Feb. 24, 1942. K. B. RIS 2,274,247

HEAT EXCHANGER

Filed Aug. 2, 1938 4 Sheets-Sheet 1

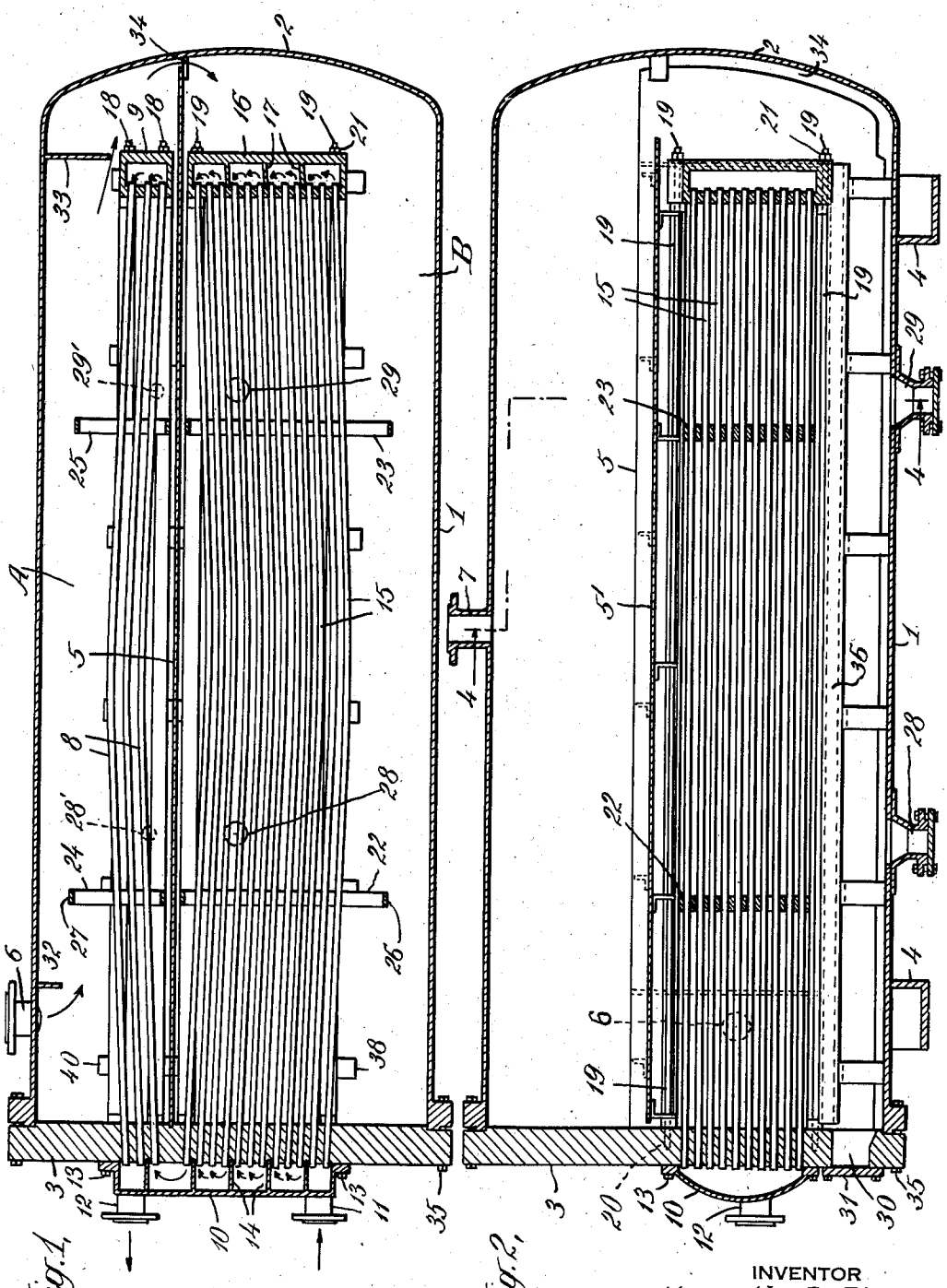


Fig. 1.

