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HEATER FOR MULTIPLE EFFECT EVAPORATORS

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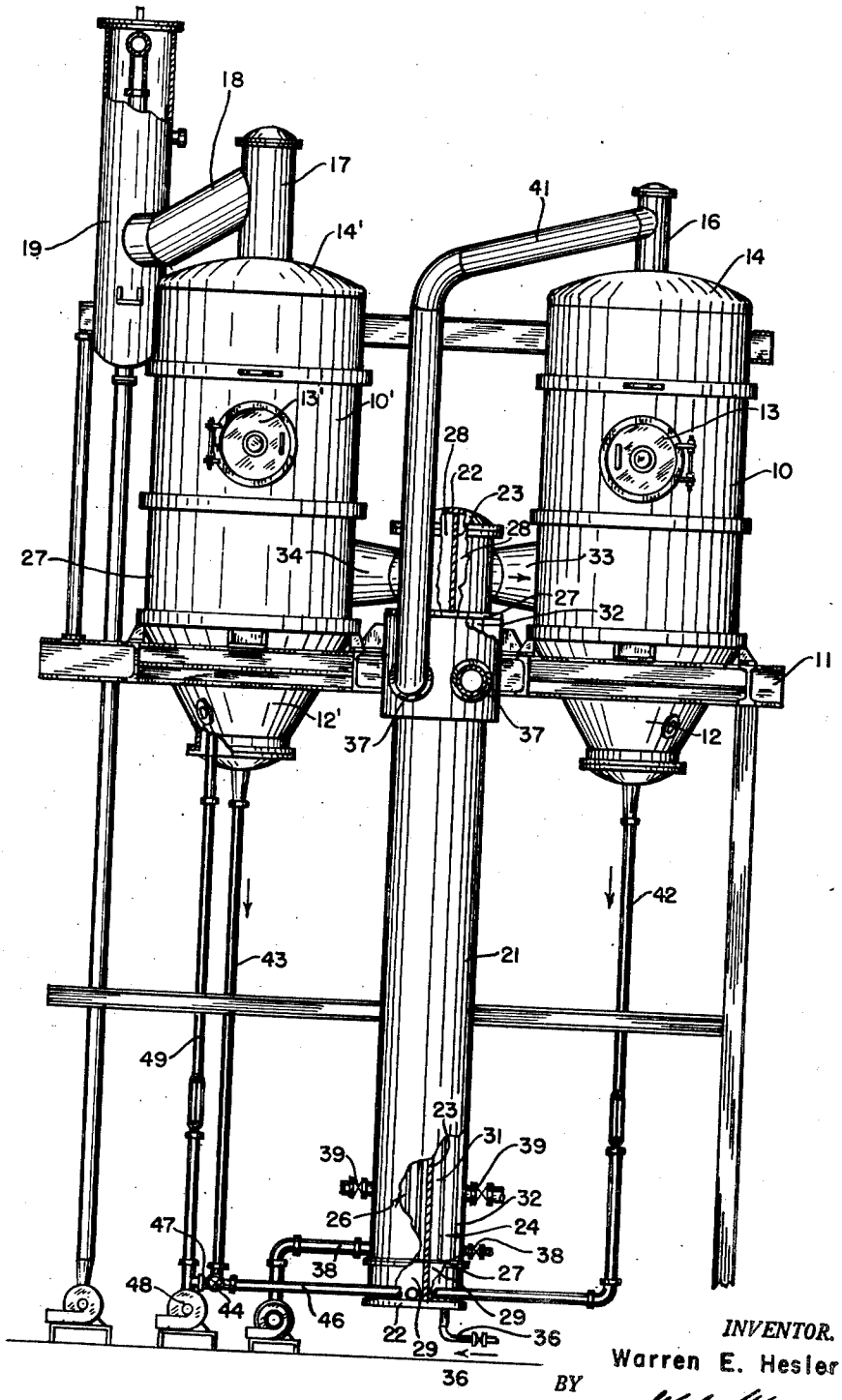


FIG. — 1

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HEATER FOR MULTIPLE EFFECT EVAPORATORS

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3 Claims. (Cl. 159—27)

My invention is directed to an improved liquid heater for use with a plurality of evaporator bodies connected in series.

Conventionally each evaporator body is provided with a cylindrical heater containing a bundle of tubes for conducting the liquid to be heated through the heater and supplied with heat through the medium of steam or other condensable vapor. Despite the use of good insulation, an appreciably quantity of heat escapes from the external walls of these heaters. In addition, they occupy considerable space which is frequently made available only with great difficulty.

