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W. G. NOACK
STEAM GENERATOR

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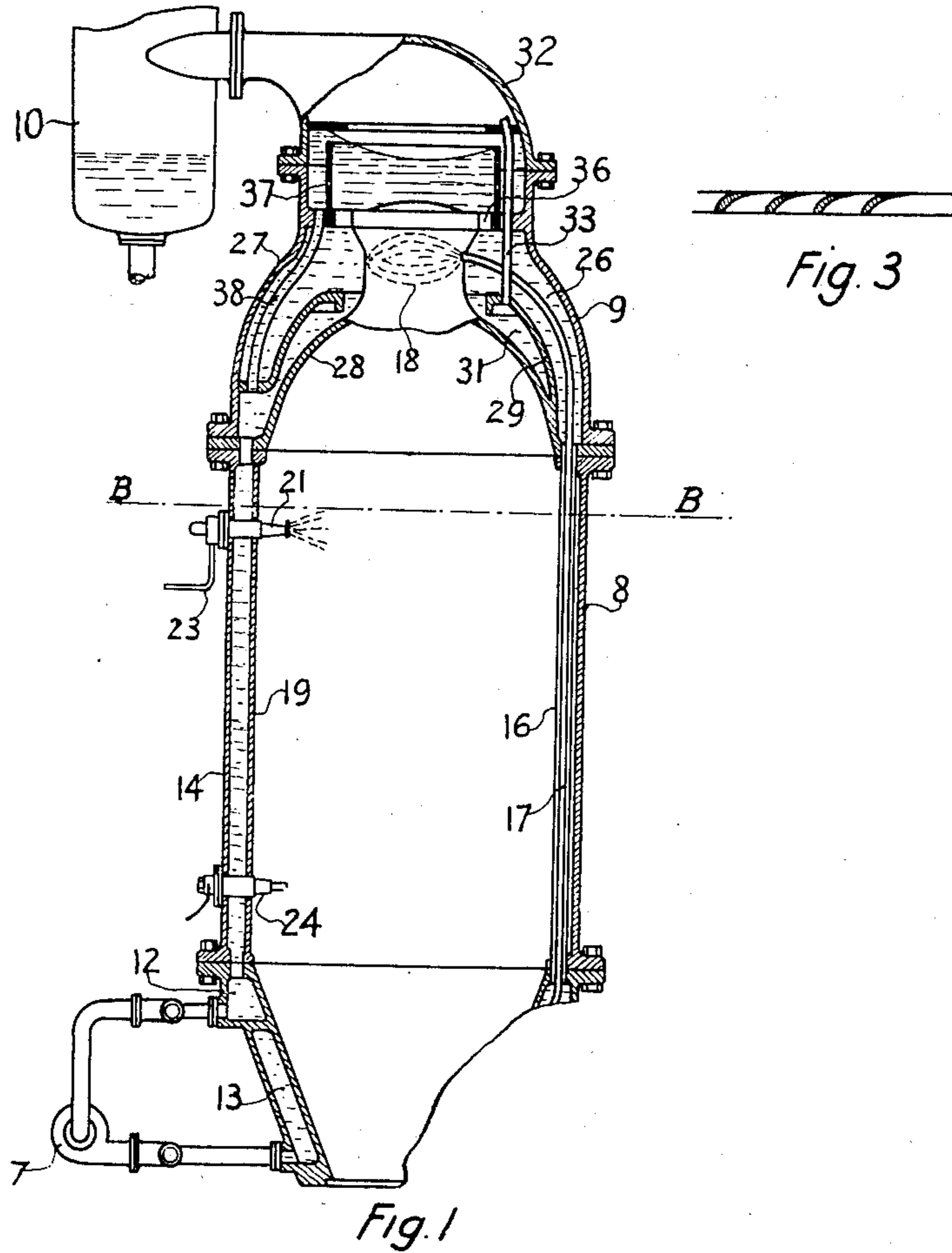


