

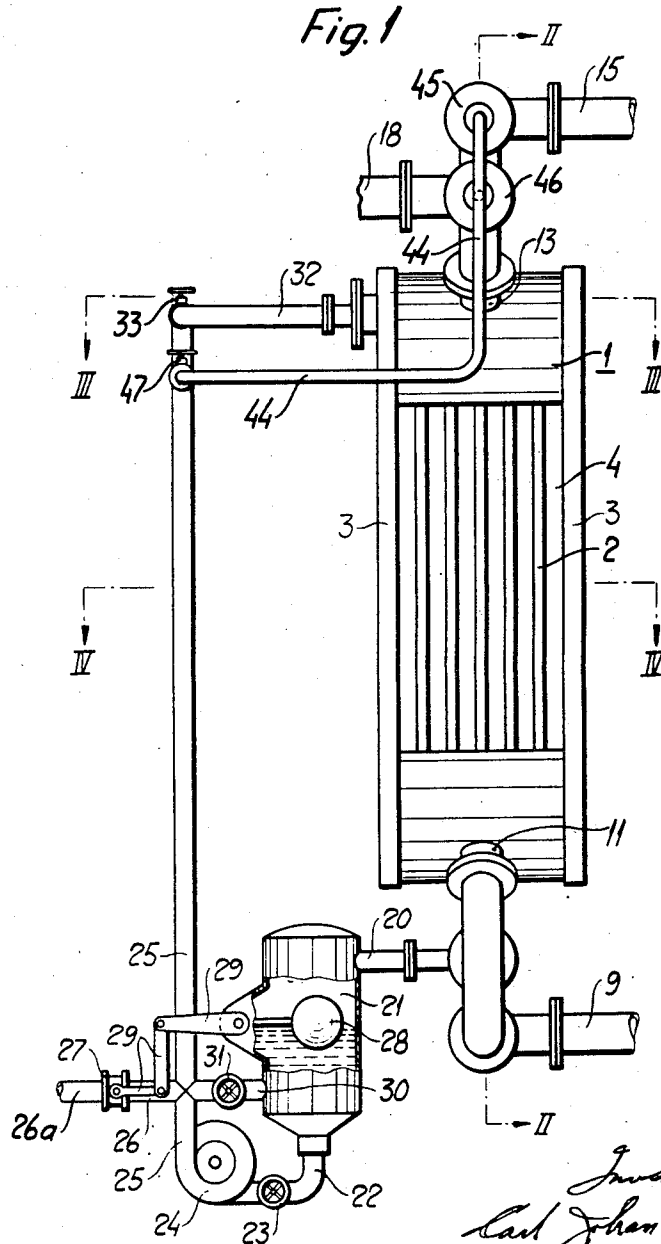
April 9, 1957

C. J. LOCKMAN
SURFACE TYPE EVAPORATOR EMPLOYING CHANNEL
SWITCHING FOR CLEANING PURPOSES

2,788,065

Filed Aug. 14, 1950

4 Sheets-Sheet 1



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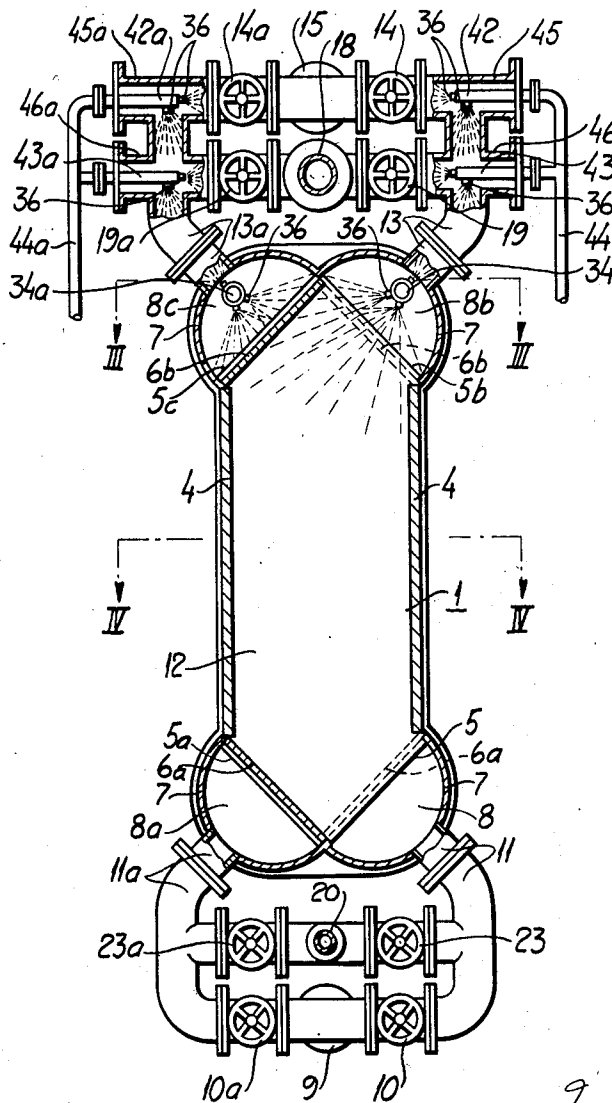
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Fig. 2



