June 9, 1931. H. GLEICHMANN 1,809,270

STEAM GENERATOR

Filed Sept. 8, 1926 2 Sheets-Sheet 1

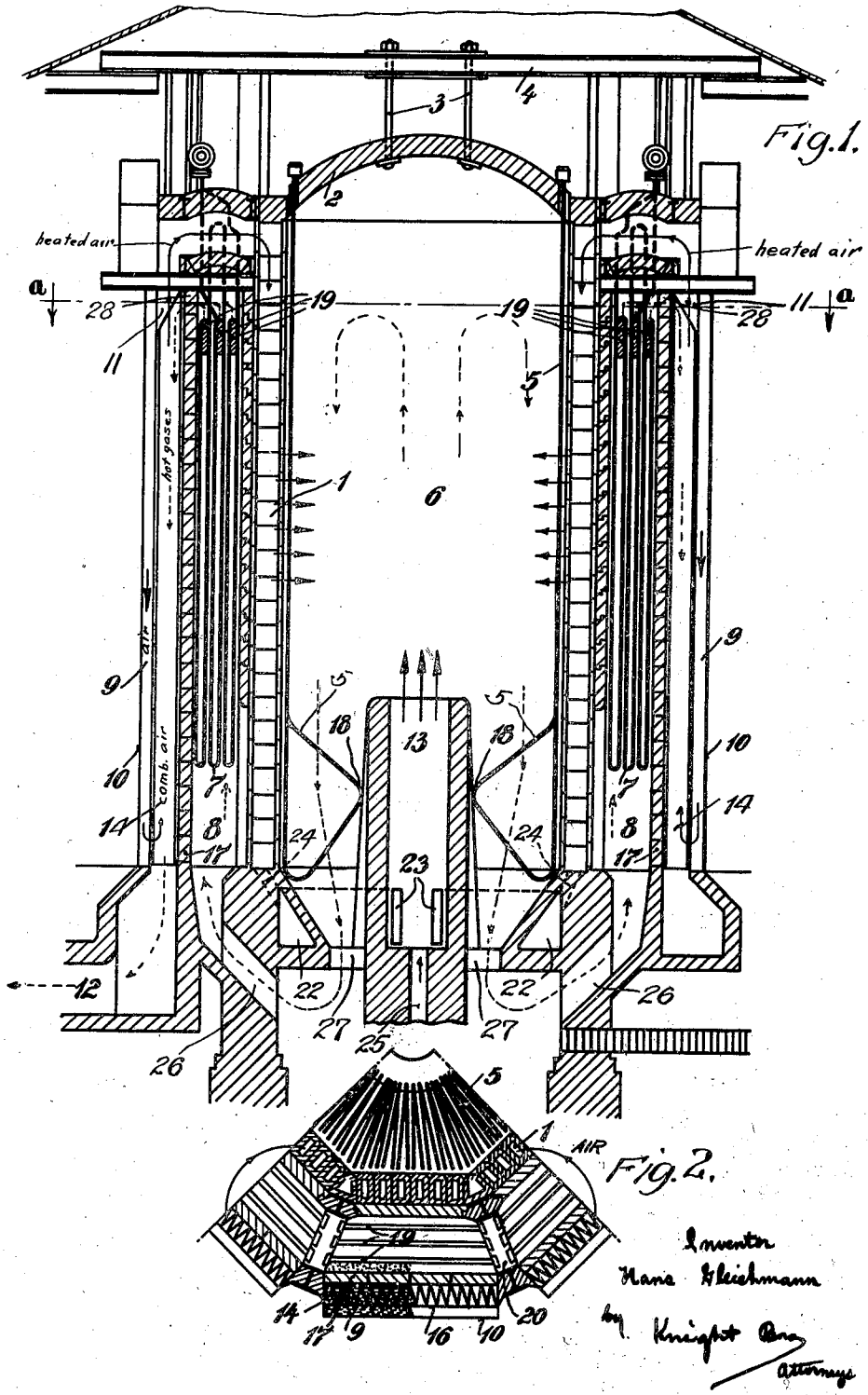


Fig. 1.

Fig. 2.

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Fig. 4.

