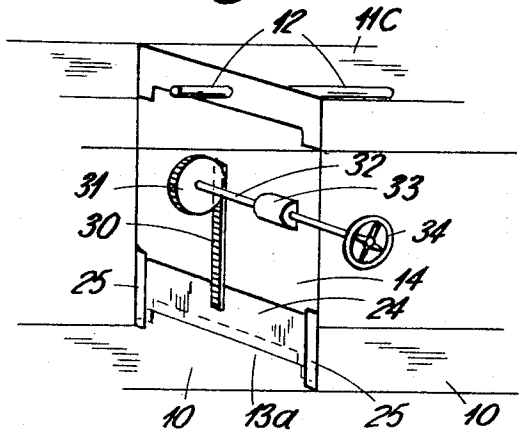


Fig. 2.



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MULTI-STAGE EVAPORATORS HAVING DISTILLAND BY-PASS MEANS

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ABSTRACT OF THE DISCLOSURE

A multi-stage evaporator comprising a succession of stages, a submerged passage between each stage and the succeeding stage to allow a liquid to flow through the stages and, connecting at least one set of two succeeding stages, a by-pass passage, in addition to the aforesaid passage, means being provided for controlling the rate of flow of liquid through the by-pass passage whereby the flow through the evaporator can be increased or decreased.

This invention relates to a multi-stage evaporators in a distillation plant employed, for example, in the production of distilled or potable water from sea-water or brine.

More specifically this invention is related to the control of the flow of liquid through the stages of the evaporator in order to control, for varying throughputs, the liquid levels in the various stages, some such control means being beneficial since it is found that a high rate of flow tends to produce too high a level in at least some stages and that a slow rate of flow may allow the condition which is termed "undersealing."

According to the invention a multi-stage evaporator comprises a succession of stages, a submerged passage or aperture between each stage and the succeeding stage whereby a stream of liquid can flow through the succession of stages, and means for controlling the levels of the liquid in at least some of the stages, which means comprise a by-pass passage connecting two successive stages, in addition to the aforesaid passage or aperture between the two stages, and means for controlling the rate of flow of liquid through the by-pass passage.

In one form of the invention the rate of flow through the by-pass passage is controlled by an adjustable valve.

In another form of the invention the rate of flow through the by-pass passage is controlled by interchangeable members within the by-pass, each member having a different size or orifice.

The evaporator is preferably a flash evaporator.

The or each opening provided by the passage or aperture between each stage and the preceding stage of the evaporator for allowing the fluid to flow through the succession of stages of the evaporator, may be fixed or may be adjustable.

An evaporator in accordance with the invention allows a faster rate of flow at least between two of the evaporator stages than is possible with a similar evaporator which is not provided with the by-pass passage. Furthermore, the range of the rate of flow can be still further increased by reducing the size of the passage or aperture between the stages having the by-pass passage whereby, with the by-pass passage closed, the rate of flow would be slower than would otherwise be the case.

A by-pass passage may be provided between more than one set of two successive stages.

By way of example, a specific embodiment of a multi-stage evaporator in accordance with the invention will now be described with reference to the accompanying

diagrammatic drawings in which:

FIGURE 1 is a layout of the evaporator; and

FIGURE 2 is a perspective view of the dividing wall between two stages of the evaporator shown in FIGURE 1 to show means for adjusting the size of the orifice therein.

With reference to the drawings, the evaporator is a flash evaporator and comprises five stages **9A** through **9E**, each stage having a lower associated portion **10A** through **10E** through which a stream of brine is fed and in which a part of the brine is flashed off, the steam evolved passing into their respective upper portions **11A** through **11E** in which portion the steam condenses on a condensing surface **12** to form a distillate. The part of the brine which is not flashed off passes into the succeeding stage through an associated orifice **13** or **13***a* in the wall **14** which divides the two stages.

It is normal that the sizes of the orifices **13**, **13***a* determine the level of the brine in the stages of the evaporator and it is desirable that the size of each orifice **13**, **13***a* should be progressively greater than the preceding orifice (although, in practice, such increases are normally carried out in steps, there being a number of stages between each increase in the size of the orifice). A level controller, shown in FIGURE 1 as a ball-cock **15**, is also provided in the last stage of the evaporator to assist in the control of the level of the brine.

