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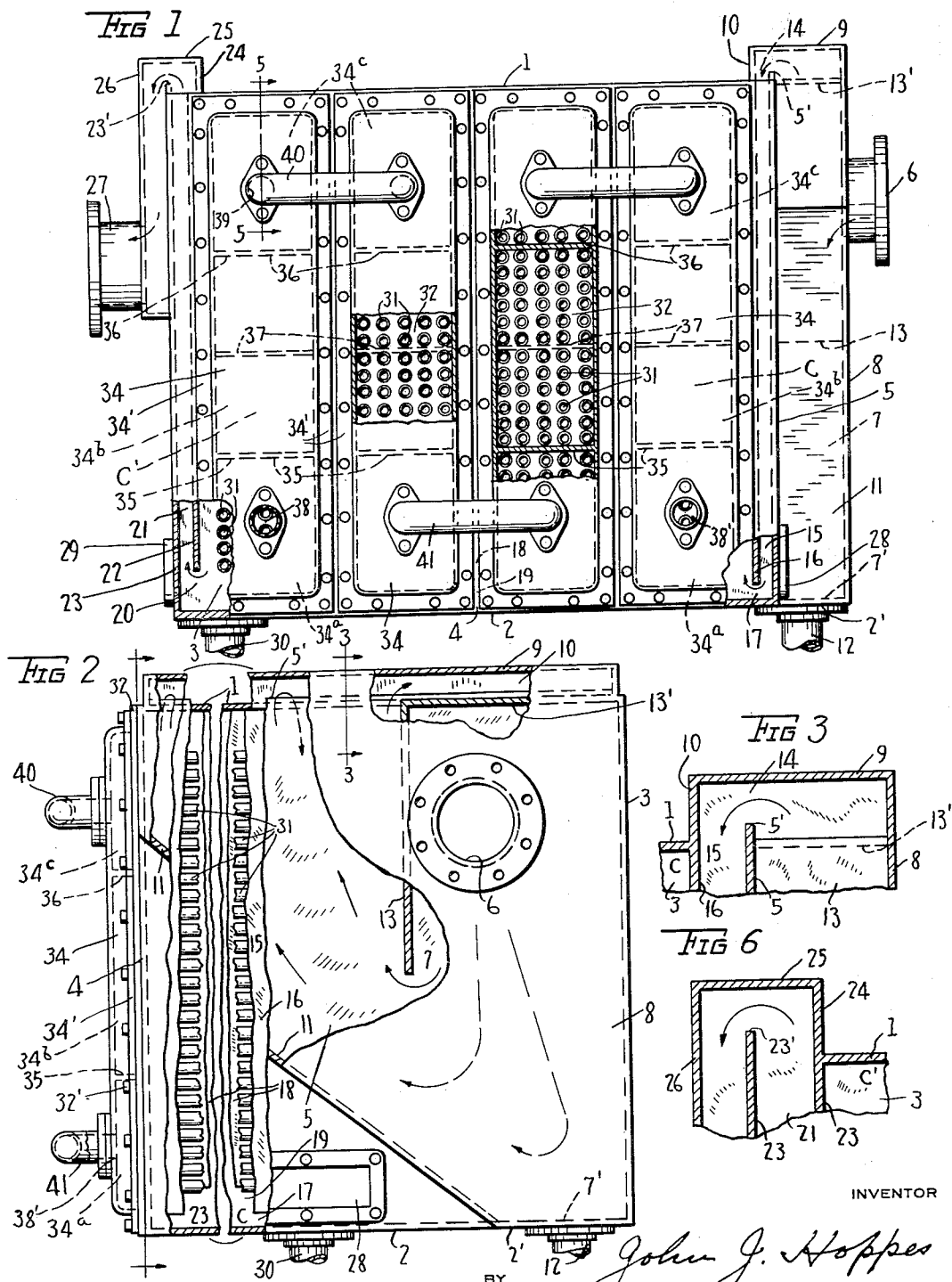
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1,957,779

