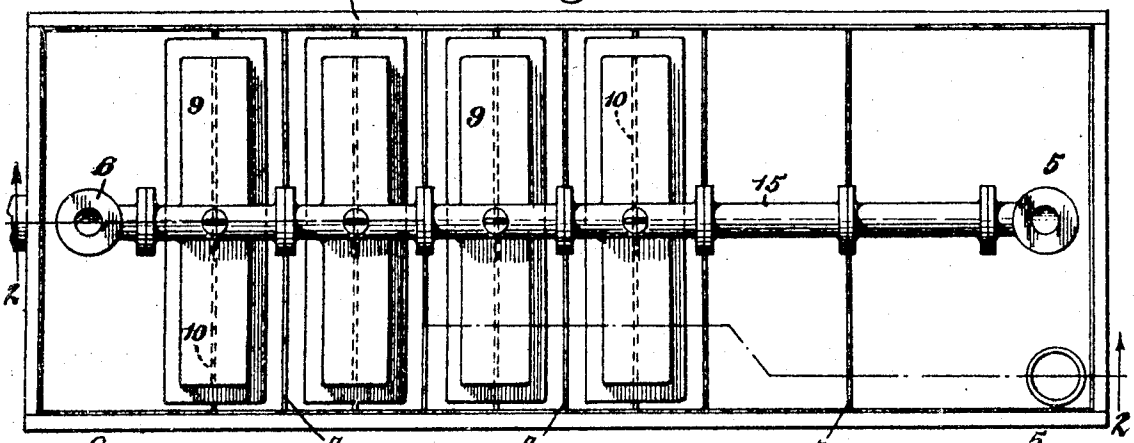
June 16, 1931. O. E. FRANK ET AL 1,810,165

HEAT INTERCHANGER

Filed Sept. 24, 1928

Fig. 1.



