

Aug. 8, 1933.

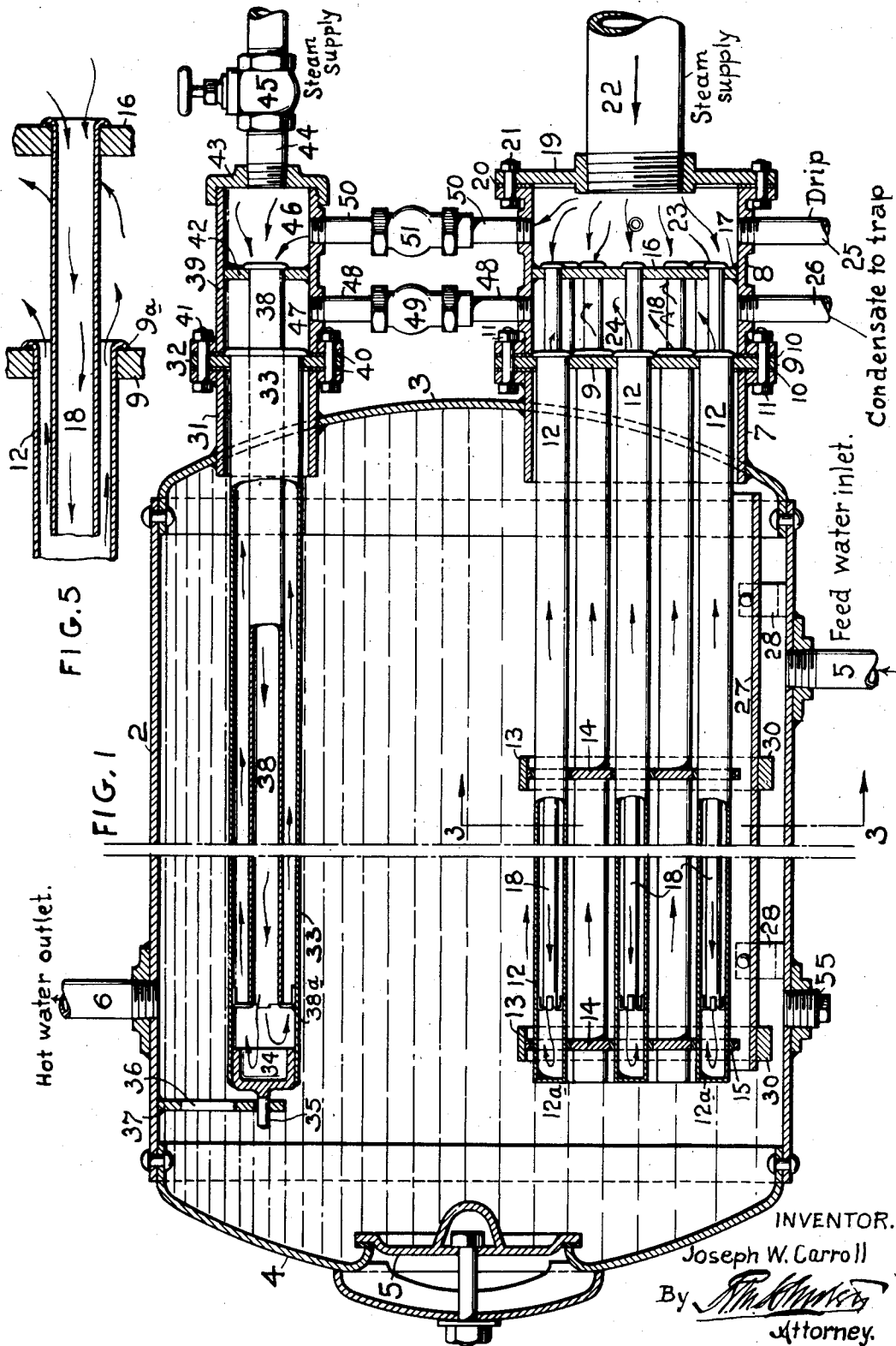
J. W. CARROLL

1,921,807

WATER HEATER

Filed May 31, 1932

2 Sheets-Sheet 1



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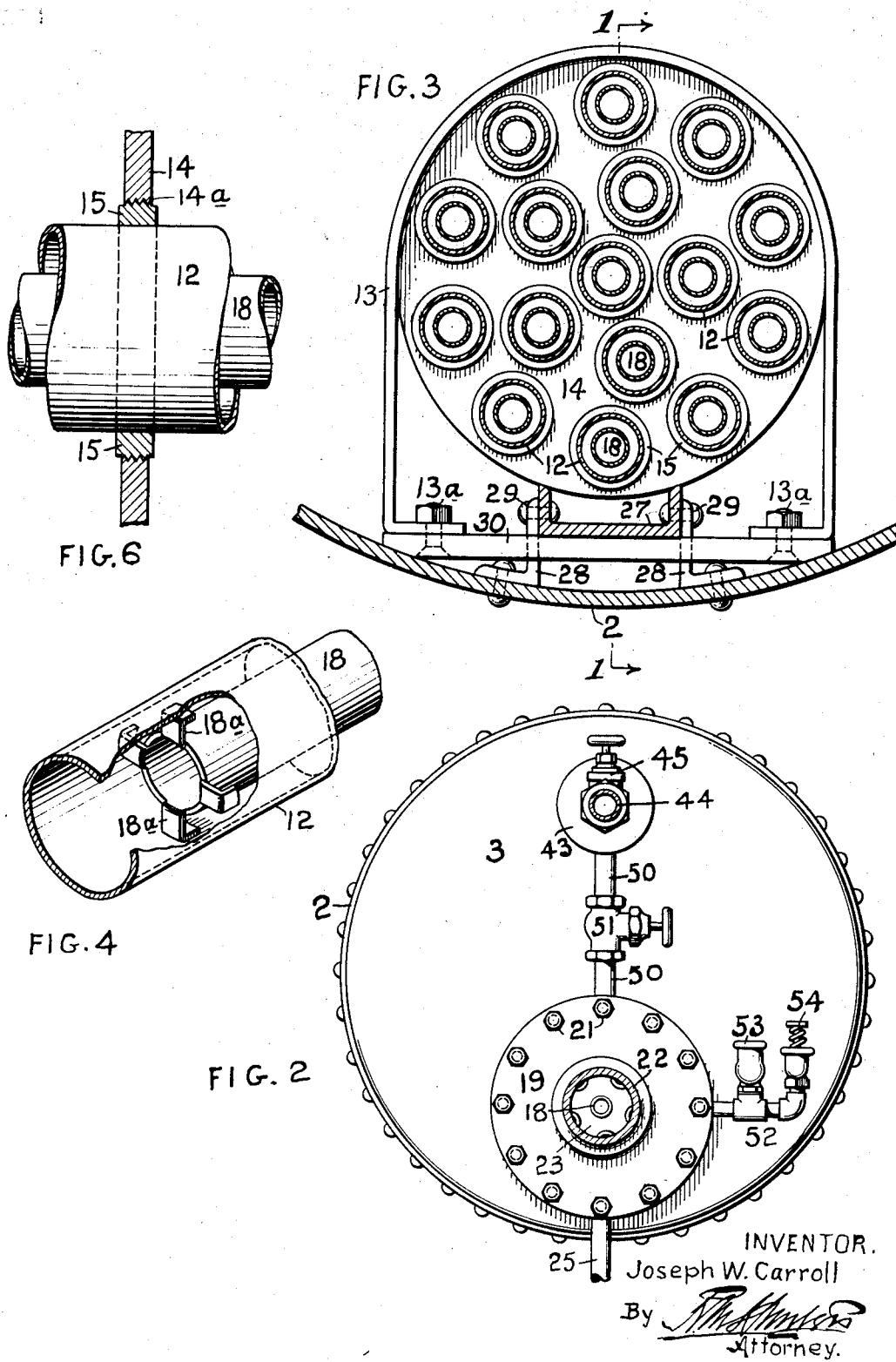
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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WATER HEATER

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P. Carroll & Sons, Philadelphia, Pa., a co-part-
nership consisting of Edward P. Carroll and
Joseph W. Carroll

Application May 31, 1932. Serial No. 614,423

12 Claims. (Cl. 257—238)

My invention has special utility as a hot water generator suitable for use in apartment houses, hotels, laundries, etc., in which the heating medium is live or exhaust steam, or both, as may be convenient or necessary.