Fig. 1

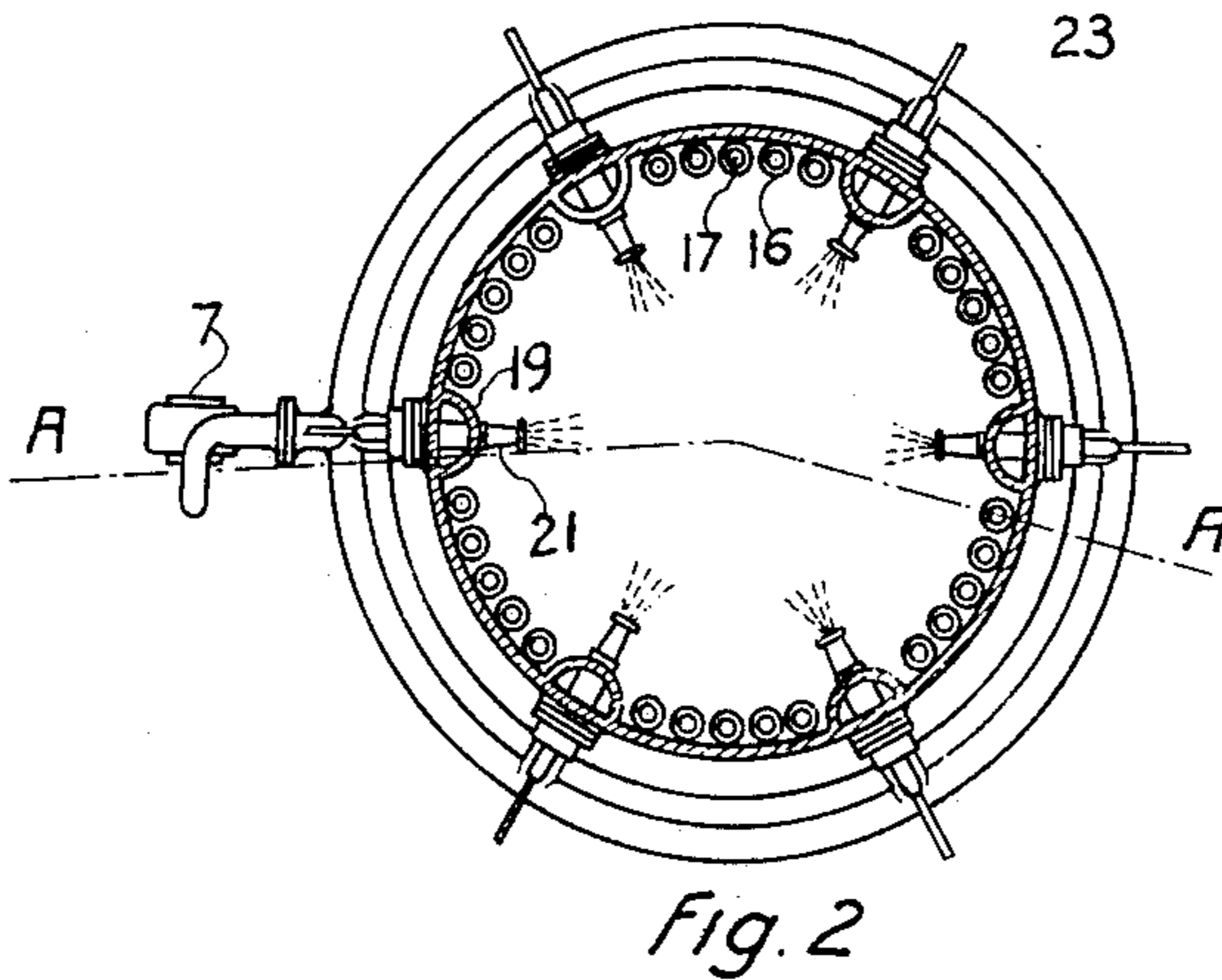


Fig. 2

Inventor
Walter Gustav Noack
By *Alfred H. Ryan*
Attorney.

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STEAM GENERATOR

Walter Gustav Noack, Baden, Switzerland, assignor to Aktiengesellschaft Brown Boveri & Cie., Baden, Switzerland, a joint-stock company of Switzerland

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7 Claims. (Cl. 122—488)

This invention relates to improvements in steam generators, and particularly to steam generators of the type in which the combustible charge is burned under high-pressure and the pressure head of the products of combustion is used to obtain high combustion gas velocities and therethrough high heat transmission to the water to be vaporized, as described in my copending applications Serial Nos. 333,453 filed January 18, 1929, 343,745 filed March 1, 1929, 414,428 filed December 16, 1929, and 419,026 filed January 7, 1930.

