June 4, 1935. O. JACOBSEN 2,003,593

HEAT EXCHANGER

Filed Feb. 23, 1935 2 Sheets-Sheet 1

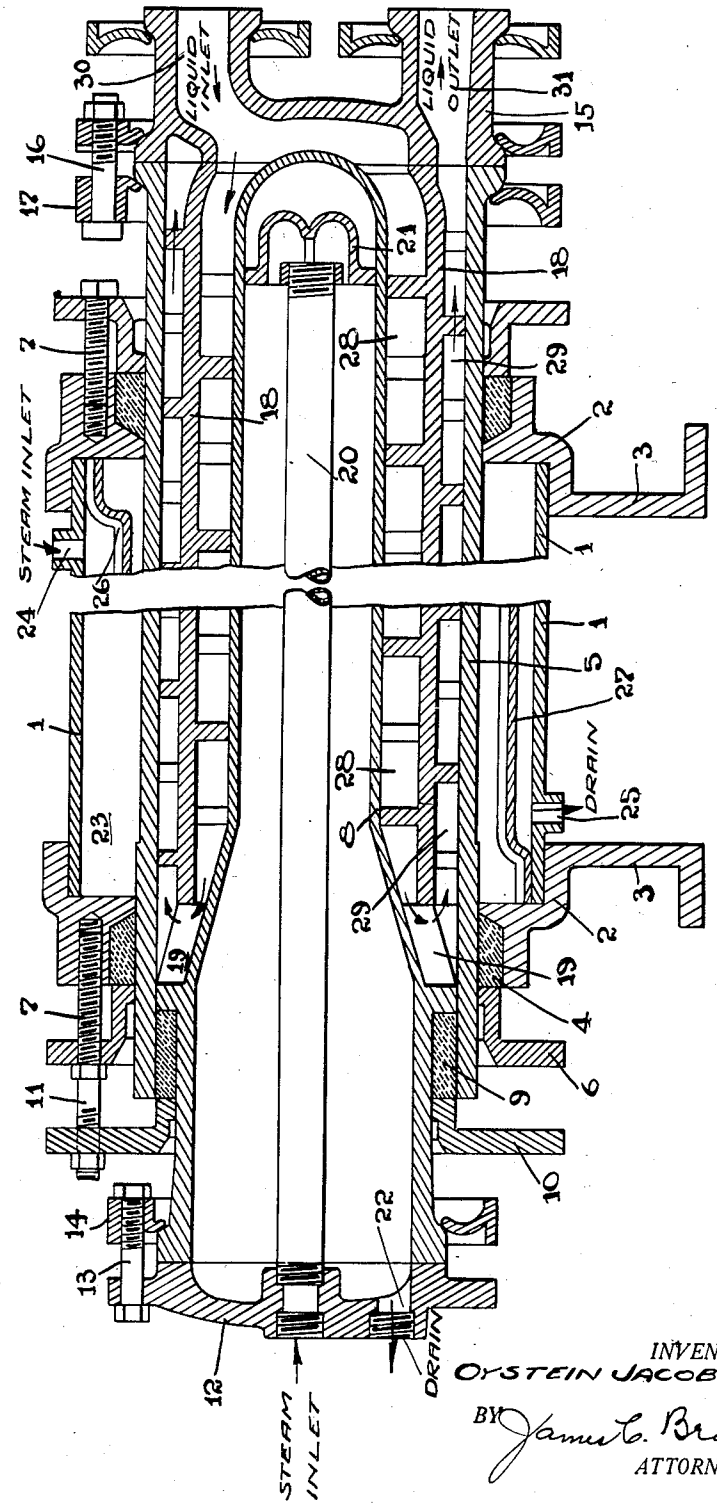

Fig. 1.

