

May 23, 1939.

E. S. STACK

2,159,571

WATER HEATER

Filed Aug. 13, 1935

2 Sheets-Sheet 1

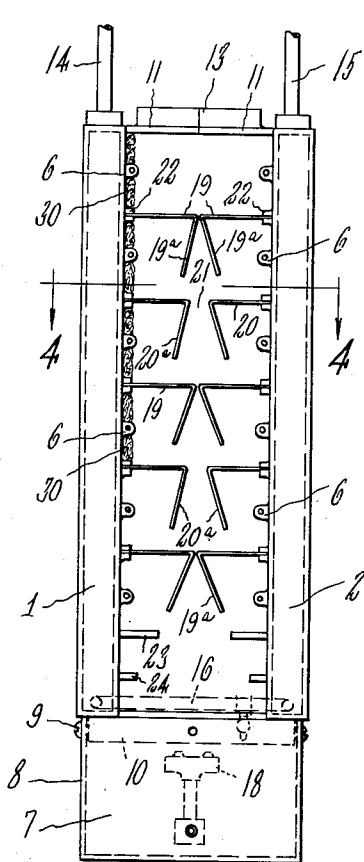


Fig. 1.

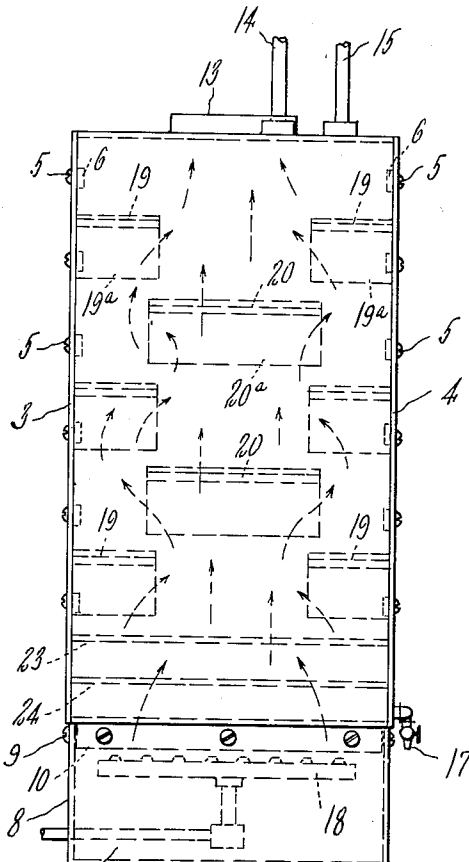


Fig. 2.

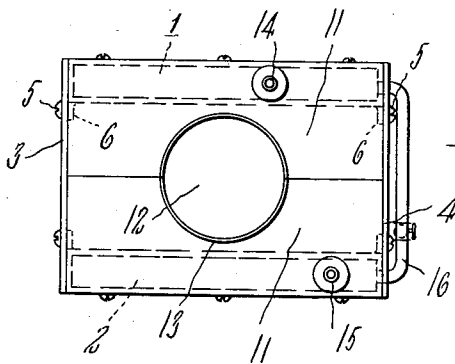


Fig. 3.

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2 Sheets-Sheet 2

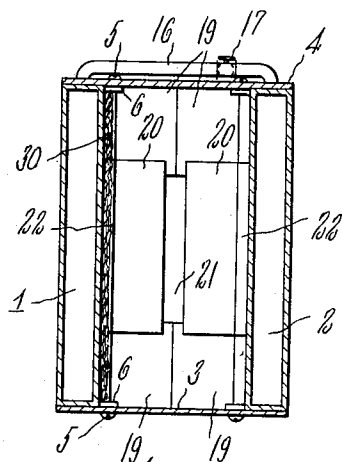


Fig. 4.