In steam generators in which fuel is burned under high pressure, and the pressure is utilized to impart to the combustion gases high velocity across the heating surfaces, it is necessary that the high rate of heat transfer on the gas side shall be matched by an even higher degree of heat transfer to the water flowing in contact with the opposite side of the heater walls. The water to be vaporized must therefore be circulated at a high velocity, and the amount of the water circulated must be a multiple of the quantity of water vaporized to secure continuous contact of the heated walls with water. To attain the desired result, special means must be provided to secure adequate circulation of the water and effective separation of the steam generated from the water.

It is among the objects of the present invention to overcome the foregoing difficulties and to provide special arrangements for circulation of a multiple of the quantity of water to be evaporized along the heating surfaces, and efficiently separating the generated steam therefrom.

The foregoing and other objects of the invention will be apparent from the following description of exemplifications thereof reference being had to the accompanying drawing in which

Figure 1 is a vertical cross-sectional view of one embodiment of the present invention taken on the plane A—A of Fig. 2,

Fig. 2 is a horizontal cross-sectional view taken on the plane B—B of Fig. 1, and

Fig. 3 is a developed view of a nozzle structure embodied in and forming a portion of the steam generator shown in section in Fig. 1 and designated by numeral 36.

In the drawing is shown a steam generator comprising a bottom section 6, a main section 8 and a top section 9 forming a hollow combustion chamber. A water circulating pump 7 and a water separator 10 are connected to the generator as shown.

The bottom section 6 is substantially in the shape of a hollow frustrum of a cone having double walls to provide a water outlet duct 12 leading the water to the circulating pump 7 and a water inlet duct 13 adapted to receive water from the pump 7 at relatively high pressure. Through the lower end of the conical bottom section combustion air is admitted to the chamber.

The intermediate section 8 is in the form of a cylinder 14 which is substantially covered or sheathed on the inside by a plurality of water tubes 16, connected with the water inlet duct 13 of the bottom section 6, and extending upwardly to discharge into the top section 9. Each of the water tubes 16 has a tube 17 arranged concentrically therein to provide a path for the outflow of the combustion gases from the combustion chamber. The water is returned from the top section 9 through a plurality of return conduits 19 formed on the inner surface of the shell 14 connected through outlet duct 12 to the water pump 7. The fuel is injected into the combustion chamber through nozzles 21 extending through the water return conduits 19, the fuel being supplied from a fuel line 23. The fuel-air mixture is ignited by a spark plug 24 or other suitable means. The combustion gases are discharged from the chamber through the gas tubes 17 and heat the relatively thin cylinder of water moving through tubes 16 under high pressure from the pump 7 toward the top section 9.

The heated and partially vaporized water rising in the water tubes 16 discharges into a space 26 in the top section 9 which is inclosed by an outer shell 28. A portion of the water flows downwardly through an annular inlet formed between the inner shell 29 and an extension therefrom forming a confined space 31 which is connected with a steam dome 32 by a tube 33. As the water passes into space 31 the steam bubbles separate therefrom due to the flattening of the steam, and due to the pressure drop through throttling in the narrow inlet slot to space 31. The steam separated from the water rises to the top of the space 31 and discharges through pipe 33 into steam dome 32 and the water is carried downwardly through the return conduits 19 into the outlet duct 12. The portion of the water not flowing into confined space 31 rises through openings 36 provided with nozzles, as shown developed in Fig. 3, into an apertured basin 37 spaced from the outer shell 28. The water flowing through nozzle openings 36 is given a rotating motion which causes the heavier water particles to col-

lect in the space around basin 37 from which the water is returned through a pipe 38 to the return conduits 19. The steam rising from the basin 37 collects in steam dome 32 and is discharged tangentially into water separator 10 from which where by reason of the centrifugal action the dry steam is collected in the top of separator and led to points of consumption, and the water is returned through a pipe 39 to the pump 7.

10 A plurality of steam generators described may be connected in parallel to require only one water circulating pump and one separate steam separator. Where individual water separators are used, they may be connected in parallel to a common reservoir. On this common reservoir may be mounted the control arrangements of the entire battery of boilers, such as the feed water regulators, pressure instruments, and alarm signalling systems.

20 Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

The invention claimed is:

1. In a steam generator, a main section, a plurality of tubes containing the water to be vaporized and substantially covering the inner surface of said main section, a bottom section having a water return and a water distributing channel formed therein, said tubes being connected with the water distributing channel, a top section receiving the water discharging thereinto, conduits formed interiorly on said main section for returning the water from said top section to said bottom section, fuel injection nozzles extending through said water return conduits into said main section, means within said top section for partially separating the steam formed from the water by producing a pressure drop therein, and means within said top section for substantially separating the steam formed from the water by centrifugal action thereof.