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Fig. 3

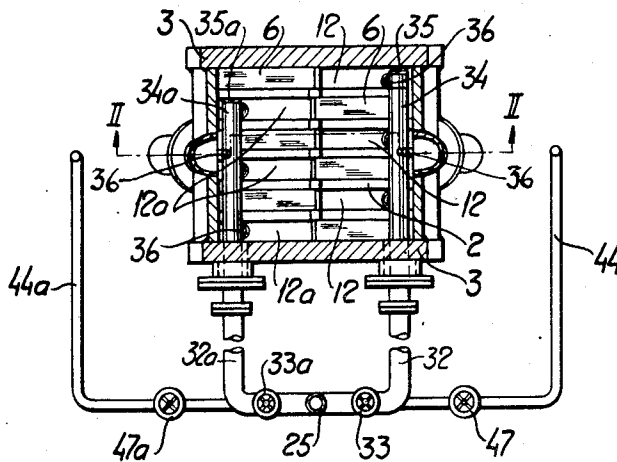
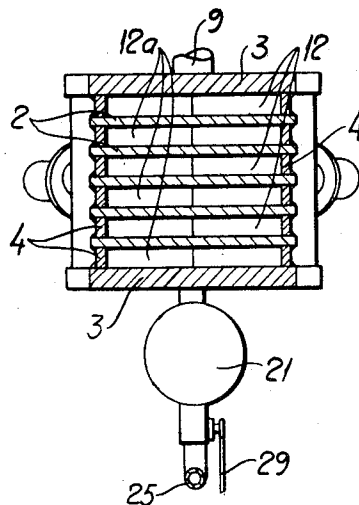


Fig. 4



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Fig. 5

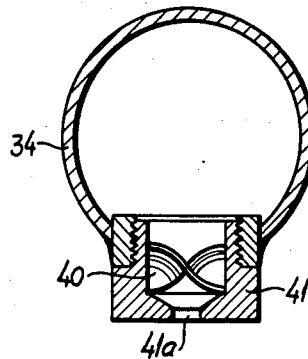
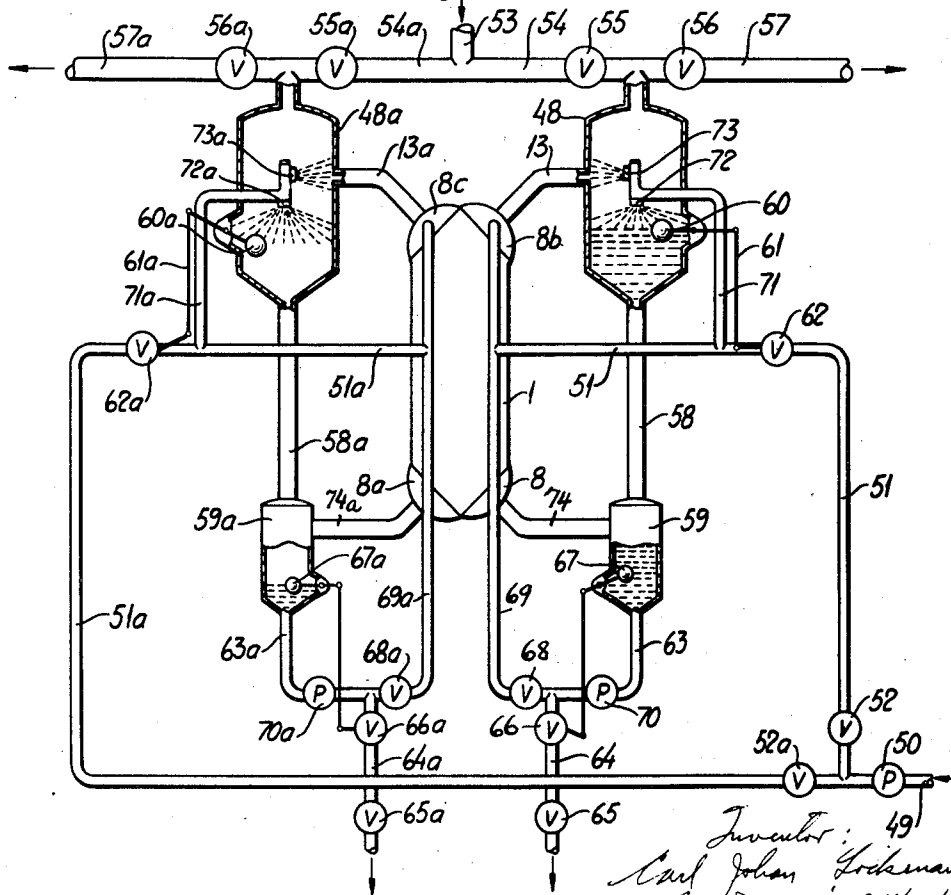


