Nov. 28, 1939. W. C. KEERAN 2,181,602

HEAT EXCHANGE APPARATUS

Filed Jan. 2, 1937 3 Sheets-Sheet 1

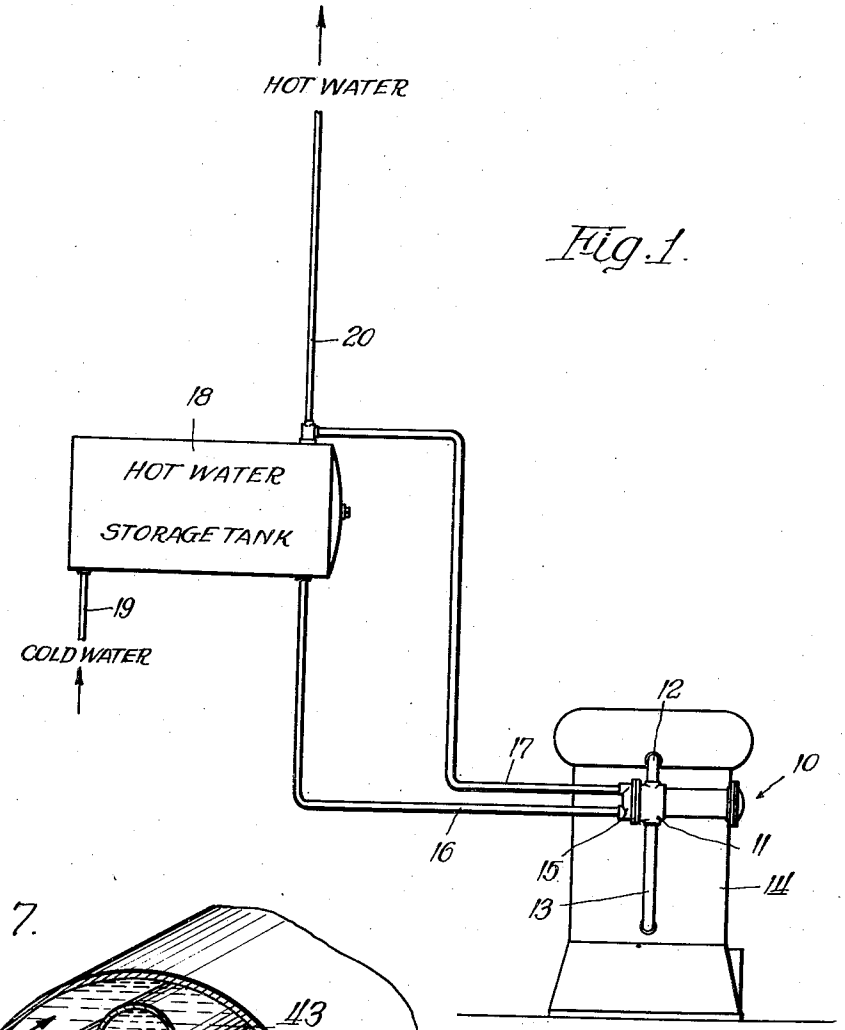
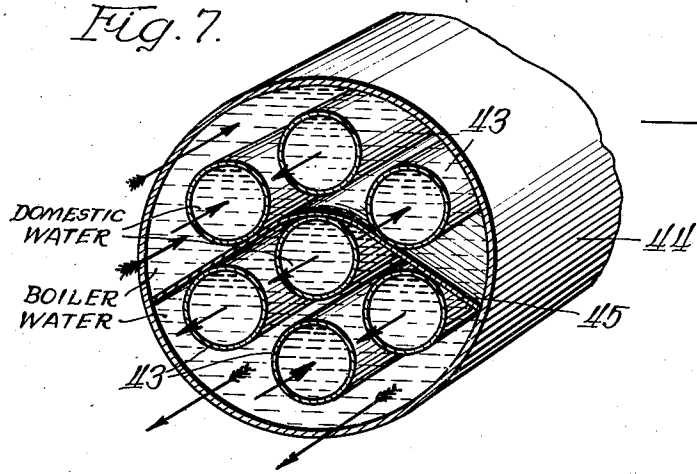


Fig. 1.

