

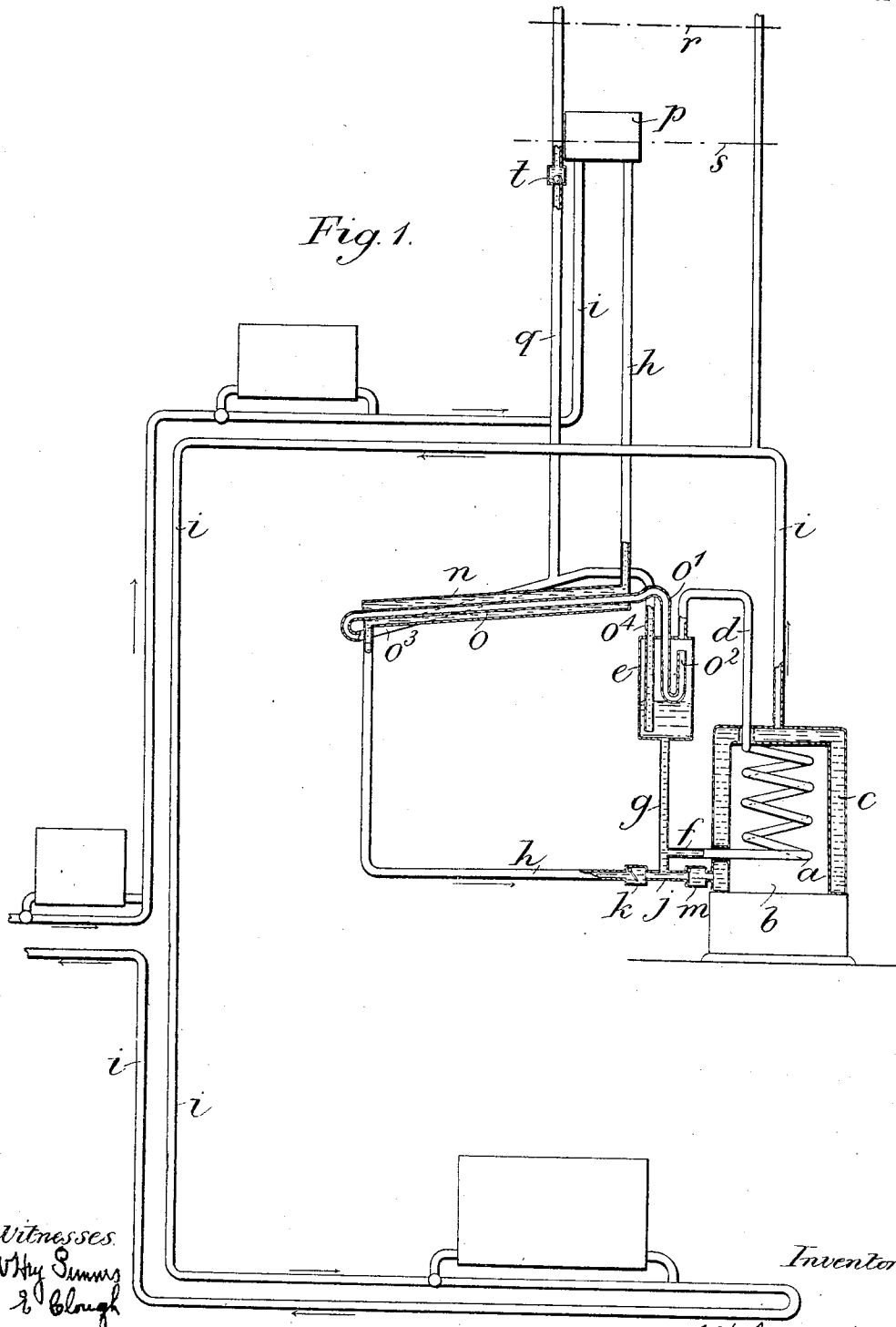
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PATENTED JAN. 2, 1906.

W. H. BEANES & H. WALTON.
HOT WATER HEATING APPARATUS.

APPLICATION FILED MAR. 23, 1905.

4 SHEETS—SHEET 1.



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No. 809,164.

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HOT WATER HEATING APPARATUS.

APPLICATION FILED MAR. 28, 1905.

4 SHEETS—SHEET 2.

Fig. 2.

