Nov. 12, 1935. T. H. IRELAND 2,021,009

HEAT EXCHANGER

Filed May 16, 1934

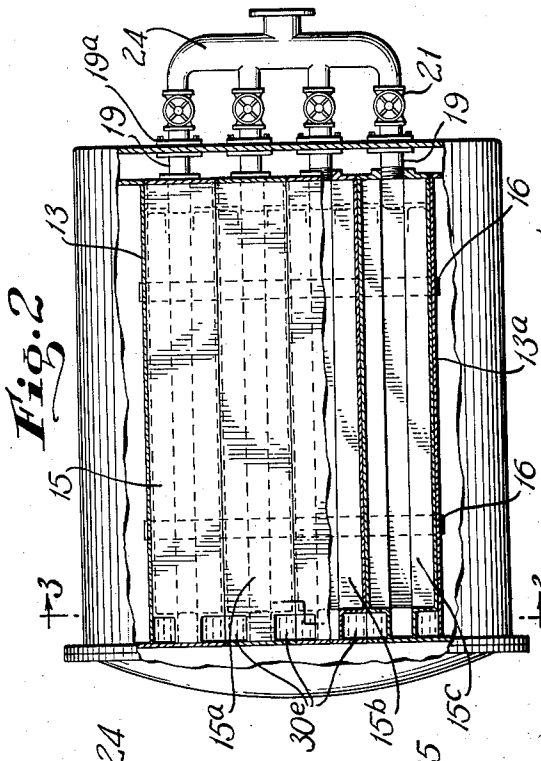

Fig. 2

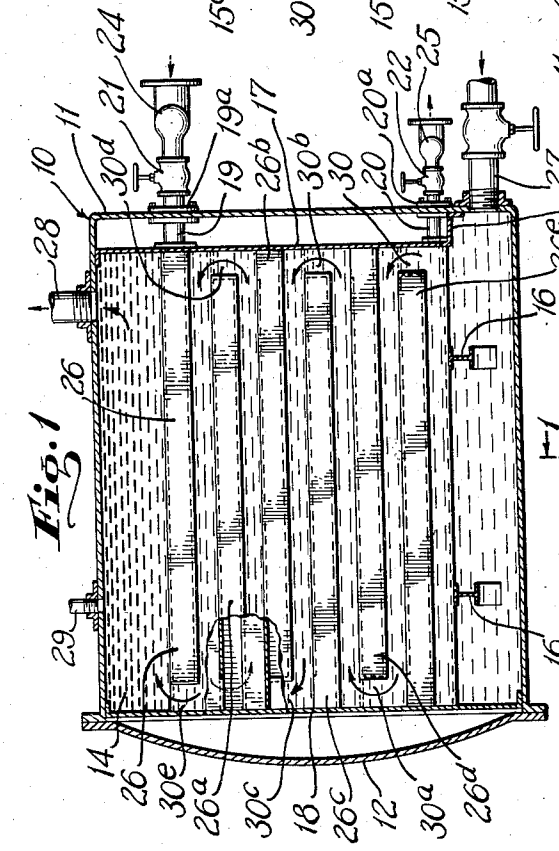

Fig. 1

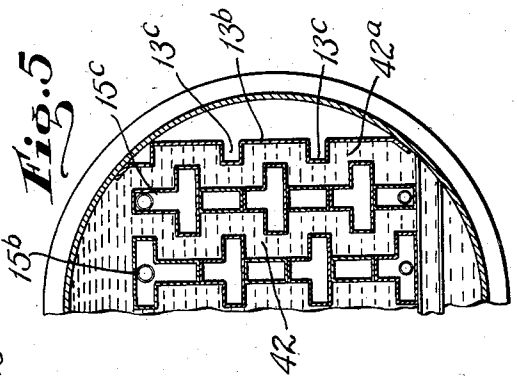

Fig. 5

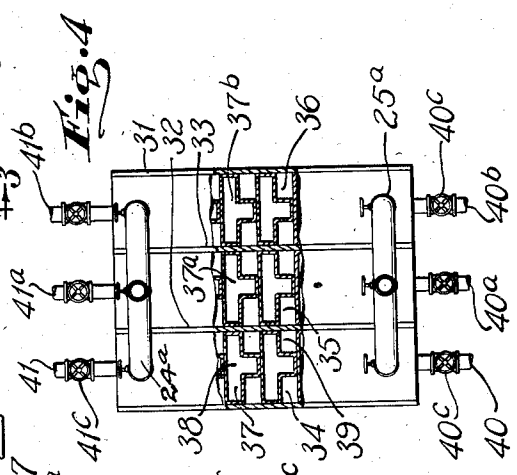

Fig. 4

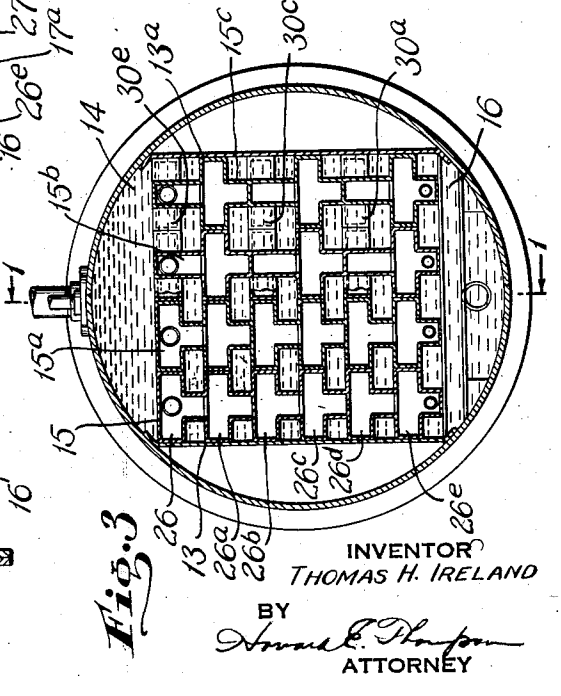

Fig. 3

INVENTOR
THOMAS H. IRELAND
BY
ATTORNEY

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HEAT EXCHANGER

Thomas H. Ireland, Rockville Centre, N. Y.

Application May 16, 1934, Serial No. 725,962

16 Claims. (Cl. 257—240)

This invention relates to devices or apparatus for use in heating fluids or plastic substances; and the object of the invention is to provide a heat exchanger consisting of a series of tubular sections in which is formed a continuous coil like passage through which a heating medium or a fluid or other elements to be heated is adapted to pass, the structure of said section being such as to provide fluid or other circulating passages of irregular contour disposed outwardly of the tubular section; a further object being to provide a tubular section of such cross sectional form as to provide a relatively large radiating or contact surface providing a quick transfer of the heat from the medium employed; a further object being to provide a heat exchanging unit wherein the series of tubular sections are disposed side by side to form therebetween circulating passages, and whereby each section may be separately removed from the unit for cleaning, repair or replacement; a further object being to provide a unit of the class described wherein the separate sections are subdivided one from the other to provide independent series of circulating passages or chambers; and with these and other objects in view, the invention consists in a device of the class and for the purpose specified, which is simple in construction, efficient in use, and which is constructed as hereinafter described and claimed.

The invention is fully disclosed in the following specification, of which the accompanying drawing forms a part, in which the separate parts of my improvement are designated by suitable reference characters in each of the views, and in which:

Fig. 1 is a longitudinal sectional view through one form of heat exchanger which I employ, showing parts of the construction broken away, the section being substantially on the line 1—1 of Fig. 3.

Fig. 2 is a plan view of the structure shown in Fig. 1, with parts broken away and in section.

Fig. 3 is a section on the line 3—3 of Fig. 2.

Fig. 4 is an end view of a modified form of heat exchanger which I employ, with parts of the construction broken away and in section; and

Fig. 5 is a view similar to Fig. 3 showing only a part of the construction and showing a modification.

