A. A. CARDWELL.

DIFFERENTIAL WATER HEATER.

APPLICATION FILED MAR. 15, 1911.

997,749.

Patented July 11, 1911.

Fig. 1.

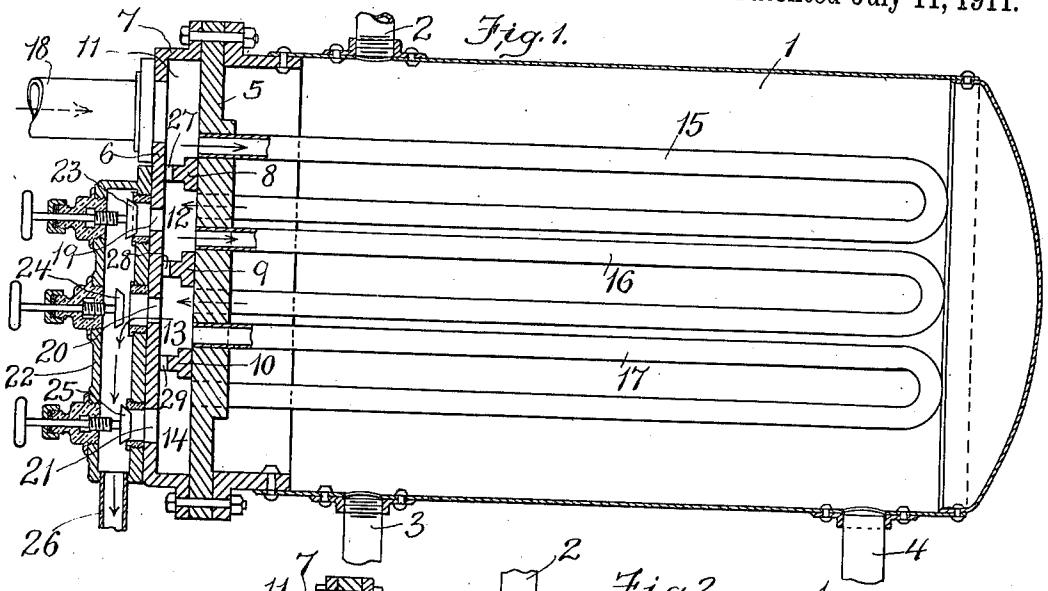


Fig. 2.

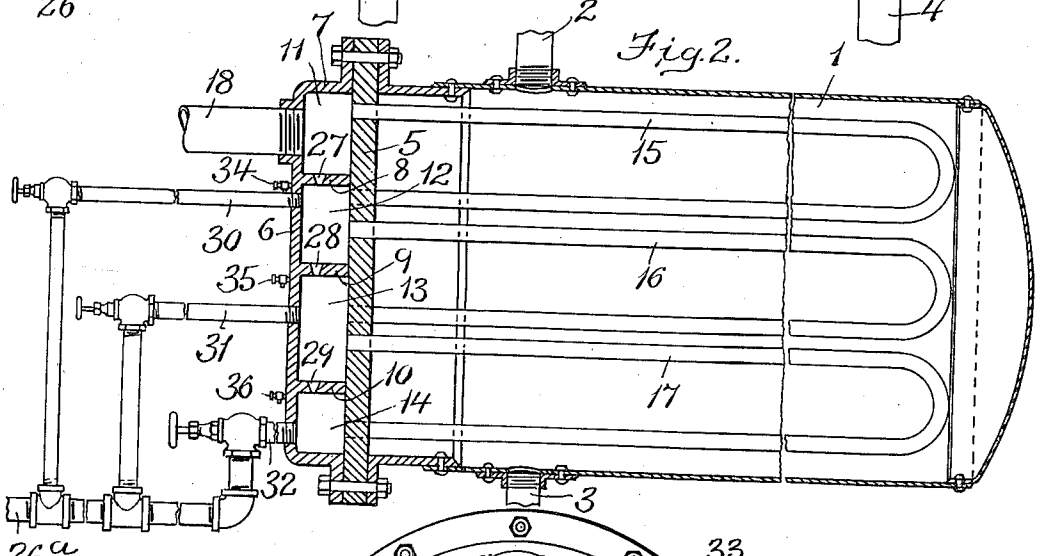
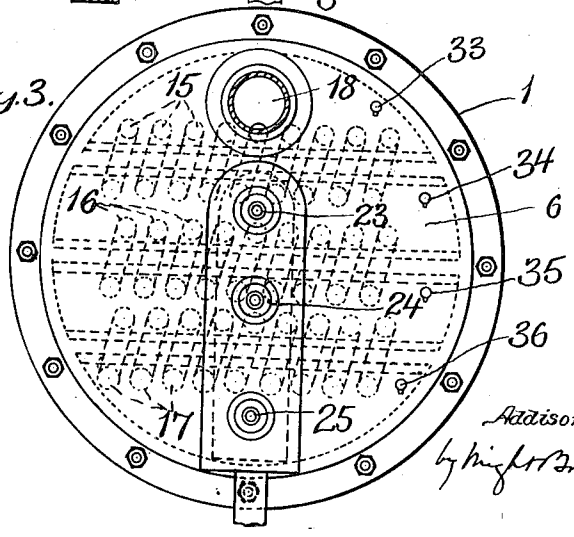