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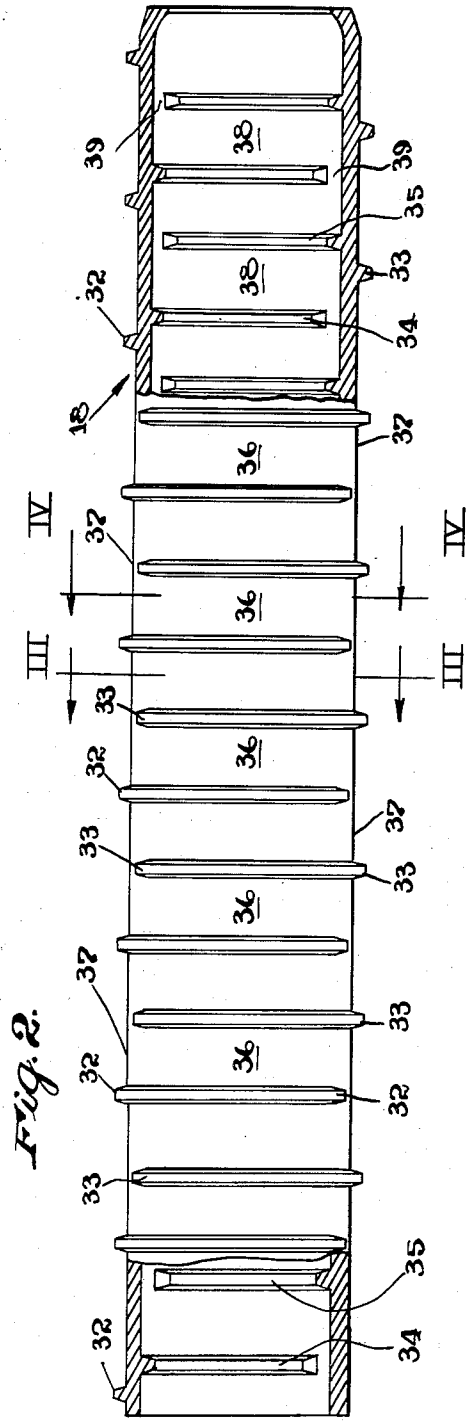

Fig. 2.

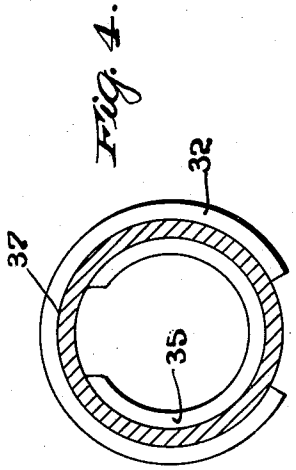

Fig. 4.

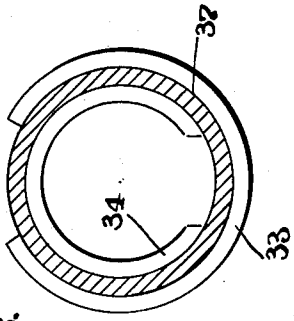

Fig. 3.

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UNITED STATES PATENT OFFICE

2,003,593

HEAT EXCHANGER

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Application February 23, 1935, Serial No. 7,744

7 Claims. (Cl. 257—246)

The invention relates to heat exchangers for liquids or fluids and more particularly to an apparatus for heating liquid in which steam is the heating fluid. It has for its principal object the provision of an improved apparatus having a high degree of efficiency. A further object is the provision of an improved construction wherein a high degree of turbulence is secured in the liquid to be heated as it passes the tortuous heating passage of the apparatus, which turbulence, I have found essential to an effective heat transfer since it causes a larger area of the liquid to contact with the heated surfaces than would be the case in a smooth flow. More particularly, the tortuous passageway for the liquid is designed to give a substantial improvement in heat transfer, as compared with apparatus of equal heat transfer areas heretofore used having the well-known spiral type of flow passage. A further object is the provision of a structure which is cheap and simple and may be readily fabricated from corrosion resisting material. One embodiment of the invention is shown in the accompanying drawings, wherein:

Figure 1 is a longitudinal section through the apparatus. Fig. 2 is a side elevation partly in section of the ribbed tube which divides the flow of liquid to be heated into two streams. And Figs. 3 and 4 are sections on the lines III—III and IV—IV respectively of Fig. 2.