In Figs. 1 to 3 inclusive, I have shown a heat exchanger consisting of a cylindrical casing 10 having a closed end wall 11, the other end of the casing being open. A detachable cover 12 is employed for gaining access to the interior of the casing. Within the cylinder 10 are two side wall plates 13, 13a which form therewithin a heat exchanging chamber 14 in which a plurality of tubular units 15, 15a, 15b and 15c are employed. These units rest upon transverse supporting rails 16. Each unit or section 15, 15a, 15b and 15c is of similar construction, and therefore, the brief description of one will apply to all.

Each section includes end wall plates 17 and 18, and a pipe or nipple 19 is coupled with the plate 17 and in communication with the upper portion of the section. Another pipe 20 is coupled with the plate 17 and the lower portion of the section. Each of these pipes or nipples is detachably coupled with the wall 11 through flanged nipples 19a, 20a, in which are disposed respectively valves 21, 22 with which manifolds 24, 25 have their separate branches connected so as to provide intake and exhaust passages communicating with the four tubular units 15, 15a, 15b and 15c, as will be apparent from a consideration of Figs. 1 and 2 of the drawing.

For the purpose of describing one use of my invention, let us assume that the manifold 24 constitutes a steam inlet manifold and the manifold 25 a steam or condensation exhaust manifold. It will thus be seen that steam will enter the top portion 26 of the respective tubular sections, which portion is T-shaped in cross sectional form, and for the purpose of this description, this passage of the steam may be said to pass forwardly. At the forward end, the steam will then enter the next adjacent part 26a and extend backwardly therethrough and again forwardly through the part 26b, again backwardly through the part 26c, forwardly through the part 26d and then backwardly through the part 26e and out through the pipe 20 and manifold 25. The parts 26 to 26e inclusive are all integrally formed to constitute the tubular sections or units 15, 15a, 15b and 15c, permitting attachment of the units and detachment with respect to the chamber 14.

Also for the purpose of illustrating one use of my invention, let us say that water to be heated will enter the bottom of the casing 10 through the pipe 27 and will be discharged through the top of the casing through the pipe 28, 29 representing a pipe for a safety valve gage or other device. The water entering the bottom of the chamber 14a will circulate forwardly and backwardly through said chamber around the sections or units 15, 15a, 15b and 15c, which result is accomplished by removing portions of the T-head at opposite ends

of the separate parts 26 to 26e in the manner indicated in Fig. 1 of the drawing. For example, the part 26e has its T-head removed at the rear end thereof to form side passages 30, whereas the part 26d has passages 30a at the forward end, the part 26c a passage 30b at the rear end, the part 26b a passage 30c at the forward end, the part 26a a passage 30d at its rear end, and the part 26 a part 30e at its forward end, thus forming a continuous coil-like passage extending forwardly between the parts 26e—26d, backwardly between the parts 26d—26c and so forth until it enters the top forward end of the chamber 14 from which the water passes to the rear end thereof and out through the discharge pipe 28 from which it may be lead to a storage tank or to any other supply for which it is intended. It will be understood from a consideration of Fig. 3 of the drawing, that the water circulating coil-like passages are disposed at both sides of each section or unit 15 to 15c inclusive, and by virtue of the arrangement of the sections side by side, relatively wide passages are formed between adjacent sections.

The left half of the cross section shown in Fig. 3 is taken through the sections 15, 15a rearwardly of the passages 30, 30a, 30c and 30e, whereas the section to the right is taken through said passages. The passages 30 to 30e inclusive are partially formed by the end plates 17, 18, the plate 17 having extending bottom flanges 17a which serve to direct the water primarily through the coil-like passages formed around the section. While a little water may pass into the compartment formed at the front and rear ends of the casing, this will not be detrimental nor in any way affect the successful operation of the heat exchanger, it being desirable to have the plates 18 independently mounted with respect to the separate sections employed to provide for any expansion and contraction that may prevail in said sections.

