Oct. 20, 1931. W. R. WOOD 1,828,483

ART OF STEAM GENERATION

Filed June 30, 1927 2 Sheets-Sheet 1

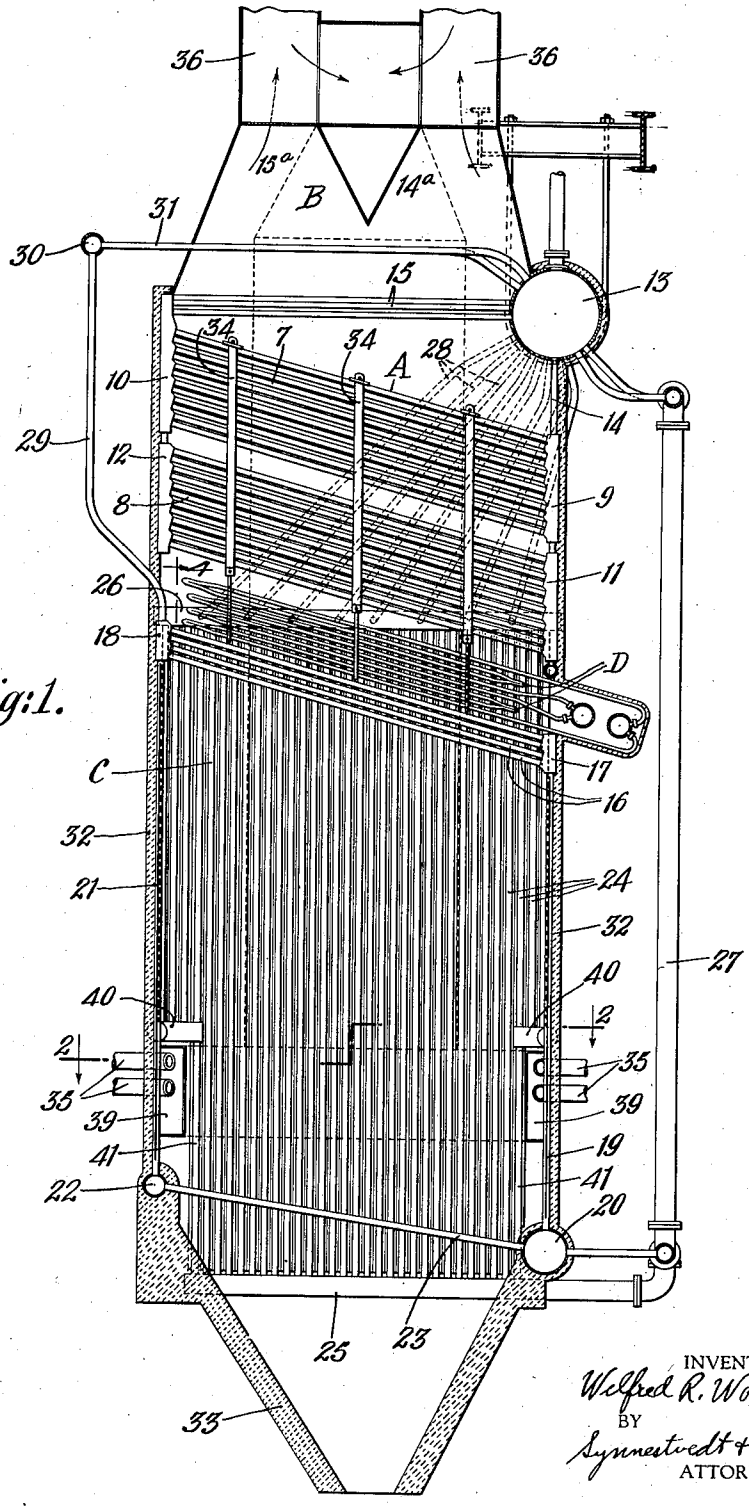


Fig:1.