Fig. 3.



Witnesses:

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UNITED STATES PATENT OFFICE.

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DIFFERENTIAL WATER-HEATER.

997,749. Specification of Letters Patent. Patented July 11, 1911.

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To all whom it may concern:

Be it known that I, ADDISON A. CARDWELL, of Rye, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Differential Water-Heaters, of which the following is a specification.

The present invention relates to means for heating water by means of an already heated fluid which is circulated through a coil of pipes in a tank containing the water to be heated. The water thus heated may be used for any purpose, but this invention is principally applicable for heating water which is circulated through radiators and pipes of a building for warming the rooms thereof.

The main object of the invention is to permit of a regulated degree and rate of heating of the water by causing the effective length and heating surface of the coil, through which the circulating fluid flows, to be increased or diminished at will. The heating fluid, which is employed to impart heat to the water, is ordinarily steam, and a second object of the invention is to enable the water of condensation to be separated from the steam at different stages of its course through the heating coil, so that only live steam or the water condensed in the coil from the steam comes into thermal relation with the water to be heated, whereby the heating effect and efficiency of the coil is increased.

The manner in which I accomplish the objects above set forth is described in detail in the following specification and illustrated in the drawings forming a part thereof. In the latter,—Figure 1 represents a longitudinal section of a heater embodying my invention, Fig. 2 is a similar view showing a different construction of some of the parts but all embodying the same principles, and Fig. 3 is a front end elevation of the heater shown in Fig. 1.

The same reference characters indicate the same or similar parts in all the figures.

The apparatus shown in Figs. 1 and 2 consists of a tank 1 containing water to be heated and is provided with inlet and outlet pipes 2, 3 and 4, through which a circulation of water to and from the radiators supplied thereby is permitted. 5 represents a plate which forms one end or head of the tank and 6 represents a second plate approximately parallel to the plate 5 and outside of the tank. The plate 6 has a flange 7 which is bolted or otherwise secured to the plate or head 5 and incloses the space between the two plates. Extending across between the plates and from side to side of the tank are partitions 8, 9 and 10, dividing the space between the plates into chambers 11, 12, 13 and 14. In this embodiment of the invention, three partitions and four chambers are shown, but the exact number is not material to the invention, since the same principles may be embodied in an apparatus having only three chambers and also in one having more than four chambers, as well as in the particular number herein illustrated. Secured in the plate 5 are the ends of return tubes 15 which have their inlets opening into the chamber 11 and their outlets opening into the chamber 12. That is their inlet and outlet ends are respectively on opposite sides of the partition 8. Other return tubes 16 have their ends fastened in the plate 5 respectively above and below the partition 9 so as to receive fluid from the chamber 12 and discharge it into the chamber 13, while a third set of similar tubes 17 are correspondingly fastened to the plate with their ends respectively above and below the partition 10. There is a horizontal set of each of these tubes extending across the entire tank, as shown in Fig. 3, the tubes of each set being in parallel while the tubes of the several sets are in series and communicate with each other through the chambers 12 and 13. In a heater having more or fewer chambers as above suggested, a correspondingly less or greater number of sets of return tubes is provided, but the principle in any case is the same provided there are at least two sets of such tubes. The heating fluid, which ordinarily is steam, is conducted from a boiler to the chamber 11 through a pipe 18, and thence flows through the tubes 15 to the chamber 12, giving its heat to the water in the tank. In the outer wall or plate 6 are outlets 19, 20 and 21 respectively which register with openings in a valve chamber 22. The latter in form is an open box and has valves 23, 24 and 25 opposite the several holes and adapted to close the same by seating against valve seats secured in the inner wall of the valve box and surrounding the holes as clearly shown in Fig. 1. These valves are controlled by hand wheels mounted on valve stems which pass