Referring to Fig. 1 of the drawings, 1 is a tubular steam jacket carried by the headers 2, 2 having the base flanges 3. Extending through the headers which are recessed to form stuffing boxes is the jacket 5, the packing 4 in the stuffing boxes being engaged by the glands 6, 6 which are drawn inward by the bolts 7. Lying inside the jacket 5 is the steam tube 8 surrounded at its left hand end by a stuffing box carrying the packing 9 which is engaged by the gland 10. This gland is adjusted inward by means of the bolts 11. The steam tube is closed at its left hand end by a header 12 clamped in position by the bolts 13 extending through the collar 14. The right hand end of the jacket is provided with a header 15 clamped in position by means of the bolts 16 extending through the collars 17.

Intermediate the jacket 5 and the steam tube 8 is a division tube 18, shown in Figs. 2, 3 and 4, and later described in detail. The right hand end of this tube 18 is engaged by the header 15, while the left hand end engages lugs 19 which are integral with the walls of the steam tube.

Steam is supplied to the tube 8 by means of the pipe 20, which carries at its inner end a cup-shaped deflector 21. The header 12 is provided with a drain outlet 22 for removing the condensation which forms in the tube 8. A steam chamber 23 is also provided between the jackets 1 and 5, such chamber having a steam inlet 24 and a drainage outlet 25. Baffle plates 26 and 27 are provided in the chamber 23 in front of the inlet 24 and drainage outlet 25 respectively.

The division tube 18 separates the space between the tube 8 and jacket 5 into two passageways 28 and 29 which communicate at their left hand ends where the end of the tube 18 engages the lugs 19. The passageway 28 has an inlet 30 at its right hand end, through which the liquid to be heated is supplied, while the passageway 29 has an outlet 31 at its right hand, through which the liquid discharges.

The division tube 18 is preferably in the form of a casting provided on its exterior with the two sets of ribs 32, 32, etc. and 33, 33, etc., and on its interior with the two sets of ribs 34, 34, etc. and 35, 35, etc. The ribs 32 and 33 alternate and each extends around about 300 degrees of the circumference of the tube. This provides a series of circumferential passages 36, 36, etc. (Fig. 2) connected at their ends by the longitudinal passages 37, 37, etc. when the tube is fitted into the jacket 5. Together these circumferential and longitudinal passages constitute the passageway 29. Similarly, the interior ribs 34 and 35 alternate and each extends around about 300 degrees of the circumference of the tube. This provides a series of circumferential passages 38, 38, etc. connected at their ends by the longitudinal passages 39, 39, etc. when the steam tube 8 is fitted into the division tube. Together the circumferential passages 38, 38, etc. and the longitudinal passages constitute the passageway 28.

In operation, the liquid to be heated flows through the passageway 28 to the lugs 19, where it is directed reversely into the passageway 28 and returns therethrough to the right hand end of the apparatus and discharges through the outlet 31. In its flow through the passageway 28, the liquid is heated from the wall of the steam tube 8, and in its flow through the passageway 29 it is heated by the steam jacket 5. The passageways 28 and 29 not only provide the desired length of travel of the liquid to be heated in contact wtih the heated walls 8 and 5, similar to that secured with the spiral passageways heretofore employed, but also insure a much more efficient heat transfer than such spiral passageways. With spiral passageways, the flow of the liquid is accompanied with only a slight amount of turbulence, whereas the present arrangement gives a maximum amount of turbulence with a corresponding increase of heat transfer, due to the greater amount of contact between the liquid and the heated walls. In its flow through the passageways 28 and 29, the direction of travel is abruptly changed in passing from a circumferential passage 36 to a longitudinal passage 37, and again abruptly changed in passing back from