Fig. 6



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SURFACE TYPE EVAPORATOR EMPLOYING CHANNEL SWITCHING FOR CLEANING PURPOSES

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Application August 14, 1950, Serial No. 179,256

2 Claims. (Cl. 159—20)

This invention relates to heat exchange apparatus of the surface type for heating, evaporating and like purposes and to a method of operating the same, and is a continuation-in-part of my copending application Serial No. 22,215 filed April 20, 1948, now Patent No. 2,576,843.

More particularly the invention has for its object to provide an apparatus of this kind having separate passages for conducting a vaporous heating medium and scale forming liquid in heat exchange relation, and in which the paths of the different fluids may be interchanged periodically during the operation in order that at least the substantial portion of any scale precipitated from the liquid on the walls of the liquid-conveying passages during a given period may be removed by the dissolving action of the vapors and more particularly of their condensate formed on the heating surfaces when the vapors are passed through the same passages during the succeeding period.

This method of removing scale by passing each of the fluids alternatively through the different passages is obviously very expedient since it may be performed in practice without stopping the operation and the interchanging of the passages may be effected at shorter or longer intervals as desired in the actual case without disturbing the continuance of operation so that the cleaning may be timed to set in when the scale deposits are still very moderate and relatively easy to dissolve.

For an effective cleaning action it is necessary to insure the flow of a sufficient volume of condensate over the whole scale-contaminated passage walls. If however steam is caused to condense on a more or less vertical heating surface, the highest part of said surface will be flooded only by condensate deposited on that part directly, while the lower part of the surface will be flooded not only by the condensate directly deposited thereon but also by the accumulated condensate running down from the higher parts. Consequently, in case of relatively resistant scale deposits the cleaning action on the heating surface will be insufficient in and adjacent to its highest zone but may be more or less acceptable in its central zone and rather satisfactory in and adjacent to its lowest zone. In this case, however, the practical value of the cleaning method is reduced to a great extent because the incompletely removed scale deposits will increase continually and sooner or later necessitate taking the apparatus out of operation for a more thorough cleaning by chemical or mechanical means and this will involve substantial excess cost.

It is an object of the invention to provide means for recirculating and distributing accumulated condensate, withdrawn from the heating surface, over the highest zone of said surface so as to supply to all parts of said heating surface a quantity of condensate sufficient for efficient cleaning.

In practice it has moreover been found that not only the heating surfaces but also other parts, such as conduits,

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switching valves and flash chambers, which may be connected to the heat exchanger, are liable to be contaminated by scale in contact with heated scale forming liquid.

5 A further object of the invention is to eliminate these drawbacks by causing circulating condensate to clean the said parts of the system exposed to the scale-contaminating action of the scale forming liquid.

10 Another object of the invention is to provide means for distributing circulated condensate in a sub-divided state, for instance by means of spraying nozzles, in order to facilitate flooding and wetting of the passage walls and other parts contaminated by scales from the liquid.

A still further object of the invention is to circulate 15 the condensate in quantities substantially exceeding the quantity formed by new condensation.