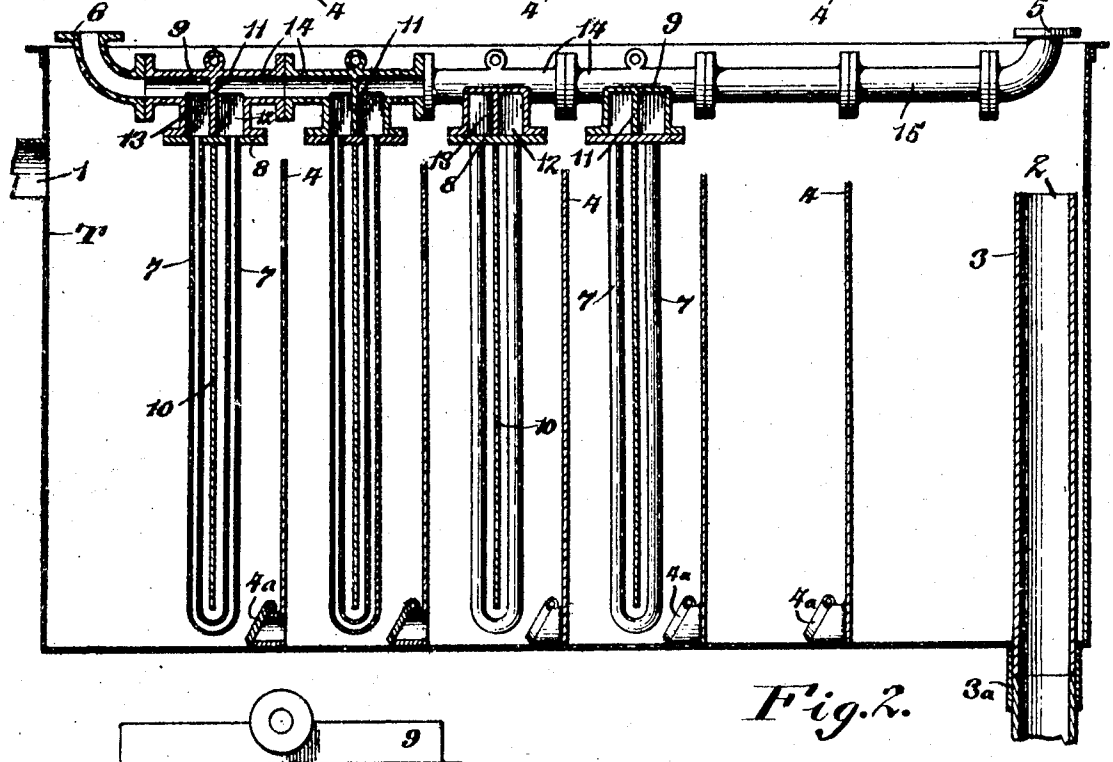


Fig. 2.

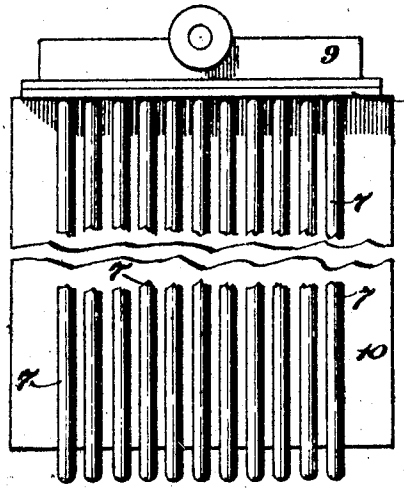


Fig. 3.

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Patented June 16, 1931 1,810,165

UNITED STATES PATENT OFFICE

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HEAT INTERCHANGER

Application filed September 24, 1928. Serial No. 307,931.

This invention relates to heat interchangers and proposes a construction which is particularly intended for, but not necessarily limited to, the reclamation of heat from the waste water of a laundry.

The principal object of the invention is to provide a heat interchanger with an active or heat interchanging surface the area of which can be readily varied whereby the capacity of the unit may be increased or decreased at will to suit the particular requirements of the installation at any time.

A further object is to provide an interchanger which will not collect dirt quickly, which will permit the free expansion of the tubes and which operates with full counter flow effect.

A further object is to attain such simplicity in design as will greatly facilitate the manufacture, inspection, cleaning and repair of the interchanger.

In the preferred embodiment, the invention comprises a tank having a series of compartments into which heat exchange elements may be bodily inserted for series communication, the elements providing a path of flow for one of the fluids and cooperating with the walls of the compartments to delimit a path of flow for the other fluid.

An embodiment of the invention is shown in the accompanying drawings, wherein:

Figure 1 is a top plan view of the unit.

Figure 2 is a section along line 2—2 of Fig. 1.

Figure 3 is a front elevation of a heat exchange element.

The tank T which preferably is of rectangular shape, is made of a length depending upon the ultimate capacity of the unit. It is provided at opposite ends, with inlet and outlet openings 1 and 2 respectively, the outlet opening in this embodiment being in the form of a drain pipe 3 which extends upwardly through the bottom of the tank. The drain pipe 3 is preferably mounted to permit its removal from the top of the tank and to this end the drain pipe is closely fitted in a sleeve 3—*a* depending from the bottom of the tank, the pipe extending into the sleeve for a distance suitable to insure a firm support. The tank is preferably divided between its inlet and outlet openings, into a series of open top compartments by a number of transversely arranged upright baffles 4. The baffles preferably decrease in height progressively from the inlet to the outlet openings in order to provide a pressure head for the fluid flowing through the compartments. The baffles 4 are provided at their lower ends preferably with drainage openings which, normally, are closed by hinged gates 4—*a*. When it is desired to drain the tank, the pipe 3 is removed and the gates 3—*a* swung to open position, a chain or other suitable device being attached to the gates for this purpose. This arrangement permits the tank and unit to be inspected, cleaned, etc., without requiring the partial or complete dismantling of the unit. It may be noted that the invention also contemplates constructions in which the baffles 4 are removably mounted. In such case, the gates 4—*a* may or may not be utilized, as desired.

