

April 1, 1952

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HEAT EXCHANGER

2,591,179

Filed Jan. 4, 1949

2 SHEETS—SHEET 1

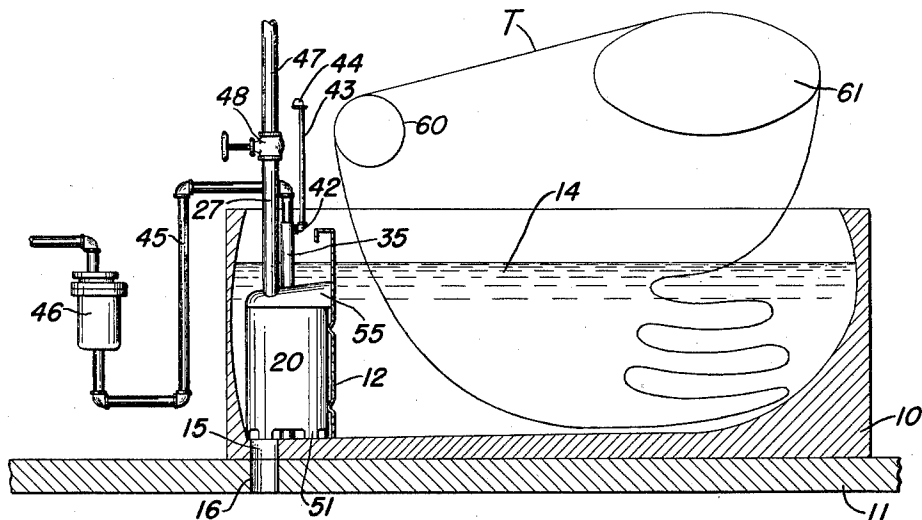


FIG. 1.

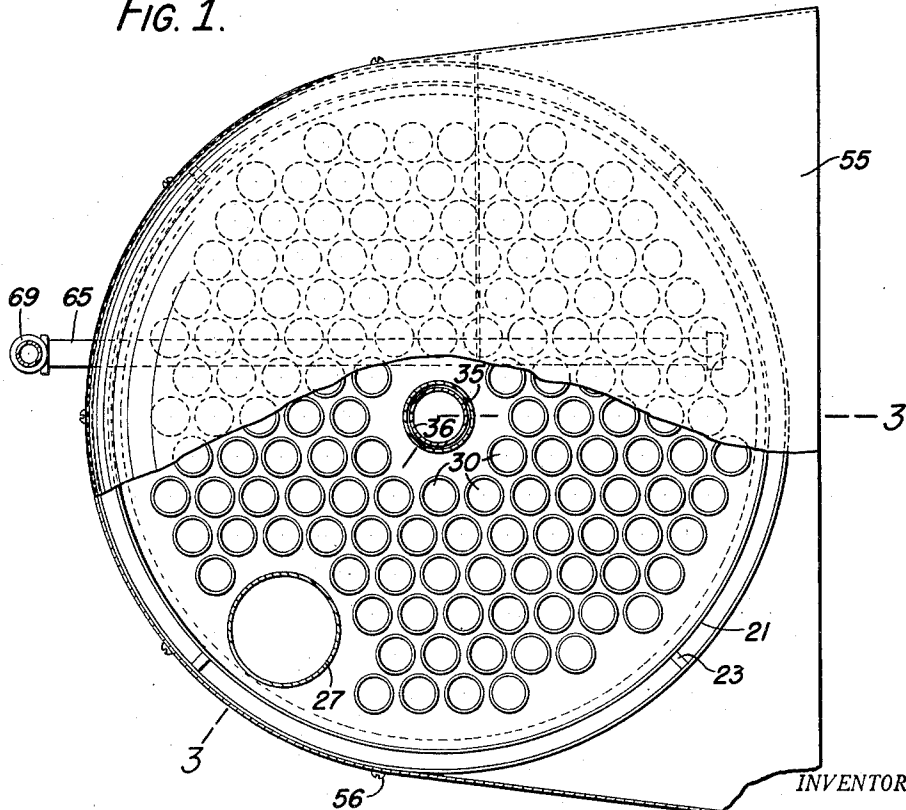


FIG. 2.

