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A. HUET

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MARINE BOILER EXHIBITING SMALL VARIATIONS OF LEVEL

Filed June 13, 1958

FIG. 1

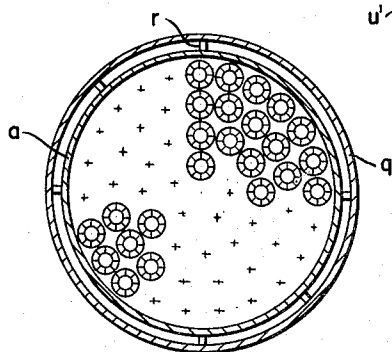
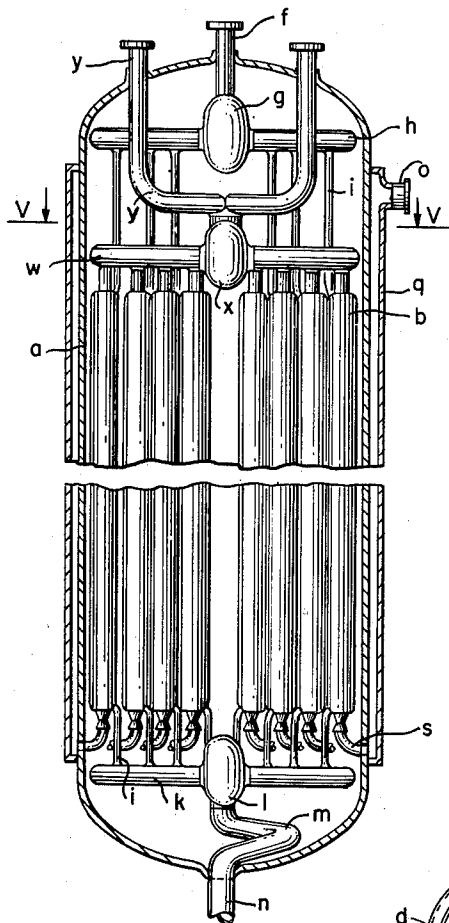


FIG. 2

FIG. 4

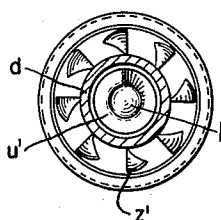


FIG. 3

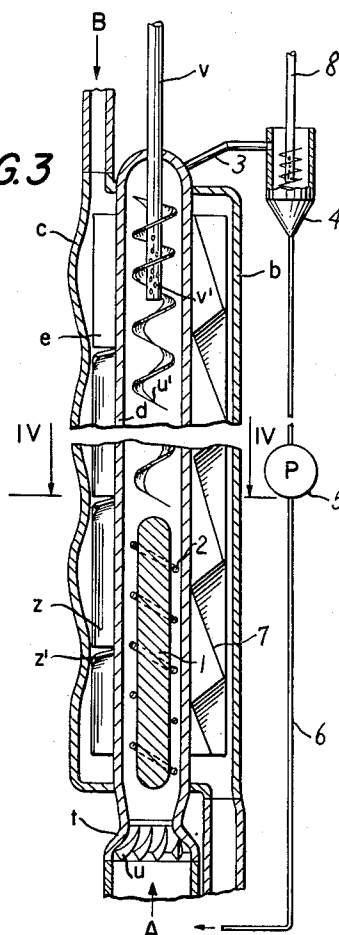
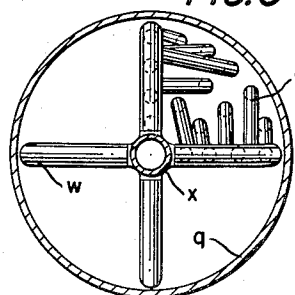


FIG. 5



INVENTOR.
ANDRÉ HUET
BY *Robert E. Burns*
his ATTORNEY

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MARINE BOILER EXHIBITING SMALL VARIATIONS OF LEVEL

André Huet, 48 Ave. du President Wilson, Paris, France

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6 Claims. (Cl. 122—34)

The present invention has for its object a marine boiler specially designed so that the water levels which are established in the different parts of the boiler are of rather limited area, so that when there are changes in the list of the ship, which may reach 40° and more, the inclination resulting therefrom in these levels cannot produce any interference with the efficiency and reliability of operation of the boiler.

