May 29, 1934. C. P. WADLEY 1,960,325

HEAT EXCHANGER

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Fig. 6.

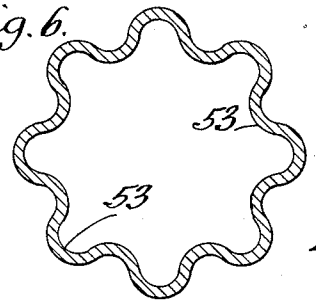


Fig. 1.

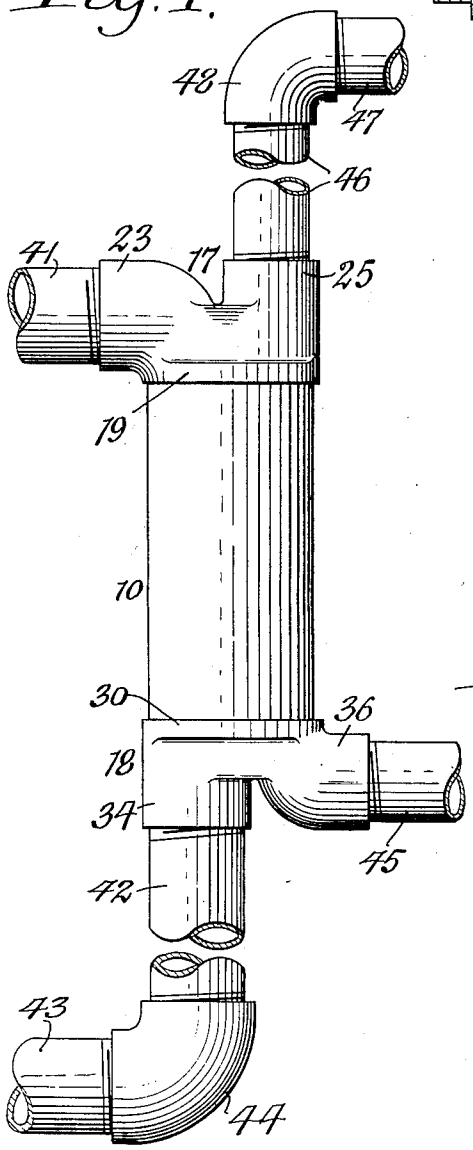
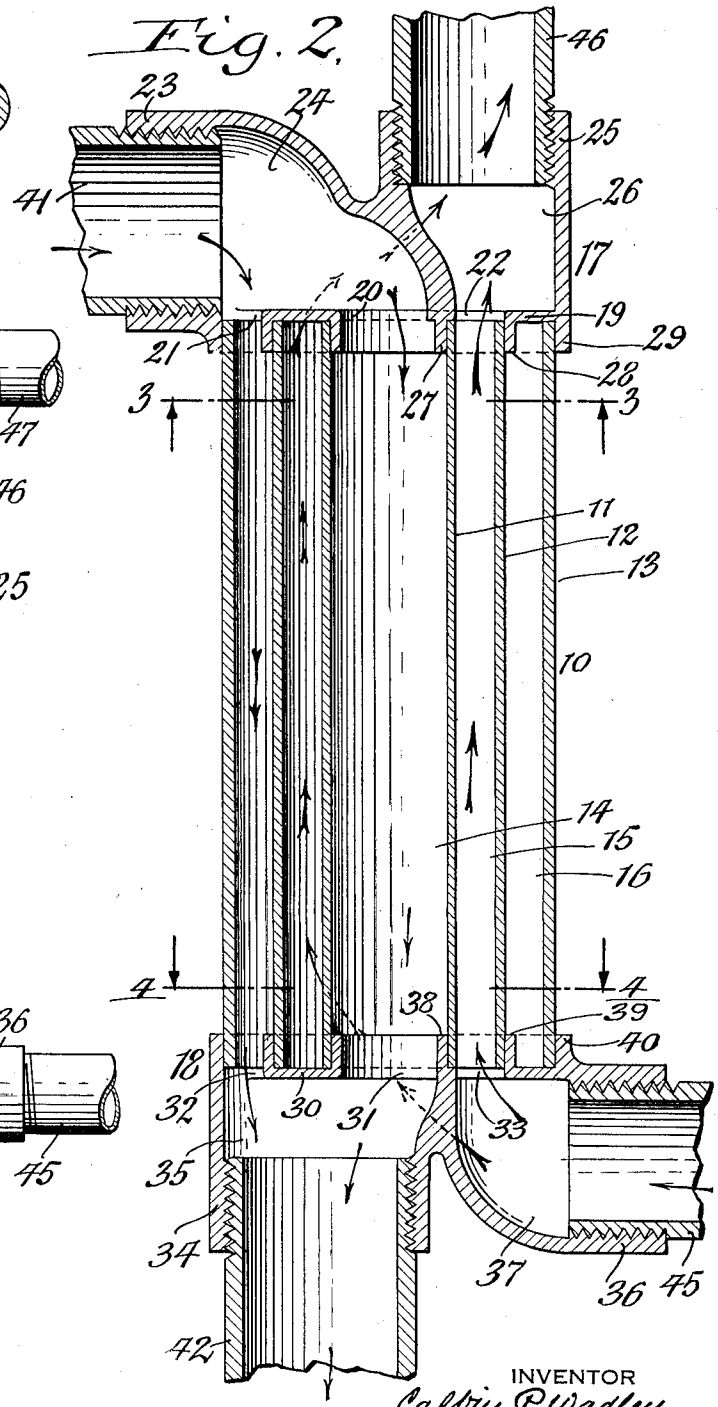