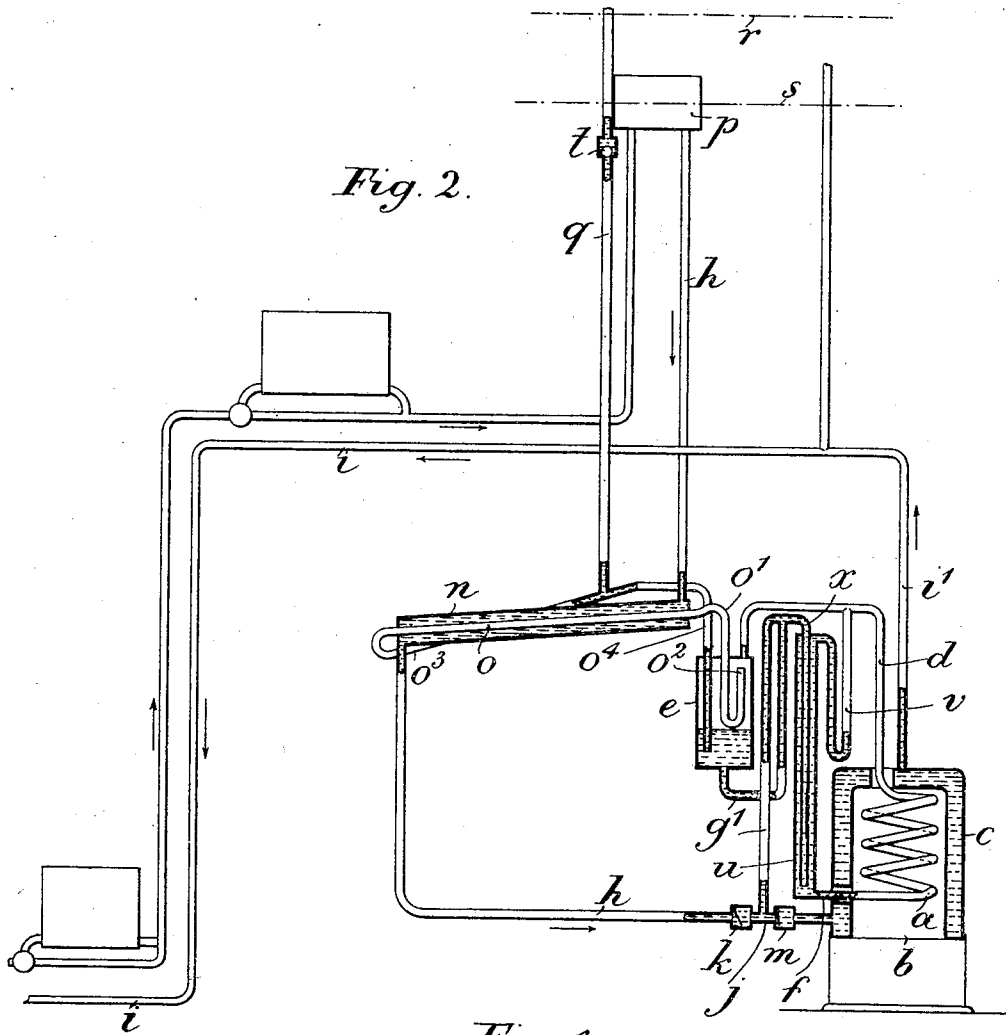
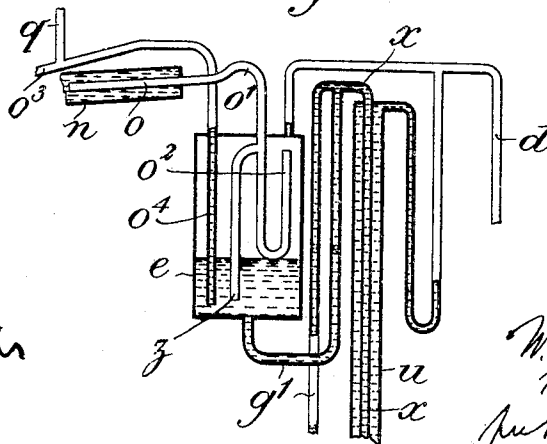


Fig. 4.