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2 SHEETS—SHEET 2

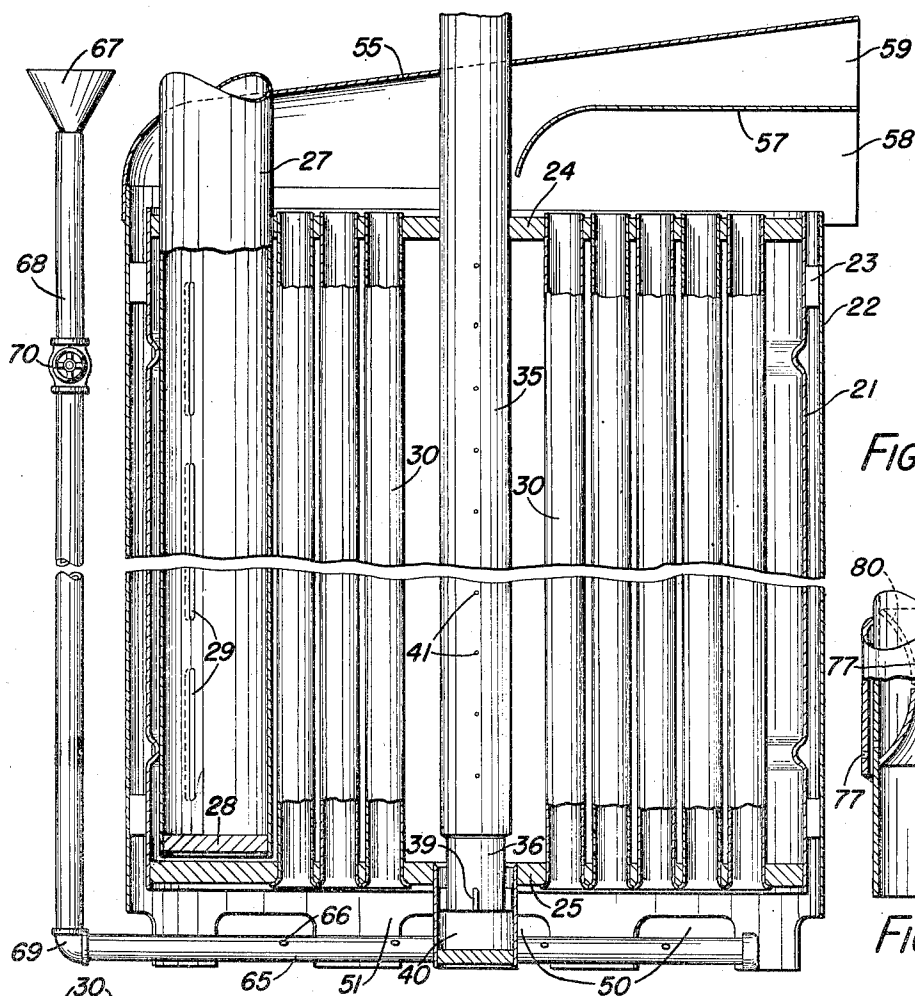


FIG. 3.

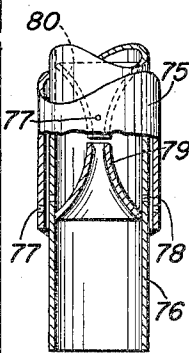


FIG. 7.

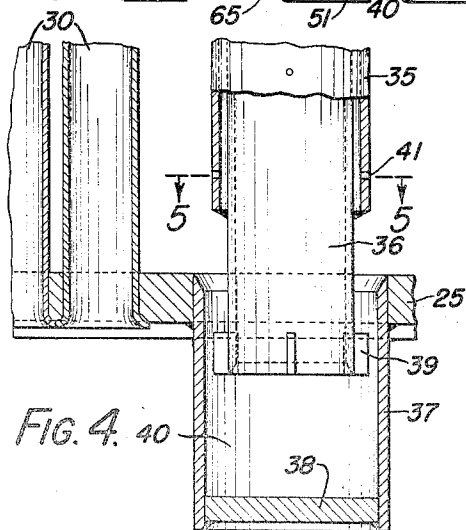


FIG. 4.