INVENTOR
Wilfred R. Wood
BY
Synnestvedt & Lechner
ATTORNEYS

Oct. 20, 1931. W. R. WOOD 1,828,483

ART OF STEAM GENERATION

Filed June 30, 1927 2 Sheets-Sheet 2

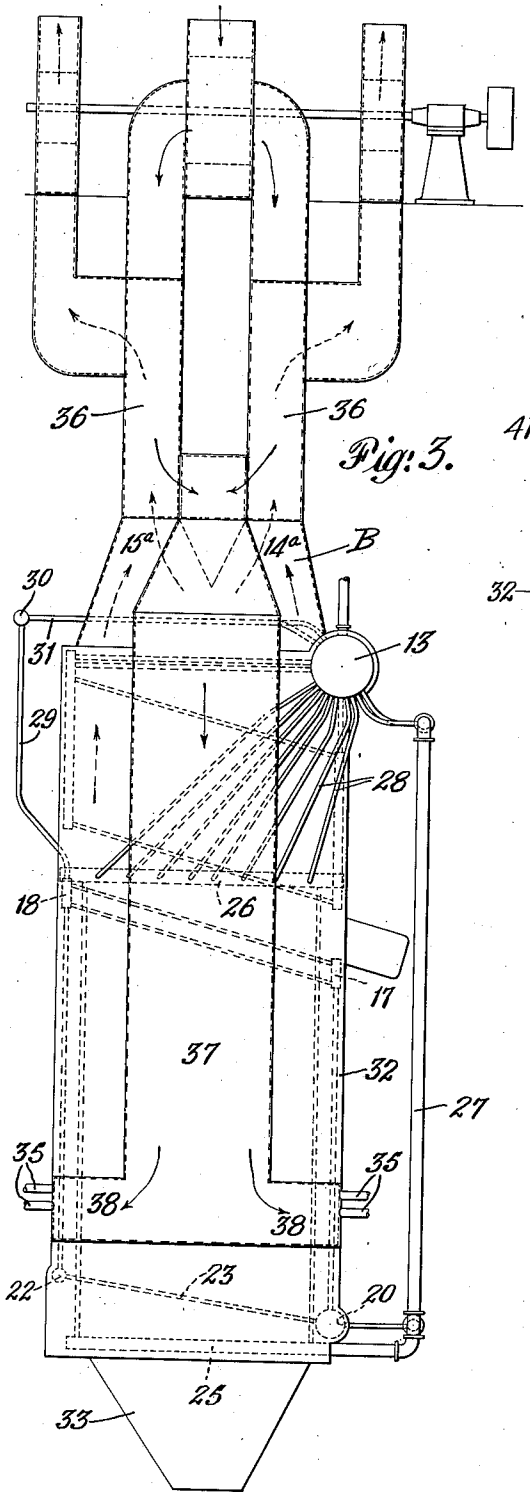
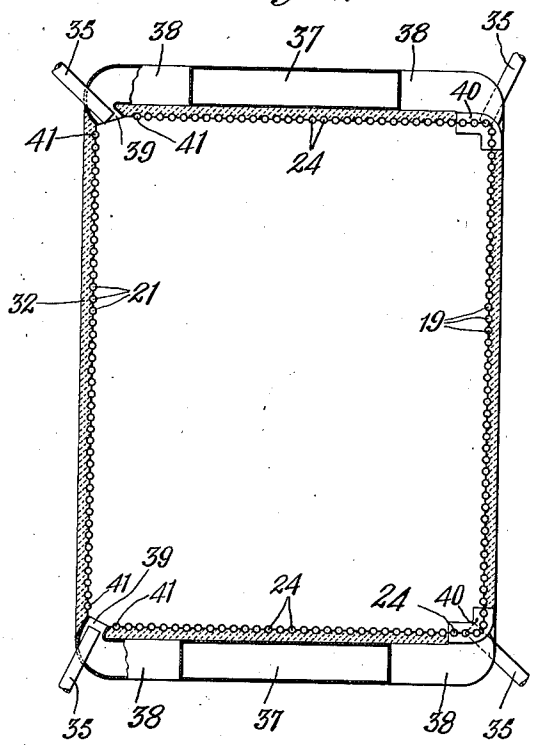


Fig: 3.

Fig: 2.



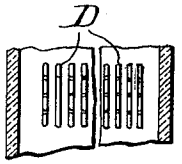


Fig: 4.

INVENTOR
Welfred R. Wood
BY
Symmestvedt & Lechner
ATTORNEYS

Patented Oct. 20, 1931 1,828,483

UNITED STATES PATENT OFFICE

WILFRED R. WOOD, OF LONDON, ENGLAND, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

ART OF STEAM GENERATION

Application filed June 30, 1927. Serial No. 202,546.

This invention relates to improvements in the art of steam generation, particularly where the steam is to be generated from the burning of fuel in finely divided form, as, for example, in the form of pulverized coal.

One of the primary objects of the invention is to attain maximum simplicity of structure and, hence, cheapness of manufacture and of erection.

Another of the objects of the invention is to make it possible to greatly increase the size of the superheater while still retaining simplicity of superheater construction, full accessibility and facility for inspection, repair, insertion and/or removal, with the superheater effectively subjected to heat but not at objectionably high temperatures.

Still another object of the invention is to provide a very simple and improved arrangement in which the draft loss is reduced to a minimum.

A further object of the invention is to so introduce the fuel and air for combustion that the fuel may be effectively burned in coarser form than usual whereby a saving in preparation of the fuel is effected.

My invention further contemplates a very simple and effective arrangement—either for entirely new installations or for adapting existing installations—whereby greatly increased capacity is obtained.