To this end, the evaporating portion of the boiler is subdivided into a large number of identical elements constituted by double-circuit heat-exchanging tubes fed by the heating fluid and by the water to be vaporized, which exchange their heat in these tubes, the variations of level which are produced inside the tubes for the water to be vaporized therefore affecting only a relatively small area by reason of the large number of these tubes.

Partitioning inside the jacket serving as an economizer for the preliminary heating of the water to be vaporized likewise enables the water levels which may be established inside the economizer to be subdivided.

Other details of the boiler forming the object of the invention will appear in the course of the following description given with reference to the drawings, which are given by way of example.

FIG. 1 is a view in elevation of a unit of the boiler.

FIG. 2 is a cross-section through the median portion II of the boiler.

FIG. 3 is a longitudinal section of one of the double-circuit heat-exchanging tubes provided inside the unit.

FIG. 4 is a section on the line IV—IV of FIG. 3.

FIG. 5 is a section on the line V—V of FIG. 1 showing the sub-headers of the heat-exchanging tubes.

The boiler is constituted by a certain number of identical units, such as the one shown in FIG. 1. Each of these units comprises an outer shell *a*, which is preferably cylindrical and has a vertical axis, containing a large number of double-circuit heat-exchanging tubes which form the evaporating portion of the boiler. The number of these tubes inside the shell *a* in the example shown is about sixty and they have a length adapted to the power of the boiler. A heat-insulating material, such as glass wool or some other material, is packed between them to reduce the internal air currents circulating between the tubes. Each of the latter is constituted, as shown in section in FIG. 3, by an outer tube *b*, the wall of which may be smooth or comprise corrugations *c*, as shown in the left-hand part of FIG. 3, and into which there is inserted a tube *d* carrying external fins *e*. There is thus produced a double circuit heat-exchanging tube through which the water to be vaporized flows from bottom to top in the direction of the arrow A, while the heating fluid flows therethrough from top to bottom in the direction of the arrow B and circulates in the space contained between the two tubes *b* and *d*.

The heating fluid B may either be water under high pressure, or a gas, or a liquid metal. The fluid enters each unit *a* through the inlet pipe *f* supplying a feeder head *g* at the top, into which feeder head there are inserted in the form of a cross four subheaders, such as shown at *h*, from which there depart the tubes such as shown at *i*, feeding each tube *b* of the evaporator at the top.

At the bottom of the tubes *b*, the tubes *j* are connected in similar manner to sub-headers *k* arranged in the form of a cross and terminating at a feeder head *l* from which

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the outlet pipe *m* for the hot fluid departs, the outlet pipe leaving the shell *a* at *n* after making a turn permitting expansion.

The water is admitted into the shell *a* through the connection *o*, which feeds a double jacket *q* surrounding the shell *a* externally, and the space between the jacket *q* and the shell *a*, which space is preferably partitioned at *r*, constitutes a heat insulation and, if necessary a first economizer heating the feed water. The annular space between the jacket *q* and the shell *a* is connected at the bottom by tubes *s* to the bottom part of the evaporating tubes *d*. In said bottom part of the tubes *d* there are provided slightly constricted inlet orifices *t* having helical ribs *u*, the effect of which is to give the water entering in the direction of the arrows A a gyratory movement. The constriction has the effect of injecting the water under pressure irrespective of the angular position which may be adopted by the device as a result of the rocking of the ship.

The lower part of each tube *d* is provided internally with a core 1 comprising helical rib devices 2 and the assembly formed by this lower part of the tube *d* functions as an economizer for first heating the water entering the tube and bringing it to the desired temperature. Following this first part of the tube functioning as an economizer there is the part of the tube functioning as an evaporator. In this evaporating portion of the tube *d* there are provided surfaces devices *u*¹ in the form of a spiral, the pitch of which preferably continually decreases in the ascending direction of the tube *d* and the effect of which is to impart a gyratory movement to the rising mass of water and steam. Owing to this movement, the water is conveyed along the inner wall of the tube *d*, while the steam produced rises along the axis of the tube where the helical deflecting surfaces come to an end, before being released at the top of the tube *d*. The gyratory movement likewise stabilizes the water level inside the tube. In this upper part, the steam-evacuating pipe *y* penetrates somewhat deeply into the tube *d* and its end is perforated like a sprinkler or has slots *v*¹, as can be seen in FIG. 3, so as to form a device acting as a water and steam separator. Each of the pipes *v* is connected to sub-headers *w* arranged in the form of a cross and terminating at a central feeder head *x*, from which the steam leaves through the double pipe *y*, which describes a turn facilitating expansion, before leaving the shell *a* and being conducted to the place of use.