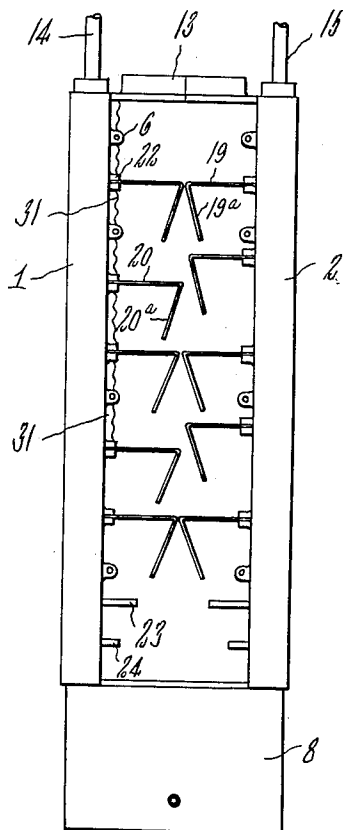


Fig. 5.

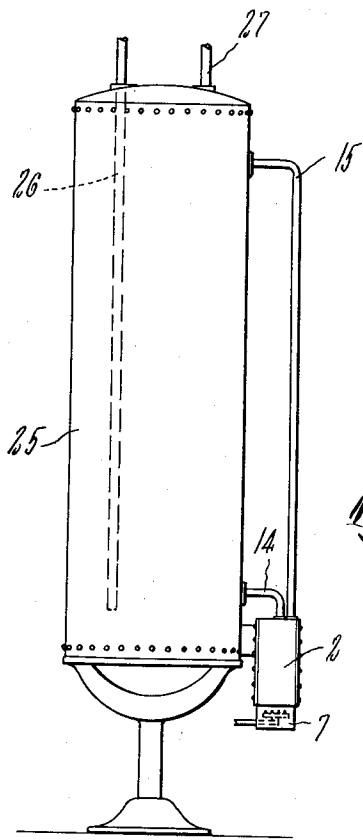


Fig. 6.

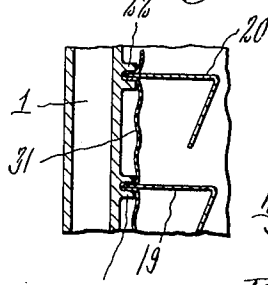


Fig. 7.

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UNITED STATES PATENT OFFICE

2,159,571

WATER HEATER

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Application August 13, 1935, Serial No. 35,974

10 Claims. (Cl. 122—367)

This invention relates to water heaters, primarily those which are used in connection with storage tanks or so-called boilers; but capable of use in other associations and for the heating of water for all purposes. It is also primarily concerned with heaters of which the heating agent is inflammable gas; but is not limited in this respect either, and may be embodied in heaters using oil or solid fuel as the heat-generating means.

The object of this invention is principally to increase greatly the efficiency of such heaters not only when operating on a full load, but also when operating on a partial or light load, such as that required merely to maintain a temperature sufficient to keep the water hot through the night. At such times, and others when there is no demand for hot water, the flame of a gas or oil burner is turned down to what is known as a standby or maintaining flame, and if solid fuel is used, the fire is banked. It is a matter of common knowledge that the ordinary types of gas water heater are efficient to a satisfactory degree when operating on full load, but when the generation of heat is reduced to the minimum, their efficiency is greatly decreased, and the fire either fails to keep the water temperature up to the required degree over a period of several hours, or else fuel is wasted in maintaining the temperature at the required degree. This phase of my object, therefore, is to economize fuel in maintaining a given temperature of the water over long periods of minimum demand.

Another object is to eliminate the bad effects of condensation. It is well known to those familiar with water heaters that there is a point in the cooling of products of combustion from a heating flame where condensation of water vapor in the gases begins, and that if the efficiency of a heater is increased by absorbing so much heat from the flue gases as to chill them below the dew point, the bad effects of condensation outweigh the benefits received from such increased efficiency. This has been the case uniformly heretofore. My object is to diminish the bad effects of condensation so much as to acquire a net benefit from the greatest possible thermal efficiency of the heater.