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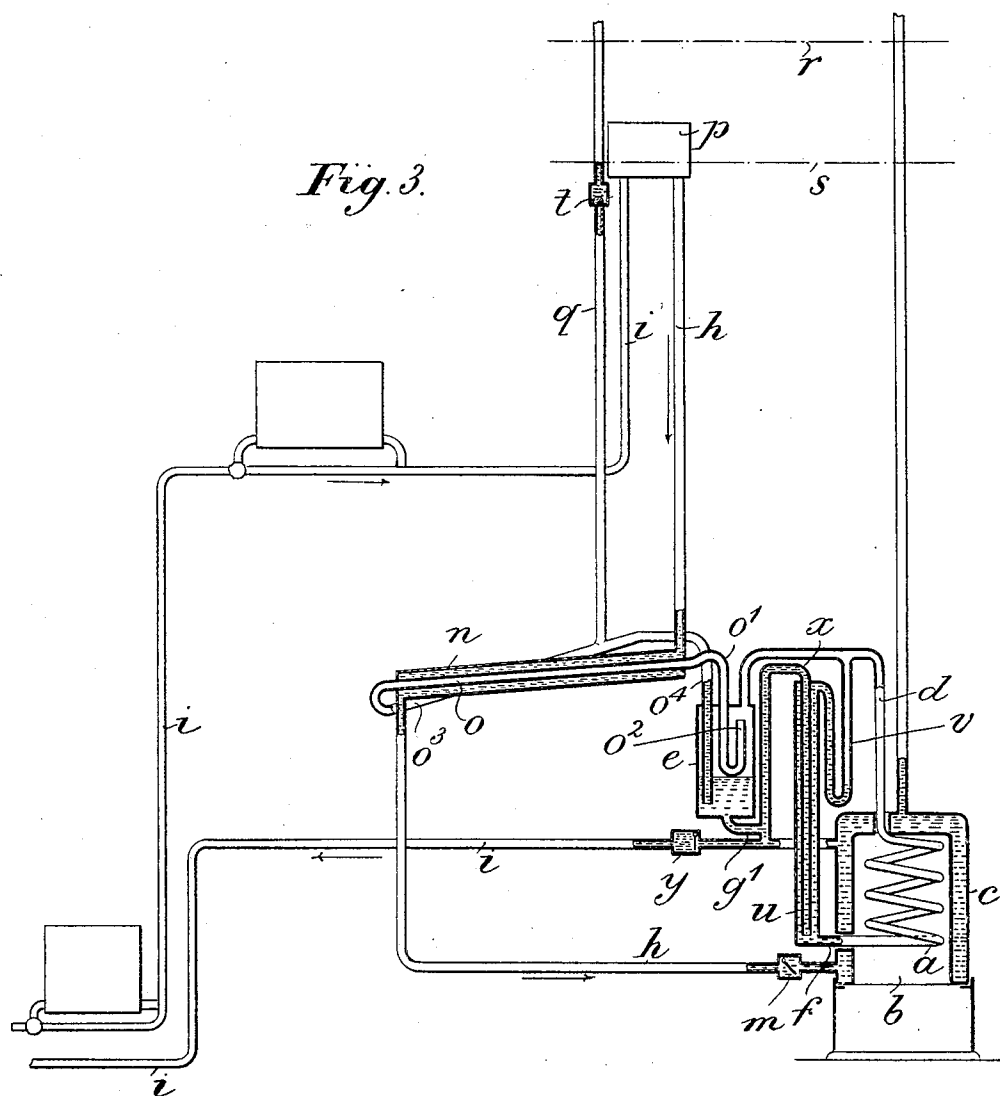
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4 SHEETS—SHEET 3.



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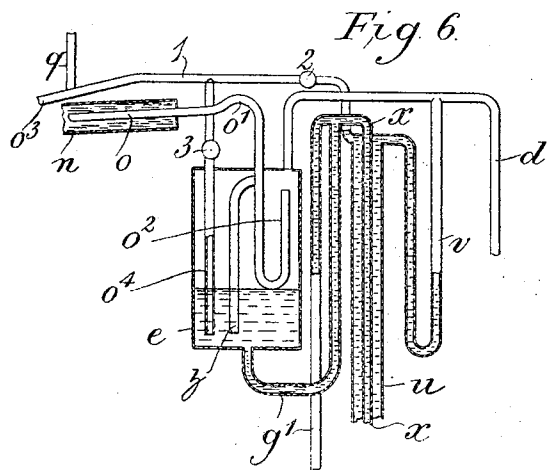
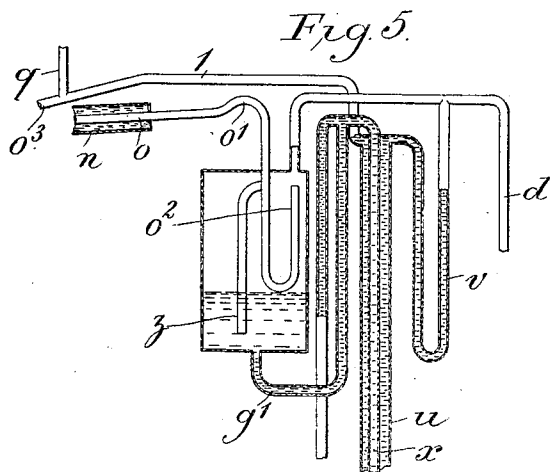
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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

WARWICK HENRY BEANES AND HUGH WALTON, OF PETERBOROUGH,
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HOT-WATER HEATING APPARATUS.