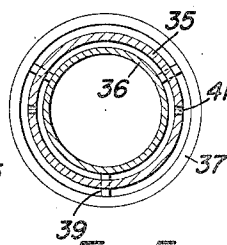


FIG. 5.

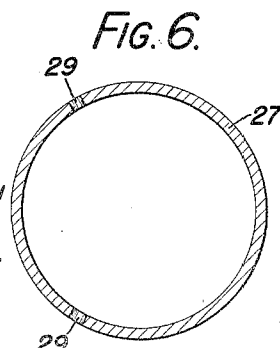


FIG. 6.

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2,591,179

HEAT EXCHANGER

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5 Claims. (Cl. 257-203)

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The present invention relates to heat exchangers and particularly to a heat exchanger for use in heating dye tubs.

Heretofore it has been the practice to inject steam directly into the dye solution in a dyeing tub to provide the heat required to heat the bath and effect a rapid and satisfactory dyeing operation. This practice has, however, several drawbacks. The dye solution is liable to be contaminated from boiler water carried over by the steam. Moreover, the dye solution is diluted by the steam condensate. Boiler water will affect the pH content of the bath and is particularly detrimental when dyeing pastel shades. The material must be redyed to obtain the desired shade. The correct amount of water is usually drawn into the tub before the dyeing operation begins and no provision is made for steam condensate being added to the bath since there are too many variables to permit determining accurately in advance what quantity of steam condensate may be added in use. The steam condensate, however, may add as much as 15% of water to the dye solution, which means that additional dye must be added to maintain the effectiveness of the solution, or the textile must be given two or more dye treatments. Moreover, the condensate forms superfluous water that must be heated; and the heat required to heat it is wasted heat.

With the conventional method of heating the bath, there is, furthermore, noise and vibration caused by injection of steam into the bath. In many cases, the vibration is so great that the seams of the tubs eventually are split. The additional vapor escaping from the surface of the bath, which is caused by the injected steam not condensing when the bath approaches the boiling temperature, presents, moreover, an additional steam removal problem.

One object of the present invention is to provide a method of heating a dye bath which will eliminate dilution of the bath and prevent possible change of pH in the bath.

Another object of the invention is to provide a method and apparatus for heating dye baths which will reduce the time required for matching shades.

Another object of the invention is to provide a method and apparatus for heating dye baths which will permit of obtaining the desired shade in a single dyeing operation.

A further object of the invention is to provide a method and apparatus for heating dye baths with which all possibility of diluting or contaminating the bath will be eliminated.

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Other objects of the invention are to provide a method and apparatus for heating dye baths which will insure a more uniform temperature throughout the bath, eliminate possibility of noise or vibration, and minimize the problem of steam removal from the surface of the bath.

Another object of the invention is to provide a method and apparatus for heating dye baths which will effect a reduction in the amount of fuel required to generate the heat needed for the bath.

Another object of the invention is to provide a heat exchanger for use in dye tubs which will produce extremely high circulation of the dye bath, if desired, and at the same time provide an extremely fast uniform temperature rise throughout the dye tub without any possibility of diluting or contaminating the solution.

Still another object of the invention is to provide a heat exchanger for dye tubs which can be installed in conventional tubs between the baffle and the adjacent end of the tub.

A still further object of the invention is to provide a heat exchanger for dye tubs in which the steam supply, condensate return, and air vent are arranged for top connection so that no holes or other openings are required in the tub.

A further object of the invention is to provide a heat exchanger for use in heating liquids in which the exchanger itself may be used as a unit, as well as through its internal construction, for heating and circulating the liquid.

Still another object of the invention is to provide a heat exchanger of the class described which can readily be installed and quickly removed from a bath for repairs or cleaning.

A still further object of the invention is to provide a method and apparatus whereby a heat exchanger may be used to effect rapid and thorough mixing of dye in a dye bath.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims.