Fig. 7.



Inventor.
William C. Keeran.

By Brown Jackson Boettcher Dennis

Attys

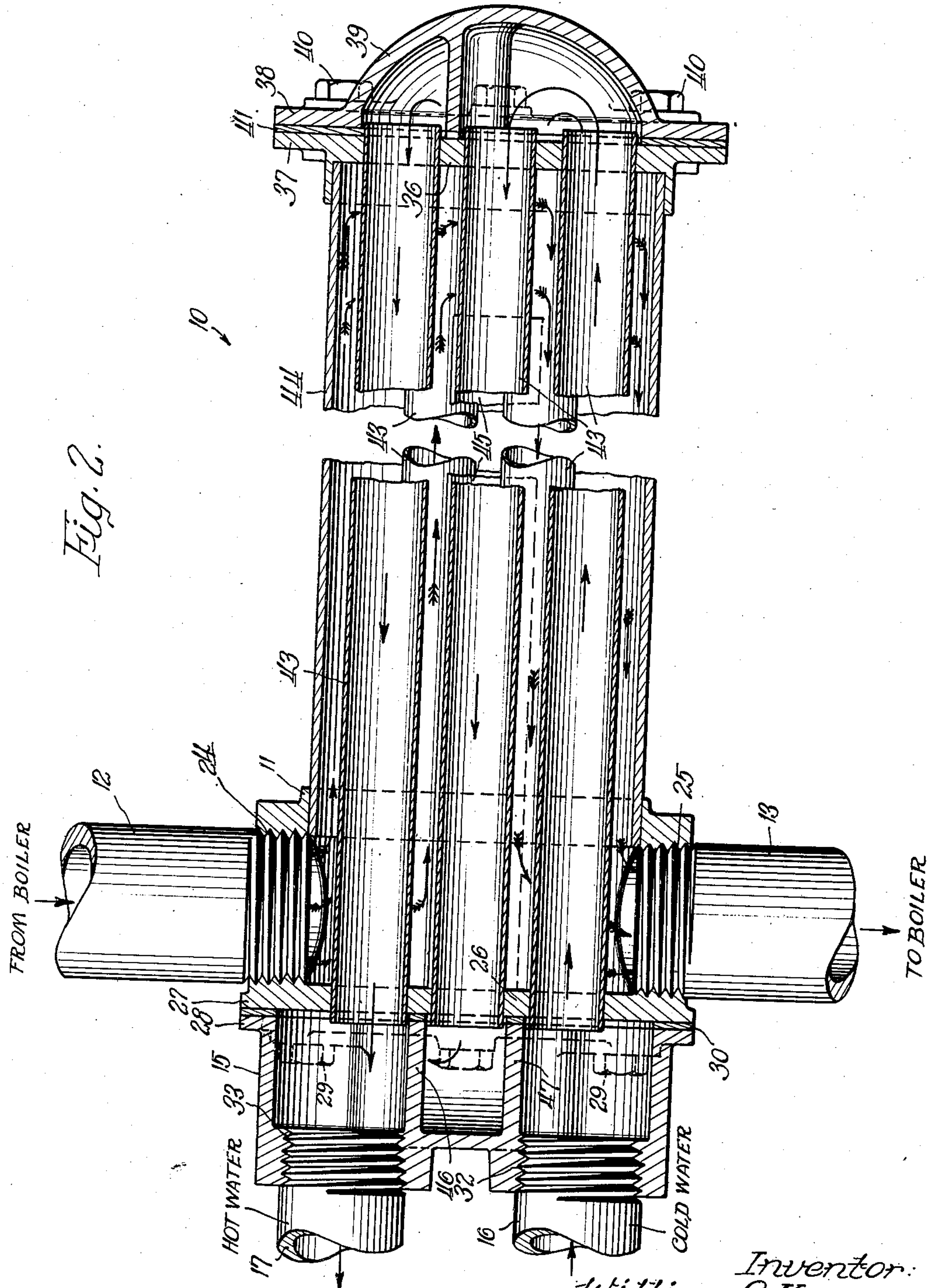


Fig. 2.