Further objects are to provide a heater in which all of the heat-absorbing surfaces may be readily exposed to view and easily cleaned, and to simplify the design and minimize the cost of construction.

These objects are accomplished in the heater shown in the accompanying drawings, which represent the embodiment or embodiments which at present I prefer to others.

The invention comprises the new features of construction and principles of operation thus illustrated, and explained and claimed in the following specification, as well as all substantial equivalents thereof within the scope of novelty.

In the drawings:
Fig. 1 is a front elevation of a heater exemplifying this invention, represented with the front cover plate or door removed;

Fig. 2 is a side elevation as seen from the right of Fig. 1;

Fig. 3 is a plan view of the heater;
Fig. 4 is a cross section on line 4—4 of Fig. 1;

Fig. 5 is a view similar to Fig. 1, showing a slightly different arrangement of heat-collecting surfaces having certain advantages;

Fig. 6 is a view showing the heater in operating connection with a storage tank of the type of the so-called range boiler;

Fig. 7 is a fragmentary sectional view showing a detail of one form of means for diminishing obnoxious condensation effects.

Like reference characters designate the same parts wherever they occur in all the figures.

The heater consists of two separated water sections 1 and 2 with connecting parts and auxiliary heat-collecting surfaces, and a heat generator. These water sections are preferably made as thin rectangular boxes, closed except for the water connections later described, and arranged parallel to one another with their longest dimensions vertical when in use. They may be economically made as castings of iron or other suitable metal. Cover plates 3 and 4 are placed across the openings between the water sections at front and rear and are detachably connected thereto by screws 5 entering lugs or flanges 6 projecting from the inner sides of the respective sections at or near their front and rear extremities. A fire chamber 7 is enclosed below the heater by walls 8 connected by screws 9 to lugs or flanges 10 which project from the lower end of the sections. On the upper ends of the two sections are inwardly projecting lips or webs 11—11 which, when assembled, overlap the upper end of the intermediate space except for an area 12 where these webs are recessed to provide a vent opening for the products of combustion. A flange 13 is formed at the rim of the vent opening for connection with a stove pipe.

A pipe 14 for admission of cold water is connected to the top of one of the sections, as the lefthand section 1, and a pipe 15 for the delivery

of hot water is connected to the top of the other section. The bottoms of the two sections are connected together by a yoke 16, which may be a pipe or a metal casting, and is provided with a drainage tap 17.

As the heater here shown is designed to be heated by gas, I have represented a gas burner 18 in the chamber 7 beneath, and symmetrically arranged with respect to, the water sections. The chamber in which this burner is located is substantially enclosed by the walls 8, and a bottom wall in which there are openings large enough to admit sufficient air for complete combustion of the fuel. This burner and chamber, however, typifies any heating means delivering hot gas, whether a gas or oil burner, or a fire pot containing a grate on which coal or other solid fuel may be burned.

In the space between the sections are heat-collecting surfaces in the form of vanes or fins at different levels. At an upper level are two pairs of fins 19—19 located in the front and rear portions of the intermediate space but terminating well short of the vertical transverse plane midway between the front and rear ends of the heater. The fins of each pair extend toward one another approximately horizontally and in the same plane from the inner walls of the opposite side sections and practically meet at the vertical front to rear plane midway between the sections. If they do not actually make contact with one another, at least the width of the space between them is the practical minimum. The fins are bent downward and outward from the lines where they most closely approach one another, and the parts thus bent down have substantial length. They are designated by the character 19a, in Figures 1 and 2.

At a lower level than the fins 19 are a single pair of fins 20—20, which project toward one another from the opposite side sections but both terminate short of the front to rear middle plane, leaving a passageway 21 between them. These fins also are shorter than the front to rear dimension of the heater and are located symmetrically between its front and rear walls, preferably overlapping at their ends the inner ends of the fins 19, substantially as shown in Figure 2. These fins 20 also have depending end portions designated as 20a which are inclined downwardly and outwardly with respect to the middle plane of the heater, as shown by Figure 1.