HEAT EXCHANGE DEVICE

Original Filed Feb. 14, 1931

2 Sheets-Sheet 1



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FIG 4

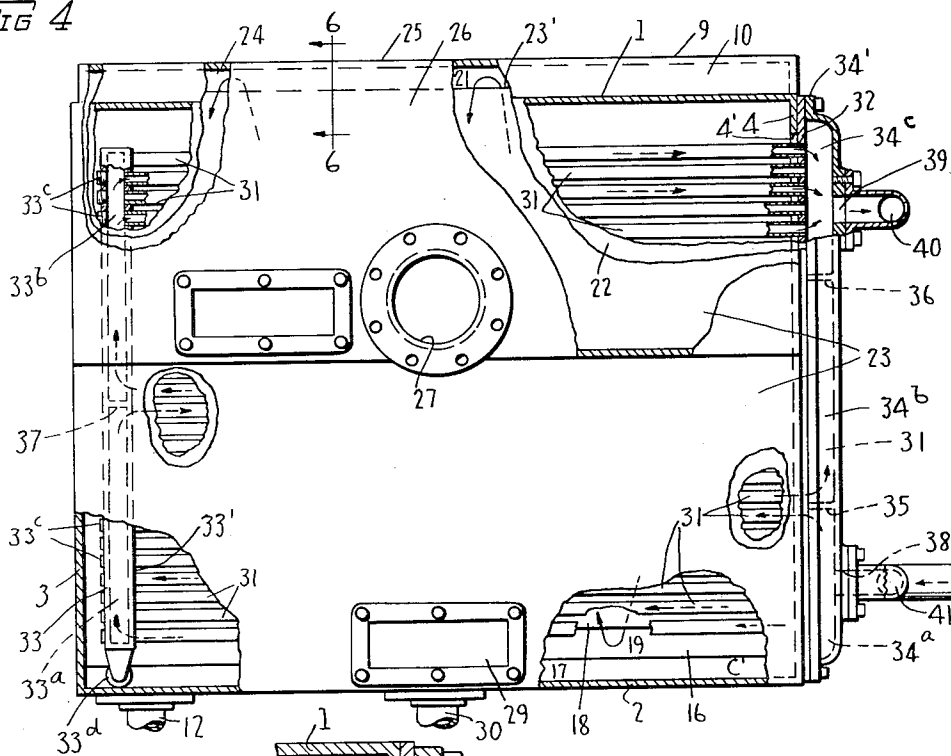
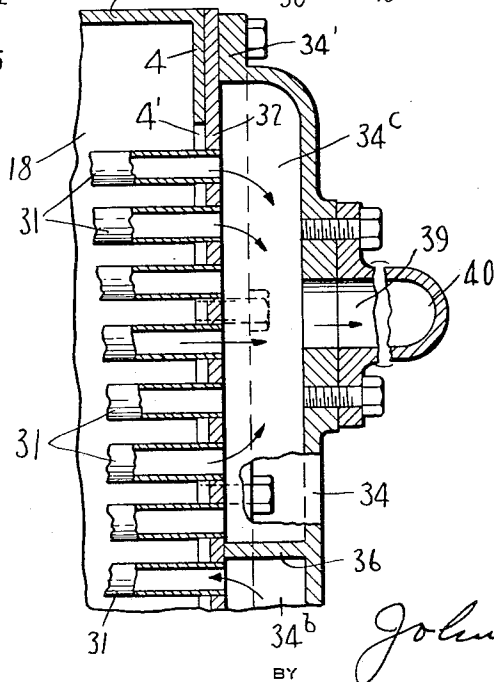


FIG 5



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGE DEVICE

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Original application February 14, 1931, Serial No. 515,808. Divided and this application January 25, 1933, Serial No. 653,461

7 Claims. (Cl. 257—240)

This invention relates to improvements in that class of heat exchange devices in which a heated fluid is passed through a fluid-tight casing, the heat of this fluid being transmitted to a second fluid passing through tubes arranged in the path of the heated fluid; this application being a division of my application Serial No. 515,808, filed February 14th, 1931, upon which issued Letters Patent No. 1,898,727, dated February 21, 1933.