In the drawings:

Fig. 1 is a longitudinal sectional view of a dye tub with a heat exchanger made according to the present invention installed therein;

Fig. 2 is a plan view, with parts broken away, of the heat exchanger, and showing, also, a pipe which may be associated with the heat exchanger, when in the dye tub, to supply dye to the bath;

Fig. 3 is a vertical sectional view of the exchanger taken on the line 3-3 of Fig. 2, and also showing the dye supply pipe;

Fig. 4 is a fragmentary sectional view on an enlarged scale showing the sump of the heat ex-

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changer, the condensate return pipe, the pipe for collecting non-condensables, and the manner in which the tubes of the exchanger are mounted in the lower wall thereof;

Fig. 5 is a section on the line 5—5 of Fig. 4;

Fig. 6 is a section through the steam feed pipe; and

Fig. 7 is a fragmentary sectional view showing an alternate construction of the condensate return pipe and the pipe for collecting the non-condensables.

Referring now to the drawings by numerals of reference, 10 denotes a dye tub of conventional construction, and 11 the floor of the dye room. The tub 10 has a baffle 12 near one end thereof which extends from side to side of the tube and which is perforated so as to permit the dye solution 14 to pass therethrough. 15 denotes the conventional drain plug through which the spent dye solution may be drained from the tub through an opening 16 in the floor for disposal.

The heat exchanger of the present invention, which is denoted as a whole at 20, is adapted to be placed between the baffle 12 and the adjacent end wall of the tub 10; and it may be made of a size to fit in this space without alteration whatsoever of the conventional tub. The heat exchanger comprises an internal cylindrical shell 21 and an outer cylindrical shell 22. The inner shell 21 is surrounded by the outer shell 22 and is supported from the outer shell by the spacer brackets 23. The upper and lower ends of the inner shell 21 are closed by tube sheet headers 24 and 25, respectively, so as to form a hollow drum.

A steam pipe 27 extends through a hole in the upper header 24 downwardly in the shell 21 very close to the lower header 25. The lower end of this steam pipe is closed by an end plate or disk 28. The steam pipe is provided with a plurality of slots 29, which are spaced from one another both vertically and angularly and through which the steam may escape into the interior of the shell 21. These openings 29 are so located angularly that the steam emitted therefrom does not impinge directly on the shell 21 or on the tubes, hereinafter referred to, mounted therein. Thus, maximum life of the tubes and shell is insured.

The headers 24 and 25 are provided with a plurality of aligned openings in which are mounted tubes 30. These tubes are open at both ends and the dye solution is adapted to circulate through them. The ends of the tubes 30 may be expanded or otherwise secured in the headers 24 and 25 so that the tubes have water-tight connection therewith. Suitable bell mouthings may be employed to reduce entrance and exit friction losses in the circulating liquid.

Mounted in a central opening in the header 24 is a pipe 35. Mounted within the pipe 35 to project below the lower end thereof is a pipe 36. Pipe 36 extends downwardly into a sump, denoted as a whole at 40, formed by welding a short pipe section 37 into a central opening in the lower header 25, and by welding a header or disk 38 into the lower end of the pipe section 37 to close the lower end thereof. The pipe 36 may be provided at its lower end with centering lugs 39 to center it in the sump section 37.

The inside pipe 36 is open at its lower end, but the outside pipe 35 has its lower end closed as by welding it to the pipe 36 and it terminates above the pipe 36, as clearly shown in Figs. 3 and 4. The outside pipe 35 is provided with a plurality

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of vent openings 41 which allow air or other non-condensables to enter it from shell 21. The lower end of pipe 35 is closed as by welding it to pipe 36. The pipe 35 is connected, however, at its upper end by an elbow 42 (Fig. 1) to a duct 43. Duct 43 connects with a trap that is denoted at 44 and which may be of any suitable construction. The purposes of this trap are to keep back any steam, that enters the pipe, until the steam condenses, and to vent air to the atmosphere or to a suitable system for carrying off the non-condensable gas.