Fig. 2.

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HEAT EXCHANGER

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Fig. 3,

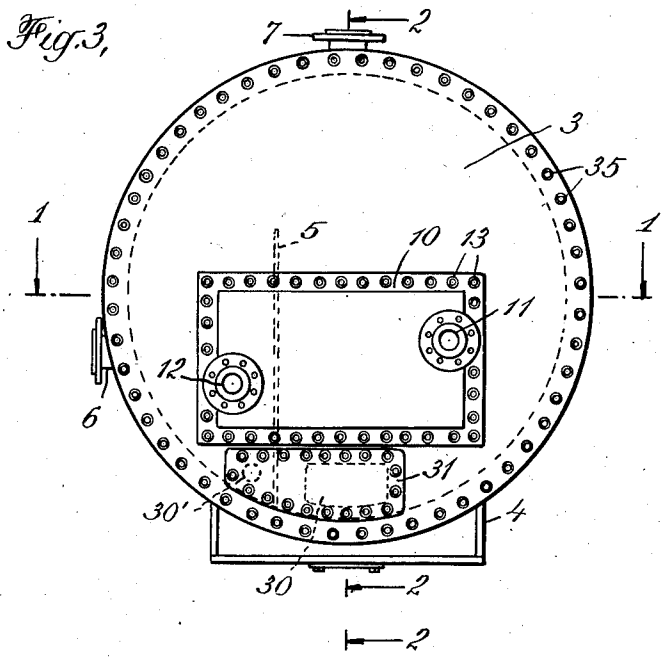
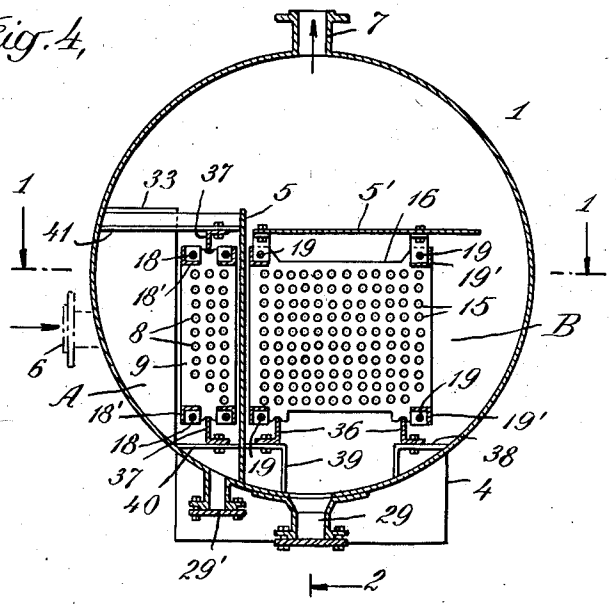