Each compartment is adapted to receive a heat exchange element which, when inserted, is connected in series with the other elements between inlet and outlet pipes 5 and 6 respectively. These elements are preferably identically constructed and include a series of tubes 7 preferably of U-shape. The opposite ends of the tubes are secured to, and pass through, a tube sheet or plate 8 which is bolted or otherwise removably secured to a hollow header 9. The tube sheet 8 provides a convenient support for a baffle 10 which is secured thereto and extends between the legs of each tube down to a point adjacent their lower ends. The header 9 is divided by a barrier 11 into inlet and outlet chambers 12 and 13, these chambers communicating with the opposite ends of the tubes. The chambers also communicate with adjacent elements through extensions 14 formed on opposite walls of the header. Of course, it will be understood that in place of the U-shaped tubes, straight tubes may be utilized together with a lower connecting header.

The positioning of an element in the unit

is accomplished merely by bodily placing the element, tubes first, into one of the compartments and bolting the extensions of the element to the extensions of adjacent elements, the opposite ends of the entire series of elements being similarly secured to the inlet and outlet pipes respectively. If desired, the elements may be supported by ledges secured to the inner sides of the tank and engaging the under sides of the tube sheets 8 or by suitably engaging the baffle 10 of each element. To facilitate the manipulation of the elements into or out of the compartments, the headers are provided with eyebolts 15. When the elements are properly positioned in the compartments, the tubes 7 are spaced from the bottom of the tank a distance sufficient to permit the free expansion of the tubes at all times. The baffle 10 carried by each element is also spaced from the bottom to provide a passage for the flow of the liquid in the tank.

In the operation of the unit, a fluid such as the hot waste water of a laundry is admitted to the tank through the inlet opening 1 and flows downwardly in one compartment around the lower end of the baffle 10, thence upwardly in the same compartment along the opposite side of the baffle 10 into the next compartment wherein the cycle is repeated and so on to the outlet pipe 2. It should be noted that the sinusoidal or U-shaped path of flow thus defined for the waste water is maintained substantially parallel to the tubes 8 throughout the unit instead of transversely across the tubes as is the usual practice. This arrangement has the advantage that it tends to prevent the collection of dirt upon the tubes, thereby enabling the units to be operated for longer intervals before cleaning is necessary. It also enables the unit to be operated with full counter flow effect which is realized by passing the water in the tubes in a direction reverse to that of the waste water.

The fluid to be heated passes from the inlet pipe 5 through the extension 14 and inlet chamber 12 of the first element into the tubes 7 and thence through the outlet chamber 13 and extension 14 of such element into the next element and so on to the outlet pipe 6.

A feature of this invention lies in the ease with which the capacity of the unit may be increased or decreased. For example, when a unit having six elements is required, a tank adapted to hold seven or more elements may be readily installed with but slight increase in cost. Such unit can then be operated with such number of elements as is required for its immediate needs, the additional compartments while remaining idle being bridged by a removable pipe 15 such as is shown in Figures 1 and 2. When it is desirable or necessary to increase the capacity, it is a comparatively simple matter to obtain one or more additional elements and substitute them for the pipes 15. Of course, where it is desired to decrease the capacity, it is only necessary to remove an element and replace it with a pipe 15.

It will be readily appreciated that a unit of this type, especially when utilized to reclaim laundry waste water heat, may be installed directly in the floor of the laundry where it does not take up space or otherwise interfere with the regular operation of the laundry. Of course, when so installed, provision should be made to cover up the tank in a manner such as will insure safety while permitting easy access to the elements. It will also be realized that a unit of this type is not limited by external dimensions but may be made as long, as wide, or as deep as is desirable or necessary within practical limits and, that regardless of its size, the elements can always be readily inserted, removed, inspected, cleaned or repaired. Finally it may be said that the simplicity of the construction of the various parts of the unit and of the unit as a whole, facilitates its manufacture and installation.

