J. I. AYER.

ELECTRIC CIRCULATION WATER HEATER.

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978,808.

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Fig. 1.

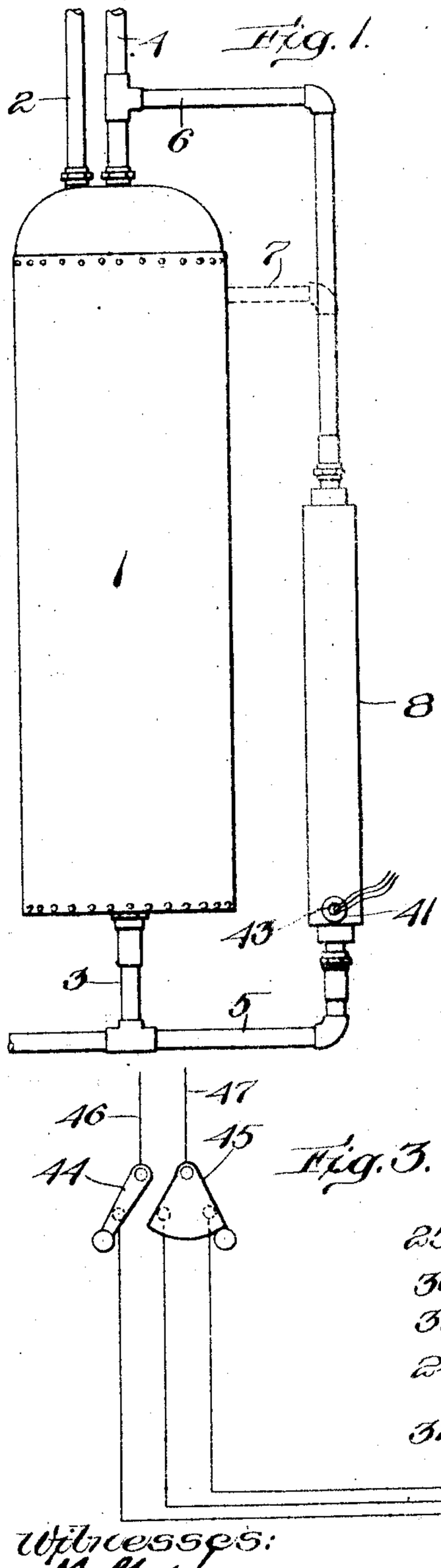

Fig. 2.

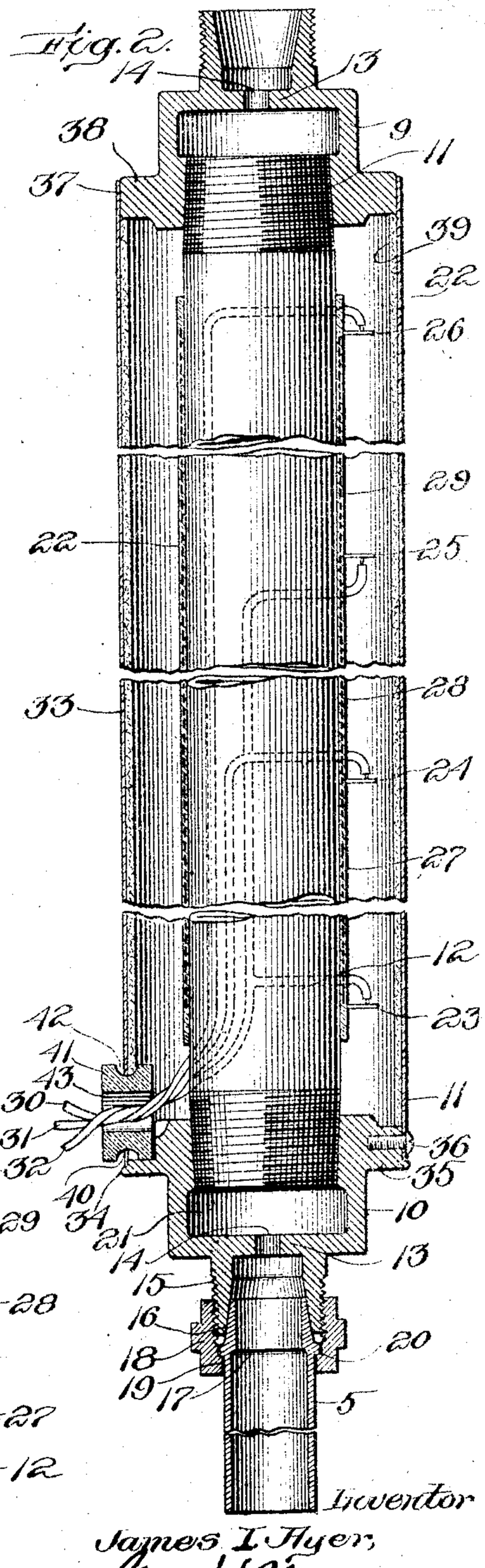

Fig. 3.