My improvements embody a number of features of construction of which the following may be noted. The generator comprises a boiler tank or shell adapted to be normally maintained full of water and under suitable pressure to insure circulation and delivery of the hot water to the place of use. The tank is provided with duplex heating tubes (preferably of copper) extending horizontally lengthwise of the same, receiving steam adjacent to one end of the tank and insuring discharge of condensate from the same end, whereby the said heating tubes may be detached and withdrawn for replacement or repairs. The generator has a specially constructed combined steam chest and condensate chamber, which is bolted to the end of the tank, permitting live or exhaust steam to enter the principal heating pipe section at the lower part of the generator tank and also, if desired, to enter the auxiliary heating pipe section arranged at the upper part of the tank. The steam may be simultaneously or independently supplied to both the principal heating section and auxiliary section, or otherwise regulated as hereinafter set out. Where it is desired to simultaneously control the supply of steam to the two heating sections, this may be done by employment of one main or master valve; but where both heating sections are to be independently controlled, a by-pass connection for steam may be employed to separately supply steam to the auxiliary heating section as later described, this latter feature being of marked importance, especially in installations where the peak load takes place for only a few hours of the day.

The lower or principal heating section consists of a number of two-inch or larger straight tubes, (the number varying to comply with the requirements of the generator), and the front ends of said tubes are securely rolled and beaded into a heavy steel tube sheet, while the opposite ends are closed, thereby forming a steam jacket. Inside of each tube thus provided is a smaller tube which conveys the steam to the extreme end of the heating tube or jacket, through which it returns to the condensate chamber, insuring at all times perfect circulation of steam in all of the tubes. This makes each tube an independent direct heating surface for its entire area, and this is of importance inasmuch as the lowest tubes in the gen-

erator are just as efficient as the higher tubes and, therefore, will transfer heat to the water in the lowest part of the tank as freely as to the water at the higher levels.

The inner or steam delivery tubes being insulated by the heated jackets or outer tubes, will retain the heat throughout their entire length, and thereby insure the supply of relatively dry steam to the closed ends of the outer tubes, whereby the greatest heating efficiency is secured. The front ends of the inner steam tubes are secured in a second tube sheet to one side of which is a steam chest and into which the steam for heating is supplied, and to the other side and between it and the tube sheet for the jacket tubes, is provided the condensate chamber by which said condensate may be taken out of the circulation.

A suitable thermostatic control (not shown) may, therefore, be set for about one hundred and thirty degrees to meet normal requirements when using only the lower heating section; and when the occasional heavier demand for hot water occurs, steam may then be admitted to the auxiliary or upper heating section to increase the temperature at the hot water outlet and also to hasten the travel of the return circulation. This means of separate control will prolong the life of the generator considerably, since it will not be necessary to maintain high temperatures throughout the entire tank for long periods in anticipation of heavier demands.

Another point in favor of the employment of an auxiliary or upper heating section, is on installations where the available supply of exhaust steam is not quite sufficient to maintain the desired water temperature during the peak loads, and at which time the upper heating section may be supplied with live steam to meet these emergencies, it being understood, of course, that the necessary steam traps, air vent and vacuum breaker be employed as indicated for the principal heating section.

My improvements further consist of other features and details of construction which, together with those above referred to, are fully described hereinafter and pointed out in the claims.

The invention will be better understood by reference to the drawings, in which: Fig. 1 is a vertical section on line 1—1 of Fig. 3, illustrating the general construction of a hot water generator embodying my invention; Fig. 2 is an end elevation of a hot water generator embodying my improvements; Fig. 3 is a sectional view taken on line 3—3 of Fig. 1; Fig. 4 is a perspec-

tive view of the steam circulating tubes forming a part of the main and auxiliary heating section; Fig. 5 is a vertical section on a larger scale showing a portion of the structure in Fig. 1; and Fig. 6 is a sectional view of a portion of Fig. 1 showing a special view for the heating tubes.

