Dec. 8, 1942. L. W. JEFFORDS 2,304,409

DRY STEAM GENERATOR

Filed Feb. 21, 1940

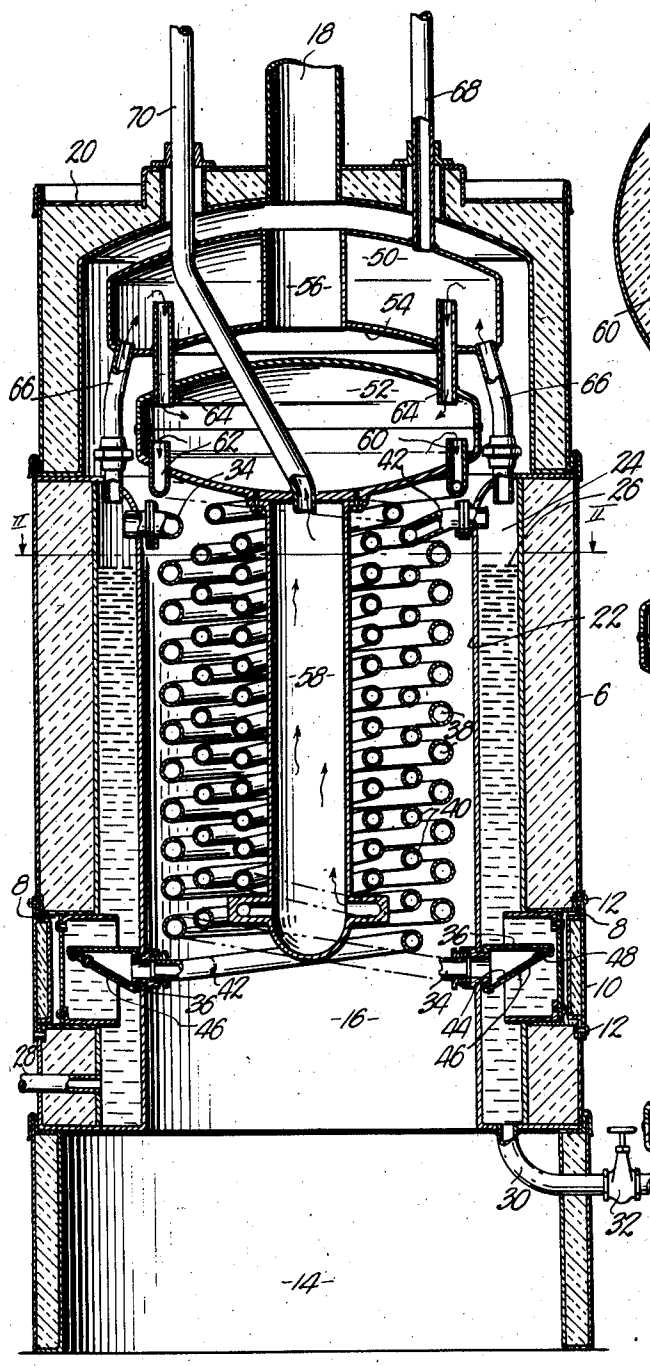



Fig. 1.

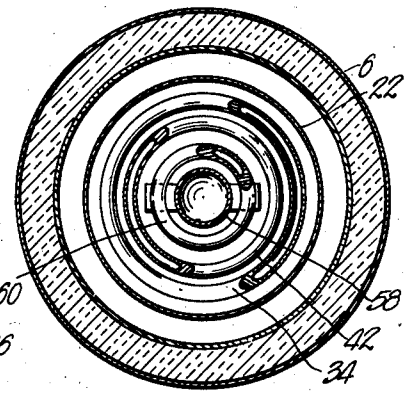



Fig. 2.

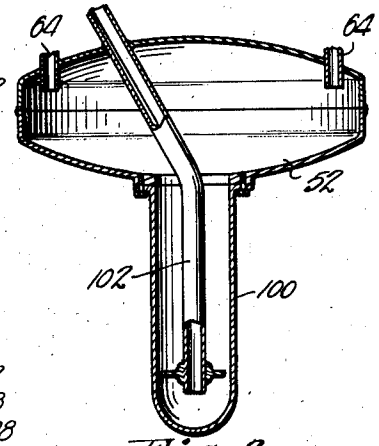



Fig. 3.