Fig. 2.



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Fig. 3.

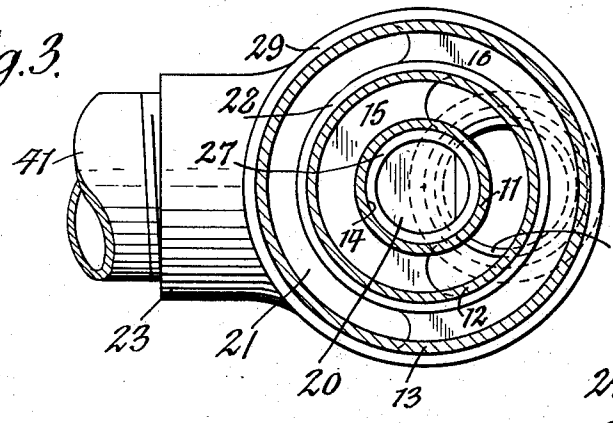


Fig. 7.

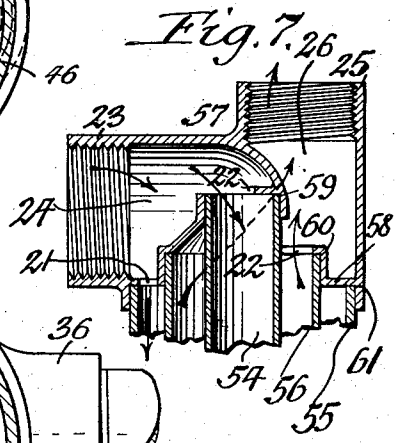


Fig. 4.

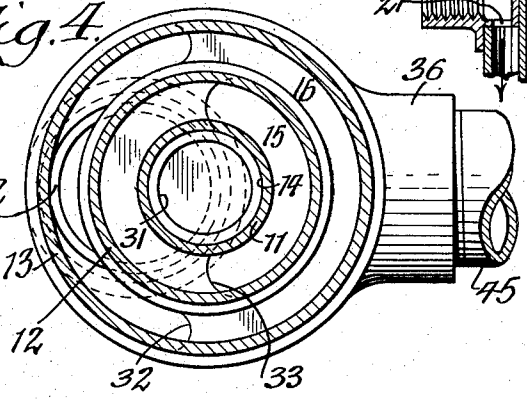


Fig. 8.