Fig. 4,



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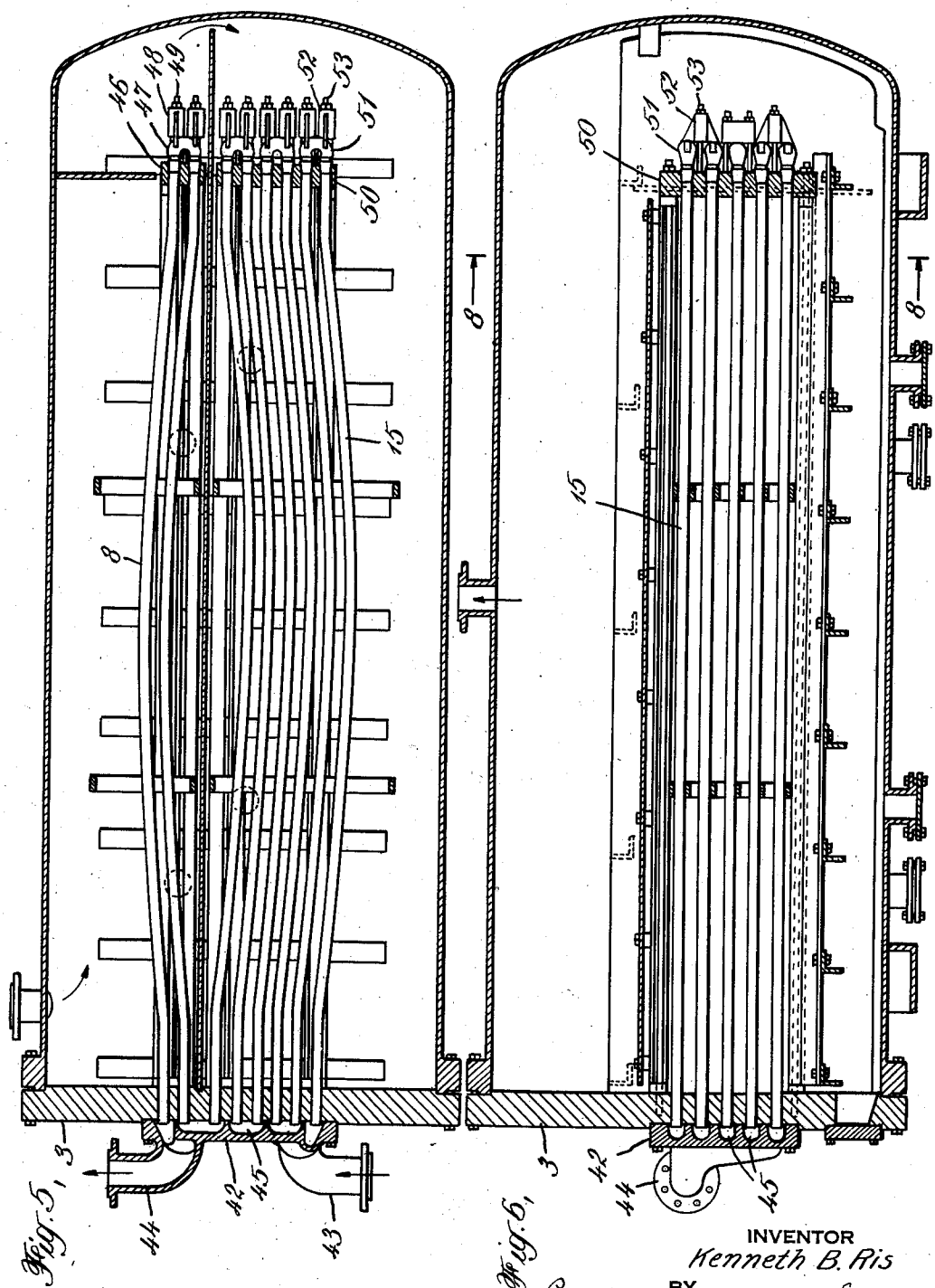