The improved heat exchanger is particularly adapted for use in such industries as laundries where large amounts of heated water unfit for further use are available, the heat of which may be transferred to a supply of clean water of lower temperatures with a consequent increase in operating economy. Since this hot waste water carries a large amount of foreign matter either in suspension or otherwise, the depositing thereof on the tubes lowers the efficiency of the heat transmission, the deposit or sludge acting as an insulator.

An object of the invention is to provide a preliminary hopper-shaped settling chamber wherein a portion of the sludge may be precipitated, thereby preventing such portions from passing into the interior of the casing of the device.

Another object is the provision of an improved casing construction so designed that the fluid carrying tubes are at all times completely submerged, whereby drying and consequent hardening of the sludge is prevented.

Another object is to provide a casing construction for a heat exchanger for the purpose of maintaining the temperature of the fluid receiving the heat at a more constant value. It is obvious that fluctuations in the temperature of the heated fluid is the cause of any fluctuations in the temperature of the fluid receiving the heat. In the improved casing construction the heating fluid is permitted to follow the natural tendency to establish upward currents within itself, the velocity and extent of the movement of the currents being in direct proportion to the amount of heat contained therein. Therefore, if an occasional quantity of colder waste water passes through the device, the currents will rise to a lesser altitude, as a consequence of which the temperature of the fluids in the upper portions of the casing is not greatly reduced.

In the accompanying drawings:

Fig. 1 is a front elevation of a heat exchanger in which the principles of the invention are embodied, the view being broken away at points to show interior elevations.

Fig. 2 is an end elevation of the right hand end

of the device, this view being broken away to show interior constructional details.

Fig. 3 is an enlarged fragmentary longitudinal section on the line 3—3 of Fig. 2.

Fig. 4 is an elevation of the left hand end of the device, the view also being broken away to show portions of the interior details.

Fig. 5 is an enlarged fragmentary vertical section on the line 5—5 of Fig. 1, showing details of the tube and header construction.

Fig. 6 is an enlarged fragmentary longitudinal section on the line 6—6 of Fig. 4.

Referring to the drawings, the casing of the improved heat-exchanger is essentially a fluid-tight sheet-metal box, admission and discharge openings for the fluid giving up its heat, which will hereafter be termed the hot or waste water, being in the nature of long, rectangular openings in the lowermost portions of the end walls. 1 represents the upper sheet, 2 the bottom or floor member, 3 the rear, 4 the front wall and 5 and 23 the end walls. The waste water enters at 6 and flows into a preliminary, hopper-shaped settling chamber 7 adjacent the end wall 5 where a portion of the sludge is deposited. This chamber is formed by an outer wall 8 extending upwardly from the extension 2' of the floor sheet 2 to a point above the level of the upper casing sheet 1.

The settling chamber 7 is closed at its upper end by a horizontal sheet 9 secured to the upper edges of the wall 8 and to a wall member 10 which in turn is secured to the right-hand edge of the upper sheet 1. The chamber has a sloping bottom 11 for the greater portion of its extent for the purpose of facilitating the deposit of any sludge, the slope causing the sludge to gravitate to the bottom 7' of the chamber from where it may be drained off at intervals through the drain pipe 12.

The flow of hot water is turned downwardly on entering the settling chamber as shown by the arrows in Fig. 2, then upwardly, there being a vertical baffle member 13 longitudinally disposed in the chamber 7; there being a horizontal wall 13' which closes the space in the settling chamber above the inlet on the outer side of the baffle so that all water must pass beneath the baffle in proximity to the inclined bottom 11. The end wall 5 of the casing forms one side of the chamber and extends upwardly to a point not less in height than the level of the upper casing member 1, and provides an opening 14 between the upper edge 5' of the wall member 5 and the chamber top member 9. This opening 14 communicates

with a vertical channel 15 formed between the end wall 5 and a partition member 16 placed in parallel relation therewith and preferably extending the full width of the casing from front to rear, the front and rear walls of the channel 15 being extensions of the wall members 4 and 3, respectively. The hot water then flows downwardly through this narrow vertical channel 15 and into the casing through an opening 17 below the baffle member 16, the baffle 16 extending to within a short distance of the floor 2 of the casing.