The generator tank 2 is made of any desired diameter and length to provide capacity to suit the purpose for which the generator is designed. In general, the forward head 3 of the tank is provided with two flanged port openings 7 and 31, the former being relatively large in diameter as compared with the latter; and the tank is further provided at its bottom and near the flanged port opening 7 with a feed water inlet 5 and at its top and distant from the flanged port opening 31 with a hot water outlet 6. In this manner, the feed water inlet and hot water outlet are spaced considerably apart in the direction of the length of the tank. The tank is further provided with a man-hole in large generators and a hand-hole in small generators, such man or hand holes being formed at 5a in the rear head 4 of the tank. There is also preferably provided a plugged hole 55 through which the interior of the tank may be flushed or cleaned.

As shown, there is a lower main heating section secured to the flanged port opening 7 and an upper auxiliary heating section secured to the flanged port opening 31. The heating sections comprise long heating tubes 12 and 33 respectively into and through which steam is respectively supplied by the tubes 18 and 33.

Referring to the main heating section, 9 is a strong tube sheet bolted at 11 to the flanged port opening 7, and said tube sheet is provided with a number of copper tubes 12, each having its end extended through the tube sheet and secured permanently therein by being expanded and beaded therein, the other and distant ends 12a being closed and sealed as shown. Extending over the outer side of the tube sheet 9 is a combined steam chest 23 and condensate chamber 24, said parts separated by a transverse tube sheet 16 and all enclosed within a tubular head 8 having a flanged end which is bolted to the tube sheet 9 and flanged port 7 aforesaid. There are steam supply tubes 18 whose forward ends are flanged and beaded into the tube sheet 16 in a steam-tight manner, said tubes 18 extending into the heating tubes 12 to near their closed ends (Fig. 1) wherein they are centrally spaced by the flanges 18a as shown in Figs. 1 and 4. These spacing flanges 18a are more particularly illustrated in Fig. 4 and shown as formed by radially flanging the ends of the inner tubes 18 and employing a portion of said flanged part to provide spacing means between the end of the said inner tube 18 and the interior wall of the outer tube 12. It will suffice to employ three or more of these spacing radially flanged portions 18a, though in practice I prefer four of such parts, as shown, for centralizing the end of the tube 18 within the closed end of the tube 12; and the surplus portion of the flanged end of the inner tube 18 is cut away so as to permit free passage of the steam through said inner tube into the outer tube 12 and thence, with the water of condensation, through the annular space between the inner tube 18 and the outer tube 12, back to the chamber 24. By reason of this construction the steam is supplied from the steam chest 23 through the tubes 18 and released within the distant end of the larger tubes 12 which act

as jackets about the smaller supply tubes 18. The outer tubes 12 provide the heat to the water in the tank throughout the length of the tank and where it is coolest. The condensate flows through the tubes 12 and discharges into the condensate receiving chamber 24, from which it is discharged through pipe 26 to any suitable steam trap (not shown), which discharges the condensate where desired while preventing the escape of steam. By this construction the steam is delivered to the most distant portions of the tubes 12 and 18 and the condensate is returned to and discharged at the steam supply end of the generator, insuring perfect circulation of steam throughout the full length of the tubes and where the water is coolest, thereby assuring the greatest efficiency.

The outer end of the steam chest 23 is closed by a cap plate 19 which is bolted in position by bolts 21 and made steam tight by a gasket 20. The steam, live or exhaust, as found desirable or convenient, is supplied to the steam chest by a pipe 22 which may be received from any suitable source under the control of valve means (not shown). Incidentally, I would point out that the tube sheet 9 is clamped between steam and water tight gaskets 10, and I have also indicated that the tube sheet 16 may be electrically welded at 17 within the tubular head 8 as a convenient means of construction. Condensate which may collect in the steam chest 23 may be passed off through a drip pipe 25 and be directly returned to the source of steam or discharged through a suitable steam trap (not shown).