Fig. 5,

Fig. 6,

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Fig. 7,

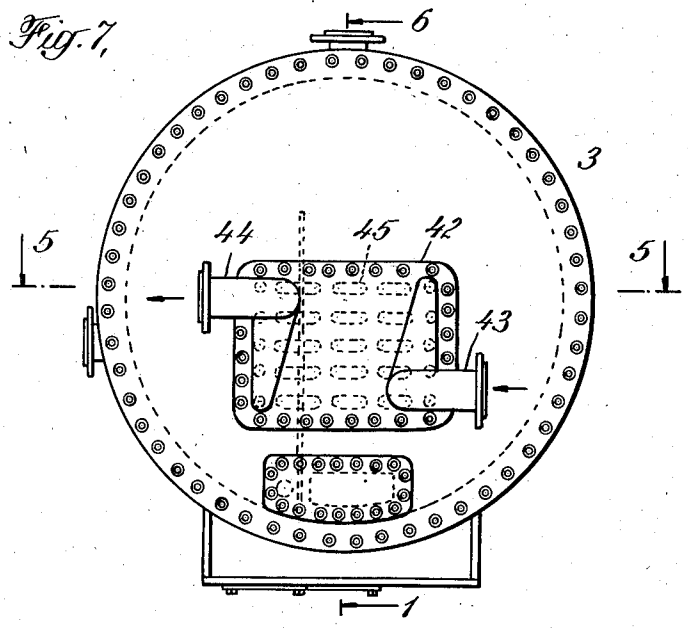
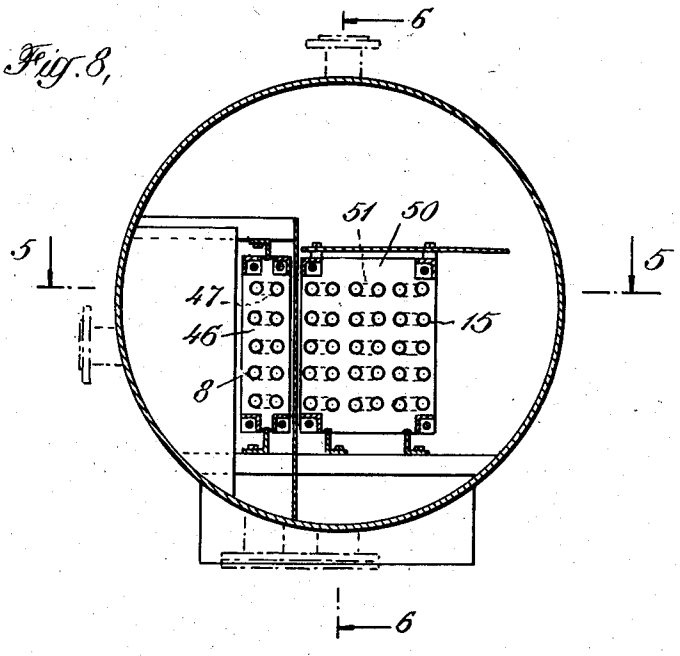


Fig. 8,



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UNITED STATES PATENT OFFICE

2,274,247

HEAT EXCHANGER

Kenneth B. Ris, Garden City, N. Y., assignor to The Griscom-Russell Company, New York, N. Y., a corporation of Delaware

Application August 2, 1938, Serial No. 222,588

1 Claim. (Cl. 257—240)

This invention relates to heat exchangers and more particularly to heat exchangers suitable for use as evaporators in regions where the water contains scale forming impurities. An object of the invention is to provide a heat exchanger of such a nature that the desired heat transfer is obtained at maximum efficiency during all operating conditions. This object may be obtained to a considerable extent by providing within the heat exchanger a preheating zone or chamber and a main heating zone or chamber communicating therewith, the arrangement being such that portions of the main heating unit are never cooled to an abnormal extent by surges of cold water or other liquid supplied to the heat exchanger. I prefer to employ a preheating chamber and a preheating unit therein for heating the water before it comes in contact with any portion of the main heating unit.

In regions where the water contains large quantities of scale forming impurities the efficiency of an ordinary heat exchanger is soon impaired by the deposits forming on the tubes of the heating unit. My invention contemplates a construction such that the scale is automatically cracked off the tubes by lateral distortion thereof occurring upon changes in the temperature of the tubes. For this purpose I prefer to employ a flexible tube bundle for carrying the heating medium and to provide tie rods, or the like, for holding the ends of the tube bundle in substantially fixed relation to each other. Whenever there is any appreciable increase in the temperature of the tubes they have a tendency to elongate, but with the ends of the tube bundle held in fixed relation to each other the tubes bow laterally instead of expanding lengthwise, and this distortion of the tubes is effective to crack off any scale deposits on the tubes. I prefer to employ such a self-scaling heating unit in the preheating chamber of my improved heat exchanger and I may also employ a similar self-scaling unit in the main heating chamber. Thus the heat exchanger may be provided with two separate tube bundles, one in the preheating chamber and the other in the main heating chamber. Where such units are employed, the tube bundles are preferably mounted, at one end, in a single tube sheet which may form a closure for one end of the heat exchanger shell, and, at the other end, the tube bundles may be supported in separate headers. The shell may be provided with a longitudinally extending partition separating the preheating chamber from the main heating chamber. This partition is preferably in the form of a vertical dam or weir which divides the shell into two heating zones the arrangement being such that the water, or other liquid to be heated, first enters a preheating zone and then flows over the top of the partition into the main heating zone. I may also construct or arrange the partition in such a way that restricted passage of the fluid to be heated is provided at points below the top of the partition so that at these points the preheated fluid may flow into the main heating chamber. This feature is of particular value when the apparatus is being operated at low capacity at which time some if not all of the fluid being heated may pass from the preheating chamber into the main heating chamber at one or more points below the top of the vertical partition or weir.