At the top, for example, of each exchanger tube *d* there is also provided a device enabling any water not yet vaporized to be absorbed, the water being conveyed through a pipe 3 to a water and steam separator 4 common to all the tubes of a unit *a*, for example.

Any water which may be delivered by the pump 5 to the pipe 6 rejoins the water being fed to the shell *a*, while any steam which may be separated in the separator 4 rejoins the steam outlet circuit *y* through the pipe 8.

The steam leaving the circuits *y* of all the units *a* may also pass through a supplementary general water and steam separator formed by a dome of known type (not shown) before reaching the turbine.

Moreover, it is also possible to make the steam pass through a superheater (not shown).

It will be seen that with the arrangement adopted no clearly defined water level is established inside the tubes *d* and that, furthermore, if such a level is established, the listing of the ship producing an inclination in these levels affects an area of water which is so small that the functioning of the vaporizing tube is not thereby impeded.

Likewise, the partitions *r* which are provided between the jacket *q* and the shell *a* have the effect of dividing the water space acting as a heat insulation into compartments and, when changes are produced in the list of

the ship, the resultant inclinations in the level are limited to each of the compartments provided between the partitions *r* and consequently affect only a limited area of water, so that the effect of the inclination is limited equally.

In the space comprised between the tubes *b* and *d*, the fins *e* of the tube *d* may be slit at *z* and turned down, as can be seen at *z*¹ (FIG. 4), so that the hot fluid, circulating in the space between the two tubes *b* and *d* divided into compartments by the fins *e*, passes from time to time from the space between two adjacent fins *e* to the neighboring space, which ensures a powerful sweeping action on the fins and on the outer surface of the tube *d*, thus securing a better exchange of heat.

When a tube *b* exhibiting changes of cross-section, as shown at *c* on the left in FIG. 3, is used, these changes of cross-section cause changes of direction, pressure and velocity in the flow of the hot fluid and these changes are favorable to the exchange of heat. It is possible to substitute for these corrugations *c* a tube *b* which is completely smooth externally and to arrange inside the space contained between the tubes *b* and *d* corrugated strips *7* extending between the fins *e* and which have the effect of producing in the same way changes of cross-section in the spaces offered to the flow of the hot fluid.

It is obvious that modifications of detail may be made in the embodiment of this invention without thereby departing from the scope thereof.

What I claim is:

1. A marine boiler effective to undergo only small variations of water level in response to movements of the ship in which it is mounted comprising, in combination, a shell, a plurality of vertical double-circuit heat-exchanging tubes disposed in said shell and adapted to be fed by the heating fluid and by the water to be vaporized, each heat-exchanging tube comprising a single unidirectional inner tube and an outer coaxial tube defining an annular space between them providing a flow passage for the heating fluid, the inner tube being formed with an inlet at its lower end to receive the water to be vaporized and the outer tube being formed with an inlet at its upper end to receive the heating fluid and an outlet at its lower end for evacuation of said heating fluid, said heating fluid thereby being adapted to enter said outer tube at its upper end, to circulate through said annular space between the two coaxial tubes and to leave said outer tube at its lower end, means providing helical surfaces interiorly of the inner tube to impart a gyratory movement to the mixture of water and steam contained in the inner tube, and steam outlet means in the upper portion of said inner tube for withdrawing steam directly from the upper portion of said inner tube, headers to admit the heating fluid to the inlet at the top of each of the outer tubes, headers to collect the heating fluid at the bottom of the outer tubes, tubes to admit water to the inlet at the bottom of each of the inner tubes, said steam outlet means comprising a separator of steam and water at the top of each inner tube, means to recirculate the separated water, and headers to collect the steam from said steam outlet means.