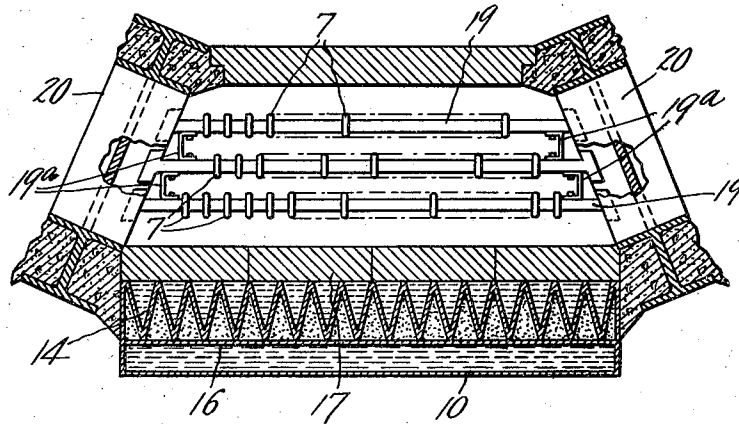
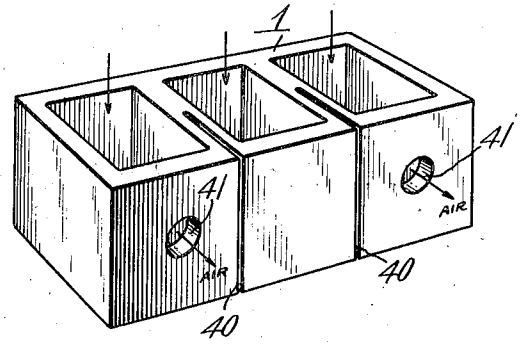


Fig. 3.



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UNITED STATES PATENT OFFICE

HANS GLEICHMANN, OF BERLIN-SIEMENSSTADT, GERMANY, ASSIGNOR TO SIEMENS-SCHUCKERTWERKE GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, OF SIEMENSSTADT NEAR BERLIN, GERMANY, A CORPORATION OF GERMANY

STEAM GENERATOR

Application filed September 8, 1926, Serial No. 134,206, and in Germany September 19, 1925.

My invention relates to steam generators, particularly suitable for carrying out the so-called "Benson" steam generation process.

The process for the generation of working steam ready for use in an engine or the like known as the Benson process is based upon the principle that the pressure and the temperature in all the stages of the generation process are so regulated that no unsteady separation of steam and water ("ebullition") takes place. The high pressures developed hereby do not permit the employment of boilers with large water spaces. The Benson steam generator consists of a heated system of pipes to which the water is supplied under pressure. Since very large quantities of heat must be applied to the system of pipes in a very short time the design and construction of the generator are very different from those of known boilers.

My invention consists of an improved construction of such a steam generator. The generator is fired by pulverized coal or any other suitable fuel adapted to be supplied through nozzles and the necessary combustion air is supplied to the flame in a heated state. Owing to the preheating of the air uncommonly high temperatures develop which are liable to become a source of danger to the masonry in two regards, viz. firstly by the masonry expanding considerably owing to the heat and secondly owing to the danger of its destruction by the heat. The first danger is avoided by constructing the furnace chamber as a self-supporting shaft capable of freely expanding in its longitudinal direction when heated. The internal working of the masonry is therefore not hindered by restraining and confining structural elements as is the case in all the hitherto known boilers. It has been found particularly advantageous not to support the upper closing arch by the shaft or stack but to suspend it from a structure entirely separate from the shaft. Whether the arch should be suspended as a unit or in separate parts is merely a question of practicability.

In order to provide also for radial expansion of the brickwork, the bricks may, if desired, be provided with radial slots towards the side of the maximum curvature so that a certain elasticity against tangential stresses is created.

To enable an easy removal of the tubes they are according to my invention merely suspended from beams or girders which are pushed through the bent-over ends of the tubes. The girders are suspended from a structure which, so far as vertical support is concerned, is independent of the shaft and need only be withdrawn to permit the removal of the individual bundles or nests of tubes from the boiler without the necessity of detaching further holding or supporting elements. The arrangement has the further advantage that the free expansion of the tubes is not interfered with by any means of attachment.