through the outer wall of the valve case and are packed by stuffing boxes. From the lower end of the valve case, a discharge pipe 26 conducts the water of condensation and exhaust steam to a steam trap and back to the boiler. No circulation of the steam through the return tubes is permitted except when at least one of the valves 23, 24 or 25 is opened. Assuming that the valve 25 is opened and the other valves closed, the circulation of steam is from the pipe 18 and chamber 11 through the return tube 15 to the chamber 12, thence through tubes 16 to chamber 13, thence through tubes 17 to chamber 14, and finally through the outlet 21 to the return pipe 26. The several sets of return tubes thus constitute a continuous coil through which the steam is passed and of which the entire length and heating surface are utilized to transfer heat from the steam to the water. The full extent of the heating coil is thus used when it is desired to heat the water to and maintain it at the highest degree possible, as in heating a building in extremely cold weather. When a more moderate degree of heating is desired, the valve 25 is closed and the valve 24 opened, thus preventing circulation of the steam through the lowest tubes 17 and which immediately fill with water of condensation, allowing that discharged from the intermediate tubes 16 to pass directly to the outlet 26. When still less heat is required, both the valves 25 and 24 are closed and valve 23 is opened, allowing the exhaust steam and water of condensation to pass away as soon as the steam has passed through the upper set of tubes, the lower two sets being full of condensation and out of commission. In this way, a regulation of the amount of heat imparted to the water is made, and the water, which circulates through the heating system of the building, may be kept at a substantially uniform temperature in mild, moderate and severe weather.

When steam is used as the heating agent, a certain proportion of it will be condensed in the coils in consequence of giving up its heat to the water in the tank. The heating efficiency is greatly diminished if that water, which is condensed in the first coils or tubes or in the supply pipe 18, is carried with the steam through all the tubes, because the latent heat is absent. For the purpose of allowing only uncondensed steam to pass through the coil in all stages, I have provided a means for separating the water of condensation or of entrainment from the steam at each stage. For this purpose, I provide holes or openings 27, 28 and 29 in the partitions 8, 9, and 10 respectively. Whatever water is brought with the steam into the chamber 11 falls through the opening 27 into the chamber below while the steam passes through the tubes 15. Likewise the water which falls through the holes 27, together with the water produced by condensation in the tubes 15, passes through the holes 28 in the partition 9 to the chamber 13, and so on, until all the water condensed in the entire heater passes through the outlet 26. When any of the lower chambers and tubes are shut off by closing of the outlet 21 or 20, the water collecting in the chambers fills up the lower chambers and tubes to the level of the outlet 20 or 19, whichever may be open. Since each of the tubes is held at both ends in the same plate or tube sheet 5, whatever distortion of the tubes takes place through heating and cooling produces no harm, because the entire length of the tubes between their ends is free. Thus the differences of temperature which result from closing some of the tubes and allowing them to fill with water while the other tubes contain live steam, does not distort the tube sheets or loosen the tubes and cause leakage.

As appears from Fig. 3, the parallel tubes of the several series are staggered so that the steam which issues from the outlet of any one tube does not all pass into the tube next below but is divided among two or more of the tubes, and a diffusion of the steam through the several tubes in the successive series is accomplished.