Other and more specific objects will appear hereinafter in connection with the accompanying description and drawings in which I have illustrated the best form of my invention as now known to me, and in which—

Fig. 1 is a vertical section through an installation embodying my improvements.

Fig. 2 is a cross section taken on the line 2—2 of Fig. 1.

Fig. 3 is a more or less diagrammatic side elevation of the installation for the purpose of illustrating a certain number of parts thereof, and

Fig. 4 is a fragmentary broken section taken on the line 4—4 of Fig. 1.

Referring now to Fig. 1, the reference character A denotes a boiler unit such, for example, as a horizontal boiler of the cross drum type. This boiler preferably comprises the two banks of tubes 7 and 8, the number of tubes of which may be varied to meet the particular requirements; appropriate sets of headers 9 and 10 and 11 and 12, the headers 9 being connected with the headers 11 and the headers 10 being connected with the headers 12 as shown; the drum 13; the downcomers 14 leading from the drum 13 to the headers 9 and the return tubes 15 leading from the headers 10 to the drum 13.

Immediately above the boiler A is the breeching B which, preferably, has the two branches 14*a* and 15*a* which ultimately discharge into the stack.

Below and spaced from the boiler unit A is a combustion chamber C formed by a second boiler unit, i. e., by a boiler unit which is its own furnace. This second boiler unit is a substantially rectangular six-sided chamber and comprises the tubes 16 of which there are any desired number of rows, four being indicated, such tubes being connected at one end to the headers 17 and at the other end to the headers 18; the wall of upright tubes 19 extending upwardly from the small drum 20 to the headers 17; the wall of upright tubes 21 extending upwardly from the header 22 to the header 18; the row of inclined tubes 23 connecting the drum 20 with the header 22 and the two side water walls composed of upright tubes 24, the tubes of each such side wall rising upwardly from a header 25 to a header 26; the downcomer means 27 which supplies the drum 20 and the headers 25, the upcomers 28 of which there are a plurality leading from each of the headers 26 to the drum 13; and the upcomers 29 leading from the headers 18 to the header 30 and the tubes 31 connecting the header 30 with the drum 13.

The walls of the furnace-shaped boiler unit C are enclosed with a suitable sheathing 32 and the bottom thereof is closed by the ash pit 33.

The superheater, indicated as a whole by the reference letter D, is located in the space between the bank of tubes 8 and the group of tubes 16, the superheater tubes extending substantially for the full horizontal breadth and depth of the installation. It will be seen that the arrangement of the two boiler

units is one which makes it possible to conveniently install a superheater of much greater size than usual, and that the superheater can be inserted and is readily accessible laterally and tubes can be removed and replaced with the greatest facility. The superheater offers even resistance to the passage of the gases.

It will also be seen that the banks of tubes 7 and 8 are convection tubes, whereas the tubes of the boiler-shaped furnace C are primarily subject to the radiant heat and also to convection, as will further appear. The circulation through the furnace-shaped boiler unit C is very rapid because of the provision of the many upright tubes and because of the fact that the furnace-shaped boiler unit is subjected to radiant heat and high temperature. Although the downcomers and the upcomers for both boiler units lead preferably from and to the same drum 13, nevertheless the circulation of the furnace-shaped boiler is not impeded by the circulation of the boiler unit A, and because of the rapid circulation through the boiler unit C it is possible not only to locate the superheater as shown, but also to install a much larger superheater than usual without running into difficulties, such as would be incident to too high a degree of superheat. Thus, I am enabled to provide a superheater of a capacity commensurate with the very great capacity of the installation, and I am enabled to effectively and uniformly but not destructively subject the superheater to heat throughout its length and breadth, in which connection it will be noted that the installation is an unbaffled one, with a straight rise of the gases around the tubes 16, the superheater D and the banks of tubes 7 and 8, an arrangement which, in addition to the advantages already pointed out, results in a minimum draft loss and a uniform resistance to flow producing uniform flow cross-sectionally considered, which results in effective utilization of all of the absorption surface and no great temperature differential throughout the length of any of the tubes.

It will be noted that the drum 13 is suspended and that the superheater is suspended from the boiler A by means of the straps 34. The boiler unit A and the boiler unit C are independently supported with full capacity for both to expand and contract.

It will be observed that the boiler installation is very simple and easy to erect and that the number of tubes which are required to be bent is very small, and that in no case is the bend a difficult one.