Inventor:
William C. Keeran.

By Brown Jackson Boettcher & Dienner
Attys.

Nov. 28, 1939. W. C. KEERAN 2,181,602

HEAT EXCHANGE APPARATUS

Filed Jan. 2, 1937 3 Sheets-Sheet 3

Fig. 3.

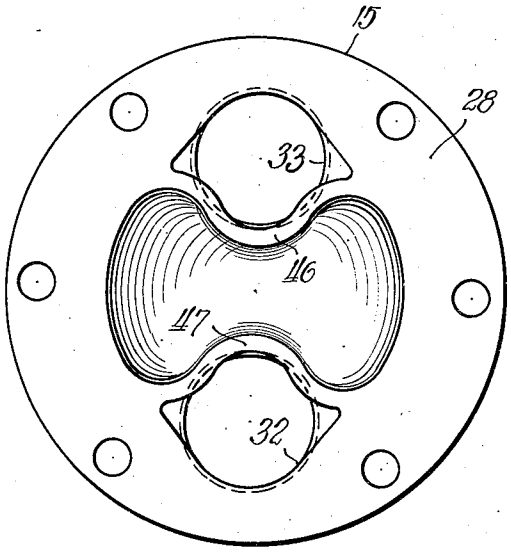


Fig. 4.

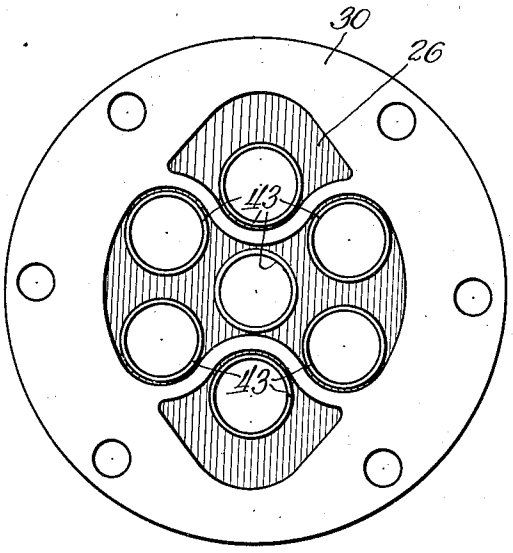


Fig. 5.

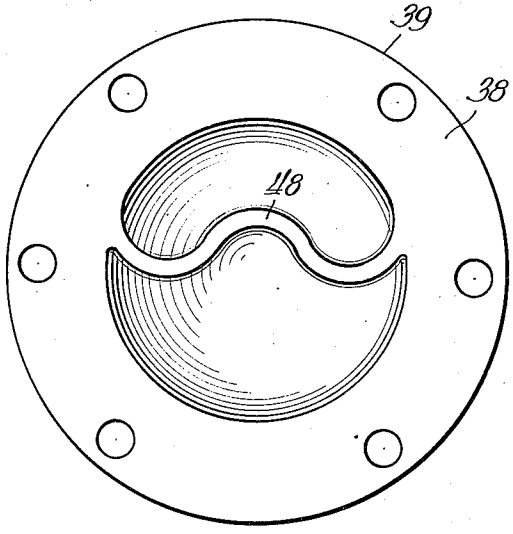
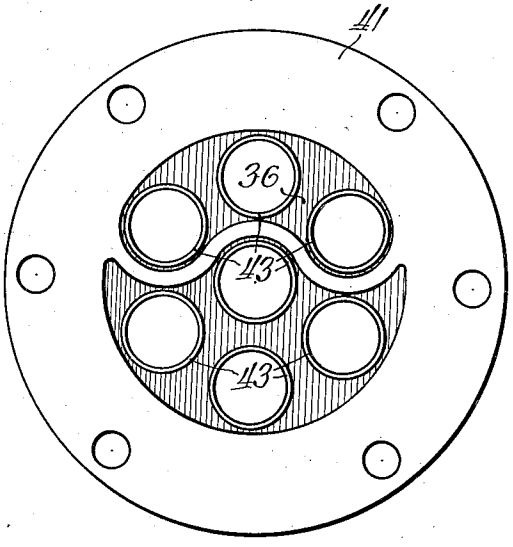