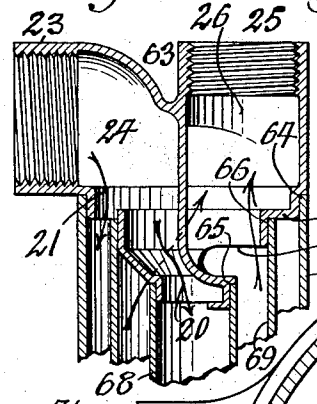
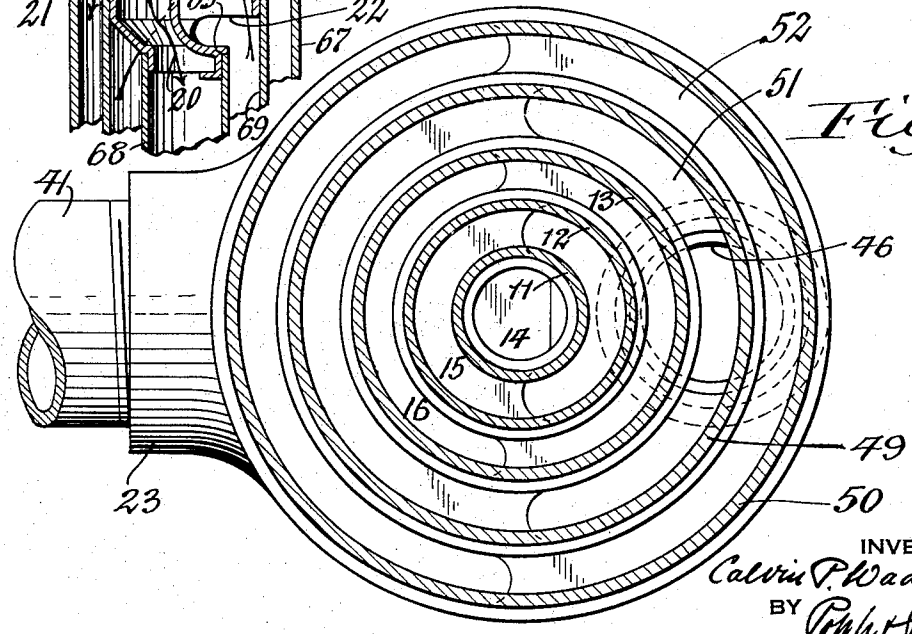


Fig. 5.



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

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Application March 21, 1933, Serial No. 661,946

5 Claims. (Cl. 257—232)

This invention relates to a heat exchanger which is more particularly designed for use as a domestic or household water heater by utilizing the heat in the hot water of a water boiler or the heat of steam in a steam boiler, for the purpose of heating water in a service line through which water is conducted from the main source of supply to the kitchen, bathroom, laundry or elsewhere of a house where hot water is required.

It is the object of this invention to provide a heat exchanger of this character which is very simple, compact and inexpensive in construction, which provides the maximum heat exchanging surface for the amount of material which is used, which can be readily and easily installed in connection with the hot water or steam heating system and the water service system of a house, and which is not liable to become clogged or get out of order nor require any attention for keeping the same in the proper working condition after it is installed.

In the accompanying drawings:

Figure 1 is a side elevation of a satisfactory form of my invention and part of the piping whereby the same is connected with the heating boiler of the house, and also part of the piping of the system whereby the house is supplied with water from a main source.

Figure 2 is a vertical longitudinal section of the same, on an enlarged scale, and some of the piping shown in Fig. 1 omitted.

Figure 3 is a horizontal section taken on line 3—3 Fig. 2 looking upwardly.

Figure 4 is a horizontal section on line 4—4 Fig. 2 looking downwardly.

Figure 5 is a horizontal section similar to Fig. 3 but showing a slight modification of this invention.

Figure 6 is a cross section showing a modified form of tubing which may be used in place of the tubes shown in Figs. 2–5.