No. 809,164.

Specification of Letters Patent.

Patented Jan. 2, 1906.

Application filed March 28, 1905. Serial No. 252,455.

To all whom it may concern:

Be it known that we, WARWICK HENRY BEANES and HUGH WALTON, subjects of the King of Great Britain and Ireland, residing at Peterborough, in the county of Northampton, England, have invented Improvements in Hot-Water Heating Apparatus, of which the following is a specification.

This invention relates to hot-water heating apparatus wherein the water is caused to circulate through the apparatus in a pulsating manner by means of steam that is caused to act upon water in a displacement vessel and force a definite volume of such water into the delivery portion of the water-circulating system, after which the steam is condensed without being able to pass into the water-circulating system, whereupon owing to the partial vacuum thereby produced its place is taken by water that is received from the return portion of the circulating system and which in like manner is afterward forced into the delivery portion of the circulating system by another charge of steam, these operations taking place automatically and intermittently so long as the supply of steam under pressure continues. In apparatus of this kind as heretofore constructed the steam has been generated in a boiler of comparatively large capacity forming part of the circulating system and connected at its upper end to the displacement vessel and at its lower end to the return portion of the water-circulating conduit, so that when the apparatus is in use the upper portion of the displacement vessel is constantly in communication with a boiler containing a large volume of water at a temperature at or approaching the boiling temperature. Consequently with this arrangement when the steam previously used to displace water from the vessel is being condensed and a partial vacuum formed in the displacement vessel a further quantity of steam will be formed in the boiler and discharged into the displacement vessel and the condenser and so delay the creation in these parts of the necessary degree of vacuum to enable water to flow into and recharge the displacement vessel, condenser, and boiler to enable the successive operations of generating steam, displacing water, and condensing the steam to recommence, with the result that the rate at which water is intermittently forced through

the circulating-conduit is comparatively slow.

Now the present invention has for object to avoid the disadvantage above referred to and enable the rate of working of the apparatus to be increased. For this purpose in apparatus according thereto the steam-generator is of small internal capacity and comprises one or more pipes or other vessels arranged within a combustion-chamber and in communication at one end with the top of the displacement vessel and at the other end with the bottom of such vessel, so as to form a combined steam-generator and displacement vessel arranged outside or external to the water-circulating system, but connected thereto, the arrangement being such that the charge of steam used for each water-delivery operation will be produced from a comparatively small volume of water, so that the amount of steam to be condensed at each condensing operation will also be small in amount and not be liable to be increased to any material extent by the conversion of an additional quantity of water into steam by reason of the production of a partial vacuum in the displacement vessel when the condensation of the steam first admitted thereto takes place.

To prevent the circulation of water between the steam-generator and the displacement vessel and the charging of the latter with hot water at or near the boiling temperature, a downtake or by-pass pipe may be arranged between the top and bottom of the steam-generator external to the combustion-chamber and displacement vessel.

The water discharged from the displacement vessel may be delivered into the heating or delivery portion of the hot-water circulating-conduit either direct or indirectly through the water-heater.

The invention further consists in various novel features and combinations and arrangements of parts, all as hereinafter more particularly described and pointed out in the claims.

In the accompanying illustrative drawings, Figure 1 shows, partly in side elevation and partly in vertical section and diagrammatically, one arrangement of water-heating apparatus embodying the present invention. Figs. 2, 3, 4, 5, and 6 are similar views to Fig. 1, showing modified constructions.

