May 19, 1942. C. S. GILLETTE ET AL 2,283,201

STEAM GENERATOR

Filed June 1, 1939 2 Sheets-Sheet 1

Fig. 1.

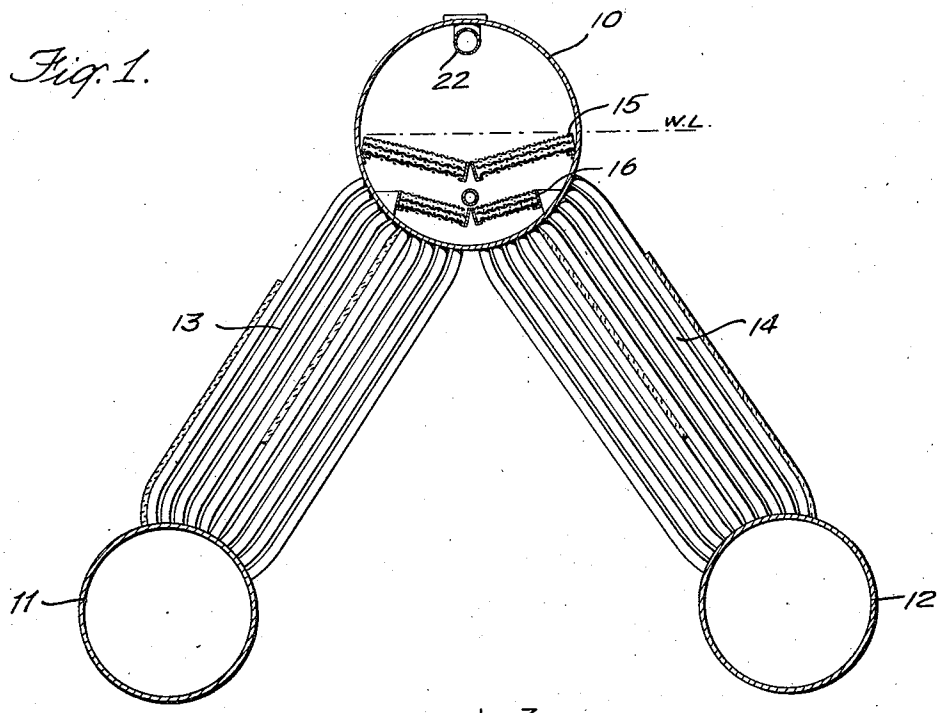
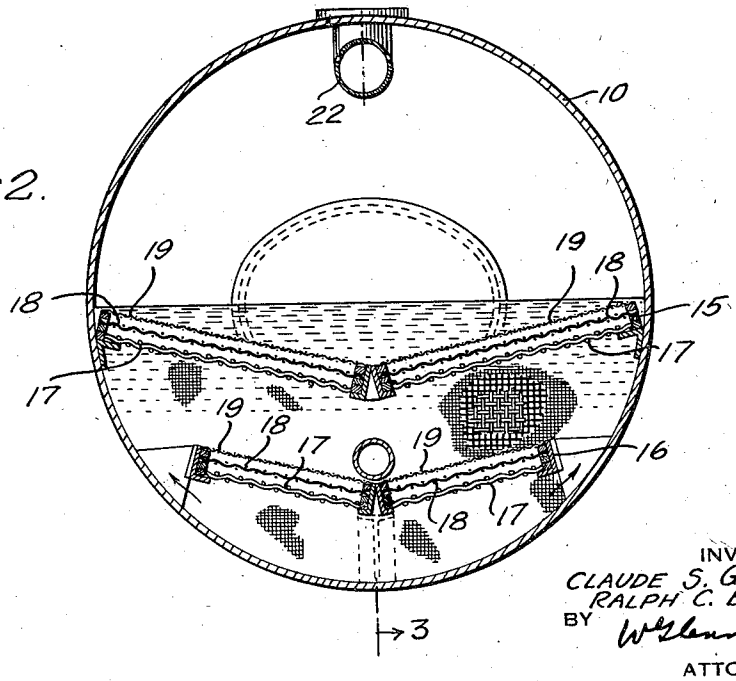


Fig. 2.