Figures 7 and 8 are fragmentary vertical sections of the upper part of the heat exchanger showing variations in the length of the tubes of the tubular body and also corresponding variations in the form of the coupling heads for receiving tubes of the body which are of varying length.

In the following description similar characters of reference indicate like parts in the several figures of the drawings.

Referring to Figs. 1, 2, 3 and 4, the numeral 10 indicates the body of this heat exchanger which in this particular construction comprises an inner upright tube 11 of small diameter, an intermediate upright tube 12 of medium diameter, and an outer upright tube 13 of large diameter which are of the same length or substantially so, and arranged concentrically one within the other so as to form an inner or central upright longitudinal fluid passage 14 of cylindrical form, an intermediate upright longitudinal passage 15 of annular form in cross section between the central tube 11 and the intermediate tube 12, and an outer upright longitudinal passage 16 which is of annular form in cross section and arranged between the intermediate tube 12 and the outer tube 13.

These tubes may be constructed of any suitable material but preferably of thin copper, brass or other metal having a relatively high heat conducting capacity. At the upper and lower ends of these tubes are arranged upper and lower coupling heads 17, 18 respectively whereby the longitudinal passages of the tubular body of the heat exchanger are connected respectively with the piping of the boiler heating system of the building with the piping of the service water supply system.

The upper coupling head comprises a cap 19 having a central port 20 communicating with the upper end of the central passage 14, a segmental outer port 21 communicating with the upper end of the outer annular passage 16 on one side of the axis of the tubular body, and an intermediate port 22 which communicates with the upper end of the intermediate passage 15 on the opposite side of the axis of the tubular body, as shown in Figs. 2 and 3. The upper coupling head is also provided with a horizontal nozzle 23 which projects laterally from this head and forms a conduit 24 through which communication is established between the central and outer ports 20 and 21 of the central and outer longitudinal passages 14 and 16 of the tubular body and the piping which forms part of the means whereby the water or steam from the hot water or steam boiler is circulated through the heat exchanger, and this upper head is also provided with a vertical nozzle 25 which projects upwardly therefrom adjacent to the horizontal nozzle 23 and forms an upright conduit 26 which places in communication the intermediate port 22 and intermediate longitudinal passage 15 with the piping through which the stream of water of the service line is supplied from the source to the place of consumption in the building.

This upper head is provided with downwardly projecting inner, intermediate and outer annular flanges 27, 28, 29, respectively, which are preferably formed integrally with the cap and nozzles of the respective head and are secured

to the adjacent circumferential surfaces at the upper ends of the inner, intermediate and outer tubes 11, 12, 13 by brazing, soldering or any other suitable means.

The lower coupling head 18 comprises a lower cap 30 which is provided with a central port 31 communicating with the lower end of the central passage 14 of the tubular body, and an outer port 32 which communicates with the lower end of the outer longitudinal passage 16 of the tubular body on one side of the axis thereof, and this cap is also provided with an intermediate port 33 which communicates with the lower end of the intermediate longitudinal passage 15 of the tubular body on the opposite side of its axis, as shown in Figs. 2 and 4.

This lower head is also provided with a vertical nozzle 34 which extends downwardly from the cap thereof and forms a conduit 35 which communicates with the central and outer ports 31, 32 of the lower cap 18 and the corresponding lower ends of the central and outer longitudinal passages 14, 16 of the tubular body and is also adapted to place the latter in communication with the pipe forming part of the means for circulating the heating fluid of the boiler through the heat exchanger for heating the service water supplied to the building.

This lower coupling head 18 is also provided with a horizontal nozzle 36 which extends laterally from the cap of the lower head and forms a conduit 37 which communicates with the lower intermediate port 33 and the lower end of the intermediate longitudinal passage 15 on the opposite side of the axis of the tubular body, and is adapted to place the last-mentioned passage in communication with the piping of the water service piping of the building. The cap of this lower coupling head is provided with inner, intermediate and outer annular flanges 38, 39, 40 which are arranged concentrically and project upwardly from this cap and are preferably formed integrally with the respective cap and lower nozzles, and are connected with the adjacent circumferential surfaces at the lower ends of the tubes 11, 12, 13 by brazing, soldering or other suitable means.

