Jan. 30, 1945. W. R. HAINSWORTH 2,368,467

STEAM GENERATING APPARATUS

Filed Nov. 26, 1941

Fig. 2.

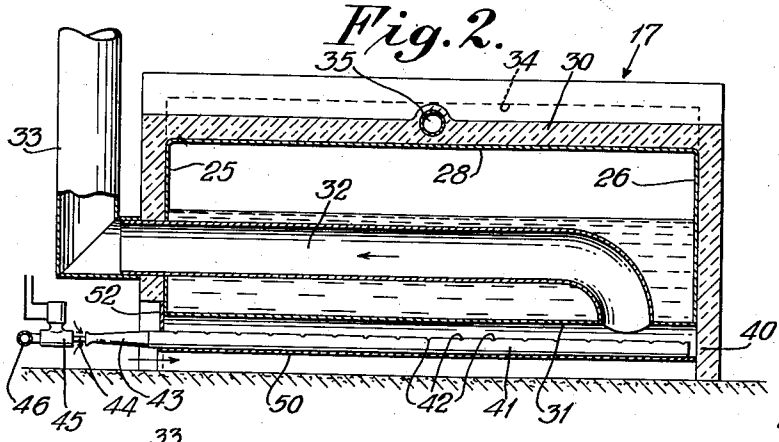


Fig. 3.

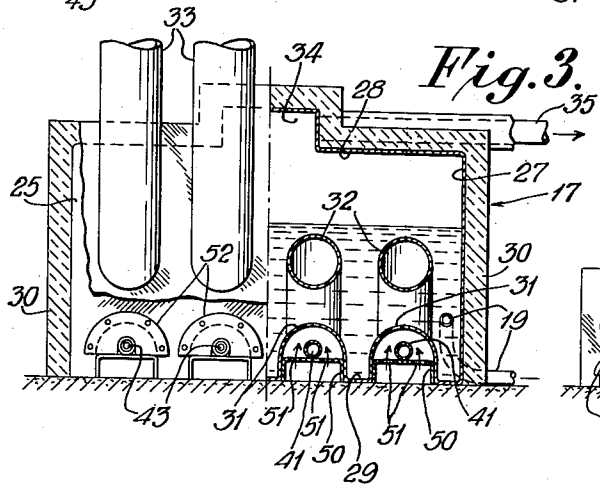


Fig. 1.