The steam condensate in shell 21 flows into the sump 40 (Fig. 3) and passes up through the pipe 36 into a condensate line 45 (Fig. 1) and a trap 46 back to the boiler. Steam is supplied to the pipe 27 through the pipe 47 and globe valve 48.

The shell 22, which is open at both ends, is slotted as denoted at 50 (Fig. 3) adjacent its lower end to provide openings through which the dye liquid may enter the tubes 30. The portions of the shell between these openings form legs 51 which support the heat exchanger in the tub.

The upper end of the heat exchanger is covered by a hood 55 which is secured to the outside of the shell 22 by screws 56 (Fig. 2). This hood has openings in it through which the pipes 27 and 35 pass. It has a deflector 57 mounted in it beneath its top and extending from one side close to the pipe 35. This deflector serves to deflect the heated dye solution rising from the tubes 30 which lie below this deflector, out through the mouth or opening 58 in the hood and through an opening or perforations in the baffle 12 back into the main body of the bath. The top of the hood 55 itself is shaped to serve as deflector and to deflect the solution rising from the other tubes of the heat exchanger out through the mouth or opening 59 in the hood and through the baffle back into the main body of the bath. Opening 59 lies above opening 58.

60 and 61 denote more or less diagrammatically, respectively, the reels over which the textile T, which is to be dyed, moves during the dyeing operation, and which serve to circulate it through the bath.

In the operation of the heat exchanger, the steam transmitted to the exchanger will pass out through the slots 29 in the pipe 27 into the interior of the shell 21 to heat the tubes 30 of the shell and to heat the shell wall itself. The solution entering the tubes 30 will therefore be heated by the steam and the solution entering between the two shells 21 and 22 will also be heated. The heated solution will rise and be deflected by the hood 55 and its deflector 57 through the perforated partition 12 back into the bath 14. The cooled liquid in the bath 14 meantime will be finding its way through the openings 50 in the outer shell 22 up into the tubes 30 and between the two shells 21 and 22, where it in turn will be heated. The steam in the shell 21 as it condenses will liquify and drop into the sump 40 whence it will be carried through pipe 36 back to the boiler. Any trapped air or any non-condensable gas will enter through holes 41 into pipe 35 and be carried upwardly through pipe 43 to escape to the atmosphere or to any suitable gas-handling system through trap 44.

The trap may be eliminated, however, and the air carried off with the condensate, if desired. Thus, the pipes for the condensate and for the non-condensable gas may be constructed as shown in Fig. 7. Here 75 denotes the pipe into which the gases pass from the heat exchanger chamber, while 76 designates the pipe into

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which the condensate rises from sump 40. The pipe 76 may be supported in sump 40 in the same manner as pipe 35. Pipe 75 is provided with vent-openings 77, like the vent openings 41 of pipe 35. Pipe 75 is closed completely at both ends, however, and has no connection with a pipe like pipe 43 or with a trap like trap 44. Instead it communicates with pipe 76 through holes 78 in the latter pipe. Thus, the air is picked up by the liquid condensate and carried upwardly by the condensate to trap 46. To increase the suction and thereby pull the gas out of pipe 75 more rapidly, an inverted funnel like member 79 may be secured in pipe 76, as by welding. This member 79 is shaped somewhat like half of a Venturi-tube and will increase the velocity of the liquid at its outlet and thereby increase the pressure differential causing the non-condensable gases to enter the tube 80. This tube 80 is aligned with member 79 and is shaped like the other half of a Venturi-tube.

The heat exchanger of the present invention provides an effective means not only for heating and circulating a dye solution, but also for thoroughly and rapidly mixing dye into solution. The usual practice is to add dye by dumping it into the baths. It then goes into the bath in gobs; and it takes quite some time to get an even, uniform solution. By supplying the dye beneath my heat exchanger, however, the dye can be carried upwardly with the circulating liquid and through the rapid circulation produced by the action of the heat exchanger will be quickly mixed thoroughly throughout the solution.