Although the piping whereby the heating fluid of the boiler is conducted to and from the heat exchanger may be variously organized, this is preferably accomplished by means of a horizontal inlet pipe 41 which connects the upper part of the hot water or steam boiler with the horizontal or laterally projecting inlet nipple 23 of the upper coupling head, while the vertical lower or outlet nipple 34 is connected with the boiler by means of an outlet pipe including an upright pipe 42 connected at its upper end with the lower outlet nipple 34, and a horizontal pipe 43 having one end connected by means of an elbow 44 with the lower end of the vertical pipe 42 while its opposite end is connected with the water space of the boiler below the water line thereof.

The lower laterally projecting nozzle 36 of the lower coupling head may be supplied with water from the service line in any suitable manner, e. g. by a horizontal supply pipe 45 connected with the outer end of the inlet nozzle 36. The piping for conducting the water from the upper or outlet nozzle 25 to the fixtures which are to be supplied with hot water, preferably includes an upright discharge pipe 26 connected at its lower end with the upper end of the outlet nozzle 25, and a horizontal pipe 47 connected at one end by means of an elbow 48 with the upper end of the outlet pipe 46, while its opposite end is connected in any suitable manner with the fixtures in different parts of the building where hot water is required.

By thus providing the heads at opposite ends of the tubular body with horizontal and vertical nozzles for connection with piping forming part of the means for circulating the heating medium through the boiler of the heat exchanger, it is possible to connect the respective horizontal nozzle directly with a definite part of the boiler while the respective vertical nozzle may be connected indirectly with another part of the boiler by the use of an elbow and a vertical pipe section of the required length to suit any particular installation, thereby enabling this heat exchanger to be readily installed on different boilers on which the points of connection for the pipes 41 and 43 of the circulating system for the heating medium may be spaced different distances apart and thereby enabling this heat exchanger to be of a standard length or height instead of varying the length of the same to suit the installing conditions of different boilers.

For the same reason the horizontal and vertical nozzles 36 and 25 of the lower and upper coupling heads may be connected with the source of water supply and the fixtures of the building where the water is consumed, inasmuch as the lower or water inlet nozzle 36 may be connected directly with a horizontal water supply pipe 45 and the upper vertical outlet nozzle 25 may be connected indirectly with the dispensing fixtures of the building by cutting the vertical pipe 46 of one length or another to suit the particular location of the delivery pipe 47 which leads to the fixtures and connecting this vertical and horizontal pipe 46 and 47 by means of the elbow 48.

By this means of connecting the coupling heads of the heat exchanger with the piping whereby the heating medium is supplied and the piping whereby the service water is supplied to the fixtures, no special fittings are required for installing this heat exchanger in connection with various boilers having coupling points spaced apart at different distances, and also permits of ready installation of this heat exchanger in connection with the supply pipe and the various places in the building where heated water is to be used without requiring unusual work for this purpose.

In the operation of this heat exchanger the heating fluid from the upper part of the boiler passes through the supply pipe 41, the passage 24 of the horizontal nozzle 23, and the central and outer ports 20, 21 of the upper coupling head into the upper ends of the central and outer longitudinal passages 14 and 16, thence downwardly through these last-mentioned passages and through the central and outer ports 31, 32 and the passage 35 of the lower outlet nozzle 34 to the piping 42, 43 and 44 leading to the lower part of the boiler.

The water from the source of supply passes from the horizontal supply pipe 45 through the passage 37 of the inlet nozzle 36 and the lower port 33 in the lower coupling head, thence upwardly through the intermediate longitudinal passage 15, thence through the upper outlet port 22 and the conduit 26 of the upper outlet nozzle 25, and thence through the delivery piping 46, 47, 48 to the dispensing fixtures of the building from which hot water is drawn.