Witnesses:

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ELECTRIC CIRCULATION WATER-HEATER

978,808. Specification of Letters Patent. **Patented Dec. 13, 1910.**

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To all whom it may concern:

Be it known that I, JAMES I. AYER, a citizen of the United States, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented an Improvement in Electric Circulation Water-Heaters, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

My invention has for its object the provision of a compact and efficient electrical heater for heating water in a boiler or tank such for instance as the usual household hot water boiler or kitchen tank. My heater heats the water in the tank by circulation, the water passing out of the bottom of the tank, up through the heater and back into the tank.

The constructional details of my invention will be pointed out more at length in the course of the following description, reference being had to the accompanying drawings, in which I have shown a preferred embodiment of the invention.

In the drawings; Figure 1 shows in side elevation my invention in operative completeness; Fig. 2 is a longitudinal sectional view of the heater proper; and Fig. 3 is a diagrammatic view showing the electrical wiring and connections.

The boiler I may be of any usual or preferred kind, being herein shown as of the closed type having a circulation inlet pipe 2, an outlet pipe 3, and a hot water service pipe 4. Connected to the outlet pipe 3, I provide a circulation pipe 5 which extends upwardly and has connection at its upper end with the top of the boiler, either directly to the hot water service pipe 4 as indicated at 6 or to the top portion of the boiler as indicated by dotted lines 7, the latter construction being used with an open top boiler. I interpose in this branch circulation system 5, 6, my heater indicated in Fig. 1 at 8 and shown in detail in Fig. 2. Referring to Fig. 2, it will be seen that I provide similar end castings 9, 10, threaded at 11 on the opposite ends of a steel tube 12 and preferably both provided with a checking plate 13 having a small orifice 14 herein shown as a single opening and centrally located, the idea being to choke or check the free flow of the water compelling it to circulate or act to the best advantage for heating purposes and to remain in the relatively large thin tube 12 long enough to get appreciably heated. The union between these end castings and the adjacent pipes is similar at each end of the heater and is shown in detail at the lower end of Fig. 2, where it will be seen that the casting 10 has an externally threaded nipple 15 against whose inner conical surface 16 a similarly conically shaped end 17 of the pipe 5 is tightly clamped by a threaded nut 18 whose inner shoulder 19 engages an external shoulder 20 of the pipe. The orifice 14 opens into a preferably enlarged chamber 21 and thence the water passes directly into the tube 12. Resistance conductor wire is embedded in a coating 22 of vitreous enamel or other suitable insulating material which is fused in usual manner on the pipe 12, four terminal plates 23, 24, 25, 26, being embedded in said enamel so as to protrude from the enamel at equidistant points, and the winding is connected to said terminals and divided thereby into three sections 27, 28, 29. Circuit wires 30, 31, 32, are then connected as shown clearly in the diagrammatic Fig. 3. An external pipe 33 preferably of brass surrounds the whole, preferably resting on a ledge 34 formed at the lower edge of a flange 35 of the casting 10 to which the tube or jacket 33 is secured preferably by screws 36, the upper end of said jacket being secured at 37 to a similar flange 38 on the upper casting 9. The tube or jacket 33 is lined with a close fitting layer 39 of asbestos to prevent heat-loss through the walls of the shell or jacket, and between this outer covering and the inner tube and its winding, is a closed air space which limits to a minimum the loss of heat by conduction or radiation in an outward direction. The tube or jacket 33 has a slot 40 in its lower end in which a porcelain bushing 41 is placed, being provided with a peripheral groove 42 for the purpose of engaging the walls of said slot to hold it firmly. This bushing has a smooth central opening 43 through which the wires 30—32 pass and thence are led to a switch 44, 45. In practice, I employ a well known type of plug switch, but for the purpose of clear description and understanding, I have simply typified the switch and its movements, the line wires being indicated at 46, 47.