2. In a combination with a steam generator comprising a receiving chamber, a water inlet duct, a set of water tubes between said duct and said chamber arranged to circulate water to be evaporated from said duct to said chamber, and means for passing hot combustion gases in heat exchange relation to said water tubes to heat the same, of means associated with said receiving chamber to separate therein the major part of the circulated water from the evaporized steam, pump means and duct means connected between the water space of said receiving chamber and said inlet duct constituting a circuit for imparting to the separated water a high circulating velocity through said water tubes, and an additional water separator connected to the steam space of said receiving chamber to receive therefrom the generated steam, said additional water separator being arranged to segregate the water from the received steam and having its water space connected to said water circuit to return the segregated water to the water circulated through said water tubes.

3. In combination with a steam generator comprising a receiving chamber, a water inlet duct, a set of water tubes between said duct and said chamber arranged to circulate water to be evaporated from said duct to said chamber, and means for passing hot combustion gases in heat exchange relation to said water tubes to heat the same, of

means associated with said receiving chamber for imparting to the water entering the same a movement separating the major part of the circulated water from the evaporized steam, pump means and duct means extending along said water tubes connected between the water space of said receiving chamber and said inlet duct constituting a circuit for imparting to the separated water a high circulating velocity through said water tubes, and an additional segregated water separator connected to the steam space of said receiving chamber to receive therefrom the generated steam, said additional water separator being arranged to segregate the water from the received steam and having its water space connected to said water circuit to return the segregated water to the water circulated through said water tubes.

4. In combination with a steam generator comprising a receiving chamber, a water inlet duct, a set of water tubes between said duct and said chamber arranged to circulate water to be evaporated from said duct to said chamber, and means for passing hot combustion gases in heat exchange relation to said water tubes to heat the same, of means associated with said receiving chamber for imparting to the water entering the same a rotary movement separating the major part of the circulated water from the evaporized steam, pump means and duct means connected between the water space of said receiving chamber and said inlet duct constituting a circuit for imparting to the separated water a high circulating velocity through said water tubes, and an additional segregated water separator connected to the steam space of said receiving chamber to receive therefrom the generated steam, said additional water separator being arranged to segregate the water from the received steam and having its water space connected to said water circuit to return the segregated water to the water circulated through said water tubes.

5. In combination with a steam generator comprising a receiving chamber, a water inlet duct, a set of water tubes between said duct and said chamber arranged to circulate water to be evaporated from said duct to said chamber, and means for passing hot combustion gases at high velocity in heat exchange relation to said water tubes to heat the same, of means associated with said receiving chamber to separate therein the major part of the circulated water from the evaporized steam, pump means and duct means connected between the water space of said receiving chamber and said inlet duct constituting a circuit for imparting to the separated water a high circulating velocity through said water tubes, and an additional water separator connected to the steam space of said receiving chamber to receive therefrom the generated steam, said additional water separator being arranged to segregate the water from the received steam and having its water space connected to said water circuit to return the segregated water to the water circulated through said water tubes.

6. In a steam generator, a receiving chamber, a water inlet duct, a set of water tubes between said inlet duct and said receiving chamber to circulate water to be evaporized from said duct to said chamber, means for passing hot combustion gases at high velocity in heat exchange relation to the water in said tubes to heat the same, pump and duct means connected between said receiving chamber and said inlet duct for imparting to water from said receiving chamber a

high circulating velocity through said heater tubes into said receiving chamber, and means associated with said receiving chamber for imparting to the entering water impelled by the pump means a rotary movement separating the major part of the circulated water from the steam generated therein.

tion to the water in said tubes to heat the same and evaporize a part thereof, pump and duct means connected between said receiving chamber and said inlet duct for imparting to a multiple of water to be evaporized a high circulating velocity in the direction from said receiving chamber through said heater tubes into said receiving chamber, and means associated with said receiving chamber for imparting to the entering water impelled by the pump means a rotary movement separating the major part of the circulated water from the steam generated therein.

7. In a steam generator, a receiving chamber, a water inlet duct, a set of water tubes between said inlet duct and said receiving chamber to circulate water to be evaporized from said duct to said chamber, means for passing hot combustion gases at high velocity in heat exchange rela-

WALTER GUSTAV NOACK.

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