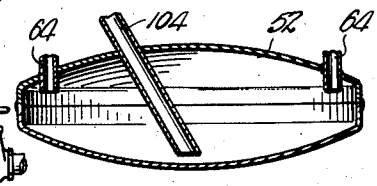



Fig. 4.

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## DRY STEAM GENERATOR

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Application February 21, 1940, Serial No. 320,030

13 Claims. (Cl. 122—169)

This invention relates to steam generators and particularly equipment of such character which is specially formed to produce dry steam that progressively raises in temperature as the take-off conduit of the boiler is approached.

The primary object of this invention is to provide a steam generator having in combination, unique means for drawing water into the vaporizing unit and a series of super-heating chambers so connected to the vaporizing unit as to receive steam and raise the temperature thereof without increasing pressure, which super-heating chambers are arranged to preclude the passage of condensate from one to the other to the end that as the steam advances toward the outlet of the generator, the same is rendered perfectly dry and exceedingly hot.

Another important object of this invention is to provide a dry steam generator having a series of super-heating chambers especially placed with respect to each other, interconnected by tubes permitting the unrestricted flow of steam therethrough, and in at least one instance, having a coiled pipe forming an interconnecting conduit, which coiled pipe directs the steam downwardly toward the fire box of the generator prior to its entrance into the take-off conduit, all to the end that exceedingly high temperature dry steam may be produced.

This invention has for a still further aim the provision of a dry steam generator of the character specified in the paragraph next above, and wherein one of the super-heating chambers consists of an elongated shell disposed on the longitudinal vertical axis of either compartment of the generator and having the aforementioned coiled interconnecting conduit circumscribing the shell in spaced relation thereto.

Another object of this invention is to provide a dry steam generator having a number of super-heating chambers from any one of which the dry steam may be withdrawn so that steam of desired temperatures may be utilized without altering the structural arrangements or function of the equipment.

The foregoing broad objects of the invention may be realized when using a steam generator such as illustrated in the accompanying drawing, wherein:

Figure 1 is a longitudinal vertical sectional view through a dry steam generator made in accordance with the present invention.

Fig. 2 is a horizontal cross sectional view through the same taken on line II—II of Fig. 1.

Fig. 3 is a fragmentary sectional view through a portion of the steam generator showing a slightly modified embodiment of the invention; and

Fig. 4 is a fragmentary sectional view through a portion of the generator showing the manner of taking off steam from one of the super-heating chambers.

This application is a continuation in part of my case filed June 5, 1939, Serial No. 277,515, now Patent 2,216,369, October 1, 1940, covering improvements for Dry steam generator, and the tank 6 thereof in this instance, should be provided with insulated walls through which is formed work openings 8, normally closed by plates 10, removably held in place by machine screws or the like 12, so that access to the hereinafter described valves may be had when necessary.

The lower part of case 6 is in the nature of a fire box 14 wherein may be positioned any burner or the like which produces heat for the heater compartment 16. The products of combustion and heated air pass upwardly through heater compartment 16 to a flue 18 carried by a cap section 20 at the top of tank 6.

An annular partition 22 within tank 6 is closed at its upper and lower ends, as shown in Fig. 1, and is spaced from the inner face of tank 6 to provide a reservoir 24 which is filled with water to approximately the water line 26, through the medium of an intake pipe 28 when the generator is in operation. A drain pipe 30 having a valve 32 thereon is used for removing the water from reservoir 22 when cleaning is desirable.

The vaporizing unit which initially converts the water into steam comprises a pair of coiled pipes each of identical nature. Pipe 34 has valve 36 at its lower end and the upper or opposite end of said coiled pipe 34 is in communication with reservoir 22 at a point above water line 26 therein. The coils 38 formed in this pipe are disposed in heater compartment 16 and circumscribe coils 40 formed in pipe 42, one end of which is in communication with reservoir 22 through the medium of its valve 36, while the other end joins reservoir 22 at a point above water line 26 as in the case of pipe 34. The coils 40 of pipe 42 are circumscribed by the coils 38 of pipe 34, and as it is desired to preclude the escape of steam into reservoir 22, valves 36 are formed to prevent such action.