In the arrangement shown in Fig. 1 the steam-generator consists of a coiled pipe *a* of small section arranged in the combustion-chamber *b* of a water-heater *c*, forming part of the water-circulating system. The upper end of the steam-generator is connected by a pipe *d* to the top of the displacement vessel *e*, and the lower end of the steam-generator is connected by a pipe *f* to a pipe *g*, that extends downward from the bottom of the displacement vessel *e* and is connected to the return portion *h* of the water-circulating conduit *h i* at a part thereof that is connected to the lower portion of the water-heater *c*. The pipe *g* is connected to the return portion *h* of the circulating system at a point *j* therein between two non-return valves *k m*, both of which open toward the water-heater *c* and one of which—viz., *k*—is hereinafter called for distinction the “inlet-valve” and the other of which—viz., *m*—is hereinafter called the “outlet-valve.” The delivery portion *i* of the hot-water-circulating conduit extends from the upper portion of the water-heater *c*. The condenser comprises a water-chamber *n* and a condenser-tube *o*, or there may be more than one condenser-tube, the chamber *n* being arranged to form part of the water-circulating conduit, it may be, as in the example now being described, of the return portion *h* thereof between the expansion-tank *p*, arranged at the highest part of the circulating-conduit and the water-heater *c*. The condenser-tube *o* extends through the condenser-chamber *n* and has one end in communication with the upper end of the displacement vessel through a tube *o'*, having a U-shaped bent or trapped-like end *o²* arranged within the displacement vessel *e*. The other end of the condenser-tube *o* is connected to a return-tube *o³*, that extends upward and is connected to a tube *o⁴*, that extends downward through the displacement vessel and terminates near to the bottom thereof. The arrangement of the condensing-tube *o* and the tubes *o'*, *o²*, *o³*, and *o⁴*, connected to its two ends, prevents water circulating through the tube *o* and heating the water in the condensing-chamber *n* before condensation of steam is to take place, and the tube *o⁴* allows of the escape of water from the condenser-tube *o* when steam enters the latter tube. The return-tube *o³* is also connected at its upper end to a vent-pipe *q*, that extends upward to a higher level *r* than the level *s* of the water in the expansion-tank *p* and is provided with a non-return valve *t*, opening upward to allow of the escape when necessary of air or steam, or both, from the condenser-tube *o*.

With the apparatus arranged as described during working thereof the comparatively small quantity of water or a portion thereof in the steam-generator *a* will be converted into steam, which upon being admitted to

the top of the displacement vessel *e* will force a definite quantity of water from such vessel into the return portion of the circulating-conduit between the two valves *k m*, one of which—viz., the inlet-valve *k*, which is on the expansion-tank side of the conduit—will close and the other of which—viz., the outlet-valve *m*—will open and allow the displaced water to be forced past such valve into the water-heater *c*, from which an equivalent quantity of hot water will be forced into the delivery portion *i* of the circulating-conduit. At the commencement of this operation the condenser-tubes *o o' o² o³ o⁴* are full of water, and during the displacement of water from the vessel *e* the level of the water in the upwardly-bent open-end portion *o²* of the tube *o'* will fall in unison with that in the vessel *e*, water in the tubes *o' o o³* being simultaneously discharged through the tube *o⁴* into the vessel *e*. The passage of steam into the condenser-tube *o* is therefore prevented by the hydrostatic seal until the level of water in the vessel *e* falls to a point just below the bottom of the bend of the tube *o' o²*, whereupon steam will be admitted from the vessel to the ascending tube *o'*, and the water in that tube and the condenser-tube *o* will escape through the tubes *o³* and *o⁴* into the vessel *e*. The seal being thus broken, the steam will enter the tube *o* and be condensed, the resulting water of condensation returning to the vessel *e* through the tubes *o³* and *o⁴*. The outlet-valve *m* then closes, and the inlet-valve *k* opens, so as to allow water from the circulating-conduit to flow into the displacement vessel *e* through the pipe *g* and fill the void produced by the condensation of the steam and recharge the said vessel and condensing-tubes with water, and water will also flow into the steam-generator *a* through the pipe *f* and recharge the same.

In order to entirely prevent the water in the displacement vessel *e* from being heated by circulation of the water through it and the steam-generator *a*, and thus to further reduce liability to formation of steam when a partial vacuum is produced in the said vessel at each condensing operation, the upper and lower ends of the steam-generator may be connected together by a downtake-pipe external to the vessel, which is, however, connected to the top of the steam-generator, the arrangement being such that during the heating of the water in the steam-generator to the boiling-point the circulation of such water will take place through the downtake-pipe, and therefore independently of the water in the displacement vessel; but upon steam of the necessary pressure being formed in the steam-generator it will pass to the top of the displacement vessel and effect the displacement of a definite portion of water therefrom, after which the steam will be condensed as before; but as the water remain-