With respect, now, to the manner of firing the installation, the finely divided fuel, such as the powdered coal, is introduced into the lower part of the furnace-shaped boiler unit C at the corners thereof by means of the nozzles 35 which may be nothing more than round pipes disposed so as to discharge tangentially to an imaginary circle, the axis of which is at the center of the furnace-shaped boiler and is vertical. The air for combustion is preferably provided as follows. There is an air heater 36 in each of the branches 14ª and 15ª of the breeching B, these air heaters discharging into the casings or ducts 37, of which there is one on each of two opposite sides of the setting, the lower end of each of these ducts being extended as indicated at 38 to terminate into nozzle-like portions 39 also disposed so as to discharge tangentially as described, and within which nozzles the fuel nozzles 35 extend. The coal is blown into the furnace-shaped boiler unit by part of the air required for combustion, the balance of the air required for combustion being supplied through the nozzles 39. The coal and air streams are delivered at such velocities that they unite to take a vortical or spiral path upward through the furnace-shaped boiler with immediate and violent mixing of the fuel and air, with consequent turbulent and intense combustion toward which end also the combustion air is preferably highly preheated in the air heaters 36. The fuel and flame stream, as above stated, spirals upwardly and sweeps relatively evenly over the tubes of the boiler C, whereby the latter are subjected both to radiant heat and to heat of convection. The boiler C, so to speak, is a huge burner, for it confines and secures the mixture of the fuel and air and causes the fuel and flame stream to take the course described after admission by the nozzles. Combustion is effected within the boiler C and before the tubes 16 are reached and because of the highly preheated combustion air and the violence of combustion, the combustion is substantially complete, and the losses in combustible values passing up beyond the tubes 16 is negligible. By firing from beneath upwardly in this fashion coarser coal than usual can be burned effectively and completely, gravity counteracting the draft of the furnace to an extent sufficient to provide ample time for the burning of the coarser particles. No appreciable losses in combustibles will occur by reason of gravitation to the ash pit, because it will be seen, on inspection of Fig. 1, that the nozzles 35 are located well up within the nozzles 39 whereby there is a substantial amount of air admitted below the point of fuel admission. Such air will not only have a sustaining effect, but will also provide oxygen for the consumption of any fuel particles as tend to sink.

This form of combustion is peculiarly suitable to the boiler installation as the fuel and flame stream fills the boiler C cross-sectionally considered and the rising gases fill the top thereof cross-sectionally, so that, beginning with the tubes 16 and from thence on up, the tubes are subjected to the gases, from

practically end to end, substantially uniformly.

A space for the reception of the nozzles 39 and 35 is provided by terminating certain of the upright tubes of the walls just above such nozzles and connecting them into headers 40, in turn connected by short tubes 41 with the headers 25 and the header 22 and drum 20.

The upright tubes of the boiler unit C are preferably provided with longitudinally extending fins cooperating with the tubes to form a substantially continuous metallic wall. The tubes 15 and 31 are fully effective for absorption of heat of convection.

The amount of convection surface is such as to reduce the temperature of the gases passing the tubes 31 to a point within the limitations of metal air heaters, say to 1000° F. The heat absorbed by the boiler unit C is such that the gases as they pass over the superheater are not too high. The absorption area of the boiler unit C is such as to provide the volume of combustion space required for the proper combustion of the fuel, in which connection I preferably provide enough surface to have the boiler unit C do about 50% more work than the boiler unit A.

I claim:

1. In combination, a tubular boiler unit having downcomer and return connection with a steam and water space, a second tubular boiler unit the tubes of which are arranged in the form of a six-sided chamber, said unit being approximately below and spaced from the first unit and having downcomer and return connection with steam and water space, a superheater between the two units, and means for tangentially introducing and burning finely divided fuel in the space defined by the second unit, the parts being arranged to provide a single pass, together with an offtake above the first unit.

2. In combination a horizontal boiler unit including a bank of unbaffled tubes having headers, a steam and water drum, and downcomer and upcomer connections between headers and the drum; a furnace shaped boiler unit providing its own combustion space located below the first unit and in spaced vertical relation, said unit in cross section being of approximately the same size as the first unit so that the same walls can enclose both units; said walls; downcomer and upcomer connections between the second unit and the drum; a superheater in the space between the two units and largely occupying said space and accessible through one of said walls; and means for introducing pulverized fuel in the lower part of the chamber at the corners thereof tangentially.

3. In combination a horizontal boiler unit including a bank of unbaffled tubes having headers, a steam and water drum, and downcomer and upcomer connections between headers and the drum; a furnace shaped boiler unit providing its own combustion space located below the first unit and in spaced vertical relation, said unit in cross section being of approximately the same size as the first unit so that the same walls can enclose both units; said walls; downcomer and upcomer connections between the second unit and the drum; a superheater in the space between the two units and largely occupying said space and accessible through one of said walls; and means for introducing pulverized fuel in the lower part of the chamber at the corners thereof tangentially; said second unit being in the form of tubes arranged in the form of a six sided box.

In testimony whereof I have hereunto signed my name.

W. R. WOOD.

CERTIFICATE OF CORRECTION.

Patent No. 1,828,483. Granted October 20, 1931, to

WILFRED R. WOOD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, lines 87, 95, 97, and 102, after the word "boiler" insert the word unit; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of December, A. D. 1931.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)