

March 21, 1950

C. W. ST. CLAIR
WATER HEATING APPARATUS

2,501,012

Filed Aug. 21, 1947

3 Sheets-Sheet 1

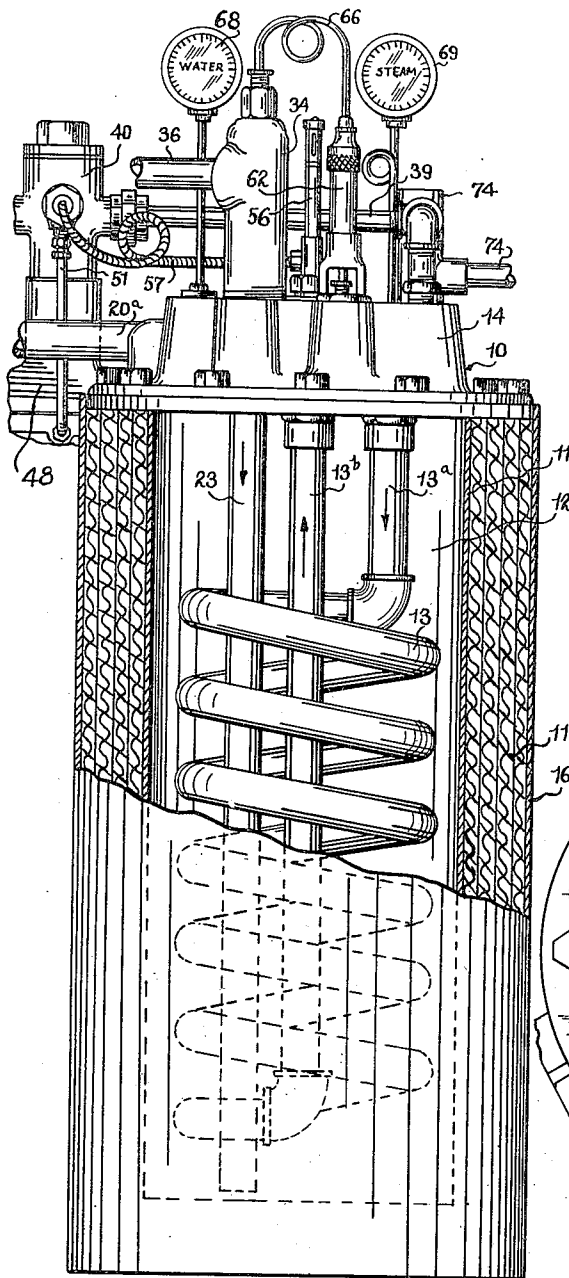