Fig. 6.



Inventor:
William C. Keeran.

By Brown Jackson Boettcher Dremer

Attys.

Patented Nov. 28, 1939 2,181,602

UNITED STATES PATENT OFFICE

2,181,602

HEAT EXCHANGE APPARATUS

William C. Keeran, Evanston, Ill., assignor, by mesne assignments, to Vapor Car Heating Co., Inc., a corporation of New York

Application January 2, 1937, Serial No. 118,842

1 Claim. (Cl. 257—240)

My invention relates, generally, to heat exchange apparatus, and it has particular relation to indirect water heaters.

In many instances it is desirable to indirectly heat water for domestic purposes by using heat obtained from the hot water of a heating system employing a steam, hot water, or vapor boiler. Ordinarily water systems of these kinds are maintained at a fixed temperature. Since it is preferable and more economical to employ a single source of heat rather than to provide an auxiliary source of heat for the domestic water, it has been proposed to employ the hot water from the heating system to indirectly heat the domestic water. The water which is thus employed is usually termed "boiler water", and by means of an indirect water heater it is caused to heat the domestic water.

There are many types of indirect water heaters that have been proposed. All of these types, of which I am aware, have one or more serious disadvantages which make them undesirable in certain respects.

At the present time there are on the market indirect water heaters which comprise a coil of copper tubing that is mounted in a cast iron casing. The domestic water flows through the coil and is heated by boiler water which is caused to flow through the cast iron case. Since a coil is employed, rather than straight unbent tubes, there is a tendency for mineral deposits to form from the water on the roughened inner surface of the coil, the roughened surface being caused by the stress to which it is subjected during the bending operation. Whether the coil is gradually filled up due to this cause or to some other cause, it is difficult, if not impossible, to clean out the coil, and it is, therefore, necessary to replace it with a new coil. Because of the provision of the cast iron case, this type of heater is heavy and, furthermore, its design is inflexible, it being necessary to provide a different set of castings, forming the case, for each different size of heater. For operation, this type of heater must be placed in an upright position, thereby requiring a relatively large distance between the connections to the boiler. This is a serious disadvantage when the heater is to be applied to certain types of modern boilers in which the vertical distance from the water line to the boiler return is relatively short. Only a small water leg or water jacket is required in these newer types of boilers due to the improved efficiency of modern construction.

Other types of indirect water heaters have other disadvantages. Some of these heaters employ straight tubes having return U bends at the ends which tend to cause the formation of mineral deposits at the bend and which are difficult, if not impossible, to clean. Other straight tube heaters having the tubes fastened rigidly at the ends in tube plates often have the tubes and casing made of materials having different thermal coefficients of expansion, with the result that the tubes may break loose from the tube plates, thereby causing leakage. In order to inspect or clean these water heaters it is necessary to first remove all of the pipe connections and then to take the heater entirely apart.

It is, therefore, an object of my invention to provide an indirect water heater which will not have any of these disadvantages and which will be simple and efficient in operation, light in weight, and readily and economically manufactured and installed.