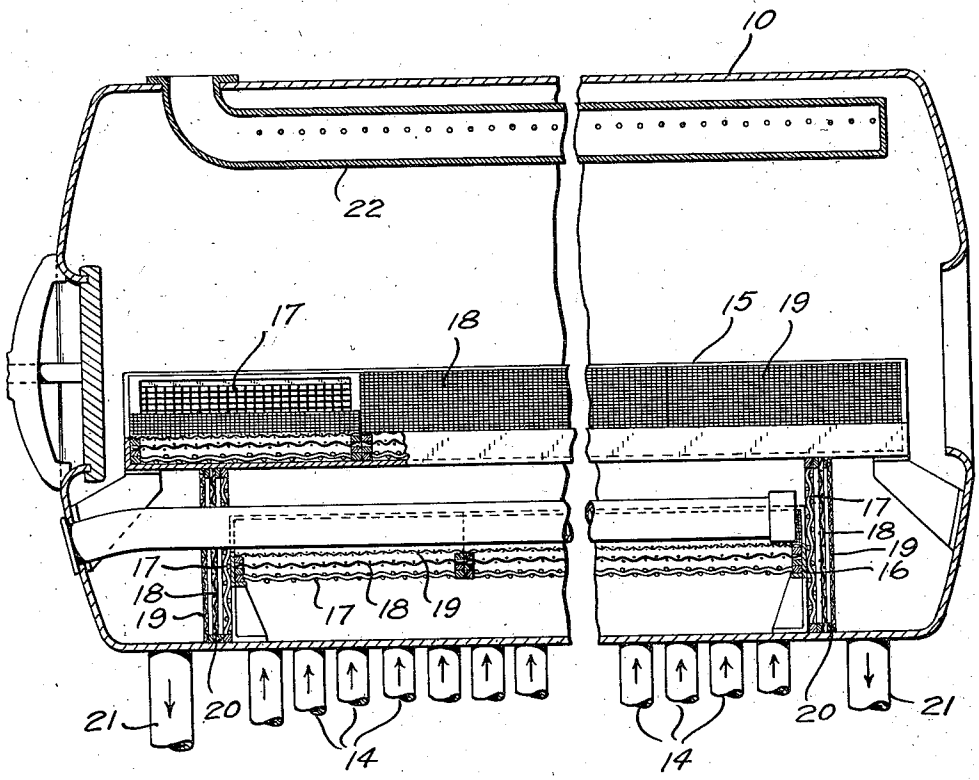
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Fig. 3.



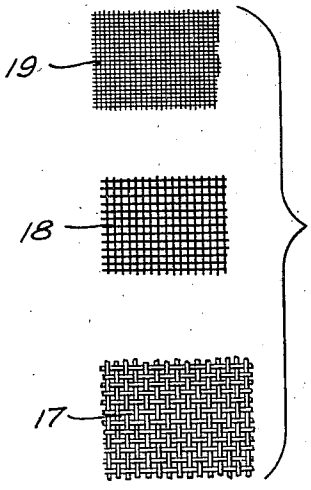


Fig. 4.

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UNITED STATES PATENT OFFICE

2,283,201

STEAM GENERATOR

Claude S. Gillette, Philadelphia, and Ralph C. Brierly, Narberth, Pa.

Application June 1, 1939, Serial No. 276,841

17 Claims. (Cl. 122—491)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

Our invention relates to vapor generators and more particularly pertains to water tube boilers of the type having one or more elevated steam drums and one or more lower or water drums. The elevated steam drum or drums are normally operated with the water level either at approximately the horizontal centerline of the drum or slightly below or above it. When such a boiler is employed on shipboard, the water level may be partially rotated with respect to the horizontal centerline when the vessel is rolling or assume various angles to the longitudinal centerline of this drum. The tube bank or banks and the water drum or drums are normally filled either with water or a mixture of water and steam.

Our invention resides in an improvement over previous methods of reducing turbulence, geysering, and entrainment of water in the steam leaving the liberating surface of the liquid in a steam drum as well as in reducing the amount of steam in the water flowing to the downcomer tubes passing from the steam drum to the water drum or drums of the boiler.