Brine is fed into the evaporator at **17**, the brine then passing through a number of tubes, which comprise the aforesaid condensing surface **12** of each stage, to a heater **18** and then to the lower portion **10A** of the first stage of the evaporator. A pump **19** is provided for returning the brine that is not flashed off in any of the stages of the evaporator into the evaporator feed. The distillate is discharged at point **20**. Also, the steam evolved in the last stage **9E** of the evaporator is condensed on a condensing surface **23** cooled by a fluid which is independent of the evaporator feed.

The level of the brine in the stages of the evaporator has been described above as being dependent on the sizes of the orifices **13**, **13***a* and the level controller **15**. The evaporator shown in FIGURE 1, however, also has a by-pass passage **21** between the second and third stages, **9B**, **9C**, respectively, which passage **21** is provided with means **22** for controlling the rate of flow therethrough. The means **22**, in this example is an adjustable valve but it could comprise a set of plates for insertion into the passage, each plate having an orifice therein of a different size except one plate which has no orifice and comprises a blanking-off plate.

In addition, the orifice **13***a* in the wall **14** dividing the second stage **9B** and the third stage **9C** is of a smaller size than would normally be employed. Thereby, when the by-pass valve **22** is shut-off, the level of the brine in at least the preceding stage, is greater than would otherwise be the case. Similarly when the valve **22** is fully open, the level of the brine in at least the preceding stage **9B** is less than for an evaporator that is not provided with the by-pass passage **21** and that has the orifice **13***a* between the second and third stages of normal size. The size of the orifice **13***a* may be fixed or, as shown in FIGURE 2, may be adjustable by means of vertical adjustment of a plate **24** within the guideways **25**. The vertical position of this plate **24** may be adjusted by means of a vertical rack **30** upstanding from the plate, and a pinion **31** in mesh with the rack, the pinion being mounted on a shaft **32** which passes through a bearing **33** fixed to the respective wall **14**, and projects out of the lower portion **10**. A wheel **34** is fitted to the free end of the shaft **32** to cause rotation of the pinion **31** and hence vertical movement of the rack **30** and the plate **34**.

The levels of the brine in the various stages **9A** through **9E**, as shown in FIGURE 1, are appropriate for an evapo-

rator in which the valve **22** is in a substantially shut-off position, i.e., the rate of flow between the second stage **9B** and the third stage **9C** is reduced. It is estimated that if the size of the orifice **13***a* in the dividing wall **14** between the second and third stages is, or is adjusted so that it is, 15% smaller than would normally be the case and if the by-pass passage **21** is capable of passing 30% of the flow between these stages **9B**, **9C**, then operation of the control means **22** enables a depth control corresponding to a flow control of 15% above and below the range of depth control of an evaporator that is not provided with the by-pass passage **21** and that is not provided with the smaller orifice **13***a*.

The invention is not restricted to the specific details of the evaporator described above. For example, the sizes of some or each of the orifices **13** may be adjustable. Also, in the case of an evaporator having five stages **9A** through **9E**, as shown in FIGURE 1, a by-pass passage between the second stage **9B** and the third stage **9C** in addition to the level controller (with or without the orifices being adjustable), is sufficient to provide the necessary control to the depth of the brine in the five stages. However, when more stages are added it may be necessary to provide one or more additional by-pass passages between other pairs of stages.

I claim:

1. A multi-stage evaporator comprising a shell, a plurality of spaced, upright partitions within said shell thereby forming a succession of evaporator stages, each of said partitions at their bottom ends having an aperture extending across the full length thereof to permit a stream of liquid to flow from each said stage to its succeeding stage, at least one open-ended by-pass conduit attached to the bottom of said shell directly beneath at least one of said partitions with an end of said conduit positioned on either side thereof for connecting at least one of said stages to a succeeding stage and, means in said at least one conduit for controlling the flow rate of fluid therethrough, whereby a difference in levels of liquid between the stages connected by said conduit can be controlled.

2. An evaporator according to claim **1**, wherein said control means comprises an adjustable valve.

3. An evaporator according to claim **1**, wherein said control means comprises a plate having an orifice therein of a size depending on the specific rate of flow desired through said conduit.

4. An evaporator according to claim **1**, further including means for adjusting the size of one of said partitioned apertures.

5. An evaporator according to claim **1**, wherein two open-ended by-pass conduits attached to the bottom of said shell are provided.

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202—180, 181; 203—1, 11, 73, 88