the longitudinal passage 37 to the circumferential passage 36, thus giving a maximum amount of agitation. As a result, the heat transfer is much more rapid than is the case where the flow along the heated surfaces is smooth and uninterrupted. The construction further lends itself readily to fabrication in corrosion resisting compositions, and requires a minimum amount of machine work, which is an important consideration in materials which are very hard and resistant to cutting. The primary advantage is found, however, in the increase in efficiency, heretofore pointed out, and incident to the construction of the division tube with its alternating circumferential and longitudinal passages which require repeated abrupt changes of direction of flow in the liquid being treated.

What I claim is:

1. In combination in heat exchange apparatus a pair of spaced concentric tubes, means for heating such tubes, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and a series of spaced circumferential ribs on the inner and outer faces of said division tube bridging the passageways, each of which extends around only a part of the circumference of the tube so that a passage is provided between the ends of each rib with each of said passages offset circumferentially with respect to the passage between the ends of the rib next adjacent on each side thereof.

2. In combination in heat exchange apparatus a pair of spaced concentric tubes, means for heating such tubes, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and a series of spaced circumferential ribs on the inner and outer faces of said division tube bridging the passageways, each of which extends around only a part of the circumference of the tube so that a passage is provided between the ends of each rib with each of said passages offset circumferentially 180 degrees with respect to the passages between the ends of the rib next adjacent on each side.

3. In combination in heat exchange apparatus a pair of spaced concentric tubes, means for heating such tubes, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and a series of spaced circumferential ribs on the inner and outer faces of said division tube bridging the passageways, each of which extends around the major portion of the circumference of the tube, so that a passage is provided between the ends of each rib with each of said passages offset circumferentially with respect to the passage between the ends of the rib next adjacent on each side thereof.

4. In combination in heat exchange apparatus a pair of spaced concentric tubes, means for heating such tubes, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and a series of spaced circumferential ribs on the inner and outer faces of said division tube bridging the passageways located in planes at right angles to the axis of the tube, each of which ribs extends around the major portion of the circumference of the tube, so that a passage is provided between the ends of each rib with each of said passages offset circumferentially with respect to the passage between the ends of the rib next adjacent on each side thereof.

5. In combination in heat exchange apparatus a pair of spaced concentric tubes, means for heating such tubes, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and a series of spaced circumferential ribs on the inner and outer faces of said division tube bridging the passageways located in planes at right angles to the axis of the tube, each of which extends around the major portion of the circumference of the tube so that a longitudinal passage is provided between the ends of each rib with each of said passages offset approximately 180 degrees with respect to the passage between the ends of the rib next adjacent on each side thereof.

6. In combination in heat exchange apparatus, a pair of spaced concentric tubes, the inner one of which is closed at its ends, means for applying heating fluid around the outer tube, a steam supply pipe extending from one end of the inner tube to a point adjacent the other end thereof and opening into such inner tube, a deflector plate in opposition to the open end of the steam supply pipe, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and circumferential ribs on the inner and outer faces of the division tube bridging the passageways and causing the fluid being heated to flow circumferentially around the steam and division tubes a plurality of times in its travel from one end of the division tube to the other.

7. In combination in heat exchange apparatus, a pair of spaced concentric tubes, the inner one of which is closed at its ends, means for applying heating fluid around the outer tube, a steam supply pipe extending from one end of the inner tube to a point adjacent the other end thereof and opening into such inner tube, a cup-shaped deflector member fitting around the open end of the steam supply pipe, a division tube between the concentric tubes dividing the space therebetween into two passageways which communicate with each other at one end, the other end of one passageway having an inlet for the fluid to be heated while the other end of the other passageway has an outlet for said fluid, and circumferential ribs on the inner and outer faces of the division tube bridging the passageways and causing the fluid being heated to flow circumferentially around the steam and division tubes a plurality of times in its travel from one end of the division tube to the other.

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