During this downward movement of the central and outer streams of hot fluid from the boiler through the central and outer passages 14 and 16, heat is transmitted through the material of the

central and intermediate tubes 11 and 12 to the intermediate stream of water which passes upwardly through the intermediate longitudinal passage 15, whereby the service water of this upwardly moving stream is rapidly raised in temperature due to the large area of this water which is exposed while moving through the heat exchanger at this time.

It is thus possible to heat the service water by means of heat derived from the boiler fluid in a comparatively short time and supply heated water in ample quantities to meet all requirements without making the heat exchanger unduly large for this purpose, thereby reducing to a minimum the cost for providing an adequate water heating system for general domestic purposes.

Inasmuch as this heat exchanger comprises comparatively few parts and the tubular body can be made of standard tubing cut to length, and the opposing faces of the coupling heads can be easily machined due to the concentric arrangement of the attaching flanges thereon, it is possible to effect economical manufacture of this heat exchanger and also market the same at low cost.

In actual construction the inner and intermediate tubes are preferably made of relatively thin metal so as to increase their heat conductivity, but the outermost tube is preferably made of somewhat heavier material for the purpose of adding strength and durability to the device as a whole.

If desired the number of tubes forming the longitudinal passages for exchanging the heat between one stream of fluid and another may be varied. For instance, if it is desired to produce a heat exchanger having smaller capacity than that shown in Figs. 2, 3 and 4, the outermost tube 13 may be omitted together with the outer ports 21 and 32 of the upper and lower coupling heads, in which case only longitudinal passages would be provided for only one stream of heat supplying fluid and only one stream of heat receiving fluid.

If a heat exchanger of greater capacity is required two additional longitudinal tubes 49, 50 of progressively larger diameters are arranged concentrically one within the other around the outer tube 13 so as to form an additional annular longitudinal passage 51, as shown in Fig. 5, for conducting service water through the heater, and an additional annular longitudinal passage 52 between the tubes 49, 50 for conducting an additional stream of heating fluid through the heater, which additional passages 51 and 52 are connected respectively by appropriate ports in the coupling heads at opposite ends of the tubular body with the conduits forming part of the water service line and the heating medium supply line of the heat exchanger in the manner explained with reference to the construction shown in Figs. 2, 3 and 4.

Instead of making each of the tubes or pipes of the tubular body of cylindrical form, as shown in Figs. 3, 4 and 5, each of said tubes may be made of corrugated or fluted form, as shown at 53 in Fig. 6, thereby increasing the radiating or heat transmitting surface of the respective tube and the area of the fluid contacting with opposite sides thereof accordingly.

In the construction shown in Fig. 2 the several members of the tubular body are all of the same length, but if desired these tubes may be of different length and terminate on different transverse lines or planes at each of the corresponding ends thereof, as shown in Figs. 7 and 8. As shown in Fig. 7 the central tube 54 is the longest, the outer tube 55 is the shortest, and the intermediate tube 56 terminates along a line between the corresponding ends of the inner and outer tubes 54 and 55. In this construction the cap 58 of the respective coupling head 57 is provided with a plurality of annular seats 59, 60, 61 which are arranged step fashion relatively to each other by locating these seats progressively out of line transversely of the axis of the tubular body from the respective outer end thereof toward the inner parts thereof.

In the construction shown in Fig. 8 the cap 62 of the coupling head 63 is provided with annular outer, inner and intermediate seats 64, 65, 66 which are also arranged step fashion relatively to each other in the form of an inverted pyramid and engaged respectively by the outer ends of a comparatively long outer tube 67, a short inner tube 68, and an intermediate tube 69 having a length midway between that of the outer and inner tubes 67, 68.