Still further objects will be apparent from the following description.

20 One embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a plant with a heat exchanger having means for circulating condensate.

25 Figure 2 is a section of the same heat exchanger taken along the line II—II in Figure 1, with inlets and outlets for the two heat exchanging fluids.

Figure 3 is a section of the heat exchanger taken along the line III—III in Figure 1,

Figure 4 is a section of the heat exchanger taken along the line IV—IV in Figure 1,

30 Figure 5 is a cross section of one embodiment of a nozzle for distributing the condensate, and

Figure 6 is a diagrammatical view illustrating a modification of the heat exchanging plant.

35 In all figures the same reference characters refer to the same parts.

The heat exchanger 1 comprises a plurality of parallel heat transmitting walls 2 of metal sheet and spaced at equal distances between two side plates 3. Together with the plates 3 and strips 4 the walls 2 form a system 40 of equally shaped parallel and vertical channels 12 and 12a. Above and beneath the ends of the strips 4 the walls 2 are extended in a V-shaped configuration so that at the top and the bottom the walls terminate in oblique edges 5, 5a, 5b and 5c, respectively. Each channel, for example channel 12, is closed along one of its oblique bottom edges, for instance the left one 5a, by means of a strip 6a, and in the same manner, the same channel is closed along one of its top edges, for instance likewise the left one, 5c by means of a strip 6b, although, instead, 50 the right top edge 5b may be closed if desired. The adjacent channels 12a are closed along the remaining bottom and top edges 5, 5b, respectively. In this manner alternate channels will be open to alternate sides, and there are thus formed two groups of channels, one group being open to one side, for instance the left one, and the other group being open to the other side, for instance the right one. Covers 7, at both sides closed by the extended side plates 3, enclose chambers 8, 8a, 8b, 8c, at the bottom and the top of the channels 12, 12a. The left-hand chambers 8a, 8c connect the channels 12a of the group open to the left while the right-hand chambers 8, 8b connect the channels 12 of the group open to the right. It is also clearly seen that the right-hand bottom chamber 8 communicates with the right-hand top chamber 8b through the channels 12 and that the left-hand bottom chamber 8a communicates with the left-hand top chamber 8c through the channels 12a.

65 The scale forming liquid to be heated may be introduced into the exchanger through a conduit 9, a valve 10 and an intake 11 and then passes through the channels 12 whereupon it is withdrawn through the conduit 13, acting as an outlet, a pipe 45, a valve 14 and a conduit

15. A vaporous heating medium may be introduced through a conduit 18, a valve 19a, a pipe 46a and an intake 13a into the channels 12a. From the channels 12a condensate may be withdrawn through the outlet 11a, a valve 23a, a conduit 20, a float chamber or vessel 21, a conduit 22, a valve 23, a pump 24, conduits 25, 26 and a discharge conduit 26a controlled by a throttle valve 27. The valve 27 is operated from the float 28 by means of a link system 29 so that the valve 27 will close when the level of the condensate in the vessel 21 sinks while the valve will open when the said condensate level rises. From the vessel 21 condensate may also be passed to the conduit 26 directly through a by-pass conduit 30 and a valve 31.

Alternately, the paths of flow of the heated and heating media passing through the heat exchanger may be interchanged so that the liquid will be introduced to the channels 12a through the valve 10a and withdrawn from said channels through the intake 13a, pipe 45a and valve 14a, while the vaporous heating medium will be introduced into the channels 12 through the valve 19, pipe 46 and conduit 13, acting as an inlet, the condensate formed being withdrawn through the valve 23. Interchanging of the passages may be effected periodically so that channels which are conveying liquid during a given period will be conveying vapor during the next period.

Condensate withdrawn from the heat exchanger is passed in circulation through the pump 24, conduits 25, 32 and valve 33 or through conduit 32a and valve 33a into a condensate distributing pipe 34 or 34a, respectively. The valves 33, 33a are set so as to supply the condensate to that one of the pipes 34, 34a which is arranged in the top chamber 8a or 8c conveying the heating medium. The condensate distributing pipes are closed at their ends 35 and 35a, respectively, and provided with a number of nozzles 36 adapted to spread the condensate over the whole top part of the heating surfaces of the channels. Thus, during a given period condensate will be flooded over said surfaces of the channels 12 conveying the heating medium, so as to remove scale therefrom precipitated from the liquid during the preceding period when said channels were conveying liquid. Owing to the fact that the channels are directed vertically and their heating surfaces likewise are vertical and since the heating surfaces have a substantially uniform width from the top to the bottom, the condensate distributed over the top part of the surfaces will continue to flood all remaining parts of the heating surfaces while flowing downwardly, so that the whole surfaces will be cleaned completely and very effectively.