We are cognizant of the perforate submerged baffle invented by H. G. Donald, and disclosed in U. S. Patent No. 1,884,614, granted October 25, 1932. That device, applicable to boilers operating at the steaming rates current at the time of its inception, has proved of inadequate utility in boilers designed for the steaming rates presently obtainable. Whereas, in that patent, by far the major portion of the steam generated was evolved in the fireside tube rows, the outer tube rows acting as downcomers in the manner described in that specification, the tubes in present high steaming rate generators all may spout steam, circulating water being supplied to these tubes by external connections or downcomers. Simultaneously, the quantity of steam ejected from all tubes acting in a generating capacity has been greatly increased and the force of the geysering action, steam velocity, turbulence and tendency toward moisture entrainment, all have been greatly magnified by present advanced steam rates. Furthermore, the use of superheaters designed for high temperature operation, together with the practice of bleeding saturated steam directly from the steam drum for use in operating auxiliaries, has increased the objectionableness of entrainment of even minor quantities of the liquid with the steam. Obviously, also, in boilers operating at high steaming rates, water passed to the external downcomers should be as free of steam as possible and the steam particles which do exist should be evenly distributed and of minimum size, thus to preclude pocketing of the steam in various portions of the circulation circuit.

It is the object of our invention to reduce the carryover of liquid with steam by diminishing the size of steam bubbles leaving the liquid surface in the steam drum, simultaneously reducing the magnitude of steam globules or bubbles in the water passing to external downcomers. We accomplish reduction in particle size and approach uniformity of the steam-water mixture by attacking the high velocity currents or rising mixture while they are still submerged below the water level in the steam drum. We are in no way concerned with reduction of carryover in steam which has already left the surface of the liquid except in the possible instance where water level is reduced to such an extent that the operations of the screen baffling of our invention is in the steam filled section of the drum rather than below the water level. We are cognizant of many methods of reducing moisture in vapor after its liberation from the surface of the liquid; these may be utilized in conjunction with our device, but the latter has no bearing upon them except to improve their functioning by reduction of entrained moisture before the steam reaches them.

We accomplish reduction in particle size and approach uniformity of their dispersion in the water through use of multiple screens having either progressively reduced free area for the flow of mixture through them or, in some cases, similar areas, or progressively increasing areas. Because, in present high rate steam generators, the entire tube bank, or banks, may be generating, it is desirable in many cases that these multiple screens cover the entire area through which the ejected vapor must pass. Our device, however, contemplates either use of screens covering these areas in their entirety or only partially. Because, even in boilers of this type, the fireside rows are generating a greater quantity of steam than those exposed to lower gas temperatures, it may be necessary to employ a greater number of screens above the exit ends of the fireside tube rows than those of the other generating tubes. Reduction of steam particle size and greater uniformity of mixture passing to the downcomers is attainable through use of multiple screen partitions between the zone or zones of generating tubes and the upper ends of the downcomers. These multiple screen partitions may be of either progressively decreasing

areas, similar areas, or progressively increasing areas.

Inspection of tubes or their cleaning may require removal of the screen baffling. For this reason, we prefer an embodiment of our invention which will facilitate removal of the various screen panels from the steam drum. This may be accomplished by assembling the screens, which may be either of progressively reduced free area, as the steam passes upward through them, or of similar areas, or of progressively increasing areas, in the form of panels which may be readily disconnected from each other or folded in such a way that their removal through the manholes of the drum or drums will be facilitated.

We have ascertained by experiment that the distance between the individual screens of the multiple screen baffling is a factor of importance in reduction of particle size and their uniform dispersion in the mixture. Our experience indicates that the distance between individual screens should be in the order of 3/8" to 3/4", the former being preferable in most cases. We accomplish more complete dissemination of the particles through the mixture and superior reduction in size of large globules through use of multiple screens set together and arranged with spacing in this order with removable panels, as stated above. While we have normally employed three screens, one above the other, in the individual panels of our baffling, the geysering from fireside tube rows has frequently necessitated use of an additional partial V baffling above those tube ends in such a manner that the number of individual screens interposed between the tube sheet and the water level may vary from three to nine or even twelve. These sets of screen may be suspended either over the exit ends of individual tube rows or may cover all of them.

The nature of our invention will become apparent from the following detailed description when considered in connection with the accompanying drawings forming a part thereof and in which:

Fig. 1 is a transverse, vertical sectional view, showing more or less diagrammatically, a steam generator embodying the invention;

Fig. 2 is a transverse, vertical sectional view on an enlarged scale, of the steam and water drum shown in Fig. 1;

Fig. 3 is a longitudinal sectional view taken on line 3—3 of Fig. 2, and

Fig. 4 is a plan view of portions of the three dispersing baffle screens employed in each set of screens in Figs. 1, 2 and 3.

Like characters of reference refer to the same or to similar parts throughout the several views.