An object of my invention is to construct a heat exchanger in such manner that its water tight integrity will be maintained regardless of the temperature to which it is subjected.

A further object of my invention is to provide a construction of indirect water heater in which the end castings are interchangeable for various sizes, and different capacities are obtained merely by increasing the length of the tubes and casing which may be formed of stock material.

Another object of my invention is to provide for inspecting and cleaning the tubes of an indirect water heater without removing any of the pipe connections thereto.

A still further object of my invention is to provide intake and exhaust boiler ports at the same end of the casing of an indirect water heater.

An object of my invention is to control the flow of heating water through the case of an indirect water heater so that the water constantly flushes sediment out of the case.

Still another object of my invention is to cause the water to be heated to flow through the tubes of an indirect water heater in a plurality of passes, and to construct the baffles in the front and rear headers in such manner as to prevent the formation of mineral deposits thereon from the water.

Other objects of my invention will, in part, be obvious and in part appear hereinafter.

My invention, accordingly, is disclosed in the embodiment hereof shown in the accompanying drawings, and it comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a view, in side elevation, showing

the installation of my novel indirect water heater and the connection thereof to a boiler and a storage tank;

Figure 2 is a longitudinal sectional view of the indirect water heater, illustrating in detail the features of construction;

Figure 3 is a view, in end elevation, of the front header;

Figure 4 is a view, in end elevation, of the front tube plate;

Figure 5 is a view, in end elevation, of the rear header;

Figure 6 is a view, in end elevation, of the rear tube plate; and

Figure 7 is a detail perspective view of the tubes and casing of my novel indirect water heater.

Referring now particularly to Figure 1 of the drawings, it will be observed that the reference character 10 designates, generally, an indirect water heater constructed in accordance with my invention. As illustrated, the indirect water heater 10 is provided with a boiler port ring 11 that is arranged to be connected by inlet and exhaust pipes 12 and 13 to a boiler 14. It will be understood that any suitable type of steam, hot water or vapor boiler may be employed, and that the boiler 14 is shown merely for illustrative purposes. A front header 15 is fastened to the boiler port ring 11 and it is connected by intake and exhaust pipes 16 and 17 to a suitable supply of domestic water to be heated, for example the hot water storage tank 18, which is connected to the city water supply line by an intake pipe 19 and which is connected to the service line and to the hot water fixtures by the pipe 20. It will also be understood that the connections of the indirect water heater 10 to the domestic water supply system are merely illustrative and that other connections may be employed without departing from the scope of my invention.

The details of construction of the indirect water heater 10 are illustrated more clearly in Figure 2 of the drawings, to which reference will now be had. It will be observed that the boiler port ring 11 is provided with intake and exhaust ports 24 and 25 to which the corresponding pipes 12 and 13 may be connected. Integrally formed with the boiler port ring 11 is a front tube plate 26, the purpose of which will appear hereinafter. The boiler port ring 11 and the front tube plate 26 are formed preferably of cast brass, bronze, or some metal having like characteristics, although it will be understood that other material may be employed if desired. A flange 27 is integral with the boiler port ring 11 for cooperating with a corresponding flange 28 integral with the front header 15 to provide a connection therebetween. Cap screws 29, extending through suitable flange openings in the flange 28 into threaded openings in the flange 27, fasten them together. A gasket 30 is provided between the flanges 27 and 28 to provide a water-tight connection.

The front header 15 is provided with intake and exhaust ports 32 and 33 for connection to the corresponding pipes 16 and 17, shown in Figure 1 of the drawings. The front header 15 is formed preferably of cast brass, but it will be understood that any other suitable material may be employed within the scope of my invention.

At the other end of the indirect water heater 10, a rear tube plate 36 is provided having an integrally formed flange 37 to which a corresponding flange 38 of a rear header 39 may be connected by cap screws 40 extending through suitable clearance openings in the flange 39 into suitable threaded openings in the flange 37. A gasket 41 is positioned between the flanges 37 and 38 to provide a water-tight connection therebetween. The rear tube plate 36 and the rear header 39 are formed preferably of cast brass, although other material may be employed if desired.