With the tube bundles mounted in a single tube sheet at one end as mentioned above the heating units may be removed from the shell as a single unit for ready inspection and repair. The headers at one end of the tube bundles may be mounted on or between guide rails or tracks carried by the shell. These tracks facilitate the insertion of the heating units and also their removal from the shell. Suitable end connections are provided for the tube bundles for causing multipass flow of the heating medium through the tube bundles and the connections may be arranged so as to provide any desired combination of series or series-parallel flow. Also, if desired, one heating medium may be supplied to the preheating unit, and another heating medium, or a heating medium from a separate source of supply, may be supplied to the main heating unit.

For commercial installations where it is desirable to use hot tar, or other heavy liquid containing carbon or other substances which have a tendency to cake or form deposits in the heat exchanger, I prefer to employ end connections, for one or both of the heating units, of such a nature that they insure approximately streamline flow of the heating medium throughout the heating element. When hot tar is used as a heating medium in a heat exchanger there is a tendency for deposits of coke to form at points where there is an abrupt change in velocity or direction of flow and in order to minimize this tendency I may employ curved end connections which avoid abrupt changes in velocity as the heating medium is discharged from one tube or bank of tubes and returned to another tube or tube bank. Also I prefer in such installations to employ individual U-shaped end connections,

separately detachable so as to provide ready access to any tubes which have become clogged or fouled, without the necessity for opening all of the tube passages.

The various objects and advantages of my invention will be more apparent upon considering the following detailed description of certain embodiments thereof illustrated in the accompanying drawings in which

Fig. 1 is a horizontal longitudinal section view of a heat exchanger embodying the invention, this view being taken on line 1—1 of Figs. 3 and 4;

Fig. 2 is a longitudinal vertical section view of the heat exchanger taken on line 2—2 of Figs. 3 and 4;

Fig. 3 is a front elevation of the heat exchanger;

Fig. 4 is a transverse section view taken on line 4—4 of Fig. 2;

Fig. 5 is a longitudinal horizontal section view of another embodiment of my invention taken on line 5—5 of Figs. 7 and 8;

Fig. 6 is a longitudinal vertical section view taken on line 6—6 of Figs. 7 and 8;

Fig. 7 is a front elevation of the heat exchanger illustrated in Figs. 5 and 6 and

Fig. 8 is a transverse section view taken on line 8—8 of Fig. 6.

Referring to the embodiment of the invention illustrated in Figs. 1–4 inclusive it will be noted that it comprises a cylindrical shell 1 having a closed rear end 2 and a combination cover and tube sheet 3 at the front end of the shell. The heat exchanger shell is intended to be mounted in a horizontal position on suitable supports 4. Within the shell there is a longitudinally extending vertical partition 5 fixed to the shell in any suitable manner and serving to divide the space within the shell into two zones or chambers, a preheating chamber A and a main heating chamber B. These chambers communicate with each other over the top of the partition 5 which thus constitutes a dam or weir. A suitable inlet connection 6 is provided for supplying water, or other liquid, to the preheating chamber A and a vapor discharge connection 7 is provided at the top of the shell.

A heating unit is provided in each of the chambers within the shell for heating the water, or other liquid, supplied to the shell. The heating unit in the preheating chamber A comprises a vertical bank of tubes 8 constituting a flexible tube bundle having its front end mounted in the tube sheet 3 and its rear end mounted in a suitable header 9. A manifold 10 having an inlet 11 and an outlet 12 is mounted on the outer face of the tube sheet or shell cover 3, in any suitable manner as by a series of bolts 13. This manifold may contain a series of partitions 14 for directing the steam or other heating medium through the heating tubes, as illustrated by the arrows in the manifold. The heating unit in the main heating chamber B may likewise consist of a plurality of tubes 15 constituting a flexible tube bundle with its front end mounted in the tube sheet 3 and its rear end mounted in a header 16 containing internal partitions 17 for directing the flow of fluid from one group of tubes to another adjacent group of tubes. If desired, the two tube bundles may be connected in series, as best illustrated in Fig. 1 so that the heating medium flows first through the tubes 15 of the main heating unit and then through the tubes 8 of the preheating unit to the outlet 12.