One of the principal objects of my invention is to provide a single heater adapted for serving a plurality of evaporators, the said heater being more compact than the conventional cylindrical type heaters and having a reduced external surface area from which heat may be dissipated.

Other objects, which include the provision of improved liquid cycling means, will be disclosed in the following description and in the appended drawing, in which:

Fig. 1 is a partially broken away elevation showing my heater applied to a double effect evaporator.

For purposes of illustration, I have elected to disclose my invention as applied to a double effect evaporator; but as subsequently explained, similar heaters suitable for use with three or more evaporator bodies may be constructed within the teachings of my invention.

Evaporator bodies **10**—**10′** of conventional design are supported in elevated position on a suitable frame **11** and are provided with inverted cone-shaped bottoms **12**—**12′** and access doors **13**—**13′**. Bodies **10**—**10′** are sealed by domes **14**—**14′**, the dome **14** having a vapor outlet **16**, and the dome **14′** having a vapor outlet **17**. The vapor outlet **17** is connected by a conduit **18** with a condenser **19** conventional design.

An upright cylindrical heater shell **21** is secured near its upper end to the frame **11** and is sealed at each end by end members **22**. An upright imperforate partition **23** is sealed within the shell **21** and divides the interior of the shell into a first chamber **24** and a second chamber **26**. Transverse tube plates **27** are sealed transversely within the shell **21**, extending through the partition **23** and are spaced from the ends **22**, as well as from each other, thus defining in each of the chambers **24** and **26** an upper liquid zone **28** and a lower liquid zone **29** separated by a steam zone **31**. A plurality of tubes **32** are provided in each of the chambers **24** and **26**, extending through the tube plates **27** and interconnecting the upper and lower liquid zones **28** and **29**.

The upper liquid zone **28** of the chamber **24** communicates with the evaporator body **10** through a conduit **33** and the upper liquid zone of the chamber **26** with the evaporator **10′** through a conduit **34**. A liquid inlet **36** is provided for the lower liquid zone **29** of the chamber **24**. Each of the steam zones **31** is provided with a vapor inlet **37** near the upper tube plate **27**, a condensate outlet **38** near the lower tube plate **27**, and a non-condensable gas outlet **39** above the condensate outlets **38**. Vapor from the vapor outlet **16** on the evaporator **10** is conveyed by a pipe **41** to the steam inlet **37** for the chamber **26**. A pipe **42** conveys liquid from the evaporator body **10** to the lower liquid zone **29** of the chamber **26**. Liquid is discharged from the second evaporator body **10′** through a pipe **43** communicating with a distributing valve **44** adapted to discharge liquid into the lower liquid zone **29** of the chamber **26**

through a conduit **46**, or through a conduit **47** to the inlet of a pump **48**. The conduit **47** communicates with a pipe **49** which extends upwardly through the conical bottom **12′** of the evaporator body **10′** and into the evaporator body, terminating some distance above the mouth of the pipe **43**.

In operation, the liquid to be evaporated, such as milk, is introduced into the system through the inlet **36**, filling the lower liquid zone **29** of the chamber **24** and passing upwardly through the pipes **32** into the upper liquid zone **28** of the same chamber, thence into the evaporator body **10** via the conduit **33**. Steam or other condensable vapor is passed into the steam zone **31** of the chamber **24** through the inlet **37**, where it is condensed and subsequently discharged through the condensate outlet **38**. Any non-condensable gas accumulating in the steam zone **31** is vented through the gas outlet **39**. Evaporation occurs in the evaporator body **10**, the partially concentrated liquid being conveyed by the pipe **42** to the lower liquid zone **29** of the chamber **26** from which it passes upwardly through the pipes **32** and the conduit **34** into the evaporator body **10′**. The vapor generated by the evaporation of the liquid in the evaporator body **10** escapes through the pipe **41** and is discharged into the steam zone **31** of the second chamber **26**, where it is condensed and discharged through the outlet **38**. Further evaporation occurs in the body **10′**, the vapors so generated being condensed by the condenser **19** in order to maintain a high vacuum in the system. The pump **48** is employed for drawing liquid from the evaporator body **10′**; and by regulation of the distributing valve **44** a portion of the liquid discharged from the body **10′** may be recycled through the chamber **26**. The portion of the liquid not recycled through the conduit **46** is discharged from the system through the pump **48**. In operation there should be a constant flow of liquid through the conduits **43** and **46**, this being blocked by the valve **44** only when it is desired to drain the system completely.