Other fins 19—19 and 20—20, like those just described, are provided at progressively lower levels in alternation, substantially as shown. In this illustration the lowermost and also the uppermost fins are of the type of fins designated as 19, but I do not intend this illustration to be a limitation of the invention, such as would exclude placing fins of the type designated by 20 at either the lowest or highest level.

All of the fins 19 and 20 are preferably made of thin plates or sheets of metal having high enough heat conductivity, (for instance, copper) cut to the proper dimensions and bent substantially to the form illustrated. They are secured to the inner walls of the water sections by any suitable means. The means which I have used and found eminently suitable and economical is to cast the water sections with projecting lugs 22 on their inner sides and cut horizontal slots in these lugs of a width approximating the thickness of the fins, and drive the edges of the fins into such slots. If forced into the slots with a driving fit they are securely held. They may be additionally

secured by solder, if desired; as the absorption of heat by the water in contact with these walls of the sections prevents melting of the solder when the heater is in use.

Below the lowermost pair or pairs of fins there are relatively narrow horizontal fins or flanges 23 and 24, at different levels; which may be of the same character and attached in the same way as above described, but are here shown as being made integral with the sections. They project from the respective water sections partially across the pathway for ascending hot gases from the burner, serving as auxiliary heat-collecting means.

When the burner is turned on full the products of combustion rise in paths approximately as indicated by the arrows in Figure 2. They travel first past the fins 24 and 23, giving up some heat thereto, and then gases from the middle part of the stream flow directly upward into the contracted throat between the depending parts of the lowest pair of fins 20—20; while the gases adjacent to the front and rear walls of the heater are obstructed by the lowermost pairs of fins 19—19 and deflected into the central part of the stream. Thus, practically the entire stream of hot gases comes into contact with some part of the lowermost pair of intermediate fins 20—20; either with the horizontal parts of these fins or the depending parts, or both. Part of the rising gases pass directly through the opening between the fins 20—20, but this opening is intentionally made so narrow as to impede and choke the flow, to some extent, when the burner is open to full capacity. Hence, some of the gases entering the contracted passageway between the depending fin extension 20a, as well as all the gases striking the horizontal parts of these fins, are deflected toward the ends of the heater and into contact with the next higher pairs of fins 19—19. In their further course upward the gases are similarly impeded and deflected by the pairs or sets of similar fins at higher levels. Thus, the gases are caused to impinge repeatedly on these fins of high heat conductivity, which are intimately connected with the heat conducting walls of the water sections.

A high efficiency of heat conduction and absorption from the products of combustion is thus obtained. Efficiency is enhanced by the downwardly extending parts or leaves of the fins, which have substantial area (as here shown approximately equal to the area of the horizontal parts of the fins, but it may be greater or less) and are mainly disposed in the hottest portion of the ascending gases. The entire area of the depending parts 20a and a considerable proportion of the areas of the fin parts 19a are thus disposed in high temperature gases. Thus they are effective for the collection of heat, which is conducted by direct metallic conduction to the walls of the respective water sections, and are more effective for that purpose than any equal area of horizontally or vertically disposed fins. The inclination of these depending parts is an important factor of efficiency because it causes impingement of ever changing particles of the gas, preventing a film of gas from forming and remaining with heat insulating effect adjacent to the depending parts, such as forms contiguous to vertical surfaces with flow of gas. A substantial horizontal component of motion is imparted to the ascending gases, due to the wide horizontal extent of the fins in the width dimension of the heater and the overlap of the ends of fins 19 75

over the fins 20, and vice versa, at different levels. The impingement of such deflected gas streams on the under sides of the fins at successively higher levels causes eddies in the gas, a constantly repeated tumbling and rearrangement of the particles of the gas, and a scouring effect on the fins which overcomes tendency of the gases to adhere in a stagnant film to the fins. Substantially all particles of the hot gases are thereby brought into contact with the fins at one time or another during their passage from the burner to the outlet. The horizontal length of the fins widthwise of the heater, and their number, are sufficient to cause the horizontal travel component of the major part of the hot gases at full load to equal or exceed the vertical component of travel.