It has already been mentioned that the brickwork of the furnace chamber is liable to suffer in its structural rigidity owing to the heat intensities developed. This drawback is eliminated according to my invention by arranging all tubes of the steam generator in the radiation chamber and in such a manner that they effectively screen the brickwork from the action of the radiation.

In order to protect the floor against the action of direct radiation and hot ashes, the generator tubes are led near the shaft bottom in loops towards the shaft center, thereby forming a water cooled grate through which the combustion products pass. In contrast with the hitherto known water-cooled granulating grates the steam generating tubes themselves are according to my invention employed for cooling the ashes. Special systems of tubes were hitherto employed for this purpose.

The furnace is fed with pre-heated combustion air. The pre-heater is constructively combined with the steam generator. To prevent a useless radiation of heat towards the outside, the steam generator is enclosed by a shell or jacket through which the combustion air is supplied to the furnace. This outer shell is comparatively thin and only serves for the guidance of the air current. The air sweeps around the entire outside of the steam generator, absorbs the heat penetrating through the heater wall and thus forms an

effective insulating cover. From the air jacket the air passes into the heat exchanging device in which it absorbs the heat still contained in the waste gases. The efficiency of the improved heat exchanging device, which will be more fully described hereafter, resides in the configuration of the swept surfaces, which are formed as corrugations or zigzag surfaces.

The preheating to the highest temperature takes place in the shaft shell proper which is constructed of hollow moulded bricks through which the air flows. This construction affords a special kind of air supply to the combustion chamber viz, through the radial slots in the bricks which, as described above, simultaneously serve for compensating stresses, the air passing radially between the boiler tubes. In this manner not only an intimate mixture of the air with the fuel is attained, but simultaneously a good cooling action by which the brickwork is effectively protected.

In the drawings affixed hereto

Fig. 1 shows a longitudinal section

Fig. 2 a partial cross-section along line *a*—*a* of Fig. 1.

Fig. 3 a perspective view of a brick used in the shaft construction, and

Fig. 4 an enlarged section on the line *a*—*a* in Fig. 1 through a superheater chamber, showing the details of the tube suspension.

Like numerals of reference indicate like parts in all figures of the drawings.

Referring to the drawings 1 is the shaft of the furnace constructed of hollow moulded bricks which extend to the vicinity of the top. It is thus able to expand freely in an axial direction. By reason of the radial slots 40 in each brick, as shown in detail in Fig. 3, the tangential stresses, set up in the shaft when its inner surface becomes hotter than its outer surface, are relieved. The arch 2 at the top of the shaft is suspended from an iron structure 4 which is entirely separate from the shaft proper. 5 are the steam generator tubes which, as particularly clearly shown in Fig. 2, are all located in the radiation space 6. The superheater tubes 7 are located in the flues 8 swept by the waste gases. The manner of suspending the superheater tubes is clearly illustrated in Fig. 4. The bundles or nests of tubes are suspended from circumferentially disposed girders 19 which rest upon radially disposed girders 20. The girders 19 are bolted together by spacing brackets 19ª and the whole tube nest or section can be drawn together out of the chamber, in case of required repair, whereafter the individual girders 19 may be unbolted from each other and be withdrawn from the loops of the tubes which they support. The fire box tubes 5 may be suspended from the roof beam 4 by suitable means not shown in detail, thus allowing vertical expansion independent of the shaft and arch. As clearly shown in all figures all the tubes 5 are located at some distance from the brickwork proper which they shield almost completely against the hot flames and gases. At their lower end 16 the generator tubes are drawn in towards the center of the shaft and form in this way a kind of grate, as particularly clearly shown in Fig. 2, through the spaces of which drop the ashes.

The air of combustion flows through the hollow space 9 between the thin outer shell 10 and the preheater chamber proper 11 in the direction of the arrows shown. From space 9 the air passes into heat exchanging chamber 11 in the direction of the curved arrows. In Fig. 2 it will be seen that zigzag-shaped sheet-iron walls 14 are located in the heater chamber 11. One side of these sheets is swept by the combustion gases, indicated by dotted arrows, and on the other by the combustion air to be heated, indicated by full line arrows. The gas and the air flow in opposite directions. Very large heat exchange surfaces may in this way be housed in comparatively small chambers.