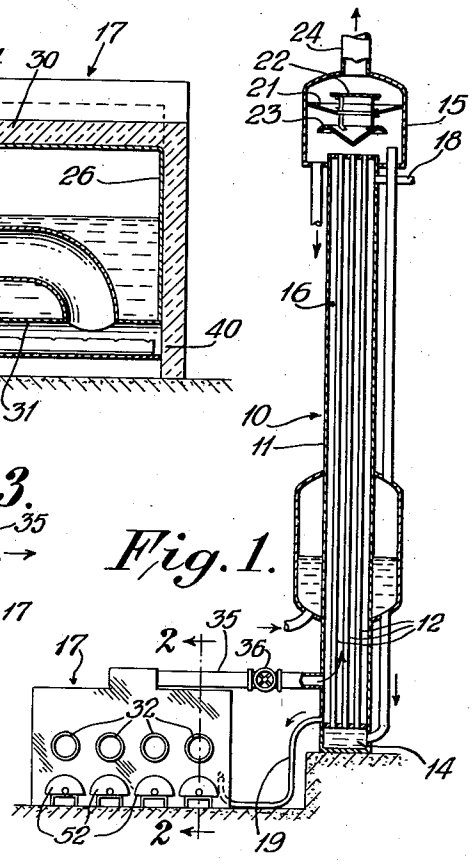
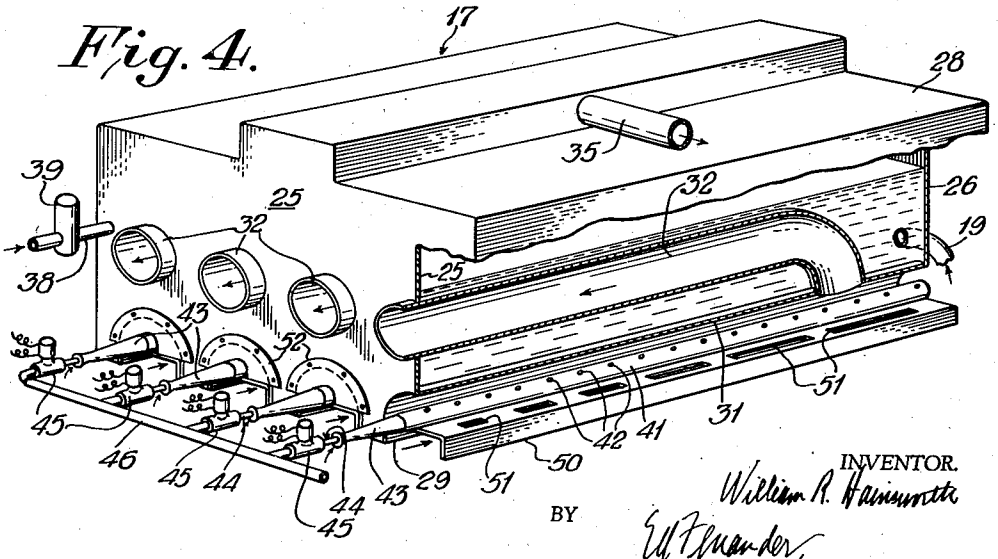


Fig. 4.



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STEAM GENERATING APPARATUS

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Application November 26, 1941, Serial No. 420,455

6 Claims. (Cl. 122—137)

This invention relates to steam generating apparatus, and more particularly to such apparatus for supplying steam to a heat receiving part of a refrigerating system operated by heat.

Refrigerating systems of the kind operated by heat include systems of the absorption type in which refrigerant is expelled from an absorbent in a generator which constitutes the heat receiving part. By way of example, a refrigerating system of this type is disclosed in application Serial No. 239,762 of A. R. Thomas and P. P. Anderson, Jr., filed November 10, 1938, now Patent No. 2,282,503, granted May 12, 1942. This application discloses an absorption type refrigerating system provided with a generator having a plurality of vertical tubes or risers about which is disposed a jacket to form a chamber to which steam is adapted to be supplied from a steam boiler. The steam supplied to the generator chamber effects heating of the tubes so that absorption solution therein is heated sufficiently to expel refrigerant vapor from the solution and also effect lifting or raising of the liquid through the tubes by gas or vapor-lift action. The steam supplied to the generator chamber condenses therein and collects in the bottom part of the chamber from which it is returned to the boiler.

Refrigerating systems of the type just described are often located in basements and other places having limited head room. Consequently, it is essential to keep the overall-height of the steam generating apparatus and refrigerating system associated therewith at a minimum. When the condensate flowing to the bottom of the generator chamber accumulates therein at a region below the liquid level in the steam boiler, provision must be made for raising and returning the liquid condensate to the boiler. In order to effect gravity return of condensate to the steam boiler the liquid level of the condensate in the generator should be above the water level maintained in the boiler, and in such cases there is usually a consequent increase in the overall-height of the refrigerating system and steam generating apparatus associated therewith.

It is an object of the invention to provide a refrigerating system and steam generating apparatus having a minimum overall-height and in which gravity flow of liquid condensate from the generator to the steam boiler is effected. I accomplish this by providing steam generating apparatus which allows the water to be carried at a very low level with respect to the floor, so that when the boiler is arranged to supply steam to a place of use, such as a generator or heat-receiving part of a refrigerating system, for example, the liquid condensate formed in the generator will return by gravity to the boiler.