While the arrangement of baffles 4 and 10 as shown and described is preferred, it is to be understood that such arrangement is not essential and may be varied even to the extent of eliminating them entirely. For example, one arrangement contemplated is to omit the baffles 10 and space alternate baffles 4 from the bottom of the tank, the remaining baffles 4 remaining as shown. In such case the path of flow extends from the inlet opening downwardly under the first baffle and upwardly over the second baffle continuing in like manner to the outlet opening. Another similar arrangement contemplated is to omit the baffles 10 and space alternate baffles 4 from one side of the tank, the remaining baffles 4 being spaced from the opposite side of the tank. With this arrangement the path of flow extends from the inlet opening to one side of the tank around the first baffle and then to the other side of the tank around the second baffle and so on to the outlet opening. In both of these cases it will be noted that a sinusoidal flow results taking in the entire area of the tubes. A further variation in which a sinusoidal flow is obtained, consists in spacing all of the baffles 4 from one side of the tank and all of the baffles 10 from the other side of the tank, suitable means being utilized to close the space between the lower edge of the baffles 10 and the bottom of the tank. In this case the flow is from one side of the tank to the other passing around baffles 4 and 10 alternately. Of course, where all of the baffles are omitted, the flow extends directly through the tank. Inasmuch as all of the modifications noted are

of a very simple nature and easily understood, illustration is not deemed necessary.

Having fully described our invention, we claim:

1. A heat interchanger comprising a tank through which one of the heat exchanging fluids flows and a series of heat exchange elements bodily insertable into and removable from said tank, each of said elements including a U-shaped tube, said elements being adapted for series connection whereby when inserted in said tank and serially connected they provide for the other heat exchange fluid a path of flow which is in heat interchange relation with the fluid flowing through said tank.

2. A heat interchanger comprising a tank, means to divide said tank into a series of compartments and connected heat exchange elements located in and severally removable from said compartments, said elements providing a path of flow for one of the heat exchanging fluids and having severally associated means therewith for cooperation with the walls of said compartments to delimit a path of flow for the other heat exchanging fluid substantially parallel to the path of flow provided by said elements.

3. A heat interchanger comprising a tank, means arranged to divide said tank into a series of compartments and heat connected exchange elements located in and severally removable from said compartments, each element providing through the compartment in which it is located a substantially U-shaped path of flow for one of the heat exchanging fluids and having associated therewith means for cooperation with the walls of such compartment to delimit a substantially U-shaped path of flow for the other heat exchanging fluid, said fluids being arranged to flow in opposite directions.

4. A heat interchanger comprising a tank, baffles arranged to divide said tank into a series of compartments through which one of the heat exchanging fluids flows, said baffles being of progressively decreasing height to provide a pressure head for said fluid, and connected heat exchange elements severally located in said compartments, said elements providing a path of flow for the other heat exchanging fluid.

5. A heat interchanger comprising a tank, means arranged to divide said tank into a series of compartments through which one of the heat exchanging fluids flows, and individual heat exchange elements bodily insertable into said compartments, for series connection to provide for the other heat exchanging fluid a path of flow in heat exchanging relation with said first mentioned fluid, said elements comprising a header formed with inlet and outlet chambers, a tube sheet secured to said header and a series of tubes secured to said tube sheet, the opposite ends of said tubes communicating respectively with said inlet and outlet chambers.

6. A heat interchanger comprising a tank, means arranged to divide said tank into a series of compartments through which one of the heat exchanging fluids flows, and individual heat exchange elements bodily insertable into said compartments for series connection to provide for the other heat exchanging fluid a path of flow in heat exchanging relation with said first mentioned fluid, said elements comprising a header formed with inlet and outlet chambers, a tube sheet secured to said header, a baffle depending from said tube sheet and a series of tubes secured to said tube sheet, the opposite ends of said tubes communicating respectively with said inlet and outlet chambers and the intermediate portions of said tubes extending downwardly around said baffle, the latter cooperating with the walls of said compartments to compel the first mentioned fluid to flow along the tubes as it passes through the compartments.