While the tubes 12 and 18 are strongly secured to the flanged port opening 7 of the generator, it is necessary in long generators to support the free ends of the tubes 12 and 18, and this I accomplish in the following manner. The several tubes 12 are spaced apart by one or more tube support circles 14, which are circular disks having spaced apertures 14a of a diameter somewhat greater than the outer diameter of the tubes 12 and preferably internally threaded as shown in Fig. 6. These apertures 14a are bushed with lead or other ductile and relatively soft metal or material 15 which, while supporting the weight of the tubes, will not objectionably injure them due to vibration, water hammering in the house pipes, or otherwise. The use of these cushion supporting means or bushings for the steam heating pipes 12 is important because it is desirable to form the tubes of relatively thin copper or copper alloy to insure the ready passage of heat from the steam within the tube to the water surrounding the same, while avoiding injury due to severe jarring of the ductile tubes. The tube supporting circles 14 are placed upon the tubes 12 near their free ends, as shown in Fig. 1, and at one or more places distant from the tube sheet 9, and these supporting circle plates are clamped tightly upon the upturned flanges of a channel rail 27 by the clamping straps 13 which have their lower ends bolted at 13a to a cross bar 30 resting upon the inside bottom of the tank and under the channel rail 27, which latter is held down by anchoring angle bars 28 riveted to the tank and to the channel rail at 29. In this manner, the tubes are free, under expansion and contraction, to slide upon the bushings of the supporting circle members. These structures are clearly shown in Figs. 3 and 6.

Referring now to the auxiliary heating section, the general construction corresponds substantially to one set of tubes 12 and 18 already described and will be readily understood. 32 is a

5 tube sheet and is clamped between the flanged
port opening 31 and the combined steam chest
46 and condensate chamber 47, by bolts 41, pack-
ing gaskets 40 being employed to insure a steam
10 and water tight joint. 33 is a copper steam tube
which is secured to the tube sheet 32 by a flange
and beaded joint, and extended for the greater
part of the length of the generator tank 2, the
15 free end of said tube 33 being closed by a plug
34 welded or soldered in position and having a
horizontal stud 35 forming a sliding fit through
a hole in a downwardly arranged arm 36, welded
in position within the tank at 37, all as shown
20 in Fig. 1. Arranged within the tube 33 is a steam
supply pipe 38 having an end 38a forming a slid-
ing connection within the tube 33 while permitting
free circulation of the steam. The other end of
the steam supply pipe 38 is secured to the tube
sheet 42 of the combined steam chest and con-
densate chamber head 39. This head 39 has its
steam chest 46 closed by a cap 43 screwed in po-
sition and receiving a steam supply pipe 44 hav-
ing a control valve 45 of any suitable construction.

25 Steam is supplied from steam chest 23 of the
main heating section to the steam chest 46 of
the auxiliary heating section through a branch
pipe 50 under the control of a shut-off valve 51
therein. Similarly, the condensate from the
30 chamber 47 is free to flow by gravity into the
condensate chamber 24 and thence to the steam
trap as before explained, but the discharge of
condensate in this manner is dependent upon the
opening of the valve 49 in the branch pipe 48 con-
necting the two condensate chambers 24 and 47.

35 It will now be understood that this hot water
generator may be employed under various con-
ditions, among which may be stated: (a) Where
the greatest quantity of hot water is required,
live steam is freely supplied to the steam chests
40 23 and 46, whereby both the main heating section
and the auxiliary heating section are each ef-
ficiently operating. (b) Where a lesser tem-
perature is required, the live steam may be sup-
plied to the steam chest 23 of the main heating
45 section alone. (c) Where a still less temperature
of heated water is required, the live steam may
be supplied to the steam chest 46 of the auxiliary
section alone. (d) Where the demand for hot
water increases to a degree between that which
50 may be supplied by the main or auxiliary sec-
tions separately or combined, the generator may
be supplied with steam direct to steam chest 23
and by-pass a portion of that steam through the
auxiliary steam chest 46 by adjustment of the
55 by-pass valve 51. (e) When very mild tempera-
ture is required the auxiliary heating section may
be used with the supply of live or exhaust steam
admitted under regulation. (f) Where the avail-
able supply of exhaust steam is not quite suf-
60 ficient to maintain the desired water tempera-
ture during the peak loads, the auxiliary section
may be supplied with live steam to meet such
conditions. Other examples of special regula-
tion for special conditions will be available, but
65 the flexibility of the apparatus is sufficiently ex-
emplified by the above examples.