Another factor of efficiency is the direction of water circulation. The cold water entering the water section 1 travels downward, opposite to the upward flow of the hot gases. Thus, the water is heated, before reaching the bottom part of that section, to a temperature too high to cause condensation, and the rising gases come into contact with successively cooler fins projecting from the section 1 so that a substantial temperature differential remains between the fins and gases throughout the entire heater. Indeed, it is possible, by making the heater of sufficient height and providing a sufficient number of fins, to lower the temperature of the spent gases to a near approach to the hot water temperature required, and thereby use all the effective heat of the gases. At the same time the travel of the water in the other section is upward, which, in connection with the storage tank, or other hot water system in which the heater may be connected, maintains a circulation and causes the water in the admission leg of the heater to travel downward.

This is made clear by reference to Figure 6, which shows a storage tank 25 having a cold water inlet pipe 26 passing into it to a low level and a hot water outlet pipe 27 leading from its top. The pipe 14 to the heater is connected with a low point of the tank, and the hot water outlet pipe 15 to a high point of the tank. Hence the greater specific gravity of the water in the tank over that in the pipe 15 when the heater is in operation causes downward flow through the heater section 1 overcoming the tendency of heated water in its lower part to rise. The same effect is produced when heaters embodying this invention are used for circulating hot water or steam through the radiators of a heating system.

The water in the righthand (delivery) section 2 receives accretions of heat from all of the fins attached to it, except possibly the uppermost fins if the heater is designed to cool the gases to approximately the temperature of the hot water. In any case, a large increment of heating is given to the water in this section.

Not only is the heater exceptionally efficient on full load, but its efficiency on minimum load is relatively more striking. On light load, when the burner flame is reduced to the minimum, the products of combustion are too small in volume to fill the inner space of the heater, wherefore, after passing the lowermost fins 19, they travel straight upward in the direction of the straight arrows shown in Figure 2. But in so traveling they come into intimate contact with the inclined depending parts 20a of the fins 20 at each level, and deliver heat. By providing a sufficiency of the fins 20, all of the available heat in the gases

from the lowest flame possible to be maintained in the burner is absorbed.

If the gases thus cooled were allowed to come into direct contact with the inner metal wall of that part of the section into which cold water enters, condensation would occur continuously and copiously, with all the known bad effects. A phase of the invention comprises means to prevent such contact of gases and water cooled surfaces. One form of such means is shown in Figure 1 and consists of a fibrous covering 30 of asbestos, mineral wool or other suitable material, applied to the wall of the water section 1 which bounds the interior space of the heater, over so much of the area of that wall as is liable to be cool enough to cause condensation. The fibers of such materials prevent direct contact of the gases with the metal wall of the section, while permitting a retarded heat conduction. The exterior of the fibrous covering is generally maintained at a temperature high enough to prevent any appreciable condensation. Whatever moisture may be there condensed under unusual circumstances is quickly evaporated. The heat insulating effect of this covering may be compensated for by making that part of the section to which it is applied of larger area than would be required for direct transfer of heat through the metal wall in order to obtain a given heating effect on the water.

An alternative means for the same purpose is shown in Figure 5 and consists of a sheet metal sheathing 31 separated from the adjacent wall of the admission water section by a dead air space. Such sheathing equally prevents contact of gas with the metal wall of the water section behind it, and is caused by the intermediate air space to acquire and hold a temperature high enough to prevent any considerable condensation and to cause quick re-evaporation of any moisture which may condense on it. The metal sheathing may be corrugated to increase its area of contact with the gases to dimensions greater than that of the section itself, whereby it may absorb enough heat units to compensate, or over compensate, for the temperature lag caused by the air space.