ing in the vessel will be comparatively cool and the cross-sectional area of the steam-generating tube is small—say, for example, less than one square inch—so that the surface area of water exposed to the partial vacuum at each condensing operation will also be small, only a small quantity of steam will be generated by reason of the partial vacuum. Fig. 2 shows one arrangement of this kind wherein the upper and lower ends of the steam-generator *a*, which is shown in the form of a coil arranged in the combustion-chamber *b* of the water-heater *c*, as in the arrangement hereinbefore described, is connected at its upper end to the top of the displacement vessel *e* by the pipe *d* and also by means of this pipe to the upper end of a downtake-pipe *u*, preferably through a U-shaped connecting-tube *v*, the lower end of the steam-generator being connected by the pipe *f* to the bottom of the said downtake-pipe *u*. The lower end of the displacement vessel *e* is connected to the return portion *h* of the hot-water-circulating conduit at a point thereof between the inlet and outlet valves *k m* by a pipe *g'*, that first extends upward and then downward and is connected at its highest part to a pipe *x*, that extends downward through the downtake-pipe *u* and terminates near to the bottom thereof and is in communication through the pipe *f* with the steam-generator *a*. The steam-condenser is constructed and arranged as in the arrangement of apparatus hereinbefore described. With this construction while the water is being heated to produce steam it will circulate through the steam-generator *a*, part of the pipe *d*, the bent pipe *v*, and the downtake-pipe *u*, and when steam at a suitable pressure is produced it will enter the top of the displacement vessel *e* and, as before, force a definite portion of the water therein through the pipe *g'*, past the outlet-valve *m*, and through the water-heater *c* into the delivery portion *i* of the hot-water-circulating conduit *h i*. The pipe *x* serves when necessary for the escape of water from the steam-generator *a* under the action of the steam-pressure produced therein and also for the admission of water to the steam-generator *a* for refilling the same after the condensation of the steam previously produced has taken place.

Fig. 3 shows an arrangement of the apparatus wherein the water is forced directly from the displacement vessel *e* into the delivery portion *i* of the circulating-conduit at a point between the water-heater *c* and a non-return valve *y*, opening away from the water-heater, the return portion *h* of the circulating-conduit being provided with a non-return valve *m*, opening toward the water-heater. In this case when the condensation of the steam admitted to the displacement vessel takes place the said vessel and con-

denser will be refilled with water directly from the water-heater *c*.

Water-heating apparatus embodying the present invention may be variously modified. Thus the pipe *o'*, connected to the condenser-tube *o* and provided with a bent end *o''*, may, as shown in Fig. 4, be connected immediately after it enters the displacement vessel *e* to a pipe *z*, that bends down and terminates near to the bottom of said vessel, so that during the displacement of water from the said vessel water from pipe *o''* can pass down pipe *z* instead of flowing through the condenser-tube *o* and its connections, and thereby causing cooled water to pass down pipe *o''* into the said vessel; also, the end of the return portion *o''* of the condenser-tube *o* instead of being connected to a pipe *o''*, extending downward into and terminating near the bottom of the displacement vessel *e*, as in Figs. 1, 2, 3, and 4, may, as shown in Fig. 5, be connected directly to the top of the downtake-pipe *u* by a pipe *1*, so that the water forced out of the condenser-tube *o* and pipe *o''* by the action of the steam admitted to the displacement vessel *e* will be discharged through the downtake-tube *u* and pipe *z* into the pipe *g'* and escape with the water being forced through that pipe from the displacement vessel *e*, or both the pipe *o''* and the pipe *1* may be used, as shown in Fig. 6, stop-valves 2 and 3 being then provided to direct the water through them in the desired direction, so that water leaving the condenser-tube *o* through the tube *o''* can escape therefrom through the tube *1* or through the tube *o''* or through both of these tubes.

It will be evident that various other changes can be made in the construction of the water-heating apparatus without departing from the spirit and scope of the invention so long as the relative arrangement of the main parts of the apparatus or the mode of operation described is retained.

What we claim is—

1. Hot-water heating apparatus comprising a hot-water-circulating conduit including a water-heater, a separate steam-generator, a water-displacement vessel arranged outside of and connected to said steam-generator and to said conduit, a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit, and valves arranged to cause the water to flow in the proper direction through said conduit.

2. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater, a separate steam-generator connected to said conduit, a water-displacement vessel connected at its upper end to said steam-generator and at its lower end to said conduit, a condenser adapted to be con-

connected to said displacement vessel each time a predetermined quantity of water is forced therefrom into said conduit, and valves arranged to cause the water to circulate through said conduit but not through said steam-generator.

3. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and provided with water-controlling valves, a combined water-displacement vessel and steam-generator arranged external to said conduit but connected thereto at one point, and a condenser adapted to be placed in communication with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

4. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and controlling-valves, a displacement vessel connected to said conduit between two of said valves, a separate steam-generator having its upper and lower ends in communication with the upper and lower ends respectively of said vessel, and a condenser adapted to be placed in communication with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

5. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves opening in the same direction, a water-displacement vessel connected to said conduit between said valves, a separate steam-generator of small capacity having its upper and lower ends in communication respectively with the upper and lower ends of said vessel, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

6. In hot-water heating apparatus the combination with a water-circulating conduit including a water-heater and non-return valves opening in the same direction, of a water-displacement vessel having a discharge-pipe connected to said conduit between said valves, a steam-generator of relatively small capacity connected at its upper end to said vessel and at its lower end to said discharge-pipe, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

7. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves opening in the same direction, a water-displacement vessel connected to said conduit between said valves, a separate steam-generator of small capacity having its upper and lower ends in communication respectively with the upper and lower ends of said vessel, a downtake-pipe arranged external to said vessel and connecting the top and bottom of

said steam-generator, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

8. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves opening in the same direction, a water-displacement vessel connected to said conduit between said valves, a separate steam-generator of small capacity having its upper and lower ends in communication respectively with the upper and lower ends of said vessel, a downtake-pipe arranged external to said vessel and connected to the lower end of said steam-generator, a U-shaped tube connecting the upper end of said pipe to the top of said steam-generator, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

9. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves opening in the same direction, a water-displacement vessel connected to said conduit between said valves, a separate steam-generator of small capacity having its upper end in communication with the top of said vessel, a downtake-pipe arranged external to said vessel and connecting the top and bottom of said steam-generator, a tube connecting the bottom of said steam-generator to the bottom of said vessel, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

10. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves opening in the same direction, a water-displacement vessel having a water-discharge pipe extending from its lower end and connected to said conduit between said valves, said discharge-pipe being bent so as to extend upward to a point above said vessel and then downward to said conduit, a steam-generator of small capacity having its upper end in communication with the top of said vessel, a downtake-pipe arranged external to said vessel and connecting the top and bottom of said steam-generator, a pipe extending downward through said downtake-pipe and connected at its upper end to the upper portion of said bent discharge-pipe, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

11. In hot-water-circulating apparatus, the combination with a water-circulating conduit including a water-heater and two non-return valves opening in the direction in which the water is to flow, of a water-displacement vessel, a water-discharge pipe connecting the bottom of said vessel to said con-

duit at a part thereof between said valves, a steam-generator of small capacity located in the combustion-chamber of said heater and having its upper end connected to the top of said vessel and its lower end in communication with said conduit between said valves, and a condenser adapted to be placed in communication with said vessel each time a predetermined quantity of water is forced therefrom by steam into said conduit.

12. In hot-water-circulating apparatus, the combination with a water-circulating conduit including a water-heater and two non-return valves opening in the direction in which the water is to flow, of a water-displacement vessel, a water-discharge pipe connecting the bottom of said vessel to said conduit at a part thereof between said valves, a steam-generator of small capacity located in the combustion-chamber of said heater and having its upper end connected to the top of said vessel and its lower end in communication with said conduit between said valves, a downtake-tube arranged external to said vessel and connecting the top and bottom of said steam-generator, and a condenser adapted to be placed in communication with said vessel each time a predetermined quantity of water is forced therefrom by steam into said conduit.

13. In hot-water-circulating apparatus, the combination with a water-circulating conduit including a water-heater and two non-return valves opening in the direction in which the water is to flow, of a water-displacement vessel, a water-discharge pipe connecting the bottom of said vessel to said conduit at a part thereof between said valves, said pipe being bent so as to extend upward to a point above said vessel and then downward, a steam-generator of small capacity located in the combustion-chamber of said heater and having its upper end connected to the top of said vessel, a downtake-pipe arranged external to said vessel and connecting the lower end of said steam-generator to the upper end thereof, a pipe extending downward through said downtake-pipe and connected at its upper end to the upper portion of said bent discharge-pipe, and a condenser adapted to be placed in communication with said vessel each time a predetermined quantity of water is forced therefrom by steam into said conduit.

14. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves arranged in the return portion of said conduit and opening toward said heater, a water-displacement vessel arranged to discharge into said conduit between said valves, a separate steam-generator of relatively small capacity connected to the top of said vessel, and a condenser adapted to be connected to said

vessel each time a predetermined quantity of water is forced therefrom into said conduit.

15. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and two non-return valves arranged in the return portion of said conduit and opening toward said heater, a water-displacement vessel arranged to discharge into said conduit between said valves, a separate steam-generator of relatively small capacity connected to the top of said vessel and having its lower end in communication with said conduit between said valves, and a condenser adapted to be connected to said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

16. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater arranged between its delivery and return portions, and an expansion-tank arranged at the highest point, non-return valves arranged in the return portion of the conduit and opening toward said water-heater, a displacement vessel, a discharge-pipe connecting the lower end of said vessel to said conduit between said valves, said pipe being bent upward to a point above said vessel and then downward, a steam-generator of small capacity located in the combustion-chamber of said heater and connected to the top of said vessel, a downtake-pipe between the top and bottom of said steam-generator, a pipe connecting the bottom of said steam-generator and downtake-pipe to the upper bent portion of said discharge-pipe, and a condenser adapted to be placed in connection with said vessel each time a predetermined quantity of water is forced therefrom into said conduit.

17. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater, a separate steam-generator, a water-displacement vessel having its upper end in connection with said steam-generator and its lower end in communication with said conduit, a condenser adapted to be placed in communication with said vessel when a predetermined quantity of water has been forced therefrom into said conduit, said condenser comprising a water-chamber forming part of said conduit, and valves arranged to cause the water to flow in the proper direction through said conduit.

18. Hot-water heating apparatus, comprising a water-circulating conduit including a water-heater, a separate steam-generator, a water-displacement vessel having its upper end in communication with the upper end of said steam-generator and its lower end in communication with the lower end of the steam-generator and with said conduit, a condenser comprising a tube having one end arranged to be placed in communication with the upper part of said vessel when a prede-

terminated quantity of water has been forced therefrom, connecting means whereby the other end of the condenser-tube can be placed in communication with the bottom of said vessel, said connecting means being adapted to prevent circulation of water through said vessel and tube, and valves arranged to cause water to flow in the proper direction through said conduit.

19. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater, a separate steam-generator of small capacity, a water-displacement vessel having its upper end in communication with said steam-generator and its lower end in communication with the lower end of said steam-generator and with said conduit, a condenser arranged to be placed in communication with said vessel when a predetermined quantity of water has been forced therefrom into said conduit, a vent-pipe with controlling-valve to allow of escape of air, or steam, or both, from said condenser, and valves arranged to cause water to flow in the proper direction through said conduit.

20. In hot-water heating apparatus the combination with a water-circulating conduit including a water-heater, of a water-displacement vessel connected at its lower end to said conduit, a steam-generator and a condenser arranged in shunt-circuits to said vessel, and non-return valves arranged in said conduit at opposite sides of the point of connection thereto of said vessel, the inlet to said condenser being arranged to admit steam thereto from said vessel when the level of water in the latter falls to a predetermined point.

21. In hot-water heating apparatus the combination with a water-circulating conduit including a water-heater, of a water-displacement vessel connected at its lower end to said conduit, steam generating and condensing tubes arranged in shunt-circuits to said vessel, the steam-generating tube being of small internal capacity and arranged in the combustion-chamber of said heater, and the steam-inlet to the condensing-tube being arranged to be uncovered when the level of water in said vessel has been depressed to a predetermined point.

22. Hot-water heating apparatus comprising a water-circulating conduit including a water-heater and having an expansion-tank at its highest part, a water-displacement vessel having its lower end connected to the delivery portion of said conduit, a separate steam-generator connected to the top and bottom of said vessel, a condenser comprising a chamber arranged to form part of the circulating-conduit, and a condenser-tube the inlet end of which is bent to a U shape and located in the upper part of said vessel, connecting means between the other end of said condenser-tube and the bottom

of said vessel and adapted to prevent circulation of water through said vessel and tube, and valves for constraining water to flow in the proper direction in the said circulating-conduit.

23. In hot-water heating apparatus, the combination with a hot-water-circulating conduit including a water-heater and having an expansion-tank at its highest part, of a steam-generating tube of relatively small internal capacity arranged within the combustion-chamber of said water-heater, a water-displacement vessel having its upper end in communication with said steam-generating tube and its lower end in communication with said conduit and with the lower end of said steam-generating tube, a steam-condenser comprising a condenser-chamber arranged to form part of said conduit, and a condenser-tube having one end bent to a U shape and located in the upper part of said vessel, connecting means between the other end of said condenser-tube and the bottom of said vessel, said connecting means being adapted to prevent water circulating through said vessel and condenser-tube, a vent-pipe that is in communication with said condenser-tube and extends to a higher level than the water in said expansion-tank, a non-return valve controlling said vent-pipe, and non-return valves arranged to constrain the water to flow in the proper direction through said conduit.

24. In hot-water heating apparatus, the combination with a hot-water-circulating conduit including a water-heater, two non-return valves opening toward said heater, and an expansion-tank at its highest part, of a separate steam-generator arranged to receive a supply of water from the conduit, a water-displacement vessel having its upper end in communication with said steam-generator and its lower end in communication with the lower end of said steam-generator and with the return portion of said conduit between said non-return valves, a condenser comprising a chamber arranged to form part of the water-circulating conduit, a condenser-tube extending through said chamber and having one end bent to a U shape and located in the upper part of said vessel, an upwardly-extending pipe connected to the other end of said condenser-tube, a pipe connecting the upper end of the last-mentioned tube to the bottom of said displacement vessel, and a vent-pipe connected to the said upwardly-extending tube.

Signed at London, England, this 10th day of March, 1905.

WARWICK HENRY BEANES.
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