Fig. 1

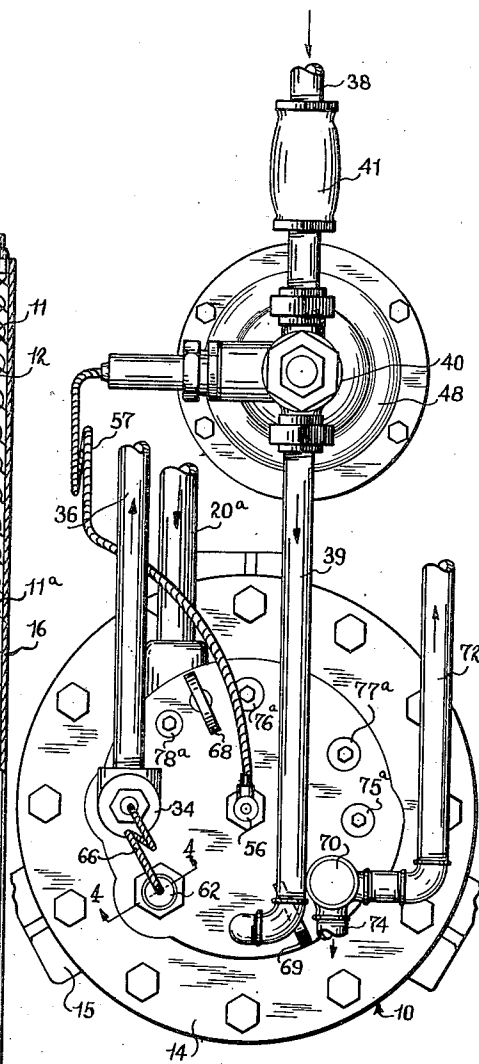


Fig. 2

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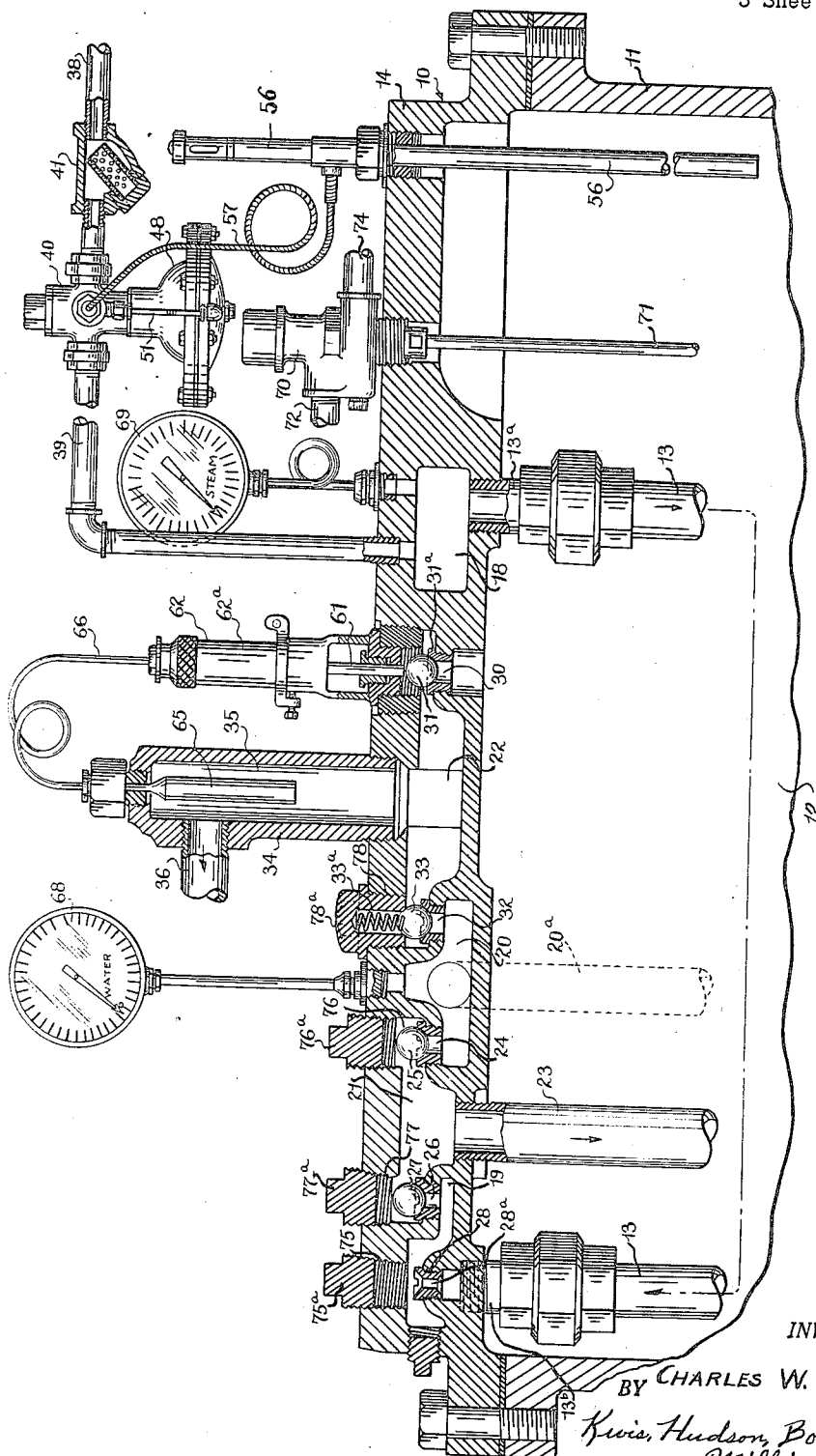