Such sheet metal sheathing may be secured in the manner shown in Fig. 7, i. e., by being offset into the slots of the lugs 22 which receive the outer edges of the fins, and being crowded by the fins against the walls of these slots. The fibrous covering 30 may be made in the form of slabs or sheets, suitably secured to the section, or applied in plastic condition with a binder, or in any other mode known to the art and suitable for the purpose.

Another modification is shown in Fig. 5, in which the fins of each pair 20, instead of being at the same level, are at different levels with the fin which is attached to one of the sections overlapping the other fin of the pair to a greater or less extent, or approaching more or less nearly to an overlap. By virtue of this arrangement, the gases which are deflected by the depending part 20a of the lower fin of any such pair are directed across the space between them and against the depending part of the companion fin. This effects a more complete distribution of the hot gases over the heat absorption surfaces, with substantial avoidance of the possibility of even a small part of the gas failing to come into direct contact with such an absorption surface. While the form last described is of advantage on account of the greater efficiency of heat delivery, the first described form has another advantage in that it

permits the sections to be made as duplicates of one another, such that one pattern can be used for both.

In either form the advantage of easy cleaning is present. Upon removal of either the front plate 3 or back plate 4 the entire interior of the heater is exposed to view and may be easily reached for cleaning. Either of these plates may be made as a door hinged to one of the sections if desired, which makes cleaning a still more simple matter.

I have found by practical test in operation that the efficiency described in the foregoing specification is actually realized in practice. Tests have shown that the efficiency, based on the ratio of units of heat absorbed by the water to units of heat generated by the fuel, remains nearly constant when the burner is turned from the full flame to the minimum standby flame. There is a slight falling off in efficiency, but not more than 3% to 4%; and the efficiency with the standby flame is much greater than in heaters of prior design which are efficient at full load. The water is maintained at the desired high temperature with a consumption of gas no greater than that required to operate a pilot light. Equivalent economy is effected in heaters and boilers having the same essential characteristics but in which other fuels than gas are burned.

In construing the following claims the term "water heater" is to be understood as including steam boilers as well as heaters for raising the temperature of water to points below the boiling point; and the term "burner" is to be understood as including not only gas burners but other means for producing flame and hot products of combustion, unless the context requires a more specific limitation.

What I claim and desire to secure by Letters Patent is:

1. A water heater comprising upright water sections spaced apart from one another having inlet and outlet connections, and heat absorbing fins in connection with each of the sections arranged to extend from their respective points of attachment part way across the intermediate space toward the other section and having downwardly extending portions from their inner extremities, the fins projecting from each section being at substantially the same level with corresponding fins projecting from the other section, and their downwardly extending portions being inclined away from one another in the downward direction.

2. A water heater comprising upright water sections of substantially rectangular formation spaced apart from one another, cover plates mounted across the ends of the space between the sections, means for delivering hot gases to the lower part in such intermediate space and fins connected to each section in pairs opposite to one another, the fins of each pair extending toward one another and having downwardly and backwardly inclined portions at their inner extremities.

3. A water heater comprising upright water sections of substantially rectangular formation spaced apart from one another, cover plates mounted across the ends of the space between the sections, means for delivering hot gases to the lower part in such intermediate space and fins connected to each section in pairs opposite to one another, the fins of each pair extending toward one another and having downwardly and

backwardly inclined portions at their inner extremities, the respective pairs of fins being at different levels and the fins at certain levels being at and near the ends of the intermediate space while those at alternate levels are in the middle part of the front to rear dimension of the space, terminating short of the ends thereof.

4. A water heater comprising upright water sections of substantially rectangular formation spaced apart from one another, cover plates mounted across the ends of the space between the sections, means for delivering hot gases to the lower part in such intermediate space and fins connected to each section in pairs opposite to one another, the fins of each pair extending toward one another and having downwardly and backwardly inclined portions at their inner extremities, the fins of certain pairs extending substantially to one another, and those of other pairs being separated from one another to leave an opening in the middle part of the intermediate space.