The accompanying drawings show a casing whose interior is divided into two compartments by a single vertical, transversely disposed partition member 18 in parallel relation with the end walls and joined at its upper front and rear edges preferably by fluid-tight joints to the upper member and front and rear walls 4 and 3. This partition also extends to within a short distance of the floor 2, providing a horizontal opening 19 similar to the opening 17. The two compartments mentioned are designated C and C', and are termed heat-exchanging chambers, since in each chamber are inserted interconnected, unitary structures comprising tubes, headers and other associated details through which the fluid to be heated is passed. In the present specification the fluid being heated is termed simply the clean water, while the description of the conduits carrying the same will appear at a later point.

The path of the flow of hot water through the chamber C is undulatory, the water arising immediately on entering the chamber through the opening 17 by virtue of its heat. As it ascends, heat is lost and the velocity of this upward current is reduced, and on impinging on the under surface of the upper sheet 1 the water is diverted to the left, flowing downwardly through the left side of the chamber C along the partition 18 towards the opening 19. The opening 19 is, of course, the inlet opening to the chamber C', wherein a repetition of the flow just described occurs. The outlet for the chamber C' is also adjacent the floor member 2 in the same manner as the openings 17 and 19 are arranged and is designated as at 20, Fig. 1. The flow after passing through this opening 20 is upwardly through a narrow vertical passage 21 formed by the parallel position of a baffle sheet 22 and the end wall 23 at the left extension of the casing. The passage 21 discharges into an enclosure comprising the walls 24, 25 and 26, Fig. 7, in connection with suitable front and rear wall extensions forming a fluid-tight passage-way leading to the discharge connection 27, it being noted that the flow through the enclosure reaches an altitude greater than the level of the upper portions of the casing, as the edge 23' of the end wall 23 extends above the upper sheet 1, in the same manner as described in connection with the upper edge 5'. The advantage gained in causing the incoming and outgoing flows of hot water to be at greater elevations than the upper portions of the casing is that the casing at all times remains completely filled with water whether in operation or not, therefore any sludge that may be deposited within the casing or passages leading to and from the same, or upon the clean water conduit arrangements, remains in a more plastic condition, being prevented from drying and consequent hardening which would result in an expensive cleaning operation. This construction also permits the drainage of the settling chamber 7 without lowering the level of the water in the interior of the casing.

By causing the waste water to enter and leave at the lowermost portions of the casing the previously mentioned advantage is gained of allowing a "short-circuiting" of any occasional quantities of colder waste water, the path of such being comparatively direct from the casing inlet 17 to the outlet 20, the water, by its greater density remaining near the floor. A further minor advantage is that, by the provision of hand-hole openings normally covered by cover-plates such as are indicated at 28, Fig. 2, and at 29, Fig. 4, access may be had to the floor area of the casing for inspection or such cleaning thereof as may be desired. The casing may be drained by opening a valve (not shown) connected with a drain-pipe 30 preferably located near the casing outlet 20.

The improved heat-exchanger is designed to provide that a modification of the effective counter-flow scheme is employed, the path of the flow of clean water receiving heat starting at the lower left extremity of the device and terminating at the lower right portion in proximity to the waste water inlet. It is clear from the description so far that the path followed by the waste water is a series of undulations moving from right to left, and that a chamber such as C encloses a single undulation consisting of a descending and ascending column of water of substantially rectangular cross-sectional area.

The simplest counter-flow arrangement would be to cause the path of the clean water to closely conform to the undulatory path of the waste water in all respects, but I prefer the modified arrangement such as is shown and described in the present case, wherein the path of the clean water zig-zags to and fro in a generally upward movement through a descending column, and conversely to and fro in a generally downward movement through an ascending column, of waste water. The exact relation of the paths one to another may be stated in other words by explaining that a cross-section taken on a horizontal plane through either an ascending or descending column of waste water is substantially rectangular in form, the long dimension extending from front to rear, and that the path of the clean water within the casing is always parallel to the long dimension.