Interconnecting the front tube plate 26 and the rear tube plate 36 are tubes 43 through which the domestic water flows to be heated. The ends of the tubes 43 are fastened rigidly into the front and rear tube plates 26 and 36 in order to provide a rigid connection therewith. This connection will, of course, be water-tight. Surrounding the tubes 43 is a casing 44, one end of which is secured rigidly, as by soldering, to the rear tube plate 36, while the other end is secured rigidly in a like manner to the boiler port ring 11.

It is evident by this construction that the tubes 43 withstand the entire longitudinal stress caused by the pressure of the domestic water. The casing 44 itself is required to withstand only the bursting pressure of the boiler water, and this pressure is ordinarily limited to a maximum of about 15 pounds per square inch. Since the casing 44 is under no longitudinal stress, the seal between it and the two plates 26 and 36 may have low tensile strength.

The tubes 43 and the casing 44 are formed preferably of copper, or at least they are formed of materials having substantially the same thermal coefficient of expansion. When so constructed there is substantially no relative expansion or contraction and consequently substantially no relative movement between the tubes 43 and the casing 44 because of temperature change. If the tubes 43 and casing 44 were not constructed of materials having substantially the same thermal coefficients of expansion, it is entirely possible that either the tubes 43 would be broken loose from the tube plates 26 or 36, or that the casing 44 would be broken loose from the rear tube plate 36 or the boiler port ring 11.

Another distinct advantage, however, lies in this particular construction. It will be readily understood that the capacity of the water heater 10 is determined by the area of its surface which is commonly in contact with the boiler water on one side and the domestic water on the other. It will now be evident that the capacity of the water heater herein disclosed may be changed merely by altering the length of the tubes 43 and the casing 44. The tubes 43 are formed of standard copper tubing which is obtainable in the open market, cut to the various required lengths. Likewise, the casing 44 is formed of copper tubing which also is available in the open market. Therefore, the same end castings may be employed with a variety of different lengths of tubes 43 and casings 44 to provide a range of heater capacities having a maximum number of interchangeable parts. Thus, for a given set of end castings, it is only necessary to provide tubes 43 and casing 44 having different lengths. Moreover, since castings are employed only at the ends rather than to provide a complete housing for the tubes 43, the weights of the heater for different capacities are materially reduced.

Since the indirect water heater 10 is mounted in operation in a horizontal position, the distance between the intake and exhaust ports 24 and 25 for the boiler water is a minimum. As a result, an indirect water heater constructed in accord-

ance with my invention may be employed with the modern type of boiler in which the water line of the boiler is low in relation to the return connection to the boiler. Only a sufficient distance between the water level and the return connection is required to provide the connections to the diametrically opposite intake and exhaust ports 24 and 25, as will be readily understood.

The advantages of the horizontal type of indirect water heater disclosed herein will now be more readily apparent when the functioning thereof is compared to that of an indirect water heater of the vertical type. As indicated hereinbefore, it is possible to take advantage of a relatively high temperature throughout the entire indirect heater when it is of the horizontal type, with the result that its efficiency is thereby improved. There is a much smaller difference in temperature of the boiler water that is available for heating the domestic water and, therefore, the domestic water is subjected to a relatively high temperature at all times. Consequently less heating surface is required in an indirect heater of the horizontal type than is required for a heater of the same capacity of the vertical type.

With a view to causing a flushing action in the flow of the boiler water in the casing 44, a baffle 45 is provided between the tubes 43, as is more clearly illustrated in Figure 7 of the drawings. One end of the baffle 45 is positioned abutting the inner surface of the front tube plate 26, while the other end is spaced from the inner surface of the rear tube plate 36. The boiler water is then caused to flow in a turbulent manner, as illustrated by the arrows in Figure 2 of the drawings, through the casing 44, and thus it imparts a maximum of heat to the domestic water in the tubes 43 and flushes sediment out of the case and back into the boiler.