Fig. 3

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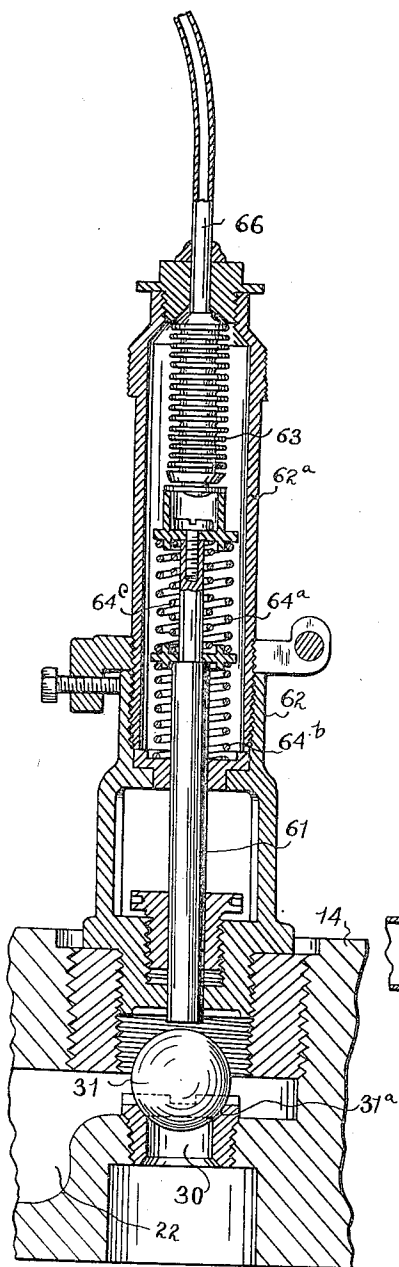


Fig. 4

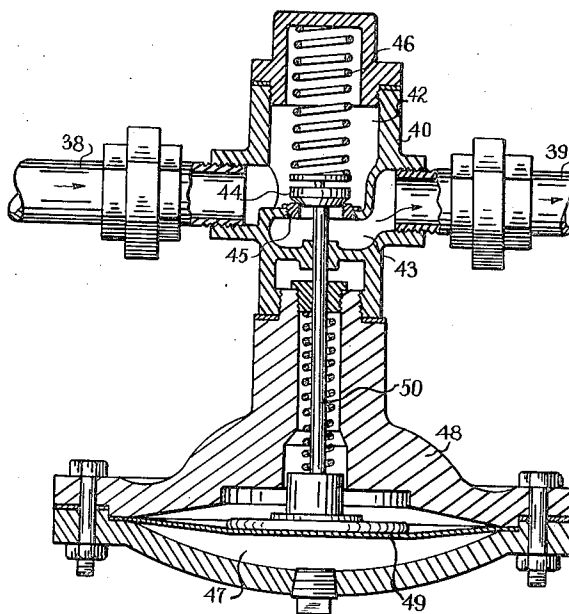


Fig. 6

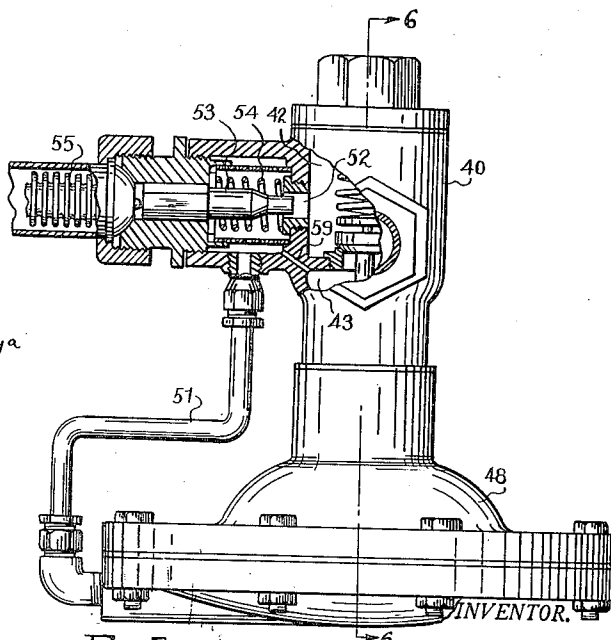


Fig. 5

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UNITED STATES PATENT OFFICE

2,501,012

WATER-HEATING APPARATUS

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Application August 21, 1947, Serial No. 769,782

6 Claims. (Cl. 257-2)

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This invention relates to apparatus for heating water or other liquids by the use of a steam coil and relates more particularly to apparatus of this kind which is an improvement over the apparatus disclosed in co-pending application, Serial No. 515,353, filed December 23, 1943, now Patent No. 2,430,837, granted November 11, 1947. As a matter of convenience, the liquid to be heated is hereinafter referred to as water, but it should be understood that there is no intent to limit the use of the improved apparatus in this respect.

The patent just mentioned discloses heating apparatus in which the water in a heating and storage chamber is heated by a steam coil and the condensate produced by the steam is discharged into the storage chamber and becomes mixed with the water. The condensate is collected or trapped in the coil so as to prevent the steam from blowing through the coil and also to prevent overheating of the water in the storage chamber. The trapping of the condensate in the coil is accomplished by providing a flow retarding means through which the condensate is discharged. The water in the storage chamber is maintained substantially at a predetermined temperature by automatic temperature responsive valve means which controls the supply of steam to the heating coil. The hot water delivered from the apparatus is tempered to a desired temperature by the action of an automatic temperature responsive mixing means which mixes cold water from the cold water supply with the hot water from the storage chamber.