In Fig. 4 of the drawing, I have shown a slight modification which consists simply in providing preferably a rectangular casing 31 which is subdivided by partitions 32 and 33 into three separate circulating chambers or compartments 34, 35 and 36 in which are disposed separate tubular units or sections 37, 37a and 37b which are substantially similar in form but slightly different in wall construction to the sections 15 shown in Figs. 1 to 3 inclusive, in other words, provided as in the illustration shown in said figures with steam circulating passages 38 and water circulating passages 39, the steam being introduced into the separate sections 37, 37a and 37b through a manifold 24a similar to the manifold 24 but having only three discharges instead of four, and steam or condensation is discharged through a manifold 25a similar to the manifold 25.

However, with the construction shown in Fig. 4, separate water supply pipes 40, 40a and 40b having valves 40c are employed, and separate discharge pipes 41, 41a and 41b all having valves 41c are also employed so that each section or unit of the complete exchanger shown in Fig. 4 may be independently operated. For example, if one section should require repair or cleaning, for example, the section 37, a supply of steam to this section will be cut off as well as the supply of water but the other two sections 37a, 37b may be operated, it being apparent that separate cover plates will be provided for each of the sections.

In Fig. 5 of the drawing, I have shown a modification of the construction shown in Figs. 1 to 3 inclusive, which, like Fig. 1, differs slightly in construction by providing a double wall between the respective tubes of the sections, and Fig. 5 further differs in that the separate sections 15, 15a, 15b and 15c are disposed alternately in inverted relation with respect to each other, the sections 15b, 15c only being shown, and as seen the section 15c is inverted with respect to the section 15b. With this construction, it is not essential to employ the cut out portions forming the passages 30—30e, and the water to be circulated around the sections passes from the bottom of the casing upwardly around and between the sections in the irregular or retarded path formed by the inverted arrangement of the sections 15b, 15c, such for example as the passage 42 shown between the sections 15b and 15c in Fig. 5. With this construction, side wall plates 13, 13b are employed having offsets 13c therein which form outwardly of the side sections, for example, the section 15c, passages 42a corresponding in general cross sectional form to the passages 42.

This type of construction does not retard the circulation of the water around the sections to the extent shown in Figs. 1 to 3 inclusive, but will nevertheless provide an effective heat exchanger providing relatively large exposed areas of the steam coils to the water circulated thereabout.

Aside from the different arrangement of the sections, the structure shown in Fig. 5 is otherwise similar to that shown in Figs. 1 to 3 inclusive, the separate sections being independently removable for cleaning, repair and other purposes.

By providing tubular sections or units of the class described, very effective and efficient heat exchangers may be constructed, the material employed in the sections or units being designed to suit the various uses to which the same is intended both as to size and grade. By using separate sections or units, cleaning and repairs may be accomplished in a quick and efficient manner, especially in the removal of sediment, scale and the like which may collect around the coils when using the device as a water heater.

With the construction shown in Fig. 4 of the drawing, it will also be apparent that in some uses of a device or apparatus of the kind here illustrated, it may be practical and desirable to provide a continuous circulation through the sections 37, 37a, 37b, that is to say, a circulation which would extend from the section 37 to the section 37a and then to the section 37b, and in like manner, circulation through the chambers 34, 35 and 36 may be likewise continuous; or, in either case, one of the circulations may be continuous and the other independent with different degrees of temperature controlling the independent circulations, especially where it is desirable to gradually increase or decrease the temperature applied to a fluid, syrup compound, gas or the like. At this time, it will also be apparent that my invention is not necessarily limited to any particular number of the separate sections employed.

It will also be understood that my invention is not necessarily limited to the circulation of steam and water through the device as the heat exchanger is adaptable for use in heating various kinds and classes of fluids, semi-fluids and plastic substances, it being also understood that various types of heating mediums may be employed

and the heat medium may be circulated either through the sections or therearound, it being further apparent that by virtue of the structure and design of my improved device, the same is adaptable for use as a condenser, and it will also be apparent that various changes in and modifications of the construction herein shown and described may be made within the scope of the appended claims without departing from the spirit of my invention or sacrificing its advantages.