Each valve 36 has a thin flap 44 overlying perforations 46 in inclined wall 48. Not only will the action of gravity cause flap 44 to lie in a position to close perforations 46 but the pressure within the pipe to which the valve 36 is attached, will cause flap 44 to remain in the place illustrated when water is not being taken into the pipe from reservoir 22.

A plurality of super-heating chambers disposed in horizontal planes are positioned above coiled pipes 34 and 42. In the instance illustrated, these super-heating chambers 50 and 52 are above heater compartment 16 and within cap section 20. The uppermost chamber 50 has a con-

cave lower wall 54 that directs heat and products of combustion toward a central opening 56 formed therethrough. This opening is in alignment with flue 18. Super-heater 52 is elliptical in vertical transverse cross section and supports an elongated shell 58 that is positioned on the longitudinal axis of heater compartment 16. This shell is mounted directly upon the bottom of super-heater 52 and is joined thereto through coiled pipes 60 and 62. Pipes 60 and 62 circumscribe shell 58 and join the same at the bottom thereof.

Super-heating chambers 50 and 52 are interconnected by a plurality of tubes 64, each of which projects upwardly into super-heater 50 to prevent the flow of moisture or condensate into super-heater 52. Super-heater 50 is joined to the upper portion of reservoir 22 through the medium of a number of tubes 66. These tubes 66 terminate above the water line 26 and above the upper ends of coiled pipes 34 and 42.

A blow-off pipe 68 extends outwardly through cap section 20 from super-heater 50 and if desired, any conventional type of pop-off valve may be mounted thereon.

A take-off conduit 70 extends from the upper portion of shell 58, through chambers 50 and 52, and thence out through cap section 20 to be joined in any suitable manner to the system which is to be supplied by the generator.

In the modified form of the invention shown in Fig. 3, super-heating chamber 52 supports elongated shell 100 and is in communication therewith. Thus, the previously described coiled pipe 60 and 62 are eliminated and the steam passes directly from super-heater 52 into shell 100 from whence it escapes through take-off conduit 102 that is similar to conduit 70. Conduit 102 terminates close to the bottom of shell 100 so that the steam may be removed from the generator when it has reached its highest temperature. The lower end of shell 100 is close to the zone of most intense heat when the parts are assembled as shown in Fig. 1.

In the form of the invention shown in Fig. 4, the shell-like chamber has been eliminated entirely and super-heater 52 placed in direct communication with take-off pipe 104 so that steam of a temperature somewhat lower than that which is taken off through apparatus shown in Fig. 3, may be removed from the generator.

It becomes obvious to one skilled in the art that steam of any predetermined, desired temperature may be removed from a generator of this type merely by attaching the take-off conduit to various portions of the super-heater.

Valves 36 are submerged in the water in reservoir 22 to thoroughly protect them from destructive actions of the heat and to insure their operation without objectionable sticking. When the heater compartment is raised in temperature by a fire in box 14, water in the major lower portions of pipes 34 and 42 is instantly converted to steam. Steam, of course, is produced in the stretches of pipes 34 and 42 closest to the source of heat, and as soon as the steam is created, an eruption takes place within the pipes which drives both steam and water from the upper ends thereof. The water will of course drop into reservoir 22 and the steam will follow the direction of the arrows at the bottom of tubes 66 and pass upwardy to super-heater 50. From super-heater 50 the steam will pass through tubes 64 and into super-heating chamber 52 and thence to shell 58 through coiled pipes 60 and 62. As this path of travel is followed, the zone of extremely high temperature is approached and the steam will be rendered dry and hot prior to its escape from the generator through take-off conduit 70.

As the steam first formed in pipes 34 and 42 forces itself and the water out the upper ends of these pipes, a partial vacuum is formed in the lower parts thereof which lifts flaps 44 to draw in a new supply of water from reservoir 22. These pipes are exceedingly hot, due to the absence of water or steam therefrom, and the instant water strikes the lower portions of these pipes, it is converted into steam to complete another eruption and unloading as above set down.

Flaps 44 preclude the passage of steam back into reservoir 22 and as long as heat is provided, the pulsating action will occur. The passage of steam through the super-heaters and tubes, above mentioned, will raise the temperature thereof without increasing the pressure. Dry super-heated steam for low pressure purposes is thus generated through the use of the equipment and due to such nature of the steam, the generator need not be as heavy nor as strong, as would be the case if the pressure increased with the temperature.