Another object is to provide an improvement in such steam generating apparatus for effectively passing the hot combustion gases in heat transfer relation with the boiler water.

A further object is to provide an improvement for uniformly distributing secondary air along an elongated burner tube provided with a row of burner openings.

The novel features which are believed to be characteristic of the invention are set forth with particularity in the claims. The invention, both as to organization and operation, together with the above and other objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawing forming a part of the specification, and in which:

Fig. 1 is a diagrammatic view, partly in section, illustrating steam generating apparatus embodying the invention arranged to supply steam to a heat-receiving part of a heat-operated refrigerating system;

Fig. 2 is a longitudinal sectional view of the steam generating apparatus taken at line 2—2 of Fig. 1;

Fig. 3 is an end view of the steam generating apparatus, partly in section, to illustrate parts thereof in detail; and

Fig. 4 is a perspective view of the boiler and burners of the steam generating apparatus, partly broken away and in section, to illustrate parts of the apparatus more clearly.

In the drawing Fig. 1 shows steam generating apparatus embodying the invention arranged to supply steam to a generator of an absorption refrigerating system of a two-pressure type as disclosed in the Thomas and Anderson application referred to above. A system of this type operates at low pressures and includes a generator or expeller 10, a condenser, an evaporator and an absorber which are interconnected in such a manner that the pressure differential in the system is maintained by liquid columns. In order to simplify the drawing, all of the parts of the refrigerating system have not been shown, a complete illustration of the system not being necessary for an understanding of this invention. The disclosure in the above-mentioned Thomas and Anderson application may be considered as being incorporated herein, and reference may be made thereto for a detailed description of the refrigerating system.

Referring to Fig. 1, the generator 10 includes an outer shell 11 within which are disposed a plurality of vertical riser tubes 12 having the lower ends thereof communicating with a space 14 and the upper ends thereof extending into a vessel 15. The space 16 within shell 11 and about the tubes 12 forms a steam chamber to which steam is supplied through a pipe 35 from steam generating apparatus 17, as will be described presently. The steam chamber 16 provides for full-length heating of the riser tubes 12 with a steam vent 18 being provided at the upper part of the shell 11. A conduit 19 is connected to the lower part of shell 11 and also to the boiler of the steam generating apparatus 17 for returning to the latter the condensate formed in steam chamber 16.

A refrigerating system of the type referred to above operates at a partial vacuum and contains a water solution of refrigerant in absorption liquid, such as, for example, a water solution of lithium chloride containing 40% lithium chloride by weight. With steam being supplied from boiler 17 to chamber 16, heat is applied to tubes 12 whereby water vapor is expelled from solution. The absorption liquid is raised by gas or vapor-lift action with the expelled water vapor forming a central core within an upwardly rising annulus of the liquid. The expelled water vapor rises more rapidly than the liquid and the latter follows along the inside walls of the tubes 12. The water vapor flows upwardly through the tubes 12 into vessel 15 which is provided with an aperture baffle 21 and deflectors 22 and 23 above and below the baffle. The baffle 21 and deflectors 22 and 23 serve as a vapor separator so that expelled water vapor is separated from the raised absorption liquid in vessel 15 and flows through a conduit 24 to the condenser. The expelled vapor is liquefied in the condenser and flows therefrom into the evaporator in which the liquid evaporates to produce a refrigerating or cooling effect, as disclosed in the above-mentioned Thomas and Anderson application.

The steam generating apparatus 17 comprises a boiler of the horizontal fire tube type having a front wall 25, a rear wall 26, side walls 27, top wall 28 and bottom wall 29. The walls of the boiler are provided with an outer layer of suitable insulating material 30. Within the boiler are disposed fire tubes 31 which are U-shaped or semi-circular in section, as shown most clearly in Fig. 3. The fire tubes 31 are formed in the bottom wall 29 and extend between the front and rear walls 25 and 26. A horizontally disposed heating tube 32 is connected to the top part of each fire tube 31 at regions near the rear wall 26. The heating tubes 32 are horizontally disposed below the water level normally maintained in the boiler and the front ends thereof pass or extend through openings in the front wall 25. The front ends of the heating tubes 32 are connected to risers 33 which are connected to a flue through which the combustion gases pass to the atmosphere.