From the foregoing description, it will be readily understood that as the water is heated and necessarily rises, it flows upwardly through the heater and thence through the pipe 6 into the service pipe 4 and back into the boiler 1, water being continuously drawn from the bottom of the boiler through the pipes 3, 5 into the bottom of the heater, and this circulation is kept up continuously so that the entire contents of the boiler is heated gradually from the top downward, and afterward maintained hot at comparatively small expenditure. If it is desired to heat the water quickly, the switch is turned to throw all the resistance wire of the three sections into multiple closed circuit, whereas a more moderate heating is obtained by cutting into service one or two sections only. By the provision of the resistance wire arranged in a series of sections along the height of the elongated vertical tube, and arranged so that heating current can be diverted to the top portion only or to all of said tube at option, it is possible to very quickly heat the small portion of water in the top portion of the tube should only so much be required, or to heat the whole tube so that the entire contents thereof will be heated in a longer period. In this connection it should be understood that it may sometimes be desirable to use the tube 12 constructed of a size to supply the desired quantities of water without any main tank 1 associated therewith. As the water escapes from the pipe 5 through the choked orifice 14 into the adjacent chamber 21 and thence into the comparatively large pipe 12, and meets the free heat conducting and large radiating surface of the pipe 12, the water is quickly heated, but, because of the choked orifice 14 at the upper end of the heater, the water is held in the heater until it has absorbed considerable heat and at length forces its way upward on account of its expansion.

Two principal points are to be emphasized, viz., first, the great advantage of my construction in heating the water with a maximum efficiency and minimum current, and second, the advantage of heating the water to a high temperature before it escapes to the boiler. In regard to the first point, by providing the enamel-embedded wire directly on the tube 12, the heater is brought within the shortest practicable conducting distance from the water and the water is brought in direct contact with this free heat conducting medium, by which construction I am enabled to take advantage of the well known fact that heat is transmitted by conduction through a metallic conductor which is free from air cells far more rapidly than by any other means. The closed air space prevents the radiation of heat in that direction and as the heat is so rapidly taken away from the tube by the direct contact therewith of the water, the external surface of the enameled tube is always at a relatively low temperature, as compared with that which it would have if the resistance-carrying medium were not in direct contact with the circulating water. In regard to the second point, by choking the water back or providing a small orifice at the top and bottom, a much higher temperature of water-delivery is insured, or in other words, the circulation begins with a temperature many degrees higher than if the opening were the full size of the circulation pipes. It is apparent that if the water were permitted to freely circulate through the heating tube and its connecting pipes from and into the main tank without restriction, the whole contents of the main tank would be more or less uniformly heated owing to the rapid circulation and consequent disturbance of the body of water, thus preventing the quick accumulation of a relatively small body of highly heated water at the top of the tank for immediate use. The retarding devices described, consisting of checking plates 13 with the small orifices 14 therein, maintain a slow continuous circulation of water through the heating tube at a less speed than would otherwise be natural through said tube and the rest of the circulation piping, and hence deliver without disturbance to the rest of the tank contents a gradual accumulation of highly heated water at the top of the tank which is available for use without waiting for the entire contents of the tank to be heated. I take advantage of the well known fact that hot water is very slow to mingle downward with cold water below it, and hence by retarding the delivery of the hot water until it has been brought by my heater to a high temperature, and then by depositing this highly heated water on the top of the relatively cold water in the tank, it remains there without appreciably affecting or being affected by the water below, with the result that my heater will permit the user to draw from the tank, after about a few minutes' application of the heat, water at 180° F. I regard this feature of providing means for limiting the rate of circulation or producing slow circulation as particularly important and advantageous. Having the heater in the form of a tubular heating section surrounding a portion of the circulation pipe is advantageous as it confines the heat radiation thereof in such a manner as to impart heat with the greatest efficiency to the water passing therethrough. As the hot water escapes up into the pipe 6 and thence back into the boiler, more cold water goes in at the bottom, and this circulation is maintained continuously.

It will be obvious to those skilled in the art that many changes, substitutions and rearrangement of parts may be resorted to within the spirit and scope of my invention

and accordingly I wish it understood that I am not limited otherwise than as expressed in the following claims.

Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A circulation water heater, comprising means providing a tubular circulation course for the continuous flow of the water to be heated, a heating section and means, including a water pipe, a transverse check plate at the end of said pipe and of said heating section having a small orifice smaller than the cross section of said pipe, for producing a slow flow of the water at said heating section, of less speed than would otherwise be natural to the circulation course.