2. A marine boiler effective to undergo only small variations of water level in response to movements of the ship in which it is mounted comprising, in combination, a shell, a plurality of vertical double-circuit heat-exchanging tubes disposed in said shell and adapted to be fed by the heating fluid and by the water to be vaporized, each heat-exchanging tube comprising a single unidirectional inner tube and an outer coaxial tube defining an annular space between them providing a flow passage for the heating fluid, the inner tube being formed with an inlet at its lower end to receive the water to be vaporized and the outer tube being formed with an inlet at its upper end to receive the heating fluid and an outlet at its lower end for evacuation of said heating fluid, said heating fluid thereby being adapted to enter said

outer tube at its upper end, to circulate through said annular space between the two coaxial tubes and to leave said outer tube at its lower end, means providing helical surfaces interiorly of the inner tube to impart a gyratory movement to the mixture of water and steam contained in the inner tube, and steam outlet means in the upper portion of said inner tube, headers to admit the heating fluid to the inlet at the top of each of the outer tubes, headers to collect the heating fluid at the bottom of the outer tubes, tubes to admit water to the inlet at the bottom of each of the inner tubes, said steam outlet means comprising a separator of steam and water at the top of each inner tube, a tube to collect the water from the separator, a second separator common to all the coaxial heat exchanging tubes, said last-named tube leading to said second separator, a tube to recirculate the water separated in said second separator, and a tube to collect the steam separated in said second separator.

3. A marine boiler as defined in claim 1, wherein said separator of steam and water comprises a steam discharge tube extending coaxially into each inner tube, said steam discharge tube being formed with a plurality of apertures for receiving the steam.

4. A marine boiler as defined in claim 2, wherein said separator of steam and water comprises a steam discharge tube extending coaxially into each inner tube, said steam discharge tube being formed with a plurality of apertures for receiving the steam.

5. A marine boiler effective to undergo only small variations of water level in response to movements of the ship in which it is mounted comprising, in combination, a shell, a plurality of vertical double-circuit heat-exchanging tubes disposed in said shell and adapted to be fed by the heating fluid and by the water to be vaporized, each heat-exchanging tube comprising a single unidirectional inner tube and an outer coaxial tube defining an annular space between them providing a flow passage for the heating fluid, the inner tube being formed with an inlet at its lower end to receive the water to be vaporized and the outer tube being formed with an inlet at its upper end to receive the heating fluid and an outlet at its lower end for evacuation of said heating fluid, said heating fluid thereby being adapted to enter said outer tube at its upper end, to circulate through said annular space between the two coaxial tubes and to leave said outer tube at its lower end, means providing helical surfaces interiorly of the inner tube to impart a gyratory movement to the mixture of water and steam contained in the inner tube, and steam outlet means in the upper portion of said inner tube for withdrawing steam directly from the upper portion of said inner tube, said steam outlet means comprising a steam discharge tube extending coaxially into each inner tube, said steam discharge tube being formed with a plurality of apertures for receiving the steam.

6. A marine boiler effective to undergo only small variations of water level in response to movements of the ship in which it is mounted comprising, in combination, a shell, a plurality of vertical double-circuit heat-exchanging tubes disposed in said shell and adapted to be fed by the heating fluid and by the water to be vaporized, each heat-exchanging tube comprising a single unidirectional inner tube and an outer coaxial tube defining an annular space between them providing a flow passage for the heating fluid, the inner tube being formed with an inlet at its lower end to receive the water to be vaporized and the outer tube being formed with an inlet at its upper end to receive the heating fluid and an outlet at its lower end for evacuation of said heating fluid, said heating fluid thereby being adapted to enter said outer tube at its upper end, to circulate through said annular space between the two coaxial tubes and to leave said outer tube at its lower end, means providing helical surfaces interiorly of the inner tube to impart a gyratory movement to the mixture of water and steam contained in the

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inner tube, and steam outlet means in the upper portion of said inner tube for withdrawing steam directly from the upper portion of said inner tube, and means defining corrugations on the surface of the outer tube, said separator of steam and water comprising a steam discharge tube extending coaxially into each inner tube, said steam discharge tube being formed with a plurality of apertures for receiving the steam.

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