The upper part of the boiler forms a steam chamber 34 to which is connected the pipe 35 for conducting steam to steam chamber 16 of generator 10. A valve 36 may be connected in pipe 35 for controlling the flow of steam to the generator 10. The condensate return conduit 19 is connected to the boiler of the steam generating apparatus at a region below the liquid level therein, as shown most clearly in Figs. 3 and 4. The water level in the boiler may be maintained at a predetermined level in any suitable manner. As shown in Fig. 4, for example, a water inlet injector 38 which is controlled by a float-operated valve 39, may be provided to keep a constant water level in the boiler.

The fire tubes 31 are closed at their rear ends at 40 by the insulating material associated with the rear wall 26, as shown most clearly in Fig. 2. In each fire tube 31 is disposed an elongated burner tube 41. The burner tubes are co-extensive in length with the fire tubes 31 with each burner tube being provided with a row of spaced burner openings 42 along their upper surfaces.

The forward parts 43 of the burner tubes 41 are tapered and serve as open-ended Venturi tubes. A suitable combustible gas is discharged into the open ends of the Venturi tubes 43 from nozzles 44 which are connected to a gas supply line 46. A solenoid-operated valve 45 is associated with each nozzle 44 for controlling the flow of gas to the steam generating apparatus. The nozzles 44 are in alignment with and spaced from the open ends of the Venturi tubes 43 to permit primary air to be drawn into the burner tubes along with the gas discharged from the nozzles 44.

All of the air necessary to effect complete combustion of the gas is not supplied as primary air into the Venturi tubes 43. For this reason secondary air is supplied to the burner flames produced at the regions of the openings 42. This is accomplished by providing a U-shaped member 50 in the lower part of each fire tube 31. The U-shaped members 50 are disposed below the burner tubes 41 and serve as a bottom closure for the fire tubes. As shown in Figs. 3 and 4, the forward parts of the fire tubes 31 are closed above the channels 50 by plates 52 to prevent escape of combustion gases from the fire tubes 31.

The horizontal parts of the U-shaped channels 50 are spaced a small distance from the floor or supporting surface and provided with slots or openings 51 for uniformly supplying air along the entire lengths of the burner tubes 41. Air from the surroundings is drawn into the front open ends of the channels 50 by the natural draft that is produced by the apparatus. The openings or slots 51 increase in size from the forward to the rear part of the apparatus in order to effect uniform distribution of secondary air to the burner flames produced along the burner tubes 41. The distribution of secondary air supplied through the slots or openings 51 effects complete combustion of the gas and at the same time serves to cool the floor or supporting surface on which the steam generating apparatus rests.

The burner flames produced at the openings 42 in each of the burner tubes 41 form a composite flame which is sheet-like in form. In this way there is a uniform distribution of heat along the entire lengths of the fire tubes, with heat being effectively transferred to a plurality of different regions of the body of the water held in the boiler of the steam generating apparatus. The hot combustion gases pass from the fire tubes 31 through the heating tubes 32 in which additional heat is given up to the water by the gases. The steam produced as a result of the heating of the boiler passes from the steam chamber 34 through pipe 35 to generator 10 of the refrigerating system. By supplying steam to the generator 10 a cooling or refrigerating effect is produced by the refrigerating system, as described in the Thomas and Anderson application referred to above.

The condensate formed in shell 11 returns by

gravity through conduit 19 to the steam generating apparatus 17. By providing steam generating apparatus of the character described in which the water is carried at a very low level with respect to the floor, the overall-height of the steam generating apparatus 17 and refrigerating systems associated therewith is kept at a minimum.