70 The auxiliary or upper heating section located
as it is, high in the tank shell and with the hot-
test portion of this unit directly below the hot
water outlet, is one of the outstanding features
of this generator. Its chief function is to main-
tain an even, high temperature in the water dur-
ing periods of heavy demands or peak loads. It
will also prove its effectiveness by increasing the
75 speed of water travel where it is employed in

a return circulating system. Another important
feature of this generator is that only one air vent
valve 53 and one vacuum breaker 54 are required
for the two heating sections on installations where
80 steam enters both heating elements at the same
pressure. This vent valve 53 and vacuum break-
er 54 may connect with steam chest 23 by pipe
52. I also emphasize that the condensate from
the auxiliary heating section on the top is piped
85 into the condensate compartment of the steam
chest, thereby eliminating the expense of pro-
viding two separate steam traps, as one steam
trap is ample to take care of the condensation
from both heating sections.

90 It will also be seen that when the tubes require
to be withdrawn for cleaning or repairs, this is
easily done as the tube sheets 9, 16, 32 or 42 may
be removed with the connected tubes, as will be
evident to one skilled in the art.

95 It will now be apparent that I have devised a
novel and useful construction which embodies
the features of advantage enumerated as de-
sirable, and while I have in the present instance
shown and described, the preferred embodiment
100 thereof which has been found in practice to
give satisfactory and reliable results, it is
to be understood that I do not restrict myself
to the details stated as the same are susceptible
of modification in various particulars, without
105 departing from the spirit or scope of the inven-
tion.

I claim:

1. A hot water generator comprising in com-
bination, a horizontally positioned tank provided
on its interior with a heating section arranged
110 near the lower portion of the tank and consist-
ing of a plurality of steam heating return tubes
each comprising an inner steam supplying tube
of relatively small diameter and a surrounding
jacketing tube of relatively larger diameter en-
115 closing the tubes of smaller diameter, said small
and large tubes being telescoped in pairs and
opening into each other at one end and having
their other ends secured to separate tube sheets
and respectively opening into a steam chest and
120 a condensate chamber, a feed water inlet open-
ing into the lower portion of the tank below the
large and small steam tubes, a hot water out-
let from the upper part of the tank, means for
supplying steam to the steam chest, means for
125 permitting the discharge of the condensate from
the condensate chamber, and means for support-
ing the distant ends of the smaller diameter
tubes upon the interior portions of the surround-
ing jacketing tubes of relatively large diameter,
130 said larger tubes being held in spaced relation
by a tube support extending downward and fixedly
secured to the interior bottom of the tank for
supporting the ends of the tubes and holding
them against movement relatively to the tank. 135

2. A hot water generator comprising in com-
bination, a horizontally positioned tank provided
on its interior with a heating section arranged
near the lower portion of the tank and consist-
140 ing of a plurality of steam heating return tubes
each comprising an inner steam supplying tube
of relatively small diameter and a surrounding
jacketing tube of relatively larger diameter en-
closing the tubes of smaller diameter, said small
145 and large tubes being telescoped in pairs and
opening into each other at one end and having
their other ends secured to separate tube sheets
and respectively opening into a steam chest and
a condensate chamber, a feed water inlet open-
150 ing into the lower portion of the tank below the

large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, means for permitting the discharge of the condensate from the condensate chamber, a tube supporting circle for holding the large diameter tubes in spaced relation, means secured within the tank for sustaining the tube supporting circle and holding it against movement relatively to the tank, and soft metal bushings interposed between the larger diameter tubes and the tube supporting circle.