In this invention, I consider that the partitions dividing the several chambers from one another are a necessity in order to compel the steam to follow a sinuous course through the several series of tubes. Direct passage of the steam to the discharge through the holes in the several partitions is prevented by the water of condensation which collects in all the chambers, and by the fact that these holes are so proportioned as ordinarily to retard the flow of water to such an extent as to obstruct the steam and to cause the steam to follow the tubes as the path of least resistance. In case the heating agent should be another fluid than steam and not liable to condensation in the tubes, the holes 27, 28 and 29 could be omitted or plugged.

In Fig. 2 is shown a working out of the invention somewhat different from that shown in Fig. 1 but embodying the same principles. In this form of the invention, the tubes, chambers and partitions are the same as above described, and are designated by the same numerals. Instead of the common valve chamber containing all the valves, however, I have provided separate outlet pipes leading from each chamber to the discharge pipe 26^a, these several pipes being designated by 30, 31 and 32 respectively, and each having its own valve. The operation however is identical with that already described.

To avoid pocketing of air in the several chambers, I propose to employ air vents as

indicated at 33, 34, 35 and 36 in Figs. 2 and 3.

I claim:—

1. A heater comprising a tank, a head at one end of the tank, an outer wall adjacent to said head and partitions between the head and wall dividing the intermediate space into a series of separate chambers, a series of return tubes one above another, the uppermost of such tubes having its ends opening into the first and second chambers, and the next lower tube having its ends opening to the second and third chambers, means for admitting steam to the uppermost chamber, and separate outlets, adapted to be independently closed, leading from the lower chambers.

2. A water heater, comprising a tank, a series of tubes arranged so that a heating fluid is caused to flow through them successively, whereby they form in effect a heating coil, means for admitting the heating fluid to the first tube of the series, and means for independently drawing off fluid from different parts of the coil, whereby the extent of heating surface may be varied.

3. A water heater, comprising a tank, a series of tubes arranged so that a heating fluid is caused to flow through them successively, whereby they form in effect a heating coil, means for admitting the heating fluid to the first tube of the series, a plurality of outlets for the exhausted fluid at different points in the coil, and means controlling said outlets operable to permit escape of the fluid from any one of the outlets and prevent escape from the others.

4. A heating coil, comprising a series of return tubes one above another, a plate or tube sheet into which both ends of the tubes are secured, a second plate beside said tube sheet, and partitions extending across the space between said plates and located between the inlet and outlet ends of the respective tubes, forming separate chambers into which the outlet and inlets of successive tubes open whereby the heating fluid is caused to pass in order through the successive tubes and chambers, means for admitting steam to the uppermost chamber, outlets from the lower chambers, and independent valves for each of said outlets.

5. A heating coil, comprising a series of return tubes one above another, a plate or tube sheet into which both ends of the tubes are secured, a second plate beside said tube sheet, and partitions extending across the space between said plates and located between the inlet and outlet ends of the respective tubes, forming separate chambers into which the outlet and inlets of successive tubes open whereby the heating fluid is caused to pass in order through the successive tubes and chambers, means for admitting steam to the uppermost chamber, and provisions for drawing water from the upper chambers so that only steam may enter the tubes.

6. A water heater, comprising a tank, a series of return tubes, a series of chambers outside of the tank through which the return ends and the admission ends of successive tubes are coupled, whereby steam admitted to the uppermost chamber and tube is compelled to flow in order through the tubes, means for draining water from the upper chamber to the one below, and an outlet from the lower chamber.

7. A water heater, comprising a tank, a series of return tubes, a series of chambers outside of the tank through which the return ends and the admission ends of successive tubes are coupled, whereby steam admitted to the uppermost chamber and tube is compelled to flow in order through the tubes, provisions in the chambers for preventing water delivered from any tube from passing into the next tube of the series, and an outlet for both water and steam from the last chamber of the series.

In testimony whereof I have affixed my signature, in presence of two witnesses.

ADDISON A. CARDWELL.

Witnesses:

WM. H. GEE,

A. H. CARDWELL.