The manner in which the parts are assembled and interconnected is illustrated in the drawing and while such features are important and constitute minor objects of the invention, the same need not be further discussed.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a series of interconnected super-heating chambers in the tank between the flue and said coiled pipe and in communication with the latter; and a take-off conduit in connection with one of the chambers, said valve being submerged within the water in the reservoir.

2. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservior that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a pair of super-heater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated

super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super-heater chamber and the bottom of said elongated shell; and a take-off conduit in connection with said shell.

3. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a pair of super-heater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super-heater chamber and the super-heating shell, said coiled pipe being circumscribed by said spirally coiled pipe; and a take-off conduit in connection with the said shell.

4. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a pair of super-heater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super-heater chamber and the super-heating shell, said coiled pipe being circumscribed by said spirally coiled pipe; and a take-off conduit in connection with said shell, said last mentioned coiled pipe being coiled around the shell in spaced relation thereto and between the shell and the spirally coiled pipe.

5. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a pair of super-heater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super-heater chamber and the super-heating shell, said coiled pipe being circumscribed by said spirally coiled pipe; and a take-off conduit in connection with the said shell, said last mentioned coiled pipe being coiled around the shell in spaced relation thereto and between the shell and the spirally coiled pipe, said take-off conduit being in communication with the shell at the upper end thereof and extending through each of the super-heater chambers of the pair thereof.

6. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a pair of super-heater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super-heater chamber and the bottom of said elongated shell; and a take-off conduit in connection with the said shell, said elongated shell being supported on the bottom of the lowermost super-heater chamber.

7. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a pair of super-heater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super-heater chamber and said elongated shell; and a take-off conduit in connection with said shell.

8. A steam generator of the character described comprising a cylindrical tank having its longi-

tudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a pair of superheater chambers disposed one above the other in the tank between the flue and said coiled pipe; a plurality of tubes joining said chambers; an elongated super-heating shell on the axis of the tank, below said pair of super-heater chambers and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost superheater chamber and said elongated shell; and a take-off conduit in connection with said shell.

9. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a super heater chamber disposed in the tank between the flue and the coiled pipe; an elongated super heating shell on the axis of the tank, below said super heating chamber and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the super heater chamber and the said elongated shell; and a take-off conduit in connection with said shell.

10. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a super heater chamber disposed between the flue and said coiled pipe; an elongated super heating shell on the axis of the tank, below said super-heater chamber and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super heater chamber and the super heating shell; and a take-off conduit in connection with said shell.

11. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a super heater chamber disposed in the tank between the flue and said coiled pipe; an elongated super heating shell on the axis of the tank, below said super heater chamber and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the super heater chamber and the super heating shell, said coiled pipe being circumscribed by said spirally coiled pipe; and a take-off conduit in connection with the said shell, said last mentioned coiled pipe being coiled around the shell in spaced relation thereto and between the shell and the spirally coiled pipe.

12. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a super heater chamber disposed in the tank between the flue and said coiled pipe; elongated super heating shell on the axis of the tank, below said super heater chamber and circumscribed by ports of said spirally coiled pipe; a coiled pipe joining the super heater chamber and the super heating shell, said coiled pipe being circumscribed by said spirally coiled pipe; and a take-off conduit in connection with the said shell, said last mentioned coiled pipe being coiled around the shell in spaced relation thereto and between the shell and the spirally coiled pipe, said take-off conduit being in communication with the shell at the upper end thereof and extending through the super heater chamber.

13. A steam generator of the character described comprising a cylindrical tank having its longitudinal axis disposed vertically and provided with a flue at its upper end and a heater compartment at the lower end thereof; an annular partition within the tank in spaced relation to the wall thereof to set off a water reservoir that circumscribes the heater compartment; a spirally coiled pipe in the heater compartment having the ends thereof in communication with the reservoir, one end of said pipe being below the normal water line of the reservoir, the other end being above said water line; a valve at the first mentioned end of said pipe permitting flow of liquid only into said pipe from the reservoir; a super heater chamber disposed between the flue and said coiled pipe; an elongated super heating shell on the axis of the tank, below said super heater chamber and circumscribed by parts of said spirally coiled pipe; a coiled pipe joining the lowermost super heater chamber and the super heating shell; and a take-off conduit in connection with said shell, said elongated shell being supported on the bottom of the super heater chamber.

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