An object of the present invention is to provide improved water heating apparatus of the character mentioned, which is safe, efficient and reliable in operation and which is of an extremely compact construction adapted to be economically manufactured and assembled.

Another object of this invention is to provide improved water heating apparatus of this character in which a head or cover for the tank containing the heating and storage chamber forms a support or carrier on which all, or substantially all, of the flow control devices can be mounted so as to constitute an assembly unit.

Other objects and advantages of the invention will be apparent in the following detailed description and in the accompanying drawings in which

Fig. 1 is an elevational view with portions broken away, showing improved water heating apparatus embodying the present invention;

Fig. 2 is a top plan view of the apparatus;

Fig. 3 is a developed sectional view of the tank head showing the various connections and flow

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control devices, the view being more or less diagrammatic in character;

Fig. 4 is a vertical sectional view taken through the temperature responsive valve device for tempering the hot water, the view being taken substantially as indicated by section line 4-4 of Fig. 2;

Fig. 5 is a detached elevational view with portions broken away, showing the temperature responsive control valve device of the steam supply means; and

Fig. 6 is a vertical sectional view taken through the temperature responsive steam control valve device, as indicated by section line 6-6 of Fig. 5.

In the embodiment of the invention herein disclosed, the improved water heater 10 comprises, in general, a tank 11 providing a water heating and storage chamber 12, a steam coil 13 disposed in the chamber 12 for heating the water therein, and a head or cover 14 for the tank and on which various flow control devices are mounted, as will be hereinafter explained.

The tank 11 is here shown as being an upright tank adapted to be supported by a suitable base or stand 15 and having a top opening which is closed by the head 14. The tank 11 may be of any desired shape, such as the cylindrical shape here shown, and is of a size to provide a heating and storage chamber 12 of appropriate capacity. The tank 11 may be provided with a thermal insulating jacket 11a and an outer protective cover or shell 16.

The steam coil 13 is connected with the head 14 and extends in depending relation from the underside thereof such that when the head is mounted on the tank 11, the coil will be suspended in the storage chamber 12. With the coil disposed in this position the condensate from the steam can be more readily collected or trapped in the coil and this will prevent steam from blowing through the coil which would be wasteful of steam and might result in over-heating of the water in the storage chamber 12 or in the discharge of steam at the point of hot water use. The coil 13 may be in the form of a simple pipe coil having a steam inlet end 13a and a condensate delivery end 13b.

In accordance with an important feature of this invention the head 14 is constructed with a number of passages and chambers therein which make it possible to mount all, or substantially all, of the flow control devices on such head as a common support and in a relation for proper cooperation with each other in the functioning of the heater. The head is preferably, though not

necessarily, constructed as a metal casting in which the chambers and certain of the passages can be formed by coring.

As best shown in Fig. 3, the head 14 is provided with a steam supply passage or chamber 18 with which the steam inlet end 13a of the coil 13 is connected. The head is also provided with a condensate passage or chamber 19 with which the condensate delivery end 13b of the coil is connected. A cold water supply passage or chamber 20 contained in the head is adapted to be connected with an available source of cold water such as the cold water supply system of a building, by means of the supply pipe 20a. The head 14 also contains a feed chamber 21 and a hot water tempering chamber 22. The chambers 21 and 22 may at times also be referred to as mixing chambers. Water to be heated is supplied to the storage chamber 12 from the feed chamber 21 through a feed pipe 23 which extends in depending relation from the underside of the head 14 to a point adjacent the bottom of the storage chamber.

The feed chamber 21 is connected with the cold water supply passage 20 to receive cold water therefrom through a passage 24, which is controlled by a check valve member 25. The check valve member 25 may be in the form of a ball element as here shown and its opening movement is in a direction toward the feed chamber 21. The condensate passage 19 communicates with the feed chamber 21 through a valve passage 26, which is controlled by a check valve member 27 adapted to be opened by movement toward the feed chamber. The condensate passage 19 also contains a flow restricting means which is here shown in the form of a choke or bushing 28 having an orifice 28a therein. The choke 28 is located between the check valve 27 and the delivery end 13b of the steam coil 13. The orifice 28a is of a size to permit condensate to flow relatively freely therethrough from the coil but which will impede or prevent the passage of steam therefrom from the coil.