Such an arrangement has an advantage in that an extended clean water path is provided in a relatively small space. There is also an advantage that it is possible that a desired number of tubes and associated parts may be combined into a unitary structure of which a plurality are employed, each of which may be inserted or withdrawn into or from the casing independently of the others, all connecting mediums conveying fluids from one to another of the structures being made on the outside of the casing.

The clean water is conveyed throughout the casing interior in tubes 31 of which a preferably equal number is associated in each unitary structure or bank, in the present case there being two banks for each single heat exchanging compartment such as C or C'. The tubes are arranged in vertical and horizontal rows, as seen best in Figs. 1 and 5, although it is clear that a staggered arrangement could be employed. Referring to the initial bank, employed in the left portion of the chamber C', the tubes are secured at their forward ends in a flat plate 32 and at their farther ends in the raised portion 33' of a hollow header 33 preferably by a rolling and calking process, this operation at their connec-

tion with the header 33 being performed through openings in alignment with each tube, the openings being closed by the plugs 33^c.

The front wall 4 of the casing is provided with 5 rectangular openings 4' through which the unit is inserted into the casing. Rollers 33^d are fitted to the bottom portions of the headers 33 whereby greater ease of assembly may be secured. The plate 32 is sufficiently large to act as a cover for 10 an opening 4' and through the overlying portions of the plate 32 screws are inserted which thread into openings in the front wall 4, and also passing through the overlying flange 34' of a dish-shaped cover casting 34. The dished interior of the cover casting is divided into compart- 15 ments by horizontal baffles 35 and 36 into the compartments 34^a, 34^b and 34^c, these baffles being of such height as to bear against the plate 32 and effectually prevent the passage of fluid from any 20 compartment to another. In the rear header 33 an integral baffle 37 is employed, which divides the interior of this header into two compartments 33^a and 33^b. The alignment of the baffles 35 and 36 in the cover 34 in relation to the baffle 37 in the 25 header 33 is such that the compartment 34^a communicates with a plurality of tubes which discharge into the lowermost portion of the compartment 33^a, while tubes leading from the uppermost portion of the compartment 33^a discharge 30 into the lowermost part of the compartment 34^b. The tubes in communication with the upper portion of the compartment 34^b lead to the lower portion of the compartment 33^b in the rear header, and from the upper part of this latter compartment the tubes discharge into the 35 compartment 34^c at the upper end portion of the cover 34.

Openings 38 and 39 are provided in the raised portion of the cover casting 34, the opening 38 40 being an inlet opening where the clean water makes its initial entrance into the conduit arrangement, communicating directly with the compartment 34^a, while the opening 39 communicates with the compartment 34^c. It will then 45 be seen that the clean water flowing into the compartment 34^a travels rearwardly through the lower tubes into the compartment 33^a and is then returned forwardly to the compartment 34^b, then again in a rearwardly direction into the lower 50 part of the compartment 33^b, then forwardly into the compartment 34^c and outwardly through the opening 39. Alternate movements are thus made in a direction generally upward, and since the bank as just described occupies the left hand portion 55 of the chamber C' in which portion a descending column of waste water is flowing, a heat transfer in accordance with the preferred modified form of counterflow takes place.

The water issuing from the upper compartment 60 34^a passes through the opening 39 and through a hollow duct 40 into the upper compartment 34^c of the cover 34 of the succeeding bank of tubes, which bank is placed in the right side of the chamber C'. By admitting the fluid to this compartment, which is in fact the compartment 34^c 65 of the second bank, the water flows towards the rearward header and thereafter in a generally downward direction to the opening 38 in this bank, and is then conveyed by the duct 41 to the 70 succeeding banks. The generally downward movement of the clean water in this bank is also in a direction counterwise to that of the waste water, which in this half of the chamber is upwardly. The flow of clean water continues as described through all of the plurality of banks of 75

tubes, finally issuing at the outlet opening 38' in the bank nearest the waste water inlet 17.