5. A water heater comprising upright water sections of substantially rectangular formation spaced apart from one another, cover plates mounted across the ends of the space between the sections, means for delivering hot gases to the lower part in such intermediate space and fins connected to each section in pairs opposite to one another, the fins of each pair extending toward one another and having downwardly and backwardly inclined portions at their inner extremities, the fins of certain pairs extending substantially to one another, and those of other pairs being separated from one another to leave an opening in the middle part of the intermediate space, the fin pairs of the two characters thus identified being arranged in alternation at different levels between the top and bottom of the heater and being also staggered with respect to one another in the front to rear dimension of the heater.

6. A water heater comprising a water section having an inlet at the top, a second section having a water outlet at the top, a water connection between the two sections at their bottom parts, said sections being arranged parallel with a space between them, and means for closing such space at the front and rear extremities of the sections, means for delivering hot gases into the lower end of the space so inclosed, and heat absorption members projecting into such space from each of the sections, said heat absorption means being substantially flat fins having depending extensions from their inner edges.

7. A water heater comprising a water section having an inlet at the top, a second section having a water outlet at the top, a water connection between the two sections at their bottom parts, said sections being arranged parallel with a space between them, and means for closing such space at the front and rear extremities of the sections, means for delivering hot gases into the lower end of the space so inclosed, and heat absorption members projecting into such space from each of the sections, said heat absorption members being substantially horizontal flat fins arranged in groups at different levels, the fins at certain levels collectively extending across the intermediate space at the front and rear end parts only thereof, leaving the rest of the space clear, and the fins at other levels extending partly across substantially so much of the space as is left clear by the fins of the first description and being separated from one another

other to leave an opening through which rising gases may pass.

5 8. A water heater comprising a water section having an inlet at the top, a second section hav-
ing a water outlet at the top, a water connec-
10 tion between the two sections at their bottom parts, said sections being arranged parallel with a space between them, and means for closing such space at the front and rear extremities of the sections, means for delivering hot gases into the lower end of the space so inclosed, and heat absorption members projecting into such space from each of the sections, said heat absorption members being substantially horizontal flat fins
15 arranged in groups at different levels, the fins at certain levels collectively extending across the intermediate space at the front and rear end parts only thereof, leaving the rest of the space clear, and the fins at other levels extending partly
20 across substantially so much of the space as is left clear by the fins of the first description and being separated from one another to leave an opening through which rising gases may pass, the fins of the second description having depend-
25 ing portions from their inner extremities and being arranged with the members of each pair at respectively different levels and with at least an approach to an overlap at their inner extremities, and the depending portion of the underlapping fin being inclined so as to deflect upwardly flowing gases against the depending
30 portion of the overlapping fin of that pair.

9. A water heater comprising a hollow body adapted to contain water and having a rising side wall, fins projecting horizontally from said wall and extending horizontally in the width direction of the body, said fins being of shorter length than the width dimension of the body and located at different levels in a staggered arrangement with one end of each fin at a higher level overlapping the nearer end of the fin at the next lower level; certain fins having a de-
5 pending portion extending from the extremity most remote from said body wall on an inclination toward said wall.
10

10. A water heater comprising two water compartments in flow connection with one another
15 at their bottoms only, one compartment having an inlet at its top for admission of water to be heated, and the other compartment having an outlet at its top for discharge of heated water, and heat absorbing fins in conducting connection with the exterior of a wall of said heater at successively higher levels, having horizontal under surfaces adapted to receive the impingement of gases rising from beneath and to compel horizontal deflection of such gases, said fins be-
20 ing constructed and relatively arranged to provide channels in which trapped gases are caused to flow with a horizontal component of motion widthwise of the heater.
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