The tubes of each heating unit are preferably made of thin walled copper nickel alloy tubing, and the tube bundles of flexible tubing are preferably, although not necessarily, initially bowed in a direction away from the partition 5. The headers 9 and 16 may be held in fixed relation to the tube sheet 3 by a number of tie rods 18 connecting the header 9 to the tube sheet 3 and another series of tie rods 19 connecting the header 16 to the tube sheet 3. As illustrated in Fig. 2 the front ends of the tie rods may be screw threaded and mounted in threaded bores or openings provided in the tube sheet, as shown at 20. The rear ends of the tie rods may be secured to the headers 9 and 16 in any suitable manner as by means of nuts 21 threaded onto the ends of the tie rods. These tie rod connections may be adjusted so as to hold the tube bundles in position with the tubes initially bowed outward from the partition 5, as best illustrated in Fig. 1. The tubes of each tube bundle may be supported at intermediate points by suitable cages such as those shown at 22 and 23 in the main heating chamber and at 24 and 25 in the preheating chamber. These cages may consist of a vertical series of horizontal bars passing between adjacent horizontal rows of tubes, with the ends of the bars welded or otherwise connected to vertical bars, as illustrated at 26 and 27 in Fig. 1. These cages confine the flexible tubes so that any lateral distortion of the tubes must occur in horizontal planes parallel with the cross bars of the cages.

The cages 22 and 23 may be welded or otherwise secured to angle members 19′ (see Fig. 4) and in like manner the cages 24 and 25 may be secured to angle members 18′. The angle members 18′ and 19′ embrace the tie rods extending between the tube sheet 3 and the headers 9 and 16.

With the ends of the tube bundles tied together by means of the tie rods 18 and 19, or the like, it will be understood that any substantial increase in the temperature of the tubes will cause the tubes to bow laterally rather than elongate and this lateral distortion of the tubes is effective in cracking off scale deposits forming on the tubes during the operation of the heat exchanger. This is of great importance where the apparatus is employed as an evaporator and the water supplied to the evaporator contains scale-forming impurities. The tie rods which are preferably made of steel, or the like, are not in direct contact with the heating medium and in any event they do not tend to expand as much as the flexible tubes and, accordingly, whenever there is an abnormal increase in the temperature of the tubes the tubes are distorted laterally to such an extent that they crack off any scale deposited on the tubes.

For removing accumulated scale in the bottom of the shell a number of blow down connections may be provided, such as those illustrated at 28 and 29 in the bottom of the main heating chamber B and at 28′ and 29′ in the bottom of the preheating chamber B, and, if desired, the front cover 3 may be provided with openings near the bottom thereof, as shown at 30 and 30′, and a suitable detachable cover 31, for facilitating the removal of loose scale from the chamber B and A respectively.

During normal operation of the apparatus the liquid to be heated is supplied to the preheating chamber A thru the inlet 6 and this preheating chamber may be provided with one or more trans-

verse baffles 32 and 33 for directing the liquid into contact with the tubes 8 of the preheating unit. After being preheated in this manner liquid may flow over the top of the partition 5 into the main heating chamber where it comes into direct contact with the main heating unit. I prefer to employ a partition 5 so associated with the shell that restricted flow of the fluid being heated is permitted at a plurality of points below the top of the partition so that at these points the preheated fluid may pass directly into the main heating chamber. Such passages for supplying the preheated fluid into the main heating chamber may be provided at any desired points in or around the partition 5, for example, the rear end of the partition may be spaced from the closed end 2 of the shell so as to provide a restricted fluid passage, as best illustrated at 34 in Fig. 2.