Having fully described my invention, what I claim as new and desire to secure by Letters Patents, is:

1. In heat exchangers of the class described, a circulating unit consisting of a unitary tubular body having a continuous circulating passage extending forwardly and backwardly therethrough, said body having outwardly projecting tubular portions at opposed sides thereof spaced one from the other to form corresponding grooves therebetween forming in conjunction with adjacent side walls circulating passages outwardly of said body, and means at opposed ends of the body for placing the grooves on each side of the body in communication with each other to form a continuous zig-zag circulating passage at each side of said body.

2. In a heat exchanger of the class described, a tubular circulating unit consisting of elongated tubular portions disposed one adjacent the other, said portions being of irregular cross sectional contour, means at opposed ends of the tubular portions for placing the same in communication with each other to form in said unit a continuous substantially coil-like circulating passage therethrough, and each tubular portion of the unit being T-shaped in cross sectional form to provide between the T-heads of adjacent tubular portions longitudinal grooves at opposite sides of the unit.

3. In a heat exchanger of the class described, a tubular circulating unit consisting of elongated tubular portions disposed one adjacent the other, said portions being of irregular cross sectional contour, means at opposed ends of the tubular portions for placing the same in communication with each other to form in said unit a continuous substantially coil-like circulating passage therethrough, each tubular portion of the unit being T-shaped in cross sectional form to provide between the T-heads of adjacent tubular portions longitudinal grooves at opposite sides of the unit, and the T-heads of the tubular portions being cut out alternately at opposed ends thereof to place adjacent grooves in communication with each other alternately at opposed ends of the unit to provide at each side of the unit and in conjunction with an adjacent wall a continuous coil-like circulating passage.

4. In a heat exchanger of the class described, a tubular circulating unit consisting of elongated tubular portions disposed one adjacent the other, said portions being of irregular cross sectional contour, means at opposed ends of the tubular portions for placing the same in communication with each other to form in said unit a continuous substantially coil-like circulating passage therethrough, each tubular portion of the unit being T-shaped in cross sectional form to provide between the T-heads of adjacent tubular portions longitudinal grooves at opposite sides of the unit, the T-heads of the tubular portions being cut out alternately at opposed ends thereof to place adjacent grooves in communication with each other alternately at opposed ends of the unit and a plurality of said units being disposed side by side in abutting relation with the zig-zag passages on the sides thereof in registering alinement with each other to provide at each side of the unit a continuous coil-like circulating passage.

5. In a heat exchanger of the class described, a tubular circulating unit consisting of elongated tubular portions disposed one adjacent the other, said portions being of irregular cross sectional contour, means at opposed ends of the tubular portions for placing the same in communication with each other to form in said unit a continuous substantially coil-like circulating passage therethrough, each tubular portion of the unit being T-shaped in cross sectional form to provide between the T-heads of adjacent tubular portions longitudinal grooves at opposite sides of the unit, the T-heads of the tubular portions being cut out alternately at opposed ends thereof to place adjacent grooves in communication with each other alternately at opposed ends of the unit, a plurality of said units being disposed side by side in abutting relation with the zig-zag passages on the sides thereof in registering alinement with each other to provide at each side of the unit a continuous coil-like circulating passage, and means for circulating a heating medium and an element or fluid to be heated, one through the passages of said units and the other through the passages formed around the units.

6. A heat exchanger of the class described comprising a casing open at one side, a cover closing said opening, a plurality of tubular circulating units mounted in the casing through the open side thereof, said units being independently attachable and detachable with respect to the casing, each unit having a continuous coil-like circulating passage therein extending from the top to the bottom thereof, and means on said units for defining outwardly of the sides of the unit and independently of the circulating passages thereof other coil-like circulating passages opening into the casing.

7. A device of the class described comprising a casing, a plurality of independent tubular sections in said casing, each section having a continuous circulating passage extending forwardly and backwardly therethrough a number of times from the top to the bottom of said section, and means on said sections when mounted in the casing forming in conjunction with the casing and adjacent sections other independent circulating passages on opposed side walls of said sections.