The hot water tempering chamber 22 is connected with the storage chamber 12 by a passage 30 which is surrounded by a valve seat 31a and is controlled by a check valve member 31 having an opening movement toward the tempering chamber. The tempering chamber 22 is also connected with the cold water supply passage 20 through a passage 32, which is controlled by a check valve member 33. The check valve member 33 opens in a direction to permit the flow of cold water through the passage 32 into the hot water tempering chamber 22 and is normally urged toward its seat by means of a compression spring 33a. As shown in the drawings, a housing or fitting 34 is connected with the head 14 so as to provide the tempering chamber 22 with a hot water delivery outlet 35 from which tempered hot water is adapted to be delivered to the desired point of use, such as to a shower bath or laundry, by means of the hot water delivery pipe 36.

The steam supplied to the coil 13 is delivered thereto from a boiler or other available source through the pipes 38 and 39 and the steam control valve 40. A suitable strainer device 41 may be located in the pipe line 38 and serves to prevent sediment from being carried into the valve 40 by the steam. The valve 40 is a temperature responsive valve having inlet and discharge chambers 42 and 43 (see Fig. 6) separated by a movable valve member 44, which is adapted to be moved toward a seat 45 by means of a compression

spring 46. The valve member 44 is adapted to be opened by steam pressure which is supplied to the lower compartment 47 of a diaphragm casing 48 and exerts pressure on the diaphragm 49. A stem 50 extending between the diaphragm and the valve member 44 transmits opening movement to the latter from the diaphragm.

The steam pressure for actuating the diaphragm 49 is transmitted from the inlet chamber 42 of the valve 40 to the compartment 47 of the diaphragm casing 48 by a tube 51. The upper end of the tube 51 is connected with the chamber 42 of the valve through a passage 52, which is controlled by an auxiliary or pilot valve member 53. The pilot valve member 53 is urged toward its open position by a compression spring 54 and is adapted to be shifted in a direction to close or restrict the passage 52 by means of an expandible element 55, such as the bellows here shown. The bellows is connected with a temperature responsive bulb 56 located in the storage chamber 12, by means of the tube 57.

When the temperature of the water in the storage chamber 12 falls to a predetermined value, the bellows 55 contracts and permits the pilot valve member 53 to be shifted toward its open position by the spring 54. This allows steam from the pressure chamber 42 of the valve 40 to flow through the passage 52 and the tube 51 to the diaphragm compartment 47 and cause opening movement of the main valve member 44. The opening of the main valve member 44 permits steam from the supply pipe 38 to be delivered through the pipe 39 and the passage 18 of the head 14 to the steam coil 13.

When the temperature of the water in the storage chamber 12 rises to a predetermined value, the bellows 55 expands causing the pilot valve member 53 to be moved toward its closed position, thereby closing or restricting the passage 52 and permitting the spring 46 to move the main valve member 44 toward its closed position. When the pilot valve member 53 is shifted toward its closed position, the steam pressure previously supplied to the compartment 47 is bled therefrom through a restricted passage 59 which, as shown in Fig. 5, communicates with the outlet chamber 43 or low pressure side of the steam control valve 40.

The check valve member 31 controlling the passage 30 leading from the storage chamber 12 to the hot water tempering chamber 22 is limited in regard to its opening movement by the lower end of a plunger 61 which projects from the housing 62a of a tempering control device 62. The housing 62a is suitably mounted on the head 14 and contains a bellows 63 (see Fig. 4) to which the upper end of the plunger 61 is connected. A group of compression springs 64a, 64b and 64c located in the housing 62a acts on the plunger 61 and cooperates with the bellows 63 in varying the position of the lower end of the plunger with respect to the valve seat 31a. The bellows 63 is connected with a temperature responsive bulb 65 by means of a tube 66 and the temperature responsive bulb is located in the delivery outlet 35 which connects the delivery pipe 36 with the hot water tempering chamber 22.

When hot water is withdrawn from the heater 10 through the delivery pipe 36, the check valve member 31 is opened by the flow of hot water from the storage chamber 12 into the tempering chamber 22. If the temperature of the water flowing from the chamber 22 through the delivery outlet 35 exceeds the temperature value

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for which the tempering control 62 is calibrated, the bellows 63 will be expanded and will cause the plunger 61 to be moved downwardly into closer relation to the valve seat 31a, thereby decreasing the extent of opening movement permitted for the check valve member 31 and thereby decreasing the volume of hot water which can flow out of the storage chamber 12 into the tempering chamber 22. When the flow of hot water into the tempering chamber 22 is thus decreased, cold water from the cold water inlet passage 20 flowing past the check valve member 33 into the tempering chamber will lower the temperature of the water being delivered through the outlet 35.