It is desirable to have the domestic water pass through the tubes 43 in a plurality of passes, rather than to have it pass only from one end of the heater to the other and then back again. In order to cause the water to flow through the heater in a plurality of passes, the front header 15 is provided with a pair of partitions 46 and 47, as is illustrated more clearly in Figure 3 of the drawings. As there shown, the partitions 46 and 47 are so arranged as to provide three chambers in the front header 15. An intermediate chamber is formed between the two outer chambers which are connected, respectively, to the intake and exhaust ports 32 and 33. The gasket 30 is correspondingly shaped as shown in Figure 4 of the drawings, in order to seal these chambers one from the other.

In like manner, as illustrated in Figure 5 of the drawings, the rear header 39 is provided with a partition 48, thereby forming two chambers therein. The gasket 41, shown in Figure 6 of the drawings, is correspondingly shaped to prevent direct flow of water between the chambers. As indicated by the arrows in Figures 2 and 7 of the drawings, the domestic water enters the intake port 32 and the lower chamber, formed by the partition 47 in the front header 15, and passes through the lowermost of the tubes 43 to the chamber formed by the baffle 48 in the rear header 39. The water then returns to the intermediate chamber between the partitions 46 and 47 in the front header 15, through the next three tubes 43. The water then returns through the next two tubes to the upper chamber formed by the partition 48 in the rear header 39, and then it returns through the uppermost tube 43 to the upper chamber formed by the partition 46 in the front header 15 from which it flows through the exhaust port 33 to the water storage tank 18, or to the hot water piping system through the pipe 20.

It will be observed that the partitions 46, 47 and 48 are curved in one direction or another throughout their entire length. By so curving these partitions, no pockets or corners are provided in which mineral deposits from the water might form which might eventually plug up the headers 15 and 39.

It will now be apparent that all that is required to permit inspection of the tubes 43 is the removal of the rear header or inspection dome 39. By removing the cap screws 40 this header may be readily removed and the tubes 44 will be open for inspection as indicated in Figure 6 of the drawings. To permit this inspection and cleaning, it is unnecessary to remove a single pipe connection to the boiler port ring 11 or to the front header 15. As a result the necessary inspection and cleaning may be effected with a minimum of dismantling of either the heater 10 itself or of the pipe connections thereto. If desired, the pipes 16 and 17 may be removed from the front header 15 by means of unions, and this header may be removed by removing the cap screws 29. Both ends of the tubes 43 will then be open for inspection and cleaning if it is deemed necessary to go to this extent in dismantling the heater 10 and its connections. However, for most purposes, it is only necessary to remove the rear header 39.

Since certain changes may be made in the above construction and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description, or shown in the accompanying drawings, shall be interpreted as illustrative, and not in a limiting sense.

I claim as my invention:

An indirect water heater comprising, in combination, a plurality of straight smooth bore tubes, a continuous unperforated tubular casing surrounding said tubes, a rear tube plate rigidly fastened to one end of said tubes and casing, a rear header carried by said rear tube plate, a boiler port ring rigidly fastened to the other end of said casing and having boiler ports substantially diametrically opposite each other, a front tube plate rigidly connected to said ring and to the other end of said tubes, a front header fastened to said ring and having intake and exhaust ports therein, and partitions cooperating with said headers for directing the flow of water through said tubes in a plurality of passes; said tubes and casing having substantially the same thermal coefficient of expansion, and said tubes and casing constituting the sole connection between said rear tube plate on the one hand and said ring and front tube plate on the other hand whereby a range of different heat exchange capacities can be provided with the same size of front and rear headers and boiler port ring by using different lengths of tubes and casings depending upon the capacity required.

WILLIAM C. KEERAN.