8. A device of the class described comprising a casing, a plurality of independent tubular sections in said casing, each section having a continuous circulating passage extending forwardly and backwardly therethrough a number of times from the top to the bottom of said section, means on said sections when mounted in the casing forming in conjunction with the casing and adjacent sections other independent circulating passages on opposed side walls of said sections, means coupled with the ends of the circulating passages of said sections for forming intakes and discharges therefor, and intake and discharge pipes on the casing communicating with the intake and discharge ends of the second named circulating passages.

9. A device of the class described comprising a casing, a plurality of independent tubular sections in said casing, each section having a con-

tinuous circulating passage extending forwardly and backwardly therethrough a number of times from the top to the bottom of said section, means on said sections when mounted in the casing forming in conjunction with the casing and adjacent sections other independent circulating passages on opposed side walls of said sections, means coupled with the ends of the circulating passages of said sections for forming intakes and discharges therefor, intake and discharge pipes on the casing communicating with the intake and discharge ends of the second named circulating passages, and means whereby the separate sections may be attached and detached with respect to said casing.

10. In heat exchangers of the class described, a circulating unit consisting of a unitary tubular body having a continuous circulating passsage extending forwardly and backwardly therethrough a number of times from the top to the bottom of said body, and the cross sectional form of said body being such as to form a plurality of spaced projecting wall portions at opposite sides of said body, said projecting wall portions forming in conjunction with adjacent side walls independent circulating grooves outwardly of the side walls of said body.

11. In heat exchangers of the class described, a circulating unit consisting of a unitary tubular body having a continuous circulating passage extending forwardly and backwardly therethrough a number of times from the top to the bottom of said body, and said body having outwardly projecting tubular portions at opposite sides thereof spaced one from the other to form grooves therebetween in communication with each other at opposite ends of said tubular portions forming in conjunction with walls arranged adjacent said body other circulating passages outwardly of opposite sides of said body.

12. A heat exchanger of the class described comprising a casing, a chamber in said casing, means for introducing a substance into the bottom of said chamber and means for discharging the same through the top thereof, a circulating unit in said chamber forming between the top and bottom thereof and side walls of said chamber continuous zig-zag circulating passages, and said unit comprising a unitary body having a continuous circulating passage independent of the passages in said casing and extending forwardly and backwardly through said unit a number of times from the top to the bottom thereof.

13. A heat exchanger of the class described comprising a casing, a chamber in said casing, means for introducing a substance into the bottom of said chamber and means for discharging the same through the top thereof, a circulating unit in said chamber forming between the top and bottom thereof and side walls of said chamber continuous zig-zag circulating passages, said unit comprising a unitary body having a continuous circulating passage independent of the passages in said casing and extending forwardly and backwardly through said unit a number of times from the top to the bottom thereof, and means at the opposed ends of the passage of said unit for introducing and discharging a predetermined substance or vapor therethrough.

14. In a heat exchanger of the class described, a tubular circulating unit consisting of elongated tubular portions disposed one directly upon the other, said portions being of substantially T-shaped cross sectional contour, and means at opposite ends of the tubular portions for placing the same in communication with each other to form in said unit a continuous substantially coil-like circulating passage extending forwardly and backwardly therethrough a number of times.

15. In a heat exchanger of the class described, a circulating unit comprising a unitary tubular body having a continuous circulating passage extending forwardly and backwardly therethrough a number of times from the top to the bottom of said body, opposite side walls of said body having spaced tubular projections of a width substantially equal to the width of the tubular body, the tubular projections on the side walls forming on said walls within the boundaries of said projections spaced grooves, opposite ends of alternate tubular projections being fashioned to place adjacent grooves in communication to form a continuous coil-like passage at opposite sides of said body within the boundaries of said projecting tubular portions.

16. In a heat exchanger of the class described, a circulating unit comprising a unitary tubular body, opposite side walls of said body having spaced tubular projections forming on said walls within the boundaries of said projections spaced grooves, means at opposite ends of alternate grooves for placing the ends of adjacent grooves in communication to form a continuous coil-like passage at opposite sides of said body within the boundaries of said projecting tubular portions.

THOMAS H. IRELAND.