One embodiment of the nozzle is shown as an example in Figure 5. The nozzle mainly consists of an insert 41 having internal screw-like guiding surfaces 40 which spread the condensate stream into a fine more or less conical spray projected through an aperture 41a. The nozzle insert 41 is threaded into the condensate distributing conduit here shown as the conduit 34. Of course, the nozzle may be constructed in many other ways without departing from the scope of the invention.

In many cases scale will deposit not only on the heating surfaces but also at other parts in contact with the scale forming liquid. Such parts are the valves and conduits at the top and bottom inlet and outlet end of the heat exchanger. Scale adhering to the valve stems for instance, may render the valves inoperative or prevent them from being closed tightly, and as a result thereof, there may arise a leakage of heating vapor to the liquid side of the system, such leakage being very detrimental to the operation of the apparatus. A continuously growing layer of scale on the walls of the conduits will soon reduce the cross-sectional area of the conduits so that the pressure necessary to force the fluids therethrough will increase to a considerable degree. It will be understood that, for instance in the case of an evaporator com-

prising several evaporating stages with heat exchangers of the type now described, the capacity of such an evaporator will decrease considerably if the drop in pressure necessary for forcing the vapor from one stage to the other is allowed to increase to any considerable degree.

The valves and conduits at the bottom end of the heat exchanger are thoroughly cleaned by the withdrawn condensate.

With the object of cleaning said valves and conduits at the top end of the heat exchanger there is provided conduits 44, 44a, branching off from the conduit 25 and communicating with distributing pipes 42, 42a, 43, 43a projecting into pipes 45, 45a, 46, 46a, respectively, and provided with nozzles 36 for spraying condensate in said pipes and on the valves 14, 14a, 19, 19a. Each conduit 44, 44a has a valve 47, 47a, respectively, so that the condensate may be conveyed through one or the other of said conduits as desired. Nozzles 36 are also provided for spraying condensate into the inlet and outlet pipings 13, 13a so as to clean scale from them. In the same manner, similar nozzles may be provided for spraying condensate on any part of the system contaminated by scales from the liquid.

In some cases it may be of advantage to circulate a quantity of condensate in excess of the quantity formed by new condensation in the heat exchanger. Thus, in starting the operation of the heat exchanger the condensate will be circulated and withdrawal of condensate will occur automatically as soon as the total quantity of the condensate is sufficient for causing the float 28 to open the valve 27.

Figure 6 illustrates a plant for evaporation of scale forming liquid with a heat exchanger 1 associated with flash chambers or steam separators 48, 48a for separating vapor from the liquid heated in said heat exchanger. The liquid to be heated is supplied through a conduit 49 by means of a pump 50 and may then be conveyed through either of the conduits 51, 51a into the heat exchanger 1 directly to the top of the heat exchanger through either of the conduits 69, 69a and indirectly to the bottom of the heat exchanger through either of the conduits 71, 71a, flash chambers 48, 48a conduits 58, 58a and float chambers 59, 59a and conduits 74, 74a. Control valves 52, 52a are provided in the conduits 51, 51a respectively, for interchanging the paths of the liquid. Heating vapor is supplied to the heat exchanger from a conduit 53, through a control valve 55 or 55a in a conduit 54 or 54a, respectively, through the flash chamber 48 or 48a and the pipe 13 or 13a leading into the chamber 8b, 8c respectively, of the heat exchanger. The liquid heated and vaporized in the heat exchanger is withdrawn therefrom through the pipe 13 or 13a and introduced into the flash chamber 48 or 48a in which the vapor is separated from the heated liquid and escapes through a valve 56, 56a, respectively. The liquid collected in the chamber 48 or 48a is recirculated through a pipe 53 or 58a, a float chamber 59 or 59a, conduits 74 or 74a, and introduced into the bottom chamber 8 or 8a of the heat exchanger.