While we have shown our invention in the drawings in connection with an A type express boiler, it is to be specifically understood that we do not limit its use to this particular type of boiler as the invention will attain equal efficiency when applied to any other type of water tube boiler where the tubes under the drum or drums submerge below the water level.

Referring to the drawings, reference character 10 designates the upper or steam and water drum of a steam generator embodying the invention, having spaced lower or water drums 11 and 12 which are connected to the drum 10 by banks of tubes 13 and 14 respectively. The furnace, not shown in the drawing, is located under and between the banks of tubes 13 and 14. The series of tubes close to the furnace are subjected to radiant as well as convection heat while the tubes further outward in the bank are normally subjected to progressively reducing gas temperatures. Thus, the tubes adjacent to the furnace normally generate a greater quantity of steam than those located further outward in the tube banks. However, in present steam generators, all or nearly all of the tubes of the banks are generating tubes, especially at advanced firing rates. For these reasons, a single set of multiple screens 15 has been shown covering the entire zone of tube ends, while a second set 16 is interposed above the tubes near the furnace. As previously stated, any number of panels employing multiple screens can be installed in these areas as required. As shown, each set of screens consists of three screens of different mesh, the coarse screen 17 being disposed at the bottom, screen 18 of intermediate mesh being disposed above the coarse screen, and the fine screen 19 being located at the top of each set. It will be understood however, that the relative positions of these screens may be interchanged, or the screens in each set may be identical, or the screens in all sets may be identical. Additionally, the number of screens in each set may be more or less than three. In some instances, the use of two sets of screens may not be necessary, while in other cases, more than two sets may be required.

Also as shown, the sets of screens are arranged in the form of a V with the angle between the legs such that the streams of mixture rich in steam, above the fireside tube rows, will be deflected toward the drum wall. Each set of screens consists of two panels each panel forming one leg of the V. These panels may be supported separately in the drums or the panels of each set may be connected together in such manner that they will fold one upon the other to facilitate the removal of the panels from the drum. If desired however, the screens may be continuous and formed into V's, thus dispensing with the use of the panels shown.

At each end of the set of screens, a vertically disposed set 20 of screens is located between the generating tubes 14 and the downcomers 21, and which extends from the drum wall toward the upper set 15 of screens. Each set 20 consists of three spaced screens 17, 18 and 19 of the same meshes as the screens in the sets 15 and 16. However, each set 20 may be composed either of screens of progressively decreasing free area, screens of the same free area, or screens of increasing free areas, in directions from the center of the drum to its ends. The number of screens in each set 20 may be more or less than three.

The screen utilized in accordance with the invention may have rectangular or other shaped openings, or it may be woven in any desired weave. Satisfactory results are obtained by the use of screen manufactured of wire and woven with regularly disposed rectangular openings. However, screens of other materials than wire may be utilized and the screen may be woven so that the openings are non-uniformly disposed.

In operation, the streams of steam and water mixture, rich in steam, which are discharged from the upper ends of the tubes 13 and 14 come in contact with and pass through the screens disposed below the water level in the drum 10. With the screens arranged V-shaped as shown, these streams of steam and water which are discharged from the fireside tube rows will be de-

flected toward the drum wall. At the same time these streams pass upwardly through the screens with the result that the size of the steam particles are reduced in size and are more or less uniformly distributed throughout the drum. The screens also reduce the velocity of the mixture and tend to stabilize the water level in the drum. The vertical sets of screens **20** provide uniform dispersion of the steam particles in the steam and water mixture which pass to the downcomer **21**, minimize the steam content of this mixture, and further reduce the size of the steam particles which may be present therein. Without the screens, the streams of steam and water from the tubes **14** would be ejected at full velocity toward the vertical axial centerline of the drum **10** and would collide with each other and thereby increase turbulence and the tendency to carry moisture into the dry pipe **22** or into any other moisture separators which may be disposed in the upper part of the drum, above the water level therein. Additionally, if the screens were not utilized, the water level in the steam drum would tend to be high at the middle of the drum, that is on the vertical centerline, and if the boiler is end-fired, especially at the drum end furthest from the fire front, with consequent increased tendency to moisture carryover into the dry pipe or other drying device. This dampening of irregularities in the water level contour renders the actual distance between the steam liberating surface of the dry pipe slots greater than would be the case if the screens were not employed. For this reason, utilization of the screens of our invention permits a reduction in the diameter of the steam drum.