When the temperature of the delivery outlet water is below a predetermined value, a contracting the bellows 63 takes place and results in a corresponding lifting of the plunger 61. The upward movement of the plunger will space the lower end thereof relative to the valve seat 31a so as to permit a greater opening movement of the check valve member 31, thereby permitting an increased flow of hot water from the storage chamber 12 to raise the temperature of the delivery outlet water.

Since the check valve member 33 is normally urged towards closed position by the spring 33a, the opening of this valve member will be retarded sufficiently to permit proper functioning of the tempering control 62 and the check valve member 31 and will prevent an excessive amount of cold water from entering the tempering chamber 22. By reason of the functioning just explained above, the amounts of hot water and cold water flowing into the chamber 22 will be such that the temperature of the water supplied to the pipe 36 will be maintained at a desired substantially constant value.

In regard to the functioning of the check valve member 33 it should be explained at this point that when the extent of the opening movement permitted the check valve member 31 is decreased by the control device 62, cold water from the supply passage 20 will readily flow into the chamber 22 because of the pressure which is maintained in the cold water supply passage. When hot water is withdrawn from the heater through the pipe 36, it tends to produce a decrease in the pressure of the water stored in the heater and this permits the water withdrawn to be replaced by water from the cold water supply passage 20. The cold water which enters the chamber 22 past the check valve member 33 is merely a portion of the cold water supply which would otherwise enter the storage chamber through the feed pipe 23.

The temperatures, pressures and volumes for which the water heater 10 is designed will vary in accordance with the size or capacity of the heater and the particular service for which it is intended. It can be pointed out by way of example, however, that the cold water supplied to the passage 20 may have a pressure on the order of 40 to 100 pounds per square inch. The pressure of the steam supplied to the coil 13 may be on the order of 5 to 150 pounds per square inch. The calibration of the steam control valve 40 may be such as to maintain the hot water in the storage chamber 12 at a temperature of approximately 180° F. although this value can be increased or decreased as desired by suitable adjustment of the steam control valve. The tempering control device 62 can be set or adjusted to provide any desired delivery water tempera-

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ture within the normal operating range of the heater. This control device normally would be set so as to provide a delivery water temperature on the order of 120° F. Instead of the delivery water temperature being regulated by the control device 62, it can be regulated by means of the temperature responsive valve device 40 and, in that case, the control device 62 serves merely as a safety means which functions only when the valve device 40 fails to operate properly and permits the water in the storage chamber to be heated to a temperature higher than the desired value.

If desired, suitable pressure gauges can be provided on the head 14 for indicating the pressure of the cold water supply and the pressure of the steam being supplied to the coil 13. As shown in Fig. 3, a suitable water pressure gauge 68 is connected with the cold water supply passage 20 and a suitable steam pressure gauge 69 is connected with the steam supply passage 18.

A conventional safety relief valve device 70 is preferably provided on the head 14 and includes a temperature responsive bulb 71 which extends into the storage chamber 12. Temperature and pressure responsive relief valves are embodied in the device 70 and are calibrated so that if the predetermined safe temperature or pressure for the heater is exceeded, one or the other of these valves will be automatically opened to relieve the pressure in the storage chamber 12 by discharging water from the heater to a sewer or drain through the relief pipe 72. The relief valve device 70 may be adjusted for a pressure on the order of 185 pounds per square inch for the tank 11 and when this pressure is exceeded, the pressure responsive valve in this device will be automatically opened to discharge water through the relief pipe 72. The temperature responsive valve which is actuated by the bulb 71 may be adjusted for a temperature value on the order of 212° F. and when this temperature is exceeded water will be discharged through the relief pipe 72.

In accordance with another feature of the improved heater 10, a secondary hot water delivery outlet is provided which, in this instance, is shown as being a delivery pipe 74 extending from the housing of the relief valve device 70. The pipe 74 supplies hot water from the storage chamber 12 to a desired point of use, such as to a sterilizer or other apparatus which requires water at a higher temperature than the temperature of the water available from the delivery outlet 35. When the heater is equipped with such a secondary hot water outlet it is capable of supplying hot water at a desired relatively higher temperature such as 160° F. to 180° F.

The head 14 is preferably constructed so that access can be had to the various check valves and the orifice member 28 for purposes of assembly and servicing. As shown in the drawings an opening 75 is provided in the head above the orifice member 28 and is adapted to be closed by the screw plug 75a. Similar openings 76 and 77 are provided in the head above the check valve members 25 and 27 and are closed by screw plugs 76a and 77a. Likewise, the check valve member 33 is accessible through an opening 78 of the head which is closed by a plug 78a.