With both tube bundles mounted at one end in a single tube sheet 3 and at the other end in separate headers 9 and 16, the tube bundles and tube sheet may be removed from the shell as a unit by merely detaching the bolts 35, or other fastening means securing the tube sheet 3 to the front end of the shell. For facilitating the insertion of the heating units into the shell and their removal from the shell I prefer to employ a plurality of guide rails or tracks in each of the compartments or chambers. For example, I have shown a pair of horizontally spaced guide rails 36 in the main heating chamber, as best illustrated in Fig. 4, and another pair of vertically spaced tracks 37 in the preheating chamber. These tracks 36 and 37 engage the headers and thus support the tube bundles and hold them in proper position in the shell. The several tracks may be mounted on suitable brackets 38, 39, 40 and 41, as best illustrated in Fig. 4.

If desired, a horizontal baffle 5' may be mounted over the tube bundle of the main heating unit, the arrangement being such that as the water is evaporated the water passes around the edges of this baffle into a vapor space in the top of the shell, from which it is discharged thru the vapor outlet 7.

For commercial applications where it is desirable to use a liquid such as hot tar as the heating medium it is desirable to employ end connections for the tube bundles which will minimize the tendency of the hot tar to coke at the points where the heating medium is supplied to and discharged from the several tube passes. Such a construction is illustrated in Figs. 5 to 8 inclusive. Upon referring to these figures it will be noted that the apparatus there illustrated is substantially the same as that illustrated in Figs. 1 to 4 inclusive except for the tube bundle end connections and, accordingly, where applicable the same reference characters have been applied and the above description may be regarded as a description of this modification of the apparatus except for the end connections for the tube bundles.

Referring to Figs. 5 to 8 inclusive the manifold 42 mounted on the face of the tube sheet 3 is provided with an inlet 43 and an outlet 44 for the hot tar or similar heating medium. The several connecting chambers 45 in the manifold have smooth curved walls for conducting the heating medium to and from the several banks of tubes, the configurations of these chambers being such as to provide approximately streamline flow of the heating medium from one set of tubes to the adjacent group of tubes.

The rear end of the preheater tube bundle is mounted in a tube sheet 46 having tapered openings for receiving the tapered ends of U-shaped connections 47 one such connection being provided for each adjacent pair of tubes, as best illustrated in Fig. 5. The internal bore of each of these connections 47 is substantially the same diameter as that of the tubes communicating therewith and thus the U-shaped end connections 47 provide streamline flow for the heating medium at the rear end of the heat exchanger. Each of the U-shaped end connections 47 is held in place by means of suitable brackets 48 and bolts 49 which secure the end connections to the tube sheet 46.

In like manner the tubes 15 of the main heating unit may be mounted in a tube sheet 50 having tapered bores for receiving the tapered ends of U-shaped end connections 51. These end connections may be like the end connections 47 of the preheating unit and in like manner they may be held in place by suitable brackets 52 and bolts 53 secured to the tube sheet 50. The individual detachable end connections 47 and 51 and the manifold 42 with its curved passages substantially increase the efficiency of the apparatus when hot tar, or the like, is used as a heating medium for they prevent the abrupt changes in direction or velocity of flow of the heating medium which ordinarily results in the formation of deposits of carbon or coke. The use of separately detachable end connections makes it possible to inspect and clean some of the tubes without opening up all of the tube passages.

It is to be understood that the embodiments of my invention described in detail herein are merely illustrative of heat exchangers employing my improvements and that the invention is not confined to such embodiments but includes all modifications thereof falling within the scope of the appended claim.

I claim:

A heat exchanger comprising a horizontal shell, a vertical partition in said shell providing therein a heating chamber and a preheating chamber communicating therewith over the top of said partition, separate tube bundles in said chambers and means for holding the opposite ends of said tube bundles in substantially fixed relation to each other, whereby changes in tube temperature cause lateral distortion of the tubes, said partition being spaced from the shell at points below the top of the partition and extending to the bottom thereof to provide restricted flow of fluid from one chamber to the other at these points.

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