3. A hot water generator comprising in combination, a horizontally positioned tank provided on its interior with a heating section arranged near the lower portion of the tank and consisting of a plurality of steam heating return tubes each comprising an inner steam supplying tube of relatively small diameter and a surrounding jacketing tube of relatively larger diameter enclosing the tubes of smaller diameter, said small and large tubes being telescoped in pairs and opening into each other at one end and having their other ends secured to separate tube sheets and respectively opening into a steam chest and a condensate chamber, a feed water inlet opening into the lower portion of the tank below the large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, means for permitting the discharge of the condensate from the condensate chamber, and supporting means for sustaining the telescoped portions of the tubes in fixed relation to the tank, said supporting means provided with soft metal parts interposed between the large steam heating tube and the supporting means.

4. A hot water generator comprising in combination, a horizontally positioned tank provided on its interior with a heating section arranged near the lower portion of the tank and consisting of a plurality of steam heating return tubes each comprising an inner steam supplying tube of relatively small diameter and a surrounding jacketing tube of relatively larger diameter enclosing the tubes of smaller diameter, said small and large tubes associated in pairs and opening into each other at one end and having their other ends secured to separate tube sheets and respectively opening into a steam chest and a condensate chamber, a feed water inlet opening into the lower portion of the tank below the large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, means for permitting the discharge of the condensate from the condensate chamber, means for anchoring the steam heating tubes to the tank, said means including a longitudinal metal member secured rigidly to the lower interior part of the tank, a transversely arranged supporting member through which the tubes extend, and means for clamping the transverse tube supporting member to the longitudinal metal member.

5. A hot water generator comprising in combination, a horizontally positioned tank provided on its interior with a heating section arranged near the lower portion of the tank and consisting of a plurality of steam heating return tubes each comprising an inner steam supplying tube of relatively small diameter and a surrounding jacketing tube of relatively larger diameter enclosing the tubes of smaller diameter, said small and large tubes being telescoped in pairs and opening into each other at one end and having their

other ends secured to separate tube sheets and respectively opening into a steam chest and a condensate chamber, a feed water inlet opening into the lower portion of the tank below the large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, means for permitting the discharge of the condensate from the condensate chamber, and wherein further, the inner tubes are split longitudinally at one end and have portions intermediate of said slits bent radially relatively to the length of the tube to provide spacing members between the inner and outer tube parts, the space between said spacing members forming a communicating passage between the tube parts for permitting the flow of steam and condensate.

6. A hot water generator comprising in combination, a horizontally positioned tank provided on its interior with a heating section arranged near the lower portion of the tank and consisting of a plurality of steam heating return tubes each comprising an inner steam supplying tube of relatively small diameter and a surrounding jacketing tube of relatively larger diameter enclosing the tubes of smaller diameter, said small and large tubes being telescoped in pairs and opening into each other at one end and having their other ends secured to separate tube sheets and respectively opening into a steam chest and a condensate chamber, a feed water inlet opening into the lower portion of the tank below the large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, and means for permitting the discharge of the condensate from the condensate chamber, and wherein further, an auxiliary smaller heating section is provided within the tank near its upper part said section including a return tube structure having telescoped inner and outer members, said members being respectively in communication with the steam chest and condensate chamber of the lower heating section, and also, wherein the lower heating section has an exhaust steam supply pipe and the upper heating section has a live steam supply pipe, and suitable means are provided for controlling the live steam.

7. A hot water generator comprising in combination, a horizontally positioned tank provided on its interior with a heating section arranged near the lower portion of the tank and consisting of a plurality of steam heating return tubes each comprising an inner steam supplying tube of relatively small diameter and a surrounding jacketing tube of relatively larger diameter enclosing the tubes of smaller diameter, said small and large tubes being telescoped in pairs and opening into each other at one end and having their other ends secured to separate tube sheets and respectively opening into a steam chest and a condensate chamber, a feed water inlet opening into the lower portion of the tank below the large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, and means for permitting the discharge of the condensate from the condensate chamber, and wherein further, an auxiliary smaller heating section is provided within the tank near its upper part said section including a return tube structure having telescoped inner and outer members, said members being respectively in communication with the steam chest and condensate chamber of the lower heating section, and wherein also, the steam

chest is provided with vacuum and relief valves.