From the foregoing, it will be perceived that by the use of the present invention, reduction in steam particle size and increased uniformity of the dispersion of the steam particles over the liberating area will result. Moreover, in the steam and water mixture which passes to the downcomers, there will be reduction in the steam content of this mixture, greater uniformity of distribution of the steam which may remain in this mixture and a reduction in the particle size thereof, thus reducing tendencies to steam pocketing in the circulation circuit of the boiler, thereby permitting higher rates of operation to be obtained. The invention further minimizes moisture carryover when utilizing high contaminated feed water, such as feed water containing sodium chloride, high alkalinity and total solids, as well as other impurities, which is a highly important consideration for boilers for marine use.

The invention described herein may be manufactured and used by or for the Government of the United States for Government purposes without the payment to us of any royalty thereon.

Inasmuch as changes in details of construction, proportion and arrangement of parts, may be made in the form of the invention disclosed without departing from the principles thereof, it will be understood that the invention is not to be limited excepting by the scope of the appended claims.

What we claim is:

1. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum, and a plurality of superposed wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes connected with the drum, the mesh openings in the uppermost screen being of smaller size than the mesh openings in another of said screens.

2. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum, and a plurality of superposed wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes connected with the drum, the mesh openings in said screens being of progressively smaller size from the lowermost screen to the uppermost screen.

3. A vapor generator having a vapor liberating drum and vapor generating and downcomer tubes connected with the drum, and wire mesh screen means disposed in the drum intermediate vapor generating tubes and downcomer tubes.

4. A vapor generator having a vapor liberating drum and vapor generating and downcomer tubes connected with the drum, and a plurality of spaced wire mesh screens disposed in the drum intermediate vapor generating tubes and downcomer tubes.

5. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, some of said tubes being nearer the furnace for firing the generator than other tubes, and a plurality of groups of screens disposed in the drum below the normal liquid level therein, said groups being vertically spaced and located above the discharge ends of tubes near the furnace, the screens in each group being vertically spaced.

6. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, some of said tubes being nearer the furnace for firing the generator than other tubes, and a plurality of groups of screens disposed in the drum below the normal liquid level therein, said groups being vertically spaced and located above the discharge ends of tubes near the furnace, the screens in each group being vertically spaced, at least one group being located above the discharge ends of all of said tubes connected with the drum.

7. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, some of said tubes being nearer the furnace for firing the generator than other tubes, and a plurality of groups of screens disposed in the drum below the normal liquid level therein, at least one group being located above the discharge ends of all of said tubes and a plurality of groups being located above the discharge ends of tubes near the furnace.

8. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of superposed wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes, the mesh openings in the uppermost screen being of different size than the mesh openings in the lowermost screen.

9. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of superposed wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes, the mesh openings in the several screens being of progressively different size.

10. A vapor generator having a vapor liberat-

ing drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of superposed and relatively closely spaced wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes.

11. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of superposed screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes, said screens being spaced apart a distance of approximately three-eighths to three-quarters of an inch.

12. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of superposed and relatively closely spaced wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of all of said tubes.

13. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of spaced, superposed screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes connected with the drum, said screens having straight horizontally inclined portions.

14. A vapor generator having a vapor liberating drum and vapor generating tubes connected with the drum below the normal liquid level therein, and a plurality of spaced, superposed screens disposed in the drum below the normal liquid level therein and above the discharge ends of tubes connected with the drum, said screens being V-shaped.

15. A vapor generator having a vapor liberating drum and vapor generating and downcomer tubes connected with the drum below the normal liquid level therein, and perforate baffle means in the drum having a substantially vertically disposed portion below the normal liquid level therein and intermediate the vapor generating and downcomer tubes.

16. A vapor generator having a vapor liberating drum and vapor generating and downcomer tubes connected with the drum below the normal liquid level therein, perforate baffle means disposed in the drum below the normal liquid level therein and above the discharge ends of vapor generating tubes, and other perforate baffle means in the drum having a substantially vertically disposed portion below the normal liquid level therein and intermediate the vapor generating and downcomer tubes.

17. A vapor generator having a vapor liberating drum and vapor generating and downcomer tubes connected with the drum below the normal liquid level therein, a plurality of superposed, spaced wire mesh screens disposed in the drum below the normal liquid level therein and above the discharge ends of vapor generating tubes, and a plurality of spaced wire mesh screens in the drum below the normal liquid level therein and intermediate the outlets of the vapor generating tubes and the inlets of the downcomer tubes.

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