From the foregoing description and the accompanying drawings, it will now be readily understood that this invention provides an improved water heating apparatus which is safe, reliable and efficient in operation and in which all, or substantially all, of the control devices and fittings

are mounted on the head of the tank so that such head and fittings constitute an assembly unit which can be economically manufactured, adjusted and tested in the shop. It will also be seen that by constructing the head of the tank with the various chambers and passages therein, a compact and simplified arrangement is obtained for the flow control devices and that many of the necessary connections are then located internally of the head so as to reduce to a minimum the number of exposed pipe connections needed to be made. Additionally, it will be understood in connection with this improved type of water heater that since condensate resulting from the steam used to heat the water is collected or trapped in the steam coil, a safer and more economical operation of the heater is obtained because the trapped condensate prevents steam from blowing through the coil and eliminates the possibility of over-heating of the stored water or the discharge of steam at the point of hot water use. The mixing of the condensate with the cold water supply also conserves heat and causes a preheating of the cold water prior to its entry into the storage chamber 12.

Although the improved water heating apparatus has been illustrated and described herein to a detailed extent, it will be understood, of course, that the invention is not to be regarded as being correspondingly limited in scope, but includes all changes and modifications coming within the terms of the claims.

Having thus described my invention, I claim:

1. A water heater comprising a tank containing a water heating and storage chamber; a pre-formed rigid head connected with said tank and having recesses and passages therein providing the head with a steam supply passage, a tempering chamber having a connection to said storage chamber and a hot water delivery outlet, a feed chamber having a feed connection with said storage chamber, a condensate passage connected with said feed chamber and a cold water supply passage having connections with said feed chamber and said tempering chamber; a steam coil disposed in said storage chamber for heating the water therein, said coil having one end connected with said steam supply passage to receive steam therefrom and its other end connected with said condensate passage to deliver condensate therethrough to said feed chamber; an orifice bushing located wholly interiorly of said head for controlling said condensate passage and providing an orifice therein of a size to permit a relatively free flow of condensate and to impede the flow of steam from said coil; valve means controlling the delivery of steam to said steam supply passage and being automatically operable in response to the temperature of the water in said storage chamber; and a temperature responsive check valve device having a free-moving check valve element adapted to vary the flow capacity of the connection between said storage chamber and said tempering chamber and said check valve device being operable automatically in response to the temperature of the water in said hot water delivery outlet for varying the free movement of said check valve element.

2. A water heater comprising a tank containing a water heating and storage chamber; a pre-formed rigid head connected with said tank and having recesses and passages therein providing the head with a steam supply passage; a tempering chamber having a connection to said storage chamber and a hot water delivery outlet, a feed

chamber having a feed connection with said storage chamber, a condensate passage connected with said feed chamber and a cold water supply passage having connections with said feed chamber and said tempering chamber; a steam coil disposed in said storage chamber for heating the water therein, said coil having one end connected with said steam supply passage to receive steam therefrom and its other end connected with said condensate passage to deliver condensate therethrough to said feed chamber; an orifice bushing restricting said condensate passage; valve means controlling the delivery of steam to said steam supply passage and being automatically operable in response to the temperature of the water in said storage chamber; a valve device adapted to vary the flow capacity of the connection between said storage chamber and said tempering chamber and being operable automatically in response to the temperature of the water in said hot water delivery outlet; a check valve controlling the connection between said cold water supply passage and said tempering chamber and adapted to open toward the latter; and a pair of check valves adapted to open toward said feed chamber and controlling respectively the connections to the latter from said cold water supply passage and said condensate passage, said orifice bushing and all of said check valves being located wholly interiorly of said head.

3. A water heater comprising a tank containing a water heating and storage chamber; a head connected with said tank and having recesses and passages therein providing the head with a steam supply passage, a tempering chamber having a connection to said storage chamber and a hot water delivery outlet, a feed chamber having a feed connection with said storage chamber, a condensate passage connected with said feed chamber and a cold water supply passage having connections with said feed chamber and said tempering chamber; a steam coil disposed in said storage chamber for heating the water therein, said coil having one end connected with said steam supply passage to receive steam therefrom and its other end connected with said condensate passage to deliver condensate therethrough to said feed chamber; means restricting said condensate passage and providing an orifice therein of a size to permit a relatively free flow of condensate but only an impeded flow of steam from said coil; valve means controlling the delivery of steam to said steam supply passage and being automatically operable in response to the temperature of the water in said storage chamber; a valve device adapted to vary the flow capacity of the connection between said storage chamber and said tempering chamber and being operable automatically in response to the temperature of the water in said hot water delivery outlet; a check valve controlling the connection between said cold water supply passage and said tempering chamber and adapted to open toward the latter; check valves adapted to open toward said feed chamber and controlling the connections to the latter from said cold water supply passage and said condensate passage, said head having openings therein affording access to said restricting means and to said check valves; and removable closures for said openings.