Although a single embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that various modifications and changes may be made without departing from the spirit and scope of the invention, as pointed out in the following claims.

What is claimed is:

1. Steam generating apparatus including a boiler shell adapted to hold a body of water, a plurality of fire tubes associated with the lower part of said shell, means to supply heating fluid from a source of supply outside of said fire tubes to a plurality of fixed regions within and lengthwise of said fire tubes, a horizontally disposed air duct extending along the lower part of each fire tube and forming a bottom closure therefor, said air ducts having vertical sides formed by parts of said boiler and being open to the floor or supporting surface to provide fixed paths of flow through which air is drawn to a plurality of fixed spaced apart regions within said fire tubes, the air passing through said channels being capable of exerting a cooling effect on said floor or supporting surface, and a heating tube connected to receive flue gases from each fire tube, said heating and fire tubes being arranged in heat transfer relationship with the water in the shell.

2. Steam generating apparatus including a boiler shell adapted to hold a body of water, a plurality of fire tubes associated with the lower part of said shell, means to supply heating fluid from a source of supply outside of said fire tubes to a plurality of fixed regions within and lengthwise of said fire tubes, and a horizontally disposed air duct extending along the lower part of each fire tube and forming a bottom closure therefor, said air ducts having vertical sides extending substantially to the floor or supporting surface to provide fixed paths of flow through which air is drawn, said air ducts having a plurality of openings along their upper surfaces arranged so that combustion supporting air is supplied uniformly along substantially the entire length of said fire tubes.

3. Steam generating apparatus including a boiler shell adapted to hold a body of water, one or more fire tubes associated with the lower part of said shell, a heating tube connected to receive flue gases from each fire tube, said fire and heating tubes being arranged in heat transfer relationship with the water in the shell, an elongated burner tube in each of said fire tubes having a row of openings arranged to discharge fuel within and along substantially the entire length of said fire tube, and an air duct associated with each fire tube for distributing secondary air therein and having openings of sizes increasing from the inlet longitudinally thereof.

4. Steam generating apparatus including a boiler shell adapted to hold a body of water, one or more fire tubes associated with the lower part of said shell, a heating tube connected to receive flue gases from each fire tube, said fire and heating tubes being arranged in heat transfer relationship with the water in the shell, an elongated burner tube in each of said fire tubes having a row of openings arranged to discharge a combustible fuel mixture along substantially the entire length of said fire tubes, and a separate secondary air duct for each fire tube having openings of sizes increasing from the inlet longitudinally thereof to supply secondary air for completing combustion of the gases of the fuel mixture uniformly along substantially the entire length of each of said fire tubes.

5. Steam generating apparatus including a boiler shell adapted to hold a body of water, a plurality of fire tubes associated with the lower part of said shell, a heating tube connected to receive flue gases from each fire tube, said fire and heating tubes being arranged in heat transfer relationship with the water in the shell, an elongated burner tube in each of said fire tubes having a row of openings arranged to discharge a combustible fuel mixture along substantially the entire length of said fire tube, and a separate secondary air duct for each fire tube having openings to supply secondary air for completing combustion of the gases of the fuel mixture, each of said secondary air ducts forming a bottom closure for one of said fire tubes and having vertical sides formed by parts of said shell extending substantially to the floor or supporting surface to provide fixed paths of flow for the secondary air.

6. Steam generating apparatus including a boiler shell adapted to hold a body of water, a fire tube, a heating tube connected to receive combustible gases from said fire tube, said heating tube and fire tube being associated with said shell and positioned to give up heat to the water, means for supplying heating fluid from a source of supply outside of said fire tube to a plurality of fixed regions within and lengthwise of said fire tube, and structure forming a confined path of flow for air beneath said fire tube, said structure having openings to said fire tube and of lengths increasing from the air inlet whereby air is drawn along a definite path of flow to a plurality of fixed spaced apart regions of unequal lengths within said fire tube.

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