These heads communicate with the longitudinal passages of the tubular body in the same manner as that described with reference to the construction shown in Figs. 1–4, and the same are also provided with appropriate nozzles for connection with the piping whereby the heating medium is supplied thereto and the service water is conducted therethrough, so that the heat will be transmitted from the heating fluid to the service water in the same manner as that described with reference to the construction shown in Figs. 1–4.

In the preferred construction this heat exchanger is arranged vertically but if desired the same may be arranged horizontally, in which case the stream of heating fluid and the stream of service water may either flow in opposite directions, as indicated in Fig. 2, or these streams may flow in the same direction through the heater. It is preferable, however, to utilize this heater in the upright position shown in Figs. 1 and 2, inasmuch as this permits the respective streams of heating fluid and service water to flow in the directions which they would naturally flow under these conditions, and it also permits of transmitting the heat gradually from the heating medium to the service water during the operation of the heater, inasmuch as the hottest water or steam from the boiler will be first brought into transmitting relation with the hottest water escaping from the heat exchanger in the service line, while the heating fluid of lower temperature before escaping from the lower end of the heat exchanger operates upon the relatively cool or fresh service water which enters the lower end of the heat exchanger.

I claim as my invention:

1. A heat exchanger for transferring heat from a hot fluid to a stream of relatively cool fluid, comprising a plurality of tubes arranged lengthwise one within the other and forming a plurality of independent longitudinal passages for conducting a plurality of streams of fluids, and coupling heads connected with opposite ends of said tubes and each having a cap connected with one end of said tubes and two nozzles, each cap having ports communicating with the respective passages and each nozzle communicating with at least one of said ports; and each longitudinal passage communicating with corresponding ports and nozzles.

2. A heat exchanger for transferring heat from a hot fluid to a stream of relatively cool fluid, comprising a plurality of tubes arranged length-

wise one within the other and forming a plurality of independent longitudinal passages for conducting a plurality of streams of fluids, and coupling heads connected with opposite ends of said tubes and each having a cap connected with one end of said tubes and two nozzles, each cap having ports communicating with the respective passages and each nozzle communicating with at least one of said ports; and each longitudinal passage communicating with corresponding ports and nozzles, and one nozzle of each head extending lengthwise thereof and the other nozzle extending laterally thereof.

3. A heat exchanger for transferring heat from a hot fluid to a stream of relatively cool fluid, comprising a plurality of tubes arranged lengthwise one within the other and forming a plurality of independent longitudinal passages for conducting a plurality of streams of fluids, and coupling heads connected with opposite ends of said tubes and each having a cap connected with one end of said tubes and two nozzles, each cap having ports communicating with the respective passages and each nozzle communicating with at least one of said ports; and each longitudinal passage communicating with corresponding ports and nozzles, and annular flanges arranged on the inner sides of the heads and secured circumferentially to opposite ends of the respective tubes.

4. A heat exchanger for transferring heat from a hot fluid to a stream of relatively cool fluid, comprising a plurality of tubes arranged lengthwise one within the other and forming a plurality of independent longitudinal passages for conducting a plurality of streams of fluids, and coupling heads connected with opposite ends of said tubes and each having a cap connected with one end of said tubes and two nozzles, each cap having ports communicating with the respective passages and each nozzle communicating with at least one of said ports; and each longitudinal passage communicating with corresponding ports and nozzles; and the companion nozzles which communicate with opposite ends of each longitudinal passage being arranged respectively lengthwise and transversely relatively to the tubes.

5. A heat exchanger for transmitting the heat in a fluid of one temperature to a fluid having a relatively lower temperature, comprising a plurality of longitudinal tubes of different diameters arranged concentrically one within the other and forming a central longitudinal passage of cylindrical form, an intermediate passage of annular form around the central passage, and an outer passage of annular form around said intermediate passage; and heads arranged at opposite ends of said tubes and each having a cap provided with central, intermediate and outer ports communicating respectively with the corresponding ends of the central, intermediate and outer passages, and a pair of nozzles one of which communicates with the central and outer ports and the other communicating with the intermediate port.

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