One way of using the heat exchanger to effect this mixing of the dye is shown in Figs. 2 and 3. 65 denotes a pipe which may be mounted in the tub 10 to run under the tubes 30 of the heat exchanger. This pipe is closed at one end but has a plurality of holes 66 in it beneath the tubes 30. Dye can be added to the bath by pouring it into a funnel 67 which fits into the upper end of a vertical pipe 68 that is connected by an elbow 69 with pipe 65. A standard valve 70 may be provided in pipe 68 to control the flow of dye to pipe 65. As will be obvious, the dye flowing out of the holes 66 in pipe 65 is carried upwardly with and by the rising liquid and the circulation of the solution produced by the heat-exchanger rapidly mixes the dye in the liquid.

The heat exchanger of the present invention, when used in a dye tub, provides a rapid circulation of the dyeing solution and insures uniform temperature throughout the bath. There is no noise or vibration. The problem of steam removal is reduced. The dyeing process is improved and an exact control over the shade of color desired can be obtained. A very considerable saving in coal or the other means required for the generation of steam is effected because none of the steam is wasted by uselessly heating condensate in the bath, and because a minimum amount of initial heat is required since the steam no longer enters the bath directly, and there is, therefore, no longer a situation where non-condensed injected steam may escape from the surface of the bath by approach of the temperature of the bath to the boiling point. The steam is employed most efficiently because it not only heats the tubes 30 within the shell 21 but heats the shell 21 itself directly thereby heating the solution between the shell and the jacket 22.

This jacket 22 is an important feature of the invention. It not only forms an added path for upward travel of the solution similar to the tubes

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30, but it also prevents excessive heating and premature boiling of the solution. Excessive heating of the solution back of the baffle would be detrimental to the incoming dye.

The heat exchanger of the present invention, moreover, prevents the steam from getting into the dye solution and so no compensation has to be made for dilution of the solution. The dyeing process itself is therefore speeded up and under absolute control. With the heat exchanger of the present invention a definite amount of dye and a definite amount of water may be employed in solution. The provision of overhead connections to the heat exchanger render it unnecessary to make any holes in the tub itself which would, if required, increase the cost of installation and render it necessary to provide against leakage. With the heat exchanger described, moreover, the condensate is returned to the boiler, enabling the boiler to operate at maximum efficiency because it is operated on heated water returns, thereby also reducing boiler water treatment.

Suitable automatic controls may be included in the steam supply line 47 (Fig. 1) so that definite rates of temperature rise may be maintained; and absolute temperature control of the solution may be secured.

One or more heat exchangers may be employed in a tub and if a plurality are used may be mounted side by side behind the baffle. The number of exchangers required depends upon the size of the tub and the rate of temperature rise required for the solution.

The heat exchanger of the present invention may also obviously be employed in various types of dye tubs, being mounted in each tub to suit the structure of the tub. Thus, in a duplex type tub, which has a pair of perforated partition walls or baffles disposed centrally of the length of the tub, the heat exchanger or exchangers would be positioned between the pair of baffles to draw in cooled solution from both ends of the tub and discharge the heated liquid in two diametrically opposite directions into both ends of the tub. In this case, however, the hood used on the heat exchanger would have two mouths at diametrically opposite sides and two deflectors constructed to direct the heated solution out through or over both baffles into both ends of the tub.

Obviously, too, the cooled solution can be drawn into the heat exchanger in various ways. Thus, instead of drawing the cooled liquid in through perforations in the baffle 12 (Fig. 1), the baffle might be made without perforations or openings and an open-ended pipe might be laid from below the heat exchanger along the bottom of the tub to the end of the tub most remote from the baffle so that the cooled liquid would flow to the heat exchanger through this pipe.

The heat exchanger of the present invention may operate below atmospheric pressure in order to heat a solution in the lower temperature range which requires, for control purposes, steam condensing below atmospheric pressure. Moreover, while the invention has been described in connection with a heat exchanger for use in dye tubs, the heat exchanger of the present invention is not limited to such use. It may be used in the food industry, the chemical industry or in any other industry where solutions are to be heated and where at the same time controlled circulation is required for any purpose as to assist in heat transfer, in mixing liquids, etc.