The external walls of the shell **21** are provided with insulation, but the partition **23**, which divides the shell **21** into the chambers **24** and **26**, is not insulated. Thus, a certain amount of heat can pass through the partition **23** between the chambers **24** and **26** and is not lost to the atmosphere. The total external surface of the shell **21** is less than the exposed surface necessarily provided where separate cylindrical heaters are employed for heating the liquid flowing to the evaporators **10** and **10′**. There is, therefore, a substantial savings in the amount of heat normally lost in operation. It is also obvious that the heater is considerably more compact and therefore requires substantially less floor area than would be required by separate cylindrical heaters.

It is not necessary that the partition **23** divide the heater into only two chambers, since it is obvious that by rearrangement and the addition of one or more other partitions the interior of the shell may be divided to form practically any desired number of chambers. Usually it is not economical to divide the shell into more than four chambers, but as the number of chambers increases, the exposed or external wall area for each chamber is reduced, and therefore somewhat improved heat economy will be realized. To a somewhat lesser extent similar economy can be effected by combining the two evaporators **10** and **10′** into a single body separated by a common partition or partitions.

Utilization of the distribution valve **44** permits recycling of liquid through the second or one of the later stages of evaporation and the corresponding heater chamber in any desired degree, thus insuring that the flow of liquid through such stage will be such as to obtain the most desirable coefficient of heat transfer. Since it is frequently very desirable to hold the temperature differential between the liquid and the heating fluid to low limits in the final stage or stages, the liquid capacity of this portion of the system is often greater than that of the preceding stages.

There are several minor modifications which may be made in the apparatus described, as for example, the discharge of condensate from the first heater stage to the second heater stage, where it partially flashes to

vapor due to pressure differential, or the similar transfer between these stages of non-condensable gases which may be metered through a small orifice.

From the foregoing it is apparent that my heater will provide the same heating capacity as separate corresponding heaters, but that the efficiency from a fuel consumption standpoint will be greater. By employing less material, the cost of my heater, as well as the cost of the supporting structure, will be reduced.

In addition the cost of maintenance is reduced since the opening of a single cover exposes the tubes of both heaters for mechanical cleaning where in certain industries, such as milk concentration, must be performed daily.

I claim:

1. A heater for use with two evaporator bodies in series comprising an upright cylindrical shell having end closures, an upright imperforate partition in the shell sealed at its sides and ends to the shell and closures respectively and defining isolated first and second chambers side by side, transverse plates sealed in the shell spaced from each other and from said closures defining in each of said chambers an upper liquid zone and a lower liquid zone separated by an intervening vapor zone, a plurality of tubes in each of the chambers interconnecting the respective upper and lower liquid zones thereof and extending through the vapor zone of said chamber, a vapor inlet and a liquid outlet for each vapor zone, a liquid inlet for each of the lower liquid zones, and a liquid outlet for each of the upper liquid zones, said liquid inlets and outlets cooperating with the tubes extending through the respective chambers to define wholly separate liquid flow paths on opposite sides of said upright partition.

2. A heater for multiple effect evaporators and the like comprising an upright generally cylindrical shell, upper and lower covers sealing the ends of the shell, an upright imperforate partition extending throughout the shell generally parallel to the major axis thereof, sealed to the shell wall and to said upper and lower covers and defining therewith a pair of chambers, spaced transverse plates in the shell dividing said chambers into four end

liquid zones separated by two intermediate vapor zones, each vapor zone having a vapor inlet and a condensate outlet, a plurality of tubes in each of the vapor zones interconnecting the upper and lower liquid zones of each chamber, a liquid inlet for each of the lower liquid zones and a liquid outlet for each of the upper liquid zones, one of said liquid inlets and one of said liquid outlets cooperating with the tubes interconnecting the upper and lower liquid zones containing said liquid inlet and liquid outlet to define a continuous path of liquid flow through one chamber wholly independent of a similar path of liquid flow through the other chamber.

3. A heater comprising an elongated hollow shell, end members sealing the ends of the shell, an imperforate partition extending through the shell generally parallel to the longer dimension of the shell sealed to the shell wall and end members and dividing the shell into independent side by side chambers, spaced transverse plates in the shell sealed to the shell wall dividing each of said chambers into two opposite end liquid zones separated by a single heating vapor zone, separate tubes extending through each of said heating vapor zones and interconnecting the liquid end zones of the chamber on the corresponding side of said partition, a vapor inlet and a condensate outlet for each vapor zone, and a liquid port in each of the liquid zones, said ports of the liquid zones on each side of said partition cooperating with the corresponding tubes to define an independent path of liquid flow through the shell.

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