7. A heat interchanger comprising a tank, baffles arranged to divide said tank into a series of compartments through which one of the heat exchanging fluids flows, heat exchange elements located in said compartments, said elements providing a path of flow for the other heat exchanging fluid, and normally closed means connecting said compartments and arranged to facilitate the drainage of each compartment.

8. A heat interchanger comprising a tank, means arranged to divide said tank into a series of compartments through which one of the heat exchanging fluids flows and a connected group of U-shaped heat exchange elements, each element of which is adapted to occupy a compartment, said group being adapted for insertion into and removal from said tank as a unit and, when inserted, providing for the other fluid a path of flow in heat exchange relation with said fluid first mentioned.

9. A heat interchanger comprising a tank, means arranged to divide said tank into a series of compartments through which one of the heat exchanging fluids flow and a connectable group of U-shaped heat exchange elements, each element of which is adapted for individual insertion into or removal from said tank, said group of elements being adapted also for insertion into or removal from said tank as a unit and, when inserted as a unit, providing for the other fluid a path of flow in heat exchange relation with said fluid first mentioned.

10. A heat interchanger comprising a tank, means arranged in said tank to define a tortuous path of flow for one of the heat exchange fluids, and a group of U-shaped heat exchange elements arranged

along said path and communicating with each other to define for the other heat exchange fluid a path of flow in heat exchange relation with the fluid first mentioned.

11. A heat interchanger comprising a tank, means arranged in said tank to define a tortuous path of flow for one of the heat exchange fluids, and a group of U-shaped heat exchange elements connected in series and arranged along said path to define for the other heat exchange fluid a path of flow in heat exchange relation with the fluid first mentioned, said group of elements being arranged for insertion or removal as a unit.

12. A heat interchanger comprising a tank, means arranged in said tank to define a tortuous path of flow for one of the heat exchange fluids, and a group of individual U-shaped heat exchange elements each element being adapted for insertion into or removal from said tank, said elements also being adapted for communication with each other whereby, when inserted, they provide for the other fluid a path of flow in heat exchange relation with the fluid first mentioned.

13. A heat interchanger comprising a tank through which one of the heat exchanging fluids flows and a series of heat exchange elements bodily insertable into and removable from said tank, each of said elements including a tube of sinuous form, the various parts of which lie in a common plane substantially parallel to the path of flow of said heat exchanging fluid, said elements being adapted for series connection whereby when inserted in said tank and serially connected they provide for the other heat exchanging fluid a path of flow which is in heat exchange relation with the fluid flowing through said tank.

14. A heat interchanger comprising a tank through which one of the heat exchanging fluids flows and a series of heat exchange elements bodily insertable into and removable from said tank, each of said elements including a plurality of tubes of sinuous form, the various parts of each tube being in a common plane substantially parallel to the path of flow of said heat exchanging fluid and substantially parallel to the planes occupied by adjacent tubes of said element, said elements being adapted for series connection whereby when inserted in said tank and serially connected they provide for the other heat exchanging fluid a path of flow which is in heat exchange relation with the fluid flowing through said tank.

15. A heat interchanger comprising a tank, means for dividing said tank into a series of compartments and connected heat exchange elements located in and severally removable from said compartments, each of said elements including a plurality of tubes of sinuous form and adapted to provide a path of flow for one of the heat exchanging fluids and means associated with said elements for co-operation with said dividing means to provide a sinuous path of flow for the other heat exchanging fluid.

In testimony whereof we hereby affix our signatures.

OLIVE E. FRANK.
HERBERT P. WILDER.