In the cross-section of the steam generator the spaces traversed by air are indicated by dashes and the waste gas flues by dots. In flowing through the passage 9 the air first carries along the heat penetrating the wall 16 while in the heat exchanger 11 it absorbs heat from the iron partitions 14 as well as from the brickwork 17. The iron partitions need not be tightly sealed against the walls 16 and 17, which is a substantial advantage of the construction.

From the top of the preheater 11 the air flows across the top of the heating chamber 8 (through ducts not shown in detail) into the hollow bricks 1 in the direction of the arrows in Figures 1 and 2, whence part of it flows through radial openings (see 41 in Fig. 3) in the direction of the arrows shown in Figure 1 radially between the generator tubes. The remainder of the air passes down through the dotted ports 24 into ring channel 22, whence it is supplied through ports 23 and central nozzle 13 into the flame in the combustion chamber. The fuel, for instance gas or powdered coal, may be supplied through pipe 25 to nozzle 13. Combustion air is supplied thus to the flame from all sides, whereby brickwork 1 is simultaneously cooled. The combustion gases flow eventually downward through the tube grid 5, leaving the chamber through openings 27 and, passing through ducts 26, enter the chamber 8 wherein they travel upwards past heating tubes 7. Thence they pass through openings 28 in wall 17 and traverse the preheater chambers 11 in a downward direction, escaping finally through the flue 12 into the stack.

As already pointed out the arch of the shaft is not carried by the shaft itself, but by an iron structure 3 and 4 entirely separate

from the shaft. In conjunction herewith and owing to the whole design of the steam generator proper particularly economical possibilities of construction result, insofar as such a generator may be erected without a boiler house in the open air, and the girder structure for supporting the generator tubes may simultaneously be designed as a roof for the generator. In such a case all apparatus for operating and controlling the generator would be contained for instance within the engine house, not shown here.

Various changes and modifications in the details of my invention may be made within the scope of my claims without departing from the spirit of my invention.

I claim as my invention:—

1. A steam generator having a nozzle furnace, heat absorbing tubes disposed in the furnace, a self-supporting furnace shaft and further heat absorbing elements disposed to absorb heat from the furnace gases after they have left the furnace, said shaft being hollow for conducting the combustion air to the furnace, said heat absorbing tubes being disposed in the furnace to shield the shaft walls against the hot gases, said shaft, said heat absorbing tubes, and said heat absorbing elements being disposed concentrically with each other, and a casing surrounding said heat absorbing elements and a plurality of partitions between said casing and said shaft, vertically supported independently of said shaft and dividing the space between the casing and the shaft into a plurality of chambers in which said absorbing elements are sectionally disposed, said partition walls having radially extending girders serving as a support for said heat absorbing elements.

2. A steam generator having a furnace shaft and an air nozzle concentrically disposed with said shaft, heat absorbing tubes disposed to absorb heat from the combustion gases, said shaft having a hollow wall for conducting combustion air, an air chamber surrounding said nozzle, a plurality of ducts leading from said hollow wall portion to said chamber, and a plurality of radial air supply ducts leading from said chamber to said nozzle.

3. A steam generator in the form of a vertical shaft, having a combustion chamber and having tubes in which the steam is generated, said tubes being disposed in said chamber along its walls, thereby screening said walls from the heat of radiation, said generator also having superheater tubes and a jacket surrounding said chamber, in which said superheater tubes are disposed, and an air preheater surrounding said jacket, the combustion gases passing from the combustion chamber through said jacket and said air preheater in series for effecting a heat exchange between the gases, the superheater tubes and the combustion air, said jacket being radially divided into a plurality of compartments, each containing a removably suspended group of superheater tubes.

4. A steam generator having a nozzle furnace, in combination with a furnace shaft, an outlet near the bottom of said shaft, heat absorbing tubes disposed adjacent to the interior wall of said shaft, said tubes forming loops extending inwardly near the outlet of the shaft and across the path of the gases passing through said outlet, and serving as a screen through which all of the products of combustion must pass on their way to the furnace stack.

In testimony whereof I affix my signature.

HANS GLEICHMANN.