2. A circulation water heater, comprising means providing a tubular closed-circuit circulation course for the continuous repeated flow of the water to be heated, including a heating section presenting an extended heating area with which the water must come in direct contact as it flows through its course, means at the heater, including a water pipe, a transverse check plate at the end of said pipe and of said heating section having a small orifice smaller than the cross section of said pipe, for retarding the water in contact with said heating area, and heating resistance mounted on said section for conducting electric current to maintain said extended area heated.

3. A circulation water heater, having at its opposite ends means for receiving a water supply pipe and water discharge pipe respectively, and provided intermediate said ends with a tubular passage for containing the water to be heated, and a choked passage at the outlet end smaller than the discharge pipe and than said tubular passage for retarding the escape of said water from said tubular passage and increasing the interval the water is retained in said tubular passage, and electric heating means surrounding said tubular passage for heating water therein.

4. A circulation water heater, comprising means providing a tubular circulation course for the continuous flow of the water to be heated, including a heating section, containing electric heating means, and means for retaining the water in a comparatively sluggishly flowing condition within said section, including means at the inlet end of the section for retarding the passage of water thereat in either direction, and means at the outlet end of the section for retarding the outward escape of the heated water from said section at a less speed than the otherwise natural flow of the water in its course beyond said section.

5. A circulation water heater, comprising circulation piping, a tube interposed therein, electric resistance medium mounted about said tube for heating the latter, divided into a plurality of sections, switching means for directing the current through a part or through all of said sections as desired, and retarding means independent of said tube and of said piping coöperating with said tube and said heating means for maintaining a slow continuous circulation of water through said tube when the current is turned on, at less speed than would otherwise be natural through said tube and the rest of said circulation piping.

6. A water heater, comprising a tube adapted to be vertically arranged in use, a water supply to the bottom and a water delivery from the top thereof, a resistance current conductor extending substantially the height of said tube and having terminals at its top and bottom and also intermediate the height thereof, and connections, including a switch, for directing current selectively through said terminals to apply heat to a selected part or all of said tube at option.

7. A water heater, comprising a tube adapted to be vertically arranged in use, a water supply to the bottom and a water delivery from the top thereof, a resistance current conductor disposed about the periphery of said tube and extending substantially the entire height thereof, said conductor having terminals at the top and bottom and also intermediate the height thereof, leaders from said terminals, and a multiple switch arranged to divert current energy to the top portion only or to all of said tube at option.

8. A circulation water heater, comprising a tube, resistance current-conductor mounted thereon for heating the tube, a jacket inclosing said tube and heating conductor to provide an insulating air space about the same, means at the outgoing end of said tube providing an enlarged chamber independent of said air space and larger in diameter than said tube, a discharge pipe leading from said chamber, and a check plate between said chamber and pipe provided with an orifice smaller than said pipe through which the water discharged from said tube into said chamber must pass from the chamber into said discharge pipe, said chamber being closed water-tight excepting for said orifice and tube.

9. A circulation water heater, comprising a tube, resistance current-conductor mounted thereon for heating the tube, a jacket inclosing said tube and heating conductor to provide an insulating air space about the same, means at the ingoing end of said tube providing an enlarged chamber independent of said air space, an inlet pipe for admitting water to said chamber, said chamber having greater diameter than said tube, a check plate between said pipe and said chamber provided with an orifice smaller than the pipe through which the water must pass

from said pipe to said chamber, means at the outgoing end of said tube providing an enlarged chamber independent of said air space, a discharge pipe leading from said chamber, and a check plate between said discharge pipe and the adjacent chamber provided with an orifice smaller than the discharge pipe through which the water discharged from said tube into said chamber must pass from the chamber into said discharge pipe, the only communication between said chambers being through said tube.

10. A water heater, comprising a tube, means for applying heat thereto, and a cap fitted to an end thereof, said cap having an inwardly directed flange with a restricted opening therethrough, and a connection for receiving a water conductor adjacent thereto, said flange opening being materially smaller than the cross section of any other part of the circulatory system.

11. A water heater, comprising a tube, means for applying heat thereto, and a cap fitted to an end thereof, said cap having an inwardly directed flange with a restricted opening therethrough, a connection for receiving a water conductor adjacent thereto, said flange opening being materially smaller than the cross section of any other part of the circulatory system, and an external flange for supporting an external jacket spaced apart from said tube.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

JAS. I. AYER.

Witnesses:

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DORA A. PROCTOR.