In the position shown in Fig. 6 the liquid circulates through the path 13, 48, 58, 59 and heating vapor is supplied through the path 54a, 55a, 48a, 13a and condensate is withdrawn from the chamber 8a to the float chamber 59a acting substantially in the same manner as the float chamber 21 shown in Figure 1. During the cycle of operation now described the float chamber 59 is filled with liquid and the liquid level in the flash chamber 48 is sufficiently high to actuate the float 60, which by means of a link system 61 operates a valve 62 so that the supply of liquid to be heated in the heat exchanger will be controlled automatically in dependence of the level in the chamber 48. A desired quantity of heat treated liquid is withdrawn from the float chamber 59 through pipes 63, 64 controlled by a valve 65. The valve 66 operated by the float 67 in the chamber 59

is open and a valve 68 in a circulation conduit 69 is closed.

The condensate in the chamber 59a is circulated through a pump 70a, the open valve 68a and the conduit 69a, the valve 52a being closed so that part of the condensate is reintroduced at the top of the heat exchanger through the chamber 8c, while part of the condensate is introduced into the flash chamber 48a through conduit 71a and the spray nozzles 72a, 73a adapted to spray condensate into the pipe 13a and on the walls of the flash chamber 48a so as to dissolve any scales precipitated thereon. In the same manner similar nozzles may be provided to spray condensate on other parts contaminated by scales.

During the cycle of operation now described condensate will be discharged from the system through the valve 66a (controlled by the float 67a), conduit 64a and the open valve 65a.

The liquid is supplied to the system from the conduit 51 partly through the conduit 69 and the nozzles 36 in chamber 8b and partly through the conduit 71 and the nozzles 72, 73. This continuous passing of liquid through the condensate circulation conduits and nozzles prevent them from being clogged by solidifying liquor otherwise left therein during the cycle in which said conduits and nozzles do not convey condensate.

It should be understood that on interchanging the path of the heating vapor and the liquid to be heated the flash chamber 48 will instead be sprayed with the circulating condensate, and a portion of the liquid to be heated will now be supplied to chamber 48a through pipe 71a and nozzles 72a, 73a, thus preventing the latter from being clogged.

What I claim is:

1. In a heat exchange system having a heat exchanger apparatus with two passages for conducting a vaporous heating medium and a scale forming liquid in heat exchange relation, two separators each being connected to one of said passages respectively, each of said passages having an inlet and an outlet, a valved inlet connection for selectively conducting said heating medium to one or the other of said passages, a valved outlet connection for selectively discharging condensate from said heating medium from one or the other of said passages, a valved inlet connection for selectively conducting said scale forming liquid to the other or the one of said passages, outlet connections for discharging heated liquid and flash vapor from the other or the one of said passages into the respective separator chambers connected thereto, said valved inlet and outlet connections for said heating medium and said condensate and said valved inlet connection for said liquid being operable for interchanging the paths of flow of said heating medium and said liquid through said passages, draining means for receiving condensate discharged from one or the other

of said passages, means for selectively circulating condensate from said draining means to the corresponding one or the other of said separator chambers and means for distributing such condensate on the internal walls of said corresponding chamber.

2. In a heat exchange system having a heat exchange apparatus providing two different passages for conducting a vaporous heating medium and a scale forming liquid in heat exchange relation, a supply conduit for scale forming liquid, a liquid supply connection between said supply conduit and each passage, valve means in each liquid supply connection, a discharge conduit for scale forming liquid, a liquid discharge connection between each passage and said discharge conduit, valve means in each liquid discharge connection, a supply conduit for vaporous heating medium, a heating medium supply connection between said heating medium supply conduit and each passage, valve means in each heating medium supply connection, a heating medium condensate discharge conduit, a condensate discharge connection between each passage and said condensate discharge conduit, valve means in each condensate discharge connection, a draining device connected to said condensate discharge conduit for receiving condensate therefrom, all of the above mentioned valve means being operable to selectively supply scale forming liquid to one or the other of said passages and heating medium to the other or the one of said passages, and to discharge concentrated liquid from one or the other of said passages and discharge condensate from the other or the one of said passages and means to circulate condensate from said draining device only over the walls of the other of said passages and the liquid discharge valve and heating medium supply valve connected thereto during the present cycle of operation and only over the walls of the one of said passages and the liquid discharge valve and heating medium supply valve connected thereto during the next succeeding cycle of operation to dissolve scale deposited in said system by said liquid.

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