While the invention has been described in connection with a particular embodiment thereof

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and a particular use therefor it will be understood that it is capable of further modification and the present application is intended to cover any variations, uses, or adaptations of the invention, following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention relates and as may be applied to the essential features hereinbefore set forth and as fall within the scope of the invention or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. A heat exchanger comprising a drum which is closed at both ends, a plurality of tubes which are open at both ends and which are mounted in parallelism to extend through the ends of the drum, a steam pipe which extends through the upper end of the drum downwardly close to the lower end thereof in parallelism to said tubes, said steam pipe having its lower end closed and being slotted within the drum to admit steam into the drum, a sump mounted at the bottom of the drum to collect steam-condensate, and a pipe mounted in parallelism to said tubes to extend through the upper end of the drum and to project at its lower end into the sump to conduct the steam-condensate from the drum.

2. A heat exchanger comprising a drum which is closed at both ends, a plurality of tubes which are open at both ends and which are mounted in parallelism to extend through the ends of the drum, a steam pipe which extends through the upper end of the drum downwardly close to the lower end thereof in parallelism to said tubes, said steam pipe having its lower end closed and being slotted within the drum to admit steam into the drum, a sump mounted at the bottom of the drum to collect steam-condensate, a pipe mounted in parallelism to said tubes to extend through the upper end of the drum and to project at its lower end into the sump to conduct the steam-condensate away from the drum, and a pipe surrounding the last-named pipe and spaced slightly therefrom and extending through the upper end of the drum, said third pipe being perforated within the drum to permit non-condensables to escape therefrom the drum.

3. A heat exchanger comprising a relatively thin-walled drum which is closed at both ends, a plurality of tubes which are open at both ends and which extend through the ends of the drum, a steam pipe which extends through the upper end of the drum downwardly close to the bottom thereof in parallelism with said tubes, said steam pipe having its lower end closed and being slotted within the drum to admit steam into the drum, a sump in the bottom of the drum to collect steam-condensate, a pipe leading from said sump upwardly through the upper end of the drum and adapted to conduct condensate from the sump, and a shell surrounding said drum, said shell being open at both ends and being spaced from the drum to permit fluid to flow between the shell and the drum.

4. A heat exchanger comprising a relatively thin-walled drum which is closed at both ends, a plurality of tubes which are open at both ends and which extend through the ends of the drum, a steam pipe which extends through the upper end of the drum downwardly close to the bottom

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thereof in parallelism with said tubes, said steam pipe having its lower end closed and being slotted within the drum to admit steam into the drum, a sump in the bottom of the drum to collect steam-condensate, a pipe leading from said sump upwardly through the upper end of the drum and adapted to conduct condensate from the sump, a pipe surrounding said condensate pipe and spaced slightly therefrom, said last-named pipe being sealed at its lower end and extending through the upper end of the drum and being perforated within the drum for admission of non-condensables, and a shell surrounding said drum, said shell being open at both ends and being spaced from the drum to permit fluid to flow between the shell and the drum.

5. A heat exchanger comprising a relatively thin-walled drum which is closed at both ends, a plurality of fluid-conducting tubes which extend through the ends of the drum, a steam pipe which is mounted parallel to the tubes to extend through the upper end of the drum downwardly close to the bottom thereof, said steam pipe being closed at its lower end and being provided with slots within the drum to admit steam into the interior of the drum, a sump in the bottom of the drum into which steam-condensate may collect, a conductor pipe mounted parallel to the tubes to extend through the upper end of the drum down into the sump, a third pipe surrounding the conductor pipe and spaced slightly therefrom, said third pipe being sealed to the second pipe at its lower end and extending upwardly through the upper end of the drum and having perforations in it within the drum through which non-condensables may pass, a shell surrounding the drum and spaced sufficiently therefrom to provide a passage for fluid between the drum and shell, a hood over the upper end of the shell to deflect fluid flowing from the upper ends of the tubes and from between drum and shell, said hood having an opening at one side thereof out of which the deflected fluid may pass and having openings through which the several pipes may extend, and a plurality of legs for supporting said shell, said legs being spaced so that fluid may enter at the bottom of the space between drum and shell.

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