4. In a water heater, a tank having a heating and storage chamber, a steam coil disposed in said storage chamber for heating water therein, means for supplying steam to one end of said coil including a control valve responsive to the

temperature of the water in said storage chamber and operable automatically to maintain the storage chamber water substantially at a given temperature, hot water mixing means having a connection to said storage chamber to receive hot water therefrom and also having a delivery outlet, cold water supply means having connections to said storage chamber and to said mixing means for supplying cold water thereto, condensate return means connecting the other end of said coil with said cold water supply means for causing mixing of condensate from said coil with the cold water being supplied to said storage chamber, a delivery connection leading from said storage chamber for discharging water therefrom at said given temperature, and valve means controlling the connection between said storage chamber and said mixing means and being automatically operable to vary the flow capacity thereof in response to the temperature of the delivery outlet water so as to maintain the latter substantially at a temperature having a desired value below said given temperature.

5. In a water heater, a tank having a storage chamber therein, a steam coil extending into said storage chamber for heating water therein, steam supply means adapted to supply steam to one end of said coil and including control valve means automatically responsive to the temperature of the water in said storage chamber, a tempering chamber having a hot water inlet thereinto from said storage chamber and a hot water delivery outlet, a feed chamber having an outlet in open communication with said storage chamber, a condensate chamber having a condensate outlet passage connected with said feed chamber, condensate return means connecting the other end of said coil with said condensate chamber and including a restriction orifice opening into said condensate chamber and being of a size to permit a relatively free flow of condensate but only an impeded flow of steam from said coil, cold water supply means including a cold water chamber having two outlets the first of which communicates with said feed chamber and is adapted to supply cold water thereto for mixing with condensate returned from said coil and the second of which communicates with said tempering chamber and is adapted to supply cold water thereto for mixing with hot water being delivered from said storage chamber, a first check valve device controlling said hot water inlet and provided with a check valve element having a limited relatively free opening movement toward said tempering chamber, means responsive to the temperature of the water in said hot water delivery outlet and adapted to limit the free opening movement of the check valve element of said first check valve device, a second check valve device controlling the condensate outlet passage of said condensate chamber and provided with a check valve element having a relatively free opening movement toward said feed chamber, a pair of check valve devices controlling the two outlets of said cold water chamber and one of which is provided with a check valve element having a relatively free opening movement toward said feed

chamber, the other check valve device of said pair being provided with a check valve element having an opening movement toward said tempering chamber, and a spring for resisting said opening movement of the last mentioned check valve element.

6. A water heater comprising a tank containing a water heating and storage chamber; a head connected with said tank so as to form a portion of the wall of said chamber and having recesses and passages therein providing the head with a steam supply passage, a tempering chamber having a connection to said storage chamber and a hot water delivery outlet, a feed chamber having a feed connection with said storage chamber, a condensate passage connected with said feed chamber and a cold water supply passage having connections with said feed chamber and said tempering chamber; a steam coil disposed in said storage chamber for heating the water therein, said coil having one end connected with said steam supply passage to receive steam therefrom and its other end connected with said condensate passage to deliver condensate therethrough to said feed chamber; means restricting said condensate passage and providing an orifice therein of a size to permit a relatively free flow of condensate but only an impeded flow of steam from said coil; valve means controlling the delivery of steam to said steam supply passage and being automatically operable in response to the temperature of the water in said storage chamber; a first check valve device controlling the connection between said storage chamber and said tempering chamber and provided with a check valve element having a limited relatively free opening movement toward said tempering chamber; means responsive to the temperature of the water in said hot water delivery outlet and adapted to limit the free opening movement of the check valve element of said first check valve device; a second check valve device controlling said condensate passage and provided with a check valve element having a relatively free opening movement toward said feed chamber; a pair of check valve devices controlling the connections from said cold water supply passage to said feed chamber and said tempering chamber and one of which is provided with a check valve element having a relatively free opening movement toward said feed chamber, the other check valve device of said pair being provided with a check valve element having an opening movement toward said tempering chamber; and a spring for resisting said opening movement of the last mentioned check valve element.

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