8. A hot water generator comprising in combination, a horizontally positioned tank provided on its interior with a heating section arranged
 5 near the lower portion of the tank and consisting of a plurality of steam heating return tubes each comprising an inner steam supplying tube of relatively small diameter and a surrounding jacketing tube of relatively larger diameter enclosing
 10 the tubes of smaller diameter, said small and large tubes being telescoped in pairs and opening into each other at one end and having their other ends secured to separate tube sheets and respectively opening into a steam chest and a condensate
 15 chamber, a feed water inlet opening into the lower portion of the tank below the large and small steam tubes, a hot water outlet from the upper part of the tank, means for supplying steam to the steam chest, and means for permitting the
 20 discharge of the condensate from the condensate chamber, and wherein further, an auxiliary smaller heating section is provided within the tank near its upper part and including a return tube structure having telescoped inner and outer
 25 members, said members being respectively in communication with the steam chest and condensate chamber of the lower heating section, and wherein further, valve means are provided for shutting off the auxiliary heating section from
 30 the steam chest and condensate chamber of the lower heating section.

9. A hot water generator comprising in combination, a horizontally arranged tank provided on its interior with a heating section arranged
 35 near the lower portion of the tank and consisting of a plurality of inner and outer telescoped tubes arranged in pairs to form return tube structures for steam and condensate, means for supplying steam to the inner tubes and providing for
 40 passage of condensate from the outer tubes of each telescoped pair of tubes, means comprising a transverse plate having a plurality of apertures provided with bushings of ductile metal through
 45 which the outer of the telescoped tubes respectively extend and by which they are supported in parallel relation to each other, means connecting the said supporting means to the bottom of the shell of the tank, means for supplying cold water
 50 to the lower part of the tank and below the telescoped tubes therein, and means for delivering hot water from the upper part of the tank.

10. A hot water generator comprising in combination, a horizontally arranged tank provided on its interior with a heating section arranged
 55 near the lower portion of the tank and consisting of a plurality of inner and outer telescoped tubes

arranged in pairs to form return tube structures for steam and condensate, means for supplying steam to the inner tubes and providing for passage of condensate from the outer tubes of each
 80 telescoped pair of tubes, transversely arranged means for supporting the telescoped tubes through which the tubes extend, means connecting the said supporting means to the shell of the tank, means for supplying cold water to the lower
 85 part of the tank and below the telescoped tubes therein, means for delivering hot water from the upper part of the tank, and soft metal bushings interposed between the outer tubes and the transversely arranged supporting means.

11. A hot water generator, comprising a horizontal tank having arranged therein a lower
 90 heating section formed of a plurality of telescoping inner and outer tubes in pairs, means for supplying steam to the inner tubes, and means for conveying condensate from the outer tubes, in combination with an auxiliary heating section
 95 arranged in the upper part of the tank and comprising inner and outer tubes in telescoped relation, means for supplying and regulating steam to the inner tube of the auxiliary section, means for permitting the passage of condensate from the
 100 outer tube of the auxiliary section and for mixing it with the condensate from the lower section, a feed water inlet opening into the lower part of the tank below the lower heating section, and a hot water outlet from the tank above the
 105 upper auxiliary heating section.

12. A hot water generator, comprising a horizontal tank having arranged therein a lower
 110 heating section formed of a plurality of telescoping inner and outer tubes in pairs, means for supplying steam to the inner tubes, means for conveying condensate from the outer tubes, in combination with an auxiliary heating section arranged
 115 in the upper part of the tank and comprising inner and outer tubes in telescoped relation, means for supplying steam to the inner tube of the auxiliary section and permitting the passage of condensate from the outer tube thereof,
 120 a feed water inlet opening into the lower part of the tank below the lower heating section and a hot water outlet from the tank above the upper auxiliary heating section, and wherein further, the telescoping tubes of the auxiliary heating section
 125 are removable longitudinally from the end of the tank and are supported at their inner ends by means of a longitudinal extension on the ends of the tubes in engagement with a transversely arranged arm upon the inner portion of
 130 the tank.

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