A plurality of banks such as have just been described are employed in the heat exchanger. The present drawings show four only, these being 80 placed two each in a single compartment such as C or C', therefore there are two forward and two rearward movements of the clean water for each ascending or descending columns of waste water, or sixteen to and fro movements 85 for two undulations in the heat exchanger illustrated in the drawings. This provides perhaps the shortest path practical for either of the fluids for an exchange of heat of any appreciable economy; certain circumstances may indicate that a 90 more complete abstraction of the available heat units in the waste water may be made by providing a longer path for the fluids. The design of the present exchanger lends itself to such extensions as it is only necessary to employ addi- 95 tional chambers and banks of clean water conduits, using the casing and constructions as described, it being understood that a partition 18 is employed between adjacent chambers.

Having thus described my invention, I claim: 100

1. In a heat exchange device, a main casing having tubes therein, a settling chamber at one end of said casing having an inclined bottom, said settling chamber being in communication 105 with said casing by a passageway that leads from a point above the bottom of said chamber to a point at the bottom of said casing, a fluid inlet leading to said chamber and a fluid outlet leading from said casing.

2. In a heat exchange device, a main casing, 110 a bank of tubes therein, a settling chamber at one end of said casing having an inclined bottom, a fluid inlet in the upper portion of said chamber, a vertically-arranged baffle adjacent said inlet and extending below the same but terminating 115 above said inclined bottom, a communicating passageway between the upper portion of said settling chamber and the lower portion of said casing, and a fluid outlet leading from said casing.

3. In a heat exchange device, a main casing, 120 a plurality of tubes therein, a settling chamber at one end of said casing, a pair of separated walls forming a passage between the upper end of said settling chamber and the lower end of said casing for the full width of the casing and chamber, said settling chamber having an inclined 125 bottom, a fluid inlet leading into the upper portion of said settling chamber, a baffle wall adjacent said inlet extending the full length of said settling chamber and terminating below said fluid inlet, and a wall enclosing the space above 130 said inlet on the outer side of said baffle member.

4. In a heat exchange device, a casing, a plurality of tubes therein, means for supplying 135 liquid to said casing including a vertically-extending passage, the entrance to said passage being above the desired liquid level to be maintained in said casing and the discharge end of said passage leading to the extreme lower portion of said casing, and means for discharging 140 liquid from said casing including a vertical passage-way, the lower end of which communicates with the extreme lower portion of said casing and the upper end of which is above the desired fluid level to be maintained in said casing. 145

5. In a heat exchange device, an enclosure, a plurality of tubes in said enclosure arranged from a point adjacent the bottom to a point adjacent the top thereof, means for admitting and dis- 150 charging fluid to said enclosure at the bottom

thereof so arranged as to maintain a constant level of fluid in said enclosure about said tubes and permit short-circuiting of the fluid through said enclosure below said tubes.

- 5 6. In a heat exchange device, an enclosure, a plurality of tubes therein, with a space in said enclosure beneath said tubes, a fluid supply passage leading to the bottom of said enclosure one point at least of which is above the desired liquid level to be maintained in said enclosure, and a
10 fluid discharge passage leading from the bottom of said enclosure one point at least of which is above said liquid level, the space in said enclosure beneath said tubes permitting a flow of cold
15 fluid directly therethrough from the supply passage to the discharge passage.

7. In a heat exchange device, an enclosure, a plurality of tubes therein with a space in said enclosure beneath said tubes, a fluid supply passage leading to the bottom of said enclosure, a fluid discharge passage leading from the bottom of
80 said enclosure, one point at least of each of said passages being above the desired liquid level to be maintained in said enclosure, means in said enclosure to direct the water upwardly and downwardly about said tubes, the space in the bottom of said enclosure permitting flow of cold
85 fluid